IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Daniel SKAGMO et al.	Group Art Unit: 2694
Application No.: 16/989,292	Examiner: GIESY, ADAM
Filing Date.: 08/10/2020	Confirmation No.: 8380
For: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	**VIA EFS-WEB**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

FEE ADDRESS FOR MAINTENANCE FEE PURPOSES
IN ACCORDANCE WITH 37 C.F.R. 1.363

In accordance with the provisions of 37 C.F.R. 1.363, the fee address set forth below is being supplied for purposes of receiving notices, receipts, and other correspondence relating to the payment of maintenance fees:

CPA Global Limited
3133 West Frye Road, Suite 400,
Chandler, AZ 85226

Payor No.: 0069353

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: May 6, 2022

By: / Arpita Bhattacharyya /
Arpita Bhattacharyya
Reg. No. 63,681
(650) 849-6650

Electronic Acknowledgement Receipt

EFS ID:	45648812
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	22852
Filer:	Aaron James Capron/Maria Poulakos
Filer Authorized By:	Aaron James Capron
Attorney Docket Number:	14700.0005-00000
Receipt Date:	06-MAY-2022
Filing Date:	10-AUG-2020
Time Stamp:	09:49:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Maintenance Fee Address Change	14700_0005_Maintenance_Fee_Address_Change_Form_As_Filed.pdf	13593 d1378b1f6606cb5319a4efda2523006594559c42	no	1

Warnings:

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 2

Information:	
Total Files Size (in bytes):	13593

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,292	03/22/2022	11281338	14700.0005-00000	8380

22852 7590 03/02/2022

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER
LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

INVENTOR(s) (Please see PAIR WEB site http://pair.uspto.gov for additional inventors):

Daniel Skagmo, Malmo, SWEDEN;
Robert Ehn, Lund, SWEDEN;
Hakan Bergstrom, Torna-Hallestad, SWEDEN;

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

FlatFrog Laboratories AB, Lund, SWEDEN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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Chemtronics Exhibit 1002 Page 4

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 21 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	581	2017/0177163	06-22-2017	Wallander et al.	
	582	2017/0185230	06-29-2017	Wallander et al.	
	583	2017/0293392	10-12-2017	Christiansson et al.	
	584	2017/0344185	11-30-2017	Ohlsson et al.	
	585	2018/0031753	02-01-2018	Craven-Bartle et al.	
	586	2018/0129354	05-10-2018	Christiansson et al.	
	587	2018/0210572	07-26-2018	Wallander et al.	
	588	2018/0225006	08-09-2018	Wall	
	589	2018/0267672	09-20-2018	Wassvik et al.	
	590	2018/0275788	09-27-2018	Christiansson et al.	
	591	2018/0275830	09-27-2018	Christiansson et al.	
	592	2018/0275831	09-27-2018	Christiansson et al.	
	593	2019/0235701	08-01-2019	Han et al.	
	594	6,031,524	02-29-2000	Kunert	
	595	9,001,086	04-07-2015	Saini, Amrinder Pal Singh	
	596	9,063,614	06-23-2015	Petterson et al.	
Change(s) applied to document, /M.H.E./ 12/28/2021	**597**	9,201,520	~~10-08-2013~~ 12/2015	Benko et al.	
	598	9,280,237	03-08-2016	Kukulj	
	599	10,282,035	05-07-2019	Kocovksi et al.	
	600	10,649,585	05-12-2020	van Beek et al.	
	601	2008/0080811	04-03-2008	Deane, Peter	
	602	2009/0000831	01-01-2009	Miller et al.	
	603	2010/0073327	03-25-2010	Mau et al.	
	604	2010/0103133	04-29-2010	Park et al.	
	605	2011/0084939	04-14-2011	Gepner et al.	
	606	2011/0141062	06-16-2011	Yu et al.	
	607	2011/0205189	08-25-2011	Newton, John David	
	608	2012/0056807	03-08-2012	Chapman et al.	
	609	2012/0062492	03-15-2012	Katoh	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 19 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	523	2014/0375607	12-25-2014	Christiansson et al.	
	524	2015/0002386	01-01-2015	Mankowski et al.	
	525	2015/0009687	01-08-2015	Lin	
	526	2015/0015497	01-15-2015	Leigh	
	527	2015/0035774	02-05-2015	Christiansson et al.	
	528	2015/0035803	02-05-2015	Wassvik et al.	
	529	2015/0053850	02-26-2015	Uvnäs	
	530	2015/0054759	02-26-2015	Christiansson et al.	
	531	2015/0083891	03-26-2015	Wallander	
	532	2015/0103013	04-16-2015	Huang	
	533	2015/0130769	05-14-2015	Björklund	
	534	2015/0138105	05-21-2015	Christiansson et al.	
	535	2015/0138158	05-21-2015	Wallander et al.	
	536	2015/0138161	05-21-2015	Wassvik	
	537	2015/0205441	07-23-2015	Bergström et al.	
	538	2015/0215450	07-30-2015	Seo et al.	
	539	2015/0242055	08-27-2015	Wallander	
	540	2015/0271481	09-24-2015	Guthrie et al.	
	541	2015/0286698	10-08-2015	Gagnier et al.	
	542	2015/0317036	11-05-2015	Johansson et al.	
	543	2015/0324028	11-12-2015	Wassvik et al.	
	544	2015/0331544	11-19-2015	Bergström et al.	
	545	2015/0331545	11-19-2015	Wassvik et al.	
	546	2015/0331546	11-19-2015	Craven-Bartle et al.	
	547	2015/0331547	11-19-2015	Wassvik et al.	
	548	2015/0332655	11-19-2015	Krus et al.	
	549	2015/0339000	~~11-26-2014~~	Lee et al. 11/2015	
	550	2015/0346856	12-03-2015	Wassvik	
	551	2015/0346911	12-03-2015	Christiansson	

Change(s) applied to document,
/M.H.E./
12/28/2021

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

22852 7590 12/16/2021

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,392	08/10/2020	Daniel Skagmo	14780.0005-00000	8380

TITLE OF INVENTION: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/16/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
OBEY, ADAM	2693	345-175000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☒ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Finnegan, Henderson,
2 Farabow, Garrett &
Dunner, LLP
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: FlatFrog Laboratories AB

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Lund, Sweden

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 06-0916

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature: /Arpita Bhattacharyya/ Date: 02/11/2022

Typed or printed name: Arpita Bhattacharyya Registration No. 63,681

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	
	)	
Daniel SKAGMO et al.	)	Group Art Unit: 2694
	)	
Application No. 16/989,292	)	Examiner: Adam R. GIESY
	)	
Filed: August 10, 2020	)	Confirmation No. 8380
	)	
For: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	)	VIA EFS-WEB
	)	

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Applicant thanks the Examiner for the Notice of Allowance dated December 16, 2021. Without withdrawing the allowed claims from issue, Applicant submits these comments for the record.

In the Examiner's Statement of Reasons for Allowance, included with the Notice of Allowance, the Examiner made characterizations and assertions regarding the basis for the allowability of the claims and the prior art of record. Although Applicant agrees with the Examiner's ultimate conclusion that the pending claims are patentable, Applicant does not necessarily agree with the characterizations and assertions made in the Examiner's Statement.

Applicant submits that each of the allowed claims is patentable based on the subject matter defined by the claim language and the combination of recitations within the claims, and not based solely on the reasons emphasized in any statement by the Examiner.

Should the Examiner disagree with the Applicant's comments submitted herewith, the Examiner is invited to contact the undersigned to resolve such disagreement.

Please charge any fee due in connection with the filing of these Comments, to Deposit Account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: February 11, 2022

By: /Arpita Bhattacharyya/
Arpita Bhattacharyya
Reg. No. 63,681
(650) 849-6650

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 9

Electronic Patent Application Fee Transmittal

Application Number:	16989292
Filing Date:	10-Aug-2020
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Filer:	Aaron James Capron/Maria Poulakos
Attorney Docket Number:	14700.0005-00000

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt

EFS ID:	44979703
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	22852
Filer:	Aaron James Capron/Maria Poulakos
Filer Authorized By:	Aaron James Capron
Attorney Docket Number:	14700.0005-00000
Receipt Date:	11-FEB-2022
Filing Date:	10-AUG-2020
Time Stamp:	16:34:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E20222AG34481235
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_Fee_Transmittal_14700_0005_00000_signed.pdf	104359 63cbda152912438cf6d4297ef94e2d97dac0e5c4	no	1
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	14700_0005_00000_Comments_on_Statement_of_Reasons_for_Allowance_signed.pdf	20295 46738dddd06f6300897a838140d4952fad4cb834	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	37977 0263179f273360234898b5cfb118a448e232a2a9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	162631		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

22852 7590 12/16/2021

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

EXAMINER
GIESY, ADAM

ART UNIT	PAPER NUMBER
2694	

DATE MAILED: 12/16/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,292	08/10/2020	Daniel Skagmo	14700.0005-00000	8380

TITLE OF INVENTION: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/16/2022

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 14

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

22852 7590 12/16/2021

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,292	08/10/2020	Daniel Skagmo	14700.0005-00000	8380

TITLE OF INVENTION: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/16/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
GIESY, ADAM	2694	345-175000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 15

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,292	08/10/2020	Daniel Skagmo	14700.0005-00000	8380

22852 7590 12/16/2021

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

EXAMINER	
GIESY, ADAM	

ART UNIT	PAPER NUMBER
2694	

DATE MAILED: 12/16/2021

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Chemtronics v. FlatFrog
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OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Notice of Allowability	Application No. 16/989,292	Applicant(s) Skagmo et al.	
	Examiner ADAM R GIESY	Art Unit 2694	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 9/27/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 6,8,11-15,17 and 23-29 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some* c) ☐ None of the:

   1. ☑ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☑ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ADAM R. GIESY/
Primary Examiner, Art Unit 2694

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

EXAMINER'S AMENDMENT

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Arpita Bhattacharyya on 11/16/2021.

The application has been amended as follows:

In the claims

Claims 7, 9, 10, 16, and 18-22 are herein **cancelled** in their entirety.

Claims 6, 8, 11-15 and 17 have been **replaced** with the following claims.

Claims 23-29 have been **added** as follows.

6. A touch sensing apparatus comprising:

a panel comprising a top surface that includes a touch surface, a back surface, and an edge surface;

a plurality of light emitters arranged along a periphery of the panel;

a substrate configured to support at least one of the plurality of light emitters such that the at least one of the plurality of light emitters transmits a portion of light in a plane extending over the touch surface;

a support structure configured to support the substrate, the support structure comprising:

a first portion extending substantially parallel to the edge surface, wherein the substrate is configured to be supported by the first portion;

a second portion extending over an edge portion of the top surface of the panel; and

a sealing element configured to rest on the edge portion of the top surface and further configured to be fitted between the edge portion of the top surface and the second portion of the support structure.

8. (Currently Amended) The touch sensing apparatus according to claim 6, wherein the substrate is affixed to the first portion of the support structure.

11. The touch sensing apparatus according to claim 6, wherein the support structure is configured to be attached to a display support, and wherein the display support is configured to support a display.

12. The touch sensing apparatus according to claim 11, wherein the support structure further comprises a recess configured to interlock with a corresponding mating feature of the display support.

13. The touch sensing apparatus according to claim 6, wherein the support structure is formed from an extrusion process, a drawing process, a rolling process, or a molding process.

14. The touch sensing apparatus according to claim 6, wherein the sealing element comprises a first surface facing the at least one of the plurality of light emitters and being configured to receive the transmitted light from that emitter and a second surface configured to receive light propagating in the plane extending over the touch surface.

15. The touch sensing apparatus according to claim 14, wherein the first surface is tilted relative to the at least one of the plurality of light emitters.

17. The touch sensing apparatus according to claim 14, wherein the sealing element comprises a protrusion or a recess to interlock with a corresponding mating feature on the second portion of the support structure.

23. The touch sensing apparatus according to claim 6, wherein the support structure is formed from a single monolithic piece of a material.

24. The touch sensing apparatus according to claim 6, wherein the sealing element is formed from a single monolithic piece of a material.

25. The touch sensing apparatus according to claim 6, wherein the sealing element comprises an optically active element or an optically passive element.

26. The touch sensing apparatus according to claim 6, wherein the sealing element is configured to inhibit ingress of a contaminant toward the at least one of the plurality of light emitters.

27. The touch sensing apparatus according to claim 6, wherein the sealing element comprises one or more optical elements that refract, deflect, divert or focus light beams.

28. The touch sensing apparatus according to claim 6, further comprising a plurality of light detectors arranged along the periphery of the panel.

29. The touch sensing apparatus according to claim 6, wherein the substrate is directly joined to the first portion of the support structure.

Allowable Subject Matter

3. The following is an examiner's statement of reasons for allowance:

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Claims 6, 8, 11-15, 17, and 23-29 are allowed over the prior art of record.

Independent claim 6 is allowed since the claim recites a touch sensing apparatus comprising: a panel comprising a top surface that includes a touch surface, a back surface, and an edge surface; a plurality of light emitters arranged along a periphery of the panel; a substrate configured to support at least one of the plurality of light emitters such that the at least one of the plurality of light emitters transmits a portion of light in a plane extending over the touch surface; a support structure configured to support the substrate, the support structure comprising: a first portion extending substantially parallel to the edge surface, wherein the substrate is configured to be supported by the first

portion; a second portion extending over an edge portion of the top surface of the panel; and a sealing element configured to rest on the edge portion of the top surface and further configured to be fitted between the edge portion of the top surface and the second portion of the support structure.

Claims 8, 11-15, 17, and 23-29 are allowed as being dependent upon aforementioned independent claim 6.

The closest prior art by Weishan (WO2014131221) discloses a touch sensing apparatus comprising a display and a plurality of emitters wherein the emitters transmit light in a plane extending over the touch surface. Weishan does not disclose a touch sensing apparatus comprising: a panel comprising a top surface that includes a touch surface, a back surface, and an edge surface; a plurality of light emitters arranged along a periphery of the panel; a substrate configured to support at least one of the plurality of light emitters such that the at least one of the plurality of light emitters transmits a portion of light in a plane extending over the touch surface; a support structure configured to support the substrate, the support structure comprising: a first portion extending substantially parallel to the edge surface, wherein the substrate is configured to be supported by the first portion; *a second portion extending over an edge portion of the top surface of the panel; and a sealing element configured to rest on the edge portion of the top surface and further configured to be fitted between the edge portion of the top surface and the second portion of the support structure*.

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ADAM R GIESY whose telephone number is (571)272-7555. The examiner can normally be reached Mon-Fri 8-6.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Edouard can be reached on 5712727603. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ADAM R. GIESY/
Primary Examiner, Art Unit 2694

Examiner-Initiated Interview Summary	**Application No.** 16/989,292	**Applicant(s)** Skagmo et al.		
	Examiner ADAM R GIESY	**Art Unit** 2694	**AIA (First Inventor to File) Status** Yes	**Page** 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	**Title**	**Type**
ADAM R GIESY	Primary Examiner	Telephonic
Arpita Bhattcharyya	Attorney of Record	
Unnat Bhansali	Agent	

Date of Interview: 16 November 2021

Issues Discussed:

Other

Examiner suggested amending around newly found prior art - Weishan (WO2014131221). Applicant submitted proposed claim amendments (attached). Examiner agrees that the proposed claim amendments overcome the newly found prior art. Examiner agreed to enter the proposed claim amendments via Examiner's Amendment.

☑ Attachment

/ADAM R. GIESY/ Primary Examiner, Art Unit 2694	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 25

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/989,292	Skagmo et al.
	Examiner	Art Unit
	ADAM R GIESY	2694

CPC - Searched*		
Symbol	Date	Examiner
(G06F3/0428 or G06F3/0421 or G06F3/0412 or G06F2203/04103 or G06F2203/04107 or G06F2203/04108) + text	09/29/2021	ARG

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Updated EAST search	09/29/2021	ARG
EAST search included	11/20/2021	ARG

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Interference search performed (see attached search history)	11/20/2021	ARG

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/989,292	Skagmo et al.
	Examiner	Art Unit
	ADAM R GIESY	2694

CPC							
Symbol						Type	Version
G06F	/	3	/	0428		F	2013-01-01
G06F	/	3	/	0421		I	2013-01-01
G06F	/	3	/	0412		A	2013-01-01
G06F	/	2203	/	04103		A	2013-01-01
G06F	/	2203	/	04107		A	2013-01-01
G06F	/	2203	/	04108		A	2013-01-01

CPC Combination Sets								
Symbol						Type	Set	Ranking	Version
	/		/						

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/ADAM R. GIESY/ Primary Examiner, Art Unit 2694	20 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/989,292	Skagmo et al.
	Examiner	**Art Unit**
	ADAM R GIESY	2694

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G06F	/	3	/	042

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
345	175

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/ADAM R. GIESY/ Primary Examiner, Art Unit 2694	20 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office

Part of Paper No.: 20211120

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/989,292	Skagmo et al.
	Examiner	**Art Unit**
	ADAM R GIESY	2694

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
-	1	-	10	-	19	14	28								
-	2	3	11	-	20	15	29								
-	3	4	12	-	21										
-	4	5	13	-	22										
-	5	6	14	9	23										
1	6	7	15	10	24										
-	7	-	16	11	25										
2	8	8	17	12	26										
-	9	-	18	13	27										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	15	
/ADAM R. GIESY/ Primary Examiner, Art Unit 2694	20 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office

Part of Paper No.: 20211120

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Chemtronics Exhibit 1002 Page 29

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	0	16/191251	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/25 01:24 PM
L2	28284	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 08:33 AM
L3	209	(("3440426") or ("3553680") or ("3673327") or ("4129384") or ("4180702") or ("4209255") or ("4213707") or ("4254333") or ("4254407") or ("4294543") or ("4346376") or ("4420261") or ("4484179") or ("4507557") or ("4521112") or ("4542375") or ("4550250") or ("4593191") or ("4673918") or ("4688933") or ("4688993") or ("4692809") or ("4710760") or ("4736191") or ("4737626") or ("4746770") or ("4752655") or ("4772763") or ("4782328") or ("4812833") or ("4837430") or ("4868912") or ("4891829") or ("4916712") or ("4933544") or ("4949079") or ("4986662") or ("4988983") or ("5065185") or ("5073770") or ("5105186") or ("5159322") or ("5166668") or ("5227622") or ("5248856") or	(US-PGPUB; USPAT)	OR	ON	ON	2019/04/29 08:34 AM

		("5254407") or ("5345490") or ("5383022") or ("5483261") or ("5484966") or ("5499098") or ("5502568") or ("5525764") or ("5526422") or ("5539514") or ("5570181") or ("5572251") or ("5577501") or ("5600105") or ("5608550") or ("5672852") or ("5679930") or ("5686942") or ("5688933") or ("5729249") or ("5736686") or ("5740224") or ("5764223") or ("5767517") or ("5775792") or ("5945980") or ("5945981") or ("5959617") or ("6061177") or ("6067079") or ("6122394") or ("6141104") or ("6172667") or ("6175999") or ("6227667") or ("6229529") or ("6333735") or ("6366276") or ("6380732") or ("6380740") or ("6390370") or ("6429857") or ("6452996") or ("6476797") or ("6492633") or ("6495832") or ("6504143") or ("6529327") or ("6538644") or ("6587099") or ("6648485") or ("6660964") or ("6664498") or ("6664952") or ("6690363") or ("6707027") or ("6738051") or ("6748098") or					

		("6784948") or ("6799141") or ("6806871") or ("6927384") or ("6940286") or ("6965836") or ("6972753") or ("6985137") or ("7042444") or ("7084859") or ("7087907") or ("7133031") or ("7176904") or ("7199932") or ("7359041") or ("7397418") or ("7432893") or ("7435940") or ("7436443") or ("7442914") or ("7465914") or ("7613375") or ("7629968") or ("7646833") or ("7653883") or ("7655901") or ("7705835") or ("7729056") or ("7847789") or ("7855716") or ("7859519") or ("7924272") or ("7932899") or ("7969410") or ("7995039") or ("8013845") or ("8031186") or ("8077147") or ("8093545") or ("8094136") or ("8094910") or ("8149211") or ("8218154") or ("8274495") or ("8325158") or ("8339379") or ("8350827")).PN. or (("8384010") or ("8407606") or ("8441467") or ("8445834") or ("8466901") or ("8482547") or ("8542217") or ("8567257") or ("8581884") or ("8624858") or ("8686974") or					

		("8692807") or ("8716614") or ("8727581") or ("8745514") or ("8780066") or ("8830181") or ("8860696") or ("8872098") or ("8872801") or ("8884900") or ("8890843") or ("8890849") or ("8928590") or ("8963886") or ("8982084") or ("9024916") or ("9035909") or ("9063617") or ("9086763") or ("9134854") or ("9158401") or ("9158415") or ("9213445") or ("9274645") or ("9317168") or ("9323396") or ("9366565") or ("9377884") or ("9389732") or ("9411444") or ("9411464") or ("9430079") or ("9442574") or ("9547393") or ("9552103") or ("9557846") or ("9588619") or ("9594467") or ("9618682") or ("9626018") or ("9626040") or ("9639210") or ("9678602") or ("9684414") or ("9710101") or ("9874978") or ("10013107") or ("10019113")).PN.					
L4	372	(("20010002694") or ("20010005004") or ("20010005308") or ("20010030642") or ("20020067348") or ("20020075243") or ("20020118177") or ("20020158823") or ("20020158853") or ("20020163505") or	(US-PGPUB; USPAT)	OR	ON	ON	2019/04/29 08:34 AM

		("20030016450") or ("20030034439") or ("20030034935") or ("20030048257") or ("20030052257") or ("20030095399") or ("20030107748") or ("20030137494") or ("20030156100") or ("20030160155") or ("20030210537") or ("20030214486") or ("20040027339") or ("20040032401") or ("20040090432") or ("20040130338") or ("20040174541") or ("20040201579") or ("20040212603") or ("20040238627") or ("20040239702") or ("20040245438") or ("20040252091") or ("20040252867") or ("20050012714") or ("20050041013") or ("20050057903") or ("20050073508") or ("20050083293") or ("20050128190") or ("20050143923") or ("20050156914") or ("20050162398") or ("20050179977") or ("20050200613") or ("20050212774") or ("20050248540") or ("20050253834") or ("20050276053") or ("20060001650") or ("20060001653") or ("20060007185") or ("20060008164") or ("20060017706") or ("20060017709") or ("20060033725") or ("20060038698") or ("20060061861") or ("20060114237") or ("20060132454") or ("20060139340") or ("20060158437") or ("20060170658") or ("20060202974") or ("20060227120") or ("20060255248") or ("20060256092") or ("20060279558") or					

		("20060281543") or ("20060290684") or ("20070014486") or ("20070024598") or ("20070034783") or ("20070038691") or ("20070052684") or ("20070070056") or ("20070075648") or ("20070120833") or ("20070125937") or ("20070152985") or ("20070201042") or ("20070296688") or ("20080006766") or ("20080007540") or ("20080007541") or ("20080007542") or ("20080011944") or ("20080029691") or ("20080036743") or ("20080062150") or ("20080068691") or ("20080074401") or ("20080088603") or ("20080121442") or ("20080122792") or ("20080122803") or ("20080130979") or ("20080150846") or ("20080150848") or ("20080151126") or ("20080158176") or ("20080189046") or ("20080192025") or ("20080238433") or ("20080246388") or ("20080252619") or ("20080266266") or ("20080278460") or ("20080284925") or ("20080291668") or ("20080297482") or ("20080133265") or ("20090002340") or ("20090006292") or ("20090040786") or ("20090066647") or ("20090067178") or ("20090073142")).PN. or (("20090077501") or ("20090085894") or ("20090091554") or ("20090115919") or ("20090122020") or ("20090122027") or ("20090128508") or ("20090135162") or					

		("20090143141") or ("20090153519") or ("20090161026") or ("20090168459") or ("20090187842") or ("20090189857") or ("20090189874") or ("20090189878") or ("20090219256") or ("20090229892") or ("20090251439") or ("20090256817") or ("20090259967") or ("20090267919") or ("20090273794") or ("20090278816") or ("20090297009") or ("20100033444") or ("20100045629") or ("20100060896") or ("20100066016") or ("20100066704") or ("20100073318") or ("20100078545") or ("20100079407") or ("20100079408") or ("20100097345") or ("20100097348") or ("20100097353") or ("20100125438") or ("20100127975") or ("20100134435") or ("20100142823") or ("20100187422") or ("20100193259") or ("20100229091") or ("20100238139") or ("20100245292") or ("20100265170") or ("20100277436") or ("20100283785") or ("20100284596") or ("20100289754") or ("20100295821") or ("20100302196") or ("20100302209") or ("20100302210") or ("20100302240") or ("20100315379") or ("20100321328") or ("20100322550") or ("20110043490") or ("20110049388") or ("20110050649") or ("20110051394") or ("20110068256") or ("20110069039") or ("20110069807") or					

		("20110074725") or ("20110074734") or ("20110074735") or ("20110090176") or ("20110102374") or ("20110115748") or ("20110121323") or ("20110122075") or ("20110122091") or ("20110122094") or ("20110134079") or ("20110147569") or ("20110157095") or ("20110157096") or ("20110163996") or ("20110163997") or ("20110163998") or ("20110169780") or ("20110175852") or ("20110205186") or ("20110216042") or ("20110221705") or ("20110221997") or ("20110227036") or ("20110227874") or ("20110234537") or ("20110254864") or ("20110261020") or ("20110267296") or ("20110291989") or ("20110298743") or ("20110309325") or ("20110310045") or ("20120019448") or ("20120026408") or ("20120038593") or ("20120062474") or ("20120068973") or ("20120086673") or ("20120089348") or ("20120110447") or ("20120131490") or ("20120141001") or ("20120146930") or ("20120153134") or ("20120154338") or ("20120162142") or ("20120162144") or ("20120169672") or ("20120181419") or ("20120182266") or ("20120188206")).PN. or (("20120191993") or ("20120200532") or ("20120200538") or ("20120212441") or ("20120217882") or ("20120249478") or					

		("20120256882") or ("20120268403") or ("20120268427") or ("20120274559") or ("20120305755") or ("20130021300") or ("20130021302") or ("20130027404") or ("20130044073") or ("20130055080") or ("20130076697") or ("20130082980") or ("20130107569") or ("20130113715") or ("20130120320") or ("20130125016") or ("20130127790") or ("20130135258") or ("20130135259") or ("20130141388") or ("20130154983") or ("20130155027") or ("20130158504") or ("20130181896") or ("20130187891") or ("20130201142") or ("20130222346") or ("20130241887") or ("20130249833") or ("20130269867") or ("20130275082") or ("20130285920") or ("20130285968") or ("20130300716") or ("20130307795") or ("20130342490") or ("20140002400") or ("20140028575") or ("20140028604") or ("20140028629") or ("20140036203") or ("20140055421") or ("20140063853") or ("20140071653") or ("20140085241") or ("20140092052") or ("20140098032") or ("20140098058") or ("20140109219") or ("20140125633") or ("20140139467") or ("20140160762") or ("20140192023") or ("20140232669") or ("20140237401") or ("20140237408") or ("20140237422") or ("20140253831") or					

		("20140267124") or ("20140292701") or ("20140300572") or ("20140320460") or ("20140347325") or ("20140362046") or ("20140368471") or ("20140375607") or ("20150002386") or ("20150009687") or ("20150015497") or ("20150035774") or ("20150035803") or ("20150053850") or ("20150054759") or ("20150083891") or ("20150103013") or ("20150130769") or ("20150138105") or ("20150138158") or ("20150138161") or ("20150205441") or ("20150215450") or ("20150242055") or ("20150271481") or ("20150286698") or ("20150317036") or ("20150324028") or ("20150331544") or ("20150331545") or ("20150331546") or ("20150331547") or ("20150332655") or ("20150346856") or ("20150346911") or ("20150363042") or ("20160026337") or ("20160034099") or ("20160050746") or ("20160070415") or ("20160070416") or ("20160124546") or ("20160124551") or ("20160154531") or ("20160154532") or ("20160202841") or ("20160216844") or ("20160224144") or ("20160299593") or ("20160328090") or ("20160328091") or ("20160334942") or ("20160342282") or ("20160357348")).PN. or (("20170010688") or ("20170090090") or ("20170102827") or ("20170115235") or					

		("20170115823") or ("20170139541") or ("20170177163") or ("20170185230") or ("20170293392") or ("20170344185") or ("20180031753") or ("20180129354") or ("20180210572") or ("20180225006") or ("20180267672") or ("20180275788") or ("20180275830") or ("20180275831")).PN.					
L5	4272	(G06F3/0421).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 09:35 AM
L6	260	L5 and (collimat$3 near2 beam)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 09:35 AM
L7	65	L5 and ((collimat$3 near2 beam) same parallel same surface)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 09:48 AM
L8	55	L5 and ((collimat$3 near2 beam) same (across parallel) with surface) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 10:51 AM
L9	55	L5 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 10:51 AM
L10	42	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2019/04/29 11:11 AM
L11	56	L2 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 11:13 AM
L12	1	L11 not L9	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/04/29 11:21 AM
L13	4289	(G06F3/0421).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 09:41 AM
L14	49	L13 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and ((emitter light) near3 above near3 (surface	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 09:41 AM

		plane))					
L15	2973	"5" and ((emitter LED diode) near3 above near3 (surface plane))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:05 AM
L16	50	L13 and ((emitter LED diode) near3 above near3 (surface plane))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:05 AM
L17	5480	(G06F3/0421 or G06F3/0428).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:15 AM
L18	52	L17 and ((emitter LED diode) near3 above near3 (surface plane))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:15 AM
L19	169	L17 and ((emitter LED diode) with (above near3 (surface plane)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:25 AM
L20	121	L19 not L18	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:26 AM
L21	190	L17 and ((emitter LED diode) with (above near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:54 AM
L22	29597	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412 or G06F3/0428).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:55 AM
L23	21	L21 not L19	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:55 AM
L24	266	L22 and ((emitter LED diode) with (above near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:59 AM
L25	76	L24 not L21	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 10:59 AM
L26	29531	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412 or G06F3/0428).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 12:38 PM
L27	274	L26 and ((emitter LED diode) with ((atop (on near2 top) above) near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 12:38 PM
L28	266	L26 and ((emitter LED diode) with (above near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 12:39 PM
L29	8	L27 not L28	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 12:39 PM
L31	146	(optical near2 (touchscreen	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 02:16 PM

		touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))					
L32	153	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:04 PM
L33	7	L32 not L31	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:18 PM
L34	1879	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:23 PM
L35	5476	(G06F3/0421 or G06F3/0428).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:23 PM
L36	1313	L35 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:23 PM
L37	1440	L34 not L36	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:24 PM
L38	346	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad))))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:27 PM

		and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))					
L39	375	L35 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:27 PM
L40	180	L39 not L38	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/05/16 04:28 PM
L41	2	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and ((light beam) adj5 (over across atop) adj3 (surface plane cover panel))).clm.	(US-PGPUB)	OR	ON	ON	2019/05/27 06:31 PM
L42	1	16/191177	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:47 AM
L43	3	(("9207800") or ("20150339000") or ("20160306501")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/12/23 05:52 AM
L44	154	(US-20010002694-$ | US-20010005004-$ | US-20010005308-$ | US-20010030642-$ | US-20020067348-$ | US-20020075243-$ | US-20020118177-$ | US-20020158823-$ | US-20020158853-$ | US-20020163505-$ | US-20030016450-$ | US-20030034439-$ | US-20030034935-$ | US-20030048257-$ | US-20030052257-$ | US-20030095399-$ | US-20030107748-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:58 AM

		US-20030137494-$ | US-20030156100-$ | US-20030160155-$ | US-20030210537-$ | US-20030214486-$ | US-20040027339-$ | US-20040032401-$ | US-20040090432-$ | US-20040130338-$ | US-20040174541-$ | US-20040201579-$ | US-20040212603-$ | US-20040238627-$ | US-20040239702-$ | US-20040245438-$ | US-20040252091-$ | US-20040252867-$ | US-20050012714-$ | US-20050041013-$ | US-20050057903-$ | US-20050073508-$ | US-20050083293-$ | US-20050128190-$ | US-20050143923-$ | US-20050156914-$ | US-20050162398-$ | US-20050179977-$ | US-20050200613-$ | US-20050212774-$ | US-20050248540-$ | US-20050253834-$ | US-20050276053-$ | US-20060001650-$ | US-20060001653-$ | US-20060007185-$ | US-20060008164-$ | US-20060017706-$ | US-20060017709-$ | US-20060033725-$ | US-20060038698-$ | US-20060061861-$ | US-20060114237-$ | US-20060132454-$ | US-20060139340-$ | US-20060158437-$ | US-20060170658-$ | US-20060202974-$ | US-20060227120-$ | US-20060255248-$ | US-20060256092-$ | US-20060279558-$ | US-20060281543-$ | US-20060290684-$ | US-20070014486-$ | US-20070024598-$ | US-20070034783-$ | US-20070038691-$ | US-20070052684-$ |				

		US-20070070056-$ | US-20070075648-$ | US-20070120833-$ | US-20070125937-$ | US-20070152985-$ | US-20070201042-$ | US-20070296688-$ | US-20080006766-$ | US-20080007540-$ | US-20080007541-$ | US-20080007542-$ | US-20080011944-$ | US-20080029691-$ | US-20080036743-$ | US-20080062150-$ | US-20080068691-$ | US-20080074401-$ | US-20080088603-$ | US-20080121442-$ | US-20080122792-$ | US-20080122803-$ | US-20080130979-$ | US-20080133265-$ | US-20080150846-$ | US-20080150848-$ | US-20080151126-$ | US-20080158176-$ | US-20080189046-$ | US-20080192025-$ | US-20080238433-$ | US-20080246388-$ | US-20080252619-$ | US-20080266266-$ | US-20080278460-$ | US-20080284925-$ | US-20080291668-$ | US-20080297482-$ | US-20090002340-$ | US-20090006292-$ | US-20090040786-$ | US-20090066647-$ | US-20090067178-$ | US-20090073142-$ | US-20090077501-$ | US-20090085894-$ | US-20090091554-$ | US-20090115919-$ | US-20090122020-$ | US-20090122027-$ | US-20090128508-$ | US-20090135162-$ | US-20090143141-$ | US-20090153519-$ | US-20090161026-$ | US-20090168459-$ | US-20090187842-$ | US-20090189857-$ | US-20090189874-$ |					

		US-20090189878-$ | US-20090219256-$ | US-20090229892-$ | US-20090251439-$ | US-20090256817-$ | US-20090259967-$ | US-20090267919-$ | US-20090273794-$ | US-20090278816-$ | US-20090297009-$ | US-20100033444-$ | US-20100045629-$ | US-20100060896-$ | US-20100066016-$ | US-20100066704-$ | US-20100073318-$ | US-20100078545-$ | US-20100079407-$ | US-20100079408-$ | US-20100097345-$ | US-20100097348-$).DID.					
L45	154	(US-20100097353-$ | US-20100125438-$ | US-20100127975-$ | US-20100134435-$ | US-20100142823-$ | US-20100187422-$ | US-20100193259-$ | US-20100229091-$ | US-20100238139-$ | US-20100245292-$ | US-20100265170-$ | US-20100277436-$ | US-20100283785-$ | US-20100284596-$ | US-20100289754-$ | US-20100295821-$ | US-20100302196-$ | US-20100302209-$ | US-20100302210-$ | US-20100302240-$ | US-20100315379-$ | US-20100321328-$ | US-20100322550-$ | US-20110043490-$ | US-20110049388-$ | US-20110050649-$ | US-20110051394-$ | US-20110068256-$ | US-20110069039-$ | US-20110069807-$ | US-20110074725-$ | US-20110074734-$ | US-20110074735-$ | US-20110090176-$ | US-20110102374-$ | US-20110115748-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:58 AM

		US-20110121323-$ | US-20110122075-$ | US-20110122091-$ | US-20110122094-$ | US-20110134079-$ | US-20110147569-$ | US-20110157095-$ | US-20110157096-$ | US-20110163996-$ | US-20110163997-$ | US-20110163998-$ | US-20110169780-$ | US-20110175852-$ | US-20110205186-$ | US-20110216042-$ | US-20110221705-$ | US-20110221997-$ | US-20110227036-$ | US-20110227874-$ | US-20110234537-$ | US-20110254864-$ | US-20110261020-$ | US-20110267296-$ | US-20110291989-$ | US-20110298743-$ | US-20110309325-$ | US-20110310045-$ | US-20120019448-$ | US-20120026408-$ | US-20120038593-$ | US-20120062474-$ | US-20120068973-$ | US-20120086673-$ | US-20120089348-$ | US-20120110447-$ | US-20120131490-$ | US-20120141001-$ | US-20120146930-$ | US-20120153134-$ | US-20120154338-$ | US-20120162142-$ | US-20120162144-$ | US-20120169672-$ | US-20120181419-$ | US-20120182266-$ | US-20120188206-$ | US-20120191993-$ | US-20120200532-$ | US-20120200538-$ | US-20120212441-$ | US-20120217882-$ | US-20120249478-$ | US-20120256882-$ | US-20120268403-$ | US-20120268427-$ | US-20120274559-$ | US-20120305755-$ | US-20130021300-$ |					

		US-20130021302-$ | US-20130027404-$ | US-20130044073-$ | US-20130055080-$ | US-20130076697-$ | US-20130082980-$ | US-20130107569-$ | US-20130113715-$ | US-20130120320-$ | US-20130125016-$ | US-20130127790-$ | US-20130135258-$ | US-20130135259-$ | US-20130141388-$ | US-20130154983-$ | US-20130155027-$ | US-20130158504-$ | US-20130181896-$ | US-20130187891-$ | US-20130201142-$ | US-20130222346-$ | US-20130241887-$ | US-20130249833-$ | US-20130269867-$ | US-20130275082-$ | US-20130285920-$ | US-20130285968-$ | US-20130300716-$ | US-20130307795-$ | US-20130342490-$ | US-20140002400-$ | US-20140028575-$ | US-20140028604-$ | US-20140028629-$ | US-20140036203-$ | US-20140055421-$ | US-20140063853-$ | US-20140071653-$ | US-20140085241-$ | US-20140092052-$ | US-20140098032-$ | US-20140098058-$ | US-20140109219-$ | US-20140125633-$ | US-20140139467-$ | US-20140160762-$ | US-20140192023-$ | US-20140232669-$ | US-20140237401-$ | US-20140237408-$ | US-20140237422-$ | US-20140253831-$ | US-20140267124-$ | US-20140292701-$ | US-20140300572-$ | US-20140320460-$ | US-20140347325-$ | US-20140362046-$ |				

		US-20140368471-$ | US-20140375607-$).DID.					
L46	179	(US-20150002386-$ | US-20150009687-$ | US-20150015497-$ | US-20150035774-$ | US-20150035803-$ | US-20150053850-$ | US-20150054759-$ | US-20150083891-$ | US-20150103013-$ | US-20150130769-$ | US-20150138105-$ | US-20150138158-$ | US-20150138161-$ | US-20150205441-$ | US-20150215450-$ | US-20150242055-$ | US-20150271481-$ | US-20150286698-$ | US-20150317036-$ | US-20150324028-$ | US-20150331544-$ | US-20150331545-$ | US-20150331546-$ | US-20150331547-$ | US-20150332655-$ | US-20150346856-$ | US-20150346911-$ | US-20150363042-$ | US-20160026337-$ | US-20160034099-$ | US-20160050746-$ | US-20160070415-$ | US-20160070416-$ | US-20160124546-$ | US-20160124551-$ | US-20160154531-$ | US-20160154532-$ | US-20160202841-$ | US-20160216844-$ | US-20160224144-$ | US-20160299593-$ | US-20160328090-$ | US-20160328091-$ | US-20160334942-$ | US-20160342282-$ | US-20160357348-$ | US-20170010688-$ | US-20170090090-$ | US-20170102827-$ | US-20170115235-$ | US-20170115823-$ | US-20170139541-$ | US-20170177163-$ | US-20170185230-$ | US-20170293392-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:58 AM

		US-20170344185-$ | US-20180031753-$ | US-20180129354-$ | US-20180210572-$ | US-20180225006-$ | US-20180267672-$ | US-20180275788-$ | US-20180275830-$ | US-0001650-$ | US-0001653-$ | US-0002340-$ | US-0002386-$ | US-0002400-$ | US-0002694-$ | US-0005004-$ | US-0005308-$ | US-0006292-$ | US-0006766-$ | US-0007185-$ | US-0007540-$ | US-0007541-$ | US-0007542-$ | US-0008164-$ | US-0009687-$ | US-0010688-$ | US-0011944-$ | US-0012714-$ | US-0014486-$ | US-0015497-$ | US-0016450-$ | US-0017706-$ | US-0017709-$ | US-0019448-$ | US-0021300-$ | US-0021302-$ | US-0024598-$ | US-0026337-$ | US-0026408-$ | US-0027339-$ | US-0027404-$ | US-0028575-$ | US-0028604-$ | US-0028629-$ | US-0029691-$ | US-0030642-$ | US-0031753-$ | US-0032401-$ | US-0033444-$ | US-0033725-$ | US-0034099-$ | US-0034439-$ | US-0034783-$ | US-0034935-$ | US-0035774-$ | US-0035803-$ | US-0036203-$ | US-0036743-$ | US-0038593-$ | US-						

		0038691-$ | US- 0038698-$ | US- 0040786-$ | US- 0041013-$ | US- 0043490-$ | US- 0044073-$ | US- 0045629-$ | US- 0048257-$ | US- 0049388-$ | US- 0050649-$ | US- 0050746-$ | US- 0051394-$ | US- 0052257-$ | US- 0052684-$ | US- 0053850-$ | US- 0054759-$ | US- 0055080-$ | US- 0055421-$ | US- 0057903-$ | US- 0060896-$ | US- 0061861-$ | US- 0062150-$ | US- 0062474-$ | US- 0063853-$ | US- 0066016-$ | US- 0066647-$ | US- 0066704-$ | US- 0067178-$ | US- 0067348-$ | US- 0068256-$ | US- 0068691-$ | US- 0068973-$ | US- 0069039-$ | US- 0069807-$ | US- 0070056-$ | US- 0070415-$ | US- 0070416-$ | US- 0071653-$ | US- 0073142-$ | US- 0073318-$ | US- 0073508-$ | US- 0074401-$ | US- 0074725-$ | US- 0074734-$ | US- 0074735-$ | US- 0075243-$ | US- 0075648-$ | US- 0076697-$ | US- 0077501-$ | US- 0078545-$ | US- 0079407-$ | US- 0079408-$ | US- 0082980-$ | US- 0083293-$ | US- 0083891-$ | US- 0085241-$ | US- 0085894-$ | US- 0086673-$ | US-					

		0088603-$ | US- 0089348-$ | US- 0090090-$ | US- 0090176-$ | US- 0090432-$ | US- 0091554-$ | US- 0092052-$ | US- 0095399-$).DID.					
L47	194	(US-0097345-$ | US- 0097348-$ | US- 0097353-$ | US- 0098032-$ | US- 0098058-$ | US- 0102374-$ | US- 0102827-$ | US- 0103013-$ | US- 0107569-$ | US- 0107748-$ | US- 0109219-$ | US- 0110447-$ | US- 0113715-$ | US- 0114237-$ | US- 0115235-$ | US- 0115748-$ | US- 0115823-$ | US- 0115919-$ | US- 0118177-$ | US- 0120320-$ | US- 0120833-$ | US- 0121323-$ | US- 0121442-$ | US- 0122020-$ | US- 0122027-$ | US- 0122075-$ | US- 0122091-$ | US- 0122094-$ | US- 0122792-$ | US- 0122803-$ | US- 0124546-$ | US- 0124551-$ | US- 0125016-$ | US- 0125438-$ | US- 0125633-$ | US- 0125937-$ | US- 0127790-$ | US- 0127975-$ | US- 0128190-$ | US- 0128508-$ | US- 0129354-$ | US- 0130338-$ | US- 0130769-$ | US- 0130979-$ | US- 0131490-$ | US- 0132454-$ | US- 0133265-$ | US- 0134079-$ | US- 0134435-$ | US- 0135162-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:58 AM

		0135258-$ | US- 0135259-$ | US- 0137494-$ | US- 0138105-$ | US- 0138158-$ | US- 0138161-$ | US- 0139340-$ | US- 0139467-$ | US- 0139541-$ | US- 0141001-$ | US- 0141388-$ | US- 0142823-$ | US- 0143141-$ | US- 0143923-$ | US- 0146930-$ | US- 0147569-$ | US- 0150846-$ | US- 0150848-$ | US- 0151126-$ | US- 0152985-$ | US- 0153134-$ | US- 0153519-$ | US- 0154338-$ | US- 0154531-$ | US- 0154532-$ | US- 0154983-$ | US- 0155027-$ | US- 0156100-$ | US- 0156914-$ | US- 0157095-$ | US- 0157096-$ | US- 0158176-$ | US- 0158437-$ | US- 0158504-$ | US- 0158823-$ | US- 0158853-$ | US- 0160155-$ | US- 0160762-$ | US- 0161026-$ | US- 0162142-$ | US- 0162144-$ | US- 0162398-$ | US- 0163505-$ | US- 0163996-$ | US- 0163997-$ | US- 0163998-$ | US- 0168459-$ | US- 0169672-$ | US- 0169780-$ | US- 0170658-$ | US- 0174541-$ | US- 0175852-$ | US- 0177163-$ | US- 0179977-$ | US- 0181419-$ | US- 0181896-$ | US- 0182266-$ | US- 0185230-$ | US-					

		0187422-$ | US- 0187842-$ | US- 0187891-$ | US- 0188206-$ | US- 0189046-$ | US- 0189857-$ | US- 0189874-$ | US- 0189878-$ | US- 0191993-$ | US- 0192023-$ | US- 0192025-$ | US- 0193259-$ | US- 0200532-$ | US- 0200538-$ | US- 0200613-$ | US- 0201042-$ | US- 0201142-$ | US- 0201579-$ | US- 0202841-$ | US- 0202974-$ | US- 0205186-$ | US- 0205441-$ | US- 0210537-$ | US- 0210572-$ | US- 0212441-$ | US- 0212603-$ | US- 0212774-$ | US- 0214486-$ | US- 0215450-$ | US- 0216042-$ | US- 0216844-$ | US- 0217882-$ | US- 0219256-$ | US- 0221705-$ | US- 0221997-$ | US- 0222346-$ | US- 0224144-$ | US- 0225006-$ | US- 0227036-$ | US- 0227120-$ | US- 0227874-$ | US- 0229091-$ | US- 0229892-$ | US- 0232669-$ | US- 0234537-$ | US- 0237401-$ | US- 0237408-$ | US- 0237422-$ | US- 0238139-$ | US- 0238433-$ | US- 0238627-$ | US- 0239702-$ | US- 0241887-$ | US- 0242055-$ | US- 0245292-$ | US- 0245438-$ | US- 0246388-$ | US- 0248540-$ | US-					

		0249478-$ | US- 0249833-$ | US- 0251439-$ | US- 0252091-$ | US- 0252619-$ | US- 0252867-$ | US- 0253831-$ | US- 0253834-$ | US- 0254864-$ | US- 0255248-$ | US- 0256092-$ | US- 0256817-$ | US- 0256882-$ | US- 0259967-$ | US- 0261020-$ | US- 0265170-$ | US- 0266266-$ | US- 0267124-$ | US- 0267296-$ | US- 0267672-$ | US- 0267919-$ | US- 0268403-$ | US- 0268427-$ | US- 0269867-$ | US- 0271481-$ | US- 0273794-$ | US- 0274559-$ | US- 0275082-$ | US- 0275788-$ | US- 0275830-$).DID.					
L48	196	(US-0276053-$ | US- 0277436-$ | US- 0278460-$ | US- 0278816-$ | US- 0279558-$ | US- 0281543-$ | US- 0283785-$ | US- 0284596-$ | US- 0284925-$ | US- 0285920-$ | US- 0285968-$ | US- 0286698-$ | US- 0289754-$ | US- 0290684-$ | US- 0291668-$ | US- 0291989-$ | US- 0292701-$ | US- 0293392-$ | US- 0295821-$ | US- 0296688-$ | US- 0297009-$ | US- 0297482-$ | US- 0298743-$ | US- 0299593-$ | US- 0300572-$ | US- 0300716-$ | US- 0302196-$ | US- 0302209-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:59 AM

		0302210-$ | US- 0302240-$ | US- 0305755-$ | US- 0307795-$ | US- 0309325-$ | US- 0310045-$ | US- 0315379-$ | US- 0317036-$ | US- 0320460-$ | US- 0321328-$ | US- 0322550-$ | US- 0324028-$ | US- 0328090-$ | US- 0328091-$ | US- 0331544-$ | US- 0331545-$ | US- 0331546-$ | US- 0331547-$ | US- 0332655-$ | US- 0334942-$ | US- 0342282-$ | US- 0342490-$ | US- 0344185-$ | US- 0346856-$ | US- 0346911-$ | US- 0347325-$ | US- 0357348-$ | US- 0362046-$ | US- 0363042-$ | US- 0368471-$ | US- 0375607-$ | US- 1234567-$ | US- 10013107-$ | US- 10019113-$ | US- 3440426-$ | US- 3553680-$ | US- 3673327-$ | US- 4129384-$ | US- 4180702-$ | US- 4209255-$ | US- 4213707-$ | US- 4254333-$ | US- 4254407-$ | US- 4294543-$ | US- 4346376-$ | US- 4420261-$ | US- 4484179-$ | US- 4507557-$ | US- 4521112-$ | US- 4542375-$ | US- 4550250-$ | US- 4593191-$ | US- 4673918-$ | US- 4688933-$ | US- 4688993-$ | US- 4692809-$ | US- 4710760-$ | US- 4736191-$ | US-					

		4737626-$ | US- 4746770-$ | US- 4752655-$ | US- 4772763-$ | US- 4782328-$ | US- 4812833-$ | US- 4837430-$ | US- 4868912-$ | US- 4891829-$ | US- 4916712-$ | US- 4933544-$ | US- 4949079-$ | US- 4986662-$ | US- 4988983-$ | US- 5065185-$ | US- 5073770-$ | US- 5105186-$ | US- 5159322-$ | US- 5166668-$ | US- 5227622-$ | US- 5248856-$ | US- 5254407-$ | US- 5345490-$ | US- 5383022-$ | US- 5483261-$ | US- 5484966-$ | US- 5499098-$ | US- 5502568-$ | US- 5525764-$ | US- 5526422-$ | US- 5539514-$ | US- 5570181-$ | US- 5572251-$ | US- 5577501-$ | US- 5600105-$ | US- 5608550-$ | US- 5672852-$ | US- 5679930-$ | US- 5686942-$ | US- 5688933-$ | US- 5729249-$ | US- 5736686-$ | US- 5740224-$ | US- 5764223-$ | US- 5767517-$ | US- 5775792-$ | US- 5945980-$ | US- 5945981-$ | US- 5959617-$ | US- 6061177-$ | US- 6067079-$ | US- 6122394-$ | US- 6141104-$ | US- 6172667-$ | US- 6175999-$ | US- 6227667-$ | US- 6229529-$ | US- 6333735-$ | US-					

		6366276-$ | US- 6380732-$ | US- 6380740-$ | US- 6390370-$ | US- 6429857-$ | US- 6452996-$ | US- 6476797-$ | US- 6492633-$ | US- 6495832-$ | US- 6504143-$ | US- 6529327-$ | US- 6538644-$ | US- 6587099-$ | US- 6648485-$ | US- 6660964-$ | US- 6664498-$ | US- 6664952-$ | US- 6690363-$ | US- 6707027-$ | US- 6738051-$ | US- 6748098-$ | US- 6784948-$ | US- 6799141-$ | US- 6806871-$ | US- 6927384-$ | US- 6940286-$ | US- 6965836-$ | US- 6972753-$ | US- 6985137-$ | US- 7042444-$ | US- 7084859-$ | US- 7087907-$ | US- 7133031-$ | US- 7176904-$ | US- 7199932-$ | US- 7359041-$ | US- 7397418-$ | US- 7432893-$ | US- 7435940-$ | US- 7436443-$ | US- 7442914-$ | US- 7465914-$ | US- 7613375-$ | US- 7629968-$ | US- 7646833-$ | US- 7653883-$ | US- 7655901-$ | US- 7705835-$ | US- 7729056-$ | US- 7847789-$ | US- 7855716-$ | US- 7859519-$).DID.					
L49	73	(US-7924272-$ | US- 7932899-$ | US- 7969410-$ | US- 7995039-$ | US- 8013845-$ | US- 8031186-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 05:59 AM

		8077147-$ | US- 8093545-$ | US- 8094136-$ | US- 8094910-$ | US- 8149211-$ | US- 8218154-$ | US- 8274495-$ | US- 8325158-$ | US- 8339379-$ | US- 8350827-$ | US- 8384010-$ | US- 8407606-$ | US- 8441467-$ | US- 8445834-$ | US- 8466901-$ | US- 8482547-$ | US- 8542217-$ | US- 8567257-$ | US- 8581884-$ | US- 8624858-$ | US- 8686974-$ | US- 8692807-$ | US- 8716614-$ | US- 8727581-$ | US- 8745514-$ | US- 8780066-$ | US- 8830181-$ | US- 8860696-$ | US- 8872098-$ | US- 8872801-$ | US- 8884900-$ | US- 8890843-$ | US- 8890849-$ | US- 8928590-$ | US- 8963886-$ | US- 8982084-$ | US- 9024916-$ | US- 9035909-$ | US- 9063617-$ | US- 9086763-$ | US- 9134854-$ | US- 9158401-$ | US- 9158415-$ | US- 9213445-$ | US- 9274645-$ | US- 9317168-$ | US- 9323396-$ | US- 9366565-$ | US- 9377884-$ | US- 9389732-$ | US- 9411444-$ | US- 9411464-$ | US- 9430079-$ | US- 9442574-$ | US- 9547393-$ | US- 9552103-$ | US- 9557846-$ | US- 9588619-$ | US-					

		9594467-$ | US-9618682-$ | US-9626018-$ | US-9626040-$ | US-9639210-$ | US-9678602-$ | US-9684414-$ | US-9710101-$ | US-9874978-$).DID.					
L50	6	(("4751379") or ("6100538") or ("20070165008") or ("20130234991") or ("8913035") or ("20130300714")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/12/23 06:04 AM
L51	32685	(G06F3/0428 or G06F3/0421 or G06F2203/04108 or G06F2203/04107 or G06F2203/04103 or G06F3/0412).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:05 AM
L52	5737	(G06F3/0421 or G06F3/0428).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:58 AM
L53	378	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:58 AM
L54	397	L52 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:58 AM
L55	186	L54 not L53	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:58 AM
L56	151	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad))))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:58 AM

		and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))					
L57	31612	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:59 AM
L58	56	L57 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 06:59 AM
L59	53	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2019/12/23 07:08 AM
L60	56	L51 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 07:09 AM
L61	158	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 07:09 AM
L62	7	L61 not L56	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2019/12/23 07:09 AM
L63	12	(US-20080080811-$ | US-20100315379-$ | US-20110134079-$ | US-20110141062-$ | US-20120170056-$ | US-20130300714-$ | US-20150131010-$ | US-20190025984-$ | US-20190196657-$ | US-20190196658-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:45 AM

		US-20190196659-$ | US-9001086-$).DID.					
L64	152	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:51 AM
L65	33069	(G06F3/0428 or G06F3/0421 or G06F2203/04108 or G06F2203/04107 or G06F2203/04103 or G06F3/0412).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:52 AM
L66	56	L65 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:52 AM
L67	159	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:52 AM
L68	7	L67 not L64	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/02/03 09:52 AM
L69	2	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and ((light	(US-PGPUB)	OR	ON	ON	2020/02/03 09:55 AM

		beam) adj5 (over across atop) adj3 (surface plane cover panel))).clm.					
L70	0	16/834905	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/26 10:26 PM
L71	56	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2020/04/26 10:27 PM
L72	34265	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/26 10:32 PM
L73	34265	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 01:33 PM
L74	30	L73 and (((optical near2 element) lens) same emitter same (surface)) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3 translat$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 01:38 PM
L75	329	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) lens) same emitter) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3 translat$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:00 PM
L76	148	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) lens) same	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:00 PM

		emitter) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3))					
L77	198	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:11 PM
L78	30	L73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:13 PM
L80	14	L73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:28 PM
L81	255	L73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:29 PM

L82	12	("20080080811"|"20100315379"|"20110134079"|"20110141062"|"20120170056"|"20130300714"|"20150131010"|"20190025984"|"20190196657"|"20190196658"|"20190196659"|"9001086").PN.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/04/27 02:33 PM
L83	1	("20140210793").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2020/06/03 12:48 PM
L84	1	("20160224300").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2020/06/11 09:44 AM
L85	34968	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/06/22 01:03 PM
L86	265	L85 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3 fitted))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2020/06/22 01:03 PM
L87	33	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and (engag$5 coupl$3 mat$3 fitted)).clm.	(US-PGPUB)	OR	ON	ON	2020/06/22 01:37 PM
L88	1	16/989292	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:31 PM
L89	40347	(G06F3/0428 or G06F3/0421 or G06F3/0412 or G06F2203/04103 or G06F2203/04107 or G06F2203/04108).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:32 PM
L90	70	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2021/07/17 10:33 PM
L91	294	L89 and (((optical near2	(US-PGPUB; USPAT;	OR	ON	ON	2021/07/17

		element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3 fitted))	EPO; JPO)				10:36 PM
L92	19	L89 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:37 PM
L93	34	L89 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:37 PM
L98	72	(US-8093545-$ | US-8094136-$ | US-8094910-$ | US-8149211-$ | US-8218154-$ | US-8274495-$ | US-8325158-$ | US-8339379-$ | US-8350827-$ | US-8384010-$ | US-8407606-$ | US-8441467-$ | US-8445834-$ | US-8466901-$ | US-8482547-$ | US-8542217-$ | US-8567257-$ | US-8581884-$ | US-8624858-$ | US-8686974-$ | US-8692807-$ | US-8716614-$ | US-8727581-$ | US-8745514-$ | US-8780066-$ | US-8830181-$ | US-8860696-$ | US-8872098-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:50 PM

		8872801-$ | US- 8884900-$ | US- 8890843-$ | US- 8890849-$ | US- 8928590-$ | US- 8963886-$ | US- 8982084-$ | US- 9001086-$ | US- 9024896-$ | US- 9024916-$ | US- 9035909-$ | US- 9063614-$ | US- 9063617-$ | US- 9086763-$ | US- 9134854-$ | US- 9158401-$ | US- 9158415-$ | US- 9201520-$ | US- 9207800-$ | US- 9213445-$ | US- 9274645-$ | US- 9280237-$ | US- 9317168-$ | US- 9323396-$ | US- 9366565-$ | US- 9377884-$ | US- 9389732-$ | US- 9411444-$ | US- 9411464-$ | US- 9430079-$ | US- 9442574-$ | US- 9547393-$ | US- 9552103-$ | US- 9557846-$ | US- 9588619-$ | US- 9594467-$ | US- 9618682-$ | US- 9626018-$ | US- 9626040-$ | US- 9639210-$ | US- 9678602-$ | US- 9684414-$ | US- 9710101-$ | US- 9874978-$).DID.					
L99	195	(US-0135258-$ | US- 0135259-$ | US- 0136788-$ | US- 0137494-$ | US- 0138105-$ | US- 0138158-$ | US- 0138161-$ | US- 0139340-$ | US- 0139467-$ | US- 0139541-$ | US- 0141001-$ | US- 0141062-$ | US- 0141388-$ | US- 0141395-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:51 PM

		0142823-$ | US- 0143141-$ | US- 0143923-$ | US- 0146630-$ | US- 0146930-$ | US- 0147569-$ | US- 0149792-$ | US- 0150846-$ | US- 0150848-$ | US- 0151126-$ | US- 0152624-$ | US- 0152985-$ | US- 0153134-$ | US- 0153519-$ | US- 0154338-$ | US- 0154531-$ | US- 0154532-$ | US- 0154533-$ | US- 0154983-$ | US- 0155027-$ | US- 0155655-$ | US- 0156100-$ | US- 0156914-$ | US- 0157095-$ | US- 0157096-$ | US- 0158176-$ | US- 0158437-$ | US- 0158504-$ | US- 0158823-$ | US- 0158853-$ | US- 0159382-$ | US- 0160155-$ | US- 0160762-$ | US- 0160871-$ | US- 0161026-$ | US- 0162142-$ | US- 0162144-$ | US- 0162398-$ | US- 0163505-$ | US- 0163996-$ | US- 0163997-$ | US- 0163998-$ | US- 0167033-$ | US- 0168459-$ | US- 0169672-$ | US- 0169780-$ | US- 0170056-$ | US- 0170658-$ | US- 0174541-$ | US- 0175852-$ | US- 0177163-$ | US- 0179261-$ | US- 0179977-$ | US- 0181419-$ | US- 0181896-$ | US- 0181953-$ | US- 0182266-$ | US- 0185230-$ | US-					

		0187422-$ | US- 0187842-$ | US- 0187891-$ | US- 0188206-$ | US- 0189046-$ | US- 0189857-$ | US- 0189874-$ | US- 0189878-$ | US- 0191993-$ | US- 0192023-$ | US- 0192025-$ | US- 0193259-$ | US- 0196657-$ | US- 0196658-$ | US- 0196659-$ | US- 0199071-$ | US- 0200532-$ | US- 0200538-$ | US- 0200613-$ | US- 0201042-$ | US- 0201142-$ | US- 0201579-$ | US- 0202841-$ | US- 0202974-$ | US- 0205186-$ | US- 0205189-$ | US- 0205441-$ | US- 0209886-$ | US- 0210537-$ | US- 0210572-$ | US- 0212441-$ | US- 0212457-$ | US- 0212603-$ | US- 0212774-$ | US- 0214486-$ | US- 0215450-$ | US- 0216042-$ | US- 0216844-$ | US- 0217882-$ | US- 0218229-$ | US- 0219256-$ | US- 0220204-$ | US- 0221705-$ | US- 0221997-$ | US- 0222346-$ | US- 0223916-$ | US- 0224144-$ | US- 0225006-$ | US- 0226084-$ | US- 0227036-$ | US- 0227120-$ | US- 0227670-$ | US- 0227874-$ | US- 0229091-$ | US- 0229892-$ | US- 0232669-$ | US- 0234537-$ | US- 0234991-$ | US-						

		0235701-$ | US- 0237401-$ | US- 0237408-$ | US- 0237422-$ | US- 0238139-$ | US- 0238433-$ | US- 0238627-$ | US- 0239702-$ | US- 0241887-$ | US- 0242055-$ | US- 0245292-$ | US- 0245438-$ | US- 0246388-$ | US- 0248540-$ | US- 0249478-$ | US- 0249777-$ | US- 0249833-$ | US- 0251439-$ | US- 0252091-$ | US- 0252619-$ | US- 0252867-$ | US- 0253187-$ | US- 0253520-$ | US- 0253831-$ | US- 0253834-$ | US- 0254864-$ | US- 0255248-$ | US- 0255713-$ | US- 0256092-$ | US- 0256817-$ | US- 0256882-$ | US- 0258353-$ | US- 0259029-$ | US- 0259967-$ | US- 0261020-$ | US- 0261323-$ | US- 0265170-$ | US- 0266266-$ | US- 0267124-$ | US- 0267296-$ | US- 0267672-$ | US- 0267919-$ | US- 0268403-$ | US- 0268427-$ | US- 0269867-$ | US- 0271481-$ | US- 0273794-$ | US- 0274559-$ | US- 0275082-$ | US- 0275788-$ | US- 0275830-$ | US- 0275831-$ | US- 0276053-$ | US- 0277436-$ | US- 0278460-$ | US- 0278816-$ | US- 0279558-$ | US- 0281543-$ | US-					

		0283785-$ | US- 0284596-$ | US- 0284925-$ | US- 0285920-$ | US- 0285968-$ | US- 0286698-$ | US- 0289754-$ | US- 0290684-$).DID.					
L100	168	(US-0291668-$ | US- 0291989-$ | US- 0292701-$ | US- 0293392-$ | US- 0295711-$ | US- 0295821-$ | US- 0296688-$ | US- 0297009-$ | US- 0297482-$ | US- 0298743-$ | US- 0299583-$ | US- 0299593-$ | US- 0300572-$ | US- 0300714-$ | US- 0300716-$ | US- 0302196-$ | US- 0302209-$ | US- 0302210-$ | US- 0302240-$ | US- 0305755-$ | US- 0306501-$ | US- 0307795-$ | US- 0309325-$ | US- 0310045-$ | US- 0310621-$ | US- 0313865-$ | US- 0314206-$ | US- 0315379-$ | US- 0317036-$ | US- 0320460-$ | US- 0321328-$ | US- 0321740-$ | US- 0322550-$ | US- 0324028-$ | US- 0324570-$ | US- 0328090-$ | US- 0328091-$ | US- 0331544-$ | US- 0331545-$ | US- 0331546-$ | US- 0331547-$ | US- 0332655-$ | US- 0334942-$ | US- 0339000-$ | US- 0341587-$ | US- 0342282-$ | US- 0342490-$ | US- 0344185-$ | US- 0346856-$ | US- 0346911-$ | US-	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:51 PM

		0347325-$ | US- 0348473-$ | US- 0357348-$ | US- 0362046-$ | US- 0363042-$ | US- 0368471-$ | US- 0373864-$ | US- 0375607-$ | US- 0377431-$ | US- 0377435-$ | US- 0387237-$ | US- 10013107-$ | US- 10019113-$ | US- 10282035-$ | US- 10649585-$ | US- 20010002694-$ | US- 20010005004-$ | US- 20010005308-$ | US- 20010030642-$ | US- 20020067348-$ | US- 20020075243-$ | US- 20020118177-$ | US- 20020158823-$ | US- 20020158853-$ | US- 20020163505-$ | US- 20030016450-$ | US- 20030034439-$ | US- 20030034935-$ | US- 20030048257-$ | US- 20030052257-$ | US- 20030095399-$ | US- 20030107748-$ | US- 20030137494-$ | US- 20030156100-$ | US- 20030160155-$ | US- 20030210537-$ | US- 20030214486-$ | US- 20040027339-$ | US- 20040032401-$ | US- 20040090432-$ | US- 20040130338-$ | US- 20040174541-$ | US- 20040201579-$ | US- 20040212603-$ | US- 20040238627-$ | US- 20040239702-$ | US- 20040245438-$ | US- 20040252091-$ | US- 20040252867-$ | US- 20050012714-$ | US- 20050041013-$ | US- 20050057903-$ | US- 20050073508-$ | US- 20050083293-$ | US- 20050128190-$ | US- 20050143923-$ | US- 20050156914-$ | US- 20050162398-$ | US-					

		20050179977-$ | US- 20050200613-$ | US- 20050212774-$ | US- 20050248540-$ | US- 20050253834-$ | US- 20050276053-$ | US- 20060001650-$ | US- 20060001653-$ | US- 20060007185-$ | US- 20060008164-$ | US- 20060017706-$ | US- 20060017709-$ | US- 20060033725-$ | US- 20060038698-$ | US- 20060061861-$ | US- 20060114237-$ | US- 20060132454-$ | US- 20060139340-$ | US- 20060158437-$ | US- 20060170658-$ | US- 20060202974-$ | US- 20060227120-$ | US- 20060255248-$ | US- 20060256092-$ | US- 20060279558-$ | US- 20060281543-$ | US- 20060290684-$ | US- 20070014486-$ | US- 20070024598-$ | US- 20070034783-$ | US- 20070038691-$ | US- 20070052684-$ | US- 20070070056-$ | US- 20070075648-$ | US- 20070120833-$ | US- 20070125937-$ | US- 20070152985-$ | US- 20070201042-$ | US- 20070296688-$ | US- 20080006766-$ | US- 20080007540-$ | US- 20080007541-$ | US- 20080007542-$ | US- 20080011944-$ | US- 20080029691-$ | US- 20080036743-$ | US- 20080062150-$ | US- 20080068691-$ | US- 20080074401-$ | US- 20080080811-$ | US- 20080088603-$ | US- 20080121442-$ | US- 20080122792-$ | US- 20080122803-$ | US- 20080130979-$ | US- 20080133265-$ | US- 20080150846-$ | US- 20080150848-$ | US-					

		20080151126-$ | US-20080158176-$).DID.					
L101	154	(US-20080189046-$ | US-20080192025-$ | US-20080238433-$ | US-20080246388-$ | US-20080252619-$ | US-20080266266-$ | US-20080278460-$ | US-20080284925-$ | US-20080291668-$ | US-20080297482-$ | US-20090000831-$ | US-20090002340-$ | US-20090006292-$ | US-20090040786-$ | US-20090066647-$ | US-20090067178-$ | US-20090073142-$ | US-20090077501-$ | US-20090085894-$ | US-20090091554-$ | US-20090115919-$ | US-20090122020-$ | US-20090122027-$ | US-20090128508-$ | US-20090135162-$ | US-20090143141-$ | US-20090153519-$ | US-20090161026-$ | US-20090168459-$ | US-20090187842-$ | US-20090189857-$ | US-20090189874-$ | US-20090189878-$ | US-20090219256-$ | US-20090229892-$ | US-20090251439-$ | US-20090256817-$ | US-20090259967-$ | US-20090267919-$ | US-20090273794-$ | US-20090278816-$ | US-20090297009-$ | US-20100033444-$ | US-20100045629-$ | US-20100060896-$ | US-20100066016-$ | US-20100066704-$ | US-20100073318-$ | US-20100073327-$ | US-20100078545-$ | US-20100079407-$ | US-20100079408-$ | US-20100097345-$ | US-20100097348-$ | US-20100097353-$ | US-20100103133-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:51 PM

		US-20100125438-$ | US-20100127975-$ | US-20100134435-$ | US-20100142823-$ | US-20100187422-$ | US-20100193259-$ | US-20100229091-$ | US-20100238139-$ | US-20100245292-$ | US-20100265170-$ | US-20100277436-$ | US-20100283785-$ | US-20100284596-$ | US-20100289754-$ | US-20100295821-$ | US-20100302196-$ | US-20100302209-$ | US-20100302210-$ | US-20100302240-$ | US-20100315379-$ | US-20100321328-$ | US-20100322550-$ | US-20110043490-$ | US-20110049388-$ | US-20110050649-$ | US-20110051394-$ | US-20110068256-$ | US-20110069039-$ | US-20110069807-$ | US-20110074725-$ | US-20110074734-$ | US-20110074735-$ | US-20110080361-$ | US-20110084939-$ | US-20110090176-$ | US-20110102374-$ | US-20110115748-$ | US-20110121323-$ | US-20110122075-$ | US-20110122091-$ | US-20110122094-$ | US-20110134079-$ | US-20110141062-$ | US-20110147569-$ | US-20110157095-$ | US-20110157096-$ | US-20110163996-$ | US-20110163997-$ | US-20110163998-$ | US-20110169780-$ | US-20110175852-$ | US-20110205186-$ | US-20110205189-$ | US-20110216042-$ | US-20110221705-$ | US-20110221997-$ | US-20110227036-$ | US-20110227874-$ |					

		US-20110234537-$ | US-20110254864-$ | US-20110261020-$ | US-20110267296-$ | US-20110291989-$ | US-20110298743-$ | US-20110309325-$ | US-20110310045-$ | US-20120019448-$ | US-20120026408-$ | US-20120038593-$ | US-20120056807-$ | US-20120062474-$ | US-20120062492-$ | US-20120068973-$ | US-20120086673-$ | US-20120089348-$ | US-20120110447-$ | US-20120131490-$ | US-20120141001-$ | US-20120146930-$ | US-20120153134-$ | US-20120154338-$ | US-20120162142-$ | US-20120162144-$ | US-20120169672-$ | US-20120170056-$ | US-20120181419-$ | US-20120182266-$ | US-20120188206-$ | US-20120191993-$ | US-20120200532-$ | US-20120200538-$ | US-20120212441-$ | US-20120212457-$ | US-20120217882-$ | US-20120218229-$ | US-20120223916-$ | US-20120249478-$ | US-20120256882-$).DID.					
L102	154	(US-20120268403-$ | US-20120268427-$ | US-20120274559-$ | US-20120305755-$ | US-20120313865-$ | US-20130021300-$ | US-20130021302-$ | US-20130027404-$ | US-20130044073-$ | US-20130055080-$ | US-20130076697-$ | US-20130082980-$ | US-20130106709-$ | US-20130107569-$ | US-20130113715-$ | US-20130120320-$ | US-20130125016-$ |	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:51 PM

		US-20130127790-$ | US-20130135258-$ | US-20130135259-$ | US-20130141388-$ | US-20130141395-$ | US-20130154983-$ | US-20130155027-$ | US-20130155655-$ | US-20130158504-$ | US-20130181896-$ | US-20130181953-$ | US-20130187891-$ | US-20130201142-$ | US-20130222346-$ | US-20130234991-$ | US-20130241887-$ | US-20130249833-$ | US-20130269867-$ | US-20130275082-$ | US-20130285920-$ | US-20130285968-$ | US-20130300714-$ | US-20130300716-$ | US-20130307795-$ | US-20130321740-$ | US-20130342490-$ | US-20140002400-$ | US-20140015803-$ | US-20140028575-$ | US-20140028604-$ | US-20140028629-$ | US-20140036203-$ | US-20140055421-$ | US-20140063853-$ | US-20140071653-$ | US-20140085241-$ | US-20140092052-$ | US-20140098032-$ | US-20140098058-$ | US-20140109219-$ | US-20140125633-$ | US-20140139467-$ | US-20140152624-$ | US-20140160762-$ | US-20140192023-$ | US-20140226084-$ | US-20140232669-$ | US-20140237401-$ | US-20140237408-$ | US-20140237422-$ | US-20140253520-$ | US-20140253831-$ | US-20140259029-$ | US-20140267124-$ | US-20140292701-$ | US-20140300572-$ | US-20140320460-$ | US-20140347325-$ |				

		US-20140362046-$ | US-20140368471-$ | US-20140375607-$ | US-20150002386-$ | US-20150009687-$ | US-20150015497-$ | US-20150035774-$ | US-20150035803-$ | US-20150053850-$ | US-20150054759-$ | US-20150083891-$ | US-20150103013-$ | US-20150121691-$ | US-20150130769-$ | US-20150131010-$ | US-20150138105-$ | US-20150138158-$ | US-20150138161-$ | US-20150199071-$ | US-20150205441-$ | US-20150215450-$ | US-20150242055-$ | US-20150261323-$ | US-20150271481-$ | US-20150286698-$ | US-20150317036-$ | US-20150324028-$ | US-20150331544-$ | US-20150331545-$ | US-20150331546-$ | US-20150331547-$ | US-20150332655-$ | US-20150339000-$ | US-20150346856-$ | US-20150346911-$ | US-20150363042-$ | US-20150373864-$ | US-20160004898-$ | US-20160026297-$ | US-20160026337-$ | US-20160034099-$ | US-20160041629-$ | US-20160050746-$ | US-20160062549-$ | US-20160070415-$ | US-20160070416-$ | US-20160077616-$ | US-20160092021-$ | US-20160103026-$ | US-20160117019-$ | US-20160124546-$ | US-20160124551-$ | US-20160154531-$ | US-20160154532-$ | US-20160154533-$ | US-20160179261-$ | US-20160202841-$ | US-20160209886-$ |				

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L103	185	(US-20170185230-$ | US-20170220204-$ | US-20170293392-$ | US-20170344185-$ | US-20180031753-$ | US-20180107373-$ | US-20180129354-$ | US-20180136788-$ | US-20180149792-$ | US-20180210572-$ | US-20180225006-$ | US-20180253187-$ | US-20180267672-$ | US-20180275788-$ | US-20180275830-$ | US-20180275831-$ | US-20180314206-$ | US-20190004668-$ | US-20190025984-$ | US-20190050074-$ | US-20190107923-$ | US-20190146630-$ | US-20190196657-$ | US-20190196658-$ | US-20190196659-$ | US-20190227670-$ | US-20190235701-$ | US-20190258353-$ | US-20190324570-$ | US-20190377431-$ | US-20190377435-$ | US-20200012408-$ | US-20200073509-$ | US-20200098147-$ | US-20200125189-$ | US-20200159382-$	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/07/17 10:52 PM

		US-20200167033-$ | US-20200249777-$ | US-20200310621-$ | US-20200341587-$ | US-20200348473-$ | US-20200387237-$ | US-3440426-$ | US-3553680-$ | US-3673327-$ | US-4129384-$ | US-4180702-$ | US-4209255-$ | US-4213707-$ | US-4254333-$ | US-4254407-$ | US-4294543-$ | US-4346376-$ | US-4420261-$ | US-4484179-$ | US-4507557-$ | US-4521112-$ | US-4542375-$ | US-4550250-$ | US-4593191-$ | US-4673918-$ | US-4688933-$ | US-4688993-$ | US-4692809-$ | US-4710760-$ | US-4736191-$ | US-4737626-$ | US-4746770-$ | US-4751379-$ | US-4752655-$ | US-4772763-$ | US-4782328-$ | US-4812833-$ | US-4837430-$ | US-4868912-$ | US-4891829-$ | US-4916712-$ | US-4933544-$ | US-4949079-$ | US-4986662-$ | US-4988983-$ | US-5065185-$ | US-5073770-$ | US-5105186-$ | US-5159322-$ | US-5166668-$ | US-5227622-$ | US-5248856-$ | US-5254407-$ | US-5345490-$ | US-5383022-$ | US-5483261-$ | US-5484966-$ | US-5499098-$ | US-					

		5502568-$ | US- 5525764-$ | US- 5526422-$ | US- 5539514-$ | US- 5570181-$ | US- 5572251-$ | US- 5577501-$ | US- 5600105-$ | US- 5608550-$ | US- 5672852-$ | US- 5679930-$ | US- 5686942-$ | US- 5688933-$ | US- 5729249-$ | US- 5736686-$ | US- 5740224-$ | US- 5764223-$ | US- 5767517-$ | US- 5775792-$ | US- 5945980-$ | US- 5945981-$ | US- 5959617-$ | US- 6031524-$ | US- 6061177-$ | US- 6067079-$ | US- 6122394-$ | US- 6141104-$ | US- 6172667-$ | US- 6175999-$ | US- 6227667-$ | US- 6229529-$ | US- 6333735-$ | US- 6366276-$ | US- 6380732-$ | US- 6380740-$ | US- 6390370-$ | US- 6429857-$ | US- 6452996-$ | US- 6476797-$ | US- 6492633-$ | US- 6495832-$ | US- 6504143-$ | US- 6529327-$ | US- 6538644-$ | US- 6587099-$ | US- 6648485-$ | US- 6660964-$ | US- 6664498-$ | US- 6664952-$ | US- 6690363-$ | US- 6707027-$ | US- 6738051-$ | US- 6748098-$ | US- 6784948-$ | US- 6799141-$ | US- 6806871-$ | US- 6927384-$ | US- 6940286-$ | US-					

		6965836-$ | US-6972753-$ | US-6985137-$ | US-7042444-$ | US-7084859-$ | US-7087907-$ | US-7133031-$ | US-7176904-$ | US-7199932-$ | US-7359041-$ | US-7397418-$ | US-7432893-$ | US-7435940-$ | US-7436443-$ | US-7442914-$ | US-7465914-$ | US-7613375-$ | US-7629968-$ | US-7646833-$ | US-7653883-$ | US-7655901-$ | US-7705835-$ | US-7729056-$ | US-7847789-$ | US-7855716-$ | US-7859519-$ | US-7924272-$ | US-7932899-$ | US-7969410-$ | US-7995039-$ | US-8013845-$ | US-8031186-$ | US-8077147-$).DID.					
L105	4	(("5515083") or ("7528898") or ("9317146") or ("20110316005")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/07/17 11:00 PM
L106	3	(("10739916") or ("10606416") or ("10437389")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/07/17 11:18 PM
L107	41138	(G06F3/0428 or G06F3/0421 or G06F3/0412 or G06F2203/04103 or G06F2203/04107 or G06F2203/04108).cpc.	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/09/29 06:56 AM
L108	34	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/09/29 06:56 AM

		element) (light near2 guide) light-guide lens) same (slid$3))					
L109	296	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3 fitted))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/09/29 06:56 AM
L110	19	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/09/29 06:56 AM
L111	10	(("9983626") or ("5729250") or ("8319729") or ("9291845") or ("9366802") or ("20130257810") or ("20130222344") or ("20140210793") or ("20150256658") or ("20170123257")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/09/29 06:58 AM
L112	1	("10775935").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/09/29 07:23 AM
L113	1	("10739916").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/09/29 07:26 AM
L114	2	(("20130300714") or ("9001086")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/09/29 08:46 AM
L115	19	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/11/18 10:46 PM
L116	1	("10775935").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/11/18 10:46 PM
L117	2	(("20130300714") or ("9001086")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/11/18 10:46 PM
L118	19	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens)	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/11/18 10:46 PM

		same (seal$3))					
L119	10	(("9983626") or ("5729250") or ("8319729") or ("9291845") or ("9366802") or ("20130257810") or ("20130222344") or ("20140210793") or ("20150256658") or ("20170123257")).PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2021/11/18 10:46 PM
L120	34	L107 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2021/11/18 10:47 PM
L121	0	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) AND ((emitter LED diode (light adj2 source)) AND (support$3 frame mount$3)) AND (engag$5 coupl$3 mat$3 fitted) AND (seal$3)).clm.	(US-PGPUB)	OR	ON	ON	2021/11/20 07:28 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Proposed Claim Amendments

(For discussion purposes only)

1-5. (Canceled).

6. (Currently Amended) A touch sensing apparatus comprising:

a panel comprising a top surface that includes a touch surface, a back surface, and an edge surface;

a plurality of light emitters ~~and detectors~~ arranged along a ~~perimeter~~ periphery of the panel;

a substrate configured to support at least one of the plurality of light emitters such that the at least one of the plurality of light emitters transmits a portion of light in a plane extending over the touch surface~~, wherein an emitter is mounted on the substrate and is configured to transmit light in a plane above the touch surface and perpendicular to a normal of the touch surface~~; [[and]]

a support structure configured to support the substrate~~;~~

~~wherein~~, the support structure ~~is formed from a single monolithic piece~~ comprising:

a first portion extending substantially parallel to the edge surface, wherein the substrate is configured to be supported by the first portion ~~and above and below the touch surface~~; [[and]]

a second portion extending over an edge portion of the top surface of the panel; and ~~parallel to the touch surface to overlap with at least a portion of the touch surface~~

a sealing element configured to rest on the edge portion of the top surface and further configured to be fitted between the edge portion of the top surface and the second portion of the support structure.

7. (Canceled).

8. (Currently Amended) The touch sensing apparatus according to claim 6, wherein the substrate is [[fixed]] affixed to the first portion of the support structure.

9. (Canceled).

10. (Canceled).

11. (Currently Amended) The touch sensing apparatus according to claim 6, wherein the support structure is configured to be attached ~~attach~~ to a display support, and wherein the display support is configured to support a display.

12. (Currently Amended) The touch sensing apparatus according to claim 11, wherein the support structure further comprises a recess configured to interlock with a corresponding mating feature ~~surface~~ of the display support.

13. (Currently Amended) The touch sensing apparatus according to claim 6, wherein the support structure is formed from an extrusion process, a drawing process, a rolling process, or a molding process.

14. (Currently Amended) The touch sensing apparatus according to claim 6, ~~comprising an optical element configured to be secured between the touch surface and the second portion of the support structure,~~ wherein the sealing ~~optical~~ element comprises a first surface facing the ~~emitter~~ at least one of the plurality of light emitters and being configured to receive the transmitted light from [[the]] that emitter and a second surface configured to receive light propagating ~~across~~ in the plane extending over ~~a touch interacting portion of~~ the touch surface.

15. (Currently Amended) The touch sensing apparatus according to claim 14, wherein the first surface is tilted relative to the at least one of the plurality of light emitters ~~normal axis of the touch surface~~.

16. (Canceled).

17. (Currently Amended) The touch sensing apparatus according to claim 14, wherein the ~~optical~~ sealing element comprises a protrusion ~~and/or~~ or a recess to interlock with a corresponding mating feature ~~surface of~~ on the second portion of the support structure.

18-22. (Canceled).

23. (New) The touch sensing apparatus according to claim 6, wherein the support structure is formed from a single monolithic piece of a material.

24. (New) The touch sensing apparatus according to claim 6, wherein the sealing element is formed from a single monolithic piece of a material.

25. (New) The touch sensing apparatus according to claim 6, wherein the sealing element comprises an optically active element or an optically passive element.

26. (New) The touch sensing apparatus according to claim 6, wherein the sealing element is configured to inhibit ingress of a contaminant toward the at least one of the plurality of light emitters.

27. (New) The touch sensing apparatus according to claim 6, wherein the sealing element comprises one or more optical elements that refract, deflect, divert or focus light beams.

28. (New) The touch sensing apparatus according to claim 6, further comprising a plurality of light detectors arranged along the periphery of the panel.

29. (New) The touch sensing apparatus according to claim 6, wherein the substrate is directly joined to the first portion of the support structure.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 1 OF 5	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	9,983,626	05-29-2018	Cao et al.	
	2	2013/0257810	10-03-2013	Niu et al.	
	3	5,729,250	03-17-1998	Bishop et al.	
	4	8,319,729	11-27-2012	Choi et al.	
	5	9,291,845	03-22-2016	Shin et al.	
	6	9,366,802	06-14-2016	Lee et al.	
	7	2013/0222344	08-29-2013	Lu et al.	
	8	2014/0210793	07-31-2014	Eriksson et al.	
	9	2015/0256658	09-10-2015	Shin et al.	
	10	2017/0123257	05-04-2017	Zhao	

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	11	CN 104391611 A	09-29-2017	SHENZHEN IBOARD TECHNOLOGY Co Ltd		X-Abs
	12	CN 203786707 U	08-20-2014	SHENZHEN TIMELINK ECHNOLOGY CO., LTD.		X-Abs
	13	CN203786708U	08-20-2014	Guangzhou Shirui Electronics Co Ltd		X-Abs
	14	WO 2014/131221	09-04-2014	SHENZHEN TIMELINK TECHNOLOGY CO LT		X-Abs
	15	CN 102117155A	07-06-2011	Guangzhou Shirui Electronics Co Ltd		
	16	CN 104808843A	07-29-2015	Interface Optoelectronics Shenzhen Co Ltd., Cheng Cheng Technology Chengdu Co Ltd.		
	17	CN202887145U	04-17-2013	HANGZHOU WANIN EDUCATION MULTIMEDIA TECHNOLOGY CO LTD		

Examiner Signature	/ADAM R. GIESY/	Date Considered	09/29/2021

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 2 OF 5	Attorney Docket No.	FFOG.054C6

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	18	CN 203720812 U	07-16-2014	CHEN YUNHUA; LI RUILIANG		
	19	CN 203786708 U	08-20-2014	GUANGZHOU SHIRUI ELECTRICAL TECHNOLOGY CO., LTD.		
	20	CN 203825586 U	09-10-2014	SHENZHEN TIMELINK TECHNOLOGY CO., LTD		
	21	CN204288179U	04-22-2015	BEIJING DONVIEW EDUCATION & TECHNOLOGY CO., LTD.		
	22	DE 10025175 A1	12-06-2001	FRIENDLYWAY AKTIENGESELLSCHAFT FUER ANWENDERFREUNDLICHE SYSTEME		
	23	DE 102009003990 A1	07-08-2010	WINCOR NIXDORF INTERNATIONAL GMBH		
	24	JP2015158831A	02-07-2018	TAKEUCHI YOSHIFUMI; YANO HISAAKI		
	25	KR 101081586B1	11-08-2011	SAMSUNG ELECTRO-MECHANICS CO., LTD.		
	26	KR 20150125374A	11-09-2015	LG ELECTRONICS INC.		
	27	TW M517370U	02-11-2016	TEKQ TECHNOLOGY CO., LTD.		
	28	WO 2014/098742	06-26-2014	FLATFROG LABORATORIES AB		
	29	WO 2014/130515	08-28-2014	CORNING INC		
	30	WO 2017/099657	06-15-2017	FLATFROG LABORATORIES AB		

Examiner Signature	/ADAM R. GIESY/	Date Considered	09/29/2021

***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PTO/SB/08 Equivalent

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 3 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	31	Defendants' Initial Invalidity Contentions, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	32	Exhibit 1: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on Prior Public Use and/or Commercial Offer for Sale of Defendant Promethean Inc.'s ActivPanel 4.5 Product, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	33	Exhibit 2: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. U.S. Pre-Grant Pub. No. 2019/0235701 to Han et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	34	Exhibit 3A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	35	Exhibit 3B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	36	Exhibit 3C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	37	Exhibit 4A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	38	Exhibit 4B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	39	Exhibit 4C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	40	Exhibit 5A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	41	Exhibit 5B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	42	Exhibit 5C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	43	Exhibit 6A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	44	Exhibit 6B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	09/29/2021

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 4 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	45	Exhibit 6C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	46	Exhibit 7A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	47	Exhibit 7B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	48	Exhibit 7C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	49	Exhibit 8: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Prior Public Use and/or Commercial Offer for Sale of Defendant Promethean Inc.'s ActivPanel 4.5 Product, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	50	Exhibit 9: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. CN 203786707 U to Chen et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	51	Exhibit 10: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on International App. Pub. No. WO2014131221 to Chen et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	52	Exhibit 11: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Pub. App. No. 104391611 A to Hu et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	53	Exhibit 12: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. 203786708 U to Cao, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	54	Exhibit 13: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. 204288179 U to Mo et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	55	Defendants' Sur-Reply Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 13, 2021, in 24 pages.	
	56	Defendants Promethean Ltd. and Promethean Inc.'s Preliminary Proposed Claim Constructions, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated May 24, 2021, in 8 pages.	
	57	Notice of Service, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 2 pages.	
	58	ASTM International, "Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass," Designation: C 1048-04, in 7 pages.	
	59	British Standard, "Glass in building - Thermally toughened soda lime silicate safety glass," EN 12150-1:2000, ISBN 0 580 36171 3, August 15, 2000, in 28 pages.	
	60	Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 92 pages.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	09/29/2021

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T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 5 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	61	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 1 of 4).	
	62	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 2 of 4).	
	63	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 3 of 4).	
	64	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 4 of 4).	

54161815

Examiner Signature	/ADAM R. GIESY/	Date Considered	09/29/2021

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T[1] - Place a check mark in this area when an English language Translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.R.G./

Doc Code: ECOMM.AUTH/ECOMM.WTDW

Doc Description: Internet Communications Authorized/Internet Communications Authorization Withdrawn

PTO/SB/439 (11-15)

AUTHORIZATION FOR INTERNET COMMUNICATIONS IN A PATENT APPLICATION OR REQUEST TO WITHDRAW AUTHORIZATION FOR INTERNET COMMUNICATIONS		
	Application No.	16/989,292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
	Examiner Name	Adam Giesy
	Practitioner Docket No.	14700.0005-00000

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I. To authorize permission for Internet Communications.

☑ Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned and practitioners in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via video conferencing, instant messaging, or electronic mail. I understand that a copy of these communications will be made of record in the application file. (MPEP 502.03)

II. To withdraw authorization for Internet Communications.

☐ The authorization given on _____, to the USPTO to communicate with the undersigned and any practitioner in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via internet communications such as video conferencing, instant messaging, or electronic mail is hereby withdrawn. I understand that the withdrawal is effective when approved rather than when received.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 63,681.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Arpita Bhattacharyya/ — Signature

11-4-2021 — Date

Arpita Bhattacharyya — Typed or printed name

650-849-6650 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Juristic entities must be represented by a patent practitioner (see 37 CFR 1.31, which is applicable to any paper filed on or after September 16, 2012, that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	44203976
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	22852
Filer:	JOHN MICHAEL MULCAHY/Susan Benesh
Filer Authorized By:	JOHN MICHAEL MULCAHY
Attorney Docket Number:	14700.0005-00000
Receipt Date:	04-NOV-2021
Filing Date:	10-AUG-2020
Time Stamp:	13:20:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Internet Communications Authorized	14700_0005_00_Internet_authorization_as_filed.pdf	87731 9bd403e14a51ec0acb37d6c494b528d5299982f6	no	2

Warnings:

Information:	
Total Files Size (in bytes):	87731

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: ECOMM.AUTH/ECOMM.WTDW
Doc Description: Internet Communications Authorized/Internet Communications Authorization Withdrawn

PTO/SB/439 (11-15)

AUTHORIZATION FOR INTERNET COMMUNICATIONS IN A PATENT APPLICATION OR REQUEST TO WITHDRAW AUTHORIZATION FOR INTERNET COMMUNICATIONS		
	Application No.	16/989,292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
	Examiner Name	Adam Giesy
	Practitioner Docket No.	14700.0005-00000

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I am the

☐ applicant.

☑ attorney or agent of record. Registration number 63,681.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Arpita Bhattacharyya/ — Signature
11-4-2021 — Date

Arpita Bhattacharyya — Typed or printed name
650-849-6650 — Telephone Number

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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Electronic Acknowledgement Receipt

EFS ID:	44203740
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	22852
Filer:	JOHN MICHAEL MULCAHY/Susan Benesh
Filer Authorized By:	JOHN MICHAEL MULCAHY
Attorney Docket Number:	14700.0005-00000
Receipt Date:	04-NOV-2021
Filing Date:	10-AUG-2020
Time Stamp:	13:05:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Internet Communications Authorization Withdrawn	14700_0005_00_Internet_withdrawal_as_filed.pdf	87731 9bd403e14a51ec0acb37d6c494b528d5299982f6	no	2

Warnings:

Information:	
Total Files Size (in bytes):	87731

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/989,292	08/10/2020	Daniel Skagmo	FFOG.054C6

CONFIRMATION NO. 8380

POWER OF ATTORNEY NOTICE

20995
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614



Date Mailed: 10/20/2021

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/15/2021.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/cvorachack/

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 101

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/989,292	08/10/2020	Daniel Skagmo	14700.0005-00000

CONFIRMATION NO. 8380

POA ACCEPTANCE LETTER

22852
FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

OC00000129191501

Date Mailed: 10/20/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/15/2021.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/evorachack/

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 102

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/989,292
Filing Date	August 10, 2020
First Named Inventor	Daniel Skagmo
Title	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Art Unit	2694
Examiner Name	Adam Giesy
Attorney Docket Number	14700.0005-00000

SIGNATURE of Applicant or Patent Practitioner

Signature	/Arpita Bhattacharyya/	Date (Optional)	
Name	Arpita Bhattacharyya	Registration Number	63,681
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of - 1 - forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 22852

OR

I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

FlatFrog Laboratories AB

Inventor or Joint Inventor (title not required below)

Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Dhwani Vyas	Date (Optional)	
Name	Dhwani Vyas		
Title	CEO, FlatFrog Laboratories AB		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	44042306
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Elizabeth Diane Ferrill/Maria Poulakos
Filer Authorized By:	Elizabeth Diane Ferrill
Attorney Docket Number:	FFOG.054C6
Receipt Date:	15-OCT-2021
Filing Date:	10-AUG-2020
Time Stamp:	14:30:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	As_Filed_POA_Transmittal_with_POA_14700_0005.pdf	228848 0ed52ae8b9504424ccf000d9b3c0710369f69a7f	no	2

Warnings:

Information:	
Total Files Size (in bytes):	228848

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 1 OF 5	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	9,983,626	05-29-2018	Cao et al.	
	2	2013/0257810	10-03-2013	Niu et al.	
	3	5,729,250	03-17-1998	Bishop et al.	
	4	8,319,729	11-27-2012	Choi et al.	
	5	9,291,845	03-22-2016	Shin et al.	
	6	9,366,802	06-14-2016	Lee et al.	
	7	2013/0222344	08-29-2013	Lu et al.	
	8	2014/0210793	07-31-2014	Eriksson et al.	
	9	2015/0256658	09-10-2015	Shin et al.	
	10	2017/0123257	05-04-2017	Zhao	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	11	CN 104391611 A	09-29-2017	SHENZHEN IBOARD TECHNOLOGY Co Ltd		X-Abs
	12	CN 203786707 U	08-20-2014	SHENZHEN TIMELINK ECHNOLOGY CO., LTD.		X-Abs
	13	CN203786708U	08-20-2014	Guangzhou Shirui Electronics Co Ltd		X-Abs
	14	WO 2014/131221	09-04-2014	SHENZHEN TIMELINK TECHNOLOGY CO LT		X-Abs
	15	CN 102117155A	07-06-2011	Guangzhou Shirui Electronics Co Ltd		
	16	CN 104808843A	07-29-2015	Interface Optoelectronics Shenzhen Co Ltd., Cheng Cheng Technology Chengdu Co Ltd.		
	17	CN202887145U	04-17-2013	HANGZHOU WANIN EDUCATION MULTIMEDIA TECHNOLOGY CO LTD		

Examiner Signature	Date Considered

***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 2 OF 5	Attorney Docket No.	FFOG.054C6

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	18	CN 203720812 U	07-16-2014	CHEN YUNHUA; LI RUILIANG		
	19	CN 203786708 U	08-20-2014	GUANGZHOU SHIRUI ELECTRICAL TECHNOLOGY CO., LTD.		
	20	CN 203825586 U	09-10-2014	SHENZHEN TIMELINK TECHNOLOGY CO., LTD		
	21	CN204288179U	04-22-2015	BEIJING DONVIEW EDUCATION & TECHNOLOGY CO., LTD.		
	22	DE 10025175 A1	12-06-2001	FRIENDLYWAY AKTIENGESELLSCHAFT FUER ANWENDERFREUNDLICHE SYSTEME		
	23	DE 102009003990 A1	07-08-2010	WINCOR NIXDORF INTERNATIONAL GMBH		
	24	JP2015158831A	02-07-2018	TAKEUCHI YOSHIFUMI; YANO HISAAKI		
	25	KR 101081586B1	11-08-2011	SAMSUNG ELECTRO-MECHANICS CO., LTD.		
	26	KR 20150125374A	11-09-2015	LG ELECTRONICS INC.		
	27	TW M517370U	02-11-2016	TEKQ TECHNOLOGY CO., LTD.		
	28	WO 2014/098742	06-26-2014	FLATFROG LABORATORIES AB		
	29	WO 2014/130515	08-28-2014	CORNING INC		
	30	WO 2017/099657	06-15-2017	FLATFROG LABORATORIES AB		

Examiner Signature	Date Considered

***Examiner:** Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 3 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	31	Defendants' Initial Invalidity Contentions, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	32	Exhibit 1: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on Prior Public Use and/or Commercial Offer for Sale of Defendant Promethean Inc.'s ActivPanel 4.5 Product, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	33	Exhibit 2: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. U.S. Pre-Grant Pub. No. 2019/0235701 to Han et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	34	Exhibit 3A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	35	Exhibit 3B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	36	Exhibit 3C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 4,751,379 to Sasaki et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	37	Exhibit 4A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	38	Exhibit 4B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	39	Exhibit 4C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0004668 to Jeong et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	40	Exhibit 5A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	41	Exhibit 5B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	42	Exhibit 5C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,983,626 to Cao et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	43	Exhibit 6A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	44	Exhibit 6B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	

Examiner Signature	Date Considered

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2694
(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 4 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	45	Exhibit 6C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Pre-Grant Pub. No. 2019/0025984 to Weilbacher et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	46	Exhibit 7A: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	47	Exhibit 7B: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	48	Exhibit 7C: Invalidity Claim Chart Against U.S. Patent No. 10,775,935 Based on U.S. Patent No. 9,207,800 to Eriksson et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	49	Exhibit 8: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Prior Public Use and/or Commercial Offer for Sale of Defendant Promethean Inc.'s ActivPanel 4.5 Product, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	50	Exhibit 9: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. CN 203786707 U to Chen et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	51	Exhibit 10: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on International App. Pub. No. WO2014131221 to Chen et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	52	Exhibit 11: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Pub. App. No. 104391611 A to Hu et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	53	Exhibit 12: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. 203786708 U to Cao, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	54	Exhibit 13: Invalidity Claim Chart Against U.S. Patent No. 10,739,916 Based on Chinese Utility Model No. 204288179 U to Mo et al., FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 26 pages.	
	55	Defendants' Sur-Reply Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 13, 2021, in 24 pages.	
	56	Defendants Promethean Ltd. and Promethean Inc.'s Preliminary Proposed Claim Constructions, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated May 24, 2021, in 8 pages.	
	57	Notice of Service, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated April 23, 2021, in 2 pages.	
	58	ASTM International, "Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass," Designation: C 1048-04, in 7 pages.	
	59	British Standard, "Glass in building - Thermally toughened soda lime silicate safety glass," EN 12150-1:2000, ISBN 0 580 36171 3, August 15, 2000, in 28 pages.	
	60	Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 92 pages.	

Examiner Signature	Date Considered

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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(Multiple sheets used when necessary)	Examiner	Giesy, Adam
SHEET 5 OF 5	Attorney Docket No.	FFOG.054C6

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
	61	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 1 of 4).	
	62	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 2 of 4).	
	63	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 3 of 4).	
	64	Joint Appendix of Exhibits to Joint Claim Construction Brief, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 1:19-cv-02246-MN, dated September 20, 2021, in 383 pages, (uploaded in 4 parts, part 4 of 4).	

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Examiner Signature	Date Considered

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

RESPONSE TO OFFICE ACTION DATED JULY 22, 2021

First Inventor: Daniel Skagmo	**Conf. No.:** 8380
App. No.: 16/989292	**Filed:** August 10, 2020
Examiner: Giesy, Adam	**Art Unit:** 2694
Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In response to the Office Action mailed July 22, 2021, the Applicant respectfully requests the above-identified application be amended as follows:

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AMENDMENTS TO THE CLAIMS

The following listing of claims replaces all prior versions thereof. Changes are shown below in highlighted form, where insertions appear as underlined text (e.g., insertions) while deletions appear as strikethrough text (e.g., ~~deletions~~) or double brackets (e.g., [[deletions]]).

1. - 5. (Canceled)

6. (Currently Amended) A touch sensing apparatus comprising:

a panel comprising a touch surface, a back surface, and an edge surface;

a plurality of light emitters and detectors arranged along a perimeter of the panel;

a substrate, wherein an emitter is mounted on the substrate and is configured to transmit light in a plane above the touch surface and perpendicular to a normal of the touch surface; and

a support structure configured to support the substrate;

wherein the support structure is formed from a single monolithic piece comprising:

a first portion extending parallel to the edge surface and above and below the touch surface; and

a second portion extending parallel to the touch surface to overlap with at least a portion of the touch surface.

7. (Previously Presented) The touch sensing apparatus according to claim 6, wherein the support structure comprises a cavity, wherein the substrate is arranged in the cavity.

8. (Previously Presented) The touch sensing apparatus according to claim 6, wherein the substrate is fixed to the first portion of the support structure.

9. (Previously Presented) The touch sensing apparatus according to claim 6, wherein the single monolithic piece of the support structure comprises a third portion extending parallel to the first portion, wherein the substrate is arranged between the first portion and the third portion.

10. (Previously Presented) The touch sensing apparatus according to claim 9, wherein the substrate is fixed to the third portion.

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11. (Previously Presented) The touch sensing apparatus according to claim 6, wherein the support structure is configured to attach to a display support, wherein the display support is configured to support a display.

12. (Previously Presented) The touch sensing apparatus according to claim 11, wherein the support structure comprises a recess configured to interlock with a corresponding mating surface of the display support

13. (Previously Presented) The touch sensing apparatus according to claim 6, wherein the support structure is formed from an extrusion process, drawing process, rolling process, or molding process.

14. (Previously Presented) The touch sensing apparatus according to claim 6, comprising an optical element configured to be secured between the touch surface and the second portion of the support structure, wherein the optical element comprises a first surface facing the emitter and being configured to receive the transmitted light from the emitter and a second surface configured to receive light propagating across a touch interacting portion of the touch surface.

15. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the first surface is tilted relative to the normal axis of the touch surface.

16. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the optical element is configured to slide between the touch surface and the second portion of the support structure.

17. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the optical element comprises a protrusion and/or recess to interlock with a corresponding mating surface of the second portion.

18. (Previously Presented) The touch sensing apparatus according to claim 17, wherein the protrusion and/or recess is configured to snap into the second portion.

19. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the optical element is configured to be secured to the second portion along a third surface and wherein a fourth surface, opposite the third surface, contacts the touch surface.

20. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the fourth surface contacts only the touch surface.

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21. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the optical element is configured to be secured against the touch surface by only the second portion.

22. (Previously Presented) The touch sensing apparatus according to claim 14, wherein the optical element contacts only the second

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REMARKS

By way of summary, Claims 6-22 remain pending.

Double Patenting Rejections

The Office Action rejected Claims 6 – 8 under the grounds of nonstatutory double patenting rejections. *Office Action*, 3. Without acquiescing to the rejections or the characterization of claims and solely in the interest of expediting prosecution, Applicant is submitting a terminal disclaimer herewith. Based on the terminal disclaimer, Applicant respectfully requests withdrawal of the rejections.

Allowable Subject Matter

Applicant thanks the Examiner for the allowable subject matter. The application is now in condition for allowance.

Co-Pending Applications of Assignee

Applicant wishes to draw the Examiner's attention to the following co-pending applications of the present application's assignee.

Docket No.	Serial No.	Title	Filed
FFOG.054C7	17/101538	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	November 23, 2020

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by

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the present application. Further, Applicant's arguments in favor of one independent claim should not be imputed to any other independent claim.

Conclusion

In view of the foregoing amendments and remarks, Applicant respectfully requests that the Examiner withdraw the outstanding rejections and allow the present application. If any issues arise during examination, the Examiner is invited to call the undersigned representative at his direct dial number listed below.

By focusing on specific claims and claim recitations in the discussion above, Applicant does not intend to imply that other claim recitations are disclosed or rendered obvious by the art of record.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: September 27, 2021

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(19)中华人民共和国国家知识产权局

(12)实用新型专利

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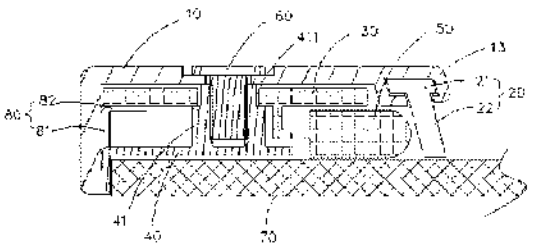
权利要求书1页 说明书3页 附图2页

(54)实用新型名称

拆装式红外触摸装置及红外触摸屏

(57)摘要

本实用新型公开了一种拆装式红外触摸装置及红外触摸屏，其中外框架包括面板及与面板相连的侧板，面板与侧板垂直设置，面板上间隔开设有卡孔，面板远离侧板一侧设有卡持部，滤光条卡持在卡持部内；支架置于外框架下方，支架匹配卡孔处设有卡柱，卡孔与卡柱通过螺丝件进行固接；电路板卡持在外框架与支架之间，红外装置电性连接在电路板上并匹配滤光条设置。本实用新型通过将滤光条卡持在外框架的卡槽内，滤光条与外框架分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架，通过螺丝件将卡孔与卡柱进行固接，使得电路板能稳定固接在外框架与支架之间；并在对装置进行维修时，拆下螺丝件即能让电路板裸露在装置外侧，方便取出维护。



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1. 一种拆装式红外触摸装置，其特征在于：包括外框架、滤光条、电路板、支架及红外装置，所述外框架包括面板及与面板相连的侧板，所述面板与所述侧板垂直设置，所述面板上间隔开设有卡孔，所述面板远离侧板一侧设有卡持部，所述滤光条卡持在卡持部内；所述支架置于所述外框架下方，所述支架匹配卡孔处设有卡柱，所述卡孔与卡柱通过螺丝件进行固接；所述电路板卡持在所述外框架与支架之间，所述红外装置电性连接在电路板上并匹配所述滤光条设置。

2. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述支架下表面贴合触摸显示屏设置。

3. 根据权利要求 2 所述的拆装式红外触摸装置，其特征在于：所述触摸显示屏一侧与支架之间设有双面胶，所述双面胶用于将所述支架与触摸显示屏固定粘合。

4. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述卡持部横向开设有卡槽，所述滤光条卡持在卡槽内。

5. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述电路板上匹配所述卡孔处开设有开孔，所述卡柱贯穿所述电路板设置；所述卡柱上端部周侧设置有支撑部，所述支撑部用于对电路板支撑固定。

6. 根据权利要求 5 所述的拆装式红外触摸装置，其特征在于：所述支撑部为 L 型构造。

7. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述外框架内侧部贴合设置有支撑条，所述支撑条设置有一体成型的侧片及支撑片，所述侧片贴合所述外框架设置，所述支撑片与所述侧片垂直设置，所述支撑片用于支撑所述电路板一端部。

8. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述滤光条包括一体成型的基部及滤光部，所述基部与滤光部呈 T 型构造，所述基部卡持容置在卡槽内。

9. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述外框架采用不锈钢材质制造。

10. 一种红外触摸屏，其特征在于：包括如权利要求 1 ～ 9 任一项所述的拆装式红外触摸装置及其贴合的触摸显示屏。

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拆装式红外触摸装置及红外触摸屏

技术领域

[0001] 本实用新型涉及触控设备技术领域，尤其是涉及一种拆装式红外触摸装置及红外触摸屏。

背景技术

[0002] 红外触摸屏是利用 X、Y 方向上密布的红外线矩阵来检测并定位用户的触摸，包括滤光条、电路板、外框、显示屏玻璃、红外发射管和红外接收器等，红外发射管和红外接收器交叉安装在高度集成的电路板上的两个相对的方向，形成一个不可见的红外线光栅，滤光条通过外框固定在红外发射管和红外接收器前方。电路板上的控制电路持续地对二极管发出脉冲形成红外线偏震光束格栅，当用户在触摸显示屏玻璃时，手指或其它物体就会挡住经过该位置上方的横竖两条红外线，阻断了光束，由控制器判断出触摸点在显示屏玻璃的位置，从而达到触摸和手写效果。

[0003] 红外触摸屏不受电流电压和静电干扰，适宜恶劣的环境条件，所以普遍认为红外线技术是触摸屏产品最终的发展趋势，如果为了美观而减少红外触摸屏的组装结构，将更多的结构进行一体成型，而当结构中存在部分瑕疵时，会将整体结构进行统一替换，无形中增加了维护成本，同时，进行一体成型化生产也会增大生产的难度，不利于生产效率的有效提高。

实用新型内容

[0004] 基于此，有必要针对现有技术的不足，提供一种生产容易、维护方便，降低成本的拆装式红外触摸装置及红外触摸屏。

[0005] 为解决上述技术问题，本实用新型所采用的技术方案是：一种拆装式红外触摸装置，其包括外框架、滤光条、电路板、支架及红外装置，所述外框架包括面板及与面板相连的侧板，所述面板与所述侧板垂直设置，所述面板上间隔开设有卡孔，所述面板远离侧板一侧设有卡持部，所述滤光条卡持在卡持部内；所述支架置于所述外框架下方，所述支架匹配卡孔处设有卡柱，所述卡孔与卡柱通过螺丝件进行固接；所述电路板卡持在所述外框架与支架之间，所述红外装置电性连接在电路板上并匹配所述滤光条设置。

[0006] 在其中一个实施例中，所述支架下表面贴合触摸显示屏设置。

[0007] 在其中一个实施例中，所述触摸显示屏一侧与支架之间设有双面胶，所述双面胶用于将所述支架与触摸显示屏固定粘合。

[0008] 在其中一个实施例中，所述卡持部横向开设有卡槽，所述滤光条卡持在卡槽内。

[0009] 在其中一个实施例中，所述电路板上匹配所述卡孔处开设有开孔，所述卡柱贯穿所述电路板设置；所述卡柱上端部周侧设置有支撑部，所述支撑部用于对电路板支撑固定。

[0010] 在其中一个实施例中，所述支撑部为 L 型构造。

[0011] 在其中一个实施例中，所述外框架内侧部贴合设置有支撑条，所述支撑条设置有一体成型的侧片及支撑片，所述侧片贴合所述外框架设置，所述支撑片与所述侧片垂直设

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置，所述支撑片用于支撑所述电路板一端部。

[0012] 在其中一个实施例中，所述滤光条包括一体成型的基部及滤光部，所述基部与滤光部呈 T 型构造，所述基部卡持容置在卡槽内。

[0013] 在其中一个实施例中，所述外框架采用不锈钢材质制造。

[0014] 一种红外触摸屏，其包括上述述的拆装式红外触摸装置及其贴合的触摸显示屏。

[0015] 综上所述，本实用新型拆装式红外触摸装置及红外触摸屏通过将滤光条卡持在外框架的卡槽内，滤光条与外框架分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架，通过螺丝件将卡孔与卡柱进行固接，使得电路板能稳定固接在外框架与支架之间；并在对装置进行维修时，拆下螺丝件即能让电路板裸露在装置外侧，方便取出维护。

附图说明

[0016] 图 1 为本实用新型拆装式红外触摸装置的结构示意图；

[0017] 图 2 为图 1 本实用新型拆装式红外触摸装置的截面示意图；

[0018] 图 3 为图 1 本实用新型拆装式红外触摸装置隐藏部分结构的截面示意图。

具体实施方式

[0019] 为能进一步了解本实用新型的特征、技术手段以及所达到的具体目的、功能，下面结合附图与具体实施方式对本实用新型作进一步详细描述。

[0020] 如图 1 至图 3 所示，本实用新型拆装式红外触摸装置包括外框架 10、滤光条 20、电路板 30、支架 40 及红外装置 50，所述外框架 10 采用不锈钢材质制造，所述外框架 10 包括面板 11 及与面板 11 相连的侧板 12，所述面板 11 与所述侧板 12 垂直设置，所述面板 11 上间隔开设有卡孔 111，所述面板 11 远离侧板 12 一侧设有卡持部 13，所述卡持部 13 横向开设有卡槽 131，所述滤光条 20 卡持在卡槽 131 内，将外框架 10 与滤光条 20 组装设置，降低了一体成型式生产的难度，同时也降低生产成本；所述支架 40 置于所述外框架 10 下方，所述支架 40 匹配卡孔 111 处设有卡柱 41，所述卡孔 111 与卡柱 41 通过螺丝件 60 进行固接，使得外框架 10 与支架 40 稳定固接；所述支架 40 下表面贴合触摸显示屏 70 设置，进一步地，所述触摸显示屏 70 一侧与支架 40 之间设有双面胶，所述双面胶用以将所述支架 40 与触摸显示屏 70 固定粘合。

[0021] 所述电路板 30 卡持在所述外框架 10 与支架 40 之间，所述红外装置 50 电性连接在电路板 30 上并匹配所述滤光条 20 设置；在其中一个实施例中，所述红外装置 50 为红外发射管或红外接收器，所述红外接收器用以接收从红外发射管发出的红外光线信号。

[0022] 进一步地，所述电路板 30 上匹配所述卡孔 111 处开设有开孔，所述卡柱 41 贯穿所述电路板 30 设置；所述卡柱 41 上端部周侧设置有 L 型支撑部 411，所述支撑部 411 用于对电路板 30 支撑固定，以保证电路板 30 能稳固装置在所述外框架 10 与支架 40 之间。

[0023] 在其中一个实施例中，所述外框架 10 内侧部贴合设置有支撑条 80，所述支撑条 80 设置有一体成型的侧片 81 及支撑片 82，所述侧片 81 贴合所述外框架 10 设置，所述支撑片 82 与所述侧片 81 垂直设置，所述支撑片 82 用于支撑所述电路板 30 一端部，与卡柱 41 的支撑部 411 共同对电路板 30 进行支撑固定，使得电路板 30 能更稳固地装设在所述外框架 10

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与支架 40 之间。

[0024] 在其中一个实施例中，所述滤光条 20 包括一体成型的基部 21 及滤光部 22，所述基部 21 与滤光部 22 呈 T 型构造，所述基部 21 卡持容置在卡槽 131 内，所述滤光部 22 斜向下设置，所述滤光部 22 用以过滤经过其内部的光线，以保证红外接收器能准确识别红外发射管发出的红外光线。

[0025] 本实用新型还提供了一种红外触摸屏，包括上述一种拆装式红外触摸装置的外框架 10、滤光条 20、支架 40、电路板 30 及红外装置 50，还包括与拆装式红外触摸装置贴合的触摸显示屏 70。

[0026] 上述一种红外触摸屏的其他技术特征与上述一种红外触摸装置相同，此处不予赘述。

[0027] 本实用新型具体组装时，首先通过双面胶将支架 40 与触摸显示屏 70 进行粘合，将组装好红外装置 50 的电路板 30 安设在卡柱 41 上，此时，卡柱 41 贯穿电路板 30 上开设的开孔，支撑部 411 对电路板 30 起到支撑作用，使得电路板 30 能稳固地进行安设；然后，将组装好滤光条 20 的外框架 10 安设在支架 40 上方，此时，外框架 10 的卡孔 111 匹配卡柱 41 设置，通过螺丝件 60 使得卡孔 111 和卡柱 41 对接，完成对外框接与支架 40 的固接，同时也使得电路板 30 稳定固定在外框架 10 与支架 40 之间；本实用新型进行拆装时，直接将螺丝件 60 拆下，将外框架 10 与支架 40 分离，此时，电路板 30 即可裸露在装置外侧，方便取出进行维护。

[0028] 综上所述，本实用新型拆装式红外触摸装置及红外触摸屏通过将滤光条 20 卡持在外框架 10 的卡槽 131 内，滤光条 20 与外框架 10 分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架 40，通过螺丝件 60 将卡孔 111 与卡柱 41 进行固接，使得电路板 30 能稳定固接在外框架 10 与支架 40 之间；并在对装置进行维修时，拆下螺丝件 60 即能让电路板 30 裸露在装置外侧，方便取出维护。

[0029] 以上所述实施例仅表达了本实用新型的几种实施方式，其描述较为具体和详细，但并不能因此而理解为对本实用新型范围的限制。应当指出的是，对于本领域的普通技术人员来说，在不脱离本实用新型构思的前提下，还可以做出若干变形和改进，这些都属于本实用新型的保护范围。因此，本实用新型的保护范围应以所附权利要求为准。

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Chemtronics Exhibit 1002 Page 122
DEF_00004632

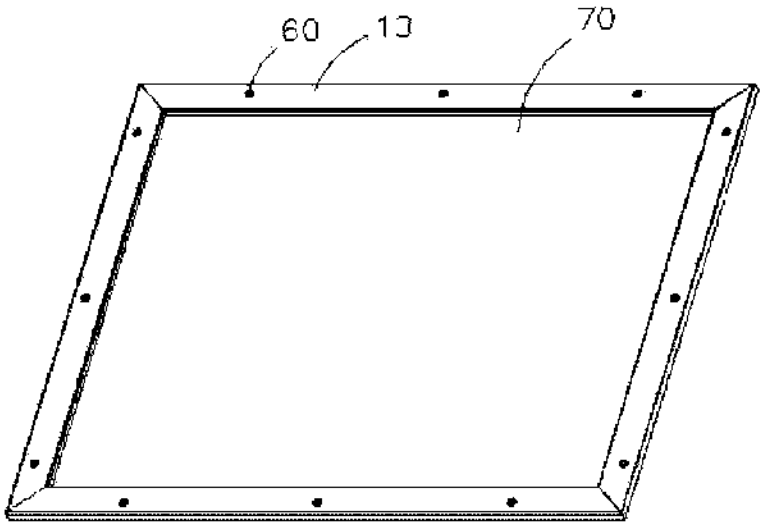


图 1

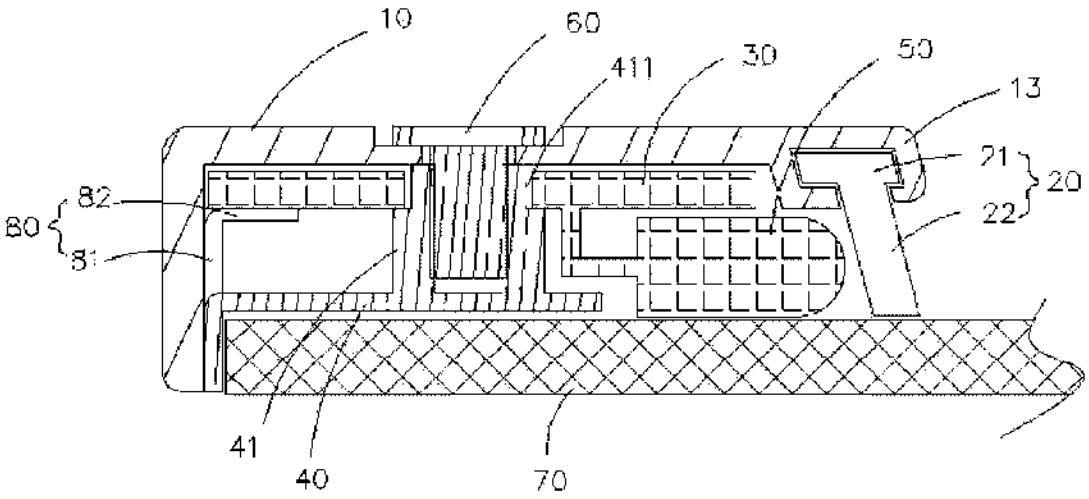


图 2

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Chemtronics Exhibit 1002 Page 123
DEF_00004633

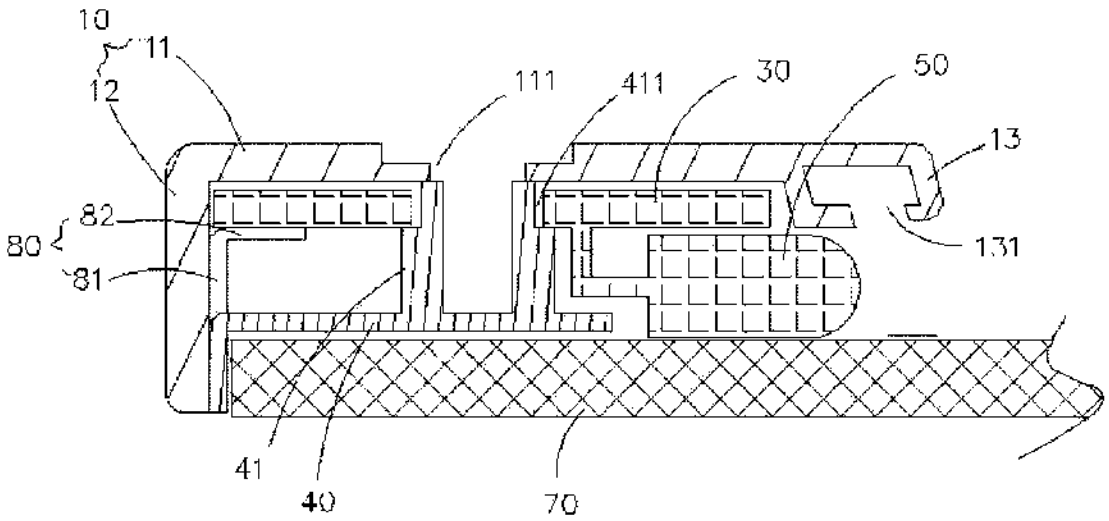


图 3

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 124
DEF_00004634

Electronic Patent Application Fee Transmittal

Application Number:	16989292
Filing Date:	10-Aug-2020
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Filer:	Harnik Shukla/Jenny Kim
Attorney Docket Number:	FFOG.054C6

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	260	260
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt

EFS ID:	43879511
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Jim Nyenhuis
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.054C6
Receipt Date:	27-SEP-2021
Filing Date:	10-AUG-2020
Time Stamp:	20:06:32
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$260
RAM confirmation Number	E20219QK07551670
Deposit Account	111410
Authorized User	Jim Nyenhuis

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Multipart Description/PDF files in .zip description

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Transmittal Letter	1	2
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Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	4
Applicant Arguments/Remarks Made in an Amendment	5	6

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Espacenet

CN104391611A Infrared touch equipment with high light resistance and touch detection unit thereof

Applicants: SHENZHEN IBOARD TECHNOLOGY CO LTD

Inventors: HU LONG

Classifications:
IPC ***G06F3/042;***

CPC **G06F3/0421 (CN)**; G06F2203/04109 (CN);

Priorities: CN201410528713A 2014-10-09

Application: CN104391611A 2014-10-09

Publication: CN104391611A 2015-03-04

Published as: CN104391611A;**CN104391611B**

Infrared touch equipment with high light resistance and touch detection unit thereof

Abstract

The invention relates to infrared touch equipment with high light resistance, which comprises a touch screen, a first group of infrared transmitters, a first group of infrared receivers and a first infrared optical filter. The touch screen is provided with a first edge and a second edge which are opposite. The first group of infrared transmitters is arranged at the first edge of the touch screen. The first group of infrared receivers is arranged at the second edge of the touch screen. The first group of infrared receivers corresponds to the first group of infrared transmitters one to one and is used for receiving infrared rays transmitted by the corresponding first group of infrared transmitters. The first infrared optical filter is arranged at a light inlet at the second edge. A tunnel structure is formed between the first infrared optical filter and the first group of infrared receivers; the tunnel structure is constructed to be used for weakening intensity of environmental light which passes through the first infrared optical filter and reaches the first group of infrared receivers.

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代理人 李亚萍

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G06F 3/042(2006.01)

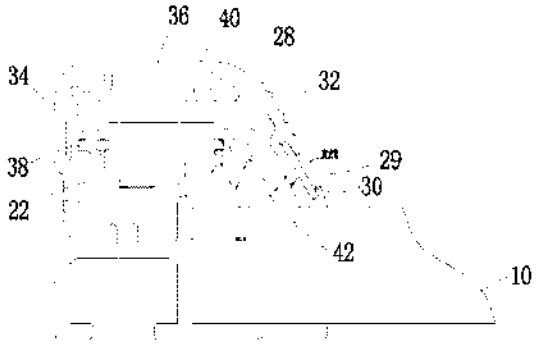
权利要求 2页 说明书 5页 附图3页

(54)发明名称

具有高抗光性能的红外触摸设备及其触摸检测单元

(57)摘要

一种具有高抗光性能的红外触摸设备，包括：触摸屏、第一组多个红外发射器、第一组多个红外接收器以及第一红外滤光片。触摸屏具有相对的第一边缘和第二边缘。第一组多个红外发射器设置在触摸屏的第一边缘。第一组多个红外接收器设置在触摸屏的第二边缘。第一组多个红外接收器与第一组多个红外发射器一一对应，用以接收对应的第一组红外发射器发出的红外线。第一红外滤光片设置在位于第二边缘的光线入口处，在第一红外滤光片与第一组红外接收器之间形成隧道结构，该隧道结构构造成用以减弱穿过第一红外滤光片并到达第一组多个红外接收器的环境光线的强度。



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1. 一种具有高抗光性能的红外触摸设备，包括：

触摸屏，所述触摸屏具有相对的第一边缘和第二边缘；

第一组多个红外发射器，设置在所述触摸屏的第一边缘；

第一组多个红外接收器，设置在所述触摸屏的第二边缘，所述第一组多个红外接收器与所述第一组多个红外发射器一一对应，用以接收对应的第一组红外发射器发出的红外线；以及

第一红外滤光片，设置在位于所述第二边缘的光线入口处；

其特征在于：

在所述第一红外滤光片与所述第一组红外接收器之间形成隧道结构，所述隧道结构构造成用以减弱穿过所述第一红外滤光片并到达所述第一组多个红外接收器的环境光线的强度。

2. 如权利要求 1 所述的具有高抗光性能的红外触摸设备，其特征在于，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上并与所述触摸屏平行，所述第一组红外接收器安装在所述电路板上的远离所述触摸屏的一端。

3. 如权利要求 1 所述的具有高抗光性能的红外触摸设备，其特征在于，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上并与所述触摸屏垂直。

4. 如权利要求 1 所述的具有高抗光性能的红外触摸设备，其特征在于，所述第一红外滤光片倾斜设置。

5. 如权利要求 4 所述的具有高抗光性能的红外触摸设备，其特征在于，所述第一红外滤光片的倾斜角度在 45 至 60 度之间。

6. 如权利要求 4 所述的具有高抗光性能的红外触摸设备，其特征在于，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上，所述边框包括面对所述第一组红外发射器的内侧框部、远离所述第一组红外发射器的外侧框部以及连接所述内侧框部和外侧框部的边框正面连接部，所述内侧框部自所述边框正面连接部沿远离所述第一组红外接收器并朝向所述触摸屏的方向倾斜延伸，所述第一红外滤光片位于所述内侧框部上。

7. 如权利要求 1 所述的具有高抗光性能的红外触摸设备，其特征在于，所述第一组红外接收器与所述光线入口的距离不小于 11 毫米。

8. 如权利要求 1 所述的具有高抗光性能的红外触摸设备，其特征在于，所述红外触摸设备包括沿所述第二边缘设置的边框，所述隧道结构由所述边框的结构形成或由所述边框的结构与所述触摸屏共同形成。

9. 如权利要求 1-8 中任意一项所述的具有高抗光性能的红外触摸设备，其特征在于，所述触摸屏具有相对的第三边缘和第四边缘，所述第三边缘和第四边缘与所述第一边缘和第二边缘不同，所述红外触摸设备还包括：

第二组多个红外发射器，设置在所述触摸屏的第三边缘；

第二组多个红外接收器，设置在所述触摸屏的第四边缘，所述第二组多个红外接收器与所述第二组多个红外发射器一一对应，用以接收对应的第二组红外发射器发出的红外

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线；以及

第二红外滤光片，设置在位于所述第四边缘的光线入口处；

其中，在所述第二红外滤光片与所述第二组红外接收器之间形成隧道结构，所述隧道结构构造成用以降低穿过所述第二红外滤光片并到达所述第二组多个红外接收器的环境光线的强度。

10. 一种具有高抗光性能的红外触摸设备的触摸检测单元，包括：

相对设置的第一组多个红外发射器和第一组多个红外接收器，所述第一组多个红外接收器与所述第一组多个红外发射器一一对应，用以接收对应的第一组红外发射器发出的红外线；

第一红外滤光片，设置在所述第一组红外发射器发出的红外线的光路上并靠近所述第一组红外接收器；

相对设置的第二组多个红外发射器和第二组多个红外接收器，所述第二组多个红外接收器与所述第二组多个红外发射器一一对应，用以接收对应的第二组红外发射器发出的红外线；

第二红外滤光片，设置在所述第二组红外发射器发出的红外线的光路上并靠近所述第二组红外接收器；

其特征在于：

至少在所述第一红外滤光片和第二红外滤光片其中之一与其对应的第一组或第二组红外接收器之间形成隧道结构，所述隧道结构构造成用以减弱穿过与所述隧道结构对应的那一红外滤光片的环境光线的强度。

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具有高抗光性能的红外触摸设备及其触摸检测单元

技术领域

[0001] 本发明涉及红外触摸领域，特别是具有高抗光性能的红外触摸设备及其触摸检测单元。

背景技术

[0002] 红外触摸的原理是由发射灯发射红外线到接收灯，形成一张由红外线布成的光网，当有物体进入红外光网阻挡住某处的红外线发射接收时，控制器就能知道何处进行了触摸。目前，红外触摸产品大多使用红外滤光片来过滤掉不需要的光线，对使用的环境要求比较高，不能有太强的光线照射，否则影响产品的使用效果或者直接无法使用。

[0003] 但是作为触摸设备却不能限制使用范围，从室内使用到室外高强度阳光下的户外使用，作为产品，它必须适应。因此，提高红外设备的抗光性是本领域技术人员的不懈追求。

发明内容

[0004] 有鉴于此，本发明所要解决的技术问题是提供一种具有改进抗光性能的红外触摸设备。

[0005] 本发明所要解决的另一技术问题是提供一种具有改进抗光性能的红外触摸设备的触摸检测单元。

[0006] 本发明提供了一种具有高抗光性能的红外触摸设备，包括：触摸屏，所述触摸屏具有相对的第一边缘和第二边缘；第一组多个红外发射器，设置在所述触摸屏的第一边缘；第一组多个红外接收器，设置在所述触摸屏的第二边缘，所述第一组多个红外接收器与所述第一组多个红外发射器一一对应，用以接收对应的第一组红外发射器发出的红外线；以及第一红外滤光片，设置在位于所述第二边缘的光线入口处。在所述第一红外滤光片与所述第一组红外接收器之间形成隧道结构，所述隧道结构构造成用以减弱穿过所述第一红外滤光片并到达所述第一组多个红外接收器的环境光线的强度。

[0007] 在一实施例中，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上并与所述触摸屏平行，所述第一组红外接收器安装在所述电路板上的远离所述触摸屏的一端。

[0008] 在一实施例中，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上并与所述触摸屏垂直。

[0009] 在一实施例中，所述第一红外滤光片倾斜设置。

[0010] 在一实施例中，所述第一红外滤光片的倾斜角度在45至60度之间。

[0011] 在一实施例中，所述红外触摸设备包括沿所述第二边缘设置的边框，所述第一组红外接收器安装在电路板上，所述电路板固定在所述边框上，所述边框包括面对所述第一组红外发射器的内侧框部、远离所述第一组红外发射器的外侧框部以及连接所述内侧框部和外侧框部的边框正面连接部，所述内侧框部自所述边框正面连接部沿远离所述第一组红外接收器并朝向所述触摸屏的方向倾斜延伸，所述第一红外滤光片位于所述内侧框部上。

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[0012] 在一实施例中，所述第一组红外接收器与所述光线入口的距离不小于 11 毫米。

[0013] 在一实施例中，所述红外触摸设备包括沿所述第二边缘设置的边框，所述隧道结构由所述边框的结构形成或由所述边框的结构与所述触摸屏共同形成。

[0014] 在一实施例中，所述触摸屏具有相对的第三边缘和第四边缘，所述第三边缘和第四边缘与所述第一边缘和第二边缘不同。所述红外触摸设备还包括：第二组多个红外发射器，设置在所述触摸屏的第三边缘；第二组多个红外接收器，设置在所述触摸屏的第四边缘，所述第二组多个红外接收器与所述第二组多个红外发射器一一对应，用以接收对应的第二组红外发射器发出的红外线；以及第二红外滤光片，设置在位于所述第四边缘的光线入口处。其中，在所述第二红外滤光片与所述第二组红外接收器之间形成隧道结构，所述隧道结构构造成用以降低穿过所述第二红外滤光片并到达所述第二组多个红外接收器的环境光线的强度。

[0015] 本发明还提供了一种具有高抗光性能的红外触摸设备的触摸检测单元，包括：相对设置的第一组多个红外发射器和第一组多个红外接收器，所述第一组多个红外接收器与所述第一组多个红外发射器一一对应，用以接收对应的第一组红外发射器发出的红外线；第一红外滤光片，设置在所述第一组红外发射器发出的红外线的光路上并靠近所述第一组红外接收器；相对设置的第二组多个红外发射器和第二组多个红外接收器，所述第二组多个红外接收器与所述第二组多个红外发射器一一对应，用以接收对应的第二组红外发射器发出的红外线；第二红外滤光片，设置在所述第二组红外发射器发出的红外线的光路上并靠近所述第二组红外接收器。至少在所述第一红外滤光片和第二红外滤光片其中之一与其对应的第一组或第二组红外接收器之间形成隧道结构，所述隧道结构构造成用以减弱穿过与所述隧道结构对应的那一红外滤光片的环境光线的强度。

[0016] 综上所述，在上述红外触摸设备及其触摸检测单元中，红外接收器与对应的红外滤光片之间形成隧道结构，通过隧道结构对环境光线的多次反射，减弱环境光线至不影响红外接收的程度，从而提高红外触摸设备的抗光性。

附图说明

[0017] 图 1 是红外触摸设备的原理示意图。

[0018] 图 2 是红外触摸设备的一个实施例的剖视图。

[0019] 图 3 是图 2 的红外触摸设备的触摸检测单元的结构示意图。

[0020] 图 4 是红外触摸设备的另一个实施例的剖视图。

[0021] 图 5 是图 4 的红外触摸设备的触摸检测单元的结构示意图。

具体实施方式

[0022] 为了使本发明要解决的技术问题、技术方案及有益效果更加清楚明白，以下结合附图及实施例，对本发明进行进一步详细说明。应当理解，此处所描述的具体实施例仅仅作为例示用途，并不用于限定本发明。

[0023] 参考图 1，为红外触摸设备的原理示意图。红外触摸设备包括触摸检测单元，围绕触摸屏 10 设置，并且设置在触摸屏 10 相对的边缘上。在所示的实施例中，触摸屏 10 为长方形，具有相对的第一边缘 12 和第二边缘 14，以及相对的第三边缘 16 和第四边缘 18。触

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摸检测单元包括第一组多个红外发射器 20 和第一组多个红外接收器 22，其中第一组多个红外发射器 20 设置在触摸屏 10 的第一边缘 12，而第一组多个红外接收器 22 设置在触摸屏 10 的第二边缘 14。第一组多个红外接收器 22 与第一组多个红外发射器 20 一一对应，用以接收对应的第一组红外发射器 20 发出的红外线。

[0024] 同样，触摸检测单元还包括第二组多个红外发射器 24 和第二组多个红外接收器 26，其中第二组多个红外发射器 24 设置在触摸屏 10 的第三边缘 16，而第二组多个红外接收器 26 设置在触摸屏 10 的第四边缘 18。第二组多个红外接收器 26 与第一组多个红外发射器 24 一一对应，用以接收对应的第二组红外发射器 24 发出的红外线。

[0025] 不同组的红外发射器发射的红外线相互交叉，在此实施例中是正交设置。如果某处（例如图 1 触摸屏中的黑点处）发生触摸事件，则对应位置的红外线无法被接收，因此可以根据红外接收器的接收情况确定发生触摸事件的位置。

[0026] 红外接收器接收正对的红外发射器发射的红外线时，也同时会接收环境光线。一般会在红外发射器发出的红外线的光路上并靠近红外接收器的位置设置红外滤光片，以滤除环境光线。但在环境光线很强的情况下，还是会有部分环境光穿过红外滤光片并到达对应的红外接收器。这部分穿过红外滤光片的环境光需要被减弱，否则会影响红外接收。

[0027] 图 2 和图 3 是红外触摸设备的一个实施例的示意图。

[0028] 红外触摸设备包括沿触摸屏 10 的第二边缘 14 设置的边框 28。边框 28 设有光线入口 29，此光线入口 29 位于红外线的光路上。在光线入口 29 处设置第一红外滤光片 30，以滤除环境光线。

[0029] 边框 28 包括面对第一组红外发射器 20 的内侧框部 32、远离第一组红外发射器 20 的外侧框部 34 以及连接内侧框部 32 和外侧框部 34 的边框正面连接部 36。内侧框部 32 自边框正面连接部 36 沿远离第一组红外接收器 22 并朝向触摸屏 10 的方向倾斜延伸。第一红外滤光片 30 位于内侧框部 32 上，因此也呈倾斜设置。第一红外滤光片 30 的倾斜角度在 45 至 60 度范围内，在本实施例中，其倾斜角度为 59 度。

[0030] 第一组红外接收器 22 安装在电路板 38 上，电路板 38 固定在边框 28 上。在所示的实施例中，电路板 38 是利用一个分离的安装件 40 安装在边框 28 上的。整体来看，此安装件 40 可视为边框 28 的一部分。在其他实施例中，电路板 38 也可以直接安装在边框 28 上，而不需要设置上述分离的安装件 40。

[0031] 在所示的实施例中，电路板 38 与触摸屏 10 平行。第一组红外接收器 22 安装在电路板 38 上的远离触摸屏 10 的一端。

[0032] 在第一红外滤光片 30 与第一组红外接收器 22 之间形成隧道结构 42。隧道结构 42 构造成用以降低穿过第一红外滤光片 30 并到达第一组多个红外接收器 22 的环境光线的强度。环境光线穿过第一红外滤光片 30 后，在隧道结构 42 中多次反射，逐渐降低环境光的强度，使其减弱到不影响红外接收的程度。由于第一组红外接收器 22 安装在电路板 38 上的远离触摸屏 10 的一端，而且边框 28 的内侧框部 32 沿远离第一组红外接收器 22 的方向倾斜延伸，这样设计可以增加上述隧道结构 42 的长度，进而增加环境光的反射次数，更大程度地减弱环境光线的强度。第一组红外接收器 22 与光线入口 29 之间的距离不小于 11 毫米。在本实施例中，第一组红外接收器 22 与光线入口 29 之间的距离为 14.3 毫米。

[0033] 在此实施例中，隧道结构 42 由边框 28 的结构形成。具体而言，其由内侧框部 32

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的部分结构、安装件 40 的部分结构以及夹持触摸屏 10 的部分边框结构共同形成。为此，边框 28 的上述部位可以形成各种有利于增加光线反射的结构。进一步地，这些部位上还可以设置吸光结构或材料，进一步减弱环境光线。

[0034] 图 4 和图 5 是红外触摸设备的另一个实施例。

[0035] 下面主要针对与前述是实施例不同之处进行描述。电路板 138 利用安装件 140 安装在边框 28 上，且电路板 138 与触摸屏 10 垂直。电路板 138 位置尽量靠近外侧框部 34。内侧框部 32 自边框正面连接部 36 沿远离第一组红外接收器 22 并朝向触摸屏 10 的方向倾斜延伸。第一红外滤光片 130 位于内侧框部 32 上，因此也呈倾斜设置。在本实施例中，其倾斜角度为 55 度。

[0036] 在第一红外滤光片 130 与第一组红外接收器 22 之间形成隧道结构 142。隧道结构 142 构造成用以降低穿过第一红外滤光片 130 并到达第一组多个红外接收器 22 的环境光线的强度。环境光线穿过第一红外滤光片 130 后，在隧道结构 142 中多次反射，逐渐降低环境光的强度，使其减弱到不影响红外接收的程度。

[0037] 由于电路板 38 位置尽量靠近外侧框部 34，而且边框 28 的内侧框部 32 沿远离第一组红外接收器 22 的方向倾斜延伸，这样设计可以增加上述隧道结构 42 的长度，进而增加环境光的反射次数，更大程度地减弱环境光线的强度。在本实施例中，第一组红外接收器 22 与光线入口 129 之间的距离为 14.3 毫米。

[0038] 在此实施例中，隧道结构 42 由边框 28 与触摸屏 10 的结构共同形成。具体而言，其由内侧框部 32 的部分结构、第一滤光片 130 的部分结构以及触摸屏 10 的部分表面共同形成。为此，边框 28 和触摸屏 10 的上述部位可以形成各种有利于增加光线反射的结构。同样，这些部位上还可以设置吸光结构或材料，进一步减弱环境光线。

[0039] 在本实施例中，内侧框部 32 末端沿远离第一组红外发射器 20 的方向反折而形成翻折部 33，第一滤光片 130 末端沿远离第一组红外发射器 20 的方向反折而形成翻折部 131。这些翻折部 33，131 都是形成上述隧道结构 142 的结构。

[0040] 上述是以第一组红外发射器和接收器为例，说明了触摸检测单元的滤光片和隧道结构的构造。应当理解的是，针对第二组红外发射器和接收器也可以按照相同的方式设置类似的滤光片和隧道结构，即在位于第四边缘 18 的光线入口设置第二红外滤光片，在第二红外滤光片与第二组红外接收器 26 之间形成隧道结构，该隧道结构构造成用以降低穿过第二红外滤光片并到达第二组多个红外接收器 26 的环境光线的强度。当然，针对第二组红外发射器和接收器也可以不同的方式设置滤光片，可以设置或不设置隧道结构。

[0041] 在第一组红外发射器 20 和第二组红外发射器 24 的一侧，理论上是不用抗光设计的。但从产品外观的角度看，发射器这一侧也可以设置相同或类似的边框结构以形成统一的外观。本说明书附图所示的实施例中，发射器这一侧设置了相同的边框结构。

[0042] 综上所述，在上述介绍的红外触摸设备及其触摸检测单元中，红外接收器与对应的红外滤光片之间形成隧道结构，通过隧道结构对环境光线的多次反射，减弱环境光线至不影响红外接收的程度，从而提高红外触摸设备的抗光性。

[0043] 以上所述仅为本发明的实施例而已，并不用以限制本发明，凡在本发明的精神和原则之内所作的任何修改、等同替换和改进等，均应包含在本发明的保护范围之内。

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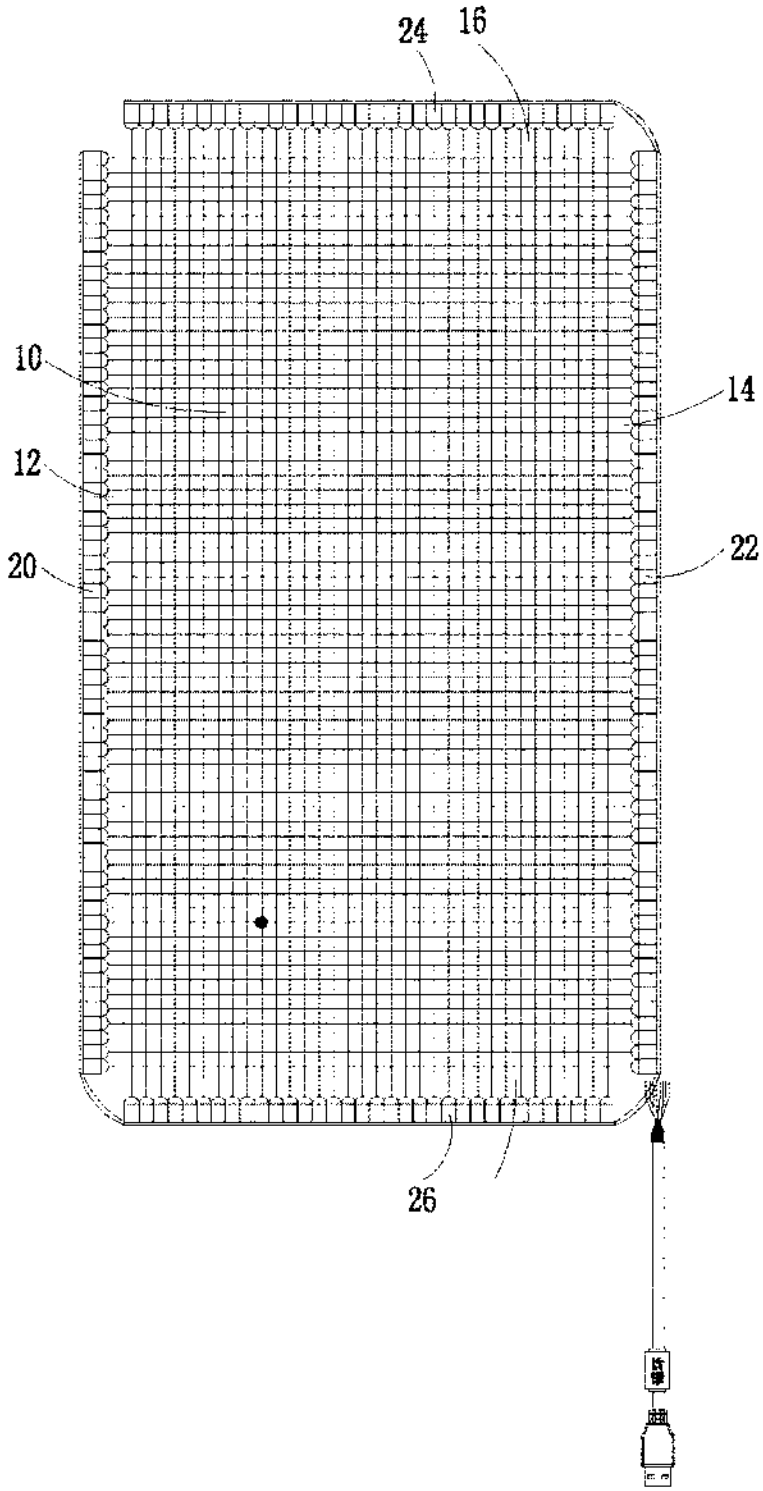


图 1

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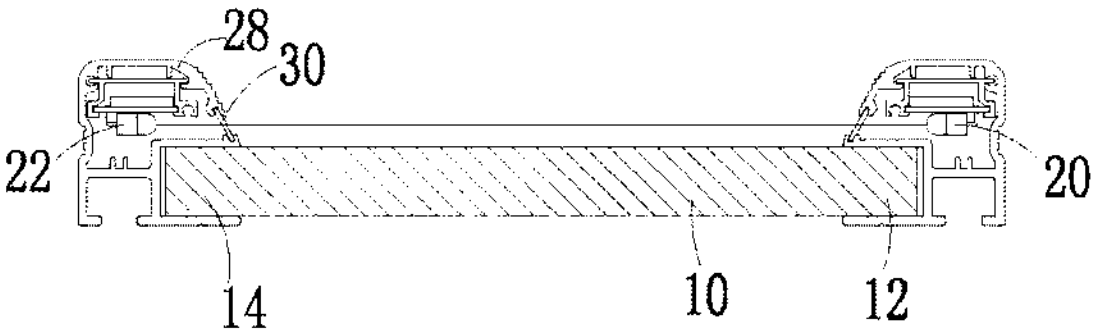


图 2

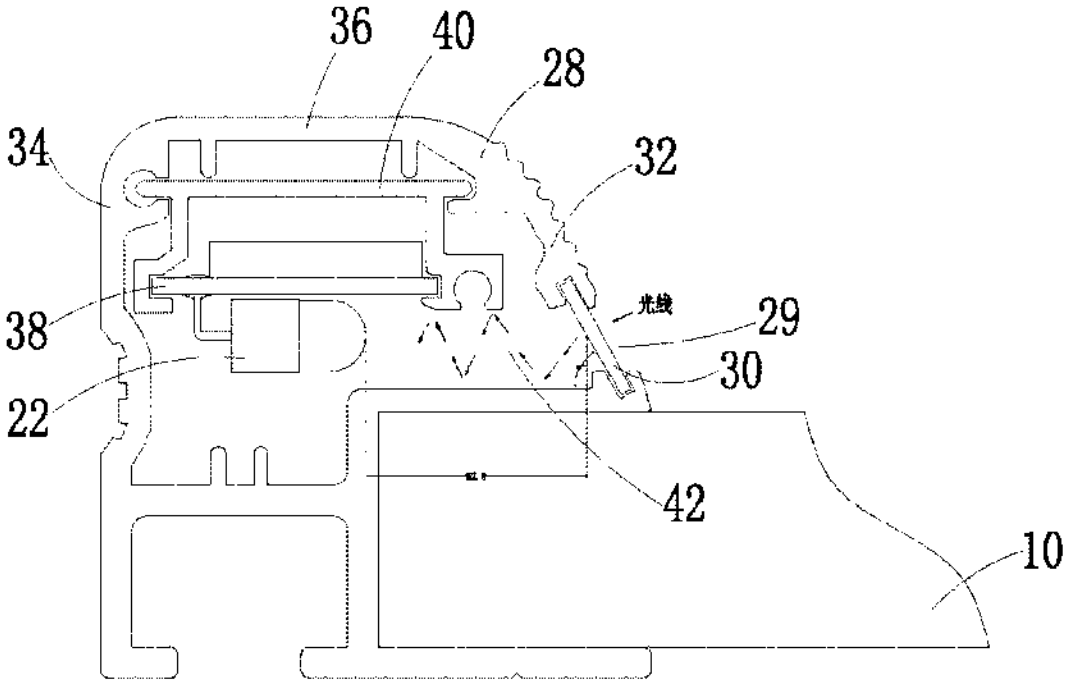


图 3

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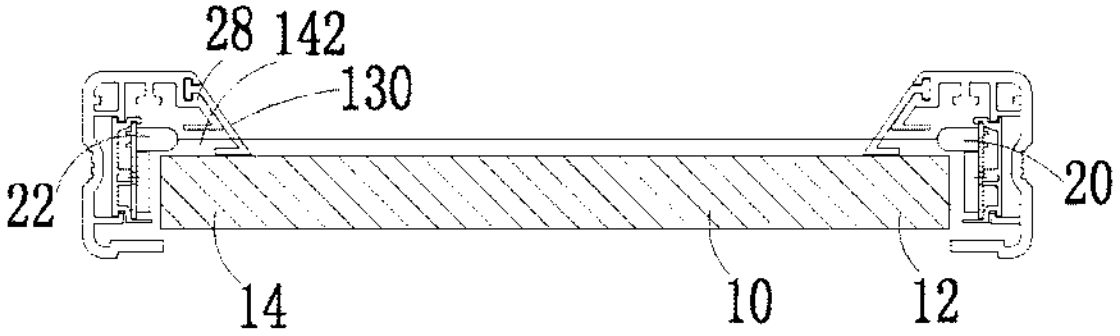


图 4

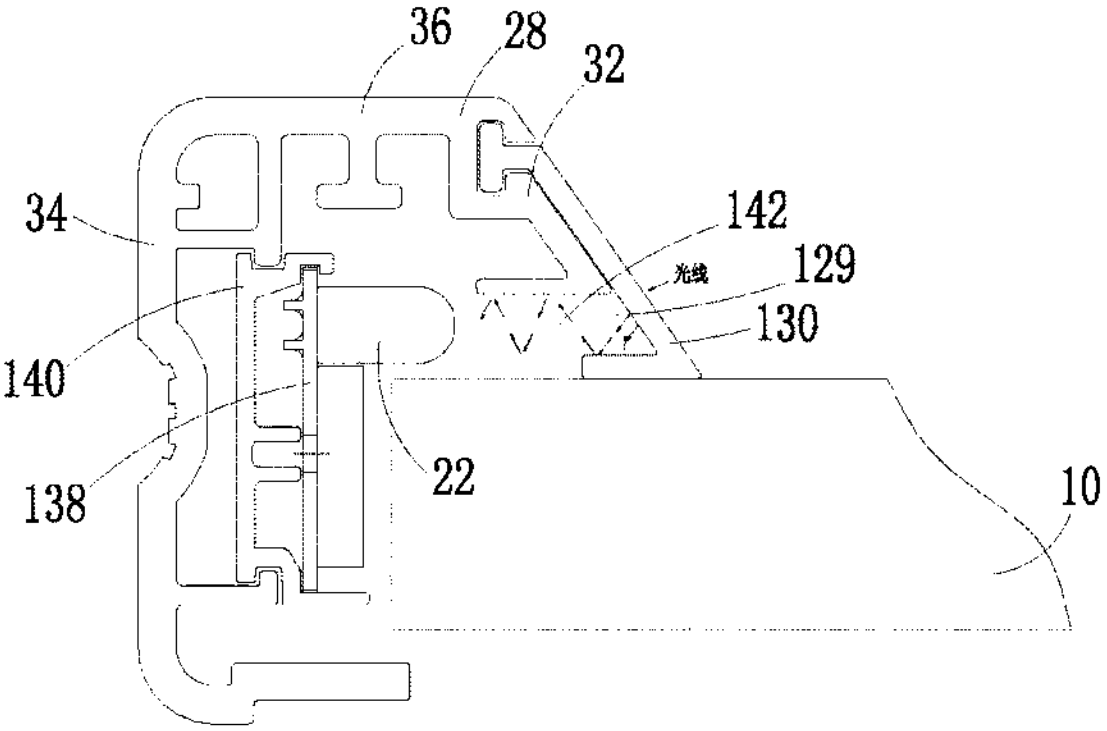


图 5

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Espacenet

WO2014131221A1 PROJECTION-TYPE TOUCH CONTROL ELECTRONIC WHITEBOARD AND FRAME STRUCTURE THEREOF

Applicants: SHENZHEN TIMELINK TECHNOLOGY CO LTD [CN]

Inventors: CHEN WEISHAN [CN],DENG HUAQIN [CN],FENG GUANGLUN [CN],GU HONGLIN [CN],LI YONG [CN],YAN GUANGLIN [CN]

Classifications:
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Publication: WO2014131221A1·2014-09-04

Published as: **CN103123556A;** WO2014131221A1

PROJECTION-TYPE TOUCH CONTROL ELECTRONIC WHITEBOARD AND FRAME STRUCTURE THEREOF

Abstract

Disclosed is a frame structure of a projection-type touch control electronic whiteboard to be arranged on the edge of an electronic whiteboard screen, comprising a frame, a light source assembly arranged inside the frame, and an optical filter arranged on the side opening of the frame; the side opening of the frame extends along the edge of the electronic whiteboard; a sensor of the light source assembly is vertically arranged on the circuit board of the light source assembly; the circuit board extends along the edge of the electronic whiteboard; and the vertically arranged sensor provides touch control positioning through the filter. Also disclosed is an electronic whiteboard with the frame structure. The electronic whiteboard and the frame structure thereof enable the electronic whiteboard to have a narrow frame, and are easy to install and maintain, thus facilitating the designing of a light and thin electronic whiteboard having a more attractive appearance.

Espacenet

CN203786707U Frame structure of front-disassembly electronic whiteboard

Applicants: SHENZHEN TIMELINK TECHNOLOGY CO LTD

Inventors: CHEN WEISHAN,FENG GUANGLUN,YAN GUANGLIN

Classifications:
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Frame structure of front-disassembly electronic whiteboard

Abstract

The utility model relates to a frame structure of a front-disassembly electronic whiteboard. A light filtering strip is relatively movably fixed by using a first clamping strip groove body of an upper cover and a holding groove of a lower shell. The light filtering strip can slide in parallel in the holding groove relative to the first clamping strip groove body. Meanwhile, the locking part of the upper cover and the fixing part of the lower shell are movably connected and fixedly in a clamped mode. In the disassembly process, the locking part is pulled by external force to be away from the fixing part, and then the upper cover and the lower shell can be separated. The edge of the lower shell and the edge of a display area are movably fixed through a second clamping strip groove body which can slide in parallel relative to the edge of the display area. In this way, in the maintenance process, the light filtering strip slides in parallel along the first clamping strip groove body and the holding groove, and then the light filtering strip can be disassembled; afterwards, the locking part is pulled by the external force to be away from the fixing part, and therefore the upper cover and the lower shell can be separated. Accordingly, a light tube and a PCB can be maintained; as the situation that the whole electronic whiteboard is disassembled is avoided, the maintenance process becomes simple and easy to implement.

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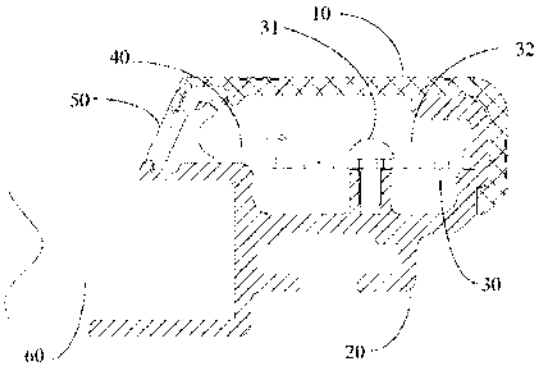
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(54)实用新型名称

前拆式电子白板的边框结构

(57)摘要

前拆式电子白板的边框结构使上盖的第一卡条槽体与下壳的托持槽相对活动固定滤光条。滤光条能够相对第一卡条槽体与托持槽平行滑动。同时，上盖的锁固部与下壳的固定部活动卡接固定。拆除时，使用外力拉动固定部远离固定部就能够使上盖与下壳分开。下壳与显示区域的边缘通过第二卡条槽体活动固定，第二卡条槽体能够相对显示区域的边缘平行滑动。因而在检修过程中，使滤光条沿第一卡条槽体及托持槽平行滑动，就能够将滤光条拆除，然后将锁固部使用外力拉开，使其远离固定部，从而使得上盖与下壳分开，进而可以对灯管及印刷电路板进行检修，避免了拆除整个电子白板，使检修过程变的简便易操作。



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1. 一种前拆式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括印刷电路板、固定于所述印刷电路板上的灯管、设置在所述灯管出光面的滤光条，其特征在于，还包括上盖和下壳；

所述上盖和所述下壳配合形成空腔，所述空腔用于收容所述灯管及所述印刷电路板；所述上盖包括锁固部并设有第一卡条槽体；所述下壳包括固定部并设有第二卡条槽体、托持槽及螺接槽；

所述第一卡条槽体用于收容所述滤光条的一端，所述滤光条的一端滑入所述第一卡条槽体内；所述托持槽用于收容所述滤光条背离所述上盖的一端，所述滤光条背离所述上盖的一端滑入所述托持槽内；所述第一卡条槽体及所述托持槽沿所述滤光条的长度方向延伸；所述第二卡条槽体用于收容显示区域的边缘，所述显示区域的边缘滑入所述第二卡条槽体内；所述第二卡条槽体沿所述显示区域的边缘长度方向延伸；所述螺接槽与所述印刷电路板的中央位置螺接；所述锁固部与所述固定部配合固定，所述锁固部卡扣于所述固定部上，使所述上盖和所述下壳固定连接。

2. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述上盖大体呈 L 形，所述上盖的长边设置所述第一卡条槽体，所述上盖的短边设置所述锁固部；所述第一卡条槽体的形状与所述滤光条的一端配合，所述滤光条的一端可相对所述第一卡条槽体平行滑动；所述锁固部设有突起，所述突起卡扣于所述固定部上，使所述上盖与所述下壳相对固定。

3. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述下壳还设有侧边卡槽，所述印刷电路板远离所述滤光条的一端与所述侧边卡槽卡合连接；所述侧边卡槽沿所述印刷电路板边缘长度方向上延伸。

4. 根据权利要求 3 所述的前拆式电子白板的边框结构，其特征在于，所述下壳沿所述侧边卡槽的短边方向延伸并弯折呈直角。

5. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述托持槽设于所述第二卡条槽体的一侧；所述托持槽与所述滤光条背离所述第一卡条槽体的一端抵持连接，所述滤光条背离所述第一卡条槽体的一端可相对所述托持槽平行滑动。

6. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述下壳设有多个螺接槽，所述螺接槽通过螺钉与所述印刷电路板螺接，使所述印刷电路板相对所述下壳固定。

7. 根据权利要求 6 所述的前拆式电子白板的边框结构，其特征在于，所述螺接槽均匀分布于所述下壳相对固定所述印刷电路板的部分。

8. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述下壳背离所述螺接槽的一面设有卡持部，所述卡持部用于将所述下壳固定于支架上。

9. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述第一卡条槽体及所述锁固部一体成型。

10. 根据权利要求 1 所述的前拆式电子白板的边框结构，其特征在于，所述第二卡条槽体、所述托持槽、所述螺接槽及所述固定部一体成型。

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前拆式电子白板的边框结构

技术领域

[0001] 本实用新型涉及电子白板技术领域，特别是涉及一种可活动拆卸的前拆式电子白板的边框结构。

背景技术

[0002] 在电子白板技术领域，特别是采用投影显示的大型电子白板中，多采用红外传感技术为电子白板提供触控定位。红外传感器一般都设置在电子白板的边框中。电子白板包括基板、设置在基板四个边缘的边框、设置在边框中印刷电路板、灯管和设置在边框侧边开口处的滤光条。其中灯管发射出信号并经过滤光条滤光后为触控区域另一侧的信号接收器接收。在传统的电子白板中，灯管、印刷电路板及滤光条是固定于边框中。当灯管或者滤光条出现异常时，对电子白板进行检修，需将整个电子白板拆除，进而对边框内部元件进行检修，这样不仅检修过程复杂，而且还给增加了工作人员的检修难度。

实用新型内容

[0003] 基于此，有必要提供一种简便的、可活动拆卸的前拆式电子白板的边框结构。

[0004] 一种前拆式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括印刷电路板、固定于所述印刷电路板上的灯管、设置在所述灯管出光面的滤光条，还包括上盖和下壳；

[0005] 所述上盖和所述下壳配合形成空腔，所述空腔用于收容所述灯管及所述印刷电路板；所述上盖包括锁固部并设有第一卡条槽体；所述下壳包括固定部并设有第二卡条槽体、托持槽及螺接槽；

[0006] 所述第一卡条槽体用于收容所述滤光条的一端，所述滤光条的一端滑入所述第一卡条槽体内；所述托持槽用于收容所述滤光条背离所述上盖的一端，所述滤光条背离所述上盖的一端滑入所述托持槽内；所述第一卡条槽体及所述托持槽沿所述滤光条的长度方向延伸；所述第二卡条槽体用于收容显示区域的边缘，所述显示区域的边缘滑入所述第二卡条槽体内；所述第二卡条槽体沿所述显示区域的边缘长度方向延伸；所述螺接槽与所述印刷电路板的中央位置螺接；所述锁固部与所述固定部配合固定，所述锁固部卡扣于所述固定部上，使所述上盖和所述下壳固定连接。

[0007] 在其中一个实施例中，所述上盖大体呈L形，所述上盖的长边设置所述第一卡条槽体，所述上盖的短边设置所述锁固部；所述第一卡条槽体的形状与所述滤光条的一端配合，所述滤光条的一端可相对所述第一卡条槽体平行滑动；所述锁固部设有突起，所述突起卡扣于所述固定部上，使所述上盖与所述下壳相对固定。

[0008] 在其中一个实施例中，所述下壳还设有侧边卡槽，所述印刷电路板远离所述滤光条的一端与所述侧边卡槽卡合连接；所述侧边卡槽沿所述印刷电路板边缘长度方向上延伸。

[0009] 在其中一个实施例中，所述下壳沿所述侧边卡槽的短边方向延伸并弯折呈直角。

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[0010] 在其中一个实施例中，所述托持槽设于所述第二卡条槽体的一侧；所述托持槽与所述滤光条背离所述第一卡条槽体的一端抵持连接，所述滤光条背离所述第一卡条槽体的一端可相对所述托持槽平行滑动。

[0011] 在其中一个实施例中，所述下壳设有多个螺接槽，所述螺接槽通过螺钉与所述印刷电路板螺接，使所述印刷电路板相对所述下壳固定。

[0012] 在其中一个实施例中，所述螺接槽均匀分布于所述下壳相对固定所述印刷电路板的部分。

[0013] 在其中一个实施例中，所述下壳背离所述螺接槽的一面设有卡持部，所述卡持部用于将所述下壳固定于支架上。

[0014] 在其中一个实施例中，所述第一卡条槽体及所述锁固部一体成型。

[0015] 在其中一个实施例中，所述第二卡条槽体、所述托持槽、所述螺接槽及所述固定部一体成型。

[0016] 上述前拆式电子白板的边框结构使用上盖的第一卡条槽体与下壳的托持槽相对活动固定滤光条。滤光条能够相对第一卡条槽体与托持槽平行滑动。同时，上盖的锁固部与下壳的固定部活动卡接固定。拆除时，使用外力拉动固定部远离固定部就能够使上盖与下壳分开。下壳与显示区域的边缘通过第二卡条槽体活动固定，第二卡条槽体能够相对显示区域的边缘平行滑动。因而在检修过程中，使滤光条沿第一卡条槽体及托持槽平行滑动，就能够将滤光条拆除，然后将锁固部使用外力拉开，使其远离固定部，从而使得上盖与下壳分开。进而可以对灯管及印刷电路板进行检修，避免了拆除整个电子白板，使检修过程变的简便易操作。

附图说明

[0017] 图 1 为前拆式电子白板的边框结构示意图之一；

[0018] 图 2 为前拆式电子白板的边框结构示意图之二；

[0019] 图 3 为前拆式电子白板的边框结构示意图之三；

[0020] 图 4 为前拆式电子白板的边框结构的爆炸图；

[0021] 图 5 为前拆式电子白板的边框结构的应用示意图之一；

[0022] 图 6 为前拆式电子白板的边框结构的应用示意图之二；

[0023] 图 7 为前拆式电子白板的边框结构的应用示意图之三。

具体实施方式

[0024] 一种前拆式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括印刷电路板、固定于所述印刷电路上的灯管、设置在所述灯管出光面的滤光条，还包括上盖和下壳。上盖和下壳配合形成容腔，容腔用于收容灯管及印刷电路板；上盖包括锁固部并设有第一卡条槽体；下壳包括固定部并设有第二卡条槽体、托持槽及螺接槽。第一卡条槽体用于收容滤光条的一端，滤光条的一端滑入第一卡条槽体内；托持槽用于收容滤光条背离上盖的一端，滤光条背离上盖的一端滑入托持槽内；第一卡条槽体及托持槽沿滤光条的长度方向延伸；第二卡条槽体用于收容显示区域的边缘，显示区域的边缘滑入第二卡条槽体内；第二卡条槽体沿显示区域的边缘长度方向延伸；螺接槽与印刷电路板的中央位置螺

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接；锁固部与固定部配合固定，锁固部卡扣于所述固定部上，使上盖和下壳固定连接。

[0025] 使用上盖的第一卡条槽体与下壳的托持槽相对活动固定滤光条。滤光条能够相对第一卡条槽体与托持槽平行滑动。同时，上盖的锁固部与下壳的固定部活动卡接固定。拆除时，使用外力拉动固定部远离固定部就能够使上盖与下壳分开。下壳与显示区域的边缘通过第二卡条槽体活动固定，第二卡条槽体能够相对显示区域的边缘平行滑动。因而在检修过程中，使滤光条沿第一卡条槽体及托持槽平行滑动，就能够将滤光条拆除，然后将锁固部使用外力拉开，使其远离固定部，从而使得上盖与下壳分开。进而可以对灯管及印刷电路板进行检修，避免了拆除整个电子白板，使检修过程变的简便易操作。

[0026] 为了使本实用新型的目的、技术方案及优点更清楚，以下结合附图及实施例，对实用新型进行进一步详细说明。

[0027] 如图 1 所示，为前拆式电子白板的边框结构示意图之一。

[0028] 请结合图 4。

[0029] 一种前拆式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括印刷电路板 30、固定于所述印刷电路板 30 上的灯管 40、设置在所述灯管 40 出光面的滤光条 50，还包括上盖 10 和下壳 20。

[0030] 所述上盖 10 和所述下壳 20 配合形成空腔，所述空腔用于收容所述灯管 40 及所述印刷电路板 50；所述上盖 10 包括锁固部 102 并设有第一卡条槽体 101；所述下壳 20 包括固定部 205 并设有第二卡条槽体 202、托持槽 201 及螺接槽 203。

[0031] 所述第一卡条槽体 101 用于收容所述滤光条 50 的一端 501，所述滤光条 50 的一端 501 滑入所述第一卡条槽体 101 内；所述托持槽 201 用于收容所述滤光条 50 背离所述上盖 10 的一端 502，所述滤光条 50 背离所述上盖 10 的一端 502 滑入所述托持槽 201 内；所述第一卡条槽体 101 及所述托持槽 201 沿所述滤光条 50 的长度方向延伸；所述第二卡条槽体 202 用于收容显示区域的边缘，所述显示区域的边缘滑入所述第二卡条槽体 202 内；所述第二卡条槽体 202 沿所述显示区域的边缘长度方向延伸；所述螺接槽 203 与所述印刷电路板 30 的中央位置螺接；所述锁固部 102 与所述固定部 205 配合固定，所述锁固部 102 卡扣于所述固定部 205 上，使所述上盖 10 和所述下壳 20 固定连接。

[0032] 上盖 10 大体呈 L 形，所述上盖 10 的长边设置所述第一卡条槽体 101，所述上盖 10 的短边设置所述锁固部 102；所述第一卡条槽体 101 的形状与所述滤光条 50 的一端 501 配合，所述滤光条 50 的一端 501 可相对所述第一卡条槽体 101 平行滑动；所述锁固部 102 设有突起，所述突起卡扣于所述固定部 205 上，使所述上盖 10 与所述下壳 20 相对固定。

[0033] 下壳 20 还设有侧边卡槽 204，所述印刷电路板 30 远离所述滤光条 50 的一端与所述侧边卡槽 204 卡合连接；所述侧边卡槽 204 沿所述印刷电路板 30 边缘长度方向上延伸。

[0034] 下壳 20 沿所述侧边卡槽 204 的短边方向延伸并弯折呈直角。

[0035] 托持槽 201 设于所述第二卡条槽体 202 的一侧；所述托持槽 201 与所述滤光条 50 背离所述第一卡条槽体 101 的一端 502 抵接连接，所述滤光条 50 背离所述第一卡条槽体 101 的一端 502 可相对所述托持槽 201 平行滑动。

[0036] 下壳 20 设有多个螺接槽 203，所述螺接槽 203 通过螺钉 31 与所述印刷电路板 30 螺接，使所述印刷电路板 30 相对所述下壳 20 固定。

[0037] 螺接槽 203 均匀分布于所述下壳 10 相对固定所述印刷电路板 30 的部分。

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[0038] 下壳 20 背离所述螺接槽 203 的一面设有卡持部 206，所述卡持部 206 用于将所述下壳 20 固定于支架上。

[0039] 第一卡条槽体 101 及所述锁固部 102 一体成型。

[0040] 第二卡条槽体 202、所述托持槽 201、所述螺接槽 203 及所述固定部 205 一体成型。

[0041] 滤光条 50 的一端 501 与上盖 10 的第一卡条槽体 101 配合，即滤光条 50 的一端 501 滑动卡入第一卡条槽体 101 内。滤光条 50 背离第一卡条槽体 101 的一端 502 与下壳 20 的托持槽 201 配合，即滤光条 50 背离第一卡条槽体 101 的一端 502 与下壳 20 的托持槽 201 抵持固定。因此，滤光条 50 固定于上盖 10 与下壳 20 之间。而上盖 10 与下壳 20 之间通过锁固部 102 卡扣于固定部 205 上来固定。

[0042] 上盖 10 与下壳 20 相对固定后形成空腔。灯管 40 与印刷电路板 30 设置于空腔内。具体的，灯管 30 设置于印刷电路板 30 上，且出光面靠近滤光条。印刷电路板 30 通过螺钉 31 与下壳 20 的螺接槽 203 固定连接。印刷电路板 30 远离灯管 30 的一端与侧边卡槽 204 卡接。从而将印刷电路板 30 固定在下壳上。

[0043] 下壳 20 的第二卡条槽体 202 用于活动固定显示区域的边缘。具体地，第二卡条槽体 202 于挤塑板 60 的边缘活动固定，即挤塑板 60 的边缘沿第二卡条槽体 202 的长度方向滑入第二卡条槽体 202 内。挤塑板 60 的边缘与第二卡条槽体 202 沿长度方向可平行滑动。

[0044] 如图 5 所示，为前拆式电子白板的边框结构应用示意图之一。

[0045] 在本实施例中，挤塑板 60 的两个边缘设置有前拆式电子白板的边框结构。电子白板通过印刷电路 30 控制灯管 40 的发光情况，滤光条 50 对灯管 40 发出光进行滤光处理。在电子白板需要检修时，通过外力拉动锁固部 102 使其远离固定部 205，从而能够使上盖 10 与下壳 20 分开。沿第一卡条槽体 101 的长度方向滑动使滤光条 50 的一端 501 不再与第一卡条槽体 101 卡合，从而能够分开上盖 10 与滤光条 50。此时，灯管 40 与印刷电路板 30 完全裸露，方便检修人员对灯管 40 及印刷电路板 30 进行检修，整个拆卸过程简便，提高了检修效率，降低检修难度。

[0046] 请结合图 2。

[0047] 在一个实施例中，上盖 10 的第一卡条槽体 101 与滤光条 50 的一端 501 抵持固定，下壳 20 的托持槽 201 与滤光条 50 背离第一卡条槽体 101 的一端 502 卡合，即滤光条 50 背离第一卡条槽体 101 的一端 502 可滑动卡入托持槽 201 内。

[0048] 如图 6 所示，为前拆式电子白板的边框结构应用示意图之一。

[0049] 在本实施例中，挤塑板 60 的两个边缘设置有前拆式电子白板的边框结构。电子白板通过印刷电路 30 控制灯管 40 的发光情况，滤光条 50 对灯管 40 发出光进行滤光处理。在电子白板需要检修时，通过外力拉动锁固部 102 使其远离固定部 205，从而能够使上盖 10 与下壳 20 分开。沿第一卡条槽体 101 的长度方向滑动使滤光条 50 的一端 501 不再与第一卡条槽体 101 抵持，从而能够分开上盖 10 与滤光条 50。此时，灯管 40 与印刷电路板 30 完全裸露，方便检修人员对灯管 40 及印刷电路板 30 进行检修，整个拆卸过程简便，提高了检修效率，降低检修难度。

[0050] 请结合图 3。

[0051] 在一个实施例中，上盖 10 的锁固部 102 可设置为卡合突起；下壳 20 的固定部 205 设为卡合槽，卡合突起与卡合槽配合使上盖 10 与下壳 20 固定。即将卡合突起卡入卡合槽

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内。

[0052] 如图 7 所示，为前拆式电子白板的边框结构应用示意图。

[0053] 在本实施例中，挤压板 60 的两个边缘设置有前拆式电子白板的边框结构。电子白板通过印刷电路 30 控制灯管 40 的发光情况，滤光条 50 对灯管 40 发出光进行滤光处理。在电子白板需要检修时，通过外力拉动锁固部 102 使其远离固定部 205，使锁固部 102 不再与固定部 205 卡合，从而能够使上盖 10 与下壳 20 分开。沿第一卡条槽体 101 的长度方向滑动使滤光条 50 的一端 501 不再与第一卡条槽体 101 抵接，从而能够分开上盖 10 与滤光条 50。此时，灯管 40 与印刷电路板 30 完全裸露，方便检修人员对灯管 40 及印刷电路板 30 进行检修，整个拆卸过程简便，提高了检修效率，降低检修难度。

[0054] 以上所述实施例仅表达了本实用新型的几种实施方式，其描述较为具体和详细，但并不能因此而理解为对本实用新型专利范围的限制。应当指出的是，对于本领域的普通技术人员来说，在不脱离本实用新型构思的前提下，还可以做出若干变形和改进，这些都属于本实用新型的保护范围。因此，本实用新型专利的保护范围应以所附权利要求为准。

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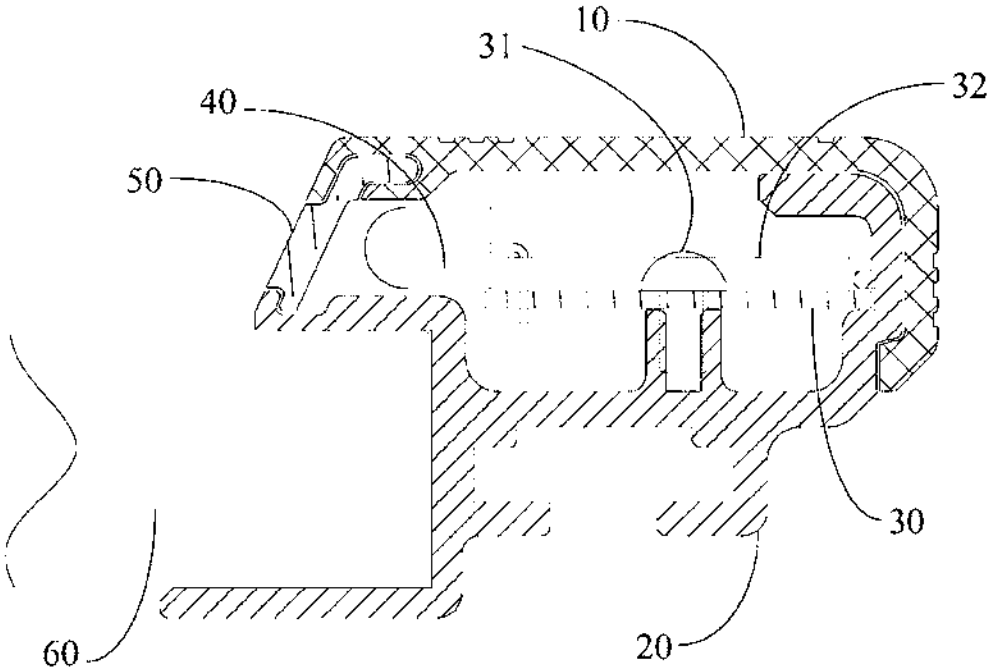


图 1

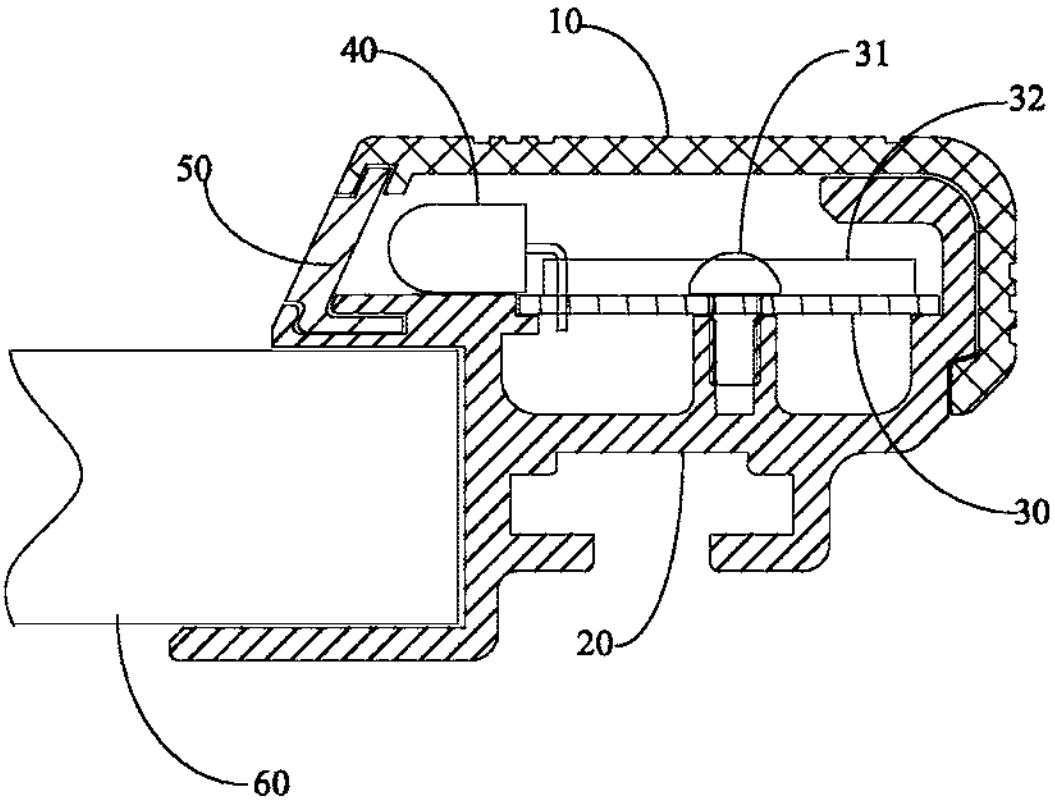


图 2

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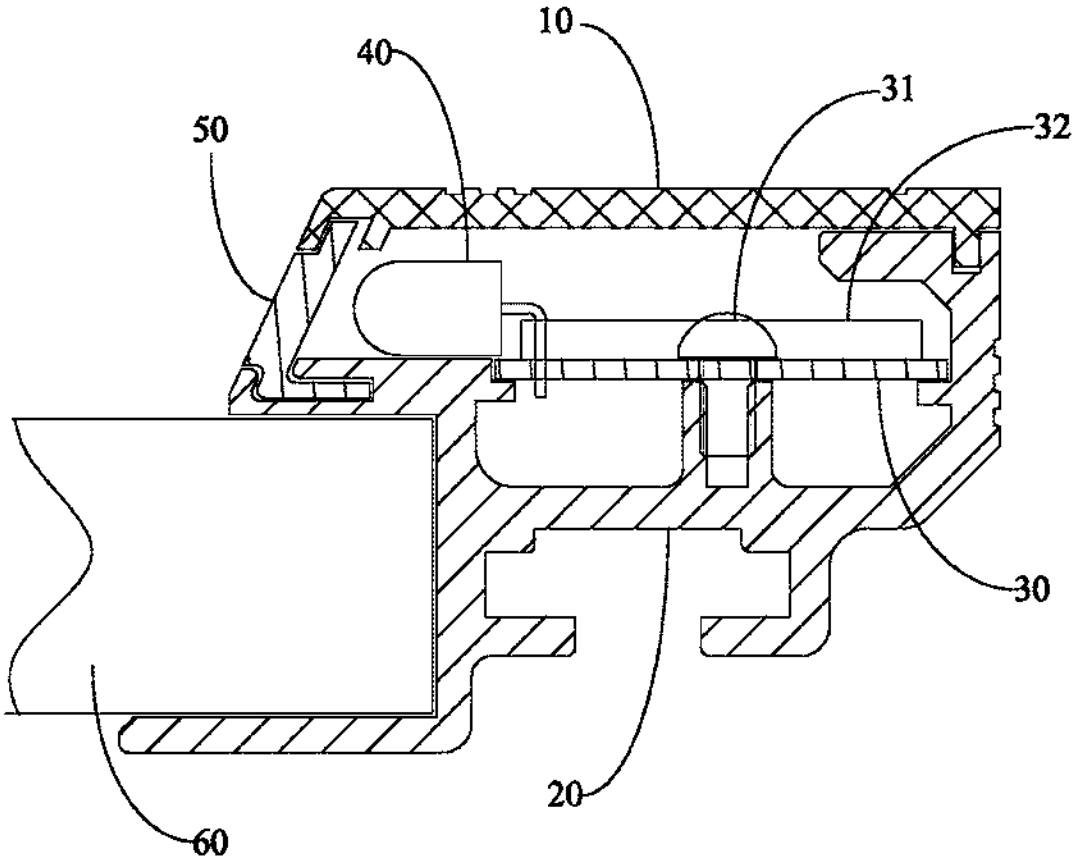


图 3

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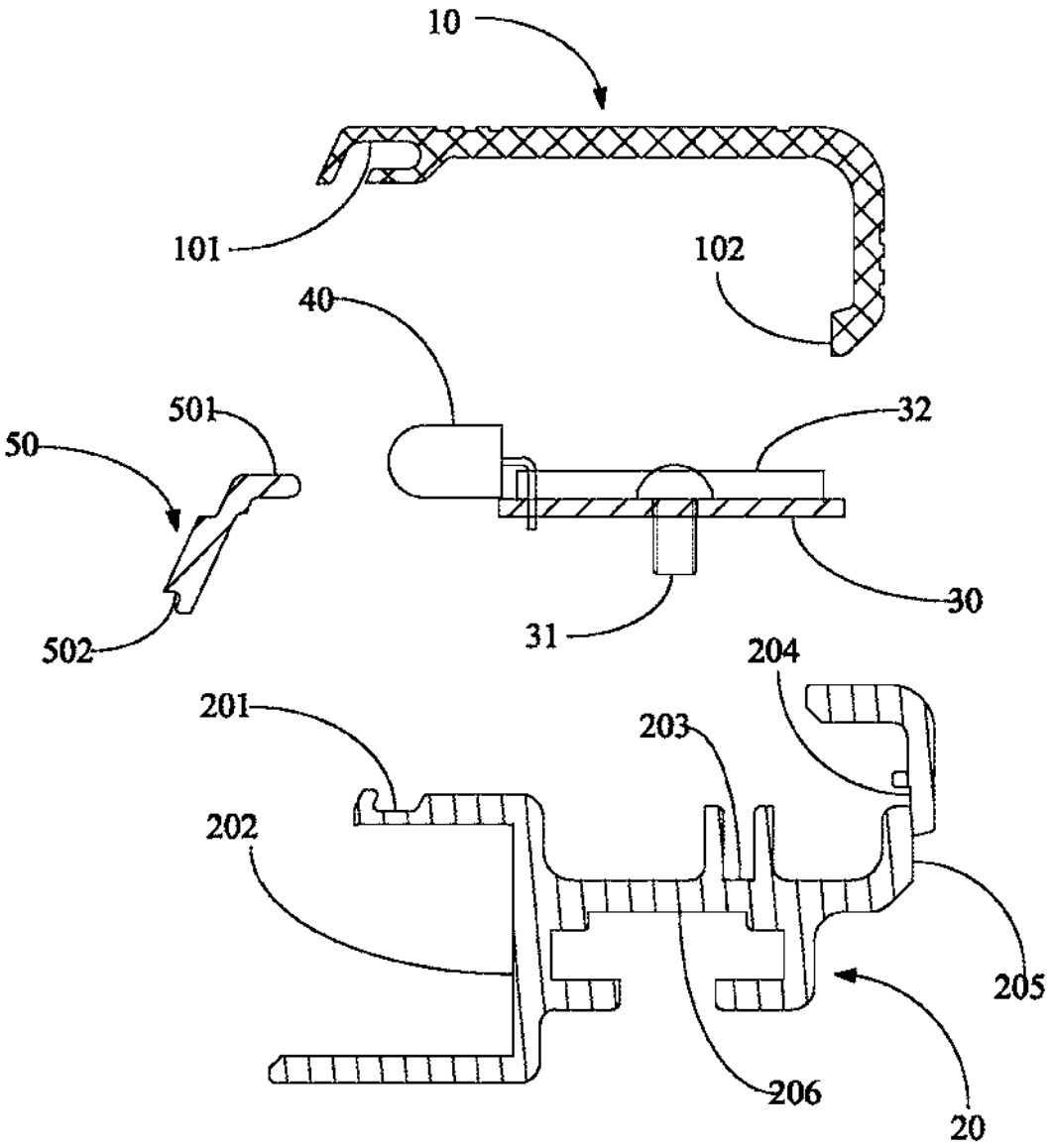


图 4

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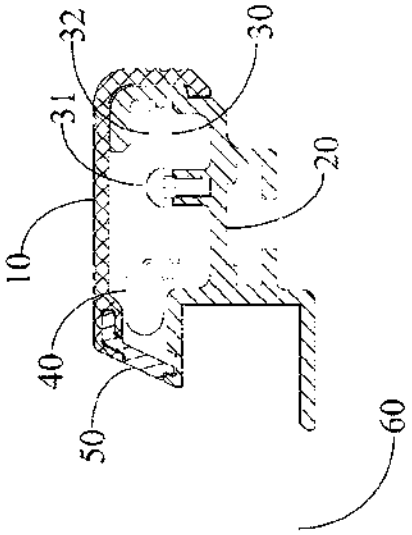


图 5

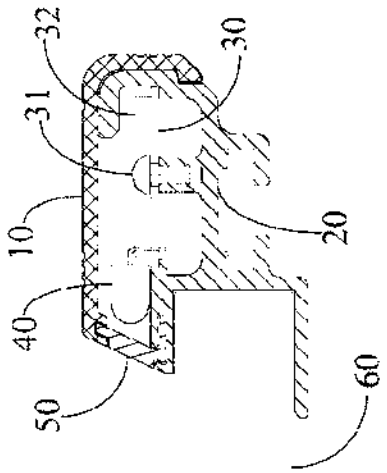
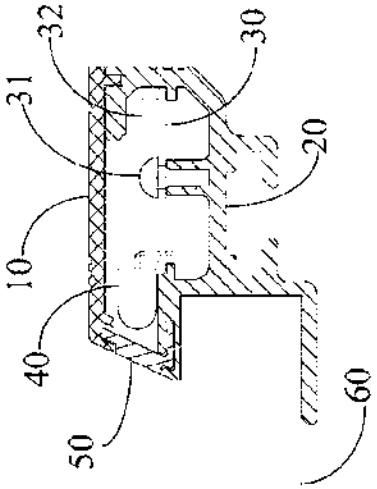


图 6

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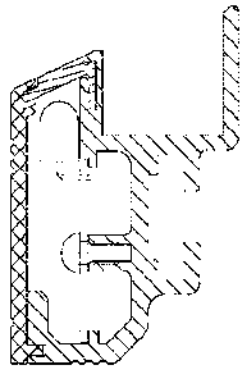


图 7

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Espacenet

CN204288179U TB infrared white board frame structure and TB infrared white board structure thereof

Applicants: BEIJING DONVIEW EDUCATION & TECHNOLOGY CO LTD

Inventors: MO SHAODONG,ZHOU JIANGHONG

Classifications:
IPC ***G06F3/042;***

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TB infrared white board frame structure and TB infrared white board structure thereof

Abstract

The utility model provides a TB infrared white board frame structure, which comprises a light filter bar, an infrared screen PCB (Printed Circuit Board), a PCB fixed strip and a frame, wherein the infrared screen PCB is fixed on the PCB fixed strip through screws; the infrared screen PCB and the PCB fixed strip are assembled to form a single infrared frame; a clamping position, a slot position and a socket are arranged on the frame; the single infrared frame is plugged in the clamping position of the frame; the light filter bar is plugged in the slot position of the frame; the socket of the frame is used for a white board body to plug in. The TB infrared white board frame structure is firm and reliable in structure, easy to disassemble and assemble, and convenient to maintain.

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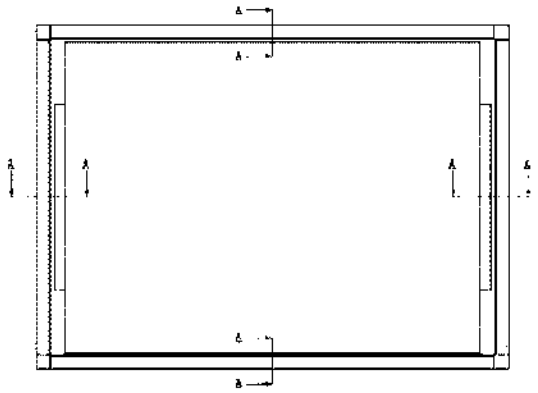
权利要求1页 说明书5页 附图2页

(54)实用新型名称

一种TB红外白板边框结构及其TB红外白板结构

(57)摘要

本实用新型提出了一种TB红外白板边框结构，包括滤光条、红外屏PCB线路板、PCB固定条、边框，所述红外屏PCB线路板通过螺丝固定在所述PCB固定条上，所述红外屏PCB线路板与所述PCB固定条组装成单根红外框；所述边框上设有一卡位和一槽位以及一插口，所述单根红外框插接于所述边框的卡位中；所述滤光条插接于所述边框的槽位中；所述边框的插口用于插接白板板体。所述TB红外白板边框结构牢固可靠、拆装容易、维护方便。



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1. 一种 TB 红外白板边框结构，其特征在于：包括滤光条、红外屏 PCB 线路板、PCB 固定条、边框，所述红外屏 PCB 线路板通过螺丝固定在所述 PCB 固定条上，所述红外屏 PCB 线路板与所述 PCB 固定条组装成单根红外框；所述边框上设有一卡位和一槽位以及一插口，所述单根红外框插接于所述边框的卡位中；所述滤光条插接于所述边框的槽位中；所述边框的插口用于插接白板板体。

2. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述滤光条为塑胶滤光条。

3. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述边框为铝合金材质。

4. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述 PCB 固定条为铝合金材质。

5. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述边框内设有若干条加强筋。

6. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述卡位呈 T 型。

7. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述槽位呈球型。

8. 如权利要求 1 所述的 TB 红外白板边框结构，其特征在于：所述边框内部设有空腔。

9. 一种 TB 红外白板结构，其特征在于：由权利要求 1-8 任一所述的 TB 红外白板边框结构连接而成。

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一种 TB 红外白板边框结构及其 TB 红外白板结构

技术领域

[0001] 本实用新型涉及电子白板领域，特别是指一种 TB 红外白板边框结构。

背景技术

[0002] 红外电子白板是现在最受教学、会议等场合十分适用的一种工具，它可以与电脑进行信息通讯，将电子白板连接到 PC，并利用投影机将 PC 上的内容投影到电子白板屏幕上，在专门的应用程序的支持下，可以构造一个大屏幕、交互式的协作会议或教学环境。利用特定的定位笔代替鼠标在白板上进行操作，可以运行任何应用程序，可以对文件进行编辑、注释、保存等在计算机上利用键盘及鼠标可以实现的任何操作。

[0003] 目前，已有技术的红外电子白板存在以下不足：1、结构稳定性差，白板板体与边框之间以及相邻两个边框之间的连接不牢固，使用中容易出现松脱现象，给用户现场带来麻烦。2、维护时，需要把电子白板从墙上拆下来，然后拆下四个铝合金边框，才能拆下 PCB 线路板进行维护，因而操作不便。3、外形单调，缺乏美感。

实用新型内容

[0004] 本实用新型提出一种 TB 红外白板边框结构，该结构牢固可靠、拆装容易、维护方便、外形美观。

[0005] 本实用新型的技术方案是这样实现的：一种 TB 红外白板边框结构，包括滤光条、红外屏 PCB 线路板、PCB 固定条、边框，所述红外屏 PCB 线路板通过螺丝固定在所述 PCB 固定条上，所述红外屏 PCB 线路板与所述 PCB 固定条组装成单根红外框；所述边框上设有一卡位和一槽位以及一插口，所述单根红外框插接于所述边框的卡位中；所述滤光条插接于所述边框的槽位中；所述边框的插口用于插接白板板体。

[0006] 优选的，所述滤光条为塑胶滤光条。

[0007] 优选的，所述边框为铝合金材质。

[0008] 优选的，所述 PCB 固定条为铝合金材质。

[0009] 优选的，所述边框内设有若干条加强筋。

[0010] 优选的，所述卡位呈 T 型。

[0011] 优选的，所述槽位呈球型。

[0012] 优选的，所述边框内部设有空腔。

[0013] 一种 TB 红外白板结构，由所述 TB 红外白板边框结构连接而成。

[0014] 本实用新型的有益效果是：所述 TB 红外白板边框结构采用铝合金型材组合而成，铝合金型材采用铝合金挤出模具制作而成，表面能做喷粉、氧化、拉丝等多种外观，具有产品精度高，外形光滑，生产制造简便，周期短，利于大批量生产等优点，所述 TB 红外白板边框结构还具备结构牢固可靠、拆装容易、维护方便的特点。

附图说明

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[0015] 为了更清楚地说明本实用新型实施例或现有技术中的技术方案，下面将对实施例或现有技术描述中所需要使用的附图作简单地介绍，显而易见地，下面描述中的附图仅仅是本实用新型的一些实施例，对于本领域普通技术人员来讲，在不付出创造性劳动性的前提下，还可以根据这些附图获得其他的附图。

[0016] 图 1 为本实用新型一种 TB 红外白板结构的主视示意图；

[0017] 图 2 为图 1 所示 TB 红外白板边框结构 A-A 面剖视图；

[0018] 图 3 为图 2 所示 TB 红外白板边框结构插入单根红外框的结构示意图；

[0019] 图 4 为图 2 所示 TB 红外白板边框结构插入白板的结构示意图。

[0020] 附图中，1 白板板体，2 滤光条，3 红外屏 PCB 线路板，4 PCB 固定条，5 边框，6- 槽位，7- 卡位。

具体实施方式

[0021] 下面将结合本实用新型实施例中的附图，对本实用新型实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本实用新型一部分实施例，而不是全部的实施例。基于本实用新型中的实施例，本领域普通技术人员在没有作出创造性劳动前提下所获得的所有其他实施例，都属于本实用新型保护的范围。

[0022] 如图 2、3、4 所示，一种 TB 红外白板边框结构，包括滤光条 2、红外屏 PCB 线路板 3、PCB 固定条 4、边框 5，所述红外屏 PCB 线路板 3 通过螺丝固定在所述 PCB 固定条 4 上，所述红外屏 PCB 线路板 3 与所述 PCB 固定条 4 组装成单根红外框；所述边框 5 上设有一卡位 7 和一槽位 6 以及一插口，所述单根红外框插接于所述边框的卡位 7 中；所述滤光条 2 插接于所述边框的槽位 6 中；所述边框的插口用于插接白板板体。

[0023] 优选的，所述滤光条 2 为塑胶滤光条。

[0024] 优选的，所述边框 5 为铝合金材质。

[0025] 优选的，所述 PCB 固定条 4 为铝合金材质。

[0026] 优选的，所述边框 5 内设有若干条加强筋。

[0027] 优选的，所述卡位 7 呈 T 型。

[0028] 优选的，所述槽位 6 呈球型。

[0029] 优选的，所述边框 5 内部设有空腔。

[0030] 如图 1 所示，一种 TB 红外白板结构，由上下左右四个所述 TB 红外白板边框结构连接而成。

[0031] 如图 1、2、3、4 所示，所述 TB 红外白板边框结构的一种组装方式：

[0032] 红外屏 PCB 线路板 3 通过螺丝固定在 PCB 固定条 4 上，组装成单根红外框，所述单根红外框插接于所述边框的 T 型卡位 7 中；所述滤光条 2 插接于所述边框的槽位 6 中；白板板体 1 插接于所述边框 5 的插口中；

[0033] 所述白板板体 1 呈矩形，白板板体 1 的四边各插接一个 TB 红外白板边框结构，四个 TB 红外白板边框结构通过连接件可拆卸连接。结构简单，安装方便，维修方便快捷。

[0034] 以上所述仅为本实用新型的较佳实施例而已，并不用以限制本实用新型，凡在本实用新型的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本实用新型的保护范围之内。

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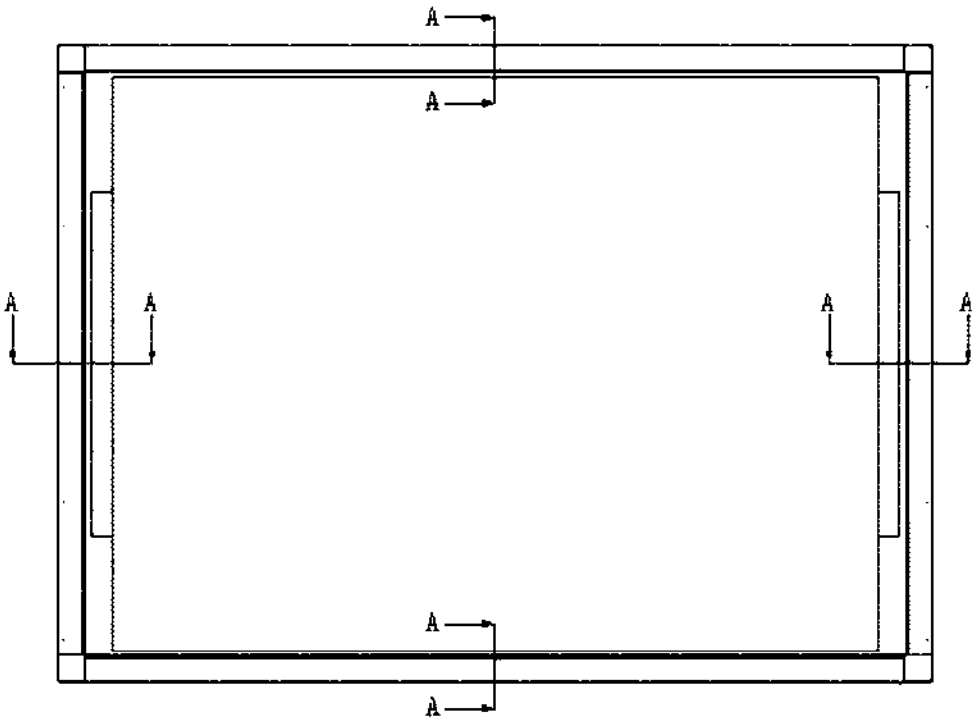


图 1

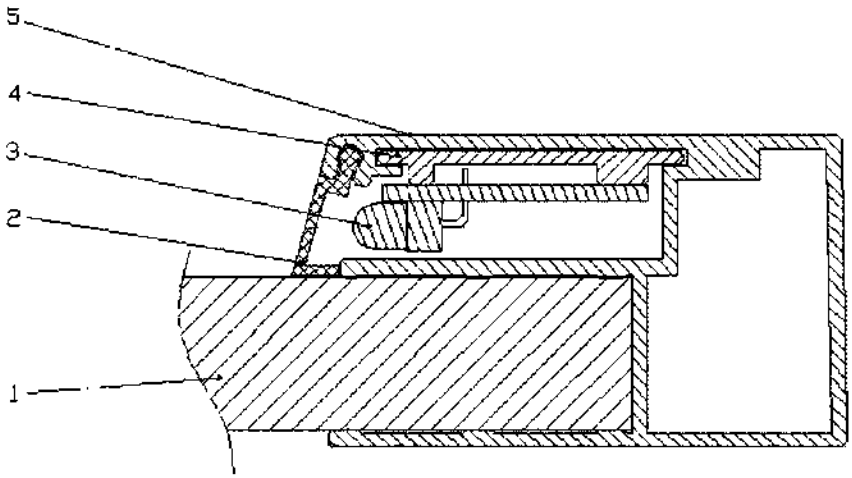


图 2

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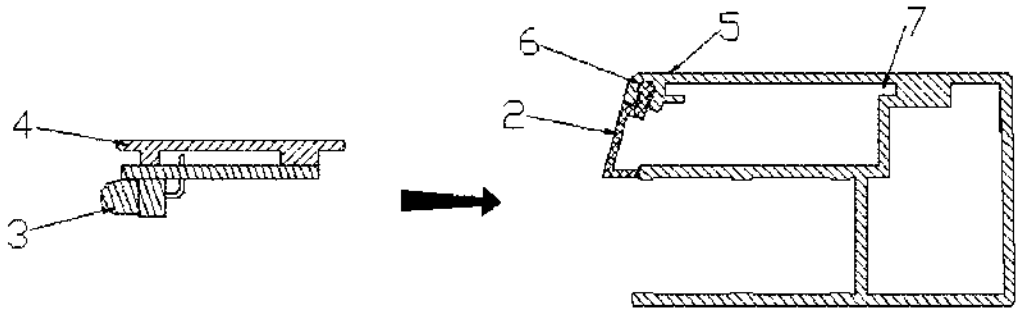


图 3

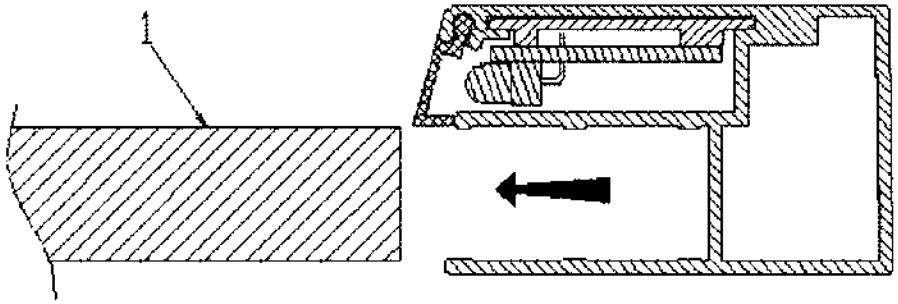


图 4

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Espacenet

WO2014131221A1 PROJECTION-TYPE TOUCH CONTROL ELECTRONIC WHITEBOARD AND FRAME STRUCTURE THEREOF

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PROJECTION-TYPE TOUCH CONTROL ELECTRONIC WHITEBOARD AND FRAME STRUCTURE THEREOF

Abstract

Disclosed is a frame structure of a projection-type touch control electronic whiteboard to be arranged on the edge of an electronic whiteboard screen, comprising a frame, a light source assembly arranged inside the frame, and an optical filter arranged on the side opening of the frame; the side opening of the frame extends along the edge of the electronic whiteboard; a sensor of the light source assembly is vertically arranged on the circuit board of the light source assembly; the circuit board extends along the edge of the electronic whiteboard; and the vertically arranged sensor provides touch control positioning through the filter. Also disclosed is an electronic whiteboard with the frame structure. The electronic whiteboard and the frame structure thereof enable the electronic whiteboard to have a narrow frame, and are easy to install and maintain, thus facilitating the designing of a light and thin electronic whiteboard having a more attractive appearance.

(12) 按照专利合作条约所公布的国际申请

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(30) 优先权：
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(81) 指定国 (除另有指明，要求每一种可提供的国家保护)：AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, ML, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国 (除另有指明，要求每一种可提供的地区保护)：ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 喊亚 (AM, AZ,

[见续页]

(54) Title: PROJECTION-TYPE TOUCH CONTROL ELECTRONIC WHITEBOARD AND FRAME STRUCTURE THEREOF

(54) 发明名称 投影式触控电子白板及其边框结构

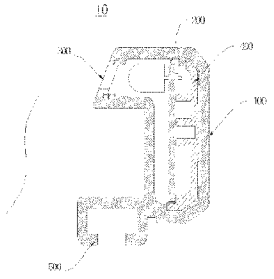


图 5/Fig.5

(57) Abstract: Disclosed is a frame structure of a projection-type touch control electronic whiteboard to be arranged on the edge of an electronic whiteboard screen, comprising a frame, a light source assembly arranged inside the frame, and an optical filter arranged on the side opening of the frame; the side opening of the frame extends along the edge of the electronic whiteboard; a sensor of the light source assembly is vertically arranged on the circuit board of the light source assembly; the circuit board extends along the edge of the electronic whiteboard; and the vertically arranged sensor provides touch control positioning through the filter. Also disclosed is an electronic whiteboard with the frame structure. The electronic whiteboard and the frame structure thereof enable the electronic whiteboard to have a narrow frame, and are easy to install and maintain, thus facilitating the designing of a light and thin electronic whiteboard having a more attractive appearance.

(57) 摘要：

[见续页]

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BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TG)。

本国际公布：

- 包括国际检索报告(条约第21条(3))。

本发明公开一种投影式触控电子白板的边框结构，用于设置在电子白板的屏幕的边缘处，包括边框、设置在所述边框内的光源组件和设于所述边框侧边开口处的滤光片，所述边框的侧边开口沿电子白板的边缘延伸，所述光源组件的传感器竖排在所述光源组件的电路板上，且所述电路板沿电子白板的边缘延伸，所述竖排的传感器透过所述滤光片提供触控定位。还公开一种具有上述边框结构的电子白板。上述电子白板及其边框结构使得电子白板具有窄边框，易安装，易维护，方便设计更加美观的轻薄电子白板。

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说 明 书

发 明 名 称 : 投 影 式 触 控 电 子 白 板 及 其 边 框 结 构

[1] 技术领域】

[2] 本发明涉及电子白板技术领域，特别是涉及一种投影式触控电子白板和一种投影式触控电子白板的边框结构。

[3] 背景技术】

[4] 在电子白板技术领域，特别是采用投影显示的大型电子白板中（参考图1），多采用红外传感技术为电子白板提供触控定位。红外传感器一般都设置在电子白板的边框中。如图2所示，是一种传统的电子白板的横向剖视图。该电子白板包括基板1、设置在基板1四个边缘的边框2、设置在边框2中的传感器组件3和设置在边框2侧边开口处的滤光片4。其中传感器组件3发射出信号并经过滤光片4滤光后为触控区域另一侧的传感器接收。参考图3a和图3b，传感器组件3包括电路板31、插设在电路板31上的传感器32和驱动传感器32的电路芯片33。在传统的电子白板中，传感器组件3中的传感器32的管脚是与传感器主体部分垂直的，也即传感器32主体部分是卧排在电路板31上的，这样就需要将整个电路板31以平行于基板1的方式放置在基板1的边缘，这样整个电子白板的边框就会太宽，无法形成窄边框设计。

[5] 发明内容】

[6] 基于此，有必要提供一种用于窄边框的投影式电子白板的边框结构。

[7] 此外，还提供一种投影式电子白板。

[8] 一种投影式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括边框、设置在所述边框内的传感器组件和设于所述边框侧边开口处的滤光片，所述边框的侧边开口沿电子白板的边缘延伸，所述传感器组件的传感器竖排在所述传感器组件的电路板上，且所述电路板沿显示区域的边缘延伸，所述竖排的传感器透过所述滤光片提供触控定位。

[9] 在其中一个实施例中，所述边框整体为条柱状，并具有截面为L型的容置腔，用于容置所述传感器组件，所述传感器组件的电路板和传感器相互垂直地设置

并置于所述截面为L型的容置腔中。

[10] 在其中一个实施例中，还包括托板，所述电路板固定在所述托板上，并与托板一起活动地容置于所述边框内。

[11] 在其中一个实施例中，还包括设于所述边框上且与设有滤光片的开口相对的边框连接结构，多个边框可通过所述边框连接结构相互连接。

[12] 在其中一个实施例中，所述边框连接结构为与角铁配合的框架。

[13] 一种投影式电子白板，包括触控板和设于所述触控板四个边缘的边框结构，所述边框结构包括边框、设置在所述边框内的传感器组件和设于所述边框侧边开口处的滤光片，所述边框的侧边开口沿触控板的边缘延伸，所述传感器组件的传感器竖排在所述光源组件的电路板上，且所述电路板沿触控板的边缘延伸，所述竖排的传感器透过所述滤光片提供触控定位。

[14] 在其中一个实施例中，所述边框整体为条柱状，并具有截面为L型的容置腔，用于容置所述光源组件，所述光源组件的电路板和传感器相互垂直地设置并置于所述截面为L型的容置腔中。

[15] 在其中一个实施例中，还包括托板，所述电路板固定在所述托板上，并与托板一起活动地容置于所述边框内。

[16] 在其中一个实施例中，还包括设于所述边框上且与设有滤光片的开口相对的边框连接结构，相邻的边框通过所述边框连接结构相互连接。

[17] 在其中一个实施例中，所述边框连接结构包括为与角铁配合的框架，相邻边框通过角铁连接，且相邻的边框连接处设有与所述角铁固定连接且覆盖边框端部的角件。

[18] 上述投影式电子白板及其边框结构，通过将红外LED光源的发光灯体与电路板垂直设置，使得电路板可以采用沿屏幕边缘延伸的方向设置，相比于传统的设置方式，可以将显示屏的边框部分变窄，便于设计更美观的显示屏。

[19] 【附图说明】

[20] 图1为触摸电子白板用于投影的示意图；

[21] 图2为一种传统的显示屏的横向剖视图；

[22] 图3a和图3b为图2中的触控组件结构示意图；

[23] 图4为一实施例的显示屏的边框结构示意图；

[24] 图5为图4所述边框结构的横向剖视图；

[25] 图6为图5中的触控组件结构示意图；

[26] 图7为一实施例的显示屏的横向剖视图；

[27] 图8为相邻的边框结构相接处带角件的示意图；

[28] 图9为相邻的边框结构相接处不带角件的示意图。

[29] 具体实施方式】

[30] 如图4所示，为一实施例的投影式电子白板的边框结构示意图，图5为图4所示的边框结构的横向剖视图。结合图4和图5，该边框结构10包括边框100、设置在边框100内的传感器组件200和设于边框100侧边开口处的滤光片300 (参考图5)。

[31] 边框100整体为条柱状，并具有截面为L型的容置腔。边框100侧边开设沿电子白板的屏幕的边缘延伸的开口，滤光片300设于该开口处。

[32] 如图6所示，传感器组件200包括传感器210和电路板220。在电子白板相对的边缘上设置的边框结构10中，对应设置发送传感器和接收传感器。这样，从电子白板一侧边缘发送的传感器信号能够被另一对侧的传感器接收。传感器210竖排在电路板220上，也即传感器210的管脚与传感器轴向相同，使得传感器210与电路板220相互垂直。电路板220沿电子白板的边缘延伸，多个传感器210即沿该延伸方向顺序排列，并且传感器信号的发射或接收方向朝向滤光片300，透过滤光片300提供触控定位。相互垂直的传感器210和电路板220容置于上述的具有L型截面的容置腔中。

[33] 进一步地，如图4~图6所示，本实施例的边框结构10还包括托板400。电路220固定在托板400上，并与托板400—起活动地容置于边框100内。

[34] 在传统的电子白板边框结构中，一旦传感器出现故障，就要更换传感器组件中的部分电路板，此吋需要将电子白板四个边框全部拆除以取出电路板。本实施例的边框结构10中，传感器组件200则可以随托板400—起整体地在边框100的容置腔中移动，在电路出现故障吋，从边框100的一端拉动托板400，即可将传感器组件200整体取出。因此可以方便地维护。

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[35] 进一步地，如图5所示，本实施例的边框结构10还包括设于边框100上的边框连接结构500。在边框100的位置上，边框连接结构500与设有滤光片300的开口相对，在边框100与电子白板边缘连接时，边框连接结构500和滤光片300分别位于电子白板的正面和背面。相邻的边框100可通过边框连接结构500相互连接，以形成紧凑的边框整体。

[36] 本实施例中，边框连接结构500为与角铁配合的框架。

[37] 上述实施例中，通过将传感器210的传感器主体与电路板220垂直设置，使得电路板210可以采用沿电子白板边缘延伸的方向设置，相比于传统的设置方式，可以将电子白板的边框部分变窄，便于设计更美观的电子白板。同时，传感器组件200作为一个整体可以随托板400活动地进出边框100的容置腔，便于在传感器故障时进行维护。

[38] 可以理解，在不同的实施例中，托板400和边框连接结构500根据成本或便利性等需求增减，且具体结构也不限于上述实施例的结构。

[39] 如图7所示，为一实施例的电子白板的横向剖视图。该电子白板包括触控板20和设于触控板20四个边缘的如上述实施例的边框结构10（图7中仅显示两个边缘的边框结构）。

[40] 参考图8，边框结构10在相邻处通过角件30连接。参考图9，边框结构10的相邻处设置角铁40，相邻边框10的边框连接结构500通过角铁40连接，角件30与角铁40固定连接并覆盖在边框10的相邻的端部。当光源组件200出现故障时，只需要将角件30拆卸，然后通过托板400将光源组件200整体拉出，即可方便地维修。

[41] 以上所述实施例仅表达了本发明的几种实施方式，其描述较为具体和详细，但并不能因此而理解为对本发明专利范围的限制。应当指出的是，对于本领域的普通技术人员来说，在不脱离本发明构思的前提下，还可以做出若干变形和改进，这些都属于本发明的保护范围。因此，本发明专利的保护范围应以所附权利要求为准。

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权利要求书

[权利要求 1] 一种投影式电子白板的边框结构，用于设置在电子白板的显示区域的边缘处，包括边框、设置在所述边框内的传感器组件和设于所述边框侧边开口处的滤光片，所述边框的侧边开口沿电子白板的边缘延伸，其特征在于，所述传感器组件的传感器竖排在所述传感器组件的电路板上，且所述电路板沿显示区域的边缘延伸，所述竖排的传感器透过所述滤光片提供触控定位。

[权利要求 2] 根据权利要求1所述的投影式电子白板的边框结构，其特征在于，所述边框整体为条柱状，并具有截面为L型的容置腔，用于容置所述传感器组件，所述传感器组件的电路板和传感器相互垂直地设置并置于所述截面为L型的容置腔中。

[权利要求 3] 根据权利要求1所述的投影式电子白板的边框结构，其特征在于，还包括托板，所述电路板固定在所述托板上，并与托板一起活动地容置于所述边框内。

[权利要求 4] 根据权利要求1所述的投影式电子白板的边框结构，其特征在于，还包括设于所述边框上且与设有滤光片的开口相对的边框连接结构，多个边框可通过所述边框连接结构相互连接。

[权利要求 5] 根据权利要求4所述的投影式电子白板的边框结构，其特征在于，所述边框连接结构为与角铁配合的框架。

[权利要求 6] 一种投影式电子白板，包括触控板和设于所述触控板四个边缘的边框结构，所述边框结构包括边框、设置在所述边框内的传感器组件和设于所述边框侧边开口处的滤光片，所述边框的侧边开口沿触控板的边缘延伸，其特征在于，所述传感器组件的传感器竖排在所述光源组件的电路板上，且所述电路板沿触控板的边缘延伸，所述竖排的传感器透过所述滤光片提供触控定位。

[权利要求 7] 根据权利要求6所述的投影式电子白板，其特征在于，所述边框整体为条柱状，并具有截面为L型的容置腔，用于容置所述光源组件，所述光源组件的电路板和传感器相互垂直地设置并置于所述截

面为L型的容置腔中。

[权利要求 8] 根据权利要求6所述的投影式电子白板，其特征在于，还包括托板，所述电路板固定在所述托板上，并与托板一起活动地容置于所述边框内。

[权利要求 9] 根据权利要求6所述的投影式电子白板，其特征在于，还包括设于所述边框上且与设有滤光片的开口相对的边框连接结构，相邻的边框通过所述边框连接结构相互连接。

[权利要求 10] 根据权利要求9所述的投影式电子白板，其特征在于，所述边框连接结构包括为与角铁配合的框架，相邻边框通过角铁连接，且相邻的边框连接处设有与所述角铁固定连接且覆盖边框端部的角件。

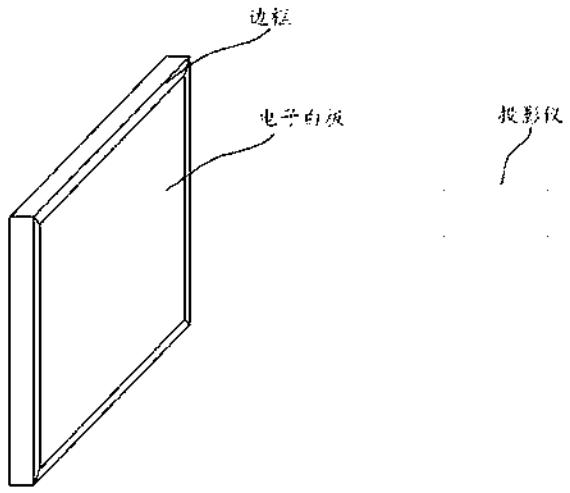


图 1

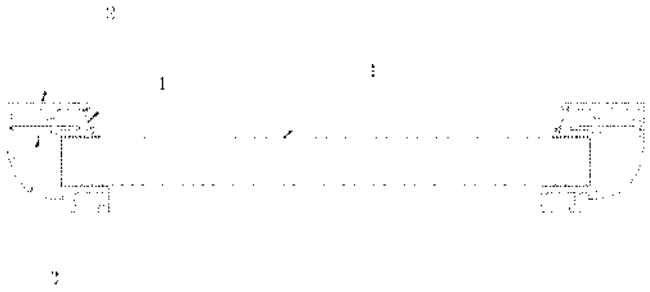


图 2

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图 3a



图 3b

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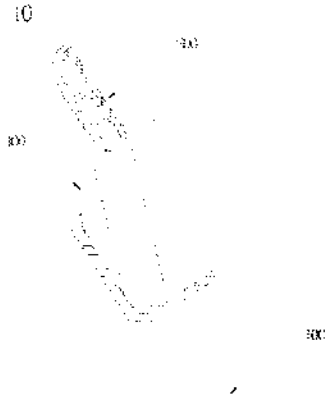


图 4

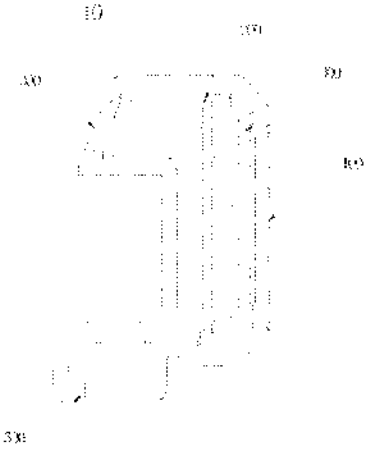


图 5

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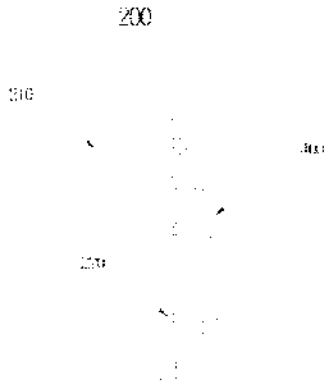


图 6

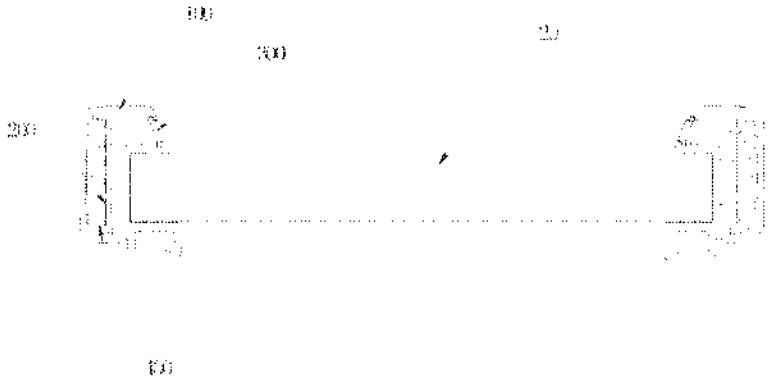


图 7

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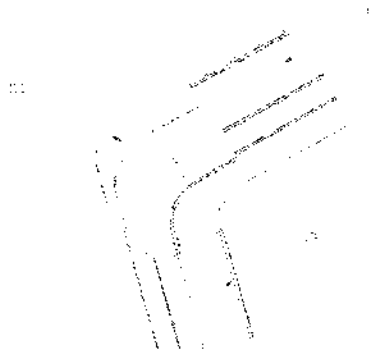


图 8

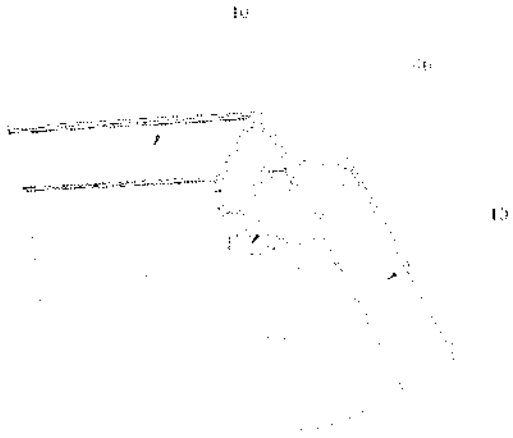


图 9

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/073781

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/042 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F 3/-

Documentetion searched other than minimum documentetion to the extent that such documents are included in the fields searched

Electronic date base consulted during the international search (name of data base and, where practicable, search terms used)
CNPAT, CNKI, DWPI, EPODOC: touch, frame, size, width, narrow, sensor, sensing, infrared, circuit board, vertical, perpendicular, white board, print circuit board, optics

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citetion of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 201917889 U (ZHEJIANG RUNZHI ELECTRONIC TECHNOLOGY CO., LTD.) 03 August 2011 (03.08.2011) description, paragraphs [0029]-[0031], [0071] and [0075], and figures 1 and 7	1-10
X	CN 102662534 A (SHENZHEN TIMELINK SCI&TECHNOLOGY CO.) 12 September 2012 (12.09.2012) description, paragraphs [0021]-[0024], and figure 1	1-10
X	CN 202661975 U (SHENZHEN TIMELINK SCI&TECHNOLOGY CO.) 09 January 2013 (09.01.2013) description paragraphs [0021]-[0024], and figure 1,	1-10
E	CN 203178984 U (SHENZHEN TIMELINK SCI & TECHNOLOGY CO.) 04 September 2013 (04.09.2013) claims 1-10	1-10
A	CN 202171790 U (IRICO GROUP CO., LTD.) 21 March 2012 (21.03.2012) the whole document	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to esteblish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevanca; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is teken alone

"Y" document of particular relevanca; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2013 (28.11.2013)	05 Decamber 2013 (05.12.2013)
Name and mailing address of the ISA State Intellectual Property Offica of the P.R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officar ZENG, Wei Telephone No. (86-10) 62411695

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/CN2013/073781

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 201917889 U	03.08.2011	None	
CN 1026625 34 A	12.09.2012	W O 2013159472 A l	31.10.2013
CN 202661975 U	09.01.2013	None	
CN 203178984 U	04.09.2013	None	
CN 202171790 U	2 1.03.2012	None	

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国际检索报告

国际申请号
PCT/CN20 13/073781

A. 主题的分类

G06F 3/042 (2006.01) i

按照国际专利分类(IPC) 或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: G06F3/-

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词 (如使用))

CNPAT, CNKI, DWPI, EPODOC: 触摸，触敏，触控，边框，宽度，窄，感应，感测，传感，光学，红外，白板，电路，电路板，印刷电路板，印制电路板，垂直，竖直，竖排，外框，框架, touch, frame, size, sensor, sensing, infrared circuit board, vertical, perpendicular

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN 201917889 U (浙江润智电子科技有限公司)03. 8 月 201 1 (03.08.201 1) 附图 1, 7，说明书 0029-0031, 0071, 0075 段	1-10
X	CN 102662534 A (深圳市天时通科技有限公司)12. 9 月 2012 (12.09.2012) 附图 1，说明书 0021-0024 段	1-10
X	CN 202661975 U (深圳市天时通科技有限公司)09. 1 月 2013 (09.01.2013) 附图 1，说明书 0021-0024 段	1-10
E	CN 203 178984 U (深圳市天时通科技有限公司)04. 9 月 2013 (04.09.2013) 权利要求 1-10	1-10
A	CN 202171790 U (彩虹集团公司)21. 3 月 2012 (21.03.2012) 全文	1-10

☐ 其余文件在 C 栏的续页中列出。

☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的¾¼ 之后公布的在先申请或荷 。

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件 (如具体说明的)

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触!, 但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
28. 11 月 2013 (28. 11.2013)	05.12 月 2013 (05.12.2013)

ISA/CN 的名称和邮寄地址：	受权官员
中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 10008S 传真号： (86-10)62019451	曾威 电话号码：(86-10) 62411695

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国际检索报告

关于同族专利的信息

国际申请号
PCT/CN2013/073781

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN 201917889 U	03.08.201 1	无	
CN 102662534 A	12.09.2012	WO 2013 159472 A I	31.10.2013
CN 202661975 U	09.01.2013	无	
CN 203 178984 U	04.09.2013	无	
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(19)中华人民共和国国家知识产权局

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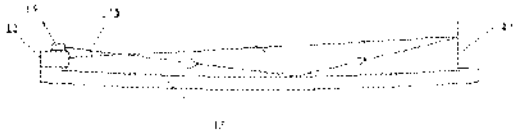
权利要求书 1 页 说明书 3 页 附图 3 页

(54)发明名称

凹面光学触摸屏

(57)摘要

本发明公开了一种凹面光学触摸屏，包括框架、光学传感器、光源、回归反射条及触摸面板，其中，所述触摸面板的表面是向下凹陷的。本发明的凹面光学触摸屏与现有技术相比，具有如下有益效果：由于安装了表面向下凹陷的触摸面板，部分光线被所述触摸面板反射到回归反射条，增强了回归反射的光的能量，使得本发明的凹面光学触摸屏具有更高的灵敏度和检测精度。



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1. 一种凹面光学触摸屏，包括框架、光学传感器、光源、回归反射条及触摸面板，其特征在于，所述触摸面板的表面是向下凹陷的。

2. 根据权利要求 1 所述的凹面光学触摸屏，其特征在于：所述触摸面板的表面中心向下凹陷，边缘水平，其余部位从所述中心向所述边缘均匀拉升。

3. 根据权利要求 2 所述的凹面光学触摸屏，其特征在于：所述触摸面板表面的中心位置比边缘位置低 0.5mm 至 5mm。

4. 根据权利要求 2 所述的凹面光学触摸屏，其特征在于：所述触摸面板是由蜂窝铝板材料制作而成的。

5. 根据权利要求 2 所述的凹面光学触摸屏，其特征在于：所述触摸面板是由亚克力板材料制作而成的。

6. 根据权利要求 2 所述的凹面光学触摸屏，其特征在于：所述触摸面板是由钢化玻璃材料制作而成的。

7. 根据权利要求 6 所述的凹面光学触摸屏，其特征在于：所述钢化玻璃的触摸面板，在制作过程钢化冷却时，所述钢化玻璃的上表面气压为 920±10MP，下表面气压为 880±10MP。

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凹面光学触摸屏

技术领域

[0001] 本发明涉及一种触摸屏，尤其涉及一种凹面光学触摸屏。

背景技术

[0002] 随着多媒体技术的发展，用于实现人机交互的触摸屏得到越来越广泛的应用。当前国内主流的触摸技术当以红外、表面声波和电阻屏为主，但这几种技术也都存在着缺陷，如声波屏点击需要力度，电阻屏性能不稳定等等。近年来，凹面光学触摸屏的出现基本解决了众多触摸屏的难题，其反应速度快，灵敏度高，所需触摸力度小。图 1 为现有一种凹面光学触摸屏的结构示意图，所述凹面光学触摸屏包括框架 101、光学传感器 102、光源 103、回归反射条 104 及触摸面板 105，所述框架 101 为矩形框架，由第一边缘 1011、第二边缘 1012、第三边缘 1013 以及第四边缘 1014 依次连接而成。当触摸物 106 在触摸面板 105 上发生触击时，就会阻挡光源 103 所发出的光线 107，在回归反射条 104 上产生阴影 108，光学传感器 102 分析阴影 108 就可以计算出触摸物 106 所在的位置。在理想状态下，所述触摸面板 105 是水平的，但是在实际情况下，所述触摸面板 105 一般都有凹凸不平，难以达到理想的水平状态。请参加图 1a，当所述触摸面板 105 表面外凸时，部分光线 109 被反射到回归反射条 104 之外，有效反射回来的光能量就很弱。反射回来的光能量低，信号就弱，使得触摸屏灵敏度不高，检测精度低。

发明内容

[0003] 本发明实施例所要解决的技术问题在于，提供一种灵敏、检测精度高的凹面光学触摸屏。

[0004] 为了解决上述技术问题，本发明实施例提供了一种凹面光学触摸屏，包括框架、光学传感器、光源、回归反射条及触摸面板，其中，所述触摸面板的表面是向下凹陷的。

[0005] 进一步的，所述触摸面板的表面中心向下凹陷，边缘水平，其余部位从所述中心向所述边缘均匀拉升。

[0006] 进一步的，所述触摸面板表面的中心位置比边缘位置低 0.5mm 至 5mm。

[0007] 进一步的，所述触摸面板是由蜂窝板材料制作而成的。

[0008] 进一步的，所述触摸面板是由亚克力板材料制作而成的。

[0009] 进一步的，所述触摸面板是由钢化玻璃材料制作而成的。

[0010] 进一步的，所述钢化玻璃的触摸面板，在制作过程钢化冷却时，所述钢化玻璃的上表面气压为 920±10MP，下表面气压为 880±10MP。

[0011] 实施本发明实施例，具有如下有益效果：由于安装了表面向下凹陷的触摸面板，部分光线被所述触摸面板反射到回归反射条，增强了回归反射的光的能量，使得本发明的光学触摸屏具有更高的灵敏度和检测精度。相比其他的在回归反射条上设置特殊物质或者发生特殊结构以提高回归反射的光的能量的技术方案，本实施例的方案简单易行，取得了预料不到的技术效果。

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附图说明

[0012] 为了更清楚地说明本发明实施例中的技术方案，下面将对实施例描述中所需要使用的附图作简单地介绍，显而易见地，下面描述中的附图仅仅是本发明的一个实施例，对于本领域普通技术人员来讲，在不付出创造性劳动性的前提下，还可以根据这些附图获得其他的附图。

[0013] 图 1 是现有凹面光学触摸屏的结构示意图；

图 2 是本发明凹面光学触摸屏的一实施例结构示意图；

图 3 是图 2 所述凹面光学触摸屏的触摸面板的结构示意图；

图 4a 是现有凹面光学触摸屏在实际应用中的光线反射时的示意图；

图 4b 是本发明凹面光学触摸屏在实际应用中的光线反射时的示意图。

具体实施方式

[0014] 下面将结合本发明实施例中的附图，对本发明实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本发明一个实施例，而不是全部的实施例。基于本发明中的实施例，本领域普通技术人员在没有做出创造性劳动前提下所获得的所有其他实施例，都属于本发明保护的范围。

[0015] 本发明实施例提供了一种凹面光学触摸屏，下面结合图 2 至图 4b 对本凹面光学触摸屏的实施例进行说明。

[0016] 图 2 为本发明凹面光学触摸屏的第一实施例结构示意图。如图 2 所示，本实施例的凹面光学触摸屏 1 的结构包括：

框架 11、光学传感器 12、光源 13、回归反射条 14 及触摸面板 15。所述框架 11 包围所述触摸面板 15。所述光学传感器 12 和光源 13 置于所述框架 11 上，具体的，可以置于所述框架 11 的左上角和右上角，或者置于所述框架 11 的上边框中央位置。所述回归反射条 14 置于所述框架 11 的边缘。其中，所述触摸面板 15 的表面是向下凹陷的。

[0017] 具体的，请参见图 3，为本发明凹面光学触摸屏的触摸面板 15 的结构示意图。如图 3 所示，所述触摸面板 15 的表面中心 151 向下凹陷，边缘 152 水平，其余部位从所述中心 151 的所述边缘 152 均匀拉升。优选的，所述触摸面板 15 表面的中心 151 位置比边缘位置 152 低 0.5mm 至 5mm，以取得较好的反射效果。

[0018] 请结合参见图 4a 和图 4b，图 4a 为现有凹面光学触摸屏在实际应用中的光线反射时的示意图；图 4b 为本发明所述凹面光学触摸屏在实际应用中的光线反射时的示意图。

[0019] 如图 4a 所示，当所述触摸面板 105 表面外凸时，光源 103 发出的部分光线 109 被所述触摸面板 105 反射到回归反射条 104 之外，有效反射回归所述光学传感器 102 的光能量就很弱。反射回归的光能量低，信号就弱，使得触摸屏灵敏度不高，检测精度低。

[0020] 如图 4b 所示，由于安装了表面向下凹陷的触摸面板 15，光源 13 发出的部分光线 153 被所述触摸面板 15 反射到所述回归反射条 14，再由所述回归反射条 14 反射回所述光学传感器 12，增强了回归反射的光的能量。反射回归的光能量高，信号就强，使得触摸屏灵敏度提高，检测精度提高。

[0021] 具体的，所述触摸面板 15 是由蜂窝铝板材料或者亚克力板材料通过加工而成的。

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[0022] 优选的，所述触摸面板 15 是由钢化玻璃材料制作而成的。所述钢化玻璃并非平常正常工艺，生产时需注意控制工艺，使其中心部位向下凹陷。控制方法是：在所述钢化玻璃钢化冷却时，上下两表面吹的风压压力设置不同，控制其上表面气压为 920±10MP，下表面气压为 880±10MP，则所述钢化玻璃向下凹陷。

[0023] 实施本发明实施例，具有如下有益效果：由于安装了表面向下凹陷的触摸面板，部分光线被所述触摸面板反射到红外反射条，增强了红外反射的光的能量，使得本发明的光学触摸屏具有更高的灵敏度和检测精度。相比其他的在红外反射条上设置特殊物质或者设置特殊结构以提高红外反射的光的能量的技术方案，本实施例的方案简单易行，取得了预料不到的技术效果。

[0024] 以上所揭露的仅为本发明较佳实施例而已，当然不能以此来限定本发明之权利范围，因此依本发明权利要求所作的等同变化，仍属本发明所涵盖的范围。

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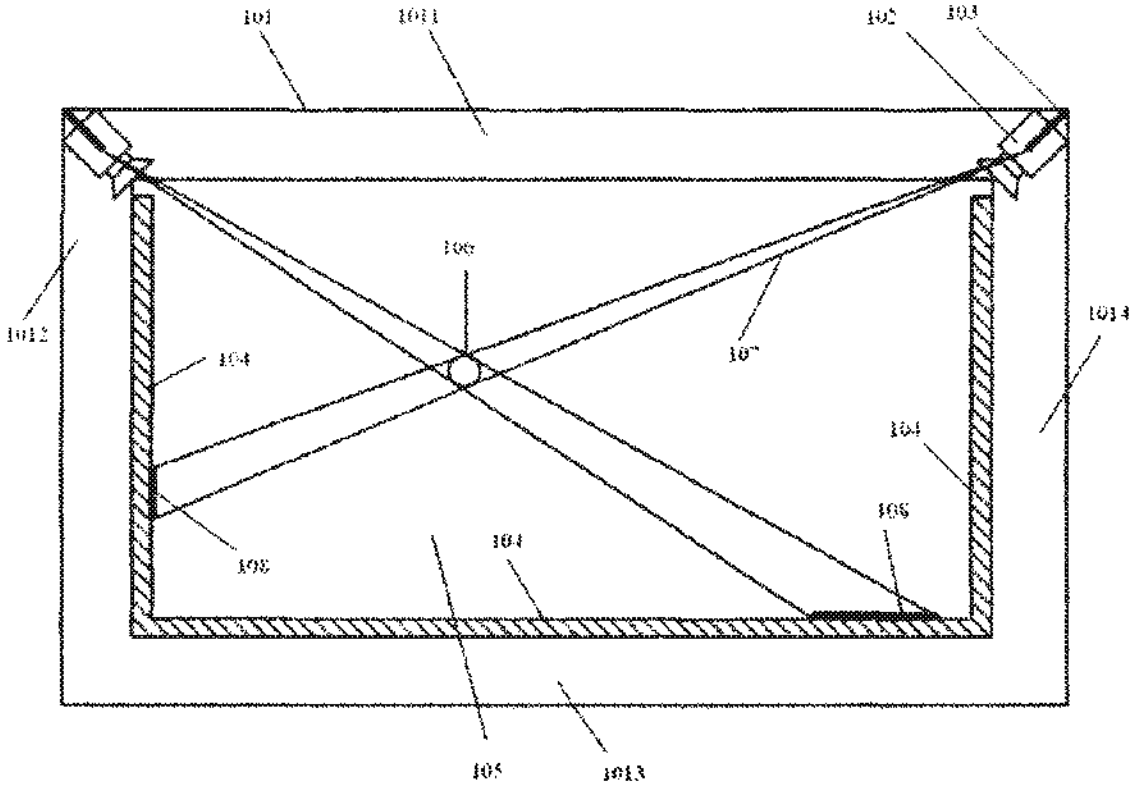


图 1

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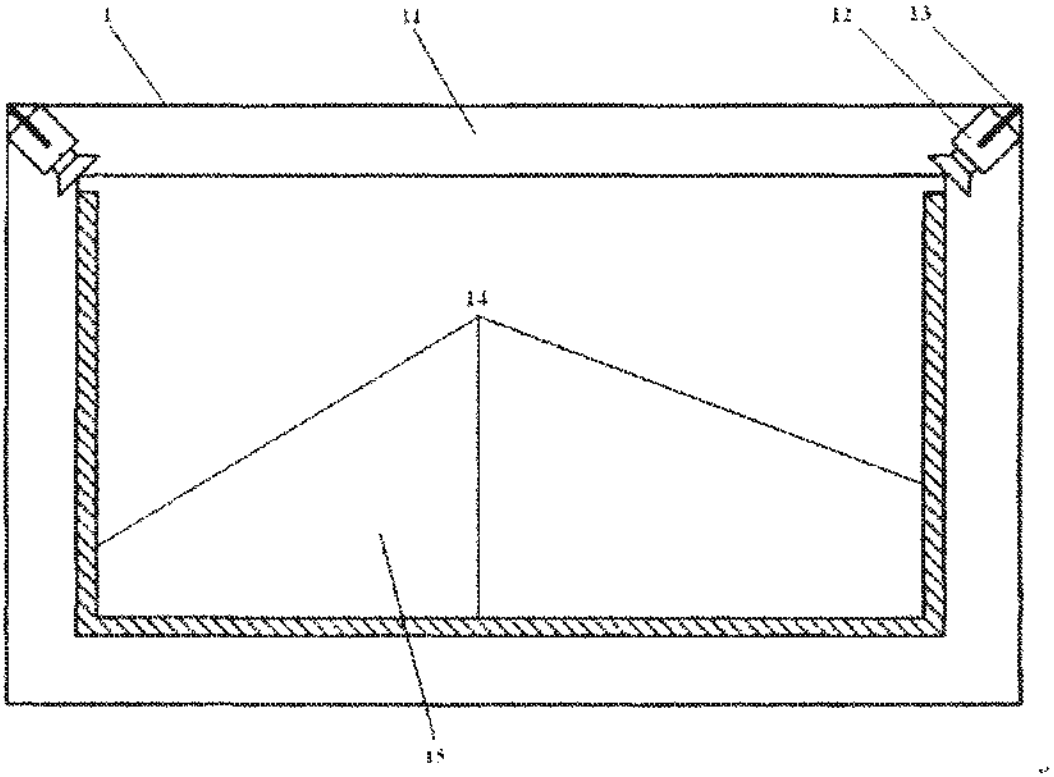


图 2

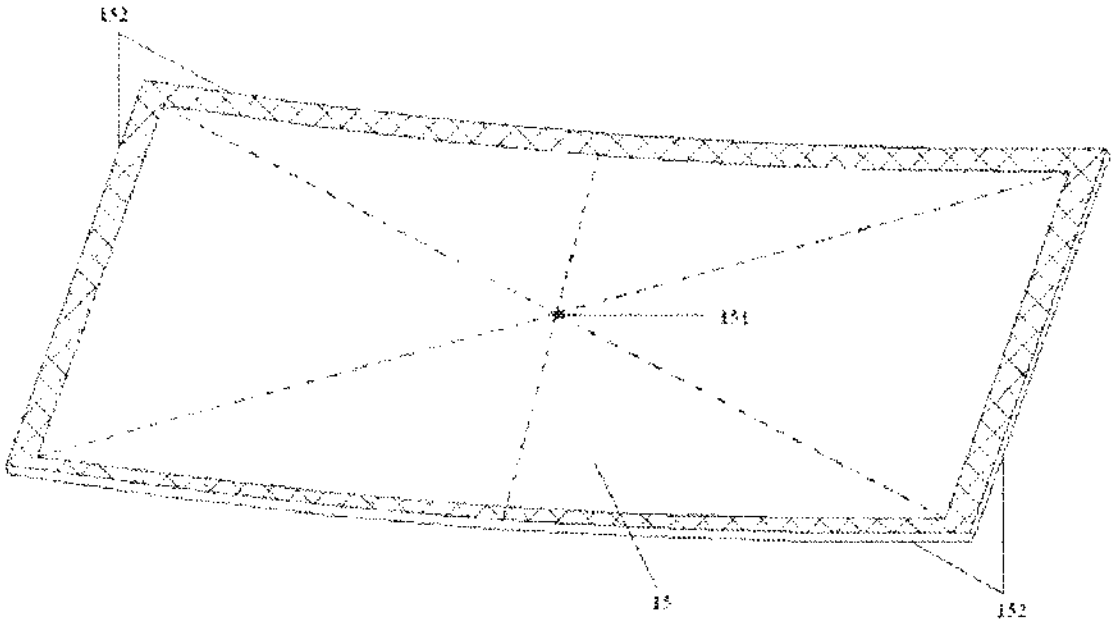


图 3

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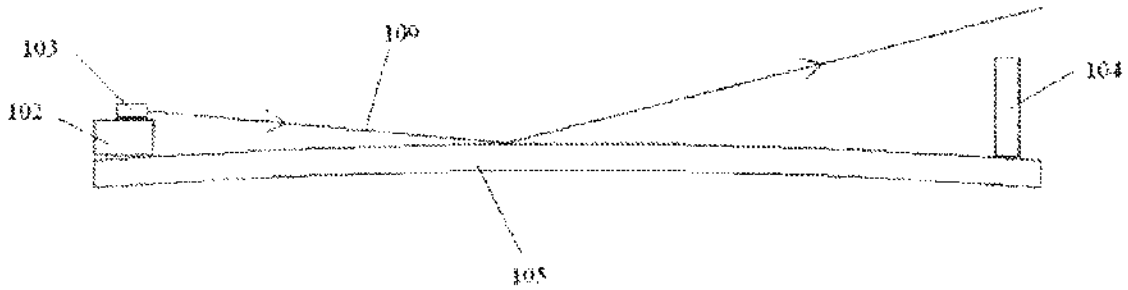


图 4a

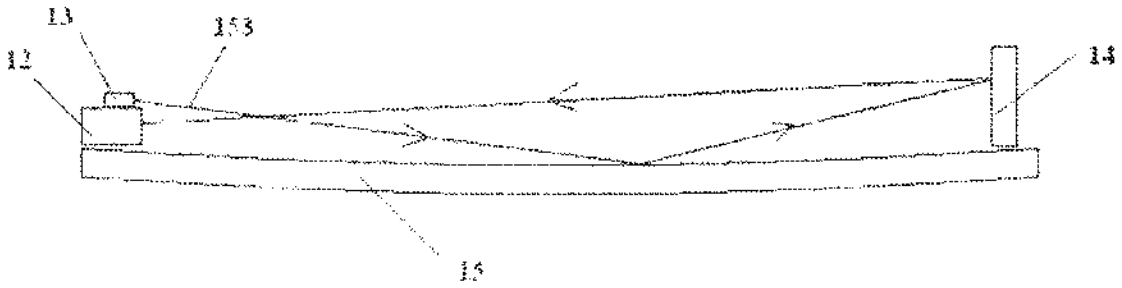


图 4b

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(19)中华人民共和国国家知识产权局

(12)发明专利申请

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(71)申请人 业成光电(深圳)有限公司
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代理人 汪飞亚

(51)Int.Cl.
G06F 3/041(2006.01)

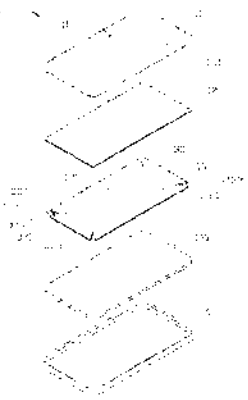
权利要求书1页 说明书5页 附图12页

(54)发明名称

触控面板及触控显示面板

(57)摘要

一种触控面板及触控显示装置。该触控显示装置包括触控面板及显示面板，该触控面板包括盖板及光学膜片组，该盖板包括触控表面及与该触控表面相对的内表面，该内表面为三维曲面，该光学膜片组固定于该内表面上，该光学膜片组包括触控区及围绕该触控区的周边区，该周边区包括至少一缺口。本发明的触控面板及触控显示面板，在光学膜片组上设置缺口，可有效解决光学膜片组与曲面盖板贴合导致的不良现象。



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1. 一种触控面板，光学膜片组该触控面板包括盖板及光学膜片组，该盖板包括触控表面及与该触控表面相对的内表面，该内表面为三维曲面，该光学膜片组固定于该内表面上，该光学膜片组包括触控区及围绕该触控区的周边区，其特征在于，该周边区包括至少一个缺口。

2. 如权利要求 1 所述的触控面板，其特征在于，该缺口为开放型缺口。

3. 如权利要求 1 所述的触控面板，其特征在于，该缺口与该触控区互相不临接。

4. 如权利要求 1 所述的触控面板，其特征在于，该触控表面与该内表面形状相同且相互平行。

5. 如权利要求 4 所述的触控面板，其特征在于，该内表面为朝向触控表面一侧凹陷的弯曲表面。

6. 如权利要求 4 所述的触控面板，其特征在于，该内表面为朝向远离该触控表面一侧凸出的弯曲表面。

7. 如权利要求 1 所述的触控面板，其特征在于，该缺口呈扇形并位于该光学膜片组的周边区的拐角处。

8. 如权利要求 5 所述的触控面板，其特征在于，该顶点处具有圆弧形倒角。

9. 如权利要求 1 所述的触控面板，其特征在于，该缺口位于该光学膜片组的周边区的相邻两个拐角之间。

10. 如权利要求 1 所述的触控面板，其特征在于，该缺口设置于该光学膜片组的周边区的拐角及相邻两个拐角之间。

11. 如权利要求 1 所述的触控面板，其特征在于，该光学膜片组为触控感应电极层、抗反射膜、防爆膜或其他功能性膜片中至少一者。

12. 一种触控显示装置，该触控显示装置包括层叠设置的触控面板及显示面板，其特征在于，该触控面板采用权利要求 1-11 所述的触控面板。

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触控面板及触控显示面板

技术领域

[0001] 本发明涉及一种触控面板及触控显示装置，尤其是触控面为三维曲面的触控面板及触控显示面板。

背景技术

[0002] 触控显示装置因其功耗小、成本低、无辐射和易操作等特点，近年来得到了广泛的应用，已越来越多的走进人们的生活、工作中。触控显示装置通常包括层叠设置的触控面板及显示模组。触控面板用于接收并识别用户的触摸操作，显示模组用于显示图像。随着科技的不断发展，三维曲面的触控屏越来越多的使用在触控显示装置中。

[0003] 然而，在三维曲面的触控模组中，盖板为三维曲面，而传统的触控感应电极层及各种光学膜片是平面的，在贴合的过程中会产生许多不良现象。

发明内容

[0004] 鉴于以上内容，有必要提供一种触控面板及具有此触控面板的触控显示装置。

[0005] 一种触控面板，该触控面板包括盖板及光学膜片组，该盖板包括触控表面及与该触控表面相对的内表面，该内表面为三维曲面，该光学膜片组固定于该内表面上，该光学膜片组包括触控区及围绕该触控区的周边区，该周边区包括至少一缺口。

[0006] 一种触控显示装置，该触控显示装置包括层叠设置的触控面板及显示面板，该触控面板采用上述的触控面板。

[0007] 相较于现有技术，本发明所提供的触控面板及触控显示装置，在光学膜片组的周边区设置缺口，减小贴合时光学膜片组周边区的面积，有效解决光学膜片组与曲面盖板贴合导致的不良现象。

附图说明

[0008] 图 1 为本发明一较佳实施方式所提供的触控显示装置 100 的立体组装示意图。

[0009] 图 2 为图 1 中所示的触控显示装置的正向分解示意图。

[0010] 图 3 为图 1 中沿 III-III 所示的剖面示意图。

[0011] 图 4 为图 1 中沿 IV-IV 所示的剖面示意图。

[0012] 图 5 为图 2 中盖板及光学膜片组粘结后的反向示意图。

[0013] 图 6 为本发明第二实施方式提供的光学膜片组的示意图。

[0014] 图 7 为本发明第三实施方式提供的光学膜片组的示意图。

[0015] 图 8 为本发明第四实施方式提供的光学膜片组的示意图。

[0016] 图 9 为本发明第五实施方式提供的光学膜片组的示意图。

[0017] 图 10 为本发明第六实施方式提供的光学膜片组的示意图。

[0018] 图 11 为本发明第七实施方式提供的光学膜片组的示意图。

[0019] 图 12 为本发明第八实施方式提供的光学膜片组的示意图。

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[0020] 图 13 为本发明第九实施方式提供的光学膜片组的示意图。

[0021] 图 14 为本发明第十实施方式提供的光学膜片组的示意图。

[0022] 图 15 为本发明第十一实施方式提供的光学膜片组的示意图。

[0023] 图 16 为本发明第十二实施方式提供的触控显示装置的一侧剖面示意图。

[0024] 主要元件符号说明

触控显示装置	100、600
触控显示区	101
非触控显示区	102
盖板	110、610
胶体层	120、620
光学膜片组	130、230、330、430、530、630
显示模组	140、640
框架	150、650
触控表面	111、611
内表面	112、612
侧壁	151
触控区	131、231、331、431、531
周边区	132、232、332、432、532
缺口	133、233、333、433、533
第一侧边	1321、2321、3321、4321、5321
第二侧边	1322、2322、3322、4322、5322
第一边	1331、2331
第二边	1332、2332
顶点	1333、2333
夹角	133a、233a、333a
圆弧形倒角	2334、5334

如下具体实施方式将结合上述附图进一步说明本发明。

具体实施方式

[0025] 请参阅图 1，图 1 为本发明一较佳实施方式所提供的触控显示装置 100 的立体组装示意图。该触控显示装置 100 可用于游戏娱乐、多媒体互动、移动设备显示与交互、仿真模拟、模拟教学等领域的触屏式显示装置。该触控显示装置 100 包括触控显示区 101 及包围该触控显示区 101 的非触控显示区 102。

[0026] 请参阅图 2，图 2 为图 1 所示触控显示装置 100 的立体分解示意图。该触控显示装置 100 包括盖板 110、胶体层 120、光学膜片组 130、显示模组 140 及框架 150。该盖板 110、该胶体层 120、该光学膜片组 130、该显示模组 140 依序层叠设置。具体地，该光学膜片组 130 用于通过胶体层 120 粘接于该盖板 110 上，该显示模组 140 设置于该光学膜片组 130 远离该盖板 110 的一侧。该盖板 110 设置于该框架 150 上方，该盖板 110 用于与该框架 150 共同围成收容空间以收容该光学膜片组 130 及该显示模组 140。该盖板 110、该胶体层 120 及该光学膜片组 130 共同构成一触控面板。该光学膜片组 130 为触控感应电极层、抗反射膜、防爆膜或其他功能膜片中至少一者，本实施方式中，该光学膜片组 130 以触控感应电极层为例进行说明。

[0027] 该盖板 110 包括触控表面 111 及与该触控表面 111 相对设置的内表面 112。该内表面 112 为一光滑的三维曲面，该触控表面 111 与该内表面 112 的形状相同且相互平行。该

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触控表面 111 用于使用者对该触控触控显示装置 100 进行触控操作。

[0028] 进一步的，请同时参阅图 3 及图 4，图 3 为图 1 中沿 III-III 所示的剖面示意图，图 4 为图 1 中沿 IV-IV 所示的剖面示意图。不管从 X 轴方向或是 Y 轴方向观看，该内表面 112 的剖面均呈一抛物线形的曲面，该内表面 112 的中心点为抛物线的焦点，且该内表面 112 为朝向该触控表面 111 一侧凹陷的弯曲表面。本实施方式中，该内表面 112 的中心点与该内表面 112 的两侧边缘的高度差不大于 1mm。

[0029] 该框架 150 包括首尾相接的四侧壁 151，该盖板 110 设置于该框架 150 的侧壁 151 的上方，且与该框架 150 形成收容该光学膜片组 130 及显示模组 140 的收容空间。该光学膜片组 130 通过该胶体层 120 粘接于该盖板 110 的内表面 112 上，该显示模组 140 固定于该框架 150 的侧壁 151 的内侧，且位于该光学膜片组 130 远离该盖板 110 的一侧。

[0030] 该光学膜片组 130 包括触控区 131、周边区 132 及缺口 133。该触控区 131 呈一矩形，位于该光学膜片组 130 的中央并与该触控显示区 101 对应设置，该周边区 132 包括两条平行设置的第一侧边 1321 及两条平行设置的第二侧边 1322，该第一侧边 1321 及该第二侧边 1322 彼此首尾连接共同围成一环形框，该周边区 132 围绕该触控区 131 并与该非触控显示区 102 对应设置。该缺口 133 为开放型缺口，设置于该周边区 132 内，并位于该光学膜片组 130 的周边区 132 的拐角处，该缺口 133 呈扇形设置，该缺口 133 包括第一边 1331、第二边 1332 及顶点 1333，该第一边 1331、该第二边 1332 及该顶点 1333 共同围成呈扇形状的该缺口 133，该缺口 133 具有夹角 133a。该第一边 1331 及该第二边 1332 的长度相同，该顶点 1333 由该第一边 1331 及该第二边 1332 交叉处定义得来，该顶点 1333 位于该周边区 132 中，并与该触控区 131 不接触，该顶点 1333 与该触控区 131 之间具有一定距离，也就是说，该缺口 133 与该触控区 131 互相不邻接。本实施方式中，该顶点 1333 与该触控区 131 之间的距离为 0.15-0.3mm，该夹角 133a 小于 90 度。本实施方式中，该缺口的数量为 4 个，且均位于该光学膜片组 130 的周边区 132 的拐角处。

[0031] 传统的触控显示面板，其触控面板及显示面板皆为平面的，所以其触控面板的光学膜片组与盖板贴合时一般不会存在不良现象，而本实施方式中的盖板 110 为一三维曲面的盖板，所以将传统的光学膜片组与之贴合时，光学膜片组的边缘由于应力无法释放，会出现皱褶、与盖板之间产生间隙、胶层中存在气泡等不良现象，从而影响触控显示装置的性能。

[0032] 请参阅图 5，图 5 为图 2 中盖板 110 及光学膜片组 130 粘结后的仰视图。本实施方式中，该光学膜片组 130 的拐角处设置有缺口 133，该周边区 132 的面积减小。当将该光学膜片组 130 通过该胶体层 120 与该盖板 110 进行粘结固定时，该触控区 131 与该触控显示区 101 对应贴合后，无任何影响，当该周边区 132 与该非触控显示区 102 对应贴合时，该第一边 1331 及该第二边 1332 收缩重合，该夹角 133a 变为 0 度，该缺口 133 可释放由于贴合所导致的该光学膜片组 130 在边缘拐角处产生的应力，从而使该光学膜片组 130 与该盖板 110 完全贴合，不会因应力问题与该盖板 110 之间产生间隙，导致胶层中产生气泡，又由于缺口 133 的设置，该周边区 132 的面积减小，不会在边缘拐角处产生皱褶。

[0033] 本实施方式中，虽然已限定该缺口 133 的夹角 133a 小于 90 度，该触控表面 111 的中心点与该触控表面 111 的两侧边缘的高度差不大于 1mm，但并不局限于此，如在其他实施方式中，光学膜片组上缺口的夹角也可以为 90 度或大于 90 度，其角度的大小需根据盖板的

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曲率大小进行调整，而盖板的曲率可通过盖板的触控表面中心点与盖板的触控表面两侧边缘的高度差进行调整。可以预知，盖板的触控表面中心点与盖板的触控表面两侧边缘的高度差进行调整高度差越大，盖板的曲率也相应越大，当盖板的曲率越大，则光学膜片组上缺口的夹角则需相应的越大，即缺口越大，缺口的数量越多，反之，则光学膜片组上缺口越小，数量越少。

[0034] 本实施方式中，该触控显示装置 100 是由三维曲面的触控面板与传统的平面形的显示面板组成的，但并不局限于此，在其他实施方式中，也可采用具有柔性的显示面板。

[0035] 请参阅图 6，图 6 为本发明第二实施方式提供的光学膜片组 230 的示意图。该光学膜片组 230 包括触控区 231、周边区 232 及缺口 233。该触控区 231 呈一矩形，并位于该光学膜片组 230 的中央位置，该周边区 232 包括两条平行设置的第一侧边 2321 及两条平行设置的第二侧边 2322，该第一侧边 2321 及该第二侧边 2322 彼此收尾连接共同围成一环形框，并围绕该触控区 231 设置。该缺口 233 为开放型缺口，设置于该周边区 232 内，并位于该光学膜片组 230 的周边区 232 的拐角处，该缺口 233 呈类似扇形设置，该缺口 233 包括第一边 2331、第二边 2332 及顶点 2333，该第一边 2331、该第二边 2332 及该顶点 2333 共同围成呈扇形状的该缺口 233，该缺口 233 具有夹角 233a。该第一边 2331 及该第二边 2332 的长度相同，该顶点 2333 由该第一边 2331 及该第二边 2332 交叉处定义得来，该顶点 2333 位于该周边区 232 中，并与该触控区 231 不接触，该顶点 2333 与该触控区 231 之间具有一定距离，也就是说，该缺口 233 与该触控区 131 互相不临接。与触控显示装置 100 中光学膜片组 130 不同的是，该光学膜片组 230 的顶点 2333 处具有圆弧形倒角 2334 设置。本实施方式中，该顶点 2333 与该触控区 231 之间的距离为 0.15-0.3mm，该夹角 233a 小于 90 度。本实施方式中，该缺口的数量为 4 个，且均位于该光学膜片组 130 的周边区 132 的拐角处，但并不局限于此，该缺口 233 的数量及该缺口 233 的大小的大小可根据盖板的曲率进行调整。

[0036] 请参阅图 7，图 7 为本发明第三实施方式提供的光学膜片组 330 的示意图。该光学膜片组 330 包括触控区 331、周边区 332 及缺口 333。该触控区 331 呈一矩形，位于该光学膜片组 330 的中央位置，该周边区 332 包括两条平行设置的第一侧边 3321 及两条平行设置的第二侧边 3322，该第一侧边 3321 及该第二侧边 3322 彼此收尾连接共同围成一环形框，并围绕该触控区 331 设置。与光学膜片组 130 不同的是，本发明第三实施方式的该光学膜片组 330 的缺口 333 设置于该周边区 332 内，并位于该光学膜片组 330 的周边区 332 的相邻两个拐角之间，即该第一侧边 3321 及该第二侧边 3322 上。本实施方式中，每一该第一侧边 3321 上设置有 3 个该缺口 333，每一该第二侧边 3322 上设置有 2 个该缺口 333，但并不局限于此，该缺口 333 的数量及该缺口 333 的夹角 333a 的大小可根据盖板的曲率进行调整。本实施方式中，该缺口 333 为等腰三角形，但并不局限于此，在其他实施方式中，该缺口 333 的形状还可以为圆弧形或方形，如图 8 及图 9 中所示，图 8 为本发明第四实施方式提供的光学膜片组的示意图，图 9 为本发明第五实施方式提供的光学膜片组的示意图。

[0037] 请参阅图 10，图 10 为本发明第六实施方式提供的光学膜片组 430 的示意图。该光学膜片组 430 包括触控区 431、周边区 432 及缺口 433。该触控区 431 呈一矩形，位于该光学膜片组 430 的中央位置，该周边区 432 包括两条平行设置的第一侧边 4321 及两条平行设置的第二侧边 4322，该第一侧边 4321 及该第二侧边 4322 彼此收尾连接共同围成一环形框，该周边区 432 围绕该触控区 431 设置。该缺口 433 设置于该周边区 432 内。与光学膜

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片组 130 不同的是，该缺口 433 不仅设置于该光学膜片组 430 的周边区 432 的拐角处，还设置于该光学膜片组 430 的周边区 432 的相邻两个拐角之间，即该第一侧边 4321 及该第二侧边 4322 上均设置有该缺口 433，该缺口 433 与该触控区 431 互相不邻接。本实施方式中，除了在该光学膜片组 430 的周边区 432 的每一个拐角处设置有一缺口 433，每一该第一侧边 4321 上设置有 3 个该缺口 433，每一该第二侧边 4322 上设置有 2 个该缺口 433，但并不局限于此，该缺口 433 的数量及该缺口 433 的大小可根据盖板的曲率进行调整。本实施方式中，位于该第一侧边 4321 及该第二侧边 4322 上的该缺口 433 为等腰三角形，但并不局限于此，在其他实施方式中，该第一侧边 4321 及该第二侧边 4322 上的该缺口 433 的形状还可以为圆弧形或方形，如图 11 及图 12 中所示，图 11 为本发明第七实施方式提供的光学膜片组的示意图，图 12 为本发明第八实施方式提供的光学膜片组的示意图。

[0038] 请参阅图 13，图 13 为本发明第九实施方式提供的光学膜片组 530 的示意图。该光学膜片组 530 包括触控区 531、周边区 532 及缺口 533。该触控区 531 呈一矩形，位于该光学膜片组 530 的中央位置，该周边区 532 包括两条平行设置的第一侧边 5321 及两条平行设置的第二侧边 5322，该第一侧边 5321 及该第二侧边 5322 彼此收尾连接共同围成一环形框，该周边区 532 围绕该触控区 531 设置。该缺口 533 设置于该周边区 532 内。与第六实施方式的光学膜片组 430 不同的是，该光学膜片组 530 的位于拐角处的该缺口 533 的顶点处圆弧形倒角 5334 设置。本实施方式中，位于该第一侧边 5321 及该第二侧边 5322 上的该缺口 533 为等腰三角形，但并不局限于此，在其他实施方式中，该缺口 533 的形状还可以为圆弧形或方形，如图 14 及图 15 中所示，图 14 为本发明第十实施方式提供的光学膜片组的示意图，图 15 为本发明第十一实施方式提供的光学膜片组的示意图。

[0039] 以上所述的实施方式中，均是以触控表面为一外凸面为例，即内表面为朝向触控表面一侧凹陷的弯曲表面为例进行说明的，但并不局限于此，当触控显示装置的触控表面为一内凹面，即内表面为远离触控表面一侧突出的弯曲表面的情况，同样适用于本发明的结构。如图 16 所示，图 16 为本发明第十二实施方式提供的触控显示装置 600 的一侧剖面示意图。

[0040] 该触控显示装置 600 包括盖板 610、胶体层 620、光学膜片组 630、显示模组 640 及框架 650。该盖板 610、该胶体层 620、该光学膜片组 630、该显示模组 640 依序层叠设置。具体地，该光学膜片组 630 用于通过胶体层 620 粘接于该盖板 610 上，该显示模组 640 设置于该光学膜片组 630 远离该盖板 610 的一侧。该盖板 610 设置于该框架 650 上方，该盖板 610 用于与该框架 650 共同围成收容空间以收容该光学膜片组 630 及该显示模组 640。该盖板 610、该胶体层 620 及该光学膜片组 630 共同构成一触控面板。该盖板 610 包括触控表面 611 及与该触控表面 611 相对设置的内表面 112。该内表面 612 的剖面同样为一呈抛物线形的曲面，与触控显示装置 100 不同的是，该内表面 612 为朝向远离该触控表面 611 一侧凸出的弯曲表面。

[0041] 以上实施例仅用以说明本发明的技术方案而非限制，尽管参照较佳实施例对本发明进行了详细说明，本领域的普通技术人员应当理解，可以对本发明的技术方案进行修改或等同替换，而不脱离本发明技术方案的精神和范围。

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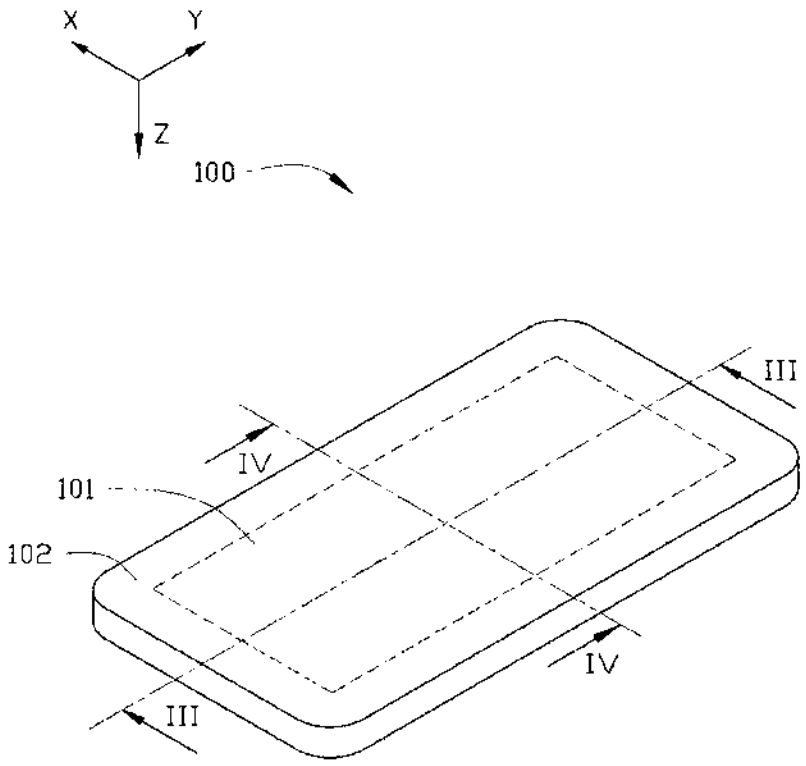


图 1

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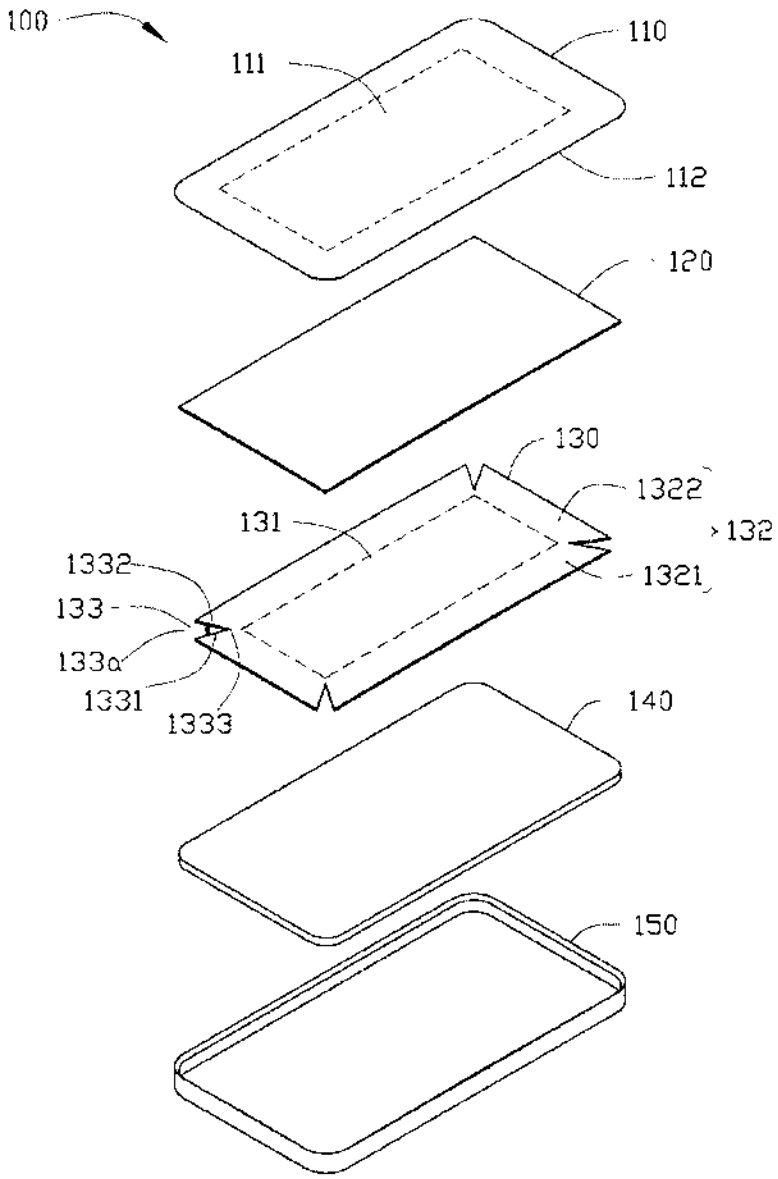


图 2

Chemtronics v. FlatFrog
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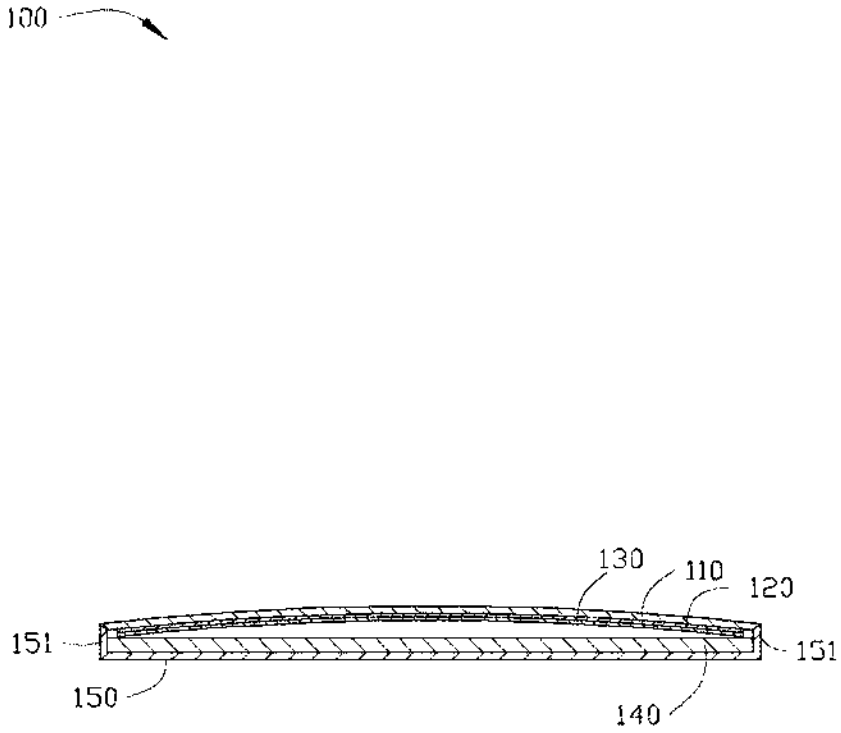


图 3

Chemtronics v. FlatFrog
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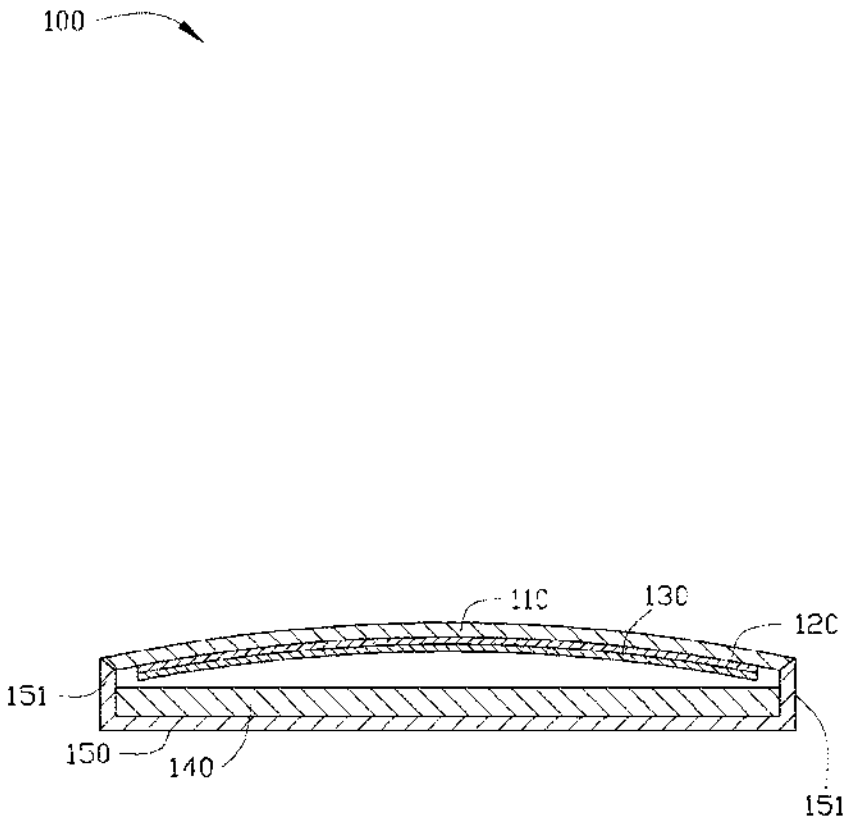


图 4

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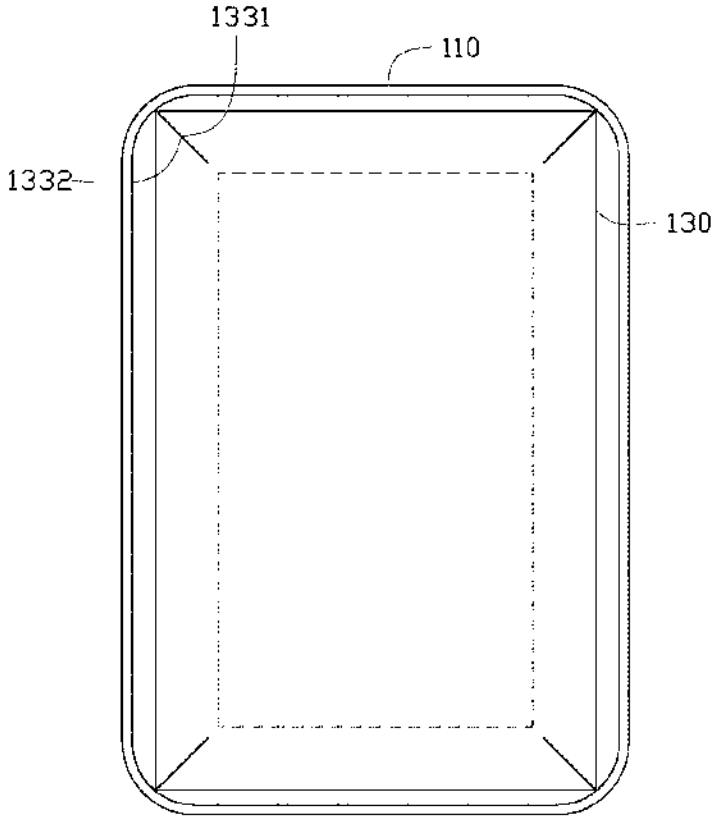


图 5

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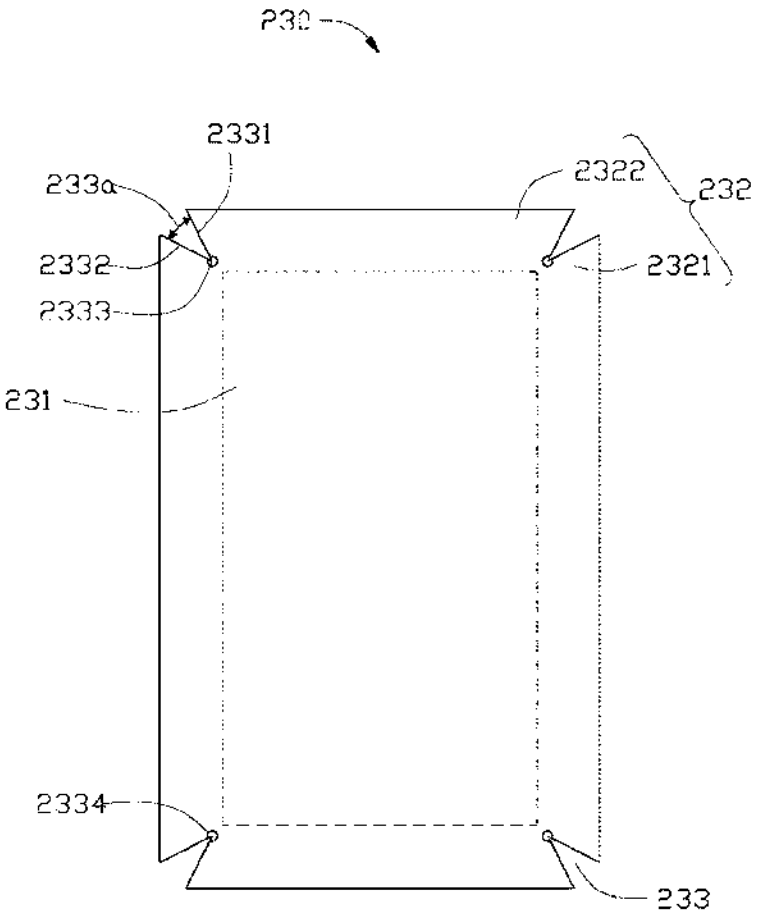


图 6

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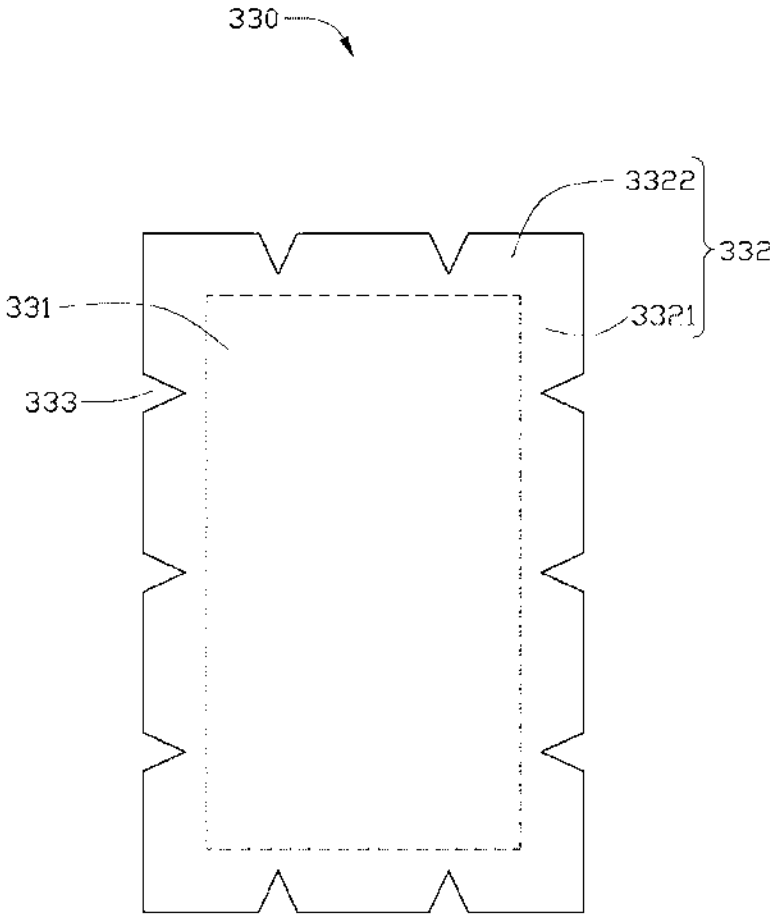


图 7

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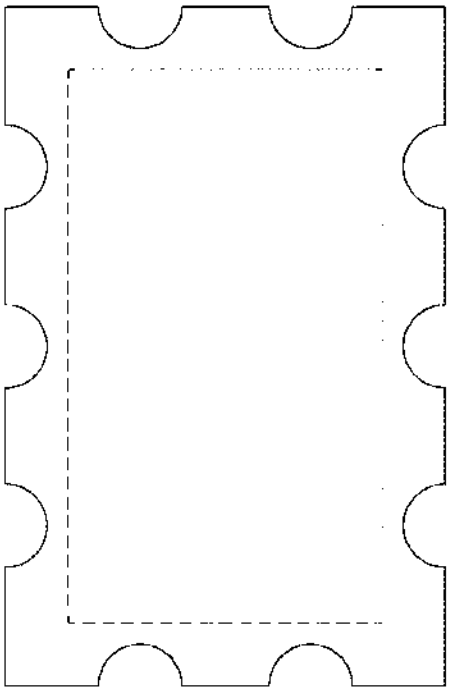


图 8

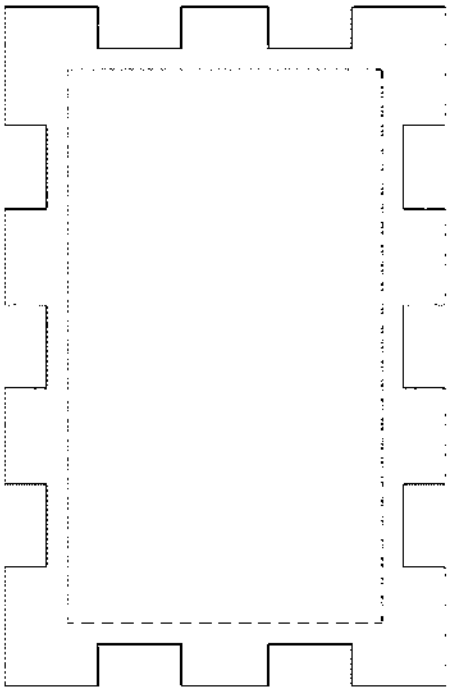


图 9

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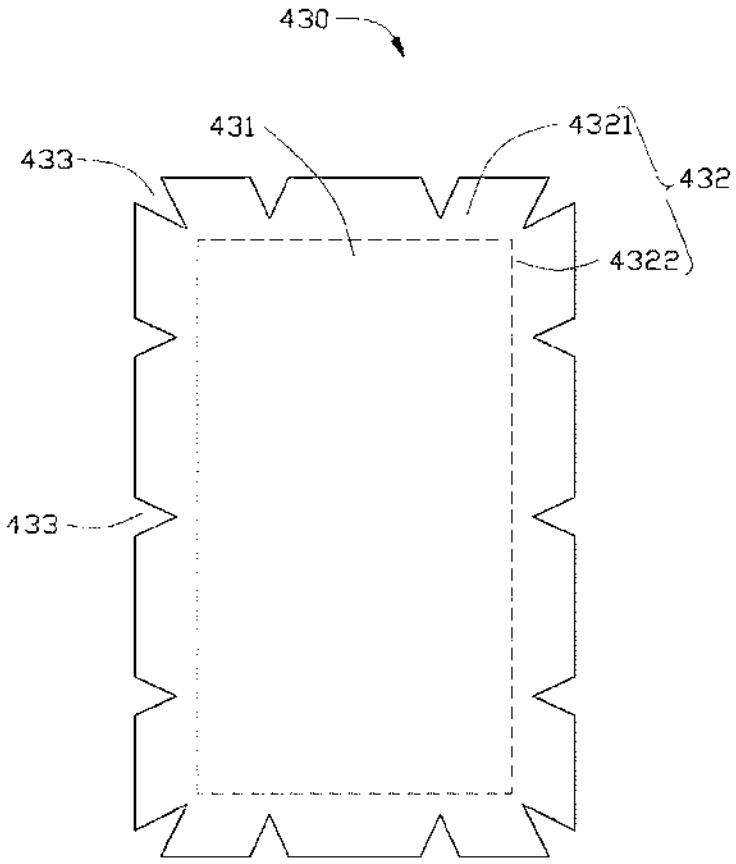


图 10

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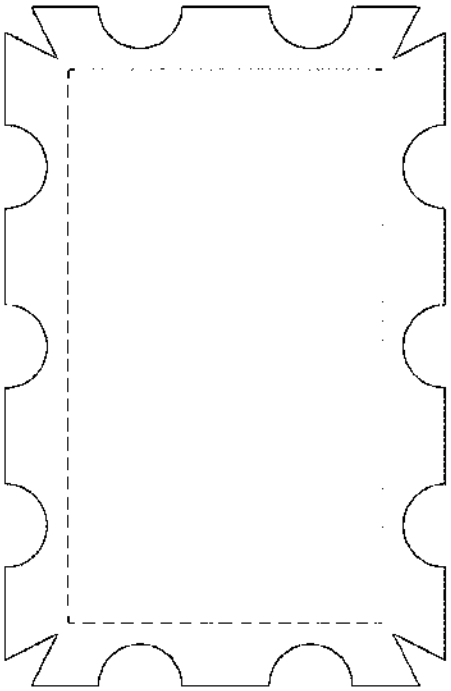


图 11

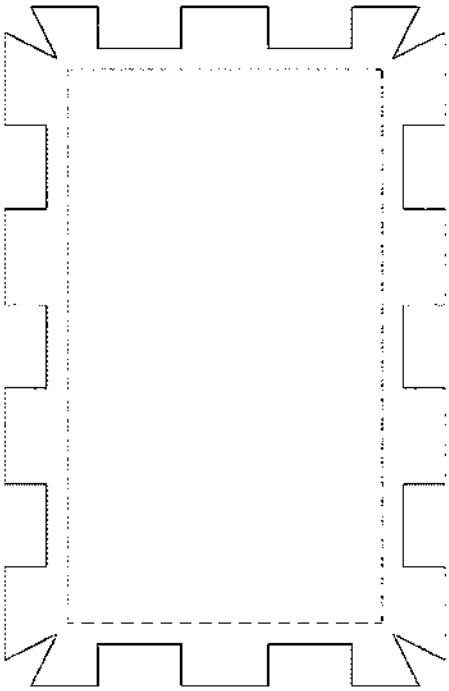


图 12

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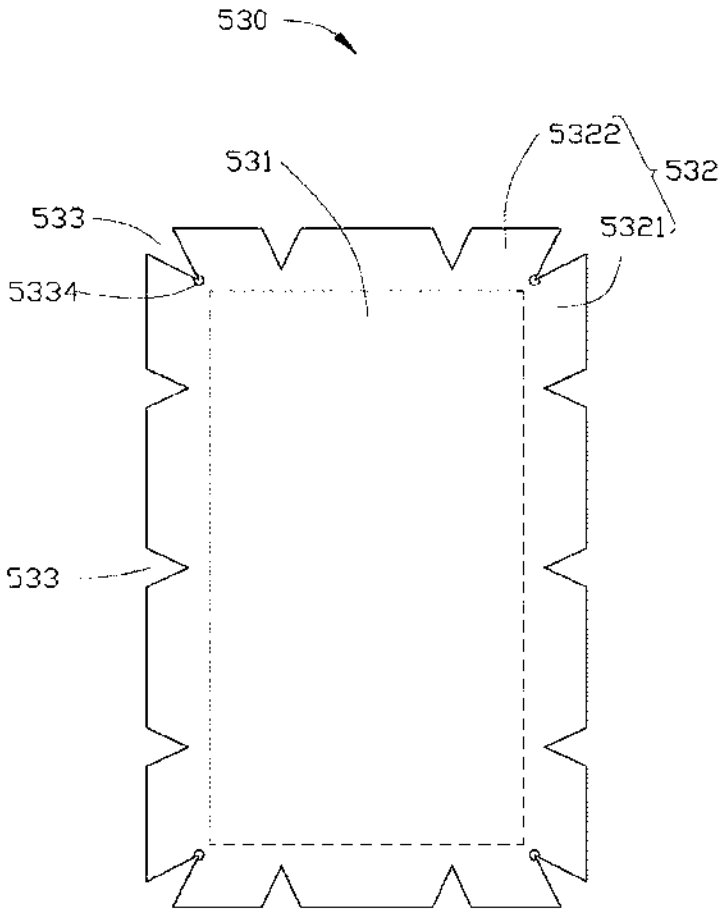


图 13

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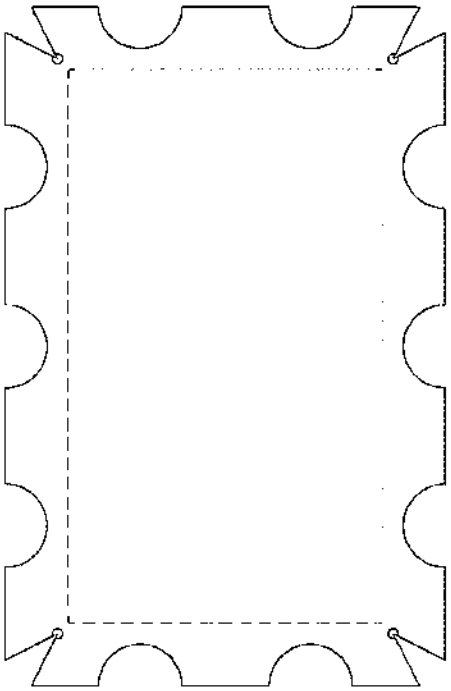


图 14

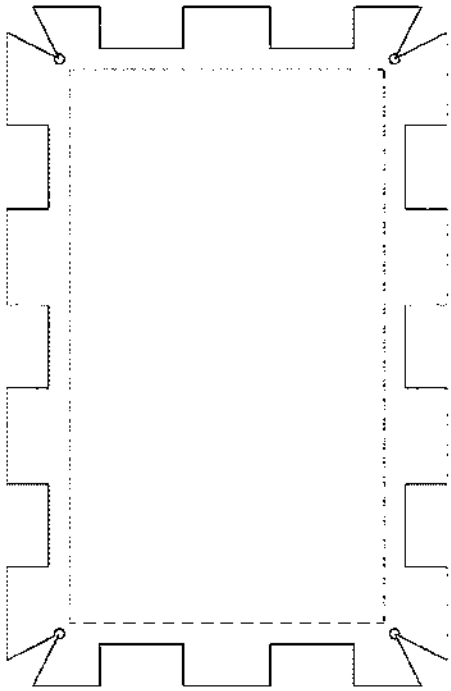
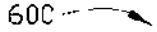


图 15



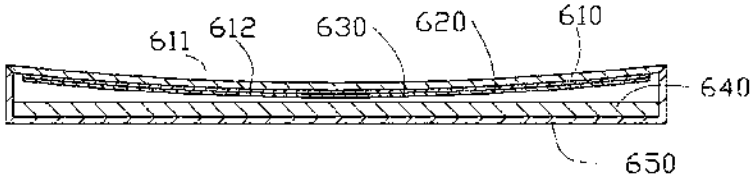


图 16

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(19)中华人民共和国国家知识产权局

(12)实用新型专利

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G06F 3/042(2006.01)

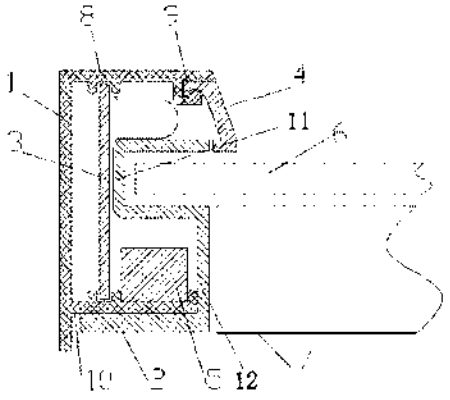
权利要求书1页 说明书2页 附图1页

(54)实用新型名称

新型触摸屏框架

(57)摘要

本实用新型提供一种易于拆卸和维修的新型触摸屏框架，所述触摸屏框架包括方形的外边框1和内边框2，所述内边框2套在外边框1内，所述外边框1包括边10，所述边10与内边框2相互贴合且相对可拆式固定，所述外边框1内侧设有电路板固定凹槽8和红外条固定凹槽9，所述内边框2上设有玻璃6的夹持凹槽11和显示器7的安装位12。本实用新型在使用的时候，如果出现故障，可以将其外边框直接从内边框上拆离，因为电路板设于外边框内，所以维修起来较为方便。



CN 202887145 U

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1. 新型触摸屏框架，其特征在于所述触摸屏框架包括方形的外边框（1）和内边框（2），所述内边框（2）套在外边框（1）内，所述外边框（1）包括边（10），所述边（10）与内边框（2）相互贴合且相对可拆式固定，所述外边框（1）内侧设有电路板固定凹槽（8）和红外条固定凹槽（9），所述内边框（2）上设有玻璃（6）的夹持凹槽（11）和显示器（7）的安装位（12）。

2. 如权利要求 1 所述新型触摸屏框架，其特征在于所述玻璃（6）的夹持凹槽（11）设置在内边框（2）上的两条对边上或是四条边上。

3. 如权利要求 1 所述新型触摸屏框架，其特征在于所述外框（1）的边（10）直接固定或通过固定零件（5）间接固定在内边框（2）上。

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新型触摸屏框架

技术领域

[0001] 本实用新型涉及触摸屏框架。

背景技术

[0002] 因为触摸屏面板的体积和重量较大，电路板有故障时需要将其整体取下拆卸，拆卸和维修都较为麻烦。

发明内容

[0003] 本实用新型所要解决的技术问题是提供一种易于拆卸和维修的新型触摸屏框架，为此，本实用新型采用以下技术方案：

[0004] 所述触摸屏框架包括方形的外边框 1 和内边框 2，所述内边框 2 套在外边框 1 内，所述外边框 1 包括边 10，所述边 10 与内边框 2 相互贴合且相对可拆式固定，所述外边框 1 内侧设有电路板固定凹槽 8 和红外条固定凹槽 9，所述内边框 2 上设有玻璃 6 的夹持凹槽 11 和显示器 7 的安装位 12。

[0005] 通过以上技术方案，本实用新型在使用的时候，如果出现故障，可以将其外边框直接从内边框上拆离，因为电路板设于外边框内，所以维修起来较为方便。

附图说明

[0006] 图 1 是本实用新型在安装上电路板、玻璃和显示器后的单边的横截面剖视图。

具体实施方式

[0007] 参照附图。本实用新型提供一种触摸屏框架，所述触摸屏框架包括方形的外边框 1 和内边框 2，所述内边框 2 套在外边框 1 内，所述外边框 1 包括边 10，所述边 10 与内边框 2 相互贴合且相对可拆式固定，所述外边框内侧设有电路板固定凹槽 8 和红外条固定凹槽 9，所述内边框 2 上设有玻璃 6 的夹持凹槽 11 和显示器 7 的安装位 12。

[0008] 如图所示，电路板固定凹槽 8 内设有电路板 3 并将其固定。红外条固定凹槽 9 内设有红外条 4 并将其固定。

[0009] 所述玻璃 6 的夹持凹槽 11 设置在内边框 2 上的两条对边上或是四条边上，将玻璃 6 安装在凹槽内，整个触摸屏框架夹持在玻璃 6 上。

[0010] 所述玻璃 6 放置平行于显示器 7。显示器 7 包括液晶屏及其它平板屏。

[0011] 电路板 3 固定在外边框 1 内，电路板的放置和玻璃 6 及显示器(触摸屏) 7 的平面呈垂直状态，接收和发射的 LED 灯管和玻璃 6 及显示器(触摸屏) 7 的平面呈平行状态。

[0012] 所述外框 1 的边 10 直接固定或通过固定零件 5 间接固定在内边框 2 上，固定方式为触摸屏在外边框 1 的 4 个转角处正面固定。

[0013] 综上所述，本实用新型所述的触摸屏框架，有效解决了下列问题：

[0014] 1、能够将外边框 1 和内边框 2 的宽度缩小，使得边框变窄，更为美观；

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[0015] 2、将固定零件 5 拆卸便可将外边框 1 拆卸，且电路板 3 设于外边框 1 内，方便维修电路板 3。

[0016] 3、LED 组装简易，可以组装测试好，触摸框之后装入整机。

[0017] 4、容易贴平整，提高触摸准度，LED 直接选用直插方式，比传统的折弯 90 度焊接方式更有利于控制 LED 灯管与触控平面的平行度，再一个就是，可以更好让 LED 贴近触控表面（玻璃 6）达到手指更贴近表面才产生有效触摸。

[0018] 红外触摸原理是通过阻挡发射管到接收管之间的光线来计算触摸位置从而达到触控效果，故光线越贴近玻璃触控效果越好。

[0019] 上述具体实施方式用来解释说明本实用新型，而不是对本实用新型进行限制，在本实用新型的精神和权利要求的保护范围内，对本实用新型作出的任何修改和改变，都落入本实用新型的保护范围。

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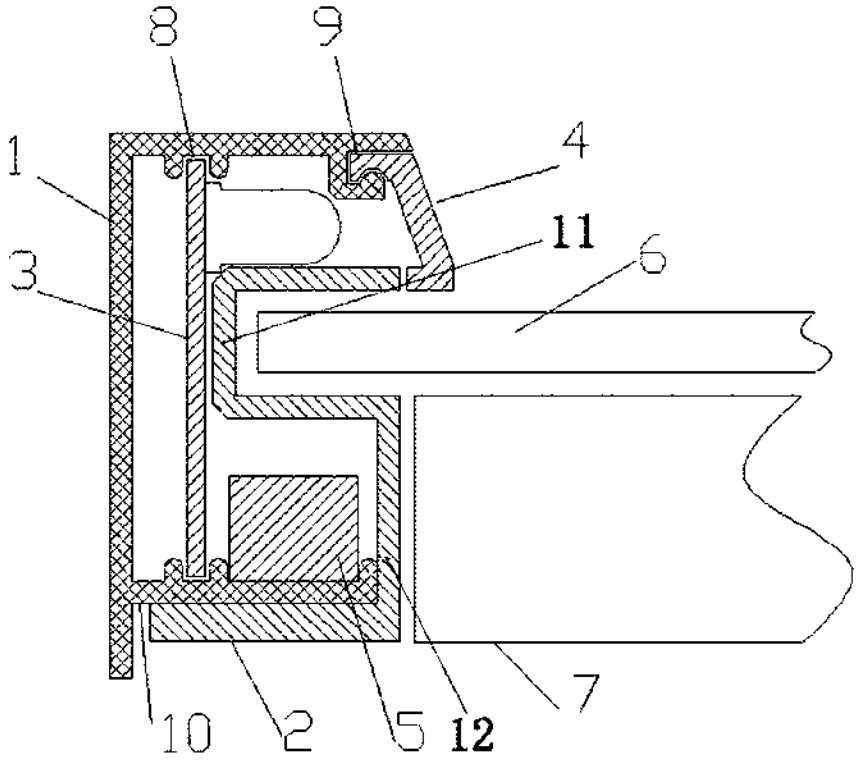


图 1

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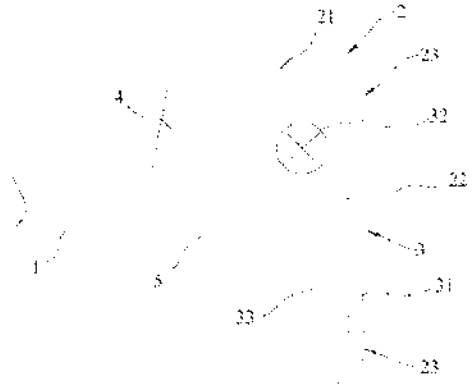
权利要求书1页 说明书3页 附图2页

(54)实用新型名称

一种新型红外触摸屏

(57)摘要

本实用新型公开了一种新型红外触摸屏，包括屏体、镶嵌屏体的矩形边框以及位于矩形边框内且围绕屏体设置的红外触控组件，矩形边框包括平行于屏体的前壁和垂直于屏体的侧壁，前壁和屏体边缘的前方玻璃通过滤光条与屏体连接，红外触控组件包括平行于侧壁设在矩形边框内的PCB板以及若干设在PCB板上、位于滤光条外侧且紧贴屏体前表面所在平面的红外管，红外管包括分别位于矩形边框的左边框和下边框的红外发射管、以及分别位于右边框和上边框的红外接收管，本实用新型通过上述设计使得PCB板上的电子元器件位于屏体前表面的后方，克服现有红外触摸屏框体过宽、框体前壁与触摸屏外表面距离过大，在改善产品外观的同时，降低误触现象的发生。



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1. 一种新型红外触摸屏，其特征在于：包括屏体、装嵌屏体的矩形边框以及位于所述矩形边框内且围绕屏体设置的红外触控组件，所述矩形边框包括平行于屏体的前壁和垂直于屏体的侧壁，所述前壁探至屏体边沿的前方并通过滤光条与屏体连接，所述红外触控组件包括平行于侧壁设在矩形边框内的 PCB 板以及若干设在所述 PCB 板上、位于滤光条外侧且紧贴屏体前表面所在平面的红外管，所述红外管包括分别位于矩形边框的左边框和下边框的红外发射管，以及分别位于右边框和上边框的红外接收管。

2. 根据权利要求 1 所述的新型红外触摸屏，其特征在于：围绕所述屏体后表面的四周边沿设有遮光层。

3. 根据权利要求 1 或 2 所述的新型红外触摸屏，其特征在于：所述滤光条包括设在红外发射管内侧的聚光滤光条和设在红外接收管内侧的非聚光滤光条。

4. 根据权利要求 1 或 2 所述的新型红外触摸屏，其特征在于：所述矩形边框在侧壁的内侧形成装嵌所述 PCB 板的卡槽。

5. 根据权利要求 1 或 2 所述的新型红外触摸屏，其特征在于：所述滤光条的前、后表面分别与矩形边框的前壁和屏体的前表面精附连接。

6. 根据权利要求 5 所述的新型红外触摸屏，其特征在于：所述矩形边框的前壁内侧形成嵌入所述滤光条内的凸棱。

7. 根据权利要求 1 或 2 所述的新型红外触摸屏，其特征在于：所述矩形边框还包括夹紧屏体后表面四周边沿的底框，所述底框与侧壁形成将所述红外触控组件封装在矩形边框内的内腔。

8. 根据权利要求 7 所述的新型红外触摸屏，其特征在于：所述底框与侧壁固定连接或采用一体成型工艺形成整体。

9. 根据权利要求 7 所述的新型红外触摸屏，其特征在于：所述矩形边框为铝合金构件或塑胶构件。

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一种新型红外触摸屏

技术领域

[0001] 本实用新型涉及一种触摸屏，特别是涉及一种新型红外触摸屏。

背景技术

[0002] 当前触摸屏主要有表面声波、红外、电阻、电容等类型。表面声波触摸屏具分辨率高、响应时间短、不宜实现多点触摸、稳定性很好、防暴性好、透光性好、实现大尺寸困难等特点；红外屏触摸屏分辨率较好、响应时间快、容易实现多点触摸、稳定性较好、防暴性好、透光性好、容易实现大尺寸等特点；电阻触摸屏具分辨率高、响应时间短、不宜实现多点触摸、稳定性好、透光率差、防暴性差、实现大尺寸困难等特点；电容触摸屏具分辨率高、响应时间短、容易实现多点触摸、稳定性一般、透光性一般、防暴性较好、容易漂移、实现大尺寸困难等特点。综上所述，红外触摸屏由于其具有红外屏触摸屏分辨率较好、响应时间快、容易实现多点触摸、稳定性较好、防暴性好、透光性好、容易实现大尺寸等优点，特别是现在触摸需要用户体念好、触感好，是几种主流触摸屏大尺寸中最具推广使用价值的触摸屏。

[0003] 现有红外触摸屏一般由框体、滤光条、玻璃、PCB板及焊装在PCB板上的电子元器件、红外发射管及红外接收管等组成，并且一般来说PCB板、焊接在PCB板上的红外发射管发出的红外光中心线以及红外接收管接收红外光的中心线均与触摸屏触摸面平行，触摸屏的所有电子部件都封装在框体与滤光条组成的封装内，存在触摸屏框体过宽、触摸屏框体表面至显示器外加装的玻璃表面距离过大的缺点，影响产品的外观。此外，由于红外发射管发出的红外光悬浮过高，也容易引起误触摸的发生。

实用新型内容

[0004] 为解决上述问题，本实用新型提供一种克服现有红外触摸屏框体过宽、框体上表面与触摸屏外表面距离过大，改善产品外观，降低误触摸发生的新型红外触摸屏。

[0005] 本实用新型解决其技术问题所采用的技术方案是：一种新型红外触摸屏，包括屏体、装嵌屏体的矩形边框以及位于矩形边框内且围绕屏体设置的红外触控组件，矩形边框包括平行于屏体的前壁和垂直于屏体的侧壁，前壁探至屏体边沿的前方并通过滤光条与屏体连接，红外触控组件包括平行于侧壁设在矩形边框内的PCB板以及若干设在PCB板上、位于滤光条外侧且紧贴屏体前表面所在平面的红外管，红外管包括分别位于矩形边框的左边框和下边框的红外发射管，以及分别位于右边框和上边框的红外接收管。

[0006] 进一步作为本实用新型技术方案的改进，围绕所述屏体后表面的四周边沿设有遮光层。

[0007] 进一步作为本实用新型技术方案的改进，滤光条包括设在红外发射管内侧的聚光滤光条和设在红外接收管内侧的非聚光滤光条。

[0008] 进一步作为本实用新型技术方案的改进，矩形边框在侧壁的内侧形成装嵌PCB板的卡槽。

[0009] 进一步作为本实用新型技术方案的改进，滤光条的前、后表面分别与矩形边框的

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前壁和屏体的前表面精圈连接。

[0010] 进一步作为本实用新型技术方案的改进，矩形边框的前壁内侧形成嵌入滤光条内的凸棱。

[0011] 进一步作为本实用新型技术方案的改进，矩形边框还包括夹紧屏体后表面四周边沿的底框，底框与侧壁形成将所述红外触控组件装在矩形边框内的内腔。

[0012] 进一步作为本实用新型技术方案的改进，底框与侧壁固定连接或采用一体成型工艺形成整体。

[0013] 进一步作为本实用新型技术方案的改进，矩形边框为铝合金构件或塑胶构件。

[0014] 本实用新型的有益效果：本新型红外触摸屏中，位于矩形边框内的PCB板平行于侧壁设置，使得PCB板上的电子元器件能够位于屏体前表面的后方，使得红外管在紧贴屏体前表面所在平面的同时，能够避免PCB板上电子元器件对于矩形边框前壁到屏体前表面距离的限制。本实用新型通过上述设计克服了现有红外触摸屏框体过宽、框体上表面与触摸屏外表面距离过大，在改善产品外观的同时，触摸悬浮更低，触摸精度、可靠性更高，能够有效降低误触摸的发生。

附图说明

[0015] 下面结合附图对本实用新型作进一步说明：

[0016] 图1是本实用新型第一实施例结构示意图；

[0017] 图2是本实用新型第二实施例结构示意图；

[0018] 图3是本实用新型第三实施例结构示意图。

具体实施方式

[0019] 参照图1一图3，本实用新型提供了一种新型红外触摸屏，包括屏体1、装嵌屏体1的矩形边框2以及位于矩形边框2内且围绕屏体1设置的红外触控组件3，屏体1是红外触摸屏的一部分，一般由玻璃构成，包括前表面和后表面。矩形边框2包括平行于屏体1的前壁21和垂直于屏体1的侧壁22，前壁21扳至屏体1边沿的前方并通过滤光条4与屏体1连接，红外触控组件3包括平行于侧壁22设在矩形边框2内的PCB板31以及若干设在PCB板31上、位于滤光条4外侧且紧贴屏体1前表面所在平面的红外管32，红外管32包括分别位于矩形边框2的左边框和下边框的红外发射管，以及分别位于右边框和上边框的红外接收管。

[0020] 本新型红外触摸屏中，位于矩形边框2内的PCB板31平行于侧壁22设置，使得PCB板31上的电子元器件33能够位于屏体1前表面的后方，使得红外管32在紧贴屏体1前表面所在平面的同时，能够避免PCB板31上电子元器件33对于矩形边框2前壁到屏体1前表面距离的限制。本实用新型通过上述设计克服了现有红外触摸屏框体过宽、框体上表面与触摸屏外表面距离过大，在改善产品外观的同时，触摸悬浮更低，触摸精度、可靠性更高，能够有效降低误触摸的发生。

[0021] 作为本实用新型优选的实施方式，围绕屏体1后表面的四周边沿设有遮光层5，遮光层5采用印刷或粘贴的黑色薄膜，以使产品更加美观、耐用。

[0022] 作为本实用新型优选的实施方式，滤光条4包括设在红外发射管内侧的聚光滤光

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条和设在红外接收管内侧的非聚光滤光条。一方面能实现红外接收管通过聚光结构接收到更强信号以触摸更可靠、触摸效果更好；另方面达到一个红外发射管发射，多个红外接收管接收的效果，以实现多点触摸。

[0023] 作为本实用新型优选的实施方式，矩形边框 2 在侧壁 22 的内侧形成装嵌 PCB 板 31 的卡槽 23，红外触控组件 3 在矩形边框 2 内安装时，红外触控组件 3 在 PCB 板 31 上形成一个整体结构，配合侧壁 22 内侧的卡槽 23 实现快速安装调试。

[0024] 作为本实用新型优选的实施方式，滤光条 4 的前、后表面分别与矩形边框 2 的前壁 21 和屏体 1 的前表面粘固连接。

[0025] 作为本实用新型优选的实施方式，矩形边框 2 的前壁 21 内侧形成嵌入滤光条 4 内的凸棱 24。

[0026] 作为本实用新型优选的实施方式，矩形边框 2 还包括夹紧屏体 1 后表面四周边沿的底框 25，底框 25 与侧壁 22 固定连接或采用一体成型工艺形成整体。底框 25 与侧壁 22 形成将红外触控组件 3 装在矩形边框 2 内的内卡，在保证屏体 1 在矩形边框 2 上安装牢固的同时，保障内部红外触控组件 3 的安全，避免损坏。

[0027] 作为本实用新型优选的实施方式，矩形边框 2 为铝合金构件或塑胶构件，以使得触摸屏重量更轻、成本更低。

[0028] 当然，本发明创造并不局限于上述实施方式，熟悉本领域的技术人员在不违背本实用新型精神的前提下还可作出等同变形或替换，这些等同的变型或替换均包含在本申请权利要求所限定的范围内。

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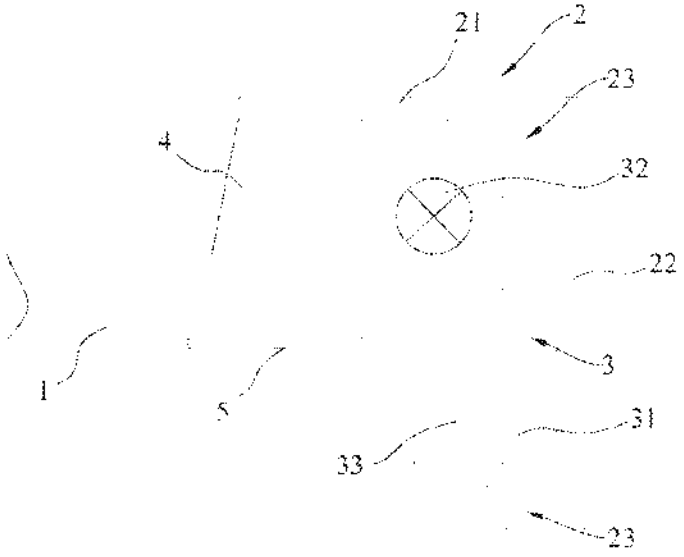


图 1

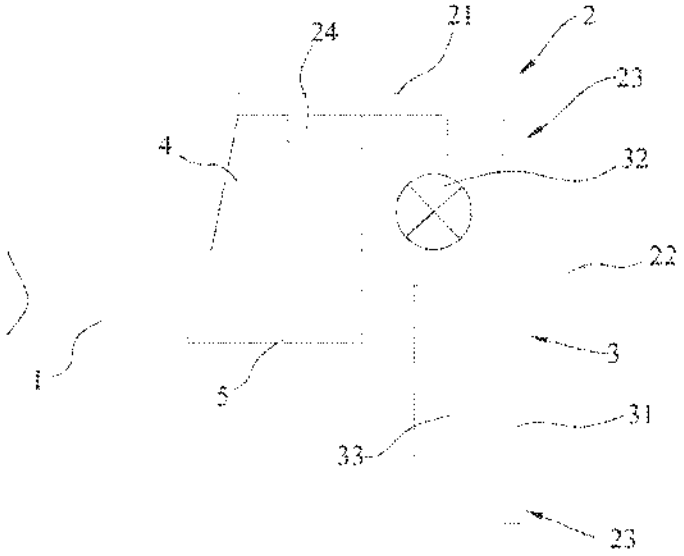


图 2

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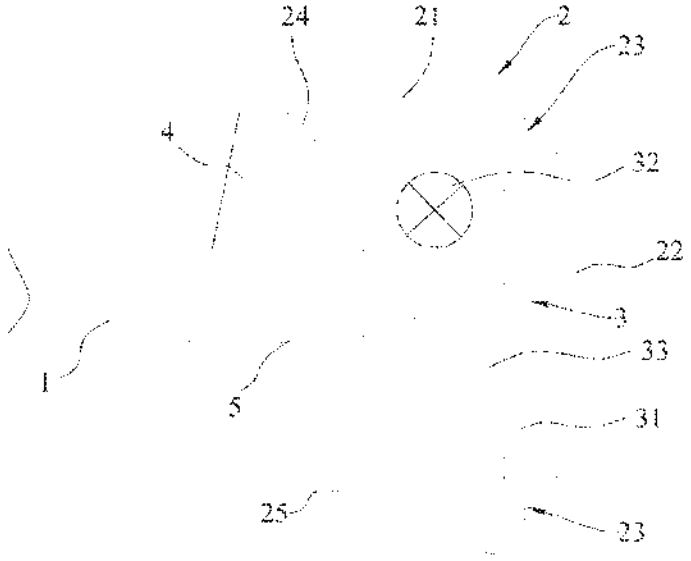


图 3

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Espacenet

CN203786708U Dismountable infrared touch device and infrared touch screen

Applicants: GUANGZHOU SHIRUI ELEC TECH CO

Inventors: CAO JIANHUI

Classifications:
IPC ***G06F3/042;***

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Dismountable infrared touch device and infrared touch screen

Abstract

The utility model discloses a dismountable infrared touch device and an infrared touch screen, wherein an outer framework comprises a panel and a side plate connected with the panel, the panel and the side plate are in vertical arrangement, clamp holes are formed in the panel at intervals, one side, far away from the side plate, of the panel is provided with a clamping part, a light filtering strip is clamped in the clamping part, a support frame is arranged under the outer framework, clamp posts are arranged in positions, matched with the clamp holes, of the support frame, the clamp holes and the clamp posts are fixedly connected through screw elements, a circuit board is clamped between the outer framework and the support frame, and an infrared device is electrically connected onto the circuit board and is in arrangement being matched with the light filtering strip. The light filtering strip is clamped in a clamp groove of the outer framework, and is arranged in a way of being separated from the outer framework, the difficulty of the integral forming production is reduced, and meanwhile, the production cost can also be reduced; meanwhile, the support frame is arranged in a matched way, and the clamp holes and the clamp posts are fixedly connected through the screw elements, so the circuit board can be stably and fixedly connected between the outer framework and the support frame; when the device is repaired, the circuit board can be exposed outside the device only through dismounting the screw elements, and the circuit board can be conveniently taken out to be maintained.

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G06F 3/042(2006.01)

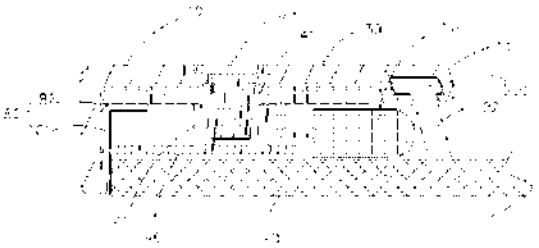
权利要求1页 说明书3页 附图2页

(54)实用新型名称

拆装式红外触摸装置及红外触摸屏

(57)摘要

本实用新型公开了一种拆装式红外触摸装置及红外触摸屏，其中外框架包括面板及与面板相连的侧板，面板与侧板垂直设置，面板上间隔开设有卡孔，面板远离侧板一侧设有卡持部，滤光条卡持在卡持部内；支架置于外框架下方，支架四配卡孔处设有卡柱，卡孔与卡柱通过螺丝件进行固接；电路板卡持在外框架与支架之间，红外装置电性连接在电路板上并四配滤光条设置。本实用新型通过将滤光条卡持在外框架的卡槽内，滤光条与外框架分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架，通过螺丝件将卡孔与卡柱进行固接，使得电路板能稳定固接在外框架与支架之间；并在对装置进行维修时，拆下螺丝件即能让电路板裸露在装置外侧，方便取出维护。



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1. 一种拆装式红外触摸装置，其特征在于：包括外框架、滤光条、电路板、支架及红外装置，所述外框架包括面板及与面板相连的侧板，所述面板与所述侧板垂直设置，所述面板上间隔开设有卡孔，所述面板远离侧板一侧设有卡持部，所述滤光条卡持在卡持部内；所述支架置于所述外框架下方，所述支架匹配卡孔处设有卡柱，所述卡孔与卡柱通过螺丝件进行固接；所述电路板卡持在所述外框架与支架之间，所述红外装置电性连接在电路板上并匹配所述滤光条设置。

2. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述支架下表面贴合触摸显示屏设置。

3. 根据权利要求 2 所述的拆装式红外触摸装置，其特征在于：所述触摸显示屏一侧与支架之间设有双面胶，所述双面胶用于将所述支架与触摸显示屏固定粘合。

4. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述卡持部横向开设有卡槽，所述滤光条卡持在卡槽内。

5. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述电路板上匹配所述卡孔处开设有开孔，所述卡柱贯穿所述电路板设置；所述卡柱上端部底侧设置有支撑部，所述支撑部用于对电路板支撑固定。

6. 根据权利要求 5 所述的拆装式红外触摸装置，其特征在于：所述支撑部为 L 型构造。

7. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述外框架内侧部贴合设置有支撑条，所述支撑条设置有一体成型的侧片及支撑片，所述侧片贴合所述外框架设置，所述支撑片与所述侧片垂直设置，所述支撑片用于支撑所述电路板一端部。

8. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述滤光条包括一体成型的基部及滤光部，所述基部与滤光部呈 T 型构造，所述基部卡持容置在卡槽内。

9. 根据权利要求 1 所述的拆装式红外触摸装置，其特征在于：所述外框架采用不锈钢材质制造。

10. 一种红外触摸屏，其特征在于：包括如权利要求 1 ～ 9 任一项所述的拆装式红外触摸装置及其贴合的触摸显示屏。

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拆装式红外触摸装置及红外触摸屏

技术领域

[0001] 本实用新型涉及触控设备技术领域，尤其是涉及一种拆装式红外触摸装置及红外触摸屏。

背景技术

[0002] 红外触摸屏是利用 X、Y 方向上密布的红外线矩阵来检测并定位用户的触摸，包括滤光条、电路板、外框、显示屏玻璃、红外发射管和红外接收器等，红外发射管和红外接收器交叉安装在高度集成的电路板上的两个相对的方向，形成一个不可见的红外线光栅，滤光条通过外框固定在红外发射管和红外接收器前方。电路板上的控制电路持续地对二极管发出脉冲形成红外线偏震光束格栅，当用户在触摸显示屏玻璃时，手指或其它物体就会挡住经过该位置上方的横竖两条红外线，阻断了光束，由控制器判断出触摸点在显示屏玻璃的位置，从而达到触摸和手写效果。

[0003] 红外触摸屏不受电流电压和静电干扰，适宜恶劣的环境条件，所以普遍认为红外线技术是触摸屏产品最终的发展趋势，如果为了美观而减少红外触摸屏的组装结构，将更多的结构进行一体成型，而当结构中存在部分瑕疵时，会将整体结构进行统一替换，无形中增加了维护成本，同时，进行一体成型化生产也会增大生产的难度，不利于生产效率的有效提高。

实用新型内容

[0004] 基于此，有必要针对现有技术的不足，提供一种生产容易、维护方便，降低成本的拆装式红外触摸装置及红外触摸屏。

[0005] 为解决上述技术问题，本实用新型所采用的技术方案是：一种拆装式红外触摸装置，其包括外框架、滤光条、电路板、支架及红外装置，所述外框架包括面板及与面板相连的侧板，所述面板与所述侧板垂直设置，所述面板上间隔开设有卡孔，所述面板远离侧板一侧设有卡持部，所述滤光条卡持在卡持部内；所述支架置于所述外框架下方，所述支架匹配卡孔处设有卡柱，所述卡孔与卡柱通过螺丝件进行固接；所述电路板卡持在所述外框架与支架之间，所述红外装置电性连接在电路板上并匹配所述滤光条设置。

[0006] 在其中一个实施例中，所述支架下表面贴合触摸显示屏设置。

[0007] 在其中一个实施例中，所述触摸显示屏一侧与支架之间设有双面胶，所述双面胶用于将所述支架与触摸显示屏固定粘合。

[0008] 在其中一个实施例中，所述卡持部横向开设有卡槽，所述滤光条卡持在卡槽内。

[0009] 在其中一个实施例中，所述电路板上匹配所述卡孔处开设有开孔，所述卡柱贯穿所述电路板设置；所述卡柱上端部周侧设置有支撑部，所述支撑部用于对电路板支撑固定。

[0010] 在其中一个实施例中，所述支撑部为 L 型构造。

[0011] 在其中一个实施例中，所述外框架内侧部贴合设置有支撑条，所述支撑条设置有一体成型的侧片及支撑片，所述侧片贴合所述外框架设置，所述支撑片与所述侧片垂直设

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置，所述支撑片用于支撑所述电路板一端部。

[0012] 在其中一个实施例中，所述滤光条包括一体成型的基部及滤光部，所述基部与滤光部呈T型构造，所述基部卡持容置在卡槽内。

[0013] 在其中一个实施例中，所述外框架采用不锈钢材质制造。

[0014] 一种红外触摸屏，其包括上述述的拆装式红外触摸装置及其贴合的触摸显示屏。

[0015] 综上所述，本实用新型拆装式红外触摸装置及红外触摸屏通过将滤光条卡持在外框架的卡槽内，滤光条与外框架分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架，通过螺丝件将卡孔与卡柱进行固接，使得电路板能稳定固接在外框架与支架之间；并在对装置进行维修时，拆下螺丝件即能让电路板裸露在装置外侧，方便取出维护。

附图说明

[0016] 图 1 为本实用新型拆装式红外触摸装置的结构示意图；

[0017] 图 2 为图 1 本实用新型拆装式红外触摸装置的截面示意图；

[0018] 图 3 为图 1 本实用新型拆装式红外触摸装置隐藏部分结构的截面示意图。

具体实施方式

[0019] 为能进一步了解本实用新型的特征、技术手段以及所达到的具体目的、功能，下面结合附图与具体实施方式对本实用新型作进一步详细描述。

[0020] 如图 1 至图 3 所示，本实用新型拆装式红外触摸装置包括外框架 10、滤光条 20、电路板 30、支架 40 及红外装置 50，所述外框架 10 采用不锈钢材质制造，所述外框架 10 包括面板 11 及与面板 11 相连的侧板 12，所述面板 11 与所述侧板 12 垂直设置，所述面板 11 上间隔开设有卡孔 111，所述面板 11 远离侧板 12 一侧设有卡持部 13，所述卡持部 13 横向开设有卡槽 131，所述滤光条 20 卡持在卡槽 131 内，将外框架 10 与滤光条 20 组装设置，降低了一体成型式生产的难度，同时也降低生产成本；所述支架 40 置于所述外框架 10 下方，所述支架 40 对配卡孔 111 处设有卡柱 41，所述卡孔 111 与卡柱 41 通过螺丝件 60 进行固接，使得外框架 10 与支架 40 稳定固接；所述支架 40 下表面贴合触摸显示屏 70 设置，进一步地，所述触摸显示屏 70 一侧与支架 40 之间设有双面胶，所述双面胶用以将所述支架 40 与触摸显示屏 70 固定粘合。

[0021] 所述电路板 30 卡持在所述外框架 10 与支架 40 之间，所述红外装置 50 电性连接在电路板 30 上并对配所述滤光条 20 设置；在其中一个实施例中，所述红外装置 50 为红外发射管或红外接收器，所述红外接收器用以接收从红外发射管发出的红外光线信号。

[0022] 进一步地，所述电路板 30 上对配所述卡孔 111 处开设有开孔，所述卡柱 41 贯穿所述电路板 30 设置；所述卡柱 41 上端部周侧设置有 L 型支撑部 411，所述支撑部 411 用于对电路板 30 支撑固定，以保证电路板 30 能稳固装置在所述外框架 10 与支架 40 之间。

[0023] 在其中一个实施例中，所述外框架 10 内侧部贴合设置有支撑条 80，所述支撑条 80 设置有一体成型的侧片 81 及支撑片 82，所述侧片 81 贴合所述外框架 10 设置，所述支撑片 82 与所述侧片 81 垂直设置，所述支撑片 82 用于支撑所述电路板 30 一端部，与卡柱 41 的支撑部 411 共同对电路板 30 进行支撑固定，使得电路板 30 能更稳固地装设在所述外框架 10

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与支架 40 之间。

[0024] 在其中一个实施例中，所述滤光条 20 包括一体成型的基部 21 及滤光部 22，所述基部 21 与滤光部 22 呈 T 型构造，所述基部 21 卡持容置在卡槽 131 内，所述滤光部 22 斜向下设置，所述滤光部 22 用以过滤经过其内部的光线，以保证红外接收器能准确识别红外发射管发出的红外光线。

[0025] 本实用新型还提供了一种红外触摸屏，包括上述一种拆装式红外触摸装置的外框架 10、滤光条 20、支架 40、电路板 30 及红外装置 50，还包括与拆装式红外触摸装置贴合的触摸显示屏 70。

[0026] 上述一种红外触摸屏的其他技术特征与上述一种红外触摸装置相同，此处不予赘述。

[0027] 本实用新型具体组装时，首先通过双面胶将支架 40 与触摸显示屏 70 进行粘合，将组装好红外装置 50 的电路板 30 安设在卡柱 41 上，此时，卡柱 41 贯穿电路板 30 上开设的开孔，支撑部 411 对电路板 30 起到支撑作用，使得电路板 30 能稳固地进行安设；然后，将组装好滤光条 20 的外框架 10 安设在支架 40 上方，此时，外框架 10 的卡孔 111 匹配卡柱 41 设置，通过螺丝件 60 使得卡孔 111 和卡柱 41 对接，完成对外框接与支架 40 的固接，同时也使得电路板 30 稳定固定在外框架 10 与支架 40 之间；本实用新型进行拆装时，直接将螺丝件 60 拆下，将外框架 10 与支架 40 分离，此时，电路板 30 即可裸露在装置外侧，方便取出进行维护。

[0028] 综上所述，本实用新型拆装式红外触摸装置及红外触摸屏通过将滤光条 20 卡持在外框架 10 的卡槽 131 内，滤光条 20 与外框架 10 分离设置，降低了一体成型式生产的难度，同时也降低生产成本；同时，配合设置支架 40，通过螺丝件 60 将卡孔 111 与卡柱 41 进行固接，使得电路板 30 能稳定固接在外框架 10 与支架 40 之间；并在对装置进行维修时，拆下螺丝件 60 即能让电路板 30 裸露在装置外侧，方便取出维护。

[0029] 以上所述实施例仅表达了本实用新型的几种实施方式，其描述较为具体和详细，但并不能因此而理解为对本实用新型范围的限制。应当指出的是，对于本领域的普通技术人员来说，在不脱离本实用新型构思的前提下，还可以做出若干变形和改进，这些都属于本实用新型的保护范围。因此，本实用新型的保护范围应以所附权利要求为准。

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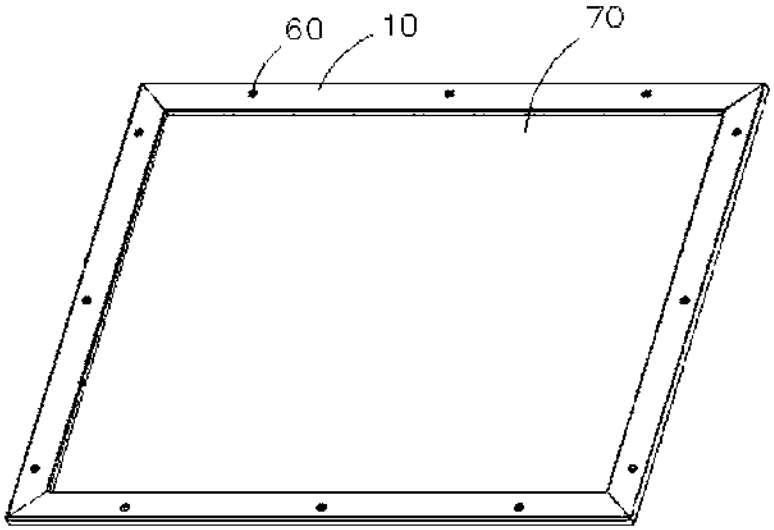


图 1

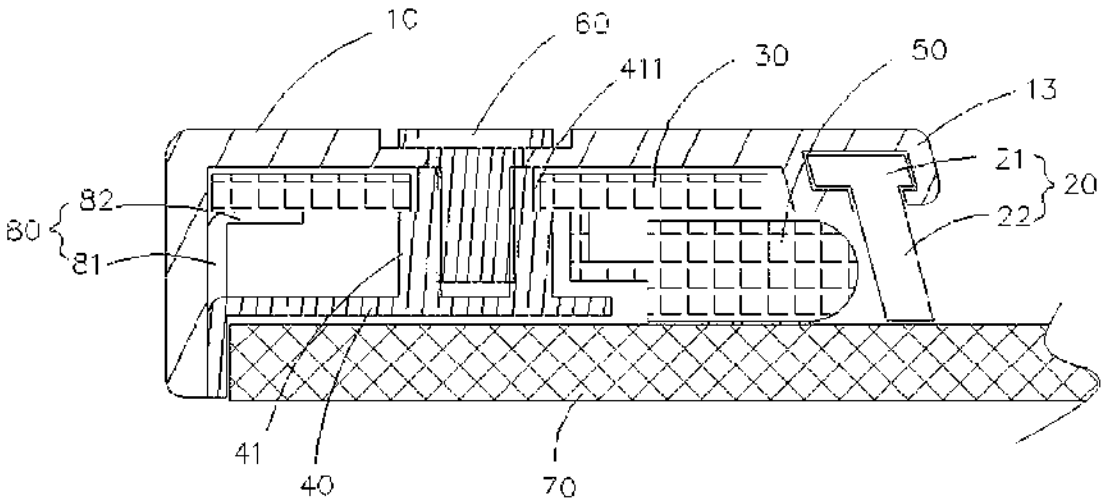


图 2

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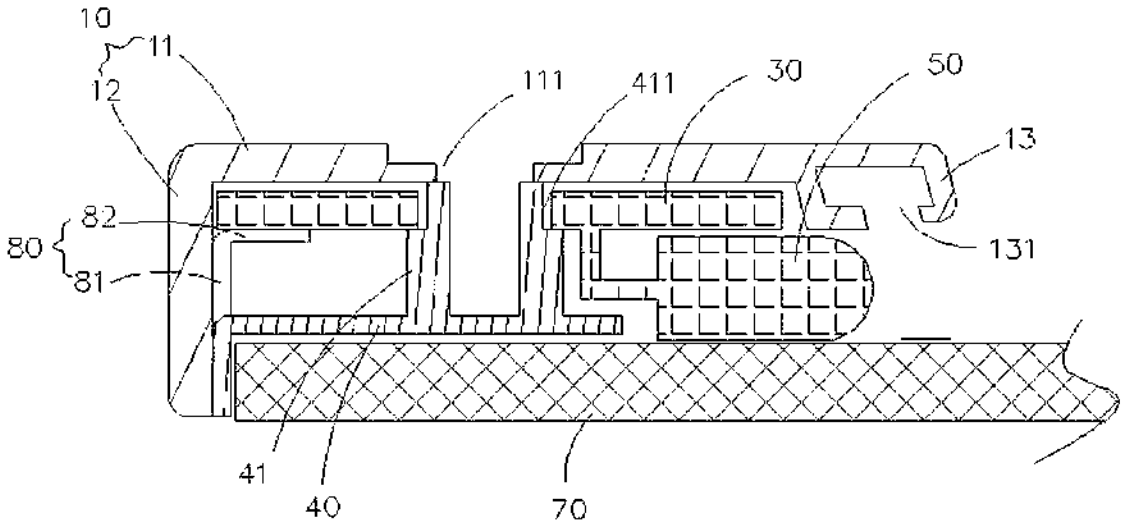


图 3

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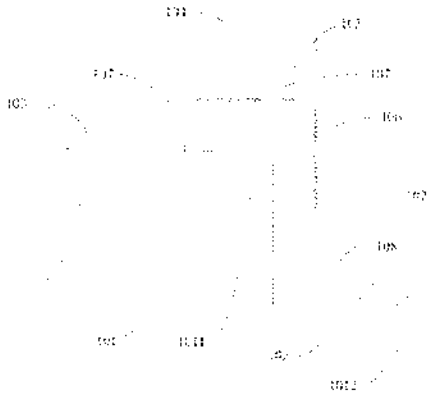
权利要求书1页 说明书4页 附图3页

(54)实用新型名称

显示器边框结构

(57)摘要

一种显示器边框结构，包括：遮光条、玻璃盖板、灯管、印刷电路板、以及包括印刷电路板支撑板和第一双面胶；显示器边框结构采用第一双面胶将印刷电路板与印刷电路板支撑板的主体板固定，再将印刷电路板支撑板的第一板面与玻璃盖板上，从而将印刷电路板相对显示器及玻璃盖板固定，再将遮光条及灯管依次安装即完成显示器边框结构的安装。由于印刷电路板沿长度方向安装，减小了显示器的边缘宽度，同时使得Z轴高度降低。



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1. 一种显示器边框结构，包括：滤光条、玻璃盖板、灯管、印刷电路板，其特征在于，还包括印刷电路板支撑板和第一双面胶；

玻璃盖板，用于盖设在所述显示器的显示面；

印刷电路板支撑架，用于设于所述显示器的侧边，所述印刷电路板支撑架具有固定印刷电路板的主体板和自所述主体板两端分别向相反的方向垂直延伸的第一挡板和第二挡板，其中所述第一挡板向玻璃盖板延伸并固定于所述玻璃盖板上，所述第二挡板背向玻璃盖板延伸并与所述印刷电路板一端抵接；所述主体板通过所述第一双面胶与所述印刷电路板固定，所述第一挡板通过所述第一双面胶与所述玻璃盖板固定；

印刷电路板，通过所述第一双面胶固定于所述印刷电路板支撑架的主体板上；

灯管，设于所述印刷电路板上并突出于所述主体板；

滤光条，置于所述灯管的出光面并与所述玻璃盖板所在的平面平行。

2. 根据权利要求 1 所述的显示器边框结构，其特征在于，所述印刷电路板支撑板的第一挡板覆盖于所述玻璃盖板靠近显示器的一面。

3. 根据权利要求 1 所述的显示器边框结构，其特征在于，所述玻璃盖板与所述显示器通过第一双面胶固定连接。

4. 根据权利要求 1 所述的显示器边框结构，其特征在于，所述印刷电路板支撑板的第一挡板覆盖于所述玻璃盖板远离显示器的一面。

5. 根据权利要求 1-4 任意一项所述的显示器边框结构，其特征在于，所述第一双面胶为 0.3 厚 3M 双面胶。

6. 根据权利要求 1 所述的显示器边框结构，其特征在于，所述滤光条置于所述玻璃盖板上，并与所述玻璃盖板通过第二双面胶连接。

7. 根据权利要求 1 所述的显示器边框结构，其特征在于，所述滤光条置于所述印刷电路板支撑板的第一挡板上，并与所述印刷电路板支撑板的第一挡板通过第二双面胶连接。

8. 根据权利要求 6 或 7 所述的显示器边框结构，其特征在于，所述第二双面胶为 0.1 厚 3M 双面胶。

9. 根据权利要求 1 所述的显示器边框结构，其特征在于，还包括显示器支撑板，所述显示器支撑板靠近所述显示器的一端与所述显示器螺接，所述显示器支撑板远离所述显示器的一端与外部设备采用螺接。

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显示器边框结构

技术领域

[0001] 本实用新型涉及显示器边框结构，特别是涉及一种安装简便、边框窄的显示器边框结构。

背景技术

[0002] 显示器的黑边为屏幕中显示的内容除了正常显示区域外，两侧或四周多出来的不能显示的区域，因该区域为黑色，故称之为黑边。传统的触控模组，由于PCB的宽度较宽，导致边缘较宽，使得安装后的显示器边缘较宽，Z轴触控太高，从而影响用户体验。

实用新型内容

[0003] 基于此，有必要提供一种安装简便、显示边缘窄、低Z轴触控的显示器边框结构。

[0004] 一种显示器边框结构，包括：滤光条、玻璃盖板、灯管、印刷电路板，还包括印刷电路板支撑板和第一双面胶；

[0005] 玻璃盖板，用于盖设在所述显示器的显示面；

[0006] 印刷电路板支撑架，用于设于所述显示器的侧边，所述印刷电路板支撑架具有固定印刷电路板的主体板和自所述主体板两端分别向相反的方向垂直延伸的第一挡板和第二挡板，其中所述第一挡板向玻璃盖板延伸并固定于所述玻璃盖板上，所述第二挡板背向玻璃盖板延伸并与所述印刷电路板一端抵接；所述主体板通过所述第一双面胶与所述印刷电路板固定，所述第一挡板通过所述第一双面胶与所述玻璃盖板固定；

[0007] 印刷电路板，通过所述第一双面胶固定于所述印刷电路板支撑架的主体板上；

[0008] 灯管，设于所述印刷电路板上并突出于所述主体板；

[0009] 滤光条，置于所述灯管的出光面并与所述玻璃盖板所在的平面平行。

[0010] 在其中一个实施例中，所述印刷电路板支撑板的第一挡板覆盖于所述玻璃盖板靠近显示器的一面。

[0011] 在其中一个实施例中，所述玻璃盖板与所述显示器通过第一双面胶固定连接。

[0012] 在其中一个实施例中，所述印刷电路板支撑板的第一挡板覆盖于所述玻璃盖板远离显示器的一面。

[0013] 在其中一个实施例中，所述第一双面胶为0.3厚3M双面胶。

[0014] 在其中一个实施例中，所述滤光条置于所述玻璃盖板上，并与所述玻璃盖板通过第二双面胶连接。

[0015] 在其中一个实施例中，所述滤光条置于所述印刷电路板支撑板的第一挡板上，并与所述印刷电路板支撑板的第一挡板通过第二双面胶连接。

[0016] 在其中一个实施例中，所述第二双面胶为0.1厚3M双面胶。

[0017] 在其中一个实施例中，还包括显示器支撑板，所述显示器支撑板靠近所述显示器的一端与所述显示器螺接，所述显示器支撑板远离所述显示器的一端与外部设备采用螺接。

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[0018] 上述显示器边框结构采用第一双面胶将印刷电路板与印刷电路板支撑板的主体板固定，再将印刷电路板支撑板的第一板固定于玻璃盖板上，从而将印刷电路板相对显示器及玻璃盖板固定。再将滤光条及灯管依次安装即完成显示器边框结构的安装，由于印刷电路板沿长度方向安装，减小了显示器的边缘宽度，同时使得 Z 轴高度降低。

附图说明

[0019] 图 1 为显示器边框结构的示意图；

[0020] 图 2 为一个实施例中显示器边框结构的示意图；

[0021] 图 3 为又一个实施例中显示器边框结构的示意图；

[0022] 图 4 为另一个实施例中显示器边框结构的示意图。

具体实施方式

[0023] 一种显示器边框结构，用于设置在显示器的四周以提供基于红外线探测的触控操作组件，包括：玻璃盖板、灯管、印刷电路板，其特征在于，还包括印刷电路板支撑板和第一双面胶。

[0024] 玻璃盖板，用于盖设在所述显示器的显示面。

[0025] 印刷电路板支撑架，用于设于所述显示器的侧边，所述印刷电路板支撑架具有固定印刷电路板的主体板和自所述主体板两端分别向相反的方向垂直延伸的第一挡板和第二挡板，其中所述第一挡板向玻璃盖板延伸并固定于所述玻璃盖板上，所述第二挡板背向玻璃盖板延伸并与所述印刷电路板一端抵接；所述主体板通过所述第一双面胶与所述印刷电路板固定，所述第一挡板通过所述第一双面胶与所述玻璃盖板固定。

[0026] 印刷电路板，通过所述第一双面胶固定于所述印刷电路板支撑架的主体板上。

[0027] 灯管，设于所述印刷电路板上并突出于所述主体板。

[0028] 滤光条，置于所述灯管的出光面并与所述玻璃盖板所在的平面平行。

[0029] 印刷电路板支撑板通过第一双面胶与玻璃盖板固定，然后沿主体板的长度方向通过第一双面胶与印刷电路板平行固定。玻璃盖板与显示器之间也采用第一双面胶固定，因而显示器、玻璃盖板、印刷电路板支撑板及印刷电路板相对固定。再将灯管与印刷电路板电连接，滤光条设置于灯管的出光面。显示器与显示器支架之间采用螺接。因而，显示器的边框结构能够快速简便的安装完毕，同时，将印刷电路板沿长度方向固定，使得显示器边框结构占用面积变小，减小了显示器的边缘宽度，同时也降低了 Z 轴触控高度。

[0030] 为了使本实用新型的目的、技术方案及优点更清楚，以下结合附图及实施例，对本实用新型进行进一步详细说明。

[0031] 如图 1 所示，为一个实施例中的显示器边框结构示意图。

[0032] 一种显示器边框结构，包括：玻璃盖板 103、灯管 105、印刷电路板 106，还包括印刷电路板支撑板 108 和第一双面胶 107。

[0033] 玻璃盖板 103，用于盖设在显示器 101 的显示面。

[0034] 印刷电路板支撑架 108，用于设于显示器 101 的侧边，所述印刷电路板支撑架 108 具有固定印刷电路板 106 的主体板和自所述主体板两端分别向相反的方向垂直延伸的第一挡板和第二挡板，其中所述第一挡板向玻璃盖板 103 延伸并固定于所述玻璃盖板 103 上，

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所述第二挡板背向玻璃盖板 103 延伸并与所述印刷电路板 106 一端抵接，所述主体板通过所述第一双面胶 107 与所述印刷电路板 106 固定，所述第一挡板通过所述第一双面胶 107 与所述玻璃盖板 103 固定。

[0035] 印刷电路板 106，通过所述第一双面胶 107 固定于所述印刷电路板支撑架 108 的主体板上。

[0036] 灯管 105，设于所述印刷电路板 106 上并突出于所述主体板。

[0037] 滤光条 104，置于所述灯管 105 的出光面并与所述玻璃盖板 103 所在的平面平行。

[0038] 显示器边框结构还包括显示器支撑板 102，所述显示器支撑板 102 靠近所述显示器 101 的一端通过螺钉 1011 与所述显示器 101 螺接，所述显示器支撑板 102 远离所述显示器 101 的一端与外部设备通过螺钉 1012 螺接。

[0039] 显示器 101 与显示器支撑板 102 通过螺钉 1011 固定，同时，显示器支撑板 102 背离显示器 101 的一端自由延伸并通过螺接将显示器 101 固定于外部设备上。

[0040] 在一个实施例中，玻璃盖板 103 与所述显示器 101 的接触部分通过第一双面胶 107 连接。

[0041] 在一个实施例中，印刷电路板支撑板 108 的第一挡板覆盖于所述玻璃盖板 103 远离显示器 101 的一面。

[0042] 在另一个实施例中，印刷电路板支撑板 108 的第一挡板覆盖于所述玻璃盖板 103 靠近显示器 101 的一面

[0043] 玻璃盖板 103 与显示器 101 通过第一双面胶 107 固定连接。

[0044] 如图 2 所示，为显示器边框结构的示意图。在本实施例中，印刷电路板支撑板 108 的第一挡板覆盖于玻璃盖板 103 远离显示器 101 的一面，印刷电路板支撑板 108 的第一挡板沿玻璃盖板 103 长度方向延伸，并与玻璃盖板 103 固定连接。滤光条 104 置于印刷电路板支撑板 108 的第二挡板上，并与印刷电路板支撑板 108 的第二挡板所在的平面及玻璃盖板 103 所在的平面平行设置。

[0045] 滤光条 104 置于所述印刷电路板支撑板 108 的第二挡板上，并与所述印刷电路板支撑板 108 的第二挡板通过第二双面胶连接。

[0046] 如图 3 所示，为显示器边框结构的示意图。在本实施例中，印刷电路板支撑板 108 的第一挡板覆盖于玻璃盖板 103 远离显示器 101 的一面。印刷电路板支撑板 108 沿玻璃盖板 103 长度方向延伸的第一挡板与滤光条 104 的边缘对齐，即滤光条 104 置于玻璃盖板 103 上，且滤光条 104 所在的平面与玻璃盖板 103 所在的平面平行，并采用第二双面胶 109 与玻璃盖板 103 固定连接。

[0047] 如图 4 所示，为显示器边框结构的示意图。印刷电路板支撑板 108 的第一挡板覆盖于显示器 101 上，印刷电路板支撑板 108 沿显示器 101 长度方向延伸的第二挡板与滤光条 104 固定。印刷电路板支撑板 108 与显示器 101 及玻璃盖板 103 接触的部分采用第一双面胶 107 固定连接。滤光条 104 置于灯管 105 的出光面，同时与玻璃盖板 103 通过第二双面胶 109 固定连接。

[0048] 上述实施例中，印刷电路板支撑板 108 与所述玻璃盖板 103 的接触部分均采用第一双面胶 107 连接。

[0049] 上述实施例中，第一双面胶 107 为 0.3 厚 3M 双面胶。

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[0050] 上述实施例中，第一双面胶 109 为 0.1 厚 3M 双面胶。

[0051] 显示器支撑板 102 远离所述显示器 101 的一端与外部设备采用螺接。

[0052] 上述显示器边框结构采用第一双面胶 107 将印刷电路板 106 与印刷电路板支撑板 108 的主体板固定，再将印刷电路板支撑板 108 的第二挡板与固定于玻璃盖板 103 上，从而将印刷电路板 106 相对显示器 101 及玻璃盖板 103 固定。再将滤光条 104 及灯管 105 依次安装即完成显示器边框结构的安装，由于印刷电路板 106 沿长度方向安装，减小了显示器的边缘宽度，同时使得 Z 轴高度降低。

[0053] 以上所述实施例仅表达了本实用新型的几种实施方式，其描述较为具体和详细，但并不能因此而理解为对本实用新型专利范围的限制。应当指出的是，对于本领域的普通技术人员来说，在不脱离本实用新型构思的前提下，还可以做出若干变形和改进，这些都属于本实用新型的保护范围。因此，本实用新型专利的保护范围应以所附权利要求为准。

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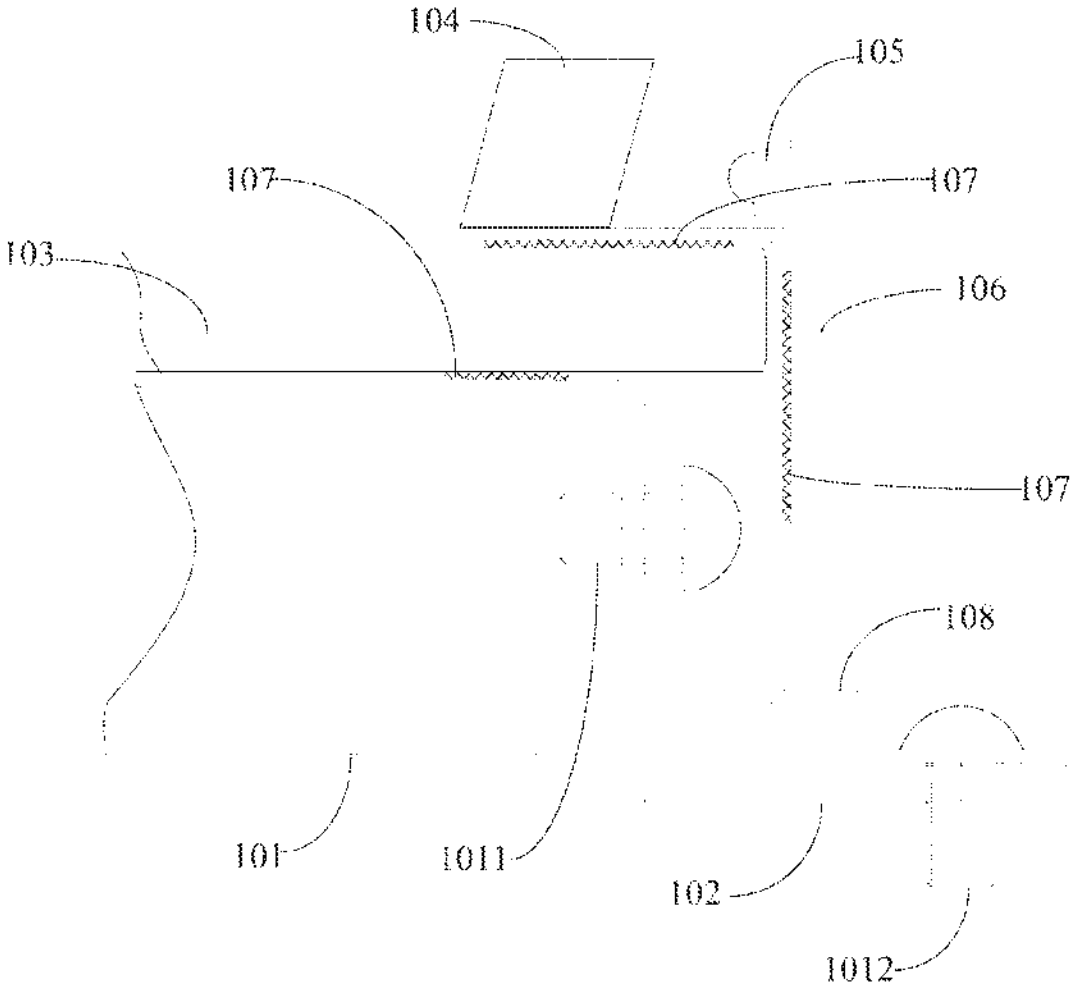


图 1

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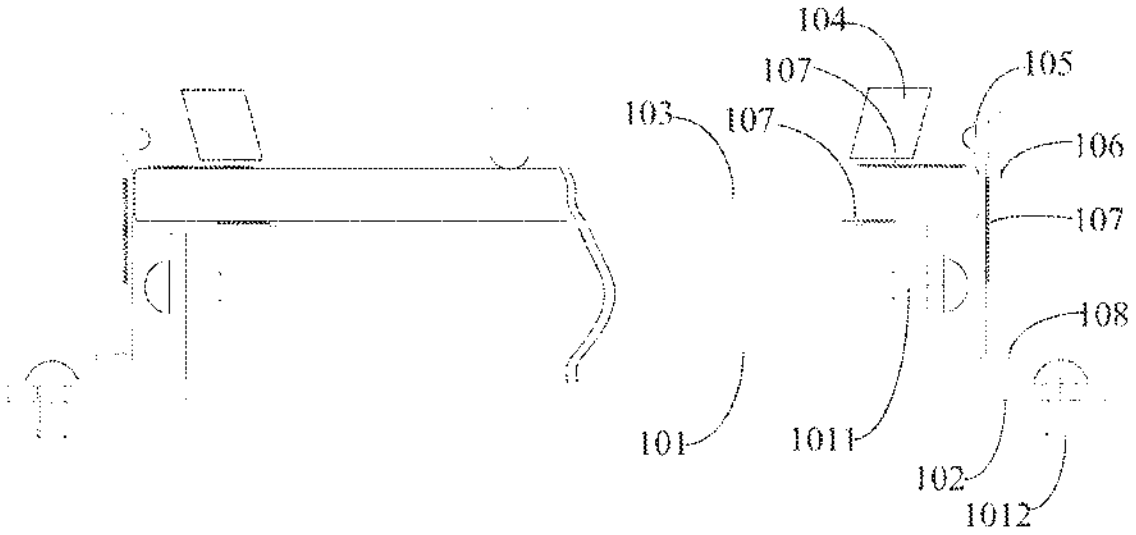


图 2

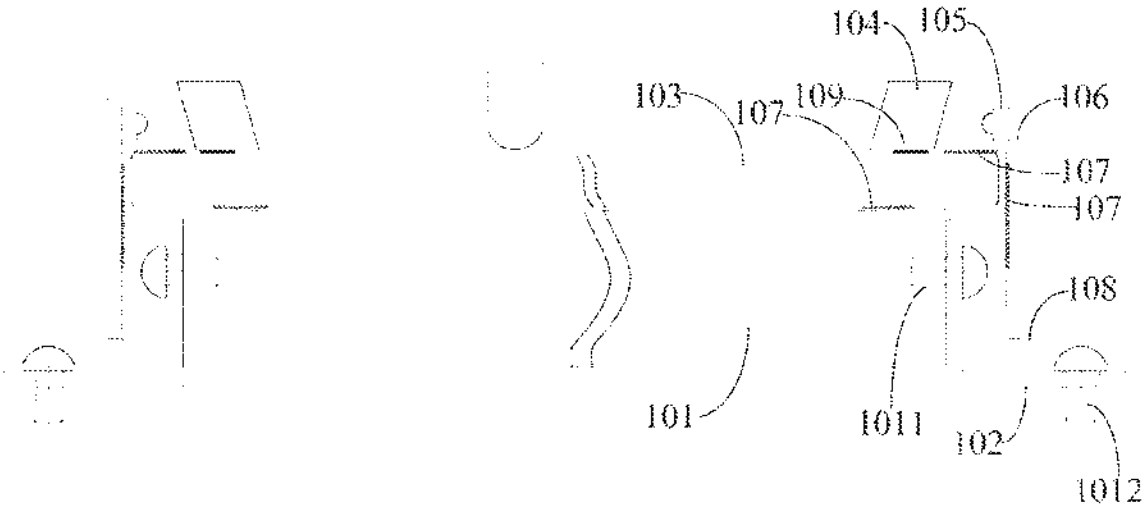


图 3

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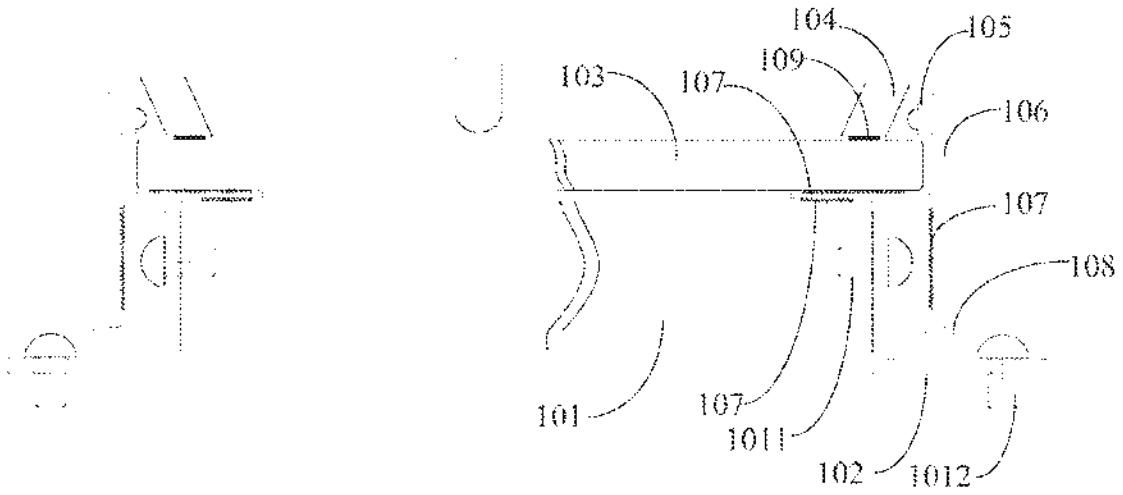


图 4

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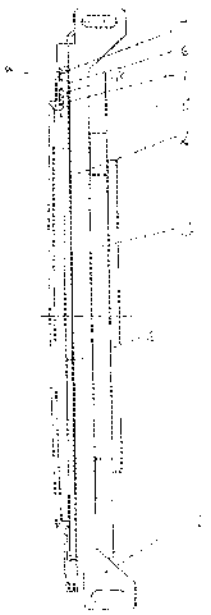
(56) Entgegenhaltungen:
DE 37 14 535 C2
US 53 32 238 A
US 5 79 250 A

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Prüfungsantrag gem. § 44 PatG ist gestellt

(54) Einbaurahmen für einen berührungssensitiven Schirm

(57) Zum schnellen und einfachen Einbau eines berührungssensitiven, im wesentlichen transparenten Schirms (2) in ein Terminalgehäuse ist ein Einbaurahmen (1) mit einer darin ausgebildeten Öffnung (12) vorgesehen, wobei wenigstens ein Teil der berührungssensitiven Oberfläche (S) des Schirms (2) freiliegt, wobei der Einbaurahmen (1) wenigstens einen Teil des Außenumfangs des Schirms (2) abdeckt, und wobei der Einbaurahmen (1) Mittel zur Anbringung des Rahmens (1) an weiteren Elementen aufweist.



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Beschreibung

[0001] Die vorliegende Erfindung betrifft einen Einbaurahmen für einen berührungssensitiven, im wesentlichen transparenten Schirm gemäß Patentanspruch 1. Ferner betrifft die vorliegende Erfindung eine eigenständig handhabbare Montageeinheit gemäß Patentanspruch 17.

[0002] Im Stand der Technik sind sogenannte Touchscreens bekannt. Als Beispiel sei hier auf das US-Patent US-A-5,591,945 hingewiesen, aus welchem ein akustischer Berührungspositionssensor bekannt ist, welcher die Ausbreitung von horizontal polarisierten Scherwellen höherer Ordnung zur Lokalisierung verwendet. Dieser Touchscreen weist einen Wandler auf, welcher eine Welle generiert, die sich auf der Oberfläche des Touchscreens ausbreitet. Eine reflektierende Anordnung ist zur Reflexion der Welle anfangsmäßig an die Oberfläche vorgesehen. Die durch die Reflexion entstandenen Wellen werden durch einen Gegenstand, z. B. ein Finger, der das Substrat berührt teilweise absorbiert, abgeschwächt oder gestört, um eine modifizierte Wellenform zu erzeugen. Aus der Welleperturbation kann der Ort und/oder weitere Kontaktzustände des Gegenstandes bestimmt werden.

[0003] Bei einem derartigen Touchscreen, insbesondere basierend auf der Oberflächenwellentechnologie, stellt der Einbau in ein Gehäuse eines Terminals ein besonderes Problem dar. Dies beruht darauf, daß die aktive Seite keinen Kontaktierungen ausgesetzt sein darf, welche lediglich durch die Montage und nicht durch den Betrieb verursacht sind. Ferner befinden sich um einen derartigen Schirm Reflektoren und Wandler bzw. Transducer, welche ebenfalls für einen Anwender des Terminals nicht zugänglich sein dürfen. Weitere Probleme des Einbaus eines derartigen Touchscreens in ein Terminal ist die Abdichtung, z. B. gegenüber Feuchtigkeit oder Staub, der Schutz gegen Manipulationen und die Robustheit im Hinblick auf Vandalismus.

[0004] Insbesondere aufgrund der inhärenten Druckempfindlichkeit der Touchscreenoberfläche hat es sich als besonders schwierig herausgestellt, derartige Touchscreens in Terminals einzubauen, da der Einbau individualisiert, d. h. für jedes Terminal speziell, vorgenommen werden mußte. Die durch die Befestigung auftretenden Drücke wurden mechanisch, d. h. durch Anbringung von den der Polsterung dienenden Schaumstoffmaterialien, und elektronisch bzw. durch Software d. h durch Herausrechnen des durch die Befestigung entstandenen Beitrags aus den Signalen durch Computerverarbeitung, korrigiert.

[0005] Die Aufgabe der vorliegenden Erfindung besteht daher darin, die Nachteile des Standes der Technik zu vermeiden, und insbesondere auf einfache, kostengünstige, betriebssichere, reproduzierbare und für eine Serienfertigung geeignete Art und Weise den Einbau eines Touchscreens in ein Terminal sicherzustellen.

[0006] Vorteilhafterweise ist der Einbaurahmen aus einem harten Kunststoffmaterial. Dabei ist insbesondere ein mit Glasfasern verstärktes Polyamidmaterial bevorzugt. Ein hartes Material ist deshalb bevorzugt, da die Steuereinrichtung für den Touchscreen die sich durch den Kontakt ergebenden Dämpfungen genau berechnen kann. Bei dem bisher im Stand der Technik eingesetzten weicheren Schaumstoffmaterial besteht die Gefahr, das die Dämpfung zu hoch ist, und damit zu indifferent wird.

[0007] Zur Fixierung des in dem Einbaurahmen aufgenommenen Schirms ist vorzugsweise der Einbaurahmen mit einer Halteplatte derart verbunden, daß der Schirm zwischen der Halteplatte und dem Einbaurahmen angeordnet ist. Der Touchscreen ist daher in dem Einbaurahmen aufgenommen und wird von hinten von der Halteplatte in diesem gehalten.

Die Halteplatte, die vorzugsweise aus Metall hergestellt ist, drückt den Schirm gleichmäßig an den Einbaurahmen, weshalb die eingangs erwähnte Beeinträchtigung der Funktion des Touchscreens durch die Befestigung vermindert wird.

[0008] Eine besonders günstige Realisierung ergibt sich dadurch, daß die Halteplatte als Rahmen mit einer Öffnung ausgebildet ist, wobei in der Öffnung eine Anzeigeeinrichtung aufgenommen ist. Auf diese Weise sind sowohl der Einbaurahmen als auch die Halteplatten als Rahmen ausgebildet und die Anzeigeeinrichtung, insbesondere ein Computerdisplay, ist vollständig hinter dem Schirm angeordnet. Somit lassen sich lediglich durch eine Berührung des Schirms mit dem Finger oder einem Stift oder dergleichen Eingaben an einer auf dem Computermonitor dargestellten Menüsteuerung realisieren.

[0009] Eine besonders einfache Befestigungsmethode ergibt sich dadurch, daß der Halterahmen an dem Einbaurahmen durch eine lösbare Verbindung, insbesondere eine Klemmverbindung befestigt ist. Vorzugsweise erfolgt eine derartige Klemmverbindung über den Außenumfang der beiden Bauteile.

[0010] Vorteilhafterweise sind zur Erfassung der Position einer Berührung dienende Elemente auf der Außenseite des Schirms von dem Einbaurahmen verdeckt. Somit können insbesondere die an der Vorderseite vorstehenden Transducer, welche sehr empfindlich sind und nicht beschädigt werden dürfen, geschützt werden.

[0011] Bevorzugt weist der Einbaurahmen an seiner, der Außenseite des Schirms zugewandten Innenseite eine Umfangsnut zur Freilegung der Sensorik-Elemente auf. Die Freilegung der Elemente, ist insbesondere deshalb bevorzugt, um Beschädigungen zu vermeiden, und um insbesondere einen direkten Druck auf diese Elemente zu verhindern. Die eingangs beschriebene Touchscreeneinrichtung basiert zwar auf der Oberflächenwellentechnologie, die vorliegende Erfindung ist aber ebenfalls auf Touchscreens anderer Technologien, wie z. B. durch optische Erfassung, anwendbar. Auch bei diesen ist besonders vorteilhaft, wenn z. B. die Infrarotsignale aussendenden und empfangenden Sende- bzw. Empfangsmittel für einen Anwender verdeckt sind.

[0012] Weiter ist bevorzugt, daß der Einbaurahmen an seiner, der Außenseite des Schirms zugewandten Innenseite eine nach innen ragende Dichtkante aufweist. Die Dichtkante ist das einzige direkt auf die aktive Außenseite des Schirms direkt drückende Element und übt einen umfangsmäßigen gleichen Druck auf die aktive Fläche des Touchscreens, d. h. bereits innerhalb der am Außenumfang angeordneten Transducer bzw. Reflektoren, vor. Deshalb ist die Dichtkante vorzugsweise radial innerhalb der Umfangsnut, welche die Transducer aufnimmt, angeordnet.

[0013] Um besonders Schmutz am Eintritt in ein Terminalgehäuse zu hindern, ist die Dichtkante derart ausgebildet, daß sie den berührungssensitive Bereich des Schirms vollständig abdichtet.

[0014] Um einen besonders leichten Einbau in ein Terminalgehäuse, welches eine entsprechende Ausnehmung aufweist zu ermöglichen, steht die Dichtkante auf der Außenseite des Einbaurahmens nach außen vor, wobei die freiliegende Stirnfläche nach innen abgeschrägt ist. Durch das Vorstehen nach außen ergibt sich zum einen eine Montagehilfe, da ein Einsetzen des Einbaurahmens somit möglich wird, und zum anderen hast sich die nach innen abgeschrägte Kante ebenfalls aus Abdichtgründen bewährt.

[0015] Vorteilhafterweise sind der Einbaurahmen und der Halterahmen umfangsmäßig außerhalb des Schirms miteinander verbunden. Auf dieses Weise wird eine gleichmäßige Druckverteilung der Befestigungsmittel für den Touchscreen sichergestellt.

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[0016] Die Erfindung, sowie weitere Merkmale, Ziele, Vorteile und Anwendungsmöglichkeiten derselben wird bzw. werden nachfolgend unter Bezugnahme auf die beigefügten Zeichnungen näher erläutert. Dabei bilden alle beschriebenen und/oder bildlich dargestellten Elemente für sich oder in beliebiger sinnvoller Kombination den Gegenstand der vorliegenden Erfindung, und zwar unabhängig von ihrer Zusammenfassung in den Patentansprüchen oder deren Rückbeziehung. Sofern zum Zwecke der vorliegenden Beschreibung die Ausdrücke "außen", "innen", "oben" und "unten" verwendet werden, so dienen diese zum Zwecke einer einfachen Beschreibung der Erfindung und beziehen sich auf den eingebauten Teil des Einbaurahmens in einem Terminal gemäß **Fig. 1**. Überall in den Zeichnungen bezeichnen die selben Bezugszeichen dieselben oder entsprechenden Elemente, in den Zeichnungen zeigen:

[0017] **Fig. 1** eine schematische Querschnittsansicht des erfindungsgemäßen Einbaurahmens, welcher mit weiteren Komponenten eine eigenständig handhabbare Montageeinheit bildet;

[0018] **Fig. 2** eine schematische Ansicht von oben auf den erfindungsgemäßen Einbaurahmen;

[0019] **Fig. 3** eine schematische Seitenansicht des erfindungsgemäßen Einbaurahmens; und

[0020] **Fig. 4** eine schematische Ansicht von unten auf den erfindungsgemäßen Einbaurahmen.

[0021] In **Fig. 1** ist der Einbaurahmen **1** gezeigt, in welchem ein Schirm oder Touchscreen **2** aufgenommen ist. Vom Standpunkt eines Betrachters (in **Fig. 1** auf der linken Seite) ist hinter dem Touchscreen **2** eine Anzeigeeinrichtung oder Display **3** angeordnet, welche in einem Halte- oder Klemmrahmen **4** befestigt ist. Der Halterahmen **4** ist an dem Einbaurahmen **1** durch eine Klemmverbindung befestigt. Der Schirm **2** ist aus Glas hergestellt und ist in etwa rechteckig. Entlang seinem Umfang weist er eine Vielzahl von Transducern, d. h. piezoelektrische Wandler, und Reflektoren auf. Der Ansicht der **Fig. 1** entnimmt man, daß die Transducer außerhalb einer Dichtkante **5** des Einbaurahmens **1** angeordnet sind. Nur der innere Bereich des Schirms **2**, d. h. im eingebauten Zustand der Bereich innerhalb der Dichtkante **5**, also der Öffnung **12** des Einbaurahmens **1**, ist für einen Anwender zugänglich. Über die Dichtkante **5** wird auf dem Schirm **2** ein gleichmäßiger Druck aufgebracht, welcher insbesondere durch ein geeignetes Software-Programm zur Auswertung der gewandelten Signale einfach herausgerechnet werden kann. Die Dichtkante **5** steht oberhalb nach außen vor und besitzt eine abgeschrägte Innenseite, was den Einbau in Montageöffnungen, z. B. zum Einbau in ein (nicht dargestelltes) Terminal, erleichtert. Das Display **3** ist über vier (nicht gezeigte) Drahtbolzen in dem Halterahmen **4** aufgenommen. Der aus Metall hergestellte Halterahmen **4** preßt den Schirm **2** über ein Druckband **6** auf die Dichtkante **5**.

[0022] In **Fig. 1** ist daher eine eigenständig handhabbare Montageeinheit dargestellt, welche kombiniert einen vor einem Display **3** angeordnete Touchscreen **1** aufweist, und welche einen unmittelbaren Einbau in ein Terminalgehäuse gestattet.

[0023] In den **Fig. 2** bis **4** ist der Einbaurahmen **1** in verschiedenen Ansichten dargestellt. Zur Aufnahme des Schirms **2** weist der Einbaurahmen **1** umfangsmäßig eine Nut **9** auf, in welcher die Transducer **8** kontaktlos aufgenommen sind, wobei an der Stelle der Nut **9** über das Druckband **6** der Druck vom Halterahmen **4** auf den Schirm **2** auf der, der aktivierten Seite gegenüberliegenden Innenseite ausgeübt wird. Zur Befestigung des Halterahmens **4** an dem Einbaurahmen **1** ist eine Vielzahl von umfangsmäßig angeordneten Schraubverbindungen vorgesehen. Die entsprechenden Bohrungen sind in den Zeichnung klar ersichtlich und mit dem Bezugszeichen **10** angezeigt. Eine entsprechende Nut **11** ist zur Zu- und Abführung von elektrischen Kabeln vorgesehen.

[0024] Die Erfindung wurde zuvor anhand eines bevorzugten Ausführungsbeispiels derselben näher erläutert. Für einen Fachmann ist es jedoch offensichtlich, daß unterschiedliche Abwandlungen und Modifikationen gemacht werden können, ohne den der Erfindung zugrundeliegenden Gedanken zu verlassen.

Bezugszeichenliste

1 Einbaurahmen
2 Touchscreen oder Schirm
3 Anzeigeeinrichtung oder Display
4 Halte- oder Klemmrahmen
5 Dichtkante
6 Druckband
9 Nut
10 Gewindebohrung
11 Nut
12 Öffnung
S berührungssensitive Oberfläche
T Transducer
R Reflexionselement

Patentansprüche

1. Einbaurahmen (**1**) für einen berührungssensitiven, im wesentlichen transparenten Schirm (**2**), mit einer derart ausgebildeten Öffnung (**12**), daß wenigstens ein Teil der berührungssensitiven Oberfläche (S) des Schirms (**2**) freiliegt, wobei der Einbaurahmen (**1**) wenigstens einen Teil des Außenumfangs des Schirms (**2**) abdeckt, und wobei der Einbaurahmen (**1**) Mittel zur Anbringung des Rahmens (**1**) an weiteren Elementen aufweist.

2. Einbaurahmen (**1**) nach Anspruch 1, dadurch gekennzeichnet, daß der Einbaurahmen aus einem harten Kunststoffmaterial ist.

3. Einbaurahmen (**1**) nach Anspruch 2, dadurch gekennzeichnet, daß der Einbaurahmen (**1**) aus einem mit Glasfaser verstärktem Polyamidmaterial ist.

4. Einbaurahmen (**1**) nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß zur Fixierung des in dem Einbaurahmen (**1**) aufgenommenen Schirms (**2**), der Einbaurahmen (**1**) mit einer Halteplatte (**4**) derart verbunden ist, daß der Schirm (**2**) zwischen der Halteplatte (**4**) und dem Einbaurahmen (**1**) angeordnet ist.

5. Einbaurahmen (**1**) nach Anspruch 4, dadurch gekennzeichnet, daß die Halteplatte (**4**) aus Metall hergestellt ist.

6. Einbaurahmen (**1**) nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die Halteplatte (**4**) als Rahmen mit einer Öffnung ausgebildet ist, wobei in der Öffnung eine Anzeigeeinrichtung (**3**) aufgenommen ist.

7. Einbaurahmen (**1**) nach einem der Ansprüche 4 bis 6, dadurch gekennzeichnet, daß der Halterahmen (**4**) mit dem Einbaurahmen (**1**) durch eine lösbare Verbindung, insbesondere eine Klemmverbindung, befestigt ist.

8. Einbaurahmen (**1**) nach einem der Ansprüche 4 bis 7, dadurch gekennzeichnet, daß die Anzeigeeinrichtung vollständig hinter dem Schirm (**2**) angeordnet ist.

9. Einbaurahmen (**1**) nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß zur Erfassung der Position einer Berührung dienende Elemente (T, R) auf der

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Außenseite des Schirms (2) von dem Einbaurahmen (1) verdeckt sind.

10. Einbaurahmen (1) nach Anspruch 9, dadurch gekennzeichnet, daß der Einbaurahmen (1) an seiner, der Außenseite des Schirms (2) zugewandten Innenseite eine Umfangsnut (9) zur Verlegung der Elemente (F, R) aufweist.

11. Einbaurahmen (1) nach einem der Ansprüche 1 bis 10, dadurch gekennzeichnet, daß der Einbaurahmen (1) an seiner, der Außenseite des Schirms (2) zugewandten Innenseite eine nach innen ragende Dichtkante (5) aufweist.

12. Einbaurahmen (1) nach Anspruch 11, dadurch gekennzeichnet, daß die Dichtkante (5) radial innerhalb der Umfangsnut (9) angeordnet ist.

13. Einbaurahmen (1) nach Anspruch 12, dadurch gekennzeichnet, daß die Dichtkante (5) einer berührungssensitiven Bereich des Schirms (2) vollständig abdichtet.

14. Einbaurahmen (1) nach einem der Ansprüche 11 bis 13, dadurch gekennzeichnet, daß die Dichtkante (5) die Umfangsnut (9) einseitig begrenzt.

15. Einbaurahmen (1) nach einem der Ansprüche 11 bis 13, dadurch gekennzeichnet, daß die Dichtkante (5) auf der Außenseite des Einbaurahmens (1) nach außen vorsteht, wobei die freiliegende Stirnfläche nach innen abgeschrägt ist.

16. Einbaurahmen (1) nach einem der Ansprüche 4 bis 15, dadurch gekennzeichnet, daß der Einbaurahmen (1) und der Halterahmen (4) umfangsmäßig außerhalb des Schirms (2) miteinander verbunden sind.

17. Eigenständig handhabbare Montageeinheit, welche einen Einbaurahmen (1) nach einem der vorhergehenden Ansprüche, einen Halterahmen (4), einen berührungssensitiven Schirm (2) und eine Anzeigeeinrichtung (3) aufweist.

Hierzu 2 Seiten) Zeichnungen

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Nummer: DE 100 25 175 A1
Int. Cl.?: G 06 K 11/06
Offenlegungstag: 6. Dezember 2001

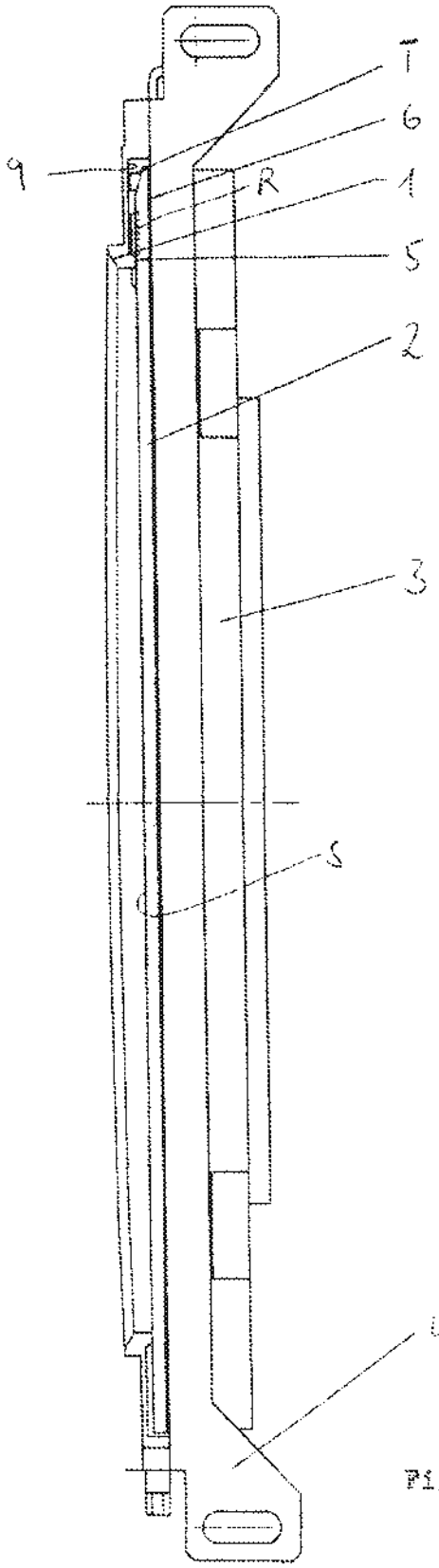


Fig. 1

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Nummer: DE 100 25 175 A1
Int. Cl.?: G 06 K 11/06
Offenlegungstag: 6. Dezember 2001

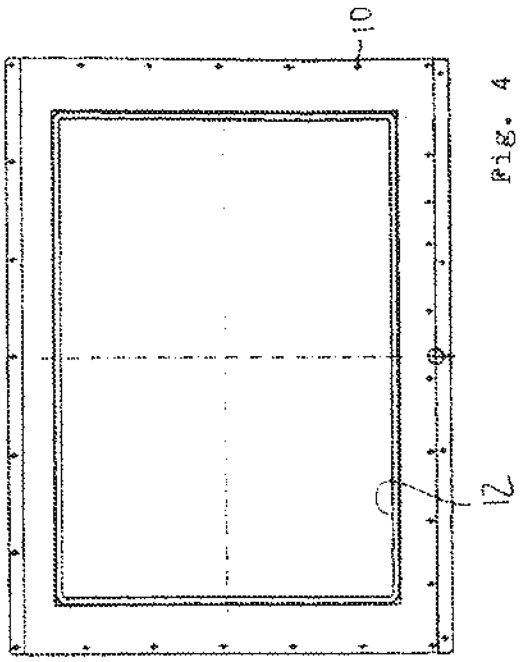


Fig. 4

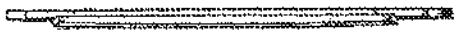


Fig. 3

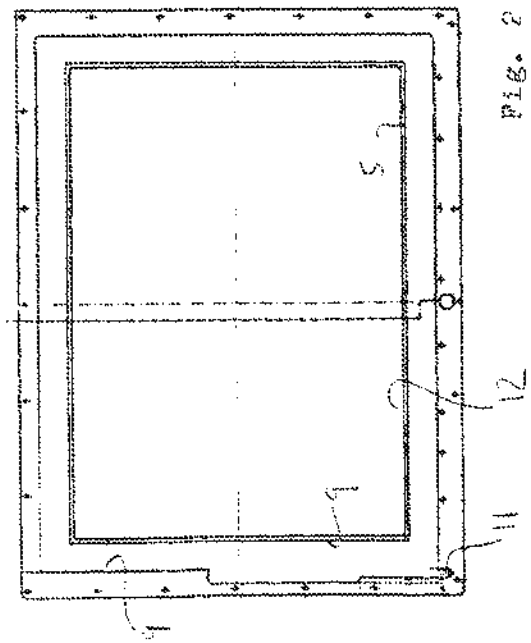


Fig. 2

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(56) Für die Beurteilung der Patentfähigkeit in Betracht zu ziehende Druckschriften.

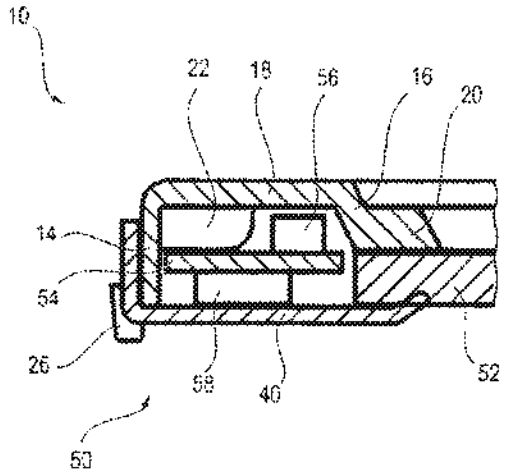
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US	2002/01 49 572	A1
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Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Rechercheantrag gemäß § 43 Abs. 1 Satz 1 PatG ist gestellt.

(54) Bezeichnung: **Berührungssensitive Eingabevorrichtung**

(57) Zusammenfassung: Die Erfindung betrifft eine berührungssensitive Eingabevorrichtung (30, 50, 60, 70, 80) mit einem eine Öffnung (12) aufweisenden Rahmen (10) und mit einer Scheibe (32, 52, 62, 72). Ferner umfasst die Eingabevorrichtung (30, 50, 60, 70, 80) eine Sensoranordnung zur Ermittlung der Position einer Berührung der Scheibe (32, 52, 62, 72). Der Rahmen (10) hat ein Profil mit einem der Öffnung (12) zugewandten Schenkel (16), einem der Öffnung (12) abgewandten Schenkel (14) und einem die beiden Schenkel (14, 16) verbindenden Grundsegment (18). Zumindest ein Teil der Sensoranordnung ist innerhalb der durch den der Öffnung (12) zugewandten Schenkel (16) den der Öffnung (12) abgewandten Schenkel (14) und das Grundsegment (18) gebildeten Vertiefung angeordnet.



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Beschreibung

[0001] Die Erfindung betrifft eine berührungssensitive Eingabevorrichtung mit einer Sensoranordnung zur Ermittlung der Position einer Berührung einer Scheibe.

[0002] Die erfindungsgemäße berührungssensitive Eingabevorrichtung wird insbesondere in Verbindung mit Selbstbedienterminals, Kassen und Geldautomaten verwendet und auch als Touchmodul bezeichnet. Ein solches Touchmodul umfasst zumindest eine transparente Scheibe und eine Sensoranordnung zur Ermittlung einer Berührung dieser Scheibe. Zusammen mit einer Anzeigeeinheit, insbesondere einem Bildschirm, bildet ein solches Touchmodul einen Touchscreen. Mit Hilfe eines solchen Touchscreens können Eingaben von einer Bedienperson für ein Computersystem, insbesondere für das Computersystem eines Selbstbedienungsgerätes, erfasst und das Selbstbedienungsgerät auf einfache Weise intuitiv gesteuert werden. Die Eingabe von Informationen und Befehlen erfolgt durch Berührung der Scheibe des Touchmoduls. Die Position der Berührung wird erfasst. Die Anzeigeeinheit ist hinter der Scheibe des Touchmoduls angeordnet und zeigt auswählbare Felder, denen Eingabefelder zugeordnet sind. Liegt die erfasste Position in einem solchen Eingabefeld wird eine dem Eingabefeld zugeordnete Funktion aktiviert. Die eingegebene Information bzw. der eingegebene Befehl kann dadurch eingegeben bzw. aktiviert werden.

[0003] Als Sensoranordnung zur Ermittlung der Position der Berührung der Scheibe des Touchmoduls können verschiedene Technologien zum Einsatz kommen. Eine der Technologien ist die sogenannte kapazitive Touchtechnologie. Bei ihr wird die Scheibe des Touchmoduls beispielweise mit einer durchsichtigen Metalloxydschicht beschichtet. Eine an den Ecken der Beschichtung angelegte Spannung erzeugt ein exakt gleichmäßiges elektrisches Feld. Es entsteht ein geringer Ladungstransport der in einem Entladezyklus in Form eines Stroms an den Ecken der Scheibe gemessen wird. Die resultierenden Ströme aus den Ecken stehen im direkten Verhältnis zu der Position, an der die Scheibe des Touchmoduls durch eine Bedienperson berührt wird.

[0004] Eine weitere Technologie zur Ermittlung der Position einer Berührung der Scheibe des Touchmoduls durch eine Bedienperson ist die sogenannte Infrarottouchtechnologie. Bei dieser Technologie wird mit Hilfe von Infrarotlicht sendenden Dioden ein Netz aus Infrarotstrahlen über der Scheibe des Touchmoduls erzeugt. Den infrarotlicht sendenden Dioden gegenüberliegend sind Infrarotlicht detektierende Fotodioden vorgesehen, die ohne Unterbrechung der ausgesandten Infrarotstrahlen diese empfangen. Bei einer Berührung der Scheibe wird zumindest ein Teil der ausgesandten Infrarotstrahlen unterbrochen, so dass ein Teil der Fotodioden keine oder eine wesentlich geringere Infrarotstrahlung erfassen. Die Infrarotdioden und die Fotodioden sind in X-Richtung und in Y-Richtung der X-Y-Ebene der auf Berührung zu überwachenden Scheibenoberfläche angeordnet. Auf diese Weise können die X- und Y-Position der Berührung der Scheibe durch eine Bedienperson ermittelt werden.

[0005] Das Touchmodul kann einen Rahmen umfassen, der die Scheibe und die Sensoranordnung umschließt. Je nach verwendeter Touchtechnologie unterscheidet sich zwangsläufig auch der verwendete Rahmen. Nachteilig hieran ist, dass hierdurch zum Einen der logistische Aufwand zur Bereitstellung unterschiedlicher Rahmen erhöht wird und zum Anderen je nach verwendeten Rahmen das Touchmodul andere Maße und Anschlüsse aufweisen muss, so dass beispielweise bei Wartungsarbeiten beispielsweise an einem Selbstbedienungsterminal, wie einem Geldautomaten, ein Touchmodul mit einer Touchtechnologie nicht auf einfache Weise gegen ein Touchmodul mit einer anderen Touchtechnologie ausgetauscht werden kann.

[0006] Ein Einbaurahmen ist beispielsweise aus dem Dokument DE 10025175A1 bekannt. Der dort beschriebene Einbaurahmen hat eine im Rahmen ausgebildete Öffnung, wobei wenigstens ein Teil einer berührungssensitiven Oberfläche eines Schirms freilegt und der Einbaurahmen wenigstens einen Teil des Außenumfangs des Schirms abdeckt.

[0007] Aufgabe der Erfindung ist es, eine berührungssensitive Eingabevorrichtung anzugeben, die einfach und kompakt aufgebaut ist und die für mehrere Sensortechnologien zur berührungssensitiven Eingabe geeignet ist.

[0008] Die Aufgabe wird durch die Eingabevorrichtung mit den Merkmalen des Patentanspruches 1 gelöst. Vorteilhafte Weiterbildungen der Erfindung sind in den abhängigen Patentansprüchen angegeben.

[0009] Gemäß der Erfindung umfasst die berührungssensitive Eingabevorrichtung einen eine Öffnung aufweisenden Rahmen, eine Scheibe und eine Sensoranordnung zur Ermittlung einer Berührung der Scheibe durch eine Bedienperson. Der Rahmen hat ein Profil mit einem der Öffnung zugewandten Schenkel, einen der Öffnung abgewandten Schenkel und einem die beiden Schenkel verbindenden Grundsegment. Die Scheibe kontaktiert den der Öffnung zugewandten Schenkel. Durch den der Öffnung zugewandten Schenkel, den der Öffnung abgewandten Schenkel und das Grundsegment wird eine Vertiefung, insbesondere eine nutförmige Vertiefung, gebildet, in der zumindest ein Teil der Sensoranordnung anordenbar ist. Hierdurch wird erreicht, dass in ein

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und demselben Rahmen verschiedene Sensoranordnungen und auch Scheiben mit unterschiedlichen Abmessungen anordenbar sind. Auf diese Weise kann der Rahmen unabhängig von der verwendeten Sensoranordnung verwendet werden. Hierdurch kann die Anzahl der vorzuhaltenden Bauteile, insbesondere der vorzuhaltenden Rahmen und der vorzuhaltenden Touchmodule, reduziert werden, wodurch der logistische Aufwand und die hiermit verbundenen Kosten gesenkt werden. Da keine konstruktiven Änderungen an dem Rahmen vorzunehmen sind, werden auch die Bearbeitungszeit und die Werkzeugkosten verringert. Darüber hinaus wird erreicht, dass die berührungssensitive Eingabevorrichtung unabhängig von der verwendeten Sensoranordnung immer in etwa die gleichen Abmessungen hat, so dass sie auf einfache Weise in die verschiedensten Geräte integriert werden kann. Des Weiteren können in ein Gerät alternativ mit verschiedenen Sensoranordnungen ausgestatteten berührungssensitiven Eingabevorrichtungen integriert werden, ohne dass konstruktive Änderungen an dem Gerät notwendig sind.

[0010] Vorzugsweise ist der Rahmen umlaufend ausgebildet. Auf diese Weise kann die berührungssensitive Eingabevorrichtung auf einfache Weise eigenständig gehandhabt werden. Dies ermöglicht eine vielseitige Verwendung der berührungssensitiven Eingabevorrichtung. Es ist besonders vorteilhaft, wenn der Rahmen ein Gehäuse für die Scheibe und die Sensoranordnung bildet oder mit einem Blendenrahmen verbindbar ist.

[0011] Darüber hinaus ist es vorteilhaft, wenn zwischen dem der Öffnung zugewandten Schenkel und dem Grundsegment ein stumpfer Winkel ist. Es ist besonders vorteilhaft, wenn der der Öffnung zugewandte Schenkel kürzer ist als der der Öffnung abgewandte Schenkel und an dem dem Grundsegment entgegengesetzten Ende des der Öffnung zugewandten Schenkels ein parallel zum Grundsegment angeordnetes Kontaktsegment vorgesehen ist. Dieses Kontaktsegment kontaktiert die Scheibe. Durch das Kontaktsegment wird eine größere Kontaktfläche zwischen dem Rahmen und der Scheibe erzeugt. Hierdurch wird die Verwendung unterschiedlich großer Scheiben ermöglicht. Des Weiteren wird durch eine solche große Kontaktfläche das Eindringen von Staub und/oder Feuchtigkeit erschwert. Bei einer besonders vorteilhaften Ausführungsform der Erfindung ist der Abstand des dem Grundsegment entgegengesetzten Endes des der Öffnung abgewandten Schenkels zum Grundsegment und der Abstand der dem Kontaktsegment abgewandten Oberfläche der Scheibe zu dem Grundsegment identisch. Auf diese Weise wird ein glatter Abschluss der Eingabevorrichtung erreicht, so dass an der dem Grundsegment abgewandten Seite auf einfache Weise mindestens eine weitere Baugruppe, insbesondere ein Bildschirm, anordenbar ist.

[0012] Des Weiteren ist es vorteilhaft, wenn die Sensoranordnung mindestens eine Infrarotsensoranordnung umfasst und zumindest ein Teil der von einem Infrarotlichtsender der Infrarotsensoranordnung ausgesandten und einem Infrarotlichtempfänger der Infrarotsensoranordnung empfangenen Infrarotstrahlung bei Berühren einer Berührungsoberfläche der Scheibe unterbrochen wird. Die Berührungsoberfläche ist diejenige Oberfläche der Scheibe, an der der Öffnung zugewandte Schenkel des Rahmens die Scheibe kontaktiert und die einem Benutzer der berührungssensitiven Eingabevorrichtung zugewandt ist. Mit Hilfe einer solchen Infrarotsensoranordnung kann die Position der Berührung der Scheibe auf einfache Weise ermittelt werden. Hierzu sind die Infrarotlichtsender derart angeordnet, dass über der Scheibe ein Netz aus Infrarotstrahlen erzeugt wird, wobei die Infrarotstrahlen von Infrarotlichtempfängern empfangen werden. Je nach Position der Berührung der Berührungsoberfläche der Scheibe wird zumindest ein Teil der Infrarotstrahlen unterbrochen und abhängig hiervon die Position der Berührung der Scheibe ermittelt. Die Infrarotlichtsender und die Infrarotlichtempfänger sind vorzugsweise in X-Richtung und in Y-Richtung der X-Y-Ebene der auf Berührung zu überwachenden Scheibenoberfläche angeordnet. Auf diese Weise können die X- und Y-Position der Berührung der Scheibe durch eine Bedienperson ermittelt werden.

[0013] Vorzugsweise umfasst die Sensoranordnung eine Vielzahl von Infrarotsensorelementen. Die Infrarotsensorelemente sind auf einem Sensorträgerrahmen angeordnet. Zumindest die Infrarotsensorelemente sind innerhalb der Vertiefung des Rahmens angeordnet. Auf diese Weise wird eine kompakte Bauform der berührungssensitiven Eingabevorrichtung erreicht. Bei dem Sensorträgerrahmen handelt es sich insbesondere um einen Leiterplattenrahmen. Die Infrarotsensorelemente können beispielweise die Infrarotlichtsender und Infrarotlichtempfänger, insbesondere Infrarotdioden und Fotodioden, sein.

[0014] Der Sensorträgerrahmen ist vorteilhafterweise zwischen dem der Öffnung abgewandten Schenkels des Rahmens und der Scheibe angeordnet. Auf diese Weise wird die Scheibe positioniert und ein Verrutschen der Scheibe innerhalb der durch die Scheibe gebildeten Ebene verhindert bzw. minimiert.

[0015] Es ist vorteilhaft, wenn zumindest der der Öffnung zugewandte Schenkel des Rahmens, vorzugsweise der gesamte Rahmen, aus einem infrarotstrahlendurchlässigen Material, insbesondere einem infrarotstrahlendurchlässigen Kunststoff, gefertigt ist. Auf diese Weise kann die von den in der Vertiefung des Rahmens angeordneten Infrarotlichtsendern ausgestrahlte Infrarotstrahlung durch den der Öffnung zugewandten Schenkel und auf der gegenüberliegenden Seite durch den gegenüberliegenden der

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Öffnung zugewandten Schenkel des Rahmens hindurchstrahlen und die dort angeordneten Infrarotlichtempfänger erreichen und somit das Netz aus Infrarotstrahlung über der Berührungsoberfläche der Scheibe herstellen. Es ist besonders vorteilhaft, den gesamten Rahmen aus einem infrarotstrahlungsdurchlässigen Material zu fertigen, da auf diese Weise der Fertigungsprozess vereinfacht wird und die Kosten reduziert werden. Ferner wird das Recycling des Rahmens vereinfacht.

[0016] Alternativ kann der Rahmen auch aus einem nicht infrarotstrahlungsdurchlässigen Material gefertigt werden und der der Öffnung zugewandte Schenkel an den Stellen, an denen die Infrarotlichtsender und Infrarotlichtempfänger innerhalb der Vertiefung angeordnet sind, Durchlassöffnungen aufweisen, durch die die Infrarotstrahlung durch den der Öffnung zugewandten Schenkel hindurchgehen kann.

[0017] Bei einer alternativen Ausführungsform der Erfindung umfasst die Sensoranordnung mindestens ein Piezoelement zur Erfassung von durch eine Berührung der Scheibe erzeugten Schallwellen. Vorzugsweise ist eine Vielzahl von Piezoelementen vorgesehen, die an der dem der Öffnung abgewandten Schenkel zugewandten Seite der Scheibe angeordnet sind. Bei einer Berührung der Scheibe wird eine Schallwelle erzeugt. Abhängig von der Position der Beruhrung der Scheibe wird von den verschiedenen Piezoelementen der Schall nach unterschiedlichen Zeitspannen nach der Berührung empfangen, und hieraus die Position der Berührung der Scheibe durch eine Bedienperson bestimmt.

[0018] Bei einer weiteren alternativen Ausführungsform der Erfindung hat die Sensoranordnung mehrere auf der Scheibe aufgedampfte Elektroden oder eine auf der Scheibe aufgebrachte Metalloxydschicht. Bei Berührung der Berührungsoberfläche der Scheibe wird ein elektrisches Signal ausgesandt. Abhängig von der Position der Berührung der Scheibe wird an den Ecken der Scheibe ein unterschiedlich starker Stromfluss gemessen.

[0019] Es ist besonders vorteilhaft, wenn innerhalb der Vertiefung des Rahmens zumindest auf einem Sensorträgerrahmen angeordnete Infrarotsensorelemente anordenbar sind und mindestens ein Piezoelement zwischen dem der Öffnung abgewandten Schenkel des Rahmens und der diesem Schenkel zugewandten Seite der Scheibe anordenbar ist und eine Scheibe, auf der Elektroden oder eine Metalloxydschicht aufgebracht sind, derart anordenbar ist, dass diese Scheibe zumindest den der Öffnung zugewandten Schenkel kontaktiert. Auf diese Weise wird erreicht, dass in ein und demselben Rahmen zumindest eine Infrarottouchtechnologie, eine kapazitive Touchtechnologie und eine akustische Touchtechnologie integrierbar sind. Bei ein besonders vorteilhaften Ausführungsform der Erfindung ist zusätzlich auch eine resistive Touchtechnologie integrierbar.

[0020] Darüber hinaus ist es vorteilhaft, wenn eine Dichtung vorgesehen ist, die zumindest die Scheibe und den der Öffnung abgewandten Schenkel kontaktiert und die Öffnung der Vertiefung zumindest staub- und/oder feuchtigkeitsdicht verschließt. Auf diese Weise kann auf weitere Dichtungselemente verzichtet werden und die Montage des Touchmoduls wird vereinfacht.

[0021] Es ist vorteilhaft, wenn der Rahmen mindestens ein Positionierelement zur Positionierung und/oder Befestigung der Scheibe umfasst. Bei diesen Positionierelementen handelt es sich vorzugsweise um eine umlaufende oder einseitige Erhebung auf der der Scheibe zugewandten Seite des Kontaktsegments. Hierdurch wird trotz der Verwendung von Scheiben unterschiedlicher Abmessungen eine genaue Positionierung der Scheibe erreicht.

[0022] Bei einer vorteilhaften Ausführungsform der Erfindung sind innerhalb der Vertiefung des Rahmens mehrere Erhebungen ausgebildet, mit deren Hilfe die Scheibe und/oder die Sensoranordnung auf Abstand zum Grundsegment gehalten werden. Mit Hilfe dieser Erhebungen wird insbesondere der Sensorträgerrahmen einer Infrarotsensoranordnung auf Abstand zum Grundsegment gehalten, so dass die Infrarotsensorelemente, die auf dem Sensorträgerrahmen angeordnet sind, in der Vertiefung anordenbar sind, ohne mit dem Grundsegment in Kontakt zu kommen. Dadurch ist eine einfache Positionierung und Fixierung von weiteren Bauelementen und Baugruppen möglich. Bei der Verwendung einer Scheibe mit einer Metalloxidschicht bzw. aufgedampften Elektroden wird durch die Erhebungen eine zusätzliche Kontaktfläche neben der durch das Kontaktsegment gebildeten Kontaktfläche erreicht, wodurch eine noch stabilere Positionierung der Scheibe möglich ist.

[0023] Weitere Merkmale und Vorteile der Erfindung ergeben sich aus der folgenden Beschreibung, welche in Verbindung mit den beigefügten Figuren die Erfindung anhand von Ausführungsbeispielen näher erläutert.

[0024] Es zeigen:

[0025] Fig. 1 eine schematische perspektivische Darstellung der Innenseite eines Rahmens einer berührungssensitiven Eingabevorrichtung;

[0026] Fig. 2 eine schematische perspektivische Darstellung der Innenseite einer berührungssensitiven Eingabevorrichtung mit einer kapazitiven Sensoranordnung;

[0027] Fig. 3 einen Ausschnitt eines Schnittes

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durch die berührungssensitive Eingabevorrichtung nach Fig. 2;

[0028] Fig. 4 eine schematische perspektivische Darstellung der Innenseite einer berührungssensitiven Eingabevorrichtung mit einer Infrarotsensoranordnung;

[0029] Fig. 5 einen Ausschnitt eines Schnittes durch die berührungssensitive Eingabevorrichtung nach Fig. 4;

[0030] Fig. 6 eine schematische perspektivische Darstellung der Innenseite einer berührungssensitiven Vorrichtung mit einer akustischen Sensoranordnung;

[0031] Fig. 7 eine schematische perspektivische Ansicht der Innenseite einer berührungssensitiven Vorrichtung mit einer Dichtung;

[0032] Fig. 8 eine weitere schematische perspektivische Darstellung der Innenseite der berührungssensitiven Vorrichtung nach Fig. 7;

[0033] Fig. 9 eine schematische perspektivische Darstellung der Außenseite einer berührungssensitiven Eingabevorrichtung nach den Fig. 7 und Fig. 8;

[0034] Fig. 10 eine schematische perspektivische Darstellung der Außenseite und der Innenseite einer berührungssensitiven Eingabevorrichtung nach den Fig. 7 bis Fig. 9 mit einer Frontblende; und

[0035] Fig. 11 eine schematische perspektivische Darstellung einer berührungssensitiven Eingabevorrichtung und einer mit der berührungssensitiven Eingabevorrichtung verbundenen Anzeigeeinheit.

[0036] In Fig. 1 ist eine perspektivische schematische Darstellung der Innenseite eines Rahmens **10** einer berührungssensitiven Eingabevorrichtung gemäß einer ersten Ausführungsform der Erfindung gezeigt. Die berührungssensitive Eingabevorrichtung wird im Folgenden auch als Touchmodul bezeichnet. Neben dem Rahmen **10** umfasst das Touchmodul zumindest eine nicht dargestellte Scheibe und eine ebenfalls nicht dargestellte Sensoranordnung. Die Innenseite des Touchmoduls ist diejenige Seite, die beim Einbau des Touchmoduls in ein Gerät, insbesondere ein Selbstbedienungsterminal, eine Kasse oder einen Geldautomaten, vom Benutzer abgewandt ist, und somit dem Inneren des Gerätes zugewandt ist.

[0037] Der Rahmen **10** hat ein Profil mit einer im Wesentlichen U-förmigen Grundform. Der Rahmen ist umlaufend ausgebildet und somit geschlossen. Ferner hat der Rahmen **10** eine Öffnung **12**. Das Profil des Rahmens **10** umfasst einen der Öffnung **12** abgewandten Schenkel **14** und einen der Öffnung **12** zugewandten Schenkel **16**. Der der Öffnung **12** abgewandte Schenkel **14** und der der Öffnung **12** zugewandte Schenkel **16** sind über ein Grundsegment **18** miteinander verbunden. Ferner ist an dem dem Grundsegment **18** abgewandten Ende des der Öffnung **12** zugewandten Schenkels **16** ein Kontaktsegment **20** angeordnet. Das Kontaktsegment **20** ist vorzugsweise parallel zum Grundsegment **18** angeordnet. Der der Öffnung **12** abgewandte Schenkel **14** und das Grundsegment **18** sind orthogonal zueinander angeordnet. Alternativ kann zwischen dem der Öffnung **12** abgewandten Schenkel **14** und dem Grundsegment **18** auch ein spitzer oder stumpfer Winkel sein. Zwischen dem der Öffnung **12** zugewandten Schenkel **16** des Rahmens **10** und dem Grundsegment **18** ist vorzugsweise ein stumpfer Winkel. Alternativ kann zwischen dem der Öffnung **12** zugewandten Schenkel **16** und dem Grundsegment **18** auch ein spitzer oder rechter Winkel sein. Der Rahmen **10** ist derart ausgebildet, dass der Abstand des von dem Grundsegment **18** abgewandten Endes des der Öffnung **12** abgewandten Schenkels **14** zum Grundsegment **18** größer ist als der Abstand der dem Grundsegment **18** abgewandten Seite des Kontaktsegmentes **20** zum Grundsegment **18**.

[0038] Durch die beiden Schenkel **14**, **16**, das Grundsegment **18** und das Kontaktsegment **20** wird eine Vertiefung gebildet. Diese Vertiefung wird im Folgenden auch als Nut bezeichnet. Innerhalb dieser Nut ist eine Vielzahl von Erhebungen vorgesehen. Eine dieser Erhebungen ist beispielhaft mit dem Bezugszeichen **22** bezeichnet. Der Abstand jeweils zweier benachbarter Erhebungen **22** ist vorzugsweise jeweils gleich. Insbesondere ist die Länge einer Erhebung **22** genauso groß wie der Abstand zwischen zwei benachbarten Erhebungen **22**. Die Erhebungen **22** sind vorzugsweise derart ausgebildet, dass ihre Höhe gleich dem Abstand zwischen der dem Grundsegment **18** abgewandten Seite des Kontaktsegments **20** und dem Grundsegment **18** ist

[0039] Der der Öffnung **12** abgewandte Schenkel **14** hat zwei Aussparungen **24a**, **24b**, über die Anschlüsse einer innerhalb der Nut und/oder auf einer mit dem Rahmen **12** in Kontakt stehenden Scheibe angeordneten Sensoranordnung nach außen geführt werden können.

[0040] Des Weiteren sind an der der Öffnung **12** abgewandten Seite des der Öffnung **12** abgewandten Schenkels **14** eine Vielzahl kleiner Klemmelemente und einige größere Klemmelemente angeordnet. Eines der kleinen Klemmelemente ist beispielhaft mit dem Bezugszeichen **26** bezeichnet, eines der großen Klemmelemente ist beispielhaft mit dem Bezugszeichen **28** bezeichnet. Die kleinen Klemmelemente **26** und die großen Klemmelemente **28** sind derart ausgebildet, dass zumindest ein Teil eines jeden kleinen

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Klemmelements **26** und ein Teil jedes größeren Klemmelements **28** über das dem Grundsegment **18** abgewandte Ende des der Öffnung **12** abgewandten Schenkels **14** hinausragt.

[0041] Der Rahmen **10** ist derart ausgebildet, dass in ihm, wie im Folgenden beschrieben, zumindest eine kapazitive Sensoranordnung, eine Infrarotsensoranordnung und eine akustische Sensoranordnung anordenbar ist.

[0042] In Fig. 2 ist eine schematische perspektivische Darstellung der Innenseite eines Touchmoduls **30** mit einer kapazitiven Sensoranordnung gezeigt. Elemente mit gleichem Aufbau oder gleicher Funktion haben dieselben Bezugszeichen.

[0043] Innerhalb des Rahmens **10** ist eine Scheibe **32** derart angeordnet, dass durch sie die gesamte Öffnung **12** verdeckt wird und die Scheibe **32** mit einer Berührungsoberfläche das Kontaktsegment **20** kontaktiert. Die Berührungsoberfläche ist einem Benutzer des Touchmoduls **30** zugewandt und in Richtung der Außenseite des Rahmens **10** gerichtet. Die Scheibe **32** ist zumindest teilweise, vorzugsweise vollständig, transparent. Die Scheibe **32** ist insbesondere aus Glas oder Kunststoff gefertigt.

[0044] Die Scheibe **32** ist derart innerhalb des Rahmens **10** positioniert, dass die Scheibe **32** an der die Aussparungen **24a**, **24b** aufweisenden Seite des Rahmens **10** bündig an die der Öffnung **12** zugewandten Seite des der Öffnung **12** abgewandten Schenkels **14** anliegt und an der der die Aussparung **24a**, **24b** aufweisenden Seite des Rahmens **10** entgegengesetzten Seite des Rahmens **10** die Erhebungen **22** nicht kontaktiert. An der die Aussparung **24a**, **24b** aufweisenden Seite des Rahmens **10** kontaktiert die Scheibe **32** mit ihrer Berührungsoberfläche sowohl das Kontaktsegment **20** als auch die an dieser Seite des Rahmens **10** angeordneten Erhebungen **22**.

[0045] Die Positionierung der Scheibe **32** in Bezug auf die anderen beiden Seiten des Rahmens **10** wird durch zwei Positionierelemente **34**, **36** erreicht. Die Positionierelemente **34**, **36** sind derart angeordnet, dass der Abstand der Positionierelemente **34**, **36** und somit auch der an den Positionierelementen **34**, **36** anliegenden Kanten der Scheibe **32** zu dem der Öffnung **12** abgewandten Schenkel **14** des Rahmens **10** gleich ist. Ferner verhindern die Positionierelemente **34**, **36** ein Verschieben der Scheibe **32**.

[0046] Auf der Berührungsoberfläche der Scheibe **32** sind eine Vielzahl Elektroden und/oder eine durchsichtige Metalloxydschicht aufgebracht, insbesondere aufgedampft. Eine an den Ecken der Beschichtung angelegte Spannung erzeugt ein exaktes, gleichmäßiges elektrisches Feld. Es besteht ein geringer Ladungstransport, der in Form eines Stroms an den Kanten der Scheibe **32** gemessen wird. Die an den Kanten gemessenen Ströme stehen im direkten Verhältnis zu der Position an der die Berührungsoberfläche der Scheibe **32** von einer Bedienperson mit einem Finger oder einer Eingabehilfe berührt wird. Auf diese Weise kann die Position der durch die Bedienperson vollzogenen Berührung der Berührungsoberfläche der Scheibe **32** auf einfache Weise ermittelt werden. Mit Hilfe des Anschlusselements **38** werden diese Ströme bzw. aus diesen Strömen gewonnenen Informationen an eine Verarbeitungseinheit übertragen. Das Anschlusselement **38** ist fest mit der Scheibe **32** verbunden, und derart an der dem der Öffnung **12** abgewandten Schenkels **14** zugewandten Seite der Scheibe **12** angeordnet, dass das Anschlusselement **38** zumindest teilweise innerhalb der Aussparung **24b** angeordnet ist. Die Verarbeitungseinheit ermittelt aus den Strömen bzw. den aus den Strömen gewonnen Informationen die Position der Berührung der Scheibe **32**.

[0047] In Fig. 3 ist einen Schnitt durch einen Ausschnitts des Touchmoduls **30** nach Fig. 2 entlang der Schnittlinie A-A gezeigt. Der Rahmen **10** und die Scheibe **32** sind vorteilhafterweise derart ausgebildet, dass der Abstand des dem Grundsegment **18** entgegengesetzten Endes des der Öffnung **12** abgewandten Schenkels **14** zum Grundsegment **18** und der Abstand der der Berührungsoberfläche entgegengesetzten Oberfläche der Scheibe **32** zum Grundsegment **18** gleich sind. Auf diese Weise wird ein ebener Abschluss der Innenseite gebildet, so dass auf einfache Weise weitere Bauteile auf der Innenseite des Tochmoduls **30** anordenbar sind. Ein solches Bauteil kann beispielsweise eine Dichtung **40** sein.

[0048] Die der Nut zugewandte Seite des der Öffnung **12** zugewandten Schenkels **16** und des Kontaktsegments **20** sind parallel zu der der Nut abgewandten Seite des der Öffnung **12** zugewandten Schenkels **16** und des Kontaktsegments **20**.

[0049] In Fig. 4 ist eine perspektivische schematische Darstellung der Innenseite eines Touchmoduls **50** mit einer Infrarotsensoranordnung gemäß einer zweiten Ausführungsform der Erfindung dargestellt. In den Rahmen **10** ist mittig eine Scheibe **52** eingesetzt, die die Öffnung **12** des Rahmens **10** vollständig bedeckt. Die Scheibe **52** ist vorzugsweise aus Glas oder Kunststoff hergestellt und dient hauptsächlich dem Schutz von hinter der der Berührungsoberfläche entgegengesetzten Oberfläche der Scheibe **52** angeordneten Bauteilen, insbesondere einer hinter der Scheibe **52** angeordneten Anzeigeeinheit.

[0050] Die Infrarotsensoranordnung umfasst einen Sensorträgerrahmen **54**. Der Sensorträgerrahmen **54** ist vorzugsweise eine Leiteplatte mit einer rah-

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menförmigen Form oder mehrerer Leiterplattensegmente, die als im Wesentlichen umlaufender Rahmen angeordnet sind. Der Sensorträgerrahmen **54** ist derart dimensioniert, dass seine äußere Kante an allen vier Seiten die der Öffnung **12** zugewandte Seite des der Öffnung **12** abgewandten Schenkels **14** kontaktiert oder zwischen dem Schenkel **14** und der äußeren Kante des Sensorträgerrahmens **54** nur ein kleiner Spalt verbleibt. Die Scheibe **52** ist derart dimensioniert, dass sie bündig in der Öffnung des Sensorträgerrahmens **54** anordenbar ist. Auf diese Weise dient der Sensorträgerrahmen **54** als Positionierhilfe und Aufnahmeelement für die Scheibe **52**. Der Sensorträgerrahmen **54** kontaktiert mit der dem Grundsegment **18** zugewandten Seite die Erhebungen **22** des Rahmens **10**.

[0051] In Fig. 5 ist ein Ausschnitt eines Schnitts durch das Touchmodul **50** nach Fig. 4 entlang der Schnittlinie B-B gezeigt. Die Scheibe **52** ist derart dimensioniert, dass ihre Kante bündig mit der dem der Öffnung **12** abgewandten Schenkel **14** zugewandten Seite des Kontaktsegments **20** abschließt.

[0052] Ferner ist die Scheibe **52** derart ausgebildet, dass der Abstand der vom Grundsegment **18** abgewandten Seite der Scheibe **52** zum Grundsegment **18** und der Abstand des dem Grundsegment **18** abgewandten Endes des der Öffnung **12** abgewandten Schenkels **14** zum Grundsegment **18** gleich sind.

[0053] Die dem Grundsegment **18** zugewandte Oberfläche des Sensorträgerrahmens **54** und die Berührungsoberfläche der Scheibe **52** liegen näherungsweise in einer Ebene. Auf der dem Grundsegment **18** zugewandten Oberfläche des Sensorträgerrahmens **54** sind eine Vielzahl von Infrarotsende- und Infrarotempfangsdioden angeordnet, die im Folgenden kurz als Infrarotdioden bezeichnet werden. Eine dieser Infrarotdioden ist beispielhaft mit dem Bezugszeichen **56** bezeichnet. Die Infrarotdioden **56** sind elektrisch leitend mit den Leiterbahnen des Sensorträgerrahmens **54** verbunden.

[0054] Die Infrarotdioden **56** sind somit innerhalb der Nut des Rahmens **10** angeordnet und somit durch den Rahmen **10** vor Vandalismus und Verschmutzungen, insbesondere vor Staub, geschützt. Der Rahmen **10** ist aus einem infrarotstrahlungsdurchlässigen Material, insbesondere einem infrarotstrahlungsdurchlässigen Kunststoff, gefertigt. In einer alternativen Ausführungsform der Erfindung kann auch nur der der Öffnung **12** zugewandte Schenkel **16** und das Kontaktsegment **20** aus einem infrarotstrahlungsdurchlässigen Material gefertigt sein.

[0055] Von den Infrarotdioden **56** werden Infrarotstrahlen in Richtung des der Öffnung **12** zugewandten Schenkels **16** emittiert.

[0056] Die Infrarotstrahlen treten durch den infrarotstrahlungsdurchlässigen, der Öffnung **12** zugewandten Schenkel **16** und durch das Kontaktsegment **20** durch. Die durch die Infrarotsendedioden ausgesandten Infrarotstrahlen werden mit Hilfe von Infrarotempfangsdioden, insbesondere von infrarotstrahlungsempfindlichen Fotodioden, empfangen. Die Infrarotsende- und die Infrarotempfangsdioden können einteilig ausgebildet sein. Eine Infrarotempfangsdiode und eine Infrarotsendediode werden zusammen auch als Infrarotsensor bezeichnet. Mit Hilfe der Infrarotdioden wird ein Netz aus Infrarotstrahlen über der Berührungsoberfläche der Scheibe **52** gebildet. Berührt ein Benutzer die Berührungsoberfläche der Scheibe **52** so wird zumindest ein Teil der durch die Infrarotdioden **56** ausgesandten und zumindest ohne Berührung der Scheibe durch die Infrarotempfangsdioden empfangenen Infrarotstrahlen unterbrochen. Welcher Teil der Infrarotstrahlen unterbrochen wird, hängt von der Position ab, an der die Scheibe **52** berührt wird. Auf diese Weise kann die Position der Berührung der Scheibe **52** bestimmt werden. Zum Unterbrechen der Infrarotstrahlung ist es nicht notwendig, die Scheibe **52** tatsächlich zu berühren oder gar Druck auf die Scheibe auszuüben. Somit können auch nur annähernde Berührungen der Scheibe **52** durch das Touchmodul **50** ermittelt werden, wenn dadurch zumindest ein Teil der ausgesandten Infrarotstrahlen unterbrochen wird und von den Infrarotempfangsdioden nicht mehr empfangen wird. Das durch die Infrarotdioden **56** erzeugte Netz aus Infrarotstrahlenüber der Scheibe **52** hat vorzugsweise eine matrixförmige Struktur in X-Richtung und in Y-Richtung einer zur Scheibe **52** parallelen X-Y-Ebene.

[0057] Auf der dem Grundsegment **18** abgewandten Oberfläche des Sensorträgerrahmens **54** sind mehrere elektrische Bauelemente angeordnet, die mit den Leiterbahnen des Sensorträgerrahmens **54** elektrisch leitend verbunden sind. Eines dieser Bauelemente ist beispielhaft mit dem Bezugszeichen **58** bezeichnet. Die elektrischen Bauelemente **58** sind derart dimensioniert, dass die den Sensorträgerrahmen **54** abgewandte Oberfläche der elektrischen Bauelemente **58** näherungsweise in einer Ebene mit der dem Grundsegment **18** abgewandten Oberfläche der Scheibe **52** liegt.

[0058] Bei einer alternativen Ausführungsform der Erfindung kann der der Öffnung **12** zugewandte Schenkel **16** und das Kontaktsegment **20** an den Stellen, an denen die Infrarotdioden **56** angeordnet sind, Aussparungen aufweisen, durch die die von den Infrarotdioden **56** ausgesandten und empfangenen Infrarotstrahlen hindurchtreten können. Bei dieser Ausführungsform muss der Rahmen **10** dann nicht unbedingt aus einem infrarotstrahlungsdurchlässigen Material gefertigt sein.

[0059] In Fig. 6 ist eine schematische perspektivi-

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sche Darstellung der Innenseite eines Touchmoduls **60** mit einer akustischen Sensoranordnung gemäß einer dritten Ausführungsform der Erfindung gezeigt. Die akustische Sensoranordnung umfasst eine Vielzahl von Piezoelementen, die vorzugsweise an der dem der Öffnung **12** abgewandten Schenkel **14** zugewandten Seite einer Scheibe **62** angeordnet sind. Bei einer Berührung der Berührungsoberfläche der Scheibe **62** durch einen Benutzer werden Schallwellen erzeugt, die über die Piezoelemente erfasst werden. In Abhängigkeit von der Stärke der von einzelnen Piezoelementen erfassten Schallwellen und/oder in Abgängigkeit von der Zeit die zwischen der Berührung der Scheibe **62** und dem erfassen der Schallwelle durch die Piezoelemente vergeht, kann die Position der Berührung der Scheibe **62** ermittelt werden. Die Scheibe **62** ist derart angeordnet, dass sie mit ihrer Berührungsoberfläche zumindest die Kontaktsegmente **20** des Rahmens **10** kontaktiert. Die Piezoelemente liegen somit geschützt zwischen der Scheibe **62** und dem der Öffnung **12** abgewandten Schenkel **16** des Rahmens **10**.

[0060] In Fig. 7 ist eine schematische perspektivische Darstellung der Innenseite eines Touchmoduls **70** mit einer Dichtung **40** gemäß einer vierten Ausführungsform der Erfindung gezeigt. Innerhalb des Rahmens **10** ist eine Scheibe **72** derart angeordnet, dass die Öffnung **12** vollständig von der Scheibe **72** bedeckt und die Scheibe **72** zumindest von dem Kontaktsegment **20** des Rahmens **10** kontaktiert wird. Auf der Innenseite des Touchmoduls **70** ist eine Dichtung **40** angeordnet. Die Dichtung **40** kontaktiert zumindest die Innenseite der Scheibe **72** und das dem Grundsegment **18** abgewandte Ende des der Öffnung **12** abgewandten Schenkels **14**. Mit Hilfe der Dichtung **40** wird die Nut des Rahmens **10** und die innerhalb dieser Nut bzw. der an der dem der Öffnung **12** abgewandten Schenkel **14** zugewandten Seite der Scheibe **72** angeordneten Teil einer Sensoranordnung zumindest staub- und/oder feuchtigkeitsdicht verschlossen. Die Dichtung **40** ist über die kleinen Klemmelemente **26** fest mit dem Rahmen **10** des Touchmoduls **70** verbunden. Auf diese Weise wird erreicht, dass die Dichtung **40** zusammen mit dem Touchmodul **70** auf einfache Art und Weise handhabbar ist

[0061] In Fig. 8 ist eine weitere perspektivische schematische Darstellung der Innenseite des Touchmoduls **70** nach Fig. 7 gezeigt. In Fig. 9 ist eine schematische perspektivische Darstellung der Außenseite des Touchmoduls **70** nach den Fig. 7 und Fig. 8 gezeigt. Im eingebauten Zustand sind für den Benutzer von dem Touchmodul **70** lediglich die Berührungsoberfläche der Scheibe **72** und zumindest ein Teil des Rahmens **10** sichtbar.

[0062] In Fig. 10 ist eine schematische perspektivische Darstellung der Innenseite und der Außenseite des Touchmoduls **70** nach den Fig. 7 bis Fig. 9 und eine mit dem Touchmodul **70** verbundene Frontblende **74** gezeigt. Im linken Teil der Fig. 10 ist eine Sicht auf die Außenseite des Touchmoduls **70** und in der rechten Figur von Fig. 10 eine Sicht auf die Innenseite des Touchmoduls **70** gezeigt. Die Frontblende **74** ist an der Außenseite des Touchmoduls **70** derart angeordnet, dass die Außenseite des Rahmens **10** nahezu vollständig von der Frontlende **74** verdeckt wird. Die Position der Frontblende **74** zu dem Touchmodul **70** wird über mehrere an der dem Touchmodul **70** zugewandten Seite der Frontblende **74** angeordnete Positionierelemente festgelegt. Eines dieser Positionierelemente ist beispielhaft mit dem Bezugszeichen **76** bezeichnet.

[0063] In Fig. 11 ist eine schematische perspektivische Darstellung eines Touchmoduls **80** und einer fest mit dem Touchmodul **80** verbundenen Anzeigeeinheit **82** gemäß einer fünften Ausführungsform der Erfindung gezeigt. Die Anzeigeeinheit **82** ist derart an der Innenseite des Touchmoduls **80** angeordnet, dass ein in Fig. 11 nicht sichtbarer Bildschirm der Anzeigeeinheit **82** derart angeordnet ist, dass er an der der Berührungsoberfläche entgegengesetzten Oberfläche einer Scheibe des Touchmoduls **80** angeordnet ist. Mit Hilfe der Dichtung **40** wird ein zwischen dem Rahmen **10** des Touchmoduls **80** und der Anzeigeeinheit **82** verbleibender Spalt verschlossen. Bei der Anzeigeeinheit **82** handelt es sich vorteilhafterweise um ein Display, insbesondere ein LCD-Display, wie beispielweise ein TFT-Display Das Touchmodul **80** und die Anzeigeeinheit **82** bilden zusammen einen sogenannten Touchscreen **84**.

[0064] Solche Touchscreens **84** können zum Einen als alleinstehende Geräte, z. B. auf oder neben einem Selbstbedienterminal oder einer Registrierkasse, verwendet werden. Solche alleinstehenden Touchscreengeräte werden auch als stand-alone-Touchscreens bezeichnet. Bei einem alleinstehenden Touchscreengerätes wird ein Touchmodul **80** in die Frontblende **74** des Touchscreens **84** integriert.

[0065] Im Fall der Integration des Touchscreens **84** in das Gehäuse eines Selbstbedienterminals, wie beispielsweise in das Gehäuse eines Geldautomaten, wird das Touchmodul **80** mit dem Display **82** verbunden. Die Blende für den Touchscreen **84** wird in diesem Fall von dem Gehäuse des Selbstbedienterminals gebildet, das eine Aussparung für den Touchscreen **84** aufweist Bei der Integration des Touchscreens **84** in ein Selbstbedienterminal wird ein Displaymodul **82** verwendet, das kein Gehäuse aufweist. Ein solches Displaymodul **82** wird auch als Barebone-Displaymodul bezeichnet.

[0066] Bei einer alternativen Ausführungsform der Erfindung kann als Sensoranordnung eine resistive Sensoranordnung verwendet werden.

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Bezugszeichenliste

10	Rahmen
12	Öffnung
14, 16	Schenkel
18	Grundsegment
20	Kontaktsegment
22	Erhebung
24a, 24b	Aussparung
26	kleines Klemmelement
28	großes Klemmelement
30, 50, 60, 70, 80	Touchmodul
32, 52, 62, 72	Scheibe
34, 36	Positionierelement
38	Anschlusselement
40	Dichtung
54	Sensorträgerrahmen
56	Infrarotdiode
58	elektrisches Bauelement
74	Frontblende
76	Positionierelemente
82	Anzeigeeinheit
84	Touchscreen

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ZITATE ENTHALTEN IN DER BESCHREIBUNG

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Zitierte Patentliteratur

- DE 10025175 A1 [0006]

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Patentansprüche

1. Berührungssensitive Eingabevorrichtung,
mit einem eine Öffnung (**12**) aufweisenden Rahmen (**10**),
mit einer Scheibe (**32**, **52**, **62**, **72**), und
mit einer Sensoranordnung zur Ermittlung der Position einer Berührung der Scheibe (**32**, **52**, **62**, **72**),
wobei der Rahmen (**10**) ein Profil mit einem der Öffnung (**12**) zuwandten Schenkel (**16**), einem der Öffnung (**12**) abgewandten Schenkel (**14**) und einem die beiden Schenkel (**14**, **16**) verbindenden Grundsegment (**18**) hat,
die Scheibe (**32**, **52**, **62**, **72**) den der Öffnung (**12**) zugewandten Schenkel (**16**) des Profils kontaktiert, und
wobei zumindest ein Teil der Sensoranordnung innerhalb einer durch den der Öffnung (**12**) zugewandten Schenkel (**16**), den der Öffnung (**12**) abgewandten Schenkel (**14**) und das Grundsegment (**18**) ausgebildeten Vertiefung anordenbar ist.

2. Eingabevorrichtung nach Anspruch 1, dadurch gekennzeichnet, dass der Rahmen (**10**) umlaufend ist.

3. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass zwischen dem der Öffnung (**12**) zugewandten Schenkel (**16**) und dem Grundsegment (**18**) ein stumpfer Winkel ist

4. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der der Öffnung (**12**) zugewandte Schenkel (**16**) kürzer ist als der der Öffnung (**12**) abgewandte Schenkel (**14**), und dass an dem dem Grundsegment (**18**) entgegengesetzten Ende des der Öffnung (**12**) zugewandten Schenkels (**16**) ein parallel zum Grundsegment (**18**) angeordnetes Kontaktsegment (**20**) vorgesehen ist, das die Scheibe (**32**, **52**, **62**, **72**) kontaktiert.

5. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Sensoranordnung mindestens eine Infrarotsensoranordnung umfasst, und dass zumindest ein Teil der von mindestens einem Infrarotlichtsender der Infrarotsensoranordnung ausgesandten und von mindestens einem Infrarotlichtempfänger der Infrarotsensoranordnung empfangenen Infrarotstrahlen bei Berührung einer Berührungsoberfläche der Scheibe (**52**) unterbrochen wird.

6. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Sensoranordnung eine Vielzahl von Infrarotsensorelementen umfasst, und dass die Infrarotsensorelemente auf einem Sensorträgerrahmen (**54**) angeordnet sind und zumindest die Infrarotsensorelemente innerhalb der Vertiefung des Rahmens (**10**) angeordnet sind.

7. Eingabevorrichtung nach Anspruch 6, dadurch gekennzeichnet, dass der Sensorträgerrahmen (**54**) zwischen dem der Öffnung (**12**) abgewandten Schenkel (**14**) des Rahmens (**10**) und der Scheibe (**52**) angeordnet ist.

8. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass zumindest der der Öffnung (**12**) zugewandte Schenkel (**16**) des Rahmens (**10**), vorzugsweise der gesamte Rahmen (**10**), aus einem infrarotstrahlungsdurchlässigen Material, insbesondere einem infrarotstrahlungsdurchlässigen Kunststoff, gefertigt ist.

9. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Sensoranordnung mindestens ein Piezoelement zum Erfassen von durch eine Berührung der Scheibe (**62**) erzeugten Schallwellen umfasst.

10. Eingabevorrichtung nach Anspruch 9, dadurch gekennzeichnet, dass eine Vielzahl von Piezoelementen vorgesehen ist und die Piezoelemente an der dem der Öffnung (**12**) abwandten Schenkel (**14**) zugewandten Seite der Scheibe (**62**) angeordnet sind.

11. Eingabevorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Sensoranordnung mehrere auf der Scheibe (**32**) aufgedampfte Elektroden oder eine Metalloxidschicht hat, die bei Berührung einer Berührungsoberfläche der Scheibe (**32**) ein elektrisches Signal aussenden bzw. aussendet.

12. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass innerhalb der Vertiefung des Rahmens (**10**) zumindest auf einem Sensorträgerrahmen (**54**) angeordnete Infrarotsensorelemente anordenbar sind und mindestens ein Piezoelement zwischen dem der Öffnung (**12**) abgewandten Schenkel (**14**) des Rahmens (**10**) und der diesem Schenkel (**14**) zugewandten Seite der Scheibe (**32**, **52**, **62**, **72**) anordenbar ist und eine Scheibe (**32**, **52**, **62**, **72**), auf der Elektroden aufgedampft sind, derart anordenbar ist, dass diese Scheibe (**32**, **52**, **62**, **72**) zumindest den der Öffnung (**12**) zugewandten Schenkel (**16**) kontaktiert.

13. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass eine Dichtung (**40**) vorgesehen ist, die zumindest die Scheibe (**32**, **52**, **62**, **72**) und den der Öffnung (**12**) abgewandten Schenkel (**14**) kontaktiert und die Öffnung der Vertiefung zumindest staub- und/oder feuchtigkeitsdicht verschließt.

14. Vorrichtung nach einem der vorhergehenden

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Ansprüche, dadurch gekennzeichnet, dass der Rahmen (**10**) mindestens ein Positionierelement (**34**, **36**) zur Positionierung und/oder Befestigung der Scheibe (**32**, **52**, **62**, **72**) umfasst.

15. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass innerhalb der Vertiefung des Rahmens (**10**) mehrere Erhebungen (**22**) ausgebildet sind, mit deren Hilfe die Scheibe (**32**, **52**, **62**, **72**) und/oder die Sensoranordnung auf Abstand zum Grundsegment (**18**) gehalten werden.

Es folgen 11 Blatt Zeichnungen

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Anhängende Zeichnungen

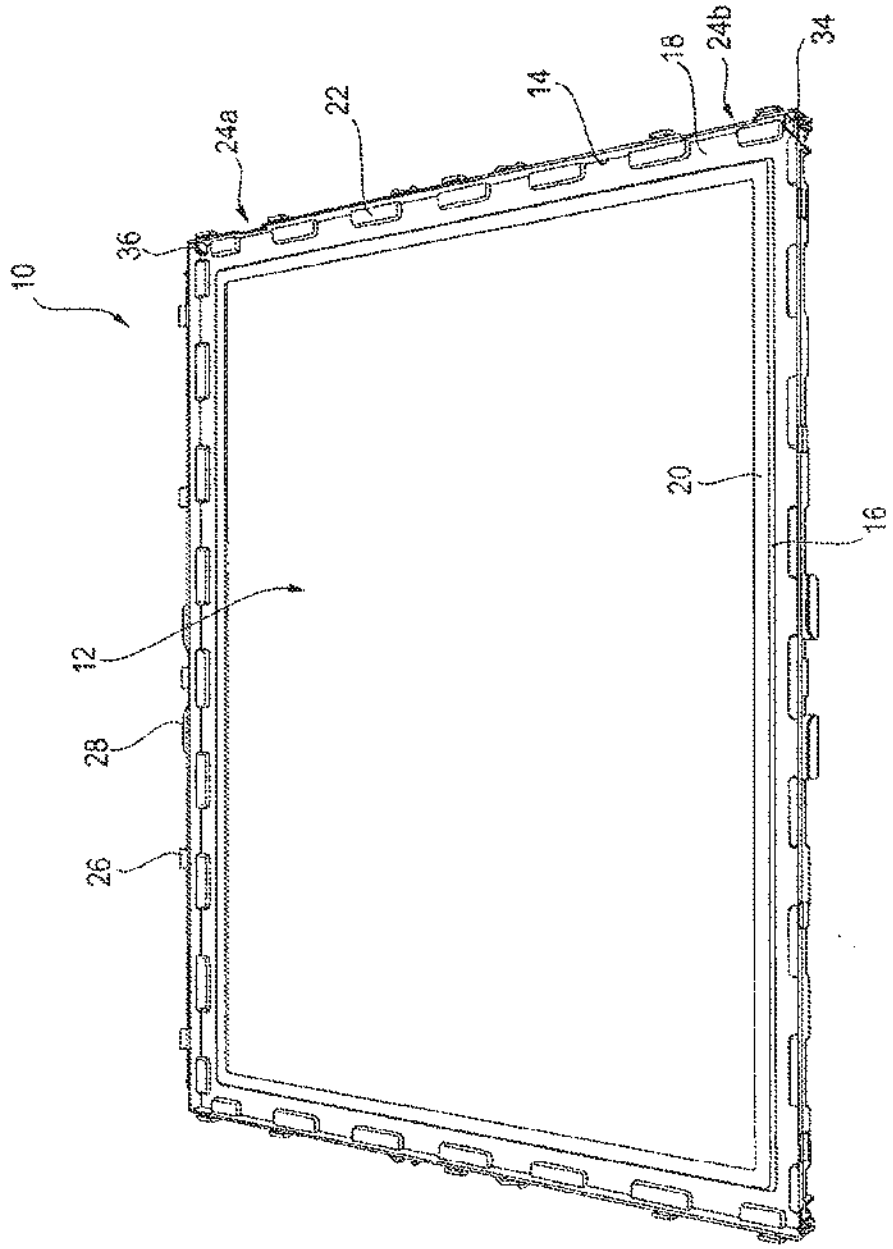


FIG. 1

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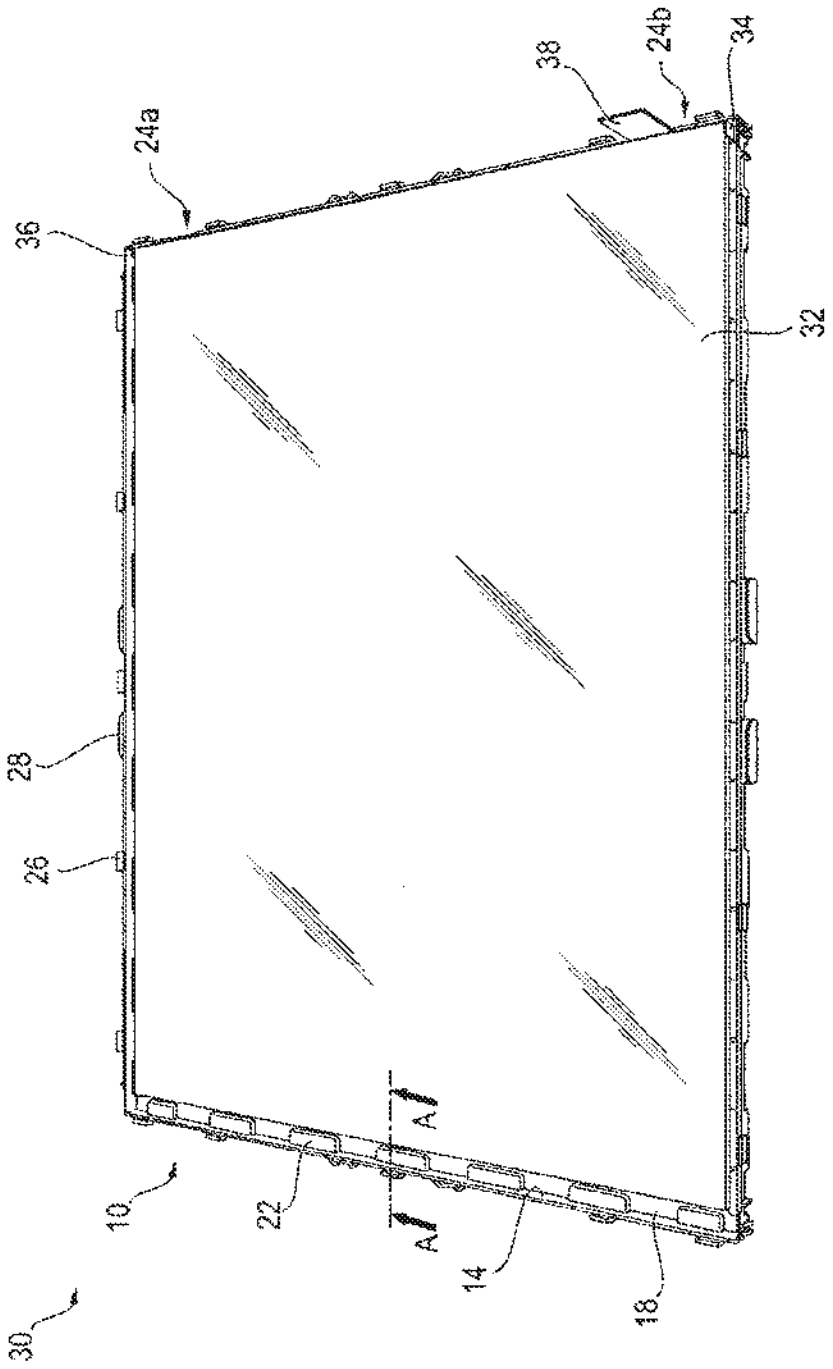


FIG. 2

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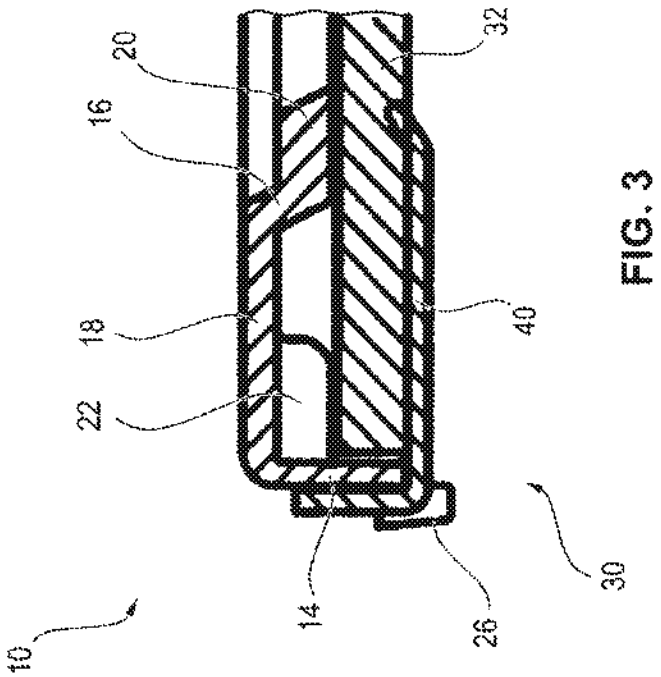


FIG. 3

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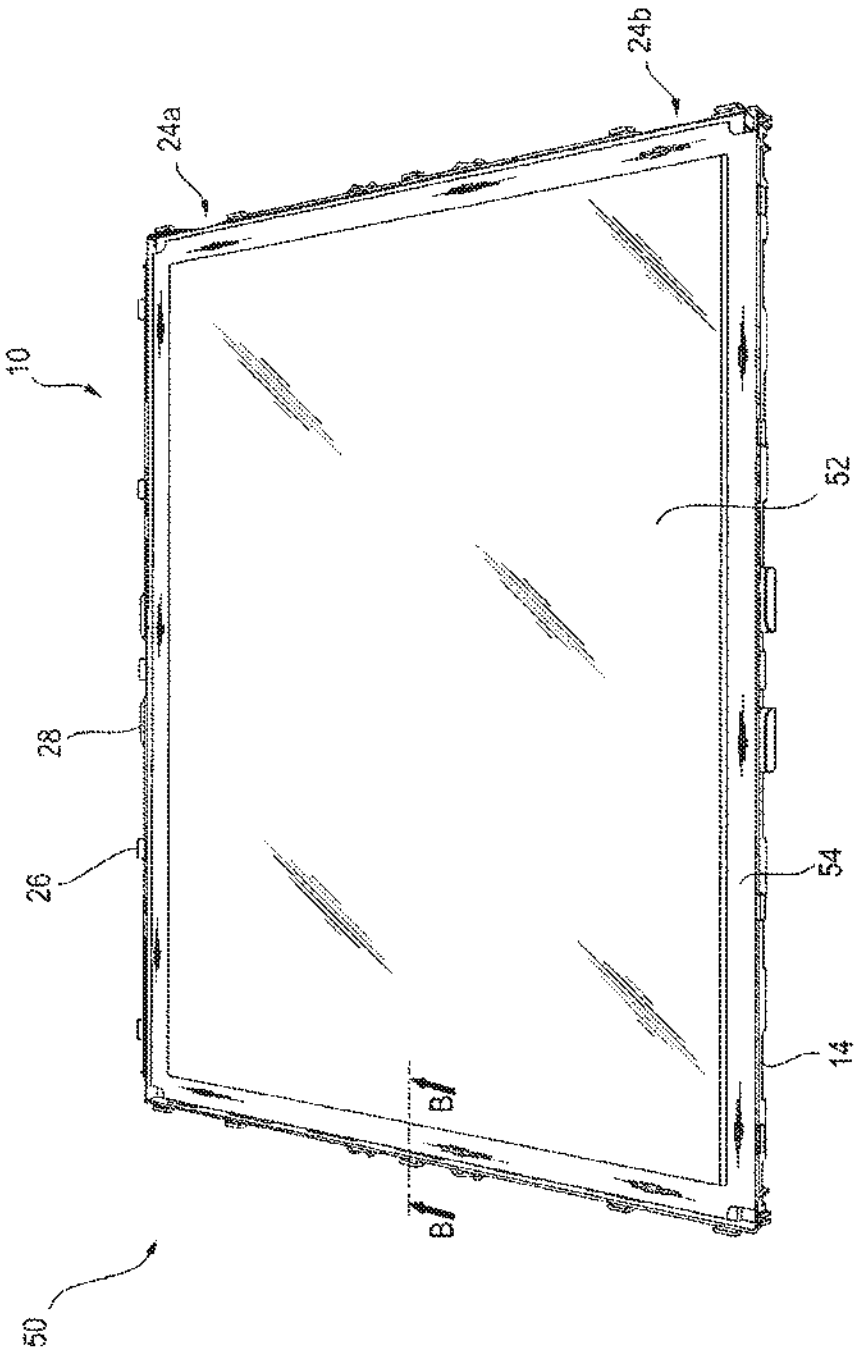


FIG. 4

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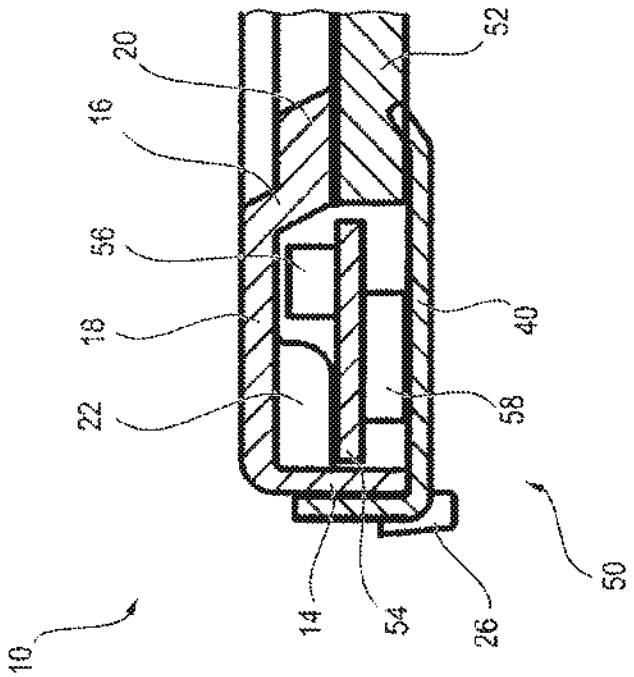


FIG. 5

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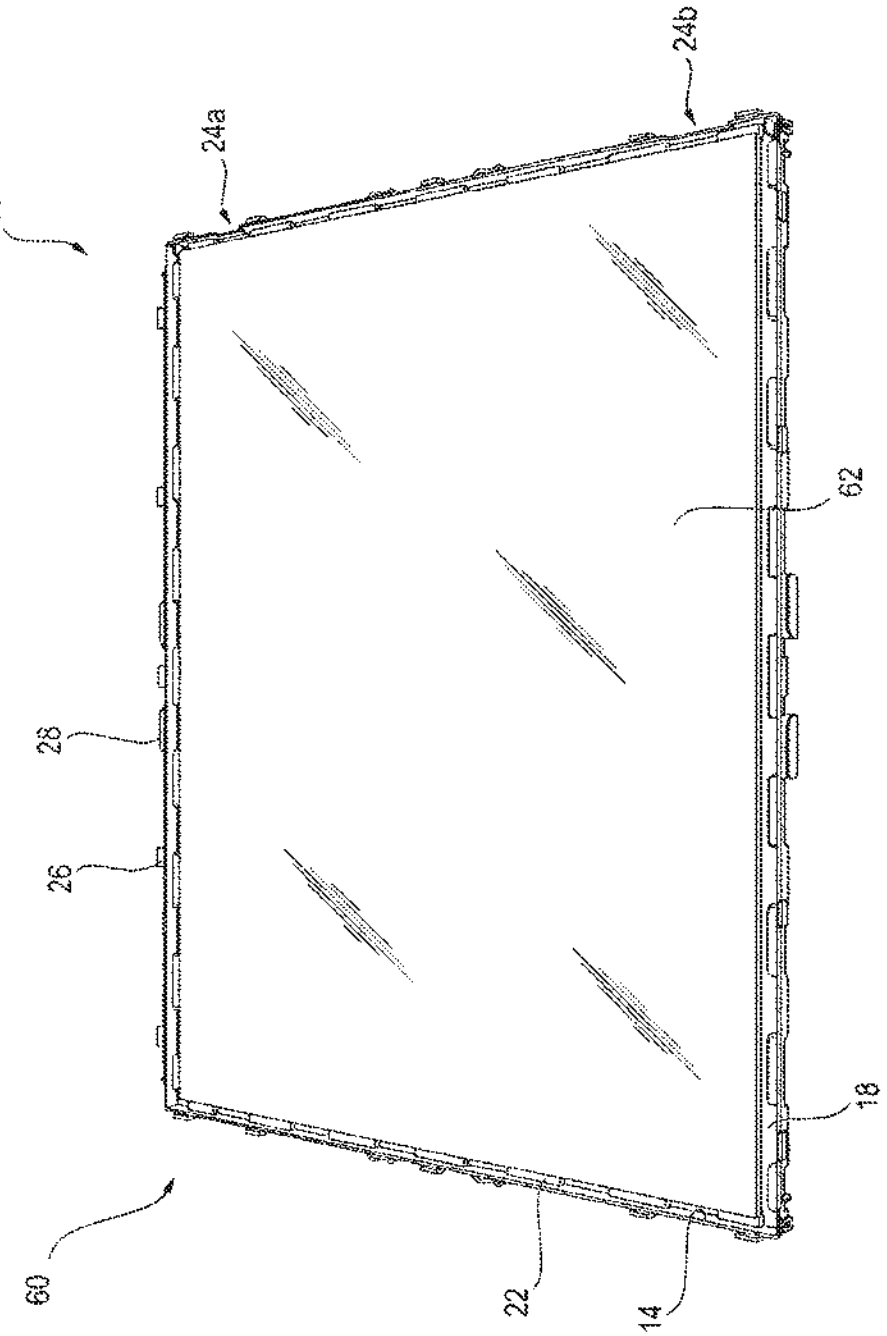


FIG. 6

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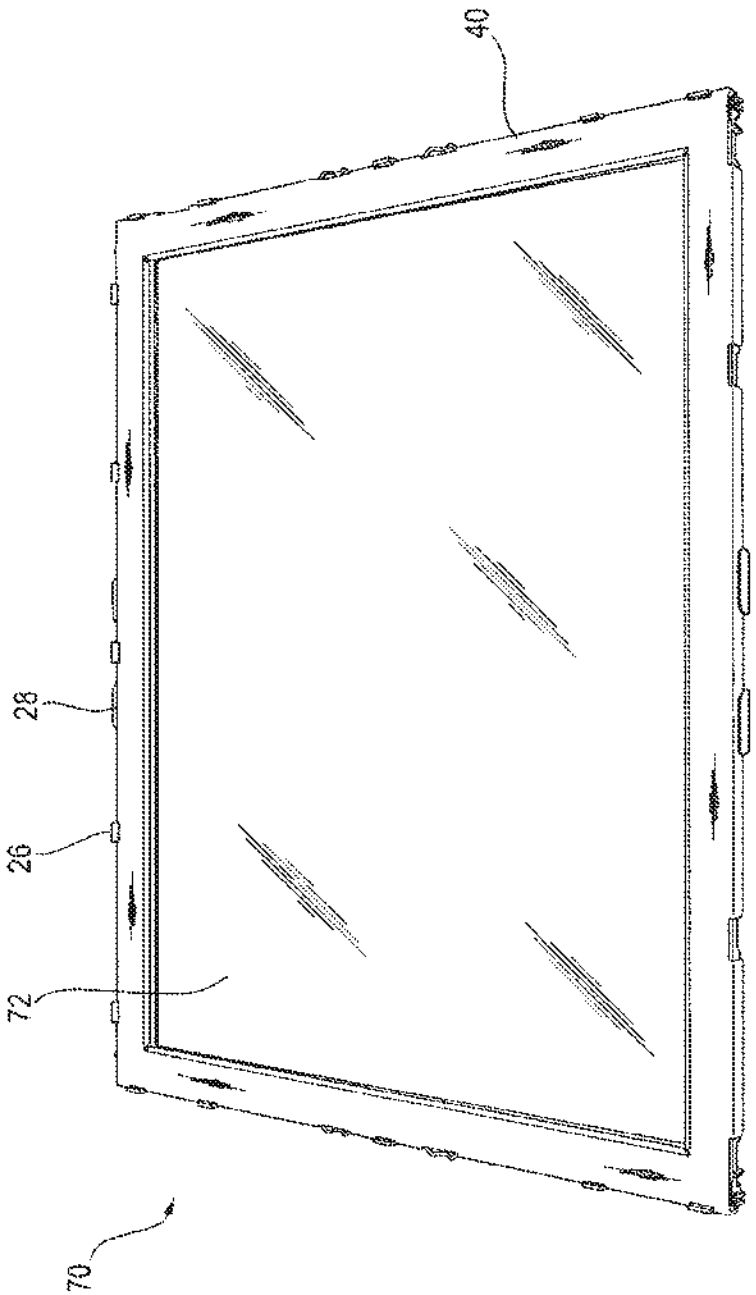


FIG. 7

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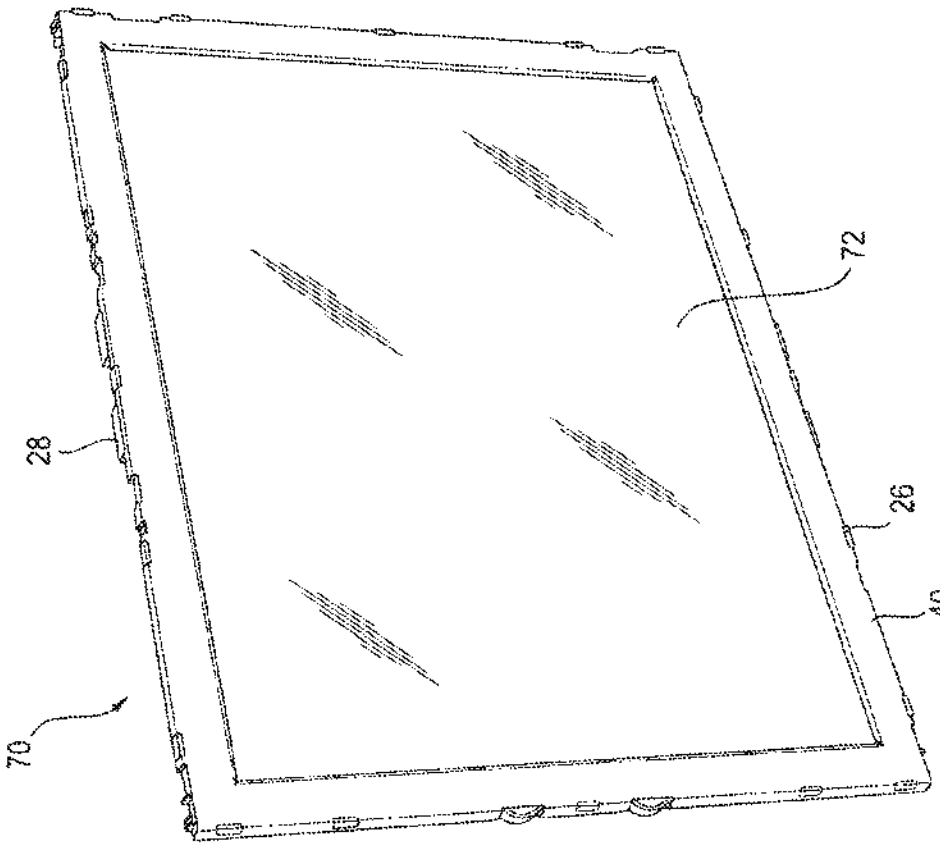


FIG. 8

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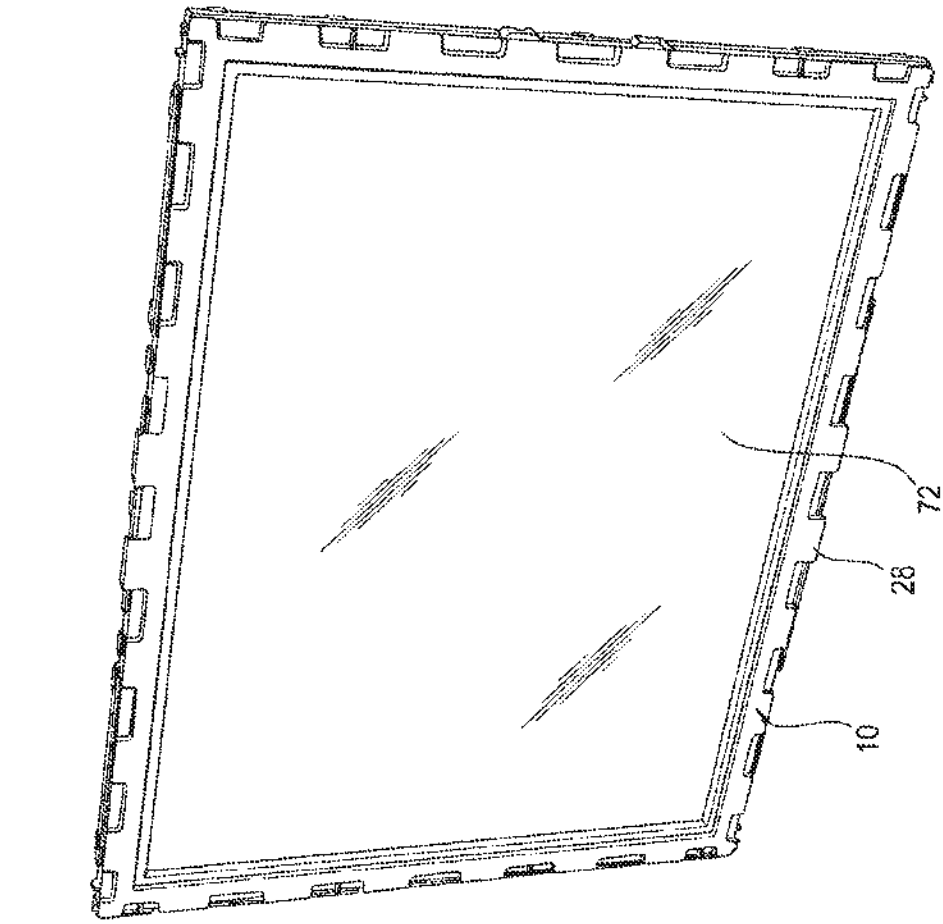


FIG. 9

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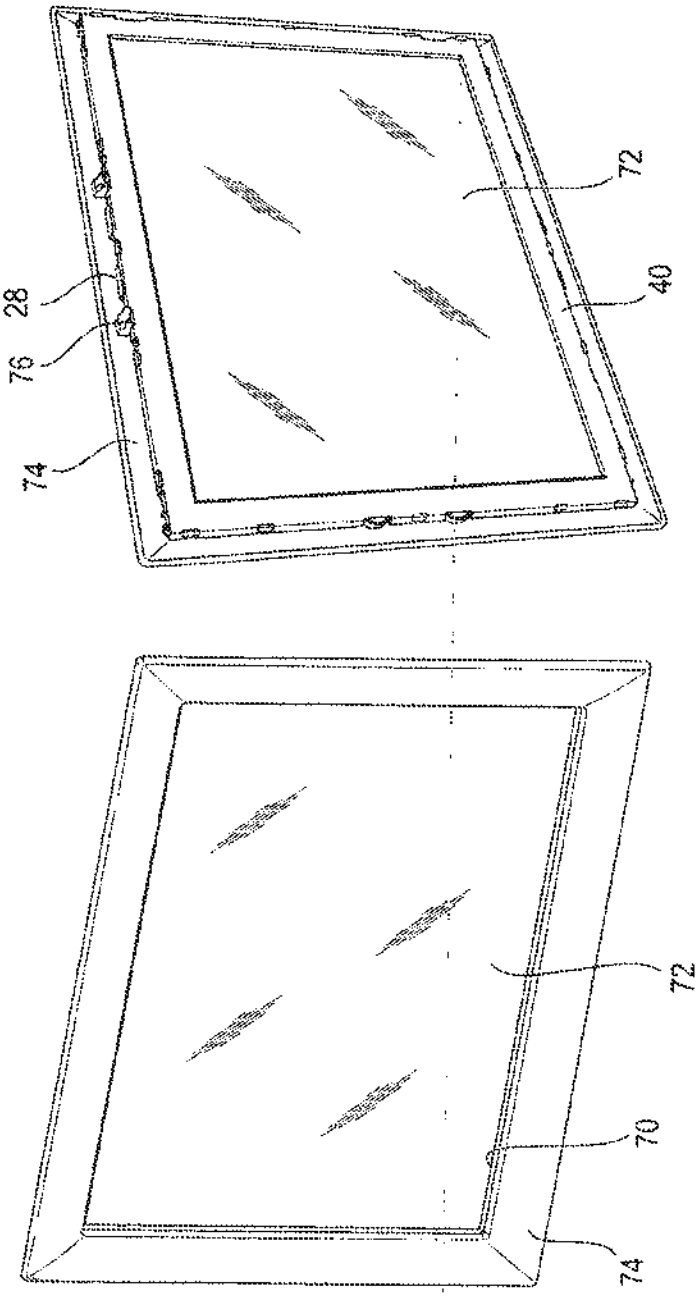


FIG.10

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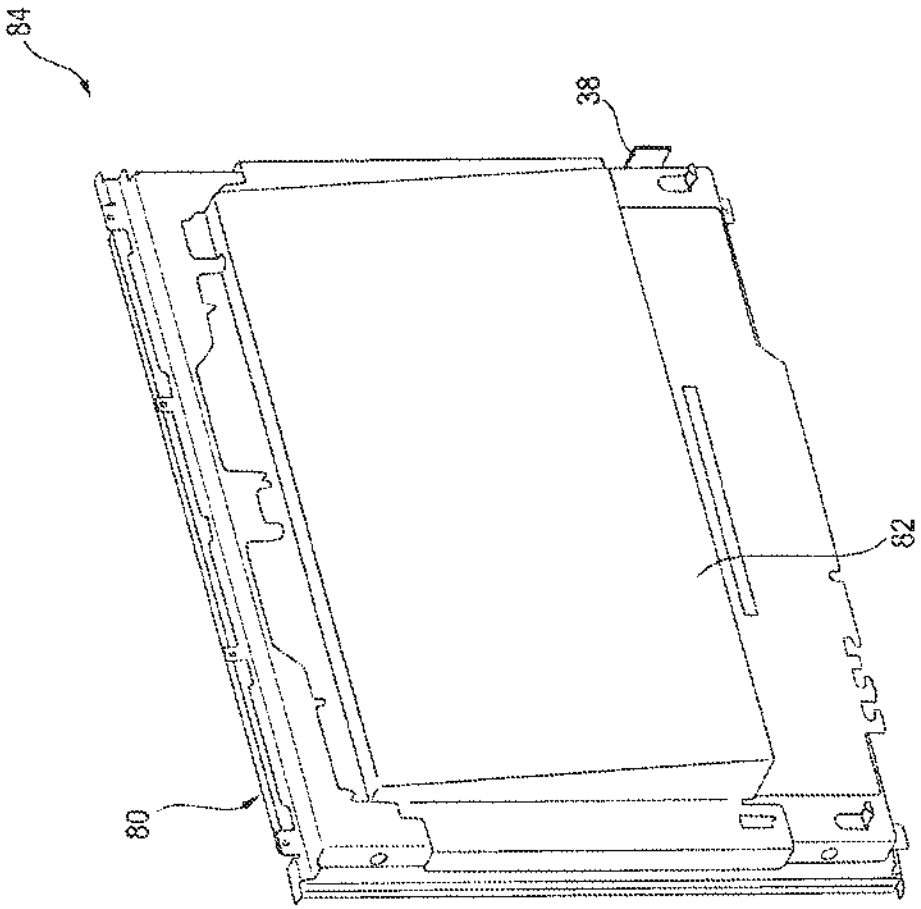


FIG. 11

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G09F	9/00	(2006.01)	G09F	9/00	350Z	
H04N	5/64	(2006.01)	G09F	9/00	366A	
			H04N	5/64	571A	

審査請求 未請求　請求項の数 5　ＯＬ　（全 12 頁）

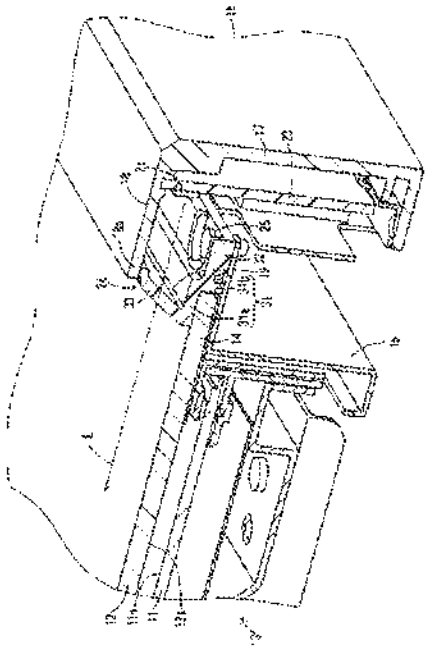
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Ｆターム(参考)　5G435 AA17　AA18　BB05　BB12　BE02
BE05　CC43　HH02　KK03

(54)【発明の名称】座標入力装置および画像表示装置

(57)【要約】
【課題】　装置全体の重量を低減し、部品点数を削減し、赤外線の透過率を場所に依らずに安定させることができる座標入力装置を提供する。
【解決手段】　タッチパネル装置１０は、液晶パネル１１と、保護ガラス１２と、液晶パネル１１および保護ガラス１２を外囲する外観ベゼル１６と、保護ガラス１２の周縁部分１４を液晶パネル１１側から支持するモジュール金属ベゼル１５とを含み、外観ベゼル１６が、保護ガラス１２の厚み方向に、周縁部分１４から離隔して配置される額縁部分１８を有する液晶表示装置１に搭載され、外観ベゼル１６内に設けられ、周縁部分１４と額縁部分１８との間の間隙１９を介して赤外線Ｌを受光する複数の受光素子２２と、赤外線Ｌを透過し、間隙１９を閉塞するＩＲフィルタ２４とを含み、ＩＲフィルタ２４が、モジュール金属ベゼル１５と協働して保護ガラス１２の周縁部分１４を挟持することで、保護ガラス１２を固定する。
【選択図】　図２



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【特許請求の範囲】
【請求項１】
画像を表示する表示面を有する表示部と、前記表示面に対向して配設される透明の板状部材と、前記表示部および前記板状部材を外囲するフレーム部材と、前記板状部材の周縁部分を前記表示部側から支持する支持部材とを含み、前記フレーム部材が、前記板状部材の厚み方向に、前記周縁部分から離間して配置される枠状部分を有する画像表示装置に搭載され、前記板状部材における、指示体によって指示された指示位置を検出する座標入力装置であって、
前記フレーム部材の内部に設けられ、前記板状部材の周縁部分と前記枠状部分との間の間隙を介して、前記指示位置を検出するために用いられる検出光を受光する複数の受光部と、
前記検出光を透過する材料から成り、前記間隙を閉塞する閉塞部材とを含み、
前記閉塞部材が、前記支持部材と協働して前記板状部材の周縁部分を挟持することにより、該板状部材を固定するように構成されていることを特徴とする座標入力装置。
【請求項２】
前記閉塞部材は、
前記板状部材の周縁部分における、前記表示部側とは反対側の表面に面接触する挟持部分と、
前記挟持部分における、前記厚み方向に垂直な面方向の外方側の端部に連なり、前記支持部材に固定される固定部分と、
前記挟持部分における、前記面方向の内方側の端部に連なり、前記間隙を閉塞する閉塞部分とを含むことを特徴とする請求項１に記載の座標入力装置。
【請求項３】
前記固定部分は、長尺の板状に形成され、前記支持部材に対向する側の対向面には、前記支持部材に対する位置決めのための複数の位置決め部が、長手方向に沿って間を空けて形成され、前記対向面とは反対側の面には、前記位置決め部が形成されている位置に対応して、リブが形成されていることを特徴とする請求項２に記載の座標入力装置。
【請求項４】
前記フレーム部材の内部に前記複数の受光部に個別に対応して設けられ、対応する前記受光部に向けて、赤外線を前記検出光として出射する複数の発光部をさらに含むことを特徴とする請求項１～３のいずれか１つに記載の座標入力装置。
【請求項５】
請求項１～４のいずれか１つに記載の座標入力装置が搭載されることを特徴とする画像表示装置。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、液晶表示装置などの画像表示装置に搭載される座標入力装置およびそれを備える画像表示装置に関する。
【背景技術】
【０００２】
従来から、液晶表示装置などの画像表示装置に搭載される座標入力装置として、赤外線遮断方式による座標入力装置が提案されている（たとえば、特許文献１参照）。
【０００３】
図５は、従来技術に係る赤外線遮断方式による座標入力装置１１０を搭載した液晶表示装置１００の構成を示す部分断面図である。液晶表示装置１００は、図５に示すように、画像を表示する表示面を一方側の主面１１１ａに有する矩形板状に構成された液晶パネル１１１と、液晶パネル１１１の表示面に対向して配置される、無色透明で矩形板状の保護ガラス１１２と、液晶パネル１１１を含む液晶モジュール１１３を四方から外囲するとともに、保護ガラス１１２の周縁部分１１４を液晶パネル１１１側から支持するモジュール

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金属ベゼル１１５と、モジュール金属ベゼル１１５と協働して、保護ガラス１１２の周縁部分１１４を挟持することにより、保護ガラス１１２を固定する金属製のガラス押えアングル１１６と、保護ガラス１１２の周縁部分１１４の損傷を防止するために、ガラス押えアングル１１６と保護ガラス１１２の周縁部分１１４との間に配設されるガラス押えクッション１１７と、液晶モジュール１１３および保護ガラス１１２を四方から外囲する、外観フレームとして機能する矩形枠状のアルミベゼル１１８とを含んで構成される。

【０００４】

アルミベゼル１１８は、液晶モジュール１１３および保護ガラス１１２の外周に沿って設けられる、該外周よりも一回り大きな大略的に矩形筒状の側壁部分１１９と、側壁部分１１９における、保護ガラス１１２の厚み方向一方側の端部であって、液晶表示装置１００の正面側に配置される端部に一体的に連なり、側壁部分１１９から内方側へ略直角に屈曲する矩形枠状の額縁部分１２０とを含み、額縁部分１２０は、保護ガラス１１２の周縁部分１１４に対し、保護ガラス１１２の厚み方向に離間して配置される。これにより、図５に示すように、アルミベゼル１１８の額縁部分１２０における内方側端部１２０ａと、保護ガラス１１２の周縁部分１１４との間には間隙１２１が形成される。

【０００５】

一方、座標入力装置１１０は、赤外線Ｌを出射する複数の発光素子１２２と、複数の発光素子１２２に個別に対応して設けられ、対応する発光素子１２２から出射された赤外線Ｌをそれぞれ受光する複数の受光素子（図示せず）と、アルミベゼル１１８内に保持され、複数の発光素子１２２および受光素子が搭載されるセンサ基板１２３とを含み、アルミベゼル１１８内に配置される発光素子１２２から出射された赤外線Ｌが、額縁部分１２０における内方側端部１２０ａと保護ガラス１１２の周縁部分１１４との間の間隙１２１を通過し、保護ガラス１１２の表面に沿って進行し、再度、額縁部分１２０における内方側端部１２０ａと保護ガラス１１２の周縁部分１１４との間の間隙１２１を通過して、アルミベゼル１１８内に配置される、対応する受光素子によって受光されるように構成される。座標入力装置１１０は、各受光素子において、対応する発光素子１２２から出射された赤外線Ｌが検出されたか否かに基づいて、ユーザが保護ガラス１２の表面をペンまたはスタイラスなどの指示体によって指示した指示位置の座標を検出する。

【０００６】

従来から、このように構成される座標入力装置１１０においては、アルミベゼル１１８内に設けられた発光素子１２２および受光素子やセンサ基板１２３が外部から視認されることにより、外観が損なわれることを防止するために、また、アルミベゼル１１８内に埃などが侵入し、発光素子１２２および受光素子に付着することにより、発光素子１２２から出射された赤外線Ｌが受光素子において検出されるときの検出レベルが低下することで、保護ガラス１１２の表面における指示位置を誤検出してしまうことを防止するために、図５に示すように、アルミベゼル１１８の額縁部分１２０における内方側端部１２０ａと保護ガラス１１２の周縁部分１１４との間に形成された間隙１２１を閉塞するように、可視光を吸収し、赤外線Ｌを透過する赤外線透過フィルタ（以下、「ＩＲフィルタ」と称する）１２４がさらに組み付けられて構成されている。

【先行技術文献】

【特許文献】

【０００７】

【特許文献１】特開平１１－４５１５５号公報

【発明の概要】

【発明が解決しようとする課題】

【０００８】

従来から、このＩＲフィルタ１２４は、可視光を吸収し、赤外線Ｌを透過するＩＲインクをシルク印刷した、たとえばポリカーボネート（ＰＣ）から成る長尺の板状体によって構成され、図５に示すように、その幅方向の一方側の端部１２４ａが、保護ガラス１１２の周縁部分１１４に対して接触するように、その幅方向の他方側の端部１２４ｂが、アル

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ミベゼル１１８の額縁部分１２０における内方側端部１２０ａに、両面テープなどで固定されている。

【０００９】

しかしながら、かかる構造では、ＩＲフィルタ１２４の一方側の端部１２４ａが固定されていないため、たとえば装置を運搬する際の揺れなどに起因して、その一方側の端部１２４ａが振動すると、一方側の端部１２４ａと保護ガラス１１２の周縁部分１１４とが擦れ、保護ガラス１１２の周縁部分１１４の表面を傷つけてしまうという問題がある。

【００１０】

また、かかる構造では、両面テープの劣化などに起因して、ＩＲフィルタ１２４が、額縁部分１２０における内方側端部１２０ａから剥離してしまうおそれがあるという問題もある。さらには、一方側の端部１２４ａが振動することで、該一方側の端部１２４ａと保護ガラス１１２の周縁部分１１４とが離間してしまうと、その間隙からアルミベゼル１１８内に埃が侵入し、発光素子１２２および受光素子に付着することで、発光素子１２２から出射された赤外線Ｌが受光素子において検出されるときの検出レベルが低下してしまうという問題もある。

【００１１】

また、前記のように、従来のＩＲフィルタ１２４は、ＩＲインクをシルク印刷することによって構成されているので、シルク印刷の印刷精度にばらつきが生じてしまうおそれがある。このように印刷精度にばらつきが生じると、赤外線Ｌの透過率が場所に依ってばらつくことにより、発光素子１２２から出射された赤外線Ｌが受光素子において検出されるときの検出レベルも場所によって異なってしまい、保護ガラス１１２の表面における指示位置の誤検出につながるおそれがあるという問題もある。

【００１２】

さらに、従来の液晶表示装置１００では、赤外線遮断方式による座標入力装置１１０を搭載するために、アルミベゼル１１８の額縁部分１２０における内方側端部１２０ａと保護ガラス１１２の周縁部分１１４との間に間隙１２１が形成されるので、保護ガラス１１２を固定するために、図５に示すように、板金部品であるガラス押えアングル１１６とガラス押えクッション１１７とを別途取り付ける必要がある。このため、装置全体の重量が増大し、また、部品点数も多くなっているという問題がある。さらに、これにより、製造コストが増大しているという問題もある。

【００１３】

引用文献１には、額縁部分における内方側端部に相当する部分と、保護ガラスに相当するアクリル板との間にＩＲフィルタを配置することについては開示されているが、アクリル板の固定方法については記載されていない。

【００１４】

本発明の目的は、装置全体の重量を低減し、部品点数を削減し、赤外線の透過率を場所に依らずに安定させることができる座標入力装置およびそれを備える画像表示装置を提供することである。

【課題を解決するための手段】

【００１５】

本発明は、画像を表示する表示面を有する表示部と、前記表示面に対向して配設される透明の板状部材と、前記表示部および前記板状部材を外囲するフレーム部材と、前記板状部材の周縁部分を前記表示部側から支持する支持部材とを含み、前記フレーム部材が、前記板状部材の厚み方向に、前記周縁部分から離間して配置される枠状部分を有する画像表示装置に搭載され、前記板状部材における、指示体によって指示された指示位置を検出する座標入力装置であって、

前記フレーム部材の内部に設けられ、前記板状部材の周縁部分と前記枠状部分との間の間隙を介して、前記指示位置を検出するために用いられる検出光を受光する複数の受光部と、

前記検出光を透過する材料から成り、前記間隙を閉塞する閉塞部材とを含み、

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前記閉塞部材が、前記支持部材と協働して前記板状部材の周縁部分を挟持することにより、該板状部材を固定するように構成されていることを特徴とする座標入力装置である。

【００１６】

また本発明は、前記閉塞部材は、

前記板状部材の周縁部分における、前記表示部側とは反対側の表面に面接触する挟持部分と、

前記挟持部分における、前記厚み方向に垂直な面方向の外方側の端部に連なり、前記支持部材に固定される固定部分と、

前記挟持部分における、前記面方向の内方側の端部に連なり、前記開隙を閉塞する閉塞部分とを含むことを特徴とする。

【００１７】

また本発明は、前記固定部分は、長尺の板状に形成され、前記支持部材に対面する側の対向面には、前記支持部材に対する位置決めのための複数の位置決め部が、長手方向に沿って間を空けて形成され、前記対向面とは反対側の面には、前記位置決め部が形成されている位置に対応して、リブが形成されていることを特徴とする。

【００１８】

また本発明は、前記フレーム部材の内部に前記複数の受光部に個別に対応して設けられ、対応する前記受光部に向けて、赤外線を前記検出光として出射する複数の発光部をさらに含むことを特徴とする。

また本発明は、前記座標入力装置が搭載されることを特徴とする画像表示装置である。

【発明の効果】

【００１９】

本発明によれば、フレーム部材の枠状部分と板状部材の周縁部分との間に開隙が形成され、その開隙を介して、板状部材における指示位置を検出するために用いられる検出光を受光して、指示位置の座標を検出するように構成された座標入力装置が搭載される画像表示装置において、板状部材を固定するための部材を、閉塞部材と別途に設ける必要がなくなるので、装置全体の重量を低減することができ、また部品点数を削減することができる。さらに、閉塞部材が、検出光を透過する材料から成るので、赤外線の透過率を場所に依らずに安定させることができる。

【図面の簡単な説明】

【００２０】

【図１】本発明の第１の実施形態に係るタッチパネル装置１０を搭載した液晶表示装置１の構成を概略的に示す正面図である。

【図２】図１における切断面線１１－１１から見た断面を示す斜視図である。

【図３】液晶表示装置１の左上の角部を拡大して示す図であり、図３（ａ）は外観ベゼル１６が装着された状態を示し、図３（ｂ）は外観ベゼル１６が取り外された状態を示している。

【図４】本発明の第２の実施形態に係るタッチパネル装置を構成するＩＲフィルタ４０の長手方向の一方側の構成を概略的に示す斜視図であり、図４（ａ）はＩＲフィルタ４０を上方から見た斜視図であり、図４（ｂ）はＩＲフィルタ４０を下方から見た斜視図である。

【図５】従来技術に係る赤外線遮断方式による座標入力装置１１０を搭載した液晶表示装置１００の構成を示す部分断面図である。

【発明を実施するための形態】

【００２１】

（第１の実施形態）

図１は、本発明の第１の実施形態に係るタッチパネル装置１０を搭載した液晶表示装置１の構成を概略的に示す正面図である。図２は、図１における切断面線１１－１１から見た断面を示す斜視図である。本実施形態に係るタッチパネル装置１０は、赤外線遮断方式による座標入力装置である。

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【００２２】
先ず、液晶表示装置１の構成について説明する。液晶表示装置１は、図２に示すように、画像を表示する表示面を一方側の主面１１ａに有する矩形板状に構成された液晶パネル１１（表示部）と、液晶パネル１１の表示面に対向して配置される、無色透明で矩形板状の保護ガラス１２（板状部材）と、液晶パネル１１を含む液晶モジュール１３を四方から外囲するとともに、保護ガラス１２の周縁部分１４を液晶パネル１１側から支持するモジュール金属ベゼル１５（支持部材）と、液晶モジュール１３および保護ガラス１２を四方から外囲する、外観フレームとして機能する矩形枠状の外観ベゼル１６（フレーム部材）とを含んで構成される。

【００２３】
外観ベゼル１６は、液晶モジュール１３および保護ガラス１２の外周に沿って設けられる、該外周よりも一回り大きな大略的に矩形筒状の側壁部分１７と、側壁部分１７における、保護ガラス１２の厚み方向の一方側の端部であって、液晶表示装置１の正面側に配置される端部に一体的に連なり、側壁部分１７から内方側へ略直角に屈曲する矩形枠状の縁部分１８（枠状部分）とを含み、縁部分１８は、保護ガラス１２の周縁部分１４に対し、保護ガラス１２の厚み方向に離間して配置される。これにより、図２に示すように、外観ベゼル１６の縁部分１８における内方側端部１８ａと、保護ガラス１２の周縁部分１４との間には間隙１９が形成される。外観ベゼル１６は、たとえばアルミ押出材によって構成される。

【００２４】
一方、タッチパネル装置１０は、赤外線Ｌ（検出光）を出射する複数の発光素子２１（発光部）と、複数の発光素子２１に個別に対応して設けられ、対応する発光素子２１から出射された赤外線Ｌをそれぞれ受光する複数の受光素子２２（受光部）と、外観ベゼル１６内に保持され、複数の発光素子２１および受光素子２２が搭載されるセンサ基板２３とを含んで構成される。

【００２５】
本実施形態では、図１に示すように、液晶パネル１１の一方の長辺に沿って、複数の発光素子２１が、液晶パネル１１の短辺に平行に赤外線Ｌを出射するように、等間隔で一列に並べて配設されるとともに、液晶パネル１１の一方の短辺に沿って、複数の発光素子２１が、液晶パネル１１の長辺に平行に赤外線Ｌを出射するように、等間隔で一列に並べて配設され、各発光部２２から出射された赤外線Ｌが受光されるように、液晶パネル１１の他方の長辺および短辺に沿って、複数の受光素子２２が、等間隔で一列に並べて配設されている。これにより、複数の発光素子２１からは、格子を形成するように、赤外線Ｌが出射される。

【００２６】
本実施形態では、図２に示すように、複数の発光素子２１および受光素子２２は、保護ガラス１２の厚み方向に関して、間隙１９が形成される位置に対応して配設されるように、センサ基板２３にそれぞれ搭載される。これにより、外観ベゼル１６内に配置される発光素子２１から出射された赤外線Ｌは、間隙１９を通過し、保護ガラス１２の表面に沿って進行し、再度、間隙１９を通過して、外観ベゼル１６内に配置される、対応する受光素子２２によって受光される。なお、発光素子２１および受光素子２２は、たとえばＬＥＤ（Light Emitting Diode）によって実現される。

【００２７】
タッチパネル装置１０は、各受光素子２２において、対応する発光素子２１から出射された赤外線Ｌが検出されたか否かに基づいて、ユーザが保護ガラス１２の表面を指またはスタイラスなどの指示体によって指示した指示位置の座標を検出する。

【００２８】
本実施形態に係るタッチパネル装置１０は、外観ベゼル１６内に設けられた複数の発光素子２１および受光素子２２ならびにセンサ基板２３が外部から視認されることにより、外観が損なわれることを防止するために、また、外観ベゼル１６内に塵埃が侵入し、塵埃

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が発光素子２１および受光素子２２に付着することにより、発光素子２１から出射された赤外線Ｌが受光素子２２において検出されるときの検出レベルが低下することで、保護ガラス１２の表面における指示位置を誤検出してしまうことを防止するために、図１に示すように、外観ベゼル１６の額縁部分１８における内方側端部１８ａと保護ガラス１２の周縁部分１４との間に形成された間隙１９を閉塞するように、可視光を吸収し、赤外線Ｌを透過する赤外線透過フィルタ（以下、「ＩＲフィルタ」と称する）２４がさらに組み付けられて構成されている。

【００２９】

ＩＲフィルタ２４は、本実施形態では、液晶パネル１１の各長辺および各短辺に沿ってそれぞれ設けられる長尺の棒状部材であり、可視光を吸収し、赤外線Ｌを透過する赤外線透過樹脂で射出成型されることによって製造される。

【００３０】

ＩＲフィルタ２４は、図２に示すように、保護ガラス１２の周縁部分１４における、液晶パネル１１側とは反対側の表面に面接触する挟持部分３１と、挟持部分３１における、保護ガラス１２の厚み方向に垂直な面方向の外方側の端部に一体的に連なり、モジュール金属ベゼル１５に固定される板状の固定部分３２と、挟持部分３１における、前記面方向の内方側の端部に一体的に連なり、間隙１９を閉塞する板状の閉塞部分３３とを含んで構成される。

【００３１】

本実施形態では、図２に示すように、固定部分３２とモジュール金属ベゼル１５とは、締結具であるねじ２５によって締結固定される。これにより、挟持部分３１は、モジュール金属ベゼル１５と協働して、保護ガラス１２の周縁部分１４を挟持する。保護ガラス１２は、各長辺および各短辺に対応する周縁部分１４が、ＩＲフィルタ２４の挟持部分３１とモジュール金属ベゼル１５とによって挟持されることにより、液晶パネル１１に対向する位置に固定される。

【００３２】

また、挟持部分３１は、図２に示すように、その断面が大略的にＬ字形状を成しており、前記のように保護ガラス１２の周縁部分１４に面接触する第１部分３１ａと、その第１部分３１ａの前記面方向の外方側の端部に連なり、第１部分３１ａからモジュール金属ベゼル１５側へ略直角に屈曲する第２部分３１ｂとから成り、この第２部分３１ｂは、ＩＲフィルタ２４がモジュール金属ベゼル１５に締結固定されたときに、保護ガラス１２の外表面を前記面方向の外方から被覆するように構成されている。

【００３３】

空中を浮遊する塵埃は、静電気力等によって保護ガラス１２の表面に引き寄せられ、その後、重力によって落下することにより、保護ガラス１２とＩＲフィルタ２４との境目の部分に溜まり易い。図５に示す従来技術によれば、振動によって保護ガラス１１２とＩＲフィルタ１２４との間に隙間が形成されてしまうと、境目の部分に溜まった塵埃がその隙間から外観ベゼル１１８内へ侵入してしまう。

【００３４】

しかしながら、本実施形態によれば、ＩＲフィルタ２４が前記のように構成されているので、境目の部分に溜まった塵埃が、保護ガラス１２と挟持部分３１との間に侵入したとしても、塵埃は保護ガラス１２と挟持部分３１との間に閉じ込め、外観ベゼル１６内へ侵入することを防止することができる。したがって、発光素子２１および受光素子２２に塵埃が付着することに起因して、発光素子２１から出射された赤外線Ｌが受光素子２２において検出されるときの検出レベルが低下してしまうことが防止され、これにより、保護ガラス１２の表面における指示位置を誤検出してしまうことを防止することができる。

【００３５】

なお、ＩＲフィルタ２４の閉塞部分３３は、本実施形態では、保護ガラス１２から離反するにつれて前記面方向の外方側へ傾斜するように形成され、挟持部分３１とは反対側の端部が、外観ベゼル１６の額縁部分１８における内方側端部１８ａと接触することで、間

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隙１９を閉塞している。

【００３６】

本実施形態では、図２に示すように、開口部分３３の保持部分３１とは反対側の端部と内方側端部１８ａとが直接接触しているが、該端部と内方側端部１８ａとの間から外観ベゼル１６内への塵埃の侵入を確実に防止するために、該端部と内方側端部１８ａとの間にクッション材を設けて、該端部と内方側端部１８ａとの間を確実に封止するように構成してもよい。

【００３７】

図３は、液晶表示装置１の左上の角部を拡大して示す図であり、図３（ａ）は外観ベゼル１６が装着された状態を示し、図３（ｂ）は外観ベゼル１６が取り外された状態を示している。

【００３８】

図３に示すように、本実施形態に係るタッチパネル装置１０は、液晶パネル１１の長辺に沿って配置されるＩＲフィルタ２４Ａが、保護ガラス１２の角部において、短辺側の周縁部分１４を部分的に覆い、ＩＲフィルタ２４Ａと、液晶パネル１１の短辺に沿って配置されるＩＲフィルタ２４Ｂとの接合部が、長辺に沿って延びるように構成されている。

【００３９】

そして、その接合部において、ＩＲフィルタ２４Ａの開口部分３３に形成された、断面がＬ字形状の段差部３４に、ＩＲフィルタ２４Ｂの開口部分３３が係合するように構成されている。これにより、塵埃が、ＩＲフィルタ２４ＡとＩＲフィルタ２４Ｂとの接合部を介して、外観ベゼル１６内へ侵入してしまうことを防止している。

【００４０】

以上のように、本実施形態によれば、ＩＲフィルタ２４は、赤外線透過樹脂で射出成型によって製造されているので、従来技術のように、ＩＲインクをシルク印刷する場合と比較して、赤外線Ｌの透過率を場所に依らずに安定させることができる。

【００４１】

また、本実施形態によれば、ＩＲフィルタ２４は、外観ベゼル１６の額縁部分１８における内方側端部１８ａと保護ガラス１２の周縁部分１４との間に形成された隙間１９を閉塞するとともに、モジュール金属ベゼル１５と協働して、保護ガラス１２の周縁部分１４を挟持することにより、保護ガラス１２を固定する機能を有しているので、保護ガラス１２を固定するための、板金部品などの部材を別途に設ける必要がない。したがって、装置全体の重量を低減し、部品点数を削減し、製造コストを低減することができる。

【００４２】

また、本実施形態によれば、装置を運搬する際に揺れなどが生じたとしても、ＩＲフィルタ２４と保護ガラス１２とが擦れることがないので、保護ガラス１２の周縁部分１４の表面の損傷を防止することができる。

【００４３】

また、本実施形態によれば、ＩＲフィルタ２４は、モジュール金属ベゼル１５に締結固定されたときに、挟持部分３１における第１部分３１ａが、保護ガラス１２の周縁部分１４に面接触し、挟持部分３１における第２部分３１ｂが、保護ガラス１２の外周面を前記面方向の外方から被覆するように構成されているので、塵埃が、保護ガラス１２と挟持部分３１との間に侵入したとしても、外観ベゼル１６内へ侵入することを防止することができる。

【００４４】

なお、本実施形態では、画像表示装置として液晶表示装置１を例示しているが、これに限らず、タッチパネル装置１０は、プラズマディスプレイ装置や有機ＥＬ（Electro-Luminescence）ディスプレイ装置などに搭載されてもよい。

【００４５】

（第２の実施形態）

図４は、本発明の第２の実施形態に係るタッチパネル装置を構成するＩＲフィルタ４０

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の長手方向の一方側の構成を概略的に示す斜視図であり、図４（ａ）はＩＲフィルタ４０を上方から見た斜視図であり、図４（ｂ）はＩＲフィルタ４０を下方から見た斜視図である。図４では、液晶パネル１１の短辺に沿って配置されるＩＲフィルタ４０を示している。本実施形態に係るタッチパネル装置は、ＩＲフィルタ４０の構成が、第１の実施形態に係るＩＲフィルタ２４と異なっている。なお、ＩＲフィルタ４０において、第１の実施形態に係るＩＲフィルタ２４と同一の構成については、同一の参照符を付し、重複する説明を省略する。

【００４６】

本実施形態に係るＩＲフィルタ４０は、固定部分３２における、モジュール金属ベゼル１５に対向する側の対向面３２ａに、モジュール金属ベゼル１５に対する位置決めのための複数の突起３６（位置決め部）が、長手方向に沿って間を空けて形成されている。

【００４７】

一方、図示しないが、モジュール金属ベゼル１５には、このＩＲフィルタ４０に形成された各突起３６がそれぞれ嵌合可能な複数の凹所が形成されており、ＩＲフィルタ４０の各突起３６とモジュール金属ベゼル１５の各凹所とをそれぞれ嵌合させることにより、ＩＲフィルタ４０が、モジュール金属ベゼル１５に対して適所に配置されるように構成されている。

【００４８】

また、ＩＲフィルタ４０の固定部分３２における、対向面３２ａとは反対側の面３２ｂには、ＩＲフィルタ４０の長手方向に関して、各突起３６が形成されている位置に対応した位置に、リブ３５がそれぞれ形成されている。

【００４９】

なお、固定部分３２には、締結具としてのねじ２５（図２参照）の軸が挿通可能な孔部３７が形成され、また、ＩＲフィルタ４０の長手方向の端部には、液晶パネル１１の長辺に沿って配置されるＩＲフィルタ４０の長手方向の端部に形成された段差部３４（図３（ｂ）参照）に係合するように、閉塞部分３３を、枠持部分３１および固定部分３２よりも長手方向に突出させた突出部分３８が形成されている。

【００５０】

以上のように、本実施形態によれば、固定部分３２に設けられたリブ３５によって、長尺の部材であるＩＲフィルタ４０を補強することができ、さらに、ＩＲフィルタ４０をモジュール金属ベゼル１５に組み付ける際、このリブ３５を視認することで、各突起３６が形成されている位置を把握することができるので、各突起３６をモジュール金属ベゼル１５の各凹所に対して容易に嵌合させることができ、ＩＲフィルタ４０のモジュール金属ベゼル１５への組付け作業の作業性を向上させることができる。

【００５１】

なお、本実施形態では、ＩＲフィルタ４０の固定部分３２には、位置決め部として突起３６が形成されているが、他の実施形態では、位置決め部として凹所が形成されてもよい。この場合には、モジュール金属ベゼル１５側に、該凹所に嵌合可能な突起が形成される。

【００５２】

（第３の実施形態）

上記の実施形態では、タッチパネル装置１０は、赤外線遮断方式による座標入力装置によって実現されていたが、第３の実施形態では、赤外線カメラ方式による座標入力装置が、タッチパネル装置として液晶表示装置１に搭載される。

【００５３】

この場合のタッチパネル装置は、たとえば、赤外線Ｌを出射する、ＬＥＤなどによって実現される赤外線投光器（発光部）と、赤外線投光器から出射された赤外線Ｌを受光するＣＣＤ（Charge Coupled Device）カメラ（受光部）とを含んで構成される。赤外線投光器およびＣＣＤカメラは、液晶表示装置１の上段における左右両端の各角部において、液晶表示装置１の外観ベゼル１６内に設置され、保護ガラス１２の表面における指示位置の

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座標は、ＣＣＤカメラによって撮像された映像に基づいて、三角測量方式により検出される。

【００５４】

このようなタッチパネル装置においても、外観ベゼル１６内に設置された赤外線投光器およびＣＣＤカメラが外部から視認されることにより、外観が損なわれることを防止するために、また、外観ベゼル１６内に塵埃が侵入し、塵埃が赤外線投光器およびＣＣＤカメラに付着することにより、ＣＣＤカメラにおける検出レベルが低下することで、保護ガラス１２の表面における指示位置を誤検出してしまうことを防止するために、外観ベゼル１６の額縁部分１８における内方側端部１８ａと保護ガラス１２の周縁部分１４との間に形成された間隙１９を閉塞するように、第１の実施形態で説明した赤外線透過フィルタ２４を設けることで、第１の実施形態と同様の効果を奏することができる。

【００５５】

なお、赤外線カメラ方式による座標入力装置としては、外観ベゼル１６内に赤外線投光器およびＣＣＤカメラを設けるものに限らず、たとえば、外観ベゼル１６内には赤外線投光器を設けずに、保護ガラス１２の表面を指示するためのスタイラスの先端部に、赤外線Ｌを出射する発光部を設けたものによって実現されてもよい。

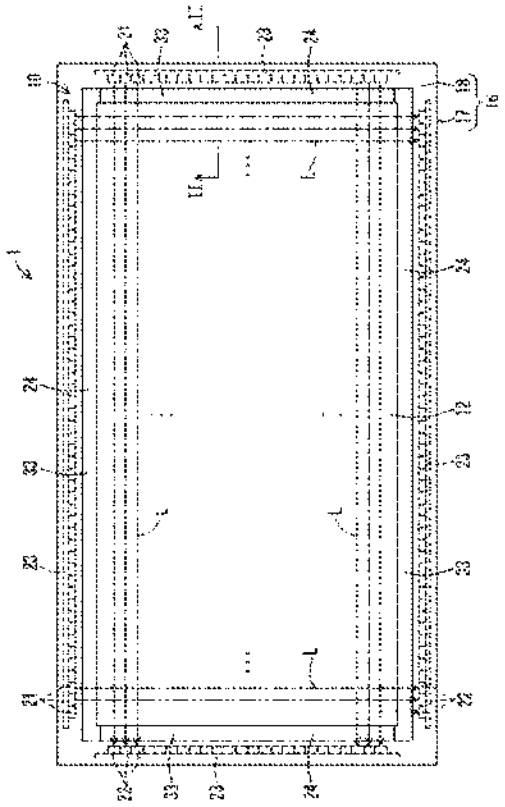
【符号の説明】

【００５６】

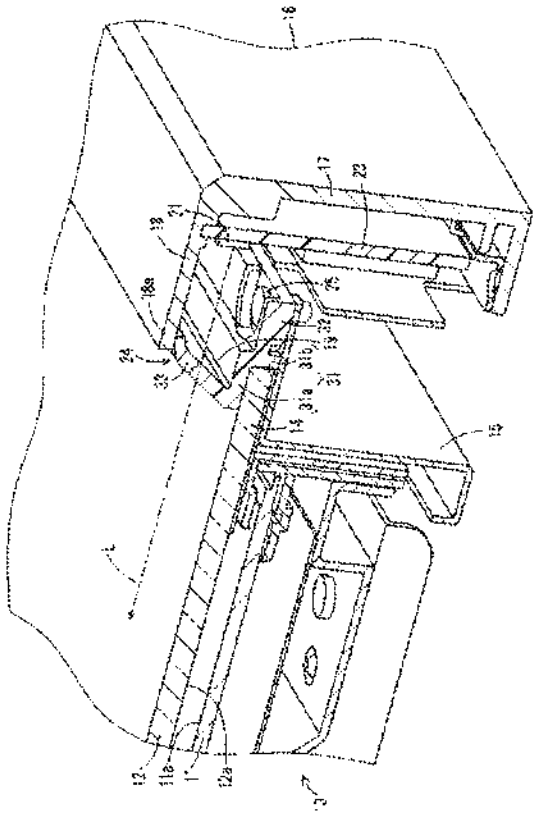
１　液晶表示装置
１０　タッチパネル装置
１１　液晶パネル
１２　保護ガラス
１３　液晶モジュール
１４　周縁部分
１５　モジュール金属ベゼル
１６　外観ベゼル
１７　側壁部分
１８　額縁部分
１９　間隙
２１　発光部
２２　受光部
２４　ＩＲフィルタ
３１　挟持部分
３２　固定部分
３３　開口部分

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【図１】

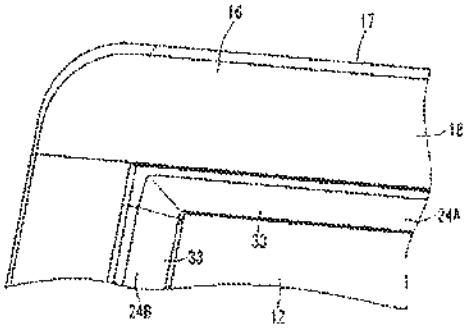


【図２】

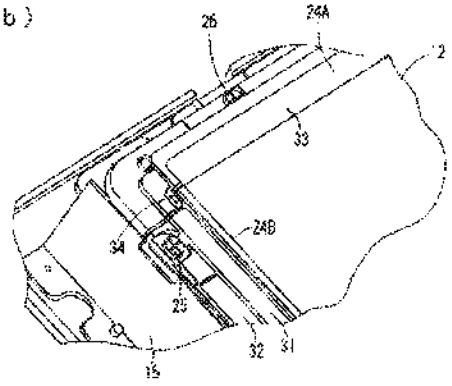


【図３】

（ａ）

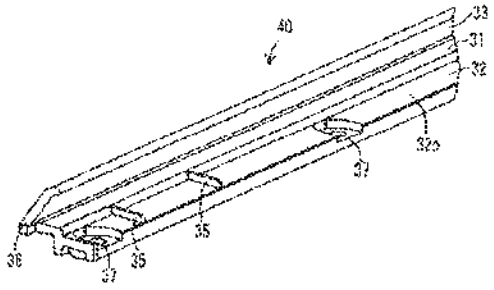


（ｂ）

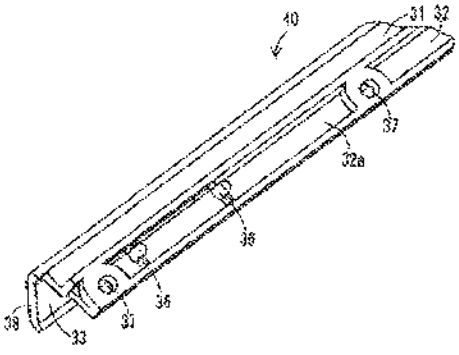


【図４】

（ａ）

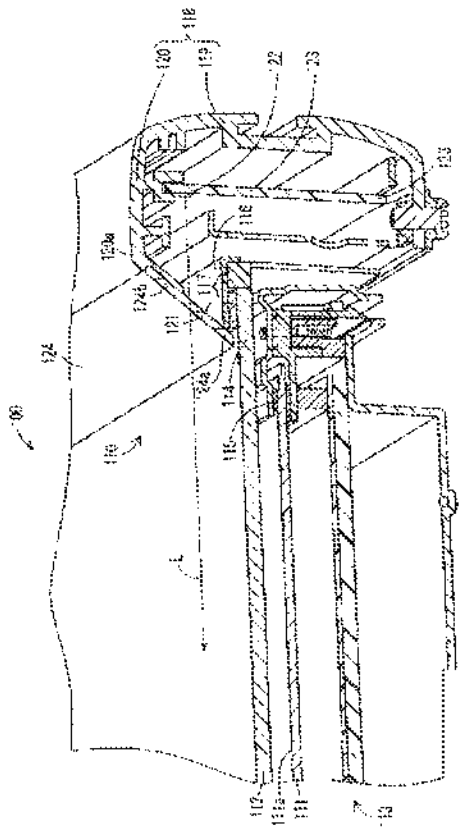


（ｂ）



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【図５】



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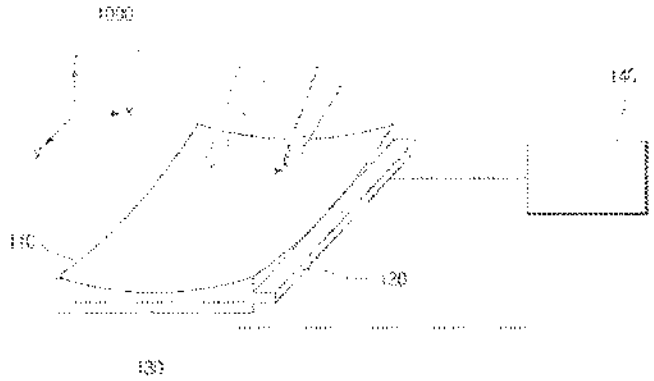
전체 청구항 수 : 총 23 항 심사관 : 허정권

(54) 촉감제시 인터페이스 장치

(57) 요 약

촉감제시 인터페이스 장치가 제시된다. 터치스크린부는 터치스크린부의 입력의 변화정도와 터치스크린부를 구성방향으로 신호세기는 구동부 및 구동부의 동작 주파수를 조절하는 제어부를 포함하는 촉감제시 인터페이스 장치는, 터치스크린부는 그 입력에 변화된 방향으로 신호세기, 사용자가 감지하는 무딘의 촉감이 변화되는 조작감을 제공 할 수 있다.

대표도 - 도1



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청구항 / 없음

청구항 1

전자기 장치에 있어서,

사용 시에 입력 표면을 형성하는 터치 민감 표면을 포함하는 터치 표면 장치 및

이 장치에 반응하도록, 상기 터치 표면에 수행 명령을 입력하기 위한 입력 장치

상기 장치는 상기 장치와 통신하는 제어기를 포함하고, 상기 제어기는 상기 장치로부터 상기 입력 장치에 의해 수행된 명령을 수신하고 상기 명령을 실행하도록 상기 장치에 지시하는 것을 특징으로 하는 전자기 장치.

청구항 2

제1항에 있어서,

상기 입력 장치는 상기 표면과 접촉하는 펜을 포함하는 것을 특징으로 하는 전자기 장치.

청구항 3

제2항에 있어서,

상기 입력 장치는 펜 팁에 위치한 하나 이상의 압력 센서를 포함하는 것을 특징으로 하는 전자기 장치.

청구항 4

제1항에 있어서,

상기 입력 장치는 주변광을 감지하는 광 센서를 포함하는 것을 특징으로 하는 전자기 장치.

청구항 5

제1항에 있어서,

상기 제어기는 상기 터치 표면 상의 다중 접촉을 동시에 추적하도록 구성되는 것을 특징으로 하는 전자기 장치.

청구항 6

제5항에 있어서,

상기 기능은 상기 터치 표면에 입력된 명령에 따라 그림을 그리는 것을 포함하는 것을 특징으로 하는 전자기 장치.

청구항 7

제1항에 있어서,

상기 장치는 상기 터치 표면에 입력된 명령에 따라 그림을 그리는 것을 포함하는 것을 특징으로 하는 전자기 장치.

청구항 8

제1항에 있어서,

상기 입력 장치는 입력을 제공하기 위해 안테나를 포함하고, 상기 입력 장치의 위치에 대한 정보를 포함하는 것을 특징으로 하는 전자기 장치.

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이 없는 조명용의 전자회로가 있다.

청구항 9

제1항에 있어서,

상기 보조기판의 양면은,

상기 보조기판의 양면에 형성되는 전극패턴에 의해 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

청구항 10

제9항에 있어서,

상기 보조기판의 양면은,

상기 보조기판의 양면에 서로 다르게 형성되는 전극패턴을 통하여 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

청구항 11

제1항에 있어서

상기 보조기판의 양면은,

상기 보조기판의 양면 중 하나의 면에 형성되는 전극패턴을 통하여 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

청구항 12

제1항에 있어서,

상기 보조기판의 양면은,

상기 보조기판의 양면에 형성되는 전극패턴을 통하여 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

청구항 13

제1항에 있어서,

상기 보조기판의 양면은,

상기 보조기판의 양면에 서로 다르게 형성되는 전극패턴을 통하여 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

청구항 14

제1항에 있어서,

상기 보조기판의 양면은,

상기 보조기판의 양면 중 하나의 면에 형성되는 전극패턴을 통하여 전기적으로 연결되는 것을 특징으로 하는 조명용의 전자회로가 있다.

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청구항 15

제1항에 있어서,

상기 센서부는,

상기 터치스크린패널 전체 영역 중 스캔부가 상기 프리스캔신호를 출력할 주요 영역을 구분하고 상기 주요영역 내에서만 검출 신호를 제어하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 16

제15항에 있어서,

상기 센서부는

상기 프리스캔신호의 전압이 서로 다른 복수개의 레벨을 가지도록 제어하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 17

제16항에 있어서,

상기 프리스캔신호의 크기에 따라 검출되는 정상검지패턴의 수 차이에 따라 상기 주요영역을 결정하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 18

제17항에 있어서,

상기 주요영역은 상기 정상검지패턴의 외곽에 검출되는 최초 1개 이상의 패턴을 포함하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 19

제17항에 있어서,

상기 주요영역은 상기 정상검지패턴의 외곽에 검출되는 최초 1개 이상의 패턴 중 검출되는 최종 1개 이상의 패턴을 포함하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 20

제17항에 있어서,

상기 주요영역은 상기 각각의 센서라인 사이에 검출되는 최종 1개 이상의 패턴을 포함하는 것을 특징으로 하는 터치스크린패널 제어장치.

청구항 21

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제17항이 없어서,

상기 입력부재는 상기 센서부의 작동신호를 무선으로 송신하는 무선통신부를 더 포함하는 것을 특징으로 하는 주차관제 장치를 이용한 주차관제 방법.

청구항 22

제17항이 없어서,

상기 입력부재는 스마트폰을 이용하여 입력하는 것을 특징으로 하는 주차관제 장치를 이용한 주차관제 방법.

청구항 23

제22항이 없어서,

상기 스마트폰은, 설정이 변경된 것으로,

상기 주차관제 장치를 통해 상기 스마트폰으로 설정값을 전송하는 것을 특징으로 하는 주차관제 장치를 이용한 주차관제 방법.

발명의 상세한 설명

기술 분야

[0001] 본 발명은 주차관제 장치를 이용한 주차관제 방법에 관한 것이다.

배 경 기 술

[0002] 일반적으로 RFID(Radio Frequency Identification) 시스템은 기술 산업의 자동화를 위해 널리 적용되고 있는 기술이다. 그 RFID 시스템은 태그(tag)와 리더(reader)로 구성되어 있다. 태그는 리더로부터 발생되는 전자기장을 이용하여 동작하며, 리더는 태그로 전자기장을 발생시키고 태그로부터 응답되는 데이터를 수신하는 역할을 한다. 이 때 태그는 제품에 부착되어 제품 정보를 저장하고 있으며, 리더는 태그로부터 제품 정보를 읽어 들이는 역할을 한다.

[0003] 최근에는, 이러한 RFID 기술을 이용한 출차시, 주차시간에 따른 할인을 적용하는 주차관제 장치가 개발되고 있다. 이러한 주차관제 장치는 차량 입구에 설치되어 차량 정보를 인식하고 차량 출구에 설치되어 차량 정보를 인식하여 주차시간을 계산하고 할인을 적용하여 요금을 정산하는 방식이다.

발명이 해결하고자 하는 과제

[0004] 본 발명은 주차관제 장치를 이용한 주차관제 방법에 있어서, 입력부재를 통해 입력된 주차시간에 따른 할인을 적용하여 요금을 정산하는 것을 목적으로 한다.

과제의 해결 수단

[0005] 본 발명의 일 실시예에 따른 주차관제 장치를 이용한 주차관제 방법은 입력부재를 통해 입력된 주차시간에 따른 할인을 적용하여 요금을 정산하는 것을 특징으로 한다.

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와 터치스크린부와 수직 방향으로 진동시키는 구동부 및 구동부의 동작 주파수를 조절하는 제어부를 포함하는 초음파 입터페이스 장치가 제공된다.

[0007] 여기서, 구동부의 동작 주파수는 1MHz이상일 수 있으며, 구동부의 동작 주파수는 가청 주파수 이상일 수도 있다. 그리고, 구동부는 압전소자를 포함하여 이루어질 수 있다.

[0008] 한편, 구동부는 복수 개일 수 있으며, 구동부는, 터치스크린의 일측에 결합될 수 있으며, 구동부는 터치스크린의 일면의 가장자리에 위치될 수 있다.

[0009] 한편, 초음파식 입터페이스 장치는 터치스크린부의 일면의 진동을 감지하는 모드감지부를 더 포함하며, 구동부는 모드감지부의 감지된 진동의 변화정도에 따라 구동부의 동작을 제어할 수 있다.

[0010] 한편, 터치스크린부의 일면은 터치스크린부의 중앙부에 대응하는 제1영역과 터치스크린부의 가장자리에 대응하는 제2영역을 포함하며, 터치스크린부의 일면은 터치스크린의 일면에서 터치스크린부를 향하는 방향으로 돌출되는 돌출부를 포함하며, 돌출부는 제1영역과 제2영역 사이에 형성될 수 있다.

[0011] 그리고, 터치스크린부의 일면은 터치스크린부의 중앙부에 터치스크린부를 향하는 방향으로 오목하게 형성된 오목부를 포함하며, 또한, 터치스크린부의 일면은 터치스크린부의 일면에서 터치스크린부를 향하는 방향으로 돌출되는 돌출부를 더 포함하며, 터치스크린부의 가장자리에서 터치스크린부의 중심을 향해 오목하게 형성된 오목부를 포함할 수 있다.

[0012] 한편, 제어부는 터치스크린부의 사용 위치에 따라 구동부가 터치스크린부로 전달하는 주파수를 조절하도록 구동부를 제어할 수 있으며, 이 때, 제어부는 터치스크린부의 일부로 사용자 초음파식 입력으로 구별하며, 터치스크린부의 사용 위치가 초음파식 입력 여부에 따라 구동부가 전달하는 주파수를 터치스크린부로 전달하도록 구동부를 제어할 수 있다.

[0013] 그리고, 초음파식 입터페이스 장치는 터치스크린부의 일면에 접촉되는 펜형표시체부재를 더 포함할 수 있으며, 구동부는 펜형표시체부재의 일측에 전달될 수 있다.

[0014] 한편, 펜형표시체부재에는 복수의 아이콘이 표시되며, 초음파식입력은 인접된 복수의 아이콘 사이의 영역에 입력될 수 있으며, 초음파식입력은 아이콘의 가장자리를 따라 환형으로 입력될 수도 있다. 그리고, 초음파식입력은 아이콘의 일측과 평행하게 입력될 수도 있다.

[0015] 그리고, 펜형표시체부재에는 스크린버튼이 표시되며, 초음파식입력은 스크린버튼에 위치되는 방향으로 점착력으로 입력될 수 있으며, 스크린버튼에 회전의 힘이가해 지는 경우, 초음파식입력은 스크린버튼 상에 방사상으로 입력될 수 있다.

도 면

[0016] 상술한 바와 같은 본 발명의 실시예에 따르면, 터치스크린부를 그 일면에 접촉한 방향으로 진동시켜, 사용자가 접촉하는 부분의 촉감의 변화하는 조작감을 제공할 수 있다.

발명의 실시를 위한 구체적인 내용

[0017] 본 발명의 특징 및 이점과 이외의 보다 명확한 설명은 첨부된 도면을 참조한 실시예에 대한 설명을 통하여 명확하게 될 것이다.

[0018] 이하, 본 발명에 따른 초음파식 입터페이스 장치의 실시예를 첨부도면을 참조하여 상세히 설명하기로 하며, 첨부 도면을 참조하여 설명함에 있어, 동일하거나 대응하는 구성 요소는 동일한 도면번호를 부여하고 이에 대한 중복되는 설명은 생략하기로 한다.

[0019] 도 1은 본 발명의 제1 실시예에 따른 초음파식 입터페이스 장치(1000)를 나타낸 사시도이다. 도 1에 도시된 바와 같이, 본 발명의 제1 실시예에 따른 초음파식 입터페이스 장치(1000)는, 터치스크린부(110), 터치스크린부(110)의 모서리의 곡선의 변화정도에 따라 터치스크린부(110)를 구동 방향으로 진동시키는 구동부(120), 구동부(120)의 동작 주파수를 조절하는 제어부(130) 및 터치스크린부(110)가 사용자 입력으로 인식하는 초음파식 입력을 처리하는 처리부(140)를 포함하여 이루어질 수 있다.

[0020] 초음파식 입터페이스 장치(1000)는 사용자의 터치의 입력 정보를 얻을 수 있으며, 이와 같은 터치입력으로

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사용자가 접촉하는 부분의 속성의 변화하는 조작감을 제공할 수 있는 입체입력장치일 수 있다.

[0071] 휴대용의 입체입력장치(1000)는 예를 들어 휴대폰(1100), PDA(Personal Digital Assistance), PMP(Portable Multimedia Player), MP3(MPEG Audio Layer 3) player와 같은 휴대용 통신기기 이외에도, 노트북, ATM(Auto Teller Machine), 게임기, 키오스크 등과 같은 각종 기기의 입력장치, 사용자와 터치스크린(1110)의 상호 작용을 가능하면, 그 작용에 대한 정보를 제어부(1200)에 전달할 수 있는 입력부로 적용될 수 있다.

[0072] 여기서, 휴대용의 입체입력장치(1000)의 입력표시제어부(1300)를 더 포함하는 경우, 휴대용의 입체입력장치(1000)가 적용된 각종 기기의 출력부와 입력부의 기능을 용이하게 수행할 수 있음은 물론이다.

[0073] 터치스크린(1110)의 입력에는 입력표시제어부(1300)가 관여하며, 입력표시제어부(1300)는 예를 들어 LCD제어부와 같이 영상을 표시할 수 있는 부분으로, 휴대용의 입체입력장치(1000)가 결합되는 기기기의 동작부로서의 기능을 수행할 수 있다.

[0074] 입력표시제어부(1300)는, 후술한 제어부(1200)와 전기적으로 연결될 수 있으며, 제어부(1200)의 제어 휴대용의 입체입력장치(1000)가 적용된 기기기의 동작 상태에 따라 다양한 입력의 영상을 표시할 수 있다. 입력표시제어부(1300)는, 예를 들어 하이패스(1110), 스피커(1150) 등과 같이 사용자의 메뉴선택과 데이터 입력이 되는 영상을 표시할 수 있다.

[0075] 구동부(1120)는 터치스크린부(110)의 표면의 속성의 변화되도록 터치스크린부(110)를 구동 방향으로 진동시킬 수 있다. 즉, 터치스크린부(110)의 입력이 검지부가 활성되고, 그 대응한 입력의 제스처 동작이 검출될 때 상대적으로 강하게 구동될 수 있으며, 이 때의 구동 방향은 터치스크린부(110)의 대면에 평행한 방향일 수 있다. 다시 말해, 터치스크린부(110)의 입력의 검출에 따라 예로 들어 이하의 설명되는 제어부, 이 때, 터치스크린부(110)의 동작 방향은 X축 또는 Y축방향을 의미할 수 있다.

[0076] 구동부(120)는 예를 들어 압전소자가 사용될 수 있으며, 이 외에도 형상되어, 터치스크린부(110)의 입력이 검출될 수 있다. 한편으로는 그 외 구동의 방법에 따라 다양한 형태의 조작감 진동을 구현할 수 있으며, 또 하나는 상황에 따라 터치스크린부(110)를 진동시킬 수 있다.

[0077] 도 2 내지 도 4는, 본 발명의 제1 실시예에 따른 휴대용의 입체입력장치(1000)의 동작원리를 나타내는 도면이다. 도 2에 도시된 바와 같이, 사용자가 터치스크린부(110)의 표면에 접촉하여 그 위치를 좌측 이동하는 경우, 터치스크린부(110)에 사용자의 손가락이 이동하는 속도(Vs) 보다 터치스크린부(110)에 더 작은 속도(Vs')로 진동하는 경우, 사용자는 손가락이 이동하는 방향과 반대방향의 마찰력(F')을 느낄 수 있다. 다시 말해, 터치스크린부(110)의 표면의 마찰이 감소한 것과 같은 촉감을 느낄 수 있다.

[0078] 그러나, 도 3에 도시된 바와 같이, 터치스크린부(110)에 작은 속도의 손가락이 이동하는 속도(Vs')보다 터치스크린부(110)에 더 큰 속도(Vs)로 진동하는 경우, 사용자는 손가락이 이동하는 방향과 동일한 방향의 마찰력(F')을 느낄 수 있다. 다시 말해, 터치스크린부(110)의 표면의 마찰이 증가한 것과 같은 촉감을 느낄 수 있다.

[0079] 한편, 사람의 피부에는 여러 수용기관이 존재하며, 각각의 수용기관은 주파수 범위에 따라 서로 다른 물리량을 검출할 수 있다. 그 중에 진동을 수용하는 메시너 소체(Meissner corpuscle)는 10 ~ 500 Hz대역에서 진동을 감지할 수 있다.

[0080] 따라서, 구동부(120)는 500 Hz이상으로 터치스크린부(110)를 진동시킴으로써, 사용자에게 진동이 아닌 터치스크린부(110)의 표면의 마찰력의 감소로 인한 촉감의 변화된 것으로 인식될 수 있는 정보를 사용자에게 제공할 수 있다.

[0081] 사용자에 따라 민감하게 인식할 수 있는 범위의 주파수는 조금씩 상이할 수 있으나, 예를 들어 320Hz이상의 주파수로 터치스크린부(110)가 진동하는 경우 대부분의 사용자가 터치스크린부(110)의 표면의 촉감의 변화된 것으로 인식할 수 있다.

[0082] 또한, 사람수에주파수인 20kHz이상에서 구동부(120)의 압에 의한 소음을 사용자가 인식할 수 있어, 사용자, 터치스크린부(110)의 표면의 촉감이 변화된 정보만을 인식할 수 있다.

[0083] 한편, 도 2에 도시된 바와 같이, 터치스크린부(110)의 입력은, 검출장치에 의해 터치스크린부(110)의 접촉을 검출

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우선하게 위상차의 합은 실제 수 μm 이하로 제어되어 있는 것에 비하여, 비교예 1의 패턴(1101)과 같이 패턴(1101)의 폭이 넓은 경우에는 위상차의 합은 수십 μm 이상으로 증가하게 된다. 이와 같이 위상차의 합이 증가하게 되면, 사용자의 손가락에 의해 Z축에 수직 방향으로 작용하는 압력(Fz)에 대한 저항력이 증가하게 된다.

[0054] 그리고, 이러한 실시예들에 의해 패턴(1101)의 폭과 손가락 사이의 거리가 좁아지게 되면, 센서는 인식할 수 없다. 만약, 패턴(1101)의 폭과 Z방향의 전송 주파수가 20kHz 이상인 경우, 패턴(1101)의 폭과 손가락 사이의 분해능은 λ/2이다. 즉, 센서의 인식은 패턴(1101)의 폭과 손가락 사이의 미세변화를 감소시키게 되면, 사용자는 패턴(1101)의 폭과의 유격의 변화로 인식하게 된다. 이것을 일명 air squeeze effect라고 한다.

[0055] 결국, 패턴(1101)의 폭과의 간격을 최소화함으로 인해, 패턴(1101)의 간격과 손가락 사이에 Z방향과 X방향이 상대운동을 무시할 수 있게 되고, 상술한 수직방향의 상대운동으로 인한 미세한 변화의 효과와, air squeeze effect의 인한 미세한 감소의 효과를 동시에 인식할 수 없게 된다. 따라서, 사용자는 여러 번의 패턴(1101)의 폭과의 유격의 변화를 부여 확실하게 느낄 수 있게 된다.

[0056] 도 5 내지 도 9는 본 발명의 제1 실시예에 따른 근접센서 인터페이스 장치에 적용 가능한 패턴부의 변형 예를 나타낸 사시도이다. 도 5 내지 도 9에 도시된 바와 같이, 패턴부(1101)의 형태는 다양한 형태를 가지는 것으로 형성될 수 있다.

[0057] 먼저, 도 5에 도시된 바와 같이, 패턴부(1101a)는 중심축으로 수직방향의 폭대를 가지며, 패턴부(1101a)의 양단에서, 패턴부(1101a)를 연결 방향으로 이등분하는 중심선(CL 5)의 C를 향해 점차적으로 작아지는 형태를 가지는 오목하게 형성될 수 있다. 도 5의 패턴부(1101a)는, 중심선(CL 5)의 C를 기준으로 대칭 형성된 형태를 가지게 된다.

[0058] 다음으로, 도 6에 도시된 바와 같이, 패턴부(1101b)는, 패턴부(1101b)의 양단에서 패턴부(1101b)를 양분하는 중심선(CL 6)의 C을 향해 점차적으로 증가하는 형태를 가지는 볼록하게 형성될 수 있다. 패턴부(1101b)는 중심선을 기준으로 좌우대칭을 이루는 형태를 가지며 따라 대칭적인 형태를 가지게 된다.

[0059] 다음으로, 도 7에 도시된 바와 같이, 패턴부(1101c)의 한쪽은 일단에서 타단으로 점차적으로 증가하는 형태를 가졌다. 패턴부(1101c)는 중심축으로 직사각형의 형태를 가지며, 한쪽의 끝부분 높이에 비하여 다른쪽 끝단의 높이가 보다 높으며, 전체적으로 패턴부(1101c)의 한면의 형태에서 대각으로 기울어진 형태를 가지게 된다.

[0060] 다음으로, 도 8에 도시된 바와 같이, 패턴부(1101d)의 일단은, 그 양단에서 패턴부(1101d)를 양분하는, 중심선(CL 8)의 C을 향해 점차적으로 증가하는 형태를 가지며, 패턴부(1101d)의 일단의 높이는, 중심선(CL 8)의 C의 지점은 가장 높으며, 전체적으로 패턴부 1101d의 양단에서 중심선(CL 8)의 C을 향해 점점 더 높아지게 되는 형태를 가진다.

[0061] 다음으로, 도 9에 도시된 바와 같이, 패턴부(1101e)의 한단은, 그 양단에서 대각으로 형성되는 동심원 형상을 이룰 수 있다. 패턴부(1101e)는 동심원 구조의 오목한 부분이 부드러운 곡선을 이루며 반복적으로 형성되며, 이러한 동심원들은 패턴부(1101e)의 양단에서 대각을 향해 패턴부(1101e)의 한면 전체에 걸쳐 형성된다.

[0062] 제어부(140)는, 구동부(120)와 전기적으로 연결될 수 있으며, 구동부(120)의 동작 주파수를 조절할 수 있다. 제어부(140)는, 구동부(120)뿐만 아니라 패턴부(110) 및 영상표시패널부(130)와도, 전기적으로 연결될 수 있으며, 그들의 동작도 제어할 수 있다.

[0063] 제어부(140)는 측정에서 인터페이스 장치(1000)의 동작을 제어하기 위해 필요한 최소한의 구성만 도시하였으며, 측정에서 인터페이스 장치(1000)가 정의되는 전자기기의 동작을 제어하는 경우에 추가적인 구성이 될 수도 있다.

[0064] 도 10은 본 발명의 제1 실시예에 따른 측정에서 인터페이스 장치 제어방법을 나타낸 순서도이고, 도 11은 본 발명의 제1 실시예에 따른 측정에서 인터페이스 장치 제어방법의 제1 동작을 나타낸 설명도이다. 도 3 내지 도 11을 참조하여, 본 발명의 일 실시예에 따른 측정에서 인터페이스 장치(1000) 제어방법은, 측정에서 인터페이스 장치(1000)가 활성화(S100)에 의하여 설정된 값들을 예로 들어 설명한다.

[0065] 측정에서 인터페이스 장치(1000)는, 활성화(S100)이 되었다면, 사용자의 조작에 의해 설정된 값들을 입력받고, 입력된 설정값들을 통해 초기화(S110)를 수행 준비한다. 패턴부(1101)에 의한 정전용량 변화량, 사용자의 조작에 의한 조작감 등을 사용자에게 제공할 수 있다.

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[0049] 최초, 대기 상태(S100)이서, 터치스크린부(110)는 사용자의 터치 입력을 위해 터치스크린부(110)에 터치가 있는지 여부를 검사한다. (S200) 이 때, 터치스크린부(110)는 사용자의 터치 입력이 없을 경우, 제어부(140)에 전송하며, 결과, 사용자의 터치가 감지되지 않고, 결국, 제어부(140)는 대기 상태(S100)를 유지한다.

[0047] 다음으로, 제어부(140)는 영상표시패널부(130)에 아이콘(110)에 대한 입력버튼의 표시여부 있는 검사하고, (S300) 아이콘(110)이 영상표시패널부(130)에 표시되어 있는 경우, 아이콘(110)의 위치와 영상에 따라 터치스크린부(110)의 한부분 구획마다 촉감제시영역(120)을 설정한다. (S400)

[0048] 여기서, 입력버튼은 사용자의 조작에 따른 장치를 입력 받기 위해 영상표시패널부(130)에 표시되는 버튼형태로, 예를 들어 아이콘(110)은 스크린메뉴바의 일부 일 수 있다.

[0049] 촉감제시설정(S400)은 터치스크린부(110)의 일부분 구획하여 설정하는 것이므로, 촉감제시영역(120)에 사용자의 터치가 있는 경우, 구동부(130)의 구동에 의해 터치스크린부(110)의 표면에 진동이 발생하여, 사용자는 촉감제시영역(120) 내에서 그 외의 영역과 상이한 촉감을 느끼게 되는 터치스크린부(110)의 일부분을 만질 수 있다.

[0050] 촉감제시설정(s420)은 입력버튼의 종류와 형태에 따라 다양한 형태로 설정될 수 있으며, 예를 들어, 도 5와 도시된 바와 같이, 아이콘(110)의 위치 및 형상에 따라 터치스크린부(110) 상에 설정될 수 있다.

[0051] 한편, 영상표시패널부(130)에 아이콘(110)에 대한 입력버튼이 표시되지 않을 경우, 제어부(140)는 다시 대기 상태(S100)로 돌아가게 된다. 사용자의 터치를 기다리게 된다.

[0052] 한편, 촉감제시영역(120)은 사용자의 조작에 의해 또는 전체적인 설계에 의해 따라 변경되어 설정될 수 있으며, 이 때, 영상표시패널부(130)에 입력버튼이 표시되었는지 여부를 판단하는 단계(S300)와 입력버튼에 따라 촉감제시영역(120)을 설정하는 단계(S400)은 생략될 수 있다.

[0053] 이 경우, 터치스크린부(110)에 터치 위치에 대한 정보를 입력 받은 제어부 110)는, 따라 설정된 촉감제시영역(120)에 따라 우선적 터치 위치가 촉감제시영역(120) 이내인지 여부를 판단하는 단계(S500)를 수행할 수 있다.

[0054] 다음으로, 터치스크린부(110)로부터 터치 위치에 대한 정보를 수신한 제어부(140)는 그 위치가 상술한 방법에 의해 설정된 촉감제시영역(120) 이내 인지를 판단하고, (S500) 터치 위치가 촉감제시영역(120) 이내인 경우, 터치스크린부(110)에 입력된 조작에 따른 변화되는 구동설정을 구동부(120)에 인가한다. (S600)

[0055] 동작신호는 사용자의 조작 또는 전체적인 설계에 의해 따라 설정될 수 있으며, 입력버튼의 종류에 따라 상이하게 설정될 수 있다. 예를 들어, 영상표시패널부(130)에 상이한 종류의 아이콘(110)이 표시되고 있는 경우, 각각의 아이콘(110) 마다 상이한 동작신호가 인가되도록 설정될 수 있다.

[0056] 이 때, 제어부(140)는 각각의 아이콘(110) 마다 설정되는 촉감제시영역(120)이 다르게 구분되는 경우, 따라 설정된 각각 상이한 동작신호를 인가할 수 있다.

[0057] 아이콘(110)과 스크롤바(115), 각각 상이한 동작신호가 설정될 수 있으며, 이 때, 각각 상이한 동작신호가 인가될 수 있음은 당연하다.

[0058] 도 12는 본 발명의 일 실시예에 따른 촉감제시 인터페이스 장치(1000) 제어방법의 동작신호 패턴을 나타낸 그래프이다. 도 12에 도시된 바와 같이, 동작신호는, 동작신호가 가지는 세기(S)의 진폭(A), 주파수(f) 및 지속시간(D)으로 정의될 수 있으며, 진폭, 주파수 및 지속시간 중 어느 하나 이상의 상이함에 따라 상이한, 다양한 형태로 구현될 수 있다.

[0059] 구체적으로, 펄스형의 동작신호는 동작의 세기(S)이 반복되는 형태를 가질 수 있으며, 이 때, 진폭, 주파수 및 지속시간뿐만 아니라, 진동의 세기(S)간의 쉬는시간(D)에 따라 상이한 동작신호로 구분될 수 있다.

[0060] 이밖에 동작신호는, 다양한 형태의 패턴을 가질 수 있으며, 제어부(130), 구동부(120)에 따라 설정된 다양한 형태의 동작신호를 인가함으로써, 사용자에게 다양한 촉감의 촉감을 제공할 수 있다.

[0061] 한편, 사용자의 터치 위치가 촉감제시영역(120)의 여부 경우, 제어부(140)는 다시 상태(S100)로 이동하게 된다. 이 때, 사용자가 촉감제시영역(120) 이외의 영역의 터치스크린부(110)를 터치한 경우, 터치스크린부(110)의 표면의 촉감의 변화를 느낄 수 없게 되고, 사용자는 사람인지 아니면 "장애" 여부에도 도 5의 도시된 아이콘(110)의 위치와 속성을 인식할 수 있게 된다.

[0062] 다음으로, 제어부(140)는 구동부(120)에 동작신호를 인가한 이후에, 동작신호가 인가되고 있는지 검사하는 과정 (S700) 제어부(140)는 측정된 결과값이 미리 설정된 기준치와 비교하여 동일한 여부를 판단하고,

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(S800) 에서 생성된 동작신호의 수속시간이 경과하지 않은 경우, 제어부(130)는 동작신호의 생성과정을 수행하고, 생성된 동작신호의 수속시간이 미리 설정된 수속시간 보다 크거나 같아지는 경우, 상술한 터치 이벤트 감지처리(S200)를 수행할 수 있다.

[0063] 즉, 사용자는 먼저 생성된 수속시간 동안 터치스크린부(110)의 촉감제시영역(120) 내에서 조작의 변화를 느껴 보고, 그리고, 추가적인 인터페이스 결정(S300)는, 수속시간 이후에, 사용자의 터치가 유지되거나 없는 등 터치 상태를 놓아지게 되고, 촉감제시 영역이 유지되고 있거나 다른 위치에 변경된 이누이지고 있는 경우, 제어부(130)는 터치스크린부(110) 표면의 조작의 변화를 제공한 것으로써, 사용자의 터치 위치를 추적하여 제공적인 조작의 변화를 제공할 수 있게 된다.

[0064] 이후, 촉감제시영역(120)의 조작 변화에 따라 사용자가 느껴볼 수 있는 조작의 차이는 주관으로 판별한다. 추측해 보는 방법이 있으나, 본 발명의 일 실시예에 따른 촉감제시 인터페이스 결정(S400) 제어방법은 상술한 도 1이 따라 이루어 질 수 있으며, 이러 나한 차별은 생략한다.

[0065] 도 13 내지 도 14는 본 발명의 일 실시예에 따른 촉감제시 인터페이스 결정 제어방법의 제3 동작을 나타낸 관련도이며, 도 13이 도시된 바와 같이, 상술한 터치스크린부(110)의 복수의 아이콘(110)이 표시되면, 촉감제시영역(120)은 아이콘(110)이 표시되는 영역과 그 외의 영역을 구분하기 위하, 인접하는 아이콘(110) 사이의 영역이 될 수 있다.

[0066] 이 때, 제어부(130)는, 터치 위치가 촉감제시영역(120) 외에 있는 경우, 구동부(120)의 동작신호를 인식하지 않아, 사용자가 터치스크린부(110)의 표면의 위치의 촉감을 느끼게 할 수 없다.

[0067] 따라서, 사용자의 손가락이 복수의 아이콘(110)을 느껴보려면, 사용자는, 복수의 아이콘(110) 사이에서, 아이콘(110)이 형성된 부분과 상이한 촉감을 느끼게 되어, 터치스크린부(110)의 표면이 조작의 상이한 지점이 경이로 구분된 것과 같은 느낌을 받을 수 있다.

[0068] 도 14에 도시된 바와 같이, 상술표시패널부(130)는, 휴대장치(100)의 이전의 사진을 표시할 수 있으며, 그 외에도 다른 이미지를 표시할 수 있는 복수의 아이콘(110)을 같이 표시할 수 있다.

[0069] 복수의 아이콘(110) 사이에는 촉감제시영역(120)으로 구분되어 질 수 있으며, 터치스크린부(110)의 터치 위치가 촉감제시영역(120) 내에 있는 경우, 제어부(130)는 구동부(120)의 동작신호를 인가하여, 사용자가 터치스크린부(110)의 표면의 조작이 변화된 것과 같은 느낌을 제공할 수 있다.

[0070] 도 15에 도시된 바와 같이, 상술표시패널부(120)에는 서로로 인접한 형태의 복수의 아이콘(110)이 표시 될 수 있다. 이 때, 촉감제시영역(120)은 복수의 아이콘(110)을 인접하고 있는 부분이, 아이콘(110)의 가장자리 일정한 범위으로 형성될 수 있다

[0071] 따라서, 사용자는 터치스크린부(110)의 표면을 상하로 느껴보면, 아이콘(110)이 표시되는 영역과, 아이콘(110) 사이의 영역에서 상이한 촉감을 느낄 수 있어, 상술표시패널부(130)에 표시되는 영상에 인접하는 서로 조작감을 제공받을 수 있게 된다.

[0072] 도 16은 본 발명의 제1 실시예의 따른 촉감제시 인터페이스 결정 제어방법의 제3 동작을 나타낸 관련도이며, 도 16에 도시된 바와 같이, 상술표시패널부(130)에는 복수의 아이콘(110)이 표시될 수 있으며, 촉감제시영역(120)은 아이콘(110)의 가장자리를 따라 원형의 형태로 터치스크린부(110)에 일부를 구획할 수 있다.

[0073] 터치스크린부(110)의 터치 위치가 촉감제시영역(120) 내에 있는 경우, 터치스크린부(110)가 진동하여, 사용자는 아이콘(110)의 가장자리의 경계 부분의 촉감을 상이하게 인식할 수 있으며, 이로 인해 사용자는 시각으로 아이콘(110)을 인식할 수 있을 뿐만 아니라 촉각으로 아이콘(110)을 인식할 수 있게 된다.

[0074] 도 17은 본 발명의 제1 실시예의 따른 촉감제시 인터페이스 결정 제어방법의 제3 동작을 나타낸 관련도이며, 도 17에 도시된 바와 같이, 휴대장치(100)에 저장된 음원 파일을 재생하는 경우, 상술표시패널부(130)에는 재생중인 음원에 대한 정보가 표시될 수 있는 스크린메뉴(415)가 생성되어 표시될 수 있다.

[0075] 이 때, 촉감제시영역(120)은 스크린메뉴(115)가 인접하는 일부 영역으로 나타나 직각형의 폐곡선으로 형성될 수 있다. 따라서 촉감제시영역(120)은 스크린메뉴(115)를 따라 서로 이격되며 배치되어, 터치스크린부(110)에 일부를 구획할 수 있다.

[0076] 따라서, 사용자가 음원을 조절하기 위해 스크린메뉴(115)를 그 형태 대로, 사용자의 손가락이 스크린메뉴(115)를 따라 가는 동안 상이한 촉감을 제공받으로 느낄 수 있어, 촉감이 변화하는 지점을 느낄 수 있게 된다.

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[0077] 도 18은 본 발명의 제1 실시예의 따른 촉감제시 인터페이스 장치 제어방법의 제5 동작을 나타낸 흐름도이다. 도 18에 도시된 바와 같이, 유니전화(100)의 직전의 촉감제공은 지정한 바, 반복적 형태는 아니고, 스크롤바(115)가 임상표시부(130)에 표시된 것 일 수 있다.

[0078] 이 때, 상술한 바와 같이, 촉감제어부(120)은 스크롤바(115)가 표시되는 터치스크린부(110) 상에 스크롤바(115)가 인접하는 일측의 방향을 따라 방향성으로 제공되며, 동일속성으로 서로 이격되며 형성되며, 사용자의 손가락이 현재의 스크롤바(115)를 따라 이동하는, 상한 상이한 촉감을 느끼게 되어, 사용자는 촉감에 의하여, 조작감을 느낄 수 있게 된다.

[0079] 도 19는 본 발명의 제2 실시예에 따른 촉감제시 인터페이스 장치(2000)를 나타낸 블록도이며, 도 19에 도시된 바와 같이, 본 발명의 제2 실시예에 따른 촉감제시 인터페이스 장치(2000)은 구동부(120), 터치스크린부(110) 및 임상표시패널부(130)의 일측에 위치 인접하여 있다.

[0080] 따라서, 구동부(120)가 인체화된 터치스크린부(110)와 임상표시패널부(130)는 같이 x방향으로 진동시킬 수 있어, 구동부(120)가 터치스크린부(110)의 진동을 선택하는 제어하여 발생할 수 있는 진동의 종류로 변경하여, 보다 종류한 촉감을 터치스크린부(110)에 전달할 수 있다.

[0081] 도 20은 본 발명의 제3 실시예에 따른 촉감제시 인터페이스 장치(3000)를 나타낸 블록도이며, 도 20에 도시된 바와 같이, 본 발명의 제3 실시예에 따른 촉감제시 인터페이스 장치(3000)는, 터치스크린부(110)를 보호하기 위해 터치스크린부(110)의 일면에 위치하며, 보호패널부(150)를 더 구비할 수 있다.

[0082] 보호패널부(150)는 터치스크린부(110)의 표면을 외부로부터 보호할 수 있으며, 사용자가 직접적으로 접촉하는 부분이 될 수 있다. 이 때, 보호패널부(150)의 일측에 구동부(120)가 결합되어, x방향으로 진동을 제공함으로써, 사용자는 촉감 전송하는 부분이 진동으로 인해 촉감의 변화를 직접적으로 전달 받을 수 있게 된다.

[0083] 도 21은 본 발명의 제4 실시예에 따른 촉감제시 인터페이스 장치(4000)를 나타낸 사시도이며, 도 21에 도시된 바와 같이, 본 발명의 제4 실시예에 따른 촉감제시 인터페이스 장치(4000)의 구동부(122)는, 터치스크린부(110)의 일면의 가장자리의 일측에 위치하며, 나와 마주보도, 다수의 진동될 수 있다.

[0084] 이 때, 구동부(122)는 압전소자로 구현될 수 있으며, 압전소자의 얇은 방향은 x방향으로 진동이 제공되도록 형성될 수 있다. 본 실시예의 구동부(122)는 터치스크린부(110)의 일측에 인접하여, 터치스크린부(110)에 종류한 진동을 제공할 수 있다.

[0085] 한편, 구동부(122)는 임상표시패널부(130)의 일측에 표시되는 위치에 위치할 수 있다.

[0086] 도 22는 본 발명의 제5 실시예에 따른 촉감제시 인터페이스 장치(5000)를 나타낸 사시도이며, 도 22에 도시된 바와 같이, 본 발명의 제5 실시예에 따른 촉감제시 인터페이스 장치(5000)의 구동부(120)는 터치스크린부(110)의 일측에 각각 인접될 수 있다. 따라서, 구동부(120)는 터치스크린부(110)에 x방향으로 종류한 진동을 제공할 수 있다.

[0087] 도 23은 본 발명의 제6 실시예에 따른 촉감제시 인터페이스 장치(6000)를 나타낸 사시도이며, 도 23에 도시된 바와 같이, 본 발명의 제6 실시예에 따른 촉감제시 인터페이스 장치(6000)의 구동부(122)는 터치스크린부(110)의 일면의 가장자리에 인접될 수 있다.

[0088] 이 때, 구동부(122)은 압전소자의 얇은 방향이 따라 인접한 방향으로 터치스크린부(110)에 전달될 수 있으며, 예를 들어, x방향의 y방향으로 진동될 수 있다. 따라서, 사용자의 손가락이 터치스크린부(110)의 표면을 x방향으로 이동하는 경우 터치스크린부(110)는 x방향으로 진동시키고, 사용자의 손가락이 y방향으로 터치스크린부(110)의 표면을 이동하는 경우 y방향으로 터치스크린부(110)는 진동시킴으로써, 사용자에 어떤 방향으로 이동하는 종류하고, 정확한 촉감의 차이를 제공할 수 있다.

[0089] 상기에서는, 본 발명의 바람직한 실시예를 참조하여 설명하였지만, 해당 기술 분야에서 통상의 지식을 가진 자에게는 하기 특허청구범위에 기재된 본 발명의 사상 및 영역으로부터 벗어나지 않는 범위 내에서 본 발명을 다양하게 수정 및 변경시킬 수 있음을 이해할 수 있을 것이다.

도면의 간단한 설명

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[0090] 도 1은 본 발명의 제1 실시예에 따른 전자칠판 장치를 개략적으로 나타낸 사시도이다.

[0091] 도 2 내지 도 4는 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 발광부재가 적용된 모습을 나타낸 도면이다.

[0092] 도 5 내지 도 9는 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 발광부재 및 센서부재의 배열 예를 개략적으로 나타낸 도면이다.

[0093] 도 10은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 발광부재 및 센서부재가 배치된 모습을 나타낸 도면이다.

[0094] 도 11은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제1 노광 방법을 나타낸 도면이다.

[0095] 도 12는 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 동작방법을 개략적으로 나타낸 흐름도이다.

[0096] 도 13 내지 도 15는 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 발광부재 및 센서부재가 배치된 모습을 나타낸 도면이다.

[0097] 도 16은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 제2 노광 방법을 나타낸 도면이다.

[0098] 도 17은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제1 노광 방법을 나타낸 도면이다.

[0099] 도 18은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치에 제3 노광 방법을 나타낸 도면이다.

[0100] 도 19는 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제4 노광 방법을 나타낸 도면이다.

[0101] 도 20은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제5 노광 방법을 나타낸 도면이다.

[0102] 도 21은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제6 노광 방법을 나타낸 도면이다.

[0103] 도 22은 본 발명의 제1 실시예에 따른 적외선 터치스크린 장치의 제7 노광 방법을 나타낸 도면이다.

[0104] <도면의 주요부분에 대한 부호의 설명>

[0105] 110: 디스플레이부 120: 커버부

[0106] 130: 영상처리부 140: 제어부

[0107] 1000: 적외선 터치스크린 장치

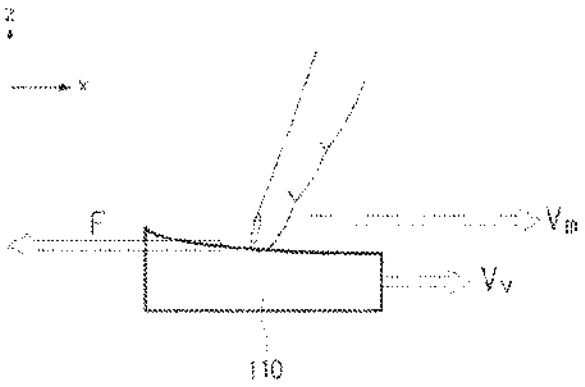
도면

도면1

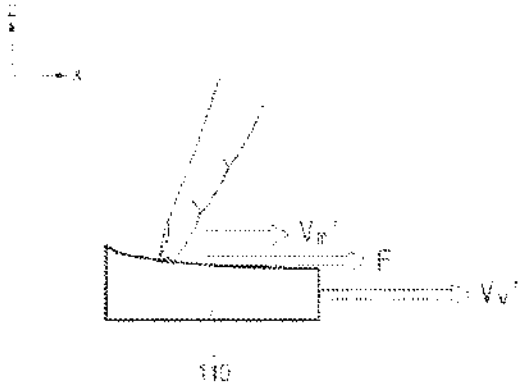
DEF_0000470?

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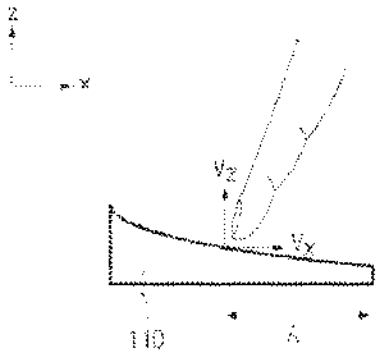
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도면3

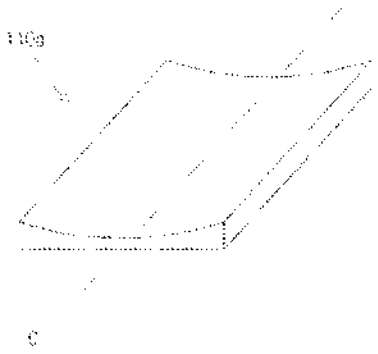


도면4

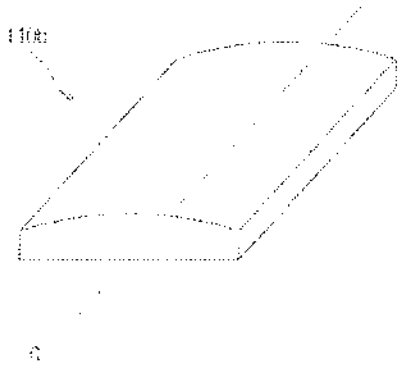


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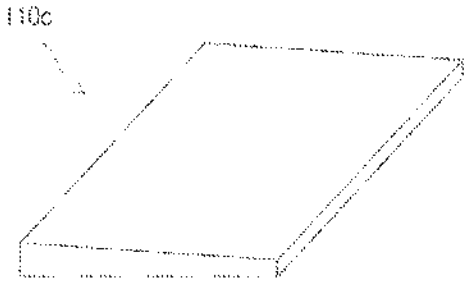
도면9a



도면9b

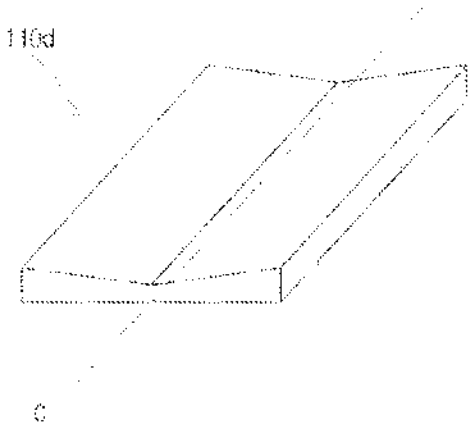


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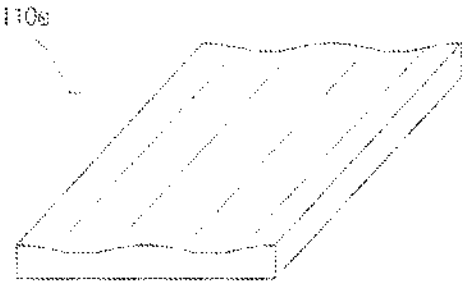


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도면6

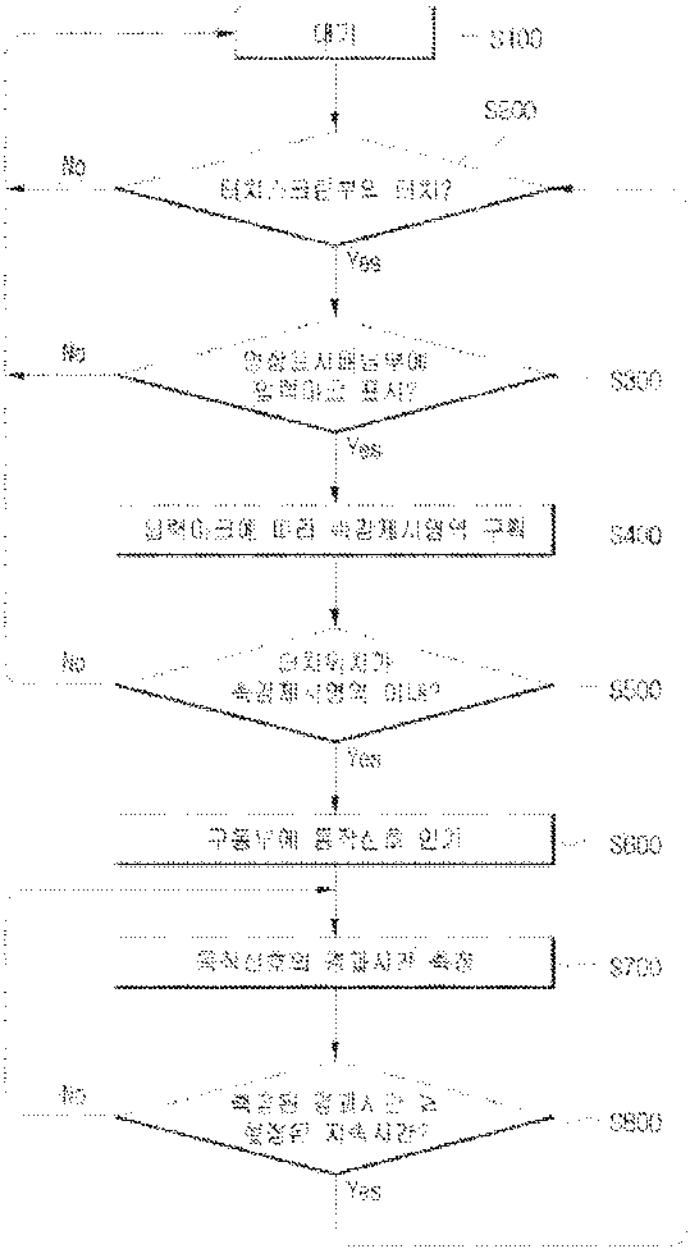


도면7



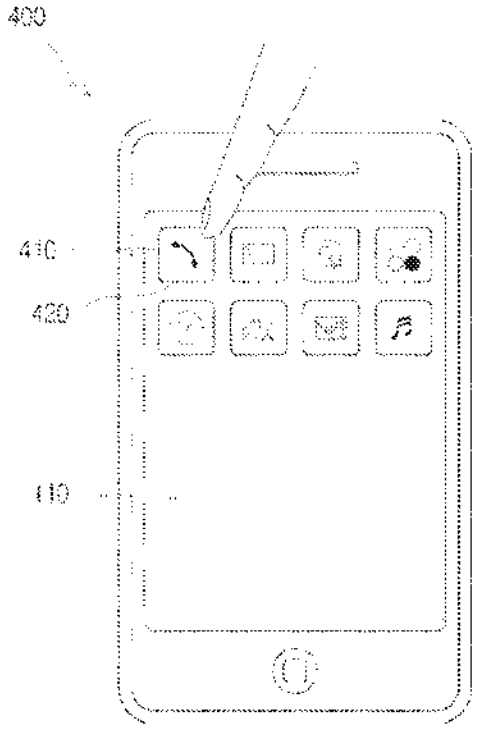
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DEF_00004710

도면7

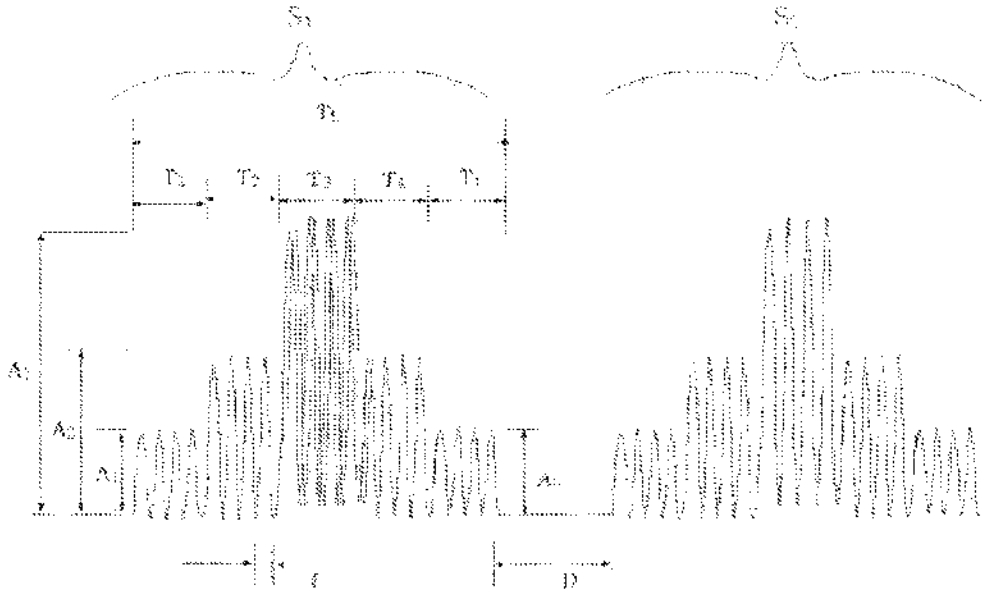


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DEF_00004711

도면11

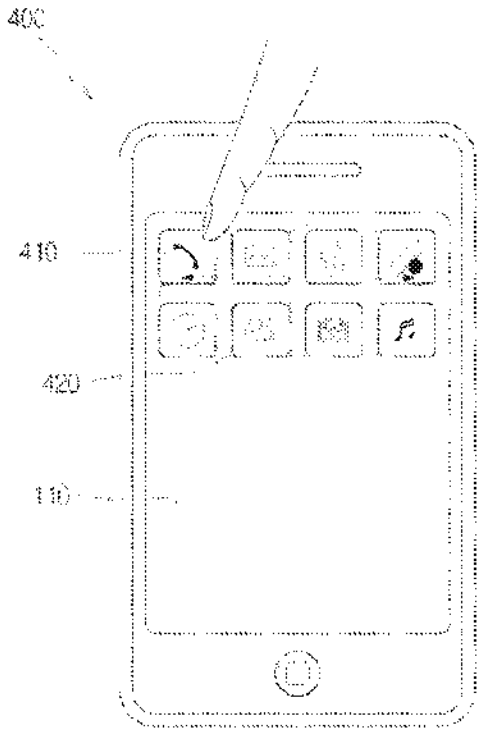


도면12

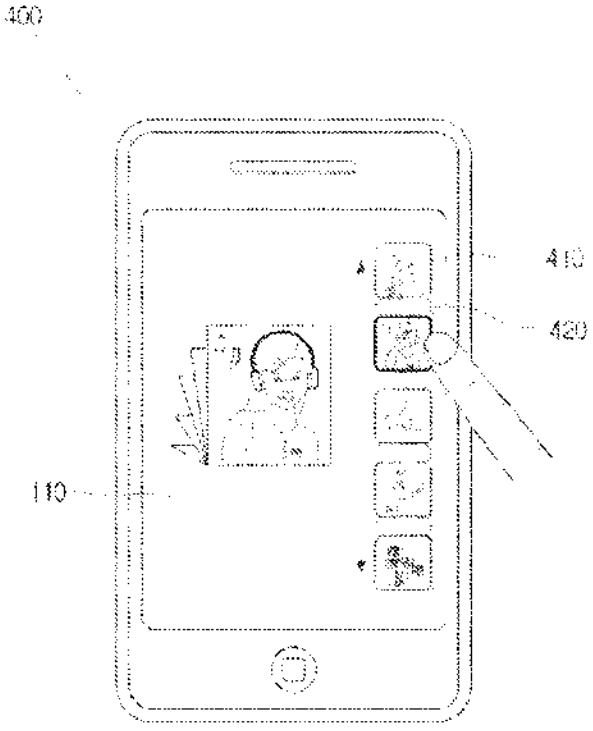


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도면13

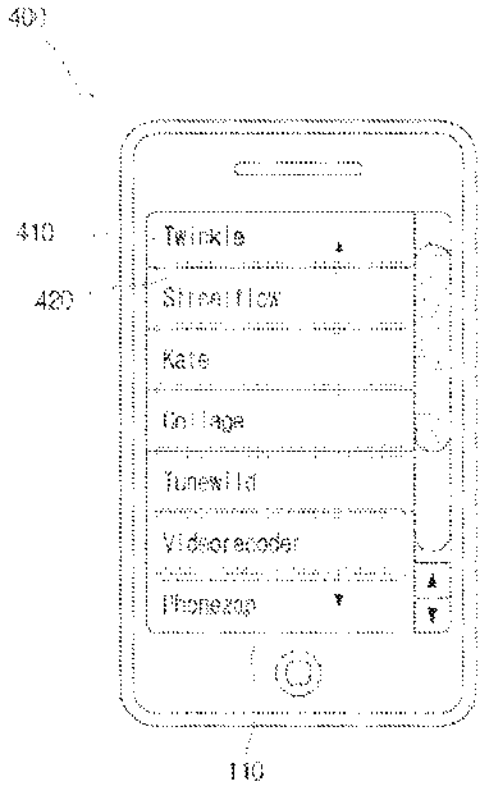


도면14



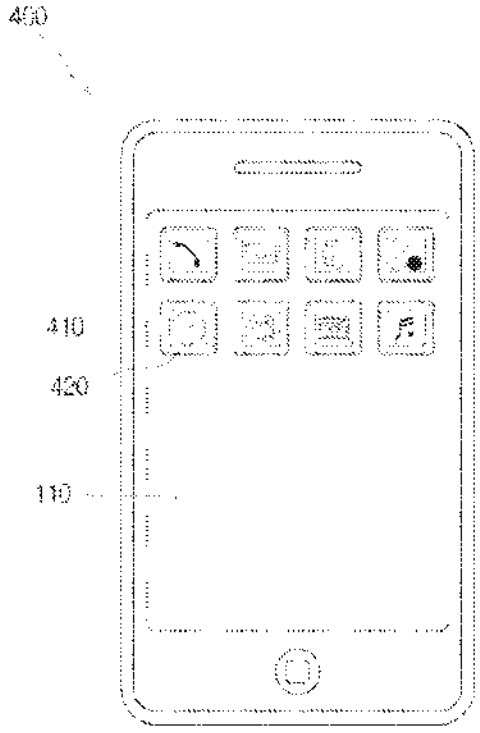
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도면3

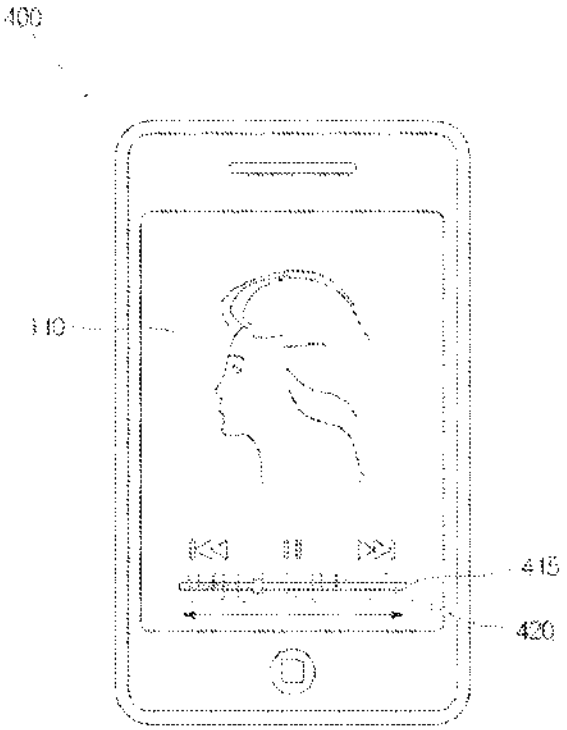


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도면16

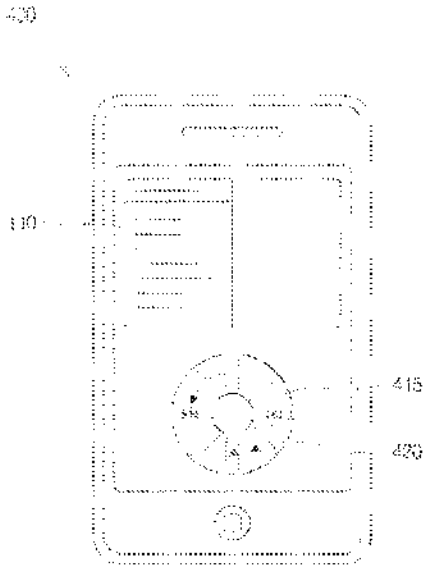


도면17

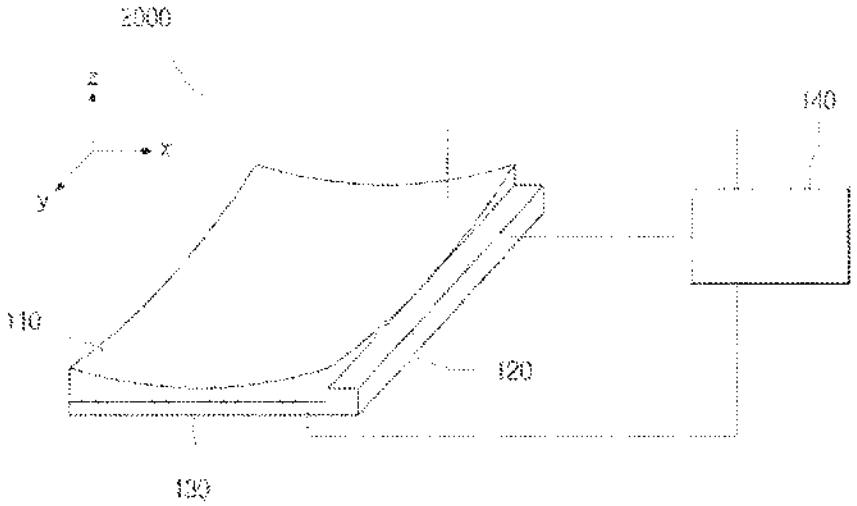


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도면14

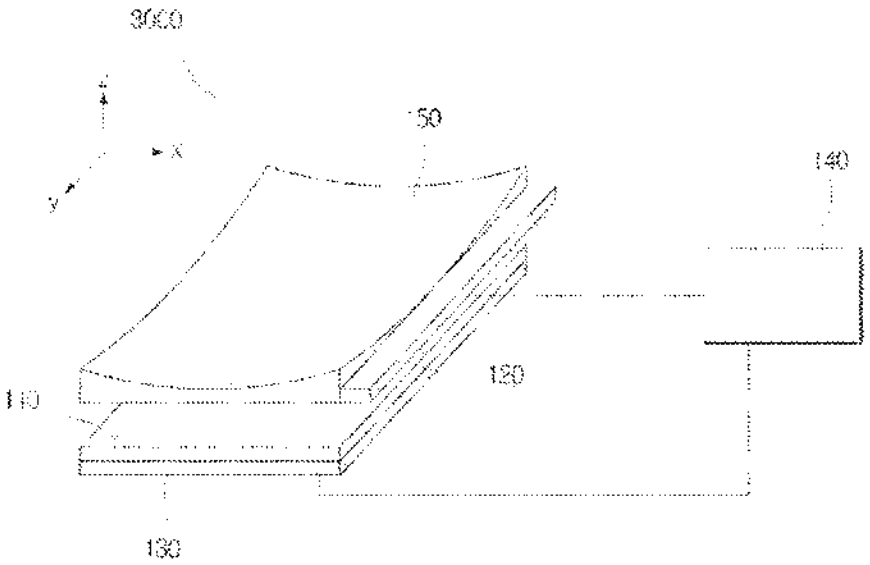


도면15

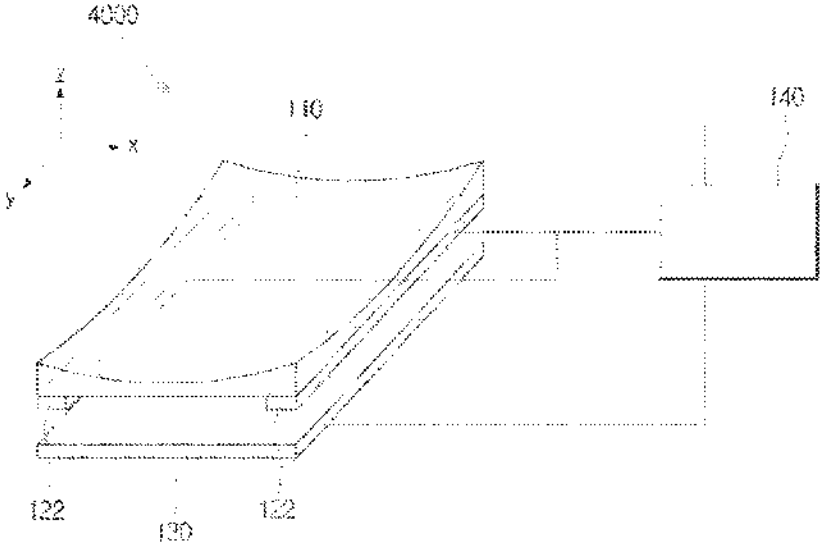


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도면2

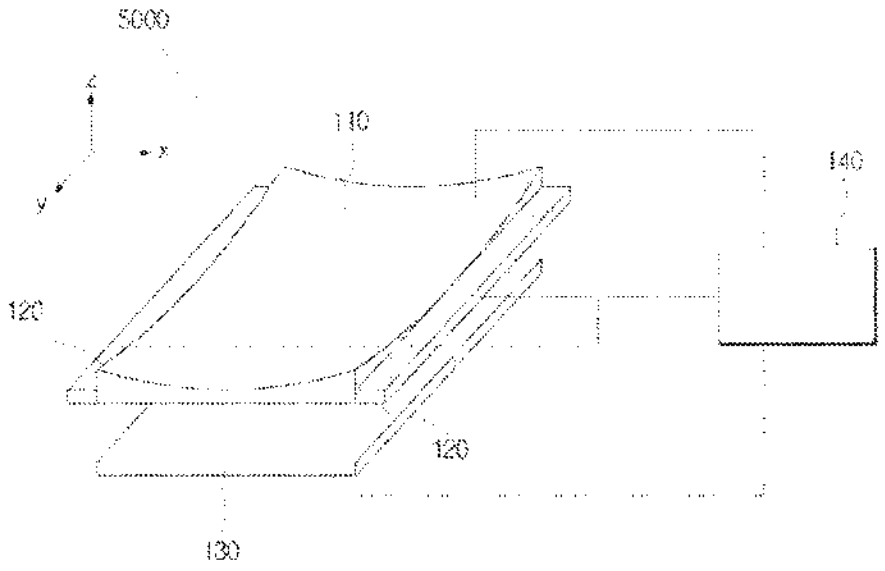


도면3

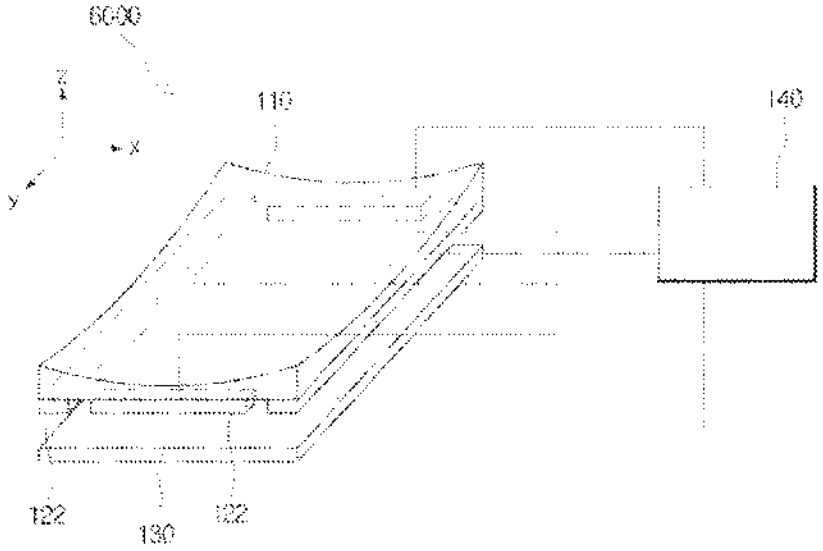


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도면22



도면23



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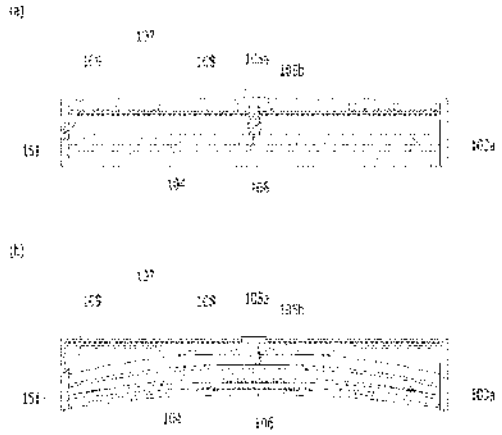
(54) 발명의 명칭 이동 단말기

(57) 요 약

상기 목적을 달성하기 위해 본 발명의 일 측면에 따르면, 이동 단말기의 본체를 형성하는 케이스; 상기 케이스에 의해 형성되는 내부 공간에 배치되고, 안테나를 구비하는 안테나 모듈; 상기 케이스에 의해 형성되는 내부 공간에 배치되고, 상기 안테나 모듈과 전기적으로 연결되는 회로 기판; 및 상기 회로 기판에 실장되고, 상기 안테나 모듈을 통해 송수신되는 무선 신호를 처리하는 무선 통신 칩을 포함하고, 상기 안테나 모듈은, 상기 케이스의 일 영역에 형성되는 방사체; 및 상기 방사체와 상기 회로 기판을 전기적으로 연결하는 급전부를 포함하고, 상기 방사체는 상기 급전부와 연결되는 제1 지점; 및 상기 제1 지점으로부터 이격되어 형성되는 제2 지점을 포함하고, 상기 제1 지점과 상기 제2 지점 사이의 거리는 상기 무선 통신 칩에서 처리하는 무선 신호의 파장의 1/4 보다 작은 것을 특징으로 하는 이동 단말기.

이외의 다른 목적들은 하기 설명에 의해 당업자에 의해 명확하게 이해될 수 있을 것이다.

대 표 도 - 도1



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청 구 범

청구항 1

제1 디스플레이 및 상기 제1 디스플레이와 연결되는 다음 프로세싱을 수행하며, 휴대할 수 있는 프로세서를 포함하는 전자부:

상기 전자부의 배면 방향에 위치하고, 상기 전자부 보다 넓은 촬영역 손재는 포함하며, 상기 전자부와 이격된 제1 영역과, 상기 전자부 방향으로 돌출된 제2 영역을 포함하는 지지부;

상기 제1 및 제2 영역에 걸쳐진 다음을;

다음은 상기 다음에 맞물려 연결되며, 다음부재는 상기 지지부의 제1 영역에 회전가능하게 지지되어 상기 전자부에 위치하는 조그휠는 포함하고,

상기 조그휠가 상기 전자부에 연결되는 위치로, 상기 제2 영역은 적어도 상기 전자부의 하단에 밀착되는 형태를 이루 전자부.

청구항 2

제 1 항에 있어서,

상기 조그휠는 사용자 손가락 터치에 의해 회전 방향으로 회전되 상기 전자부의 적어도 일부가 노출되며,

상기 다음 한 방향의 터치 방향으로 회전시 상기 전자부의 이동을 입력하는 입력 장치로 하는 터치형 이동 단말기.

청구항 3

제 1 항에 있어서,

복수은 수 있는 조절하는 조리하고, 상기 지지부의 배터리영역에 위치하는 측면부는 비 조리하고,

상기 전자부의 이동에 응답하여 상기 전자부의 이동을 무선 수행 중지하고, 상기 전자부의 이동이 정지되면 상기 전자부 이동을 재개하는 상태로 하는 터치형 이동 단말기.

청구항 4

제 1 항에 있어서,

상기 전자부는 제1 방향으로 회전되며,

상기 전자부의 상기 측면부 사이에 위치하는 프레임의 일부 보완하고,

상기 제어부의 상기 전자부와 대향하는 면에 전원부 및 상기 다음층이 지지된 부분에서 제1 방향으로 마주보으로 관통되 복수의 홀을 갖는 구조으로 하는 터치형 이동 단말기.

청구항 5

제 1 항에 있어서,

상기 스크린에 걸쳐하여 상기 지지부 측면에 노출되어 사용자가 움직 상기 스크린을 회전시키는 손잡이부 더 포함하는 것을 특징으로 하는 터치형 이동 단말기.

청구항 6

제 5 항에 있어서,

상기 손잡이부는 상기 하나 방향에 걸쳐의 스크린을 제한하는 제한부는 포함하는 것을 특징으로, 하는 터치형 이동 단말기.

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청구항 7

제 1 항에 있어서,

상기 메모리는 상기 메모리의 회로에 대한 주위 영향으로 인한 변화를 감지하기 위한 적어도 하나의 센서를 포함하는 것을 특징으로 하는 전자형 터미널.

청구항 8

제 7 항에 있어서,

상기 메모리는 온 칩 상의 전원 변화를 감지하는 적어도 하나의 센서로 하는 전자형 터미널.

청구항 9

제 1 항에 있어서,

상기 전력부는 적어도 하나의 보조배터리, 메모리카드 및 USB 중 적어도 하나를 더 포함하고,

상기 출력부의 외부면에 상기 적어도 하나의 커넥터가 노출되어 형성되는 것을 특징으로 하는 전자형 터미널.

청구항 10

전원 버튼부재의 및 상기 전원 버튼부재와 연동하는 터치 부재를 구비하고, 외력을 수 있는 부재를 포함하는 전자부;

상기 전자부의 제1 방향에 위치하고, 상기 전자부 보다 높은 경성의 재질을 포함하며, 상기 전자부와 이격된 제 1 영역과, 상기 전자부 방향으로 돌출된 제 2 영역을 포함하는 지지부;

상기 지지부의 배면방향에 위치하고, 이격될 수 있는 재질로 형성되는 하우징;

상기 지지부에 구비되는 다음을 포함하는 전자형 터미널:

다이얼은 상기 하우징의 방향에 위치하며, 상기 다이얼은 상기 다이얼을 통해 상기 지지부의 제 1 영역을 수용하여 이동하며 상기 전자부 및 상기 전자부에 최소한으로 이격되어 상기 전자부와 상기 부재 위치하는 스프링과 포함하고,

상기 스프링은 상기 전자부와 상기 출력부의 이격부을 위하여, 상기 지지부의 제 2 영역을 방향으로 상기 전자부와 상기 출력부의 적어도 하나와 연동하는 전자형 터미널.

발명의 설명

기 술 분 야

[0001] 본 발명은 다양한 디자인 형으로 제작할 수 있는 전자 단말기에 관한 것이며,

배 경 기 술

[0002] 단말기는 이동 가능여부에 따라 이동 단말기(mobile/portable terminal) 및 고정 단말기(stationary terminal)으로 나뉘, 수 있다. 다시 이동 단말기는 사용자의 직접 휴대 가능 여부에 따라 휴대형 단말기(handheld terminal) 및 차량용 단말기(vehicle mounted terminal)로 나뉠 수 있다.

[0003] 이동 단말기의 기능은 다양화 되고 있다. 예를 들면, 데이터 및 음성통신, 카메라를 통한 사진촬영 및 비디오 촬영, 음성녹음, 스피커 시스템을 통한 음악재생 및 디스플레이부에 이미지나 비디오를 출력하는 기능이 있다. 일부 단말기는 전자게임 실행에 기능이 추가되거나, 멀티미디어 기능을 수행할 수 있다. 최근에 이동 단말기는 방송과 비디오나 방송비롯 프로그램과 같은 시각적 컨텐츠를 제공하는 멀티캐스팅 신호를 수신할 수 있다.

[0004] 이와 같은 단말기(terminal)는 기능이 다양화됨에 따라 예를 들어, 사진이나 동영상의 촬영, 음악이나 동영상 파일의 재생, 게임, 방송의 수신 등과 같은 복합적인 기능들을 갖춘 멀티미디어 기기(multimedia player) 형태로 구

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수 있다.

[0005] 이러한 본 발명의 기술 사상 및 목적을 위해, 본 발명의 주요하게 포함 및/또는 포함하는 노즐 어셈블리를 제공하는 것이 고려될 수 있다.

[0006] 노즐에는 회전될 수 있는 회전부재 노즐헤드가 제공되었고, 이러 따라 회전은 이동 대상체를 분사한다.

발명의 내용

해결하려는 과제

[0007] 종래에는 노즐헤드가 자유롭게 회전될 수 있는 구조적인 노즐헤드가 존재하였으나, 이러 방법에 따라서 자체 같은 회전에 의해 회전으로 인해 좁은 범위의 크기의 노즐헤드 회전에 의해 분사되는 액체 분사가 되었다. 이 이러 방법에 의해 회전시키더라도 일정한 분사 범위를 제공 할 수 없는 문제점이 있었다. 또한, 회전력 이 없는 노즐헤드의 회전을 전제로 노즐부의 회전을 할 수 없는 구조물을 변경하는 것에 적합할 수 없다는 점이 문제점이 있었다. 관련의 어려움을 방지하기 위하여 사용할 수 있어야 하며 제품의 경량화 추세, 추세가 진행되고 있다. 이는 해결하기 위해 본 발명은 있는 이러 방법에는 제공하고, 베어링 전체가 손해라는 이유 관련 구조 전체는 다양해 하는이 변화될 이러 방법에 따라 베어링 전체가 변화적인 구조를 제공하는데 그 목적이 있다.

과제의 해결 수단

[0008] 상기 목적을 달성하기 위해 본 발명의 일 측면에 따르면, 액정 디스플레이 및 액정 디스플레이의 상부에 위치하는 터치 스크린을 구비하고 외부로 노출되는 외관과, 그리고 이 외관의 내부 방향에 위치하고 일 방향으로 유로 부재의 유로를 형성하는 유로부 및 유로부 상에 위치하는 노즐부를 포함하는 노즐부와 상기 노즐부를 회전시키는 회전부를 포함하는 노즐 어셈블리에 있어서, 상기 노즐부는 상기 유로부의 일 방향으로 연장되는 노즐부와 상기 노즐부의 일단에 형성되는 노즐헤드를 포함하고, 상기 노즐헤드

도 1b는 본 발명과 관련한 발명이지만 본 발명의 하나 이상의 실시예가 아닌 참고예의 하나 이상의 실시예에 따른 터치 입력 장치의 사시도이다.

도 1c는 본 발명과 관련한 참고예의 하나 이상의 실시예에 따른 터치 입력 장치의 사시도이다.

도 2a는 본 발명과 관련한 하나 이상의 실시예의 A-A' 방향에 대한 종단면도이다.

도 2b는 도 1c의 본 발명과 관련한 하나 이상의 실시예가 아닌 참고예의 하나 이상의 A-A' 방향에 대한 종단면도이다.

도 3은 본 발명의 관련한 하나 이상의 실시예의 메터리얼 커버를 제외한 구성에 대한 배면도이다.

도 4a는 본 발명과 관련한 하나 이상의 실시예의 B-B' 방향에 대한 종단면도이다.

도 4b는 본 발명의 관련한 하나 이상의 실시예의 메터리얼 커버를 제외한 구성에 대한 배면도이다.

도 5a는 본 발명의 관련한 하나 이상의 실시예의 C-C' 방향에 대한 종단면도이다.

도 5b는 본 발명과 관련한 하나 이상의 실시예의 메터리얼 커버를 제외한 구성에 대한 배면도이다.

도 6은 본 발명과 관련한 하나 이상의 실시예의 운전 메커니즘에 대한 블록도이다. 참조 부호는 메커니즘에 의해 회전하는 구성요소에 대한 참조부호 "도면" 및 "휠"과 명세서 전체의 동일한 도면부호에 대응하는 것으로 이해되어야 한다. 또한, 도면에 도시된 구성요소의 개수는 설명의 편의를 위한 것이며, 본 발명의 권리범위를 제한하는 것으로 해석되어서는 안 된다.

도 7은 본 발명과 관련한 하나 이상의 실시예의 운전 메커니즘에 대한 블록도이다. 참조 부호는 메커니즘에 의해 회전하는 구성요소에 대한 참조부호 "도면" 및 "휠"과 명세서 전체의 동일한 도면부호에 대응하는 것으로 이해되어야 한다. 또한, 도면에 도시된 구성요소의 개수는 설명의 편의를 위한 것이며, 본 발명의 권리범위를 제한하는 것으로 해석되어서는 안 된다.

발명을 실시하기 위한 구체적인 내용

[0017] 이하, 첨부된 도면을 참조하여 본 발명에 제시된 실시 예를 상세히 설명하며, 도면 부호에 관계없이 동일하거나 유사한 구성요소는 중복된 설명은 생략하고 이에 대한 구성적 또는 기능적 설명은 생략하기로 한다. 이하의 설명에서 사용되는 구성요소에 대한 접미사 "모듈" 및 "부"는 명세서 작성의 용이성만이 고려되어 부여되거나 혼용되는 것으로서, 그 자체로 서로 구별되는 의미 또는 역할을 갖는 것은 아니다. 또한, 본 명세서에 기재된 실시 예를 설명함에 있어서 관련된 공지 기술에 대한 구체적인 설명이 본 명세서에 개시된 실시 예의 요지를 흐릴 수 있다고 판단되는 경우 그 상세한 설명을 생략한다. 또한, 첨부된 도면은 본 명세서에 개시된 실시 예를 쉽게 이해할 수 있도록 하기 위한 것일 뿐, 첨부된 도면에 의해 본 명세서에 개시된 기술적 사상이 제한되지 않으며, 본 발명의 사상 및 기술 범위에 포함되는 모든 변경, 균등물 내지 대체물을 포함하는 것으로 이해되어야 한다.

[0018] 본 명세서에서 설명되는 이동 단말기는 휴대폰, 스마트 폰(smart phone), 노트북 컴퓨터(laptop computer), 디지털방송용 단말기, PDA(personal digital assistants), PMP(portable multimedia player), 네비게이션, 슬레이트 PC(slate PC), 태블릿 PC(tablet PC), 울트라북(ultrabook), 웨어러블 디바이스(wearable device, 예를 들어, 워치형 단말기 (smartwatch), 글래스형 단말기 (smart glass), HMD(head mounted display)) 등이 포함될 수 있다.

[0019] 그러나, 본 명세서에 기재된 실시 예에 따른 구성은 이동 단말기에만 적용 가능한 경우를 제외하고는, 디지털 TV, 데스크탑 컴퓨터, 디지털 사이니지 등과 같이 고정 단말기에도 적용될 수도 있음은 당업자라면 쉽게 알 수 있을 것이다.

[0020] 도 1a 내지 도 1c 및 도면을 참조하면, 도 1a 및 도 1c는 본 발명의 관련한 하나 이상의 실시예를 설명하기 위한 사시도이고, 도 1b 및 도 1c는 본 발명의 관련한 하나 이상의 실시예의 분해된 사시도이다.

[0021] 장치 이동 단말기(100)는 무선 통신부(110), 입력부(120), 감지부(140), 출력부(150), 인터페이스부(160), 메모리(170), 제어부(180) 및 전원 공급부(190) 등을 포함할 수 있다. 도 1a 에 도시된 구성요소들은 이동 단말기를 구현하는데 있어서 필수적인 것은 아니어서, 본 명세서 상에서 설명되는 이동 단말기는 위에서 열거된 구성요소들 보다 많거나, 또는 적은 구성요소들을 가질 수 있다.

[0022] 보다 구체적으로, 상기 구성요소들 중 무선 통신부(110)는, 이동 단말기(100)와 무선 통신 시스템 사이, 이동 단말기(100)와 다른 이동 단말기(100) 사이, 또는 이동 단말기(100)와 외부서버 사이의 무선 통신을 가능하게 하는 하나 이상의 모듈을 포함할 수 있다. 또한, 상기 무선 통신부(110)는, 이동 단말기(100)를 하나 이상의 네트워크에 연결하는 하나 이상의 모듈을 포함할 수 있다.

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[0003] 이러한 구성 요소들(100)은, 통상 구성 요소(111), 하우징용 요소(112), 구조 강화용 요소(113), 전기 장치용 요소(114), 외관용 요소(115) 중 적어도 하나를 포함할 수 있다.

[0004] 부품부(130)는, 일정 신호 입력을 위한 사용자(131) 또는 일정 입력부, 소리음 신호 외부를 위한 마이크로폰(microphone), 스피커, 리시버 등이 포함될 수 있으며, 사용자 인터페이스 입력부(125, 예를 들어, 키 패드(touch key), 푸쉬키(mechanical key) 등)와 관련된 구성이 될 수 있다. 입력부(130)에서 수집된 음성 데이터는 이후 다른 기능 또는 본체에서 적절한 재연산방법으로 처리될 수 있다.

[0005] 센싱부(140)는 이동 단말기 내 정보, 이동 단말기를 둘러싼 주변 환경 정보 및 사용자 정보 중 하나 이상을 감지하기 위한 하나 이상의 센서를 포함할 수 있다. 예를 들어, 센싱부(140)는 근접센서(141, proximity sensor), 조도 센서(142, illumination sensor), 터치 센서(touch sensor), 가속도 센서(acceleration sensor), 자기 센서(magnetic sensor), 중력 센서(G-sensor), 자이로스코프 센서(gyroscope sensor), 모션 센서(motion sensor) 등의 센서, 녹음원의 센서(RGB 센서, infrared sensor), 지문인식 센서(finger scan sensor), 초음파 센서(ultrasonic sensor), 광 센서(optical sensor, 예를 들어, 카메라(121 참조)), 마이크로폰(microphone, 123 참조), 배터리 게이지(battery gauge), 환경 센서(예를 들어, 기압계, 습도계, 온도계, 방사능 감지 센서, 열 감지 센서, 가스 감지 센서 등), 화학 센서(예를 들어, 전자 코, 헬스케어 센서, 생체 인식 센서 등) 중 적어도 하나를 포함할 수 있다. 한편, 본 명세서에 개시된 이동 단말기는, 이러한 센서들 중 적어도 둘 이상의 센서에서 센싱되는 정보들을 조합하여 활용할 수 있다.

[0006] 출력부(150)는 시각, 청각 또는 촉각 등과 관련된 출력을 발생시키기 위한 것으로, 디스플레이부(151), 음향 출력부(152), 햅팁 모듈(153), 광 출력부(154) 중 적어도 하나를 포함할 수 있다. 디스플레이부(151)는 터치 센서와 상호 레이어 구조를 이루거나 일체형으로 형성됨으로써, 터치 스크린을 구현할 수 있다. 이러한 터치 스크린은, 이동 단말기(100)와 사용자 사이의 입력 인터페이스를 제공하는 사용자 입력부(123)로써 기능함과 동시에, 이동 단말기(100)와 사용자 사이의 출력 인터페이스를 제공할 수 있다. 본 발명에서는 이동 단말기에서 처리되는 정보를 유연하게 디스플레이(Flexible display)를 이용하여 출력할 수 있다. 디스플레이부(151)는 외력에 의해 변형 가능하게 구성될 수 있다. 상기 변형은 디스플레이부(151)의 휘어짐, 부러짐, 접힘, 비틀림, 말아 올림 중 적어도 하나일 수 있다. 예를 들면 구성된 디스플레이부(151)는 '플렉서블 디스플레이부'로 명명될 수 있다. 여기에서, 플렉서블 디스플레이부(151)는 일반적인 평판 디스플레이와 곡면 디스플레이(curved) 및 그 조합을 모두 포함할 수 있다.

[0007] 일반적인 플렉서블 디스플레이는 기존의 평판 디스플레이의 특성을 유지하면서, 종이와 같이 휘어짐, 구부러짐, 접힘, 비틀림 또는 말림이 가능한 얇고 유연한 기판 위에 제작되어, 가볍고 외부 충격에 강하며 다양한 형태로 디자인 될 수 있다.

[0008] 또한, 종이는 일반적인 평판의 디스플레이 장치의 특성을 이용한 디스플레이 기술로서, 별도의 백라이트 유닛을 사용하는 점이 기존의 평판 디스플레이와 다른 점일 수 있다. 일례로 종이는 트윈스타 볼을 이용하거나, 멀티 색상 캡슐을 이용한 전기영동(Electrophoresis)을 이용하여, 정보를 표시할 수 있다.

[0009] 플렉서블 디스플레이부(151)가 변형되지 않은 상태(예를 들어, 무한대의 곡률반경을 가지는 상태, 이하 제 1 상태라고 한다)에서, 플렉서블 디스플레이부(151)의 디스플레이 영역은 평평한 면이 된다. 상기 제 1 상태에서 외력에 의하여 변형된 상태(예를 들어, 유한의 곡률반경을 가지는 상태, 이하, 제 2 상태라고 한다)에서는 상기 디스플레이 영역에 곡면이 될 수 있다. 보다 구체적인 예로, 상기 제 2 상태에서 표시되는 정보는 곡면상에 출력되는 정보일 수 있다. 이러한 정보는 매트릭스 형태로 배열되는 단위 픽셀(sub-pixel)의 발광이 독립적으로 제어됨으로써 구현될 수 있다. 상기 단위 픽셀은 하나의 색을 구현하기 위한 최소 단위를 의미한다.

[0010] 본 명세서는 디스플레이부(151)가 상기 평평한 상태인 제 1 상태(도 1b)가 아닌, 찌그러진 상태(예를 들어, 상하좌우 방향으로 찌그러진 상태)로 변형됨으로써 발생되는 상태와 제 2 상태(도 1c)에 놓일 수 있다. 이 경우, 추가적인 디스플레이부(151)에 외력이 가해지면, 플렉서블 디스플레이부(151)는 찌그러진 상태(혹은 덜 찌그러진 상태) 또는 더 찌그러진 상태로 변형될 수 있다.

[0011] 플렉서블 디스플레이부(151)의 상태 변화는 외력에 의한 것으로서 수반되는, 일례로, 이는 도면, 플렉서블 디스플레이부(151)가 제 1 상태를 유지하고 있을 때, 사용자 손은 제2프레임부의 상단에 위치한, 제 2 상태로 변형될 수 있다.

[0012] 추가로, 플렉서블 디스플레이부(151)는 터치센서와 조합되어 플렉서블 터치 스크린을 구현할 수 있다. 플렉서블 터치 스크린에 대한 터치가 발생하면, 제어부(180, 도 1a 참조)는 이러한 터치입력에 따르는, 제어를 수행

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할 수 있다. 전력선은 또한 스크린을 상기 제1 상태뿐만 아니라 상기 제2 상태에서도 터치입력을 감지하도록 이루어질 수 있다.

[0033] 한편, 본 발명 예에 따른 이동 단말기(100)에는 음향신호 프로세싱부(151)로 부터의 음향을 감지할 수 있는 센서들이 부가될 수 있다. 이러한 센서들은 센싱부(140, 도 1a 참조)에 포함될 수 있다.

[0034] 상기 센싱센서들은 음향신호 프로세싱부(151) 또는 제어부(201)(도시 되어 있지 않음)에 구비되어, 음향신호 프로세싱부(151)의 동작에 관련된 정보를 제공할 수 있다. 여기에서, 센싱센서는 음향신호 프로세싱부(151)가 인식한 음향, 인식한 음의 크기, 인식한 위치, 인식한 시간 및 인식한 음향신호 프로세싱부(151)가 획득하는 각종의 값 중 적어도 하나를 포함할 수 있으며, 이 밖에도 음향신호 프로세싱부(151)의 최적동작을 위해 필요한 각종 데이터를 획득할 수 있다.

[0035] 인터페이스부(170)는 이동 단말기(100)에 연결되는 다양한 종류의 외부 기기와의 통로 역할을 수행한다. 이러한 인터페이스부(170)는, 유/무선 헤드셋 포트(port), 외부 충전기 포트(port), 유/무선 데이터 포트(port), 메모리 카드(memory card) 포트, 식별 모듈이 구비된 장치를 연결하는 포트(port), 오디오 I/O(Input/Output) 포트(port), 비디오 I/O(Input/Output) 포트(port), 이어폰 포트(port) 중 적어도 하나를 포함할 수 있다. 이는 도 1a 참조하여 설명한 바와 같다. 상기 인터페이스부(170)에 외부 기기가 연결되는 경우에 대응하여, 연결된 외부 기기와 데이터를 교환하거나 전력을 공급하는 등 적절한 제어를 수행할 수 있다.

[0036] 또한, 메모리(170)는 이동 단말기(100)의 다양한 기능을 지원하는 데이터를 저장한다. 메모리(170)는 이동 단말기(100)에서 구동되는 다수의 응용 프로그램(application program 또는 애플리케이션(application)), 이동 단말기(100)의 동작을 위한 데이터들, 명령어들을 저장할 수 있다. 이러한 응용 프로그램 중 적어도 일부는, 무선 통신을 통해 외부 서버로부터 다운로드 될 수 있다. 또한 이러한 응용 프로그램 중 적어도 일부는, 이동 단말기(100)의 기본적인 기능(예를 들어, 전화 착신, 발신 기능, 메시지 수신, 발신 기능)을 위하여 출고 당시부터 이동 단말기(100) 상에 존재할 수 있다. 한편, 응용 프로그램은, 메모리(170)에 저장되고, 이동 단말기(100) 상에 설치되어, 제어부(180)에 의하여 상기 이동 단말기의 동작(또는 기능)을 수행하도록 구동될 수 있다.

[0037] 제어부(180)는 상기 응용 프로그램과 관련된 동작 외에도, 통상적으로 이동 단말기(100)의 전반적인 동작을 제어한다. 제어부(180)는 위에서 살펴본 구성요소들을 통해 입력 또는 출력되는 신호, 데이터, 정보 등을 처리하거나 메모리(170)에 저장된 응용 프로그램을 구동함으로써, 사용자에게 적절한 정보 또는 기능을 제공 또는 처리할 수 있다.

[0038] 또한, 제어부(180)는 메모리(170)에 저장된 응용 프로그램을 구동하기 위하여, 도 1a와 함께 살펴본 구성요소들 중 적어도 일부를 제어할 수 있다. 나아가, 제어부(180)는 상기 응용 프로그램의 구동을 위하여, 이동 단말기(100)에 포함된 구성요소들 중 둘 이상을 서로 조합하여 동작시킬 수 있다.

[0039] 또한, 제어부(180)는 상기 프로세싱영역에 대하여 감지되는 음향신호 프로세싱부(151)의 변화에 따라 동작 모드를 제어한다. 음향신호 프로세싱부(151) 상에 포커싱된 영역을 변경하거나, 이동 단말기(100)의 상황에 따라 각각 서로 다른 모드를 설정할 수 있다.

[0040] 전원공급부(190)는 제어부(180)의 제어 하에서, 외부의 전원, 내부의 전원을 인가 받아 이동 단말기(100)에 포함된 각 구성요소들에 전원을 공급한다. 이러한 전원공급부(190)는 배터리를 포함하며, 상기 배터리는 내장형 배터리 또는 교체가능한 형태의 배터리가 될 수 있다.

[0041] 아울러, 이상 단말기(100)에 구비되는 배터리(미도시)는 또한 음향신호 프로세싱부(151)의 구성을 고려하여, 이 때에 이루어진 프로세싱부(151)에 함께 변형 가능하게 구성될 수 있다. 상기 배터리는 구부리기 위해서, 배터리 전체 또는 부분이 휘어지는 형태의 배터리가 될 수 있다.

[0042] 상기 각 구성요소들 중 적어도 일부는, 이하에서 설명되는 다양한 실시 예들에 따른 이동 단말기의 동작, 제어, 또는 제어방법을 구현하기 위하여 서로 협력하여 동작할 수 있다. 또한, 상기 이동 단말기의 동작, 제어, 또는 제어방법은 상기 메모리(170)에 저장된 적어도 하나의 응용 프로그램의 구동에 의하여 이동 단말기 상에서 구현될 수 있다.

[0043] 도 1b 및 1c 를 참조하면, 개시된 이동 단말기(100)는 바 형태의 단말기에 관한 것이다. 다만, 본 발명은 이것에 한정되지 않고 워치, 클립 타입, 글래스 타입 또는 2 이상의 바디들이 상대 이동 가능하게 결합하는 폴더 타입, 플립 타입, 슬라이드 타입, 스윙 타입, 스위블 타입 등 다양한 구조에 적용될 수 있다. 이동 단말기의 특정 유형에 관한 것이다. 이동 단말기의 특정유형에 관한 설명은 다른 이동단말기에 일반적으로 적

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있으며, 이용될 수 있다.

[0044] 이 경우에서, 당업자에 따라서는 이동 단말기(100)는 적어도 하나의 결합된 본체 또는 지정하는 형태이로 이해될 수 있다.

[0045] 이동 단말기(100)는 외관을 이루는 케이스(예를 들면, 프레임, 하우징, 커버 등)를 포함한다. 도시된 바와 같이, 이동 단말기(100)는 전면 케이스(101)와 그와 케이스(102)를 포함할 수 있다. 전면 케이스(101)와 후면 케이스(102)의 결합에 의해 형성되는 내부공간에는 각종 전자부품들이 배치된다. 전면 케이스(101)와 후면 케이스(102) 사이에는 적어도 하나의 미들 케이스가 추가로 배치될 수 있다.

[0046] 단말기 바디의 전면에는 디스플레이부(151)가 배치되어 정보를 출력할 수 있다. 도시된 바와 같이, 디스플레이부(151)의 윈도우(151a)는 전면 케이스(101)에 장착되어 전면 케이스(101)와 함께 단말기 바디의 전면을 형성할 수 있다.

[0047] 경우에 따라서, 후면 케이스 102)에도 전자부품이 장착될 수 있다. 후면 케이스(102)에 장착 가능한 전자부품은 착탈 가능한 배터리, 식별 모듈, 메모리 카드 등이 있다. 이 경우, 후면 케이스(102)에는 장착된 전자부품을 덮기 위한 배터리 커버(103)가 착탈 가능하게 결합될 수 있다. 따라서, 배터리 커버(103)가 분리되면, 후면 케이스(102)에 장착된 전자부품은 외부로 노출된다.

[0048] 도시된 바와 같이, 후면 커버(103)가 후면 케이스(102)에 결합되면, 후면 케이스(102)의 측면 일부가 노출될 수 있다. 경우에 따라서, 상기 결합시 후면 케이스(102)는 후면 커버(103)에 의해 완전히 가려질 수도 있다. 한편, 후면 커버(103)에는 카메라(121b)나 음향 출력부(152b)를 외부로 노출시키기 위한 개구부가 외부에 구비될 수 있다.

[0049] 이러한 케이스들(101, 102, 103)은 사출성형에 의해 형성되거나, 또는, 금속, 예를 들어 스테인레스 스틸(STS), 알루미늄(Al), 티타늄(Ti) 등으로 형성될 수도 있다.

[0050] 이밖에 단말기(100)는, 상술한 케이스에 의한 복수개의 케이스가 내부 공간을 마련하는 예시에 한정되지 않는다. 이 경우, 하나의 케이스에 의해 내부 공간이 마련되도록 구성될 수도 있다. 이 경우, 하나의 케이스 또는 두 개 이상의 케이스에 걸쳐 연결되는 일체형의 단말기(100)가 구성될 수 있다.

[0051] 한편, 이동 단말기(100)는 단말기 바디 내부로 물이 스며들지 않도록 방지하는 방수부(미도시)를 구비할 수 있다. 예를 들어, 방수부는 윈도우(151a)와 프레임, 케이스(101) 사이, 또는 케이스(101)와 후면 케이스(102) 사이에 구비되어, 이들의 결합 시 내부 공간을 밀폐하는 방수부재를 포함할 수 있다.

[0052] 이동 단말기(100)에는 디스플레이부(151), 제1 및 제2 음향 출력부(152a, 152b), 근접 센서(141), 조도 센서(142), 광 출력부(154), 제1 및 제2 카메라(121a, 121b), 제1 및 제2 조작부(123a, 123b), 마이크(122), 인터페이스부(160) 등이 구비될 수 있다.

[0053] 이하에서는, 도 1b 및 도 1c 에 도시된 바와 같이, 단말기 바디의 전면에 디스플레이부(151), 제1 음향 출력부(152a), 근접 센서(141), 조도 센서(142), 광 출력부(154), 제1 카메라(121a) 및 제1 조작부(123a)가 배치되고, 단말기 바디의 측면에 제2 조작부(123b), 마이크(122) 및 인터페이스부(160)이 배치되며, 단말기 바디의 후면에 제2 음향 출력부(152b) 및 제2 카메라(121b)가 배치된 이동 단말기(100)의 일 예를 들어 설명한다.

[0054] 다만, 이들 구성은 이러한 배치에 한정되는 것은 아니며, 이들 구성은 필요에 따라 제외되거나, 또는 다른 면에 배치될 수 있다. 예를 들어, 단말기 바디의 전면에는 제1 조작부(123a)가 구비되지 않을 수 있으며, 제2 음향 출력부(152b)는 단말기 바디의 측면이 아닌 단말기 바디의 후면에 구비될 수 있다.

[0055] 디스플레이부(151)는 이동 단말기(100)에서 처리되는 정보를 표시(출력)한다. 예를 들어, 디스플레이부(151)는 이동 단말기(100)에서 구동되는 응용 프로그램의 실행화면 정보, 또는 이러한 실행화면 정보에 따른 UI(User Interface), GUI(Graphic User Interface) 정보를 표시할 수 있다.

[0056] 디스플레이부(151)는 액정 디스플레이(Liquid crystal display, LCD), 박막 트랜지스터 액정 디스플레이(Thin Film transistor-liquid crystal display, TFT LCD), 유기 발광 다이오드(Organic light-emitting diode, OLED), 플렉서블 디스플레이(Flexible display), 3차원 디스플레이(3D display), 전자잉크 디스플레이(e-ink display) 중에서 적어도 하나를 포함할 수 있다.

[0057] 본 발명에 따른 디스플레이부(151)는 이동 단말기(100)의 구현 형태에 따라 2개 이상 존재할 수 있다. 이 경우, 예를 들어 이동 단말기(100)는 복수의 디스플레이부들이 하나의 면에 이격되거나 일체로 배치될 수 있으며, 또한 서로 다른 면에

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지면 형성될 수도 있다.

[0058] 디스플레이부(151)는 터치 방식에 의하여 제어 명령을 입력 받을 수 있도록, 디스플레이부(151)에 의해 출력되는 터치키를 구비할 수 있다. 예를 들어, 디스플레이부(151)에 대해서 터치가 이루어지면, 상기 터치키는 상기 터치에 의해 입력된다. 제1조작부(120)는 이에 한정하여 상기 입력에 대응하는 제어명령을 입력하기 위한 수단일 수 있다. 다시 말하면 이러한 입력키는 사용자의 손가락이나 스타일러스 펜과 같은 지정 도구를 이용하여 입력될 수 있다.

[0059] 한편, 터치패드가, 터치에 대한 출력을 상호 레이어 구조를 이루어 입력부(151a)와 출력부(151b)가 서로 상기 디스플레이부(151)로서 기능하는 실시예를 개시하였다. 입력부(151a)의 대신에 적절 레이저는 적외 레이저는 적외 레이저 등 중 하나일 수 있다. 또는, 터치패드는 다수층으로 이루어 입력과 출력을 수행할 수 있다. 예를 들어, 터치패드는, 디스플레이부 상에 배치되거나, 디스플레이부의 하부에 위치될 수 있다.

[0060] 이러한, 디스플레이부(151)는 터치센서와 함께 층을 노출하는 형성할 수 있으며, 이 경우에 터치 스크린은 사용자 입력부(123, 도 1a 참조)로 기능할 수 있다. 경우에 따라, 터치 스크린은 제1조작유닛(120)의 적어도 일부 기능을 대체할 수 있다.

[0061] 제1 음향 출력부(152a)는 통화음을 사용자의 귀에 전달 시키는 리시버(receiver)로 구현될 수 있으며, 제2 음향 출력부(152b)는 각종 멀티미디어의 재생음을 출력하는 확성기(loud speaker)의 형태로 구현될 수 있다.

[0062] 디스플레이부(151)의 도전층(151a)에는 제1 음향 출력부(152a)로부터 발생되는 사운드의 방출을 위한 음향홀이 형성될 수 있다. 하지만, 본 발명은 이에 한정되는 것은 아니고, 상기 사운드는 구조물 간의 조립틈새를 따라 방출되도록 구성될 수 있다. 이 경우, 외관상 독립적으로 형성되는 홀을 보이지 않거나 숨겨지는 음향 출력을 위한 구조가 더욱 단순해질 수 있다.

[0063] 광 출력부(153)는 이벤트가 발생시 이를 알리기 위한 빛을 출력하도록 이루어진다. 상기 이벤트의 예로는 메시지 수신, 호 신호 수신, 부재중 전화, 알람, 일정 알림, 이메일 수신, 애플리케이션을 통한 정보 수신 등을 들 수 있다. 제어부(180)는 사용자의 이벤트 확인이 감지되면, 빛의 출력이 종료되도록 광 출력부(153)를 제어할 수 있다.

[0064] 제1 카메라(121a)는 촬영 모드 또는 화상통화 모드에서 이미지 센서에 의해 얻어지는 정지영상 또는 동영상의 화상 프레임을 처리한다. 처리된 화상 프레임은 디스플레이부(151)에 표시될 수 있으며, 메모리(170)에 저장될 수 있다.

[0065] 제1 및 제2 조작유닛(120a, 120b)은 입력 장치(100)의 동작을 제어하기 위한 명령을 입력 받기 위해 조작되는 사용자 입력부(123)의 일 예이며, 조작부(manipulating portion)로도 통칭될 수 있다. 제1 및 제2 조작유닛(120a, 120b)은 터치, 푸시, 스크롤 등 사용자가 촉각적인 느낌을 주면서 조작하게 되는 방식(tactile manner)이라면 어떤 방식이든 채용될 수 있다. 또한, 제1 및 제2 조작유닛(120a, 120b)은 근접 터치(proximity touch), 호버링(hovering) 등 사용자의 촉각적인 느낌이 없이 조작하게 되는 방식으로도 채용될 수 있다.

[0066] 본 도면에서는 제1 조작유닛(120a)이 터치키(touch key)인 것으로 예시한다. 본 발명에 있어 한정되는 것은 아니며, 예를 들어, 제1 조작유닛(120a)은 푸시키(mechanical key)가 될 수도, 터치키와 푸시키의 조합으로 구성될 수 있다.

[0067] 제1 및 제2 조작유닛(120a, 120b)에 의해서 입력되는 내용은 다양하게 설정될 수 있다. 예를 들어, 제1 조작유닛(120a)은 메뉴, 홈키, 취소, 검색 등의 명령을 입력 받고, 제2 조작유닛(120b)은 제1 또는 제2 음향 출력부(152a, 152b)에서 출력되는 음향의 크기 조절, 디스플레이부(151)의 터치 인식 모드로의 전환 등의 명령을 입력 받을 수 있다.

[0068] 한편, 단말기 바디의 후면에는 사용자 입력부(123)의 다른 일 예로서, 후면 입력부(미도시)가 구비될 수 있다. 이러한 후면 입력부는 이동 단말기(100)의 동작을 제어하기 위한 명령을 입력 받기 위해 조작되는 것으로서, 입력되는 내용은 다양하게 설정될 수 있다. 예를 들어, 전원의 온/오프, 시작, 종료, 스크롤 등과 같은 명령, 제1 및 제2 음향 출력부(152a, 152b)에서 출력되는 음향의 크기 조절, 디스플레이부(151)의 터치 인식 모드로의 전환 등과 같은 명령을 입력 받을 수 있다. 후면 입력부는 터치입력, 푸시입력 또는 이들의 조합에 의한 입력이 가능한 형태로 구현될 수 있다.

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[0069] 추가 실시예에 따른 무선기 배터리의 충전방법으로, 전원의 디스플레이부(151)의 근접위에 배치될 수 있다. 단, 이는, 수용액이 또한기 배터리 한 손으로 휴대용 이 실시는 이용하여 용이하게 조작 가능하도록, 이전 입력부는 단말기 바디의 측면 상단부에 배치될 수 있다. 다만, 본 발명은 본 예에 한정되는 것은 아니며, 무선 입력부의 위치는 변경될 수 있다.

[0070] 이러한 무선기 배터리 충전에 관한 기술적인 구성들은, 예를 들면 자기장 유도 방식 또는 전자기 공진 방식 등을 이용하여 무선으로 전력을 수신할 수 있다. 또한, 실시 예에 따른 이동 단말기(100)는 무선 충전부가 단말기 바디의 일면에 구비되는 경우 도시된 형태로 제한되지 않으며, 단말기 바디의 측면 또는 후면 등 다양한 위치에 구비되는 경우, 다른 실시예에 따라 배터리(191)가 바로 충전될 수 있도록 구성될 수 있다.

[0071] 한편, 이동 단말기(100)에는 사용자에 의한 입력을 제공받기 위한 사용자입력부(130)가 구비될 수 있으며, 사용자입력부(130)는 사용자의 조작에 응하여 입력되는 스위칭부로 이용될 수 있다. 상기 사용자입력부는 디스플레이부(151) 등과 같이 입력부(130)에 포함될 수 있다.

[0072] 예컨대, 사용자입력부(130)는 사용자의 제스처를 입력받는 제스처입력부가 포함될 수 있으며, 제어부(180)는 제스처입력부에 감지되는 스위칭부로 입력수단으로 이용할 수 있다. 상기 제스처입력부는 디스플레이부(151) 등과 같이 입력부(130)에 포함될 수 있다.

[0073] 예컨대, 사용자입력부(130)는 이동 단말기(100)와 외부기기가 연결되기 위한 인터페이스부(170)가 하나 이상 구비되는 경우, 이러한, 외부 스피커기기의 제어를 위한 입력부로, 스피커 동작을 위한 포트(예를 들면, 적외선 포트(IrDA Port), 블루투스 포트(Bluetooth Port), 무선 랜 포트(Wireless LAN Port) 등), 또는 이동 단말기(100)에 저장된 정보에 대한 본인 인증을 위한 유심 카드(예를 들면, SIM(Subscriber Identification Module) 카드, UIM(User Identity Module) 등) 및 정보 저장을 위한 메모리 카드 등의 외장형 카드를 수용하는 소켓의 형태로 구성될 수도 있다.

[0074] 또한, 배터리 바디의 후면에는 배터커버(191b)가 배치될 수 있다. 이 경우, 배터커버(191b)는 배터리셀(191a)의 후면을 덮도록 결합되는 구성 형태로 이루어진다.

[0075] 배터커버(191b)는 외부로 노출되는 배터리셀(191a)의 후면을 덮어 배터리셀(191a)의 이탈을 제한하고, 배터리셀(191a)을 외부의 충격과 이물질로부터 보호하도록 구성될 수 있다. 이러한 배터커버(191b)는 외부에 노출되는 것이 바람직하므로, 전자기기 바디의 후면 케이스(102)를 구성하는 것이 가능하다.

[0076] 또한, 배터리(191)는 전자기기 바디에 내장되는 내장형 배터리가 구비될 수 있다. 이 경우, 배터커버(191b)는 배터리셀(191a)의 후면을 덮어 배터리셀(191a)을 외부로부터 보호하도록 구성될 수 있다.

[0077] 한편, 전자기기 바디에는 외부 충전기(예를 들면, 충전용 크레이들 등)와 전기적으로 연결되는 외부포트가 구비될 수 있다. 외부포트는 인터페이스부(170)의 일 예로 구성될 수 있다.

[0078] 한편, 전자기기 바디에는 무선 충전을 위한 안테나가 내장될 수 있다. 안테나는 도전성 패턴으로 이루어지며, 케이스에 형성될 수 있다. 예를 들면, 충전 주파 모듈(미도시)과 전기적으로 연결되는 안테나는 전자기기 바디에 의해 지지되도록 구성될 수 있다. 또는, 안테나는 필름 타입으로 형성되어 배터리(191)의 일측면에 부착될 수도 있다. 또는, 안테나는 케이스의 일부에 형성될 수도 있다.

[0079] 본 발명의 바디에는 외부 디바이스(100)의 센싱을 감지하기 위한 센싱 감지부(140, 도 1a 참조)가 구비된다. 센싱 감지부(140)는 본체의 바디에 내장되거나, 본체의 바디의 외부에서 부착되는 형태로 구성될 수 있다.

[0080] 디스플레이부(151)는 입력부(130)에 의해 입력되는 정보 또는 제어부(180)에 의해 처리될 정보를 출력한다. 예를 들어, 디스플레이부(151)는 단말기 바디의 동작에 따른 실행화면 정보, 또는 이러한 실행화면 정보에 따른 UI(User Interface), GUI(Graphic User Interface) 정보를 출력한다.

[0081] 한편, 본 도면에서는 디스플레이부(151)가 터치센서(미도시)와 상호 레이어 구조를 이루거나 일체로 형성됨으로써, 터치스크린(touch screen)으로 구성되는 것을 예시하고 있다. 이러한 터치스크린은 사용자 입력부(123)로 기능할 뿐만 아니라, 디스플레이부(151)와 사용자 사이의 출력 인터페이스를 제공할 수 있다.

[0082] 음향출력부(152)는 호신호 수신, 통화모드 또는 녹음 모드, 음성인식 모드, 방송수신 모드 등에서 무선 통신부(110)로부터 수신되거나 메모리(160)에 저장된 오디오 데이터를 출력한다. 음향출력부(152)는 이동 단말기(100)에서 수행되는 기능(예를 들어, 호신호 수신음, 메시지 수신음 등)과 관련된 음향신호를 출력한다. 이러한 음향출력부(152)에는 리시버(receiver), 스피커(speaker), 버저(buzzer) 등이 포함될 수 있다.

[0083] 또한, 디스플레이부(151)는 광원 등을 이용하여 광을 출력하기 위한 구성요소로서, 광원에서 출력된 광을 제어하기 위한 액정 등을 포함하는 광출력부를 포함할 수 있다. 디스플레이부(151)는 광출력부를 제어함으로써 광원에서 출력되는 광의 밝기, 색상 등을 제어할 수 있다.

[0084] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0085] 또한, 디스플레이부(151)는 백라이트 유닛을 구성하는 광원을 이용하여 광을 출력하기 위한 구성요소로서, 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0086] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0087] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0088] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0089] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0090] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0091] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0092] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0093] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0094] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0095] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0096] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0097] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0098] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0099] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0100] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0101] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0102] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0103] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0104] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0105] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0106] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0107] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0108] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0109] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0110] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0111] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0112] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0113] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0114] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0115] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0116] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0117] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0118] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0119] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0120] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0121] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0122] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0123] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0124] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0125] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0126] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0127] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0128] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0129] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0130] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0131] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0132] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0133] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0134] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0135] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0136] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0137] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0138] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0139] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0140] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0141] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0142] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0143] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0144] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0145] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0146] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0147] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0148] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0149] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0150] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0151] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0152] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0153] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0154] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0155] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0156] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0157] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0158] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0159] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0160] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0161] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0162] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0163] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0164] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0165] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0166] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0167] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0168] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0169] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0170] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0171] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0172] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0173] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0174] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0175] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0176] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0177] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0178] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0179] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0180] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0181] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0182] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0183] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0184] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0185] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0186] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0187] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0188] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0189] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0190] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0191] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0192] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전체를 균일한 밝기로 보이게 하는 구성이다.

[0193] 또한, 디스플레이부(151)는 광원에서 출력된 광을 이용하여 전면에 백라이트 유닛을 구성할 수 있다. 백라이트 유닛은 광을 균일하게 확산시켜 디스플레이부(151) 전

을 수 있다. 추가 또는 대안적으로 디스플레이부(151)와 상호작용 하는 탐침기(300)가 사용자 입력을 수행할 수 있다. 예시적인 탐침기는 펜, 터치 스크린에 대한 터치입력을 모방 또는 증강하기 위한 터치볼을 포함할 수 있다.

[0083] 도 2는 일 실시예에 따른 단말기의 A-A' 방향에 따른 단면도를 도시한 것이다.

[0084] 본 발명에서 언급하고 있는 단말부(100a)는 디스플레이부(151)를 포함한다. LCD (Liquid Crystal Display), OLED (Organic Light Emitting Diode) 등을 포함한다. 이러한 디스플레이부는 flat plate의 형태로 구성될 수 있으며, 이러한 flat plate의 상부에 터치스크린(151)이 포함될 수 있다. 또한, 추가부(160)는 제1추가부(162) 또는 제2추가부(163)를 배타적 형태(161)로 포함할 수 있다.

[0085] 도2은 터치스크린 내장형 2-터치 이상 탐침기에 대한 도식 예 중 대표적 도시한 것이다. 본 실시 예는 이상 탐침기의 추가부(160)가 지지부(107)의 연장을 통하여 구성될 수 있다. 도2a는 단면부(102a)가 휘어지지 않은 상태이다. 도2b는 단면부(102a)가 휘어짐에 따라 상태를 도시한 것이다.

[0086] 단면부(102a)는 이상 탐침기 1a01의 A-A' 방향으로 취할 수 있다. 탐침부의 디스플레이부(151)는 단면부의 내부 보호막(101)과 접착층 또는 없이 단면부의 내부 전체(102)에 위치적으로 형성 디스플레이부(151)를 위치시킬 수 있다. 이러한 단면부의 내부 전체(102)은 예를 디스플레이 패널을 의미하는 터치부의 LCD plate이 될 수 있다. 또한, 단면부(102a)는 휘어질 수 있는 소재로 될 수 있다. 단면부의 모양은 원형적으로 직사각형의 형태로 될 수 있다.

[0087] 스크류부(103)의 내부(107a)는 단면부의 내부 전체(102)의 다른부(102)과 맞닿는 위치를 갖는다. 또한 스크류부(107)는 스크류부(107)과 단면부의 일정거리 이상의 변화하는 만지는는 힘에 따른 지지부(107)에 휨 또는 변형하는 부분이라고 할 수 있다. 이러한 역할부(107)는 이상 탐침기(100)의 추가부(160)으로의 역할을 수행 할 수 있다.

[0088] 스크류부의 나사산부(105a)는 시계방향으로 회전 시키는 경우 스크류부 내부의(103a)은 본체부의 나사홈(106a)과 나사산부(105a)에 결합되며 나사홈(106a) 부터의 단면부(102a)는 스크류부(105)과 지지부의 지지부(107)의 거리의 차이가 생긴다.

[0089] 반대로 스크류부의 나사산부(105a)는 반시계방향으로 회전시키는 경우 단면부의 나사홈(106a)은 단면부에 형성된 나사산부(105)의 나사산은 이동하여 나사홈(106a)에 결합되며 나사홈(106a) 부터의 단면부(102a)는 스크류부(105)과 지지부의 지지부(107)의 거리의 차이가 생긴다.

[0090] 터치스크린패널부(151)과 단면부(102a)의 내부 전체(102)은 접착층 또는 없이 접착될 수 있다. 이 단면부(102a)는 지지부(107)의 상단부와 제 1 영역(105)과는 이격된 상태로 존재하고, 추가로 지지부(107)의 상단부의 제 2영역(106)으로는 접촉되어 있으며 제 1 영역(105)과는 이격된 상태로 존재한다. 이 경우 지지부(107)는 단면부(102a)의 하단에 탄성력을 제공하는 역할을 할 수 있다고 할 수 있다. 단면부(102a)는 휘어지지 않은 단면부(102a)의 모습(1a02a)과 달리, 이 때 프로는 휘어짐(1a01)에 의해 지지부의 제 2 영역(106)의 단면부(102a)의 하단을 밀어주게 되며 이러한 힘으로 인해서 단면부(102a)는 휘어짐(1a02a)과 같은 형상적 모습부(102a)의 형상을 변화 시킬 수 있다.

[0091] 이 경우 지지부(107)는 단면부(102a)과 접촉이 되며, 별도적인 힘으로 휘어지지 않는 소재는 사용될 수 있다.

[0092] 나아가, 단면부(102a)가 휘어짐 수 있는 정도의 힘으로는 추가부(160a)의 단부의 변화가 없이는 3D (a)와 같이 단면부(102a)와 지지부(107)의 접촉부는 이격되어 있을 수 있다.

[0093] 도 3은 단면부(102a)의 추가부(160)가 모두 휘어지는 구조형 이상 탐침기(100)의 A-A' 방향에 대한 종단면의 도면을 도시한다.

[0094] 상기 도 2 의 설명 에서 같이 추가부(160a)에 접촉되는 지지부(107)의 모양 형태 또는 단면부(102a)은 변형 되지 않는 소재로 구성되어 있을 수 있다.

[0095] 스크류부(103)의 나사산(105a)은 상기 설명 예와 마찬가지로, 단면부(102a)의 내부 전체(102)에 결합하는 나사홈(106)에 결합할 수 있다. 한편 스크류부(103)의 나사산부(105a)는 지지부의 역할 전체(101)에 결합할 수 있다.

[0096] 이 때, 지지부(107)는 휘어지는 방향을 기준으로 할 때의 제2 영역(107)의 지지부의 길이부 제 1 영역(105)과 상대적으로 단면부(102a) 방향으로 돌출되어 있을 수 있다. 지지부(107)의 단면은 원통의 형태(107)에서

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은영일 제 1영역(108)로 입사된 빛은 반사 부재(107)에 의해 반사되어 제 1 방향(도 1b의 x 방향)으로 진행할 수 있다. 이 때, 제 1 영역(108)과 제 2 영역(109)의 경계면(108a)은 제 1 방향(x 방향)에 대하여 소정의 각도를 가지도록 형성될 수 있다.

[0097] 광원부(100a)에 의해 생성된 빛이 제 1 영역(108)에 의해 반사되는 경우 전면부(100c)의 측면과 접촉한 공기층(110b)과 측면부의 외부층(130a)은 서로 다른 굴절률을 가지도록 선택될 수 있다. 예를 들어, 공기층(110b)은 저굴절률을 가지도록 선택될 수 있으며, 외부층(130a)은 고굴절률을 가지도록 선택될 수 있다. 이 경우, 전면부(100c)에 입사된 빛은 전면부(100c)와 공기층(110b)의 경계면에서 전반사될 수 있다. 전반사된 빛은 후면부(100b)를 향해 진행하며, 후면부(100b)에 입사된 빛은 후면부(100b)와 외부층(130a)의 경계면에서 전반사될 수 있다. 이와 같이, 광원부(100a)에 의해 생성된 빛은 전면부(100c)와 후면부(100b) 사이에서 반복적으로 전반사되면서 도파될 수 있다.

[0098] 도 1b 및 제 2영역(107)에 대한 스크린부(165)의 상대적 굴절률 조절에 의한 광원부(100a)의 출광부(100b)로의 빛 추출 원리에 대하여 보다 구체적으로 설명하면 다음과 같다. 광원부(100a)로 부터 제 2 영역(107)의 경계면(107a)에 입사되는 빛은 스크린부(165)의 상대적 굴절률 조절에 따라 전반사되거나 굴절되어 출광부(100b)로 추출될 수 있다. 즉, 스크린부(165)의 상대적 굴절률 조절에 따라 제 2 영역(107)의 경계면(107a)에 입사되는 빛의 입사각이 변화하여 전반사 조건을 만족하는 경우 빛은 전반사되어 후면부(100b)로 진행하게 되며, 전반사 조건을 만족하지 않는 경우 빛은 출광부(100b)로 추출될 수 있다. 이와 같이 스크린부(165)의 상대적 굴절률 조절에 따라 제 2 영역(107)의 경계면(107a)에 입사되는 빛의 입사각이 변화하여 전반사 조건을 만족하는 경우 빛은 전반사되어 후면부(100b)로 진행하게 되며, 전반사 조건을 만족하지 않는 경우 빛은 출광부(100b)로 추출될 수 있다. 이와 같이 스크린부(165)의 상대적 굴절률 조절에 따라 제 2 영역(107)의 경계면(107a)에 입사되는 빛의 입사각이 변화하여 전반사 조건을 만족하는 경우 빛은 전반사되어 후면부(100b)로 진행하게 되며, 전반사 조건을 만족하지 않는 경우 빛은 출광부(100b)로 추출될 수 있다.

[0099] 도 1b 및 도 2를 참조하면, 도시된 바와 같이 본 발명의 일 실시예에 따른 백라이트 유닛은 배터리(161)를 더 포함할 수 있다.

[0100] 스크린부(165)는 후면부(100b)와 대향하여 배치되며, 광신호의 입력부의 역할을 수행할 수 있다. 따라서 이 때 배터리(161)는 스크린부(165)에 입력되는 광신호의 전체 시스템에 필요한 전력을 공급할 수 있으며, 이 경우 도 1a와 같이 배터리(161)가 필요 없을 수 있다.

[0101] 도 1b 및 도 2를 참조하면 도시된 바와 같이 배터리(161)가 입력부 시스템 전체 시스템의 A-A' 방향의 단면을 도시하고 있다.

[0102] 입력부(190a)의 제조부(167) 하부에는 다수 개의 단위셀(181)이 일정 간격 이상 떨어져 형성된 전극 부품(182)들로 이루어진 배터리(161)가 결합되어 있을 수 있다. 이러한 부품(182)들은 배터리(181)를 형성 안정화하고, 입력부(190a) 또는 후면부(100b)와 일정 간격을 유지하기 위한 스페이서 역할을 수행할 수 있다. 이 경우, 스페이서 역할을 수행하는 부품(182)들은 전면부(100c)의 측면부(183)에 가까이 형성될 수 있다. 이 때, 전극 부품(182)들은 전면부(100c)의 측면부(183)에 가까이 형성되어 있으므로

[0107] 도 1 및 도 2를 참조하면, 본 발명의 일 실시예에 따른 멤버레인 여과장치(100)에서 멤버레인 여과막(130)의 세로방향에 대한 종단면을 도시하고 있다.

[0108] 이를 위해 여과장치(100)의 외관을 형성하는 케이싱(101)은 외부압력에 대항하여 소재적으로 비투과성 재질로 형성될 수 있다. 이 때 소재적으로 비투과성 재질은 상기 스트림(103)의 투입이 이루어질 수 있도록 입구(101a)가 형성되어 있으며, 상기 입구(101a)를 통해 스트림(103)이 투입될 수 있다. 이 때 케이싱(101)에 스트림(103)이 투입되는 압력은 적절히 조절될 수 있다.

[0109] 다음으로 케이싱(101) 내부에는 여과막(130)이 구비되어 있으며 여과막(130)의 외부측에 대한 내부측의 압력차이로 인해 투과액이 생성될 수 있다.

[0110] 도 1 및 도 2를 참조하면 본 발명의 일 실시예에 따른 멤버레인의 종단면도, 즉, 케이싱 내부에 구비된 여과막의 종단면도를 도시하고 있다.

[0111] 여과막(130)의 일부는 케이싱의 일부와 접촉하여 고정될 수 있도록 고정부를 형성할 수 있다.

[0112] 다음 케이싱(101) 내에서 지지부의 역할을 하는 제1 지지부, 제2 지지부의 형성된 상태로, 제1 상태(도 1a)와 제1 상태로부터 변형된 제2 상태(도 1b)를 보여 주고 있으며, 도 2를 참조하면 멤버레인 여과장치(100)는 제1 방향(도 1a의 x-x' 방향)의 양 끝단 부분의 케이싱 내부에 제1 지지부(130a)가 형성될 수 있으며, 제1 방향(도 1a의 x-x' 방향)에 수직한 제2 방향(도 1a의 y-y' 방향)의 양 끝단 부분의 케이싱 내부에 제2 지지부(130b)가 형성될 수 있다. 이와 같은 제1 지지부(130a)와 제2 지지부(130b)는 케이싱(101)의 내부에 고정되어 있으며, 제1 지지부(130a)의 일부분은 제1 방향(도 1a의 x-x' 방향)으로 이동 가능한 제1 이동부(130a')로 형성될 수 있으며, 제2 지지부(130b)의 일부분은 제2 방향(도 1a의 y-y' 방향)으로 이동 가능한 제2 이동부(130b')로 형성될 수 있다. 이와 같은 제1 이동부(130a')와 제2 이동부(130b')는 여과막(130)의 양 끝단 부분을 고정하는 역할을 수행하며, 제1 이동부(130a')와 제2 이동부(130b')의 이동에 따라 여과막(130)의 장력을 조절할 수 있다. 즉, 제1 이동부(130a')와 제2 이동부(130b')가 제1 상태(도 1a)에서 제2 상태(도 1b)로 변형됨에 따라 여과막(130)의 장력이 증가할 수 있다(도 1a 및 도 1b 참조).

[0113] 또한 도 1 및 도 2를 참조하면 본 발명의 일 실시예에 따른 멤버레인 여과장치는 제1 이동부 및 제2 이동부의 이동을 가능하게 하는 이동 수단을 포함할 수 있다.

[0114] 여과막(130)의 양단을 이동 가능하게 고정하기 위해 멤버레인 여과장치(100)는 케이싱(101)의 외부에 구비되는 제1 나사(105)와 제2 나사(106)를 포함할 수 있으며, 제1 나사(105)와 제2 나사(106)는 각각 제1 이동부(130a')와 제2 이동부(130b')에 체결될 수 있으며, 따라서 이 때 멤버레인 여과장치(100)의 제1 나사(105)와 제2 나사(106)가 회전함에 따라 제1 이동부(130a')와 제2 이동부(130b')가 제1 방향(도 1a의 x-x' 방향)과 제2 방향(도 1a의 y-y' 방향)으로 이동하여 여과막(130)의 장력을 조절할 수 있다.

[0115] 한편 이 경우 장력을 조절하는 이동 수단에 포함되는 제1 나사(105)와 제2 나사(106)는 수동 구동부(미도시)와 연결되어 작동하는 방식이거나 구동 모터(미도시)와 연결되어 작동하는 방식일 수 있다.

[0116] 또한 도 1 및 도 2를 참조하면 본 발명의 일 실시예에 따른 멤버레인 여과장치는 제1 방향(도 1a의 x-x' 방향)의 양단부와 제2 방향(도 1a의 y-y' 방향)의 양단부를 고정하는 고정부를 포함할 수 있다.

[0117] 이와 같은 고정부의 구체적인 형상에는, 소재의 탄성력 등에 의해 고정되도록 끼워지는 형태일 수 있으며, 이에 따라 제2 상태(도 1b)의 제2 지지부(130b)에 형성된 제2 이동부(130b')에 의해 고정이 되어 있을 뿐, 다른 형태로 구성될 수 있다. 예를 들어 제1 나사(105)가 관통하는 제1 이동부(130a')와 제1 나사(105)에 의해 고정되는 것과 같이 나사 결합에 의해 고정되는 형태일 수 있다. 이러한 상태에 있을 경우 멤버레인 여과장치(100)의 제1 나사(105)와 제2 나사(106)의 회전에 따라 제1 이동부(130a')와 제2 이동부(130b')가 이동하여 제2 상태(도 1b)로 변형됨에 따라 여과막(130)의 장력이 증가할 수 있다. 이러한 경우, 하나 이상의 부분을 충분히 고정할 수 있는 정도의 제1 상태(도 1a)로 형성된 여과막(130)을 제공할 수 있다. 이러한 경우, 여과막 거치를 용이하게 하기 위해 제1 이동부(130a') 및 제2 이동부(130b')에 형성되는 고정홈(135)은 제1 방향 및 제2 방향에 대하여 여과막(130)의 양단부가 고정되는 방향으로 형성될 수 있다. 즉, 제1 이동부(130a')에 형성되는 고정홈(135)은 제1 방향에 대하여 여과막(130)의 양단부가 고정되는 방향으로 형성될 수 있으며, 제2 이동부(130b')에 형성되는 고정홈(135)은 제2 방향에 대하여 여과막(130)의 양단부가 고정되는 방향으로 형성될 수 있다.

[0118] 상기의 상세한 설명은 도면 등에서 예시적으로 해석되어야 하며, 이로부터 제한적인 것으로 해석되어서는 안되며, 또한 당업자 등은 청구범위 등가항의 범위에 대해 고려되어야 하고, 본 발명은 등가적 범위 내에서의 모든 변경은 본 발명의 범위에 포함된다.

부호의 설명

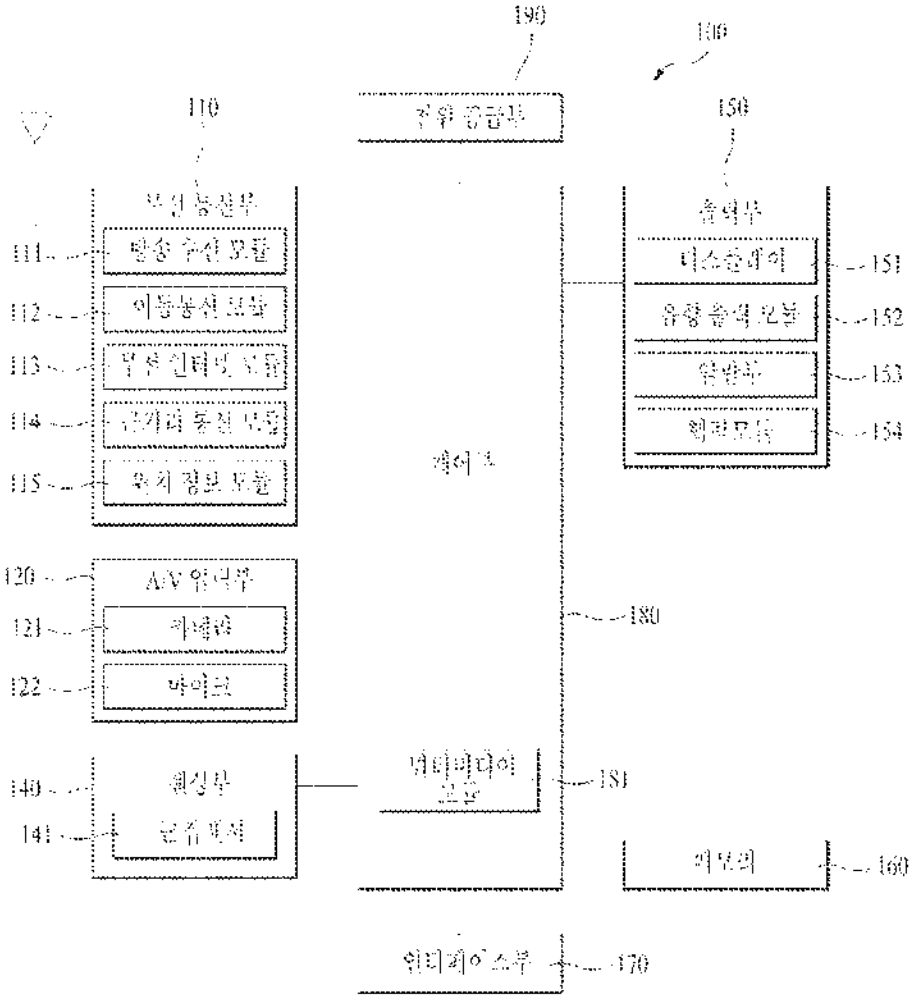
[0119] 100: 여과장치 101: 케이싱

300: 손부분 101: 프레임 어셈블리
302: 내부 에어리스 103: 베젤의 측벽
304: 외부공기의 배관 165: 스크린
305a: 스크린 냉각부재 305b: 스크린 다차식
306: 가이드 107: 상 측부
308: 제1방향의 구멍부 폭 1 영역 160: 제2 방향의 노출부 폭 2 영역
100: 정전용량센서 120: 입력부
150: 표시부 130: 중앙부
160: 인터페이스부 170: 메모리
180: 제어부 181: 프로세서
182: 수신 190: 터치입력감지부
191: 터치IC 195a: 터치 입력 감지부
195b: 터치스크린 패널 196: 센서 컨트롤러(Sensor Hub)
199: 송신 135: 주변부

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도면

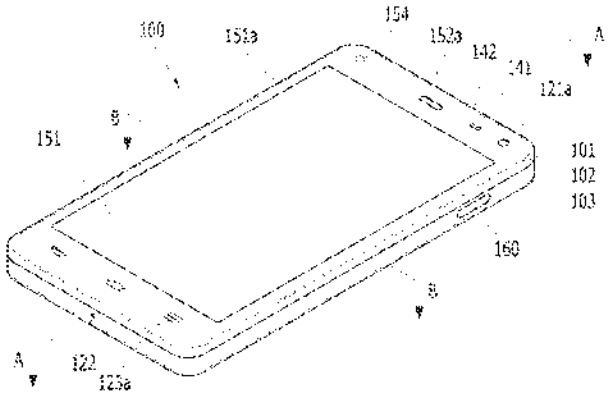
도면1a



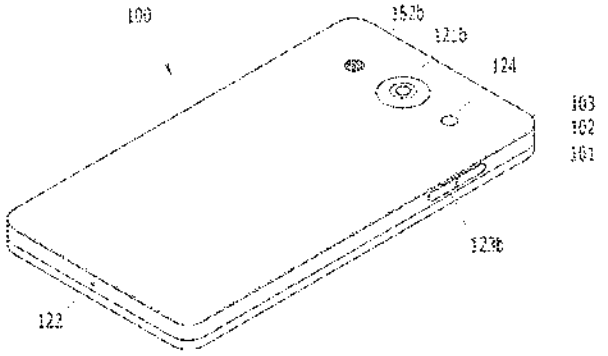
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도면3b

(a)



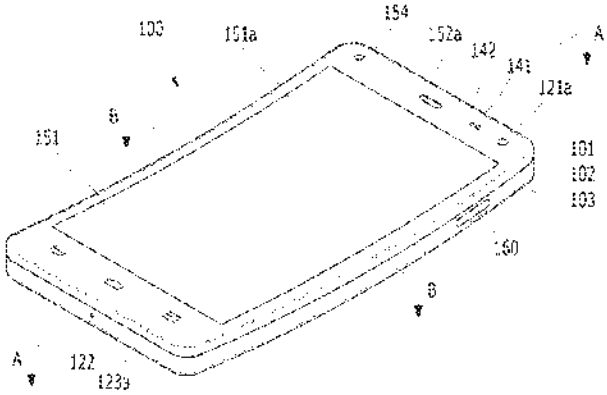
(b)



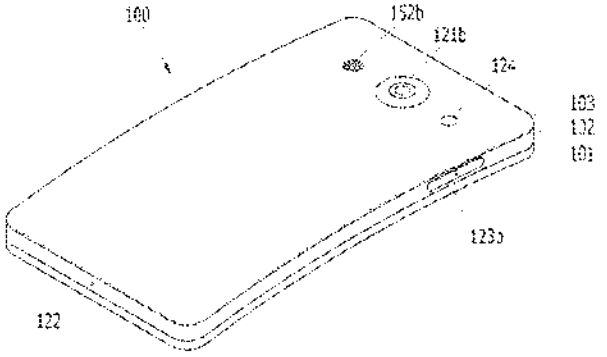
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도면3c

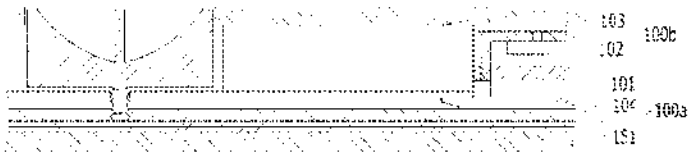
(c)



(d)



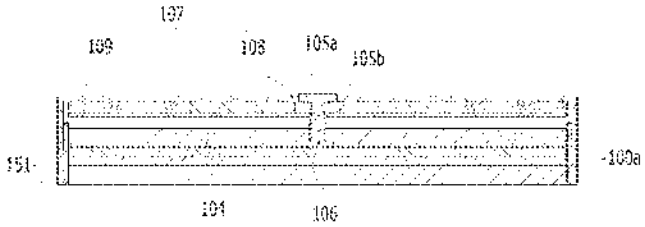
도면3d



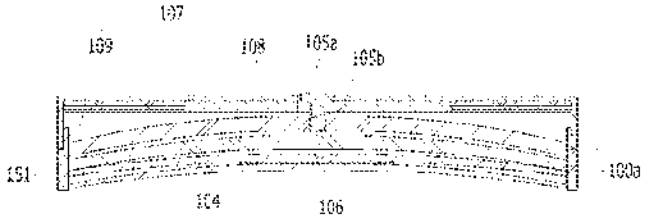
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도면3

(a)

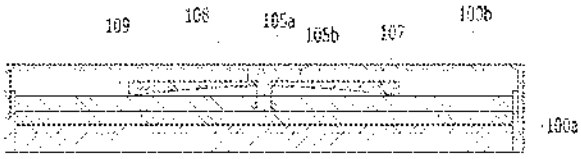


(b)

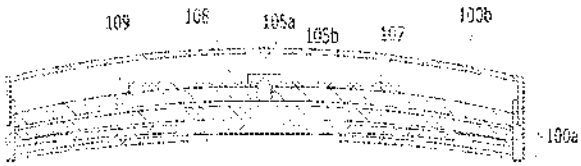


도면4

(a)



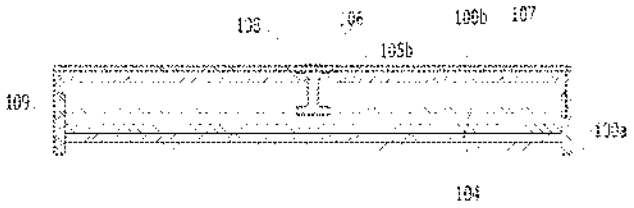
(b)



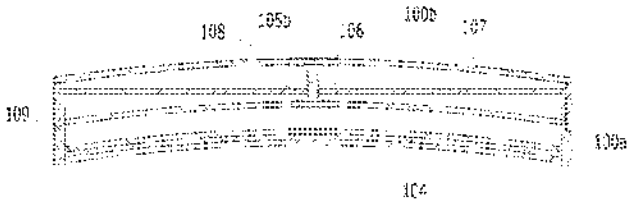
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도 6/7

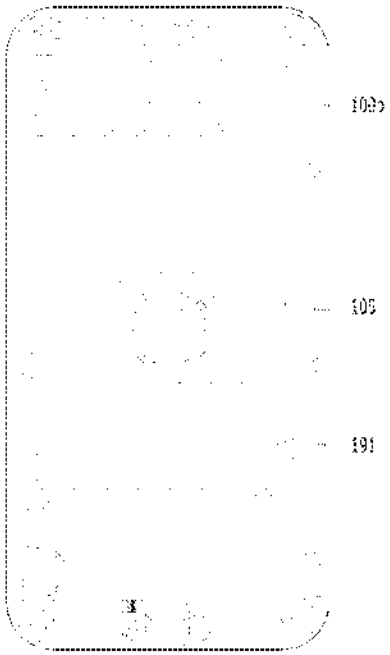
(a)



(b)



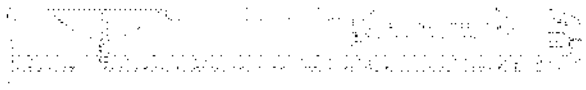
도 7/7



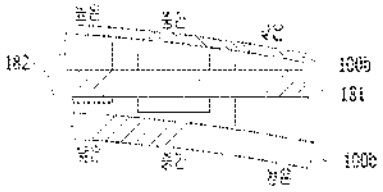
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도면17

(a)

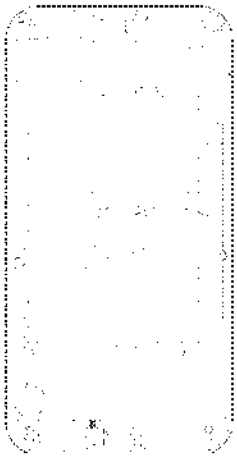


(b)

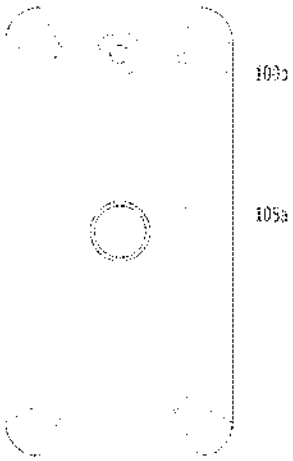


도면18

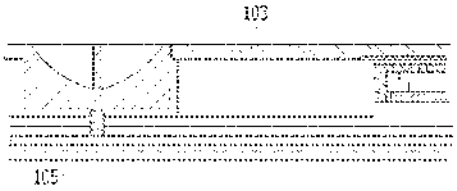
(a)



(b)



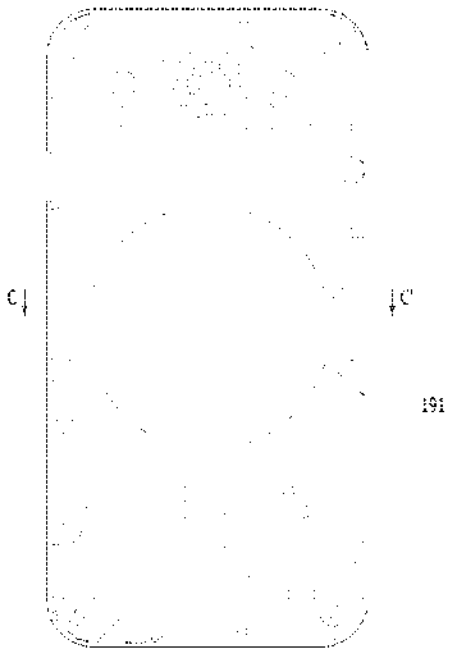
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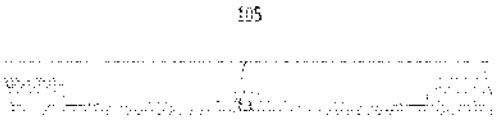
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도면10

(a)



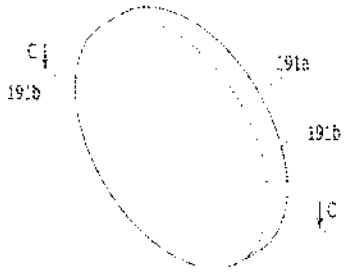
(b)



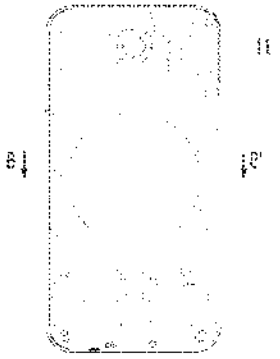
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도면3

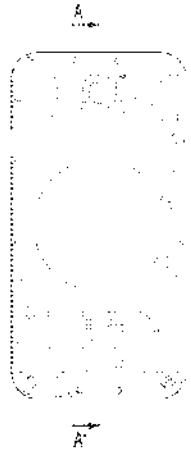
(a)



(b)



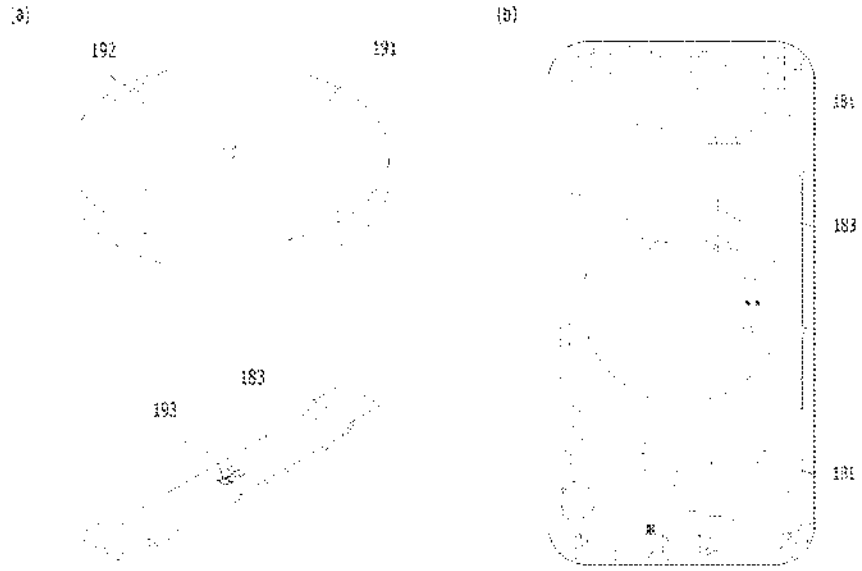
(c)



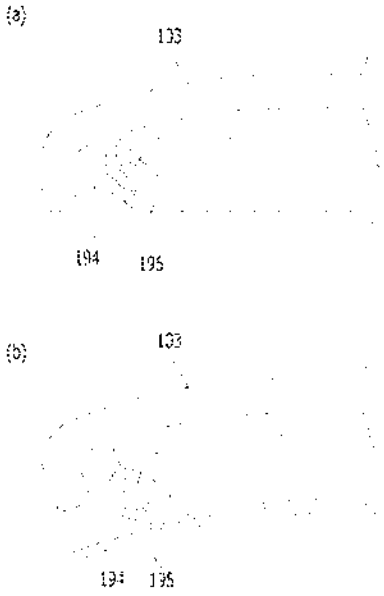


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도면13



도면14



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(19)中華民國智慧財產局

(12)新型說明書公告本 (11)證書號數：TW M517370 U

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(NOTE)備註： 相同的創作已於同日申請發明專利(Another patent application for invention in respect of the same creation has been filed on the same date)

申請專利範圍項數：10 項 圖式數：8 共 21 頁

(54)名稱

光學觸控裝置

(57)摘要

一種適用於一顯示器的光學觸控裝置，包含一透明板體、一反光層、至少二光源、至少二鄰近該等光源的光感測模組及一處理單元。透明板體設在顯示器的顯示面上，包括一頂面、一鄰近顯示面的底面、一上側面、一與上側面相對的下側面、一連接於上側面與下側面的左側面及一與左側面相對的右側面。該反光層包括一設置在透明板體的周緣的主層部，及一設置在該透明板體之底面的鄰近下側面、左側面及右側面的周緣並連接主層部的延伸層部。該延伸層部設置的位置不僅可避免該光學觸控裝置堆積灰塵，更有助於使該光學觸控裝置達到全平面的架構。

指定代表圖：

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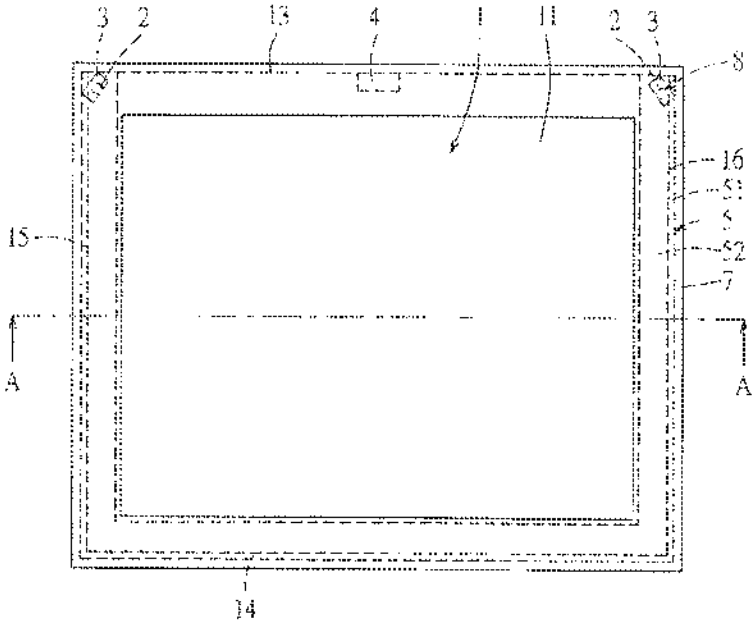


圖 1

符號簡單說明：

1・・・透明板體

11・・・頂面

13・・・上側面

14・・・下側面

15・・・左側面

16・・・右側面

2・・・光源

3・・・光感測模組

4・・・處理單元

5・・・反光層

51・・・主層部

52・・・延伸層部

7・・・框體

8・・・發光單元

新型專利說明書

（本說明書格式、順序，請勿任意更動）

【新型名稱】 光學觸控裝置

【技術領域】

【0001】 本新型是有關於一種光學觸控裝置，特別是指一種能達到全平面式的光學觸控裝置。

【先前技術】

【0002】 觸控裝置具有使設備簡潔、操作介面人性化等優點，故觸控裝置逐漸取代傳統的按鍵。近年來，隨著智慧型手機、平板電腦、電子書及觸控式提款機、公共事務機等電子化設備的普及，觸控裝置被應用的範圍也越來越廣泛。其中，光學觸控裝置因具備了低成本的優勢，因此在各種觸控面板的競爭市場中更備受關注。

【0003】 現有的光學觸控裝置通常包含一觸控板、二裝設於該觸控板頂面上端的攝影機、二分別位於鄰近該等攝影機的光發射器及一設於該觸控板的頂面的周緣的反光層。在使用時，該等光發射器發出光線，該光線碰到反光層並被該反光層反射後的影像被攝影機所擷取。當有一觸碰物接觸到該觸控板的頂面時，該觸碰物會阻擋住由反光層反射的部分光線，使該被反光層所反射的光線產生遮斷。藉由分析該等攝影機所記錄到光線產生遮斷的位置，來判斷該觸碰物所接觸到該觸控板頂面的位置。

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【0004】 然而，在現有的光學觸控裝置中，反光層設置於觸控板的頂面以增加光線反射的效果，但此種設置方式限制了觸控板的頂面可被使用的面積，也無法如期他觸控技術般做到窄邊框甚至是全平面的觸控板，故在美觀上仍需改善。此外，設置於該觸控板頂面的反光層在與該觸控板的接合處容易有卡積灰塵或被異物遮蔽之問題。

【0005】 此外，爲了擴大光線穿透該觸控板的面積範圍，往往會以加高攝影機與該觸控板頂面間的距離來達成此目的，但使得整體裝置的厚度增加，造成使用上較爲厚重不方便的問題。

【新型內容】

【0006】 因此，本新型之目的，即在提供一種不易累積灰塵的光學觸控裝置。

【0007】 本新型之另一目的，即在提供一種全平面式的光學觸控裝置。

【0008】 本新型之再一目的，即在提供一種不需增加整體觸控裝置的厚度也能擴大感應區域的光學觸控裝置。

【0009】 於是，本新型光學觸控裝置適用於一顯示器，該光學觸控裝置包含一透明板體、一發光單元、至少二光感測模組及一處理單元。

【0010】 該透明板體適於設在該顯示器的一顯示面上，且包括一頂面、一貼近該顯示面的底面、一上側面、一與該上側面相對的下側面、一連接於該上側面與該下側面的左側面及一與該左側面相對的右側面。

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【0011】 該發光單元設置於該透明板體，能產生遍佈該透明板體的光線。

【0012】 該等光感測模組分別設於靠近該等光源處，每一光感測模組用於感測當一物體接觸到該透明板體的該頂面時的光線以產生一感測信號。

【0013】 該處理單元，耦接於該等光感測模組，並接收來自於該等光感測模組之該等感測信號並據以產生一控制信號。

【0014】 在一些實施態樣中，該發光單元包括一反光層及至少二光源。該反光層包括一環繞設置在該透明板體的該下側面、該左側面及該右側面上的主層部、及一設置在該透明板體之該底面的一鄰近該下側面、該左側面及該右側面的周緣並連接該主層部的延伸層部。該等光源分別設置在該透明板體的該頂面的任兩相鄰兩角落處，該等光源分別發出紅外光。

【0015】 在一些實施態樣中，該發光單元包括至少一導光條，設置於該透明板體之任一側，並能發出紅外光。

【0016】 在一些實施態樣中，該發光單元包括一導光條，環繞設置於該透明板體之左側面、右側面及下側面。

【0017】 在一些實施態樣中，該透明板體具有兩彼此相對且逐漸朝一遠離該顯示面之方向延伸的左、右端部。

【0018】 在一些實施態樣中，該反光層的延伸層部的寬度配合該透明板體的該頂面的面積增加而增加。

【0019】 在一些實施態樣中，該反光層以反光布及反光

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條其中之一者所構成。

【0020】 在一些實施態樣中，該反光層具有至少一波浪狀的表面。

【0021】 在一些實施態樣中，該光學觸控裝置還包含一設在該反光層的該延伸層部與該透明板體的該底面之間的光學濾件(IR PASS)。

【0022】 在一些實施態樣中，光學觸控裝置還包含一框體，設在該透明板體的該頂面上用於覆蓋該等光源、該等光感測模組。

【0023】 本新型之功效在於利用設置在該透明板體的底面的反光層來加強反光效果，以補強在穿透該透明板體時因反射與折射而衰減的光線，而少了該反光層遮蔽的該透明板體的頂面不僅在外觀上能夠達成全平面的美觀，也避免灰塵卡積在該反光層與該透明板體頂面的交界處。此外，呈微凹面狀的透明板體，左、右兩端遠離該顯示器，使該透明板體能被該等光源照射到的面積增加。

【圖式簡單說明】

【0024】 本新型之其他的特徵及功效，將於參照圖式的實施方式中清楚地呈現，其中：

圖 1 是一上視圖，說明在一第一實施例中，一光學觸控裝置的元件安排；

圖 2 是一示意圖，說明該第一實施例中，該光學觸控裝置中的一反光層及二光感測模組設置的位置；

圖 3 是一剖面示意圖，說明圖 1 中的一透明板體為一

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平面時，沿 A-A 剖線切割，該透明板體的情形；

圖 4 是一剖面示意圖，說明圖 1 中的該透明板體爲一曲面時，沿 A-A 剖線切割，該透明板體的情形；

圖 5 是一圖 3 的局部放大示意圖，說明一光學濾件設於該透明板體的底面與該反光層間之情形；

圖 6 是一流程圖，說明該光學觸控裝置處理一訊號源的流程；

圖 7 是一上視圖，說明在一第二實施例中，一光學觸控裝置的發光單元爲一導光條時，該等導光條設置在該透明板體的三側邊之情形；及

圖 8 是沿圖 7 的 B-B 剖線切割的剖面示意圖，說明該導光條位於該透明板體與一框體間。

【實施方式】

【0025】 參閱圖 1 至圖 5，本新型光學觸控裝置的第一實施例包含一透明板體 1、一發光單元 8、二光感測模組 3、一處理單元 4、一光學濾件(IR PASS)6 及一框體 7。

【0026】 該透明板體 1 適於設在一顯示器 9 的一顯示面 91 上，且包括一頂面 11、一貼近該顯示面 91 的底面 12、一上側面 13、一與該上側面 13 相對的下側面 14、一連接於該上側面 13 與該下側面 14 的左側面 15 及一與該左側面 15 相對的右側面 16。

【0027】 該發光單元 8 包括二光源 2 及一反光層 5。如圖 2 所示，該等光源 2 在本實施例中分別設置在該透明板體 1 的該頂面 11 的右上方與左上方兩角落處，且該等光源 2 分

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別發出遠紅外光。該等光源 2 的數量可為二以上，且光源 2 設置的位置可以是位在該透明板體 1 的該頂面 11 的任意兩相鄰的角落處，不以本實施例中之舉例為限。

【0028】 用以反射該等光源 2 發出的光線的該反光層 5 包括一設置在該透明板體 1 的該下側面 14、該左側面 15 及該右側面 16 上的主層部 51、及一設置在該透明板體 1 之該底面 12 的一鄰近該下側面 14、該左側面 15 及該右側面 16 的周緣並連接該主層部 51 的延伸層部 52。在此實施例中，該反光層 5 的延伸部層 52 的寬度隨該透明板體 1 的該頂面 11 的面積增加而增加，如此可加強光線的反射，以彌補光線穿透玻璃時因反射、折射而減弱的能量。此外，本新型中在該透明板體 1 的周緣設置用以反射光線的反光層 5 的成本低於配置多個光學鏡頭的成本，具有降低成本的優點。

【0029】 其中，該反光層 5 可以是反光布或是反光條其中之一種形式。值得一提的是，如圖 5 所示，該反光層 5 的主層部 51 及延伸層部 52 皆具有一波浪狀的表面，能增加該反光層 5 與光線接觸的面積，進而加強光線被反射的效果。此實施例中的反光層 5 雖以反光布或是反光條為例，但不限制使用其他具有反光效果的材料作為反光層 5。

【0030】 參閱圖 5，該光學觸控裝置還包含一設在該反光層 5 的該延伸層部 52 與該透明板體 1 的該底面 12 之間的光學濾件 6。該光學濾件 6 供遠紅外線通過，以避免其他波長的光線穿透，而干擾反光的效果。

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【0031】 參閱圖 2 及圖 6，該等光感測模組 3 分別設於靠近該等光源 2 處，每一光感測模組 3 具有一感光耦合元件(CCD)，用於感測當一物體接觸到該透明板體 1 的該頂面 11 的光線時產生一觸碰點，以發出一感測信號 31。當該物體觸碰至該透明板體 1 的該頂面 11 時，該物體不僅會阻擋來自該等光源 2 的光線，也會阻擋從該反光層 5 反射的光線路徑，使該觸碰點爲一較暗區域，當該等光感測模組 3 擷取到具有該觸碰點的影像時，傳送一感測信號 41。此外，本實施例中的該等光感測模組 3 的數量雖以二爲例，但其數量可爲二以上。再者，該等光感測模組 3 設置的位置可以是位在該透明板體 1 的該頂面 11 的任意兩相鄰的角落處，不以本實施例中之舉例爲限。

【0032】 如圖 6 所示，該處理單元 4 耦接於該等光感測模組 3，接收來自於該等光感測模組 3 之該等感測信號 31，利用已知光感測模組 3 的位置與該觸碰點所投影在該反光層 5 的位置，運算出該觸碰點的位置，並據以產生一控制信號 41。

【0033】 從圖 1 及圖 3 皆可看出，該光學觸控裝置還包含一框體 7。該框體 7 設在該透明板體 1 的該頂面 11 上並包覆該透明板體 1 的周緣，用於覆蓋該等光源 2、該等光感測模組 3，使該光學觸控裝置整體視覺更加美觀。

【0034】 值得一提的是，本實施例中的透明板體 1 不限於只有平板狀的實施態樣。如圖 4 所示，該透明板體 1 具有兩彼此相對且逐漸朝一遠離該顯示面 91 之方向延伸的左

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、右端部。該左、右端部提高了該等光源 2 及該等光感測模組 3 能照射到該透明板體 1 的高度，亦增加了光線能穿透該透明板體 1 的面積，進而達到增加反射光線的效果。如此，該光學裝置不需架高該等光源 2 及該光感測模組 3 的位置，保持整體既有的厚度，就能提升光線的反射量，來增加其與該透明板體 1 間的距離，反而使該光學觸控裝置整體厚度的增加，造成使用上的厚重和不方便。

【0035】 參閱圖 7 及圖 8，本新型光學觸控裝置的一第二實施例大致上與前述的第一實施例相似，不同的地方在於，該第二實施例中的發光單元 8 爲一導光條 81，該導光條 81 環繞設置於該透明板體 1 的左側面 15、右側面 16 及下側面 14 並發出遍佈於該透明板體 1 的遠紅外光。當物體觸碰至該透明板體 1 的該頂面 11 時，會阻擋來自該等導光條 81 的光線，使該觸碰點爲一較暗區域，當該等光感測模組 3 擷取到具有該觸碰點的影像時，傳送一感測信號 41。值得注意的是，該導光條 81 至少設置於該透明板體 1 的某一側邊使光線分佈於透明板體 1 上即可，並不一定要在該透明板體 1 的左側面 15、右側面 16 及下側面 14 皆設置該導光條 81。

【0036】 綜上所述，在該第一實施例中，本新型利用設置在該透明板體 1 底面 12 的發光單元 8 使光線能分佈在該透明板體 1。該發光單元 8 可爲至少二光源 2 及一加強反光效果的反光層 5。該反光層 5 能補強光線穿透該透明板體 1 時因反射與折射而耗損的能量。此外，該透明板體 1 的頂

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面 11 少了該反光層 5 的遮蔽，不僅在外觀上更能貼近窄邊框或是全平面的設計，也克服了灰塵堆積在該反光層 5 與該透明板體 1 頂面 11 交界處的問題。而在該第二實施例中，該發光單元 8 爲能發出紅外光源的導光條 81 來產生分佈於該透明板體 1 的光線。最後，該透明板體 1 的型態能夠呈微凹面狀，即該透明板體 1 的左、右兩端遠離該顯示器 9，使該透明板體 1 能被該等光源 2 照射到的面積增加，故確實能達成本新型之目的。

【0037】 惟以上所述者，僅爲本新型之實施例而已，當不能以此限定本新型實施之範圍，凡是依本新型申請專利範圍及專利說明書內容所作之簡單的等效變化與修飾，皆仍屬本新型專利涵蓋之範圍內。

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【符號說明】

【0038】

1 …… 透明板體

11 …… 頂面

12 …… 底面

13 …… 上側面

14 …… 下側面

15 …… 左側面

16 …… 右側面

2 …… 光源

3 …… 光感測模組

31 …… 感測信號

4 …… 處理單元

41 …… 控制信號

5 …… 反光層

51 …… 主層部

52 …… 延伸層部

6 …… 光學濾件

7 …… 框體

8 …… 發光單元

81 …… 導光條

9 …… 顯示器

91 …… 顯示面

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M517370

新型摘要 公告本

※ 申請案號：104211777
※ 申請日：104. 7. 21 ※IPC 分類：G06F3/042 (2006.01)

【新型名稱】 光學觸控裝置

【中文】

一種適用於一顯示器的光學觸控裝置，包含一透明板體、一反光層、至少二光源、至少二鄰近該等光源的光感測模組及一處理單元。透明板體設在顯示器的顯示面上，包括一頂面、一貼近顯示面的底面、一上側面、一與上側面相對的下側面、一連接於上側面與下側面的左側面及一與左側面相對的右側面。該反光層包括一設置在透明板體的周緣的主層部、及一設置在該透明板體之底面的鄰近下側面、左側面及右側面的周緣並連接主層部的延伸層部。該延伸層部設置的位置不僅可避免該光學觸控裝置堆積灰塵，更有助於使該光學觸控裝置達到全平面的架構。

【英文】

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申請專利範圍

1. 一種光學觸控裝置，適用於一顯示器，該光學觸控裝置包含：

一透明板體，適於設在該顯示器的一顯示面上，且包括一頂面、一貼近該顯示面的底面、一上側面、一與該上側面相對的下側面、一連接於該上側面與該下側面的左側面及一與該左側面相對的右側面；

一發光單元，設置於該透明板體，能產生遍佈該透明板體的光線；

至少二光感測模組，分別設於靠近該等光源處，每一光感測模組用於感測當一物體接觸到該透明板體的該頂面時的光線，以產生一感測信號；及

一處理單元，耦接於該等光感測模組，並接收來自於該等光感測模組之該等感測信號並據以產生一控制信號。

2. 如請求項1所述的光學觸控裝置，其中，該發光單元包括一反光層及至少二光源，該反光層具有一環繞設置在該透明板體的該下側面、該左側面及該右側面上的主層部、及一設置在該透明板體之該底面的一鄰近該下側面、該左側面及該右側面的周緣並連接該主層部的延伸層部；該等光源分別設置在該透明板體的該頂面的任兩相鄰兩角落處，且分別發出紅外光。

3. 如請求項1所述的光學觸控裝置，其中，該發光單元包括至少一導光條，設置於該透明板體之任一側，並能發

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出紅外光。

4. 如請求項 3 所述的光學觸控裝置，其中，該發光單元包括一導光條，環繞設置於該透明板體之左側面、右側面及下側面。

5. 如請求項 2 所述的光學觸控裝置，其中，該透明板體具有兩彼此相對且逐漸朝一遠離該顯示面之方向延伸的左、右端部。

6. 如請求項 2 所述的光學觸控裝置，其中，該反光層的延伸層部的寬度配合該透明板體的該頂面的面積增加而增加。

7. 如請求項 2 所述的光學觸控裝置，其中，該反光層以反光布及反光條其中之一者所構成。

8. 如請求項 2 所述的光學觸控裝置，其中，該反光層具有至少一波浪狀的表面。

9. 如請求項 2 所述的光學觸控裝置，還包含一設在該反光層的該延伸層部與該透明板體的該底面之間的光學濾件(IR PASS)。

10. 如請求項 1 至 9 其中任一項所述的光學觸控裝置，還包含一框體，設在該透明板體的該頂面上用於覆蓋該等光源、該等光感測模組。

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圖式

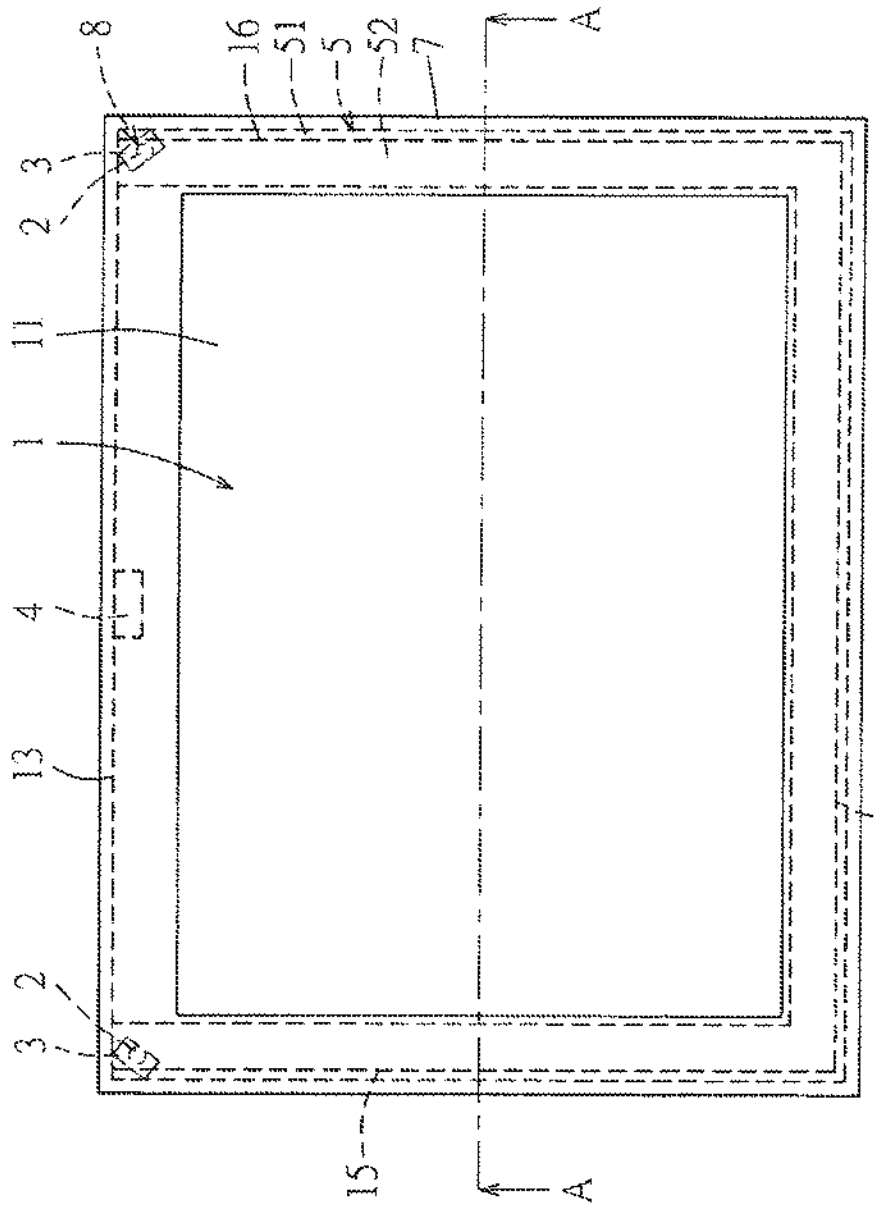


圖 1

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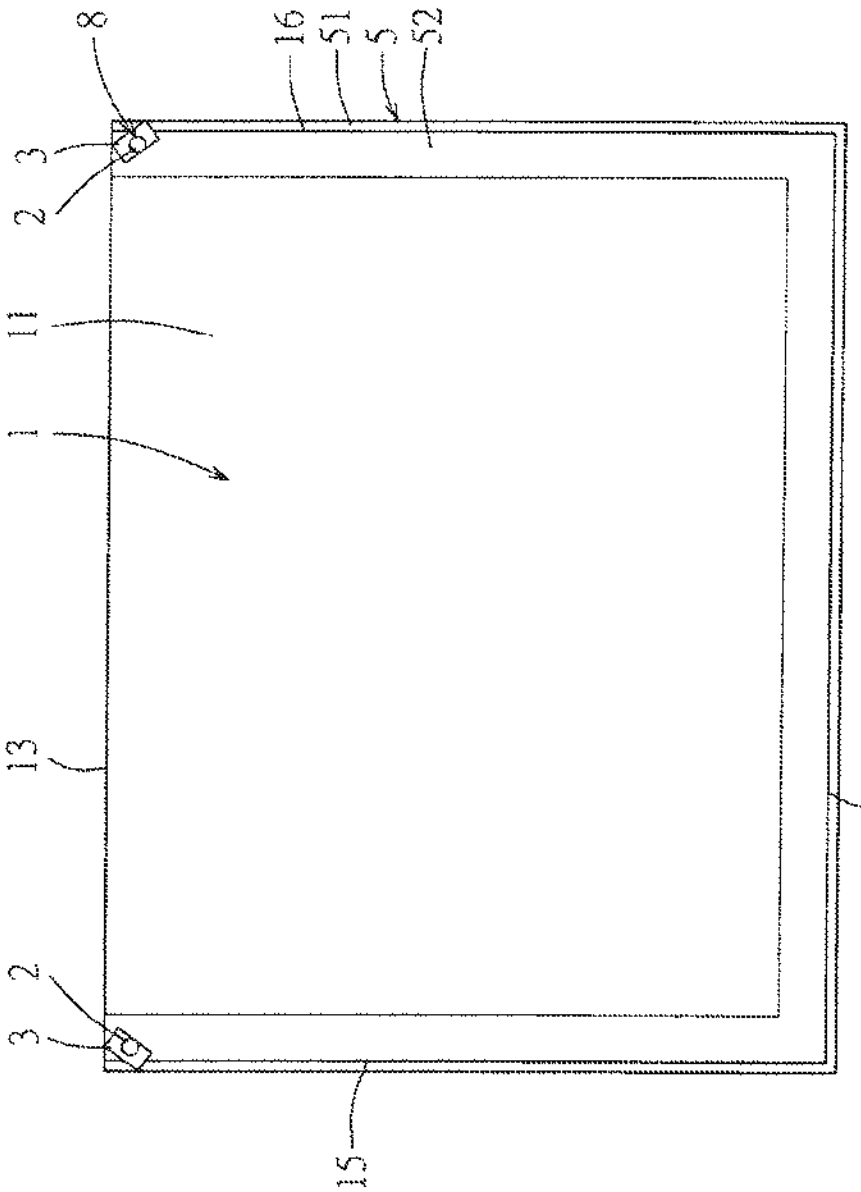


圖 2

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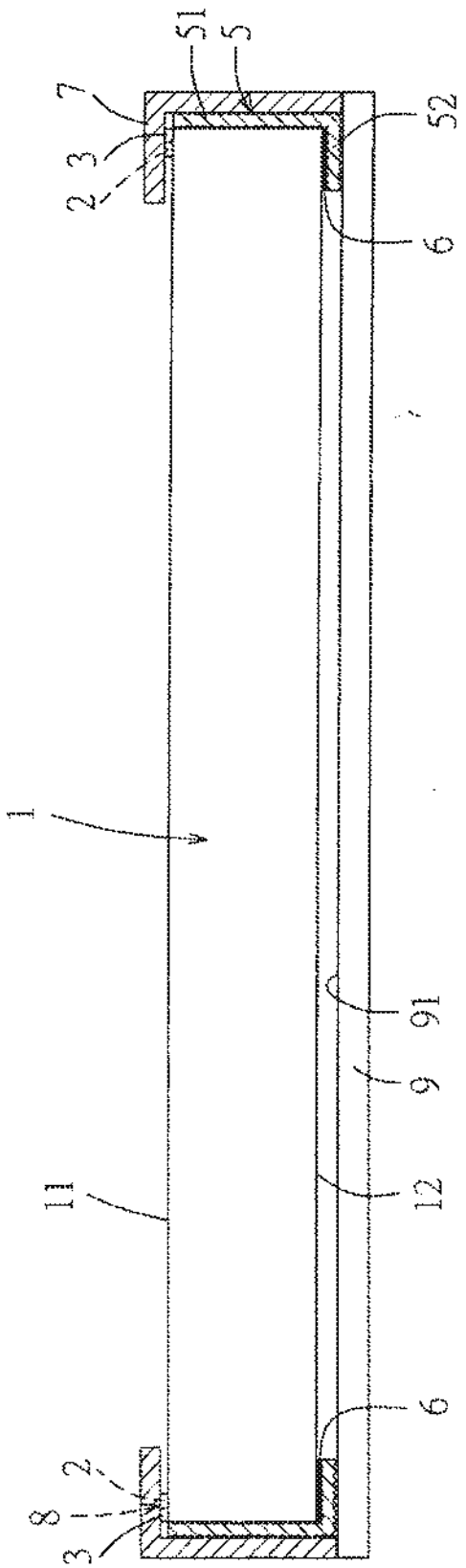


圖 3

S

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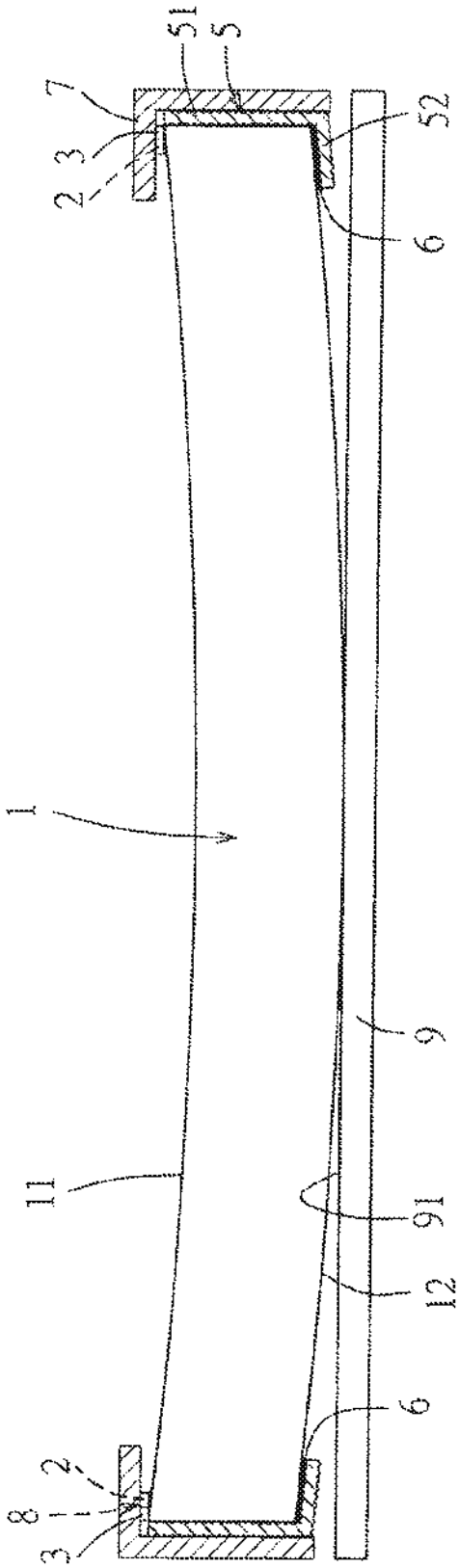


圖4

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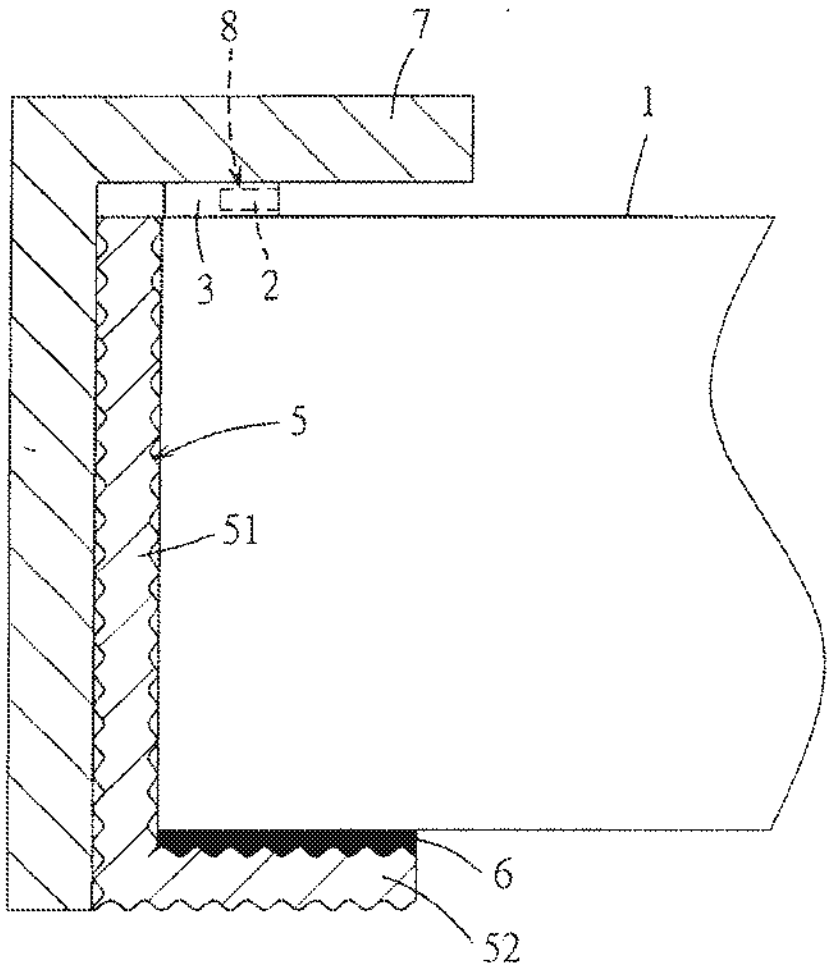


圖 5

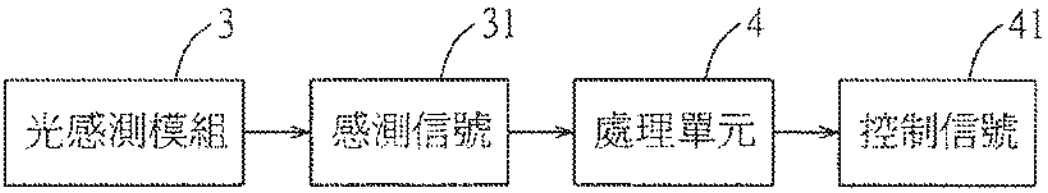


圖 6

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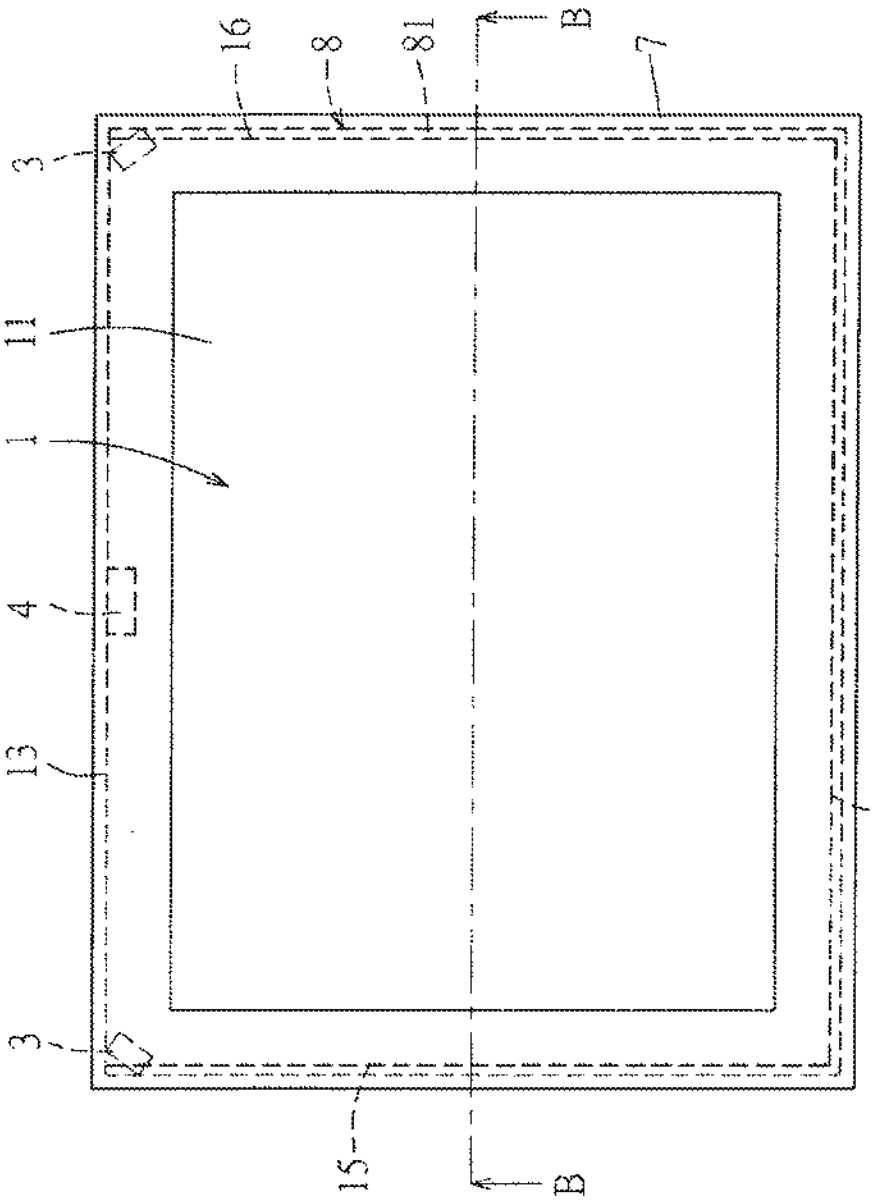


圖 7

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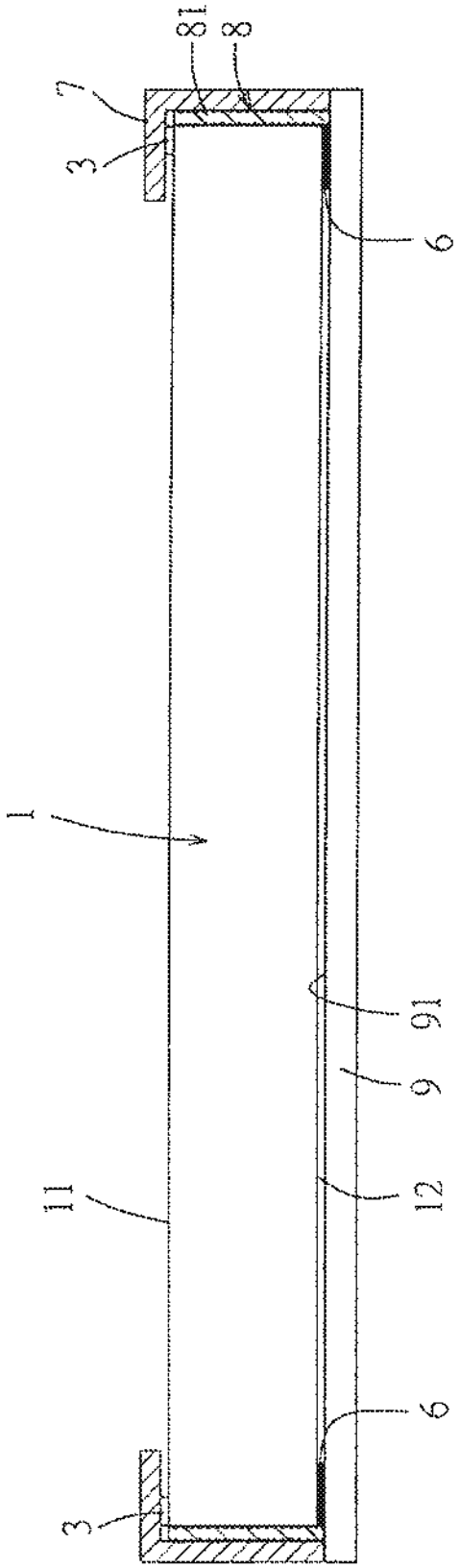


圖 8

S

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【代表圖】

【本案指定代表圖】：圖（ 1 ）。

【本代表圖之符號簡單說明】：

1 ..... 透明板體

11 ..... 頂面

13 ..... 上側面

14 ..... 下側面

15 ..... 左側面

16 ..... 右側面

2 ..... 光源

3 ..... 光感測模組

4 ..... 處理單元

5 ..... 反光層

51 ..... 主層部

52 ..... 延伸層部

7 ..... 框體

8 ..... 發光單元

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(54) Title: EDGE-COUPLED TOUCH-SENSITIVE APPARATUS

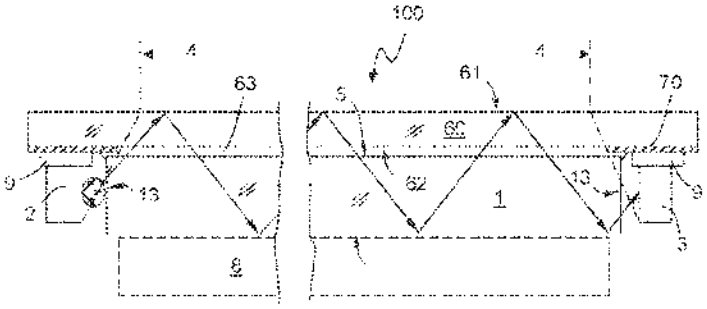


Fig. 4

(57) Abstract: A touch-sensitive FTIR apparatus (100), comprising a light-transmissive panel (1) having a front surface (5), an opposite rear surface (6), and a side edge (13) connecting the front and rear surfaces. A light emitter (2) is connected to input light at a first side edge portion and a detector (3) is connected to receive light output at a second side edge portion. A light-transmissive sheet (60) is laminated over the front surface of the panel and extends beyond the side edge of the panel to cover the emitter and the detector, wherein a lower surface (62) of the light-transmissive sheet is in optical contact with the front surface of the panel, so as to allow input light to propagate between the emitter and the detector through the panel and the light-transmissive sheet via total internal reflection in an upper surface (61) of the light-transmissive sheet.

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EDGE-COUPLED TOUCH-SENSITIVE APPARATUS

Cross-reference to Related Applications

The present application claims the benefit of Swedish patent application No. 1251438-6, filed 17 December 2012, and US provisional application No. 61/738022, filed 17 December 2012, both of which are incorporated herein by reference.

Technical Field

The present invention relates to the field of touch-sensing systems that operate by propagating light by internal reflections along well-defined light paths inside a thin light-transmissive panel, and in particular to edge-coupled solutions for providing a robust and user friendly touch-sensitive apparatus.

Background Art

This type of touch-sensing system is known as an FTIR-based system (FTIR, Frustrated Total Internal Reflection). It may be implemented to operate by transmitting light inside a solid light-transmissive panel, which defines two parallel boundary surfaces connected by a peripheral edge surface. Light generated by a plurality of emitters is coupled into the panel so as to propagate by total internal reflection (TIR) between the boundary surfaces to a plurality of detectors. The light thereby defines propagation paths across the panel, between pairs of emitters and detectors. The emitters and detectors are arranged such that the propagation paths define a grid on the panel. An object that touches one of the boundary surfaces ("the touch surface") will attenuate ("frustrate") the light on one or more propagation paths and cause a change in the light received by one or more of the detectors. The location (coordinates), shape or area of the object may be determined by analyzing the received light at the detectors. This type of apparatus has an ability to detect plural objects in simultaneous contact with the touch surface, known as "multi-touch" in the art.

There are different ways of coupling light into and out from the panel. One way is to attach prisms or wedges to the bottom surface of the panel. Such solutions have the benefit that light may be coupled within controllable angles, and it also allows a flush, edge-to-edge solution, for the top surface. However, the prisms or wedges may add significant thickness and weight to the system.

In another configuration, e.g. disclosed in US2006/0114237, the light is coupled into the panel directly through a peripheral side edge surface. Such an approach allows the light to be simply and efficiently injected into the panel. Also, such an in-coupling does not add significantly to the thickness of the touch system. On the other hand, in-

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coupling via the edge surface may add to the footprint of the touch system. Furthermore, mounting and calibration of light emitters and detectors with respect to the side edge may be difficult in order to obtain an acceptable production yield.

Summary

It is an objective of the invention to at least partly overcome one or more of limitations of prior art FTIR-based touch systems.

More specifically, it is an objective to provide an FTIR-based touch-sensitive apparatus which is comparatively robust and compact.

One or more of these objectives, and other objectives that may appear from the description below, are at least partly achieved by means of touch-sensitive apparatuses according to the independent claims, embodiments thereof being defined by the dependent claims.

In accordance with one aspect, the invention relates to a touch-sensitive apparatus, comprising: a light-transmissive panel having a front surface, an opposite rear surface, and a side edge connecting the front and rear surfaces; a light emitter connected to input light at a first side edge portion; a detector connected to receive light output at a second side edge portion; and a light-transmissive sheet laminated over the front surface of the panel and having a portion extending beyond the side edge of the panel to cover the emitter and the detector; wherein a lower surface of the light-transmissive sheet is in optical contact with the front surface of the panel, so as to allow input light to propagate between the emitter and the detector through the panel and the light-transmissive sheet via total internal reflection in an upper surface of the light-transmissive sheet.

In one embodiment, the touch-sensitive apparatus comprises a support element carrying at least one of said emitter and said detector, which support element is secured towards the lower surface of the light-transmissive sheet.

In one embodiment, the touch-sensitive apparatus comprises support element carrying at least one of said emitter and said detector, which support element is secured towards the rear surface of the panel.

In one embodiment, said support element is a printed circuit board.

In one embodiment, said support element is a flex film.

In one embodiment, said support element is an elongate strip, provided along an extended portion of the side edge, and carrying a plurality of emitters and/or detectors.

In one embodiment, the touch-sensitive apparatus comprises a side connecting element, configured to secure at least one of said emitter and detector towards the side edge of the panel.

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In one embodiment, the touch-sensitive apparatus said side connecting element comprises a transparent adhesive or silicon, and provides optical matching to the panel

In one embodiment, the touch-sensitive apparatus comprises a shielding element applied along a perimeter of the panel and under the light-transmissive sheet, covering at least said emitter and detector.

In one embodiment, the shielding element is formed on the lower surface of the light-transmissive sheet.

In one embodiment, the shielding element is a rigid metal sheet member configured to reinforce the portion of the light-transmissive sheet extending beyond the side edge of the panel

In one embodiment, the shielding element is partly sandwiched between the panel and the light-transmissive sheet.

In one embodiment, the shielding element covers an outer region of the front surface to prevent ambient light incident on the upper surface, within a predetermined wavelength range of use, from specularly reaching at least said detector

In one embodiment, the shielding element is non-transmissive to visible light.

In one embodiment, a lower surface of the shielding element which faces said outer region of the front surface of the panel is specularly reflective within the predetermined wavelength range of use.

In one embodiment, the touch-sensitive apparatus comprises a shielding element applied along a perimeter of the panel and under the light-transmissive sheet, covering at least said emitter and detector, and a support element carrying at least one of said emitter and said detector, which support element is secured towards the lower surface of the light-transmissive sheet.

In one embodiment, the light-transmissive sheet includes a rigid layer.

In one embodiment, at least one rigid layer of the light-transmissive sheet is made from the same material as the light-transmissive panel.

In one embodiment, the touch-sensitive apparatus comprises a light coupling member, arranged at the side edge to optically connect at least one of the emitter and the detector to the panel.

In one embodiment, the light coupling member includes at least one non-imaging, diffusively transmitting optical element arranged on the side edge of the panel; wherein the emitter is arranged to emit a beam of light onto the non-imaging optical element; and wherein the detector is arranged to receive detection light generated, by diffuse transmission, as propagating light from within the panel impinges on the non-imaging optical element.

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Brief Description of Drawings

Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.

Fig 1A is a section view of a light transmissive panel using FTIR for touch detection, and Fig. 1B is a top plan view of an FTIR-based touch-sensitive apparatus.

Fig. 2 is a 3D plot of an attenuation pattern generated based on energy signals from an FTIR-based touch-sensitive apparatus

Fig. 3 is a section view of an example of a touch-sensitive apparatus.

Fig. 4 is a section view of an edge-coupled laminated touch-sensitive apparatus according to an embodiment of the invention.

Fig. 5 is a bottom plan view of a touch-sensitive apparatus according to one embodiment

Fig. 6 is a section view of a portion of an edge-coupled laminated touch-sensitive apparatus according to an embodiment of the invention.

Fig. 7 shows a perspective view of a touch-sensitive apparatus according to one embodiment.

Figs 8-11 show section views of a portions of alternative embodiments of an edge-coupled laminated touch-sensitive apparatus according to the invention.

Figs 12-14 show details related to a shielding element in various embodiments of an edge-coupled laminated touch-sensitive apparatus according to the invention.

Detailed Description of Example Embodiments

In the following, embodiments of the present invention will be presented for a touch-sensitive apparatus incorporating a laminated optical element. Throughout the description, the same reference numerals are used to identify corresponding elements.

Fig. 1A illustrates the concept of touch detection based on attenuation by FTIR (Frustrated Total Internal Reflection) of propagating light. According to this concept, light is transmitted inside a panel 1 along a plurality of well-defined propagation paths. The panel 1 is made of a solid material in one or more layers and may have any shape. The panel 1 defines an internal radiation propagation channel, in which light propagates by internal reflections. In the example of Fig. 1A, the propagation channel is defined between the boundary surfaces 5, 6 of the panel 1, and the front (top) surface 5 allows the propagating light to interact with touching objects 7 and thereby defines a touch-sensitive region 4. The interaction is enabled by injecting the light into the panel 1 such that the light is reflected by total internal reflection (TIR) in the front surface 5 as it propagates through the panel 1. The light may be reflected by TIR in the rear (bottom) surface 6 or against a reflective coating thereon. It is also conceivable that the

propagation channel is spaced from the rear surface 6, e.g. if the panel comprises multiple layers of different materials. The panel 1 may thus be made of any solid material (or combination of materials) that transmits a sufficient amount of light in the relevant wavelength range to permit a sensible measurement of transmitted energy. Such material includes glass, poly(methyl methacrylate) (PMMA) and polycarbonates (PC). The panel 1 may be designed to be overlaid on or integrated into a display device or monitor (not shown in Fig. 1A).

As shown in Fig. 1A, an object 7 that is brought into close vicinity of, or in contact with, the touch-sensitive region 4 may interact with the propagating light at the point of touch. In this interaction, part of the light may be scattered by the object 7, part of the light may be absorbed by the object 7, and part of the light may continue to propagate in its original direction across the panel 1. Thus, the touching object 7 causes a local frustration of the total internal reflection, which leads to a decrease in the energy (or equivalently, the power or intensity) of the transmitted light, as indicated by the thinned lines downstream of the touching objects 7 in Fig. 1A.

Fig. 1B illustrates an example embodiment of a touch-sensitive apparatus 100 that is based on the concept of FTIR. Emitters 2 (indicated by open circles throughout the description) are distributed along the perimeter of the touch-sensitive region 4, around the panel 1, to project light onto the panel 1 such that at least part of the light is captured inside the panel 1 for propagation by internal reflections in the propagation channel. Detectors 3 (indicated by open squares throughout the description) are distributed along the perimeter of the touch-sensitive region 4, around the panel 1, to receive part of the propagating light. The light from each emitter 2 will thereby propagate inside the panel 1 to a number of different detectors 3 on a plurality of light propagation paths D. Even if the light propagation paths D correspond to light that propagates by internal reflections inside the panel 1, the light propagation paths D may conceptually be represented as "detection lines" that extend across the touch-sensitive region 4 between pairs of emitters 2 and detectors 3, as shown in Fig. 1B. Thus, the detection lines correspond to a projection of the propagation paths D onto the touch-sensitive region 4. Thereby, the emitters 2 and detectors 3 collectively define a grid of detection lines D ("detection grid") on the touch-sensitive region 4, as seen in a top plan view. The spacing of intersections in the detection grid defines the spatial resolution of the apparatus 100, i.e. the smallest object that can be detected on the touch-sensitive region 4.

As used herein, the emitters 2 may be any type of device capable of emitting radiation in a desired wavelength range, for example a diode laser, a VCSEL (vertical-cavity surface-emitting laser), an LED (light-emitting diode), an incandescent lamp, a

halogen lamp, etc. The emitter 2 may also be formed by the end of an optical fiber. The emitters 2 may generate light in any wavelength range. The following examples presume that the light is generated in the infrared (IR), i.e. at wavelengths above about 750 nm. Analogously, the detectors 3 may be any device capable of converting light (in the same wavelength range) into an electrical signal, such as a photo-detector, a CCD device, a CMOS device, etc.

The detectors 3 collectively provide an output signal, which is received and sampled by a signal processor 10. The output signal contains a number of sub-signals, also denoted "projection signals", each representing the energy of light received by a certain light detector 3 from a certain light emitter 2. Depending on implementation, the signal processor 10 may need to process the output signal for separation of the individual projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 3 on the individual detection lines D. Whenever an object touches a detection line, the received energy on this detection line is decreased or "attenuated".

The signal processor 10 may be configured to process the projection signals so as to determine a property of the touching objects, such as a position (e.g. in the x,y coordinate system shown in Fig. 1B), a shape, or an area. This determination may involve a straight-forward triangulation based on the attenuated detection lines, e.g. as disclosed in US7432893 and WO2010/015408, or a more advanced processing to recreate a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 1, where each attenuation value represents a local degree of light attenuation. An example of such an attenuation pattern is given in the 3D plot of Fig. 2, where the peaks of increased attenuation represent touching objects. The attenuation pattern may be further processed by the signal processor 10 or by a separate device (not shown) for determination of a position, shape or area of touching objects. The attenuation pattern may be generated e.g. by any available algorithm for image reconstruction based on projection signal values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the attenuation pattern may be generated by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of such reconstruction functions designed for use in touch determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

In the illustrated example, the apparatus 100 also includes a controller 12 which is connected to selectively control the activation of the emitters 2 and, possibly, the

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readout of data from the detectors 3. Depending on implementation, the emitters 2 and/or detectors 3 may be activated in sequence or concurrently, e.g. as disclosed in WO2010/064983. The signal processor 10 and the controller 12 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 10 and the controller 12 may be at least partially implemented by software executed by a processing unit 14.

Fig. 3 is a section view of an example of an FTIR-based touch-sensitive apparatus 100, which makes use of an edge-coupled mechanism for light coupling. Emitters 2 (one shown) and detectors 3 (one shown) are provided at different side edge portions of a side edge 13 of a light-transmissive panel 1. The emitter 2 may emit light within a wide cone angle, and is preferably placed near the side edge 13 such that a major part of the emitter light is coupled into the panel 1. Typically, some form of arrangement would also be employed for connecting light from the emitter 2 into the panel1, such as an optical matching or an optical coupling element. For the sake of simplicity, such elements have been left out in this drawing. It should be noted that the drawings are all schematic, which is why refraction in the side edges is not indicated. Entered light will at least partly propagate by TIR in the panel 1, of which some light will reach the side edge portion at the detector 3, and be coupled out to the detector 3. Total Internal Reflection (TIR) in the panel 1 is represented by a set of arrows from emitter 2 to detector 3, and $\theta_{c,i}$ represents the critical angle for internal reflection as given by Snell's law. As is well known to the skilled person, also light impinging on the surfaces 5 and 6 from within the panel 1 at angles that are wider than the critical angle $\theta_{c,i}$ will propagate by TIR. A light coupling mechanism (not shown) may be provided for controlling the input and/or output of light, such as a lens arrangement at the side edge 13 of the panel 1. For one thing, such a light coupling mechanism may comprise a refractive element, or alternatively a light blocker or absorber, arranged between the emitter 2 and the adjacent side edge portion, to prevent light from being coupled in to the panel 1 that would reach the detector without any reflection in the front surface 5. Such un-reflected light would only add to the background noise level at the detector 3, and would not be usable for detecting touch input. The emitter 2 is carried on a support element 22, such as a PCB (Printed Circuit Board) which is designed to supply power and transmit control signals to the emitter 2. Correspondingly, the detector 3 is carried on a support element 32, which may also be a PCB, designed to supply power to and transmit measurement data from the detector 3. A backside panel 8 may be provided under the touch-sensitive apparatus 100, such as a display device 8 having a display surface facing rear side 6 so as to be visible through the touch-sensitive apparatus 100.

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An arrangement in accordance with Fig. 3 places high requirements on assembly. In order to provide a reliable and robust touch-sensing system, the emitter(s) 2 and detector(s) 3 need to be consistently and securely attached with respect to the panel 1. Environmental factors, such as temperature and humidity, will affect the alignment of the emitters 2 and detectors 3 with respect to the panel 1, and proper assembly may also be affected by mechanical stress from mounting structures and by subsequent use of the touch-sensitive apparatus 100. From another aspect, there is a risk that ambient light, or light from the emitter 2 scattered or reflected within the apparatus 100, will reach the detector 3 without passing through the panel 1. In the drawing, this is illustrated by an arrow impinging from above on the detector 3. Any such light will have nothing but negative effect on the performance of the apparatus, since it will increase the noise level at the detector 3. Therefore, a light screen will often have to be employed above the side edge 13.

Figs 4-7 illustrate an embodiment of the invention, in which a laminated structure is employed to provide an improved touch-sensitive apparatus 100, which is set to alleviate at least some of the deficiencies associated with arrangements in accordance with prior art designs such as the one in Fig. 3. While Fig. 4 only depicts one emitter 2 and one detector 3, it should be understood that a plurality of emitters 2 and detectors 3 are normally included. These may be arranged with several emitters arranged next to each other along one side of the panel 1, and several detectors arranged next to each other along another side, corresponding to the embodiment of Fig. 1B. Alternatively, several emitters 2 and detectors 3 may be alternately arranged along at least two sides, as shown in Fig. 5.

In the embodiment of Fig. 4, a light-transmissive sheet 60 is laminated over the front surface 5 of the panel 1. This light-transmissive sheet 60 preferably covers the entire front surface 5, and also extends beyond the side edge 13. The light-transmissive sheet 60 is made from a material selected to optically comply with the panel 1. That way, the lower surface 62 of the light-transmissive sheet 60 is in optical connection with the front surface 5 of the panel 1, so as to allow input light to propagate between an emitter 2 and a detector 3 through the panel 1 and through the light-transmissive sheet 60, via total internal reflection in an upper surface 61 of the light-transmissive sheet 60, as indicated by the arrows in the drawing. Preferably, optical matching is obtained by selecting materials such that the refractive indices of the light-transmissive sheet 60 and the panel 1 are close. In one embodiment, the light-transmissive sheet 60 may be connected to the panel 1 by means of an optical bonding element 63. Such a bonding element 63 may be a film which is sandwiched between the panel 1 and the light-transmissive sheet 60 to act as an adhesive. Examples of such films are Optically Clear

Adhesive (OCA) and Contrast Enhancement Film (CEF), both provided by 3M™, which are usable for both flexible-to-rigid and rigid-to-rigid lamination. In other embodiments, the bonding element 63 may be provided in liquid form which is subsequently cured, in either a wet bonding process or a dry bonding process, both of which are well known in the art of lamination. In one embodiment, silicon may be used as a bonding element 63.

Whereas the panel 1, in one embodiment, is in the range of 500-1000 μm thick, the light-transmissive sheet 60 is preferably thinner, e.g. in the range of 50-500 μm. In a preferred embodiment, the panel 1 is made of a substantially rigid material, e.g. glass, PMMA, PC or other material, as already outlined with reference to Fig. 1A. In embodiments where the panel is substantially thicker than the light-transmissive sheet 60, the panel will act as the bulk layer for the entire sandwiched laminated optical element due to its relative thickness. The light-transmissive sheet 60 may be made from the same material as the panel 1. In another embodiment, the light-transmissive sheet 60 is a film made of or comprising a layer of PET (poly(ethylene terephthalate)). PET films may be provided with very small thicknesses, in the range of tens of μm. However, the thinner the PET film is made, the more birefringent it gets. PET in sheet form typically has distinct refractive indices in all 3 dimensions, and the in-plane indices normally increase as the film thickness decreases while the out-of-plane index decreases. In yet another embodiment, the light-transmissive sheet 60 comprises at least a layer of a comparatively rigid material, and preferably the same material as in the panel 1. The light-transmissive sheet 60 may also comprise further layers of different materials, in order to provide certain benefits, such as an anti-fingerprint coating and scratch resistance.

In accordance with the shown embodiments of the invention, touch-sensitivity is thus obtained in the upper surface 61, in which frustration may occur. However, it is only a touch-sensitive region 4 of the upper surface 61 that can be used for input. This region 4 is determined by the optical geometry of the apparatus 100. Light emitted to propagate by TIR cannot hit the upper surface 61 at any steeper angle than the critical angle. Thus, the placement and size of the emitter, and the vertical distance from the emitter 2 to the upper surface 61 may affect how far into the upper surface 61 the perimeter of the touch sensitive region 4 is located.

By providing the light-transmissive sheet 60 such that it extends outside the touch-sensitive region 4 and beyond to cover the emitters 2 and detectors 3, a top surface 61 of the apparatus is obtained which is flush. This may be beneficial in systems utilizing touch sensitivity, which are used not only for pointing input, but also for swiping gestures. Particularly, many graphical user interface operated by touch input

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involve gestures starting from within the touch-sensitive region 4 and ending at the perimeter of or outside the touch sensitive region 4, to indicate scrolling, sending, flipping, page turning or other functions. When making a gesture with an object 7, particularly when using the tip of your finger, the edge of a mounting frame or housing provided just outside the touch-sensitive region may be sensed by a user. A result thereof may be a negative effect on the user experience, due to the discomfort of swiping your finger over an edge. Another problem may be that grease and dirt may stick to the front surface 5 at the edge of such a mounting frame, which may increase the leakage of ambient light into the panel 1, reduce the overall signal level of the light to be detected, and negatively influence the touch sensitivity at the perimeter. The flush surface 61, which extends over the emitters 2 and detectors 3, may alleviate this problem.

In accordance with the embodiment shown in Fig. 4, a shielding element 70 may also be provided along the perimeter of the front surface 5 of the panel 1. The shielding element 70 is arranged to cover the emitters 2 and detectors 3, and also any light-coupling mechanism and support elements for the emitters 2 or detectors 3. The purpose of the shielding element 70 is two-fold. For one thing, it minimizes the risk of ambient light reaching the detectors 3 from above. This is specifically relevant for light within a predetermined wavelength range of use, in which the touch-sensitive apparatus 100 operates. In other words, a wavelength range in which the emitter 2 outputs light, and the detector 3 is sensitive to. This may be light within the visible range, but is preferably within the infrared region. In one embodiment the predetermined wavelength range of use is in the region of 750 to 1000 nm, in which detectors are readily available at reasonable cost. At higher wavelengths, though, suppression of ambient light may be easier. Secondly, unless shielded the emitters 2 and detectors 3, as well as support elements 22, 32 and any light-coupling mechanism, will be visible around the panel 1. These visible structures may clutter the appearance of the touch-sensitive apparatus 100 and may cause information shown by a display 8 close to its perimeter to be difficult to distinguish. For these reasons, the shielding element 70 is also opaque to visible light. As indicated in Fig. 4, the shielding element 70 is preferably substantially flat, and configured to block IR light and visible light. In embodiments incorporating a shielding element 70, the inner edge thereof may also limit the size of the touch-sensitive region 4 through mechanical vignetting. As shown in Fig. 4, the shielding element 70 preferably extends a portion into an outer region of the front surface 5 so as to protect the detector from angled incident light. In such an embodiment, a lower surface of the shielding element, which faces the outer region of the front surface 5 of the panel, may be specularly reflective with no or only a very small amount of absorption within the

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predetermined wavelength range of use, in order to minimize reflection losses of light that impinges thereon.

Providing the panel 1 with the shielding element 70 alone, without the light transmissive sheet 60 laminated above, would at least alleviate the mentioned optical issues of ambient light input and visibility of the light-coupling mechanism. However, it would also introduce an edge at the perimeter of the touch-sensitive region 4, and such an edge may be felt during finger swiping, which may have the afore-mentioned drawbacks. By providing the shielding element 70 underneath the light-transmissive sheet 60, this problem is avoided.

In the embodiment of Figs 4-7, the emitters 2 and detectors 3 are carried on a support element 9. The support element 9 may be one single structure, or a series of separate structures. More specifically, the support element 9 may be one or more PCB:s, one or more flex films, or similar, each carrying one or more emitters 2 and/or detectors. For the sake of simplicity, the same reference numeral 9 is used for all these variants.

In one embodiment of the invention, the support element 9 carrying at least one of said emitter 2 and said detector 3, is secured towards the lower surface 62 of the light-transmissive sheet. The support element 9 may be an elongate strip, provided along an extended portion of the side edge 13 of the panel 1. The "hanging" adhesion of the emitters 2 and detectors 3 to the upper light-transmissive sheet 60 provides a convenient and robust attachment. In one embodiment, the support element 9 is a flex film which is provided with an extended connector tongue (not shown) to be connected to further circuitry. Compared to a PCB, a flex film has the advantage of a very low profile.

In an embodiment incorporating a shielding element 70 as outlined above, the support member 9 may be secured towards the lower surface 62 of the light-transmissive sheet with the shielding element 70 in between, as seen in Figs 4-7. The shielding element 70 may be adhered by gluing to the lower surface 62 of the light-transmissive sheet 60, and also to the front surface 5 of the panel 1. The support element 9 may correspondingly be glued to the lower face of the shielding element 70.

In one embodiment, the shielding element may e.g. be a cut out metal sheet, shaped as a frame, which has a certain degree of rigidity. A benefit of such a design is that the shielding element 70 will provide reinforcement to the lip of the light-transmissive sheet 60 which extends beyond the edge of the panel 1. This, in turn, may increase the strength and durability of the sandwich structure, and may also decrease its sensitivity to pressure applied to the touch-sensitive surface 4. Such a shielding element may e.g. be made from stainless steel with a thickness in the range of 0.2 to 1 mm, but preferably less than 0.5 mm, e.g. 0.4 mm. Other types of metal, or even plastic

materials, are also plausible, and the thickness of the sheet may be tailored to the targeted use and size of the touch-sensing system

In another embodiment, the shielding element 70 is formed directly on the lower surface 62 of the light-transmissive sheet 60, before assembly with the panel. From a production perspective, this may be beneficial. Also, since the upper surface of the shielding element 70 may be seen through the light-transmissive sheet 60, it may be desirable nor to have glue in this interface, since bubbles, dust or other artifacts, if caught, will become visible. Forming of the shielding element directly on the lower surface 62 of the light-transmissive sheet 60 may be accomplished by spray painting, screen printing, or any known deposition method, such as by PVD or CVD (Chemical Vapor Deposition) of a suitable metal, e.g. silver, copper or chromium. In addition to the shielding element 70, a layer may be formed directly on the front surface 5 of the panel 1, e.g. by means of a chromium PVD coating of the perimeter of the panel 1. This yields a metalized bottom side reflective coating facing the body of the panel 1.

Figs 5-7 show an embodiment of the invention from different perspectives. Fig. 5 illustrates a bottom plan view of a touch-sensitive apparatus 100, i.e. from the side at which a display 8 (not shown) may be provided. The support element 9 for the emitters 2 and detectors 3 is provided by means of two separate strips, arranged along each one side edge 13 of the panel 1. These two strips 9 are attached to the shielding element 70, e.g. by gluing. Fig. 5 also shows, by partial transparency of the panel 1, that the shielding element 70 extends over (under in the drawing) the front surface 5 of the panel 1. The support element 9 may include two PCB:s or flex films, and include wiring and potentially also other electric components functionally associated with the emitters 2 or detectors 3. In an alternative embodiment (not shown), a single strip is instead provided, extending around the upper left corner of the panel 1 in the drawing. In yet another embodiment (not shown), separate support elements 9 are provide for each emitter 2 and each detector 3.

The embodiments of Figs 5-7 also include the feature of a side connecting element 11 for each one of the emitters 2 and detectors 3. Fig. 6 shows how only one such side connecting element 11 links an emitter 2 to the side edge portion at which it couples light into the panel 1. The side connecting element 11 may be a transparent adhesive, such as a glue or silicon, which adheres the emitter 2 to the side edge 13, and which provides optical matching between the emitter 2 and the panel 1. In a corresponding manner, each detector 3 is secured to the side edge 13 by means of a side connecting element 11, which provides optical matching between the emitter 2 and the panel 1. With the provision of the side connecting element 11, each emitter 2 and detector 3 will be secured to the laminated panel 1 in two directions, upwards to the

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light-transmissive sheet 60, and sideways to the side edge 13. This is also evident from the perspective view of Fig. 7. In an alternative embodiment (not shown), a string of adhesive, silicon or the like, will act as a side connecting element 11 for a plurality of emitters 2 or detectors 3, or at least one emitter 2 and one detector 3.

The result of the implementation of the side connecting element 11 is that the robustness of the touch-sensitive apparatus 100 may be improved. Also, the two-dimensional attachment of the emitters 2 and detectors 3 can make it possible to use a thinner light-transmissive sheet 60 than otherwise would have been possible, since flexing of the portion of the light-transmissive sheet 60 extending beyond the side edge 13 of the panel 1 will be damped by the securing of the side connecting element 11 to the side edge 13 of the panel, which will function as a securing lever. This, in turn, means that the overall thickness of the touch-sensitive apparatus may be decreased.

Fig. 8 shows an alternative embodiment, in which a light coupling member 15 is employed instead of a side connecting element 11 that provides optical matching. This light coupling member 15 may include e.g. a lens, a diffraction lattice, a prism, a blocker for light aimed straight through the panel 1, etc. In one embodiment a structured layer is applied to the side edge 13, so as to provide an enhanced light coupling effect at least for input. One example of such a structured layer may be Uniformity Tape by 3M™, which has a rib-like structure provided on a PET film that is adhered to side edge 13. A light coupling member 15 with such a structured layer will thus act as a series of lenses or lattices for a number of emitters 2 and/or detectors 3.

In one embodiment, the light coupling member 15 may include a diffuser, attached to side edge portion adjacent to the emitter 2. The diffuser is configured as a non-imaging component that diffusely transmits a portion of the incoming light into the panel 1. As is well-known to the skilled person, a non-imaging, diffusively transmitting surface will, when illuminated, emit light over a large solid angle at each location on the surface. The diffuse transmission is governed by "scattering" (also known as a combination of "diffuse reflection" and "diffuse transmission") which refers to reflection, refraction and interference (diffraction) of light at a surface as well as by particles dispersed in the bulk beneath the surface, such that an incident ray is scattered at many angles rather than being reflected at just one angle as in "specular reflection" or "specular transmission". Thus, part of the incoming light from the emitter 2 will be scattered by the diffuser, and a portion of this light will be transmitted into the panel 1. A "non-imaging" optical component is, in contrast to an imaging optical component, not designed with respect to the phase of the incoming light e.g. for the purpose of forming an image of a light source in a focal plane or generating a highly collimated beam of light, but is instead designed to achieve a dedicated optical radiative transfer of light

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from a source onto a target regardless of the phase of the light. Accordingly, when illuminated, the diffuser will act as a light source which is located in contact with the propagation channel inside the panel 1 to emit diffuse light. The light source realized by the diffuser thereby defines the actual origin of the detection lines that are generated by the light from the respective emitter 2. Since the diffuser more or less randomly re-distributes the incoming light, the importance of the luminance profile of the emitter 2 as well as the requirement on index matching and on the quality of the side edge 13 is reduced or even eliminated. This means that the diffuser has the ability to act as a light source for many different types of emitters 2 and for many different relative orientations between the emitter 2 and the diffuser, as long as the light from the emitter 2 hits the diffuser with a proper extent and at a proper location. Thus, compared to conventional coupling elements that operate by optical imaging, the sensitivity to manufacturing and mounting tolerances is reduced and assembly of the apparatus 100 is facilitated. This makes this embodiment better suited for mass production. The diffuser may e.g. be a coating, layer or film, or be realized by structuring of the edge by blasting, grinding, etching. In one embodiment the diffuser may be provided by means of a matte white paint or ink, applied to he side edge 13. Furthermore, the paint may be optimized to obtain a desired diffusive transmission ratio, e.g. by including pigments with low refractive index or spherical objects of different materials. One such pigment is SiO_2, which has a refractive index n=1.6. There are many dedicated materials that are commercially available, e.g. the fluoropolymer Spectralon, barium-sulphate-based paints or solutions, granular PTFE, microporous polyester, Makrofol® polycarbonate films provided by the company Bayer AG, etc.

In a corresponding manner, each detector 3 is arranged to optically face a light coupling member 15 comprising a diffuser, at the side edge 13 of the panel 1. The diffuser diffusely transmits a portion of the incoming propagating light, whereby at least part of the diffusively transmitted light reaches the detector 3. Accordingly, each diffuser such will act as a light source that diffusively emits "detection light" for receipt by the detector 3. The diffusers for the emitters 2 and the diffusers for the detectors 3 may be configured in the same way, to attain corresponding advantages. Further details with regard to diffusive coupling in an FTIR system can be found in applicants prior U.S. provisional application 61/675032 and Swedish patent application SE1250890-9, both filed on July 24, 2012, (equivalent to PCT/SE2013/050922, filed on July 22, 2013) which are hereby incorporated by reference.

Alternative embodiments for mounting of emitters 2 at the side edge 13 of the panel 1 will now be described with reference to Figs 9-11. It should be noted that for each embodiment, a corresponding arrangement may be employed for the detectors 3.

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Common for the embodiments shown in these drawings, is that a shielding element 70 preferably is included at the lower face of the light-transmissive sheet 60, which may be configured in any of the ways disclosed above. Furthermore, a mounting frame 91 is disclosed, which as such does not form part of the invention, in which the sandwiched element of the panel 1 and light-transmissive sheet 60 is suspended. A gasket or adhesive 92 may also be arranged between the light-transmissive sheet 60 and the mounting frame 91.

In Fig. 9 an emitter 2 is used, which is mounted to a support structure 9, such as a PCB or flex film as discussed for previous embodiments. The emitter 2 in this embodiment is of a type which primarily emits light from its top, i e. the side of the emitter 2 opposite to the base which attaches to the support structure 9. For this reason, the support structure 9 is arranged at angle, typically about 90°, to the front surface 5 of the panel 1, such that the emitter 2 is directed to emit light towards the side edge 13. In this embodiment, optical silicon 90 is used as a side connecting element, so as to attach the emitter 2 towards the side edge 13 of the panel 1 and provide optical matching. Preferably, and as shown in Fig. 9, optical silicon 90 is applied not only between the emitting end of the emitter 2 and the side edge 13, but also between the side of the emitter 2 facing upwards and the light-transmissive sheet 60. This way, the emitter 2 is secured in two directions, which renders a strong attachment. The support structure 9 may furthermore be suspended in the frame 91 by adhesion or other means, even though it is illustrated as unattached in the drawing.

Fig. 10 shows another embodiment, in which an emitter 2 is mounted to a support structure 9. The emitter 2 in this embodiment may be of the same type as in Fig. 6, configured to primarily emit light from its side. However, the support structure, which extends in the same general plane as the panel 1, is attached underneath the panel 1, to its rear surface 6. Attachment to the panel 1 may e.g. be accomplished by means of an adhesive or tape 93. Optical silicon 90 may also be provided, as illustrated, as a side connecting element, so as to attach the emitter 2 towards the side edge 13 of the panel 1 and provide optical matching. The optical silicon 90 may be applied not only between the emitting end of the emitter 2 and the side edge 13, but also between the side of the emitter 2 facing upwards and the light-transmissive sheet 60.

Fig. 11 shows an embodiment which is similar to the embodiment of Fig. 10. The difference is that instead of optical matching provided by means of silicon 90, a light coupling member 15 is provided between the emitter 2 and the side edge 13 of the panel 1. Functionally, this embodiment is therefore similar to the embodiment disclosed with reference to Fig. 8.

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All embodiments disclosed above have been described as optionally including a shielding element 70. Also the benefits of such an arrangement have been outlined. Where such a shielding element 70 is provided by means of a thin metal layer of paint or metal coating deposited on the lower surface of the light-transmissive sheet 60, it may be configured with a very low profile, down to single microns or even less than one micron. In such cases, there may be no reason to make any special arrangement to accommodate for the difference in the gap between the light-transmissive sheet 60 and the panel 1. However, if a substantially rigid shielding element 70 is used, such as a cutout metal sheet, its thickness may be up to several hundred microns as previously outlined. For such an embodiment, it may be suitable to make arrangements to adapt to the mechanical threshold rendered by the shielding element 70. Figs 12-14 provide different ways of solving that particular problem. For the sake of simplicity, emitters 2 and detectors 3 are left out in these drawings, and so are any side connecting elements 11 or light coupling members 15 for coupling emitters 2 and detectors 3 to the panel 1. In fact, any one of the embodiments already described with reference to Figs 4 to 11 may be combined with any one of the embodiments of Figs 12 to 14.

Fig 12 illustrates an embodiment, in which an adapter sheet 64 is provided between the panel 1 and the light-transmissive sheet 60, so as to even out the gap there between. Consequently, an adapter sheet 64 which has a thickness equal, or as close as possible, to the thickness of the shielding element 70 should be used. The adapter sheet 64 shall of course also be light-transmissive in at least the wavelength range of use for the apparatus, normally in the NIR, and also to visible light. Examples of transmissive films usable for the adapter sheet 64 are the aforementioned OCA and CEF, which are available in many different thicknesses. In other embodiments, the adapter sheet 64 may be provided in liquid form which is subsequently cured, in either a wet bonding process or a dry bonding process, both of which are well known in the art of lamination. In another embodiment, silicon may be used as a material for filling up the space, so as to act as an adapter sheet 64

Fig. 13 shows another embodiment, in which the height difference is adjusted by providing a recess 65 in the lower surface 62 of the light-transmissive sheet 60. The recess 65 should preferably be as deep as the shielding element 70 is thick, so as to more or less completely even out the gap size.

Fig. 14 shows a variant of the preceding embodiment, in which the height difference is instead adjusted by providing a recess 66 in the front surface 5 of the panel 1. The recess 66 should preferably be as deep as the shielding element 70 is thick, so as to more or less completely even out the gap size.

As the skilled person will realize, any combination of two or all of the

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embodiments of Figs 12-14 are also possible, even though the drawings do not show such combinations. In other words, a combination of a recess 65 and a recess 66 can be provided, where the added depth of those recesses are as close as possible to the thickness of the shielding element 70. Also, an adapter sheet 64 may be employed in addition to either a recess 65 or a recess 66, or both. It should also be noted that any known method may be used for laminating the light-transmissive sheet 60 to the panel 1, as discussed already with reference to Fig. 4, but that no remaining gap or separate bonding element is shown between the light-transmissive sheet 60 and the panel 1 for the sake of simplicity in Figs 12-14.

The invention has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope and spirit of the invention, which is defined and limited only by the appended patent claims.

For example, the specific arrangement of emitters and detectors as illustrated and discussed in the foregoing, as well as the specific examples of the light-coupling mechanism for input and output of light, are merely given as examples. Also, additional transmissive layers may be provided over the upper surface 61. The inventive coupling structure is useful in any touch-sensing system that operates by transmitting light, generated by a number of emitters, inside a light-transmissive panel and detecting, at a number of detectors, the decrease in propagating light caused by the frustration at the point of touch.

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CLAIMS

1. A touch-sensitive apparatus (100), comprising:

a light-transmissive panel (1) having a front surface (5), an opposite rear surface (6), and a side edge (13) connecting the front and rear surfaces;

a light emitter (2) connected to input light at a first side edge portion;

a detector (3) connected to receive light output at a second side edge portion;

a light-transmissive sheet (60) laminated over the front surface of the panel and having a portion extending beyond the side edge of the panel to cover the emitter and the detector;

wherein a lower surface (62) of the light-transmissive sheet is in optical contact with the front surface of the panel, so as to allow input light to propagate between the emitter and the detector through the panel and the light-transmissive sheet via total internal reflection in an upper surface (61) of the light-transmissive sheet.

2. The touch-sensitive apparatus of claim 1, comprising

a support element (9) carrying at least one of said emitter and said detector, which support element is secured towards the lower surface of the light-transmissive sheet.

3. The touch-sensitive apparatus of claim 1, comprising

a support element (9) carrying at least one of said emitter and said detector, which support element is secured towards the rear surface of the panel.

4. The touch-sensitive apparatus of claim 2 or 3, wherein said support element is a printed circuit board.

5. The touch-sensitive apparatus of claim 2 or 3, wherein said support element is a flex film.

6. The touch-sensitive apparatus of claim 2 or 3, wherein said support element is an elongate strip, provided along an extended portion of the side edge, and carrying a plurality of emitters and/or detectors.

7. The touch-sensitive apparatus of any of the preceding claims, comprising

a side connecting element (11), configured to secure at least one of said emitter and detector towards the side edge of the panel.

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8. The touch-sensitive apparatus of claim 7, wherein said side connecting element comprises a transparent adhesive or silicon, and provides optical matching to the panel

9. The touch-sensitive apparatus of any of the preceding claims, comprising a shielding element (70) applied along a perimeter of the panel and under the light-transmissive sheet, covering at least said emitter and detector.

10. The touch-sensitive apparatus of claim 9, wherein the shielding element is formed on the lower surface of the light-transmissive sheet.

11. The touch-sensitive apparatus of claim 9, wherein the shielding element is a rigid metal sheet member configured to reinforce the portion of the light-transmissive sheet extending beyond the side edge of the panel.

12. The touch-sensitive apparatus of any of the preceding claims 9-11, wherein the shielding element is partly sandwiched between the panel and the light-transmissive sheet.

13. The touch-sensitive apparatus of any of the preceding claims 9-12, wherein the shielding element covers an outer region of the front surface to prevent ambient light incident on the upper surface, within a predetermined wavelength range of use, from specularly reaching at least said detector.

14. The touch-sensitive apparatus of any of the preceding claims 9-13, wherein the shielding element is non-transmissive to visible light.

15. The touch-sensitive apparatus of claim 13, wherein a lower surface of the shielding element which faces said outer region of the front surface of the panel is specularly reflective within the predetermined wavelength range of use.

16. The touch-sensitive apparatus of claim 2 and any of claims 9-15, wherein said support element is attached to a lower surface of the shielding element.

17. The touch-sensitive apparatus of any of the preceding claims, wherein the light-transmissive sheet includes a rigid layer.

18. The touch-sensitive apparatus of claim 17, wherein at least one rigid layer of the light-transmissive sheet is made from the same material as the light-transmissive panel.

19. The touch-sensitive apparatus of any of the preceding claims 1-6, comprising a light coupling member (15), arranged at the side edge to optically connect at least one of the emitter and the detector to the panel.

20. The touch-sensitive apparatus of claim 19, wherein the light coupling member includes at least one non-imaging, diffusively transmitting optical element arranged on the side edge of the panel,

wherein the emitter is arranged to emit a beam of light onto the non-imaging optical element; and

wherein the detector is arranged to receive detection light generated, by diffuse transmission, as propagating light from within the panel impinges on the non-imaging optical element.

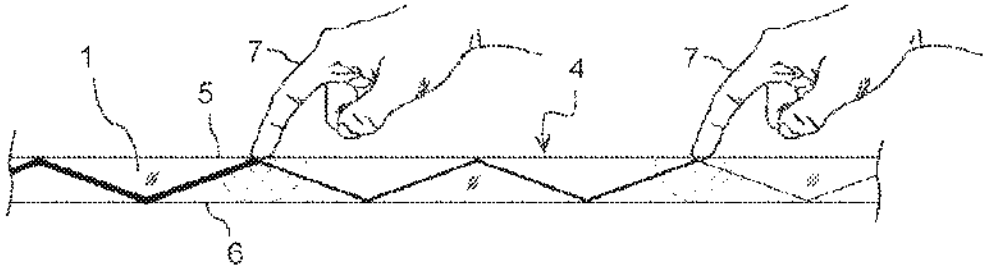


Fig. 1A (Prior Art)

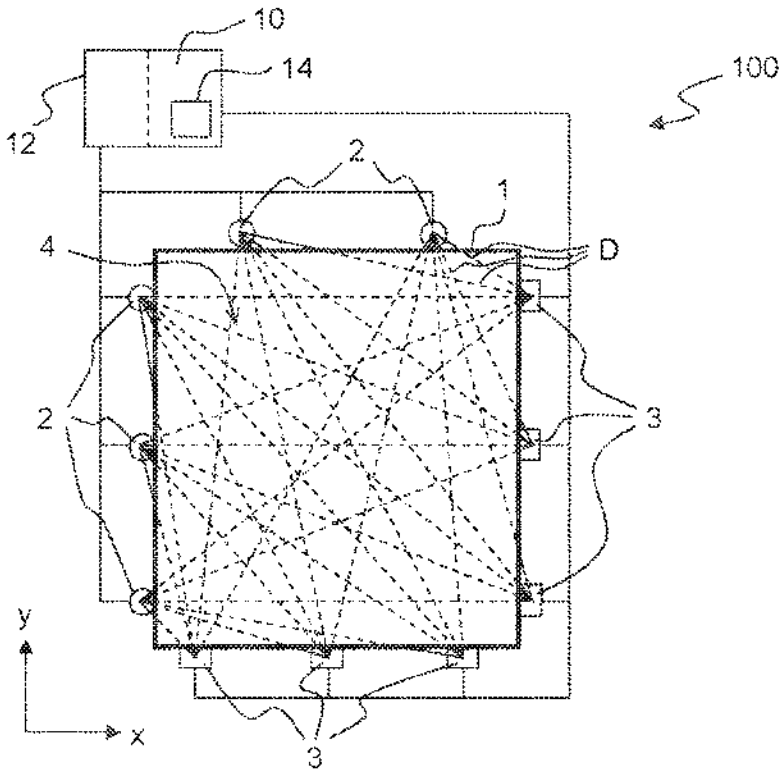


Fig. 1B

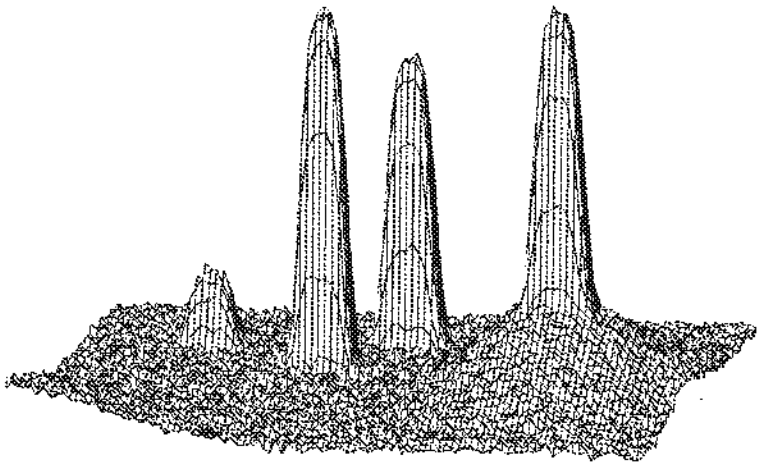


Fig. 2

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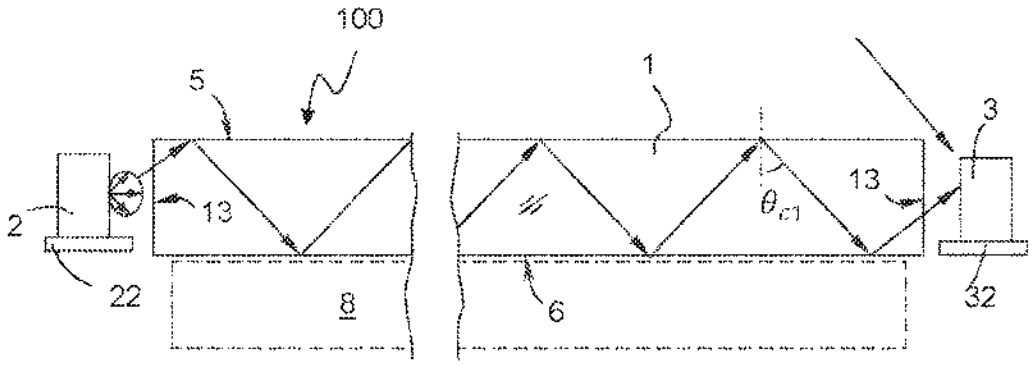


Fig. 3 (Prior art)

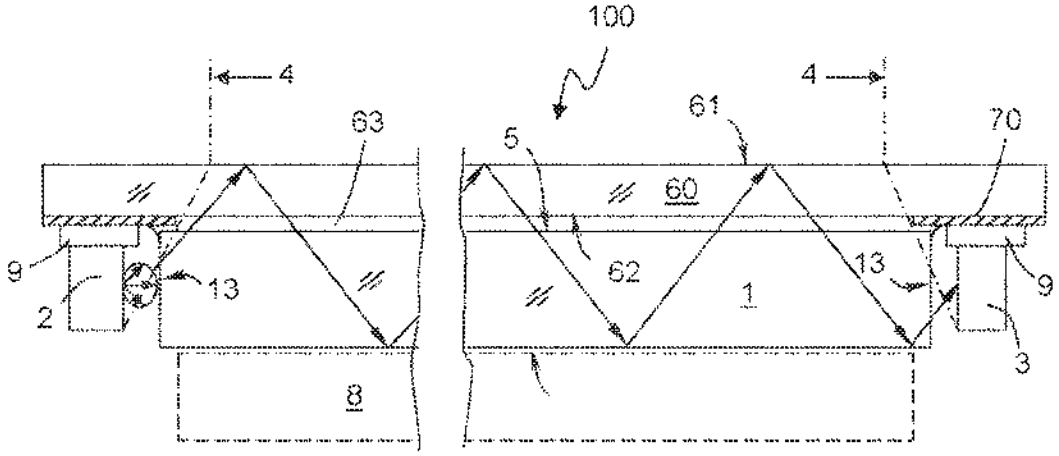


Fig. 4

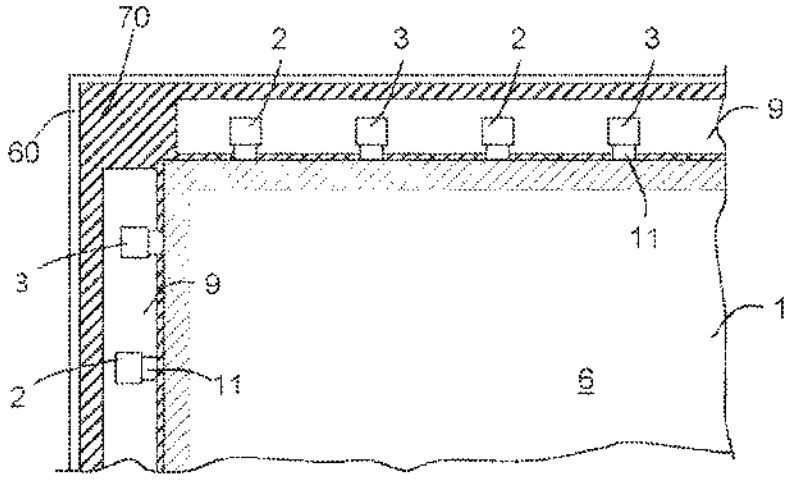


Fig. 5

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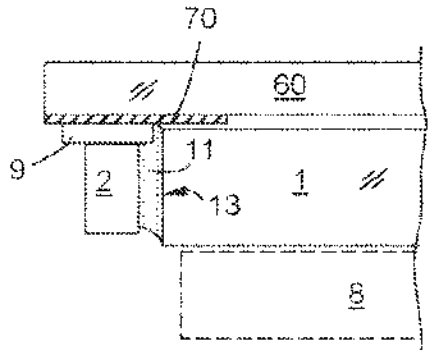


Fig. 6

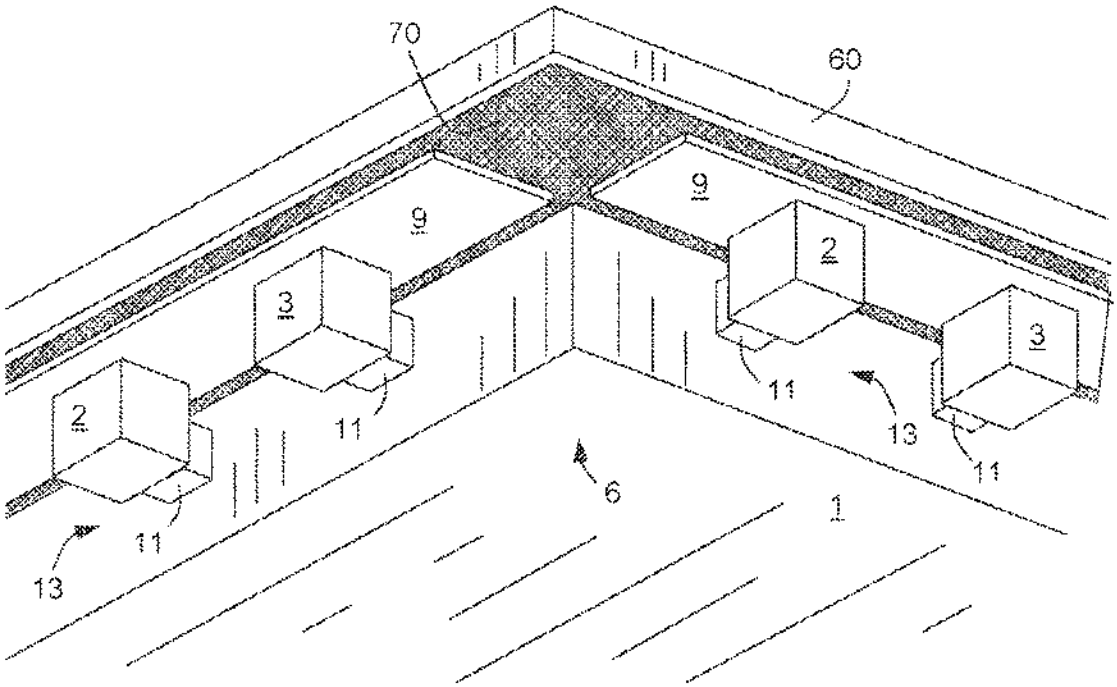


Fig. 7

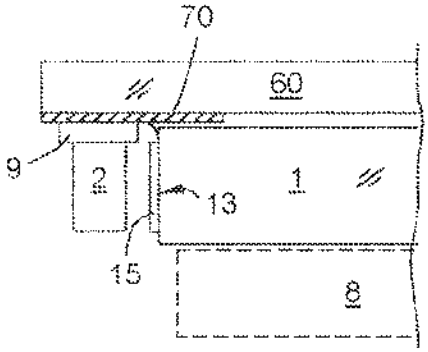


Fig. 8

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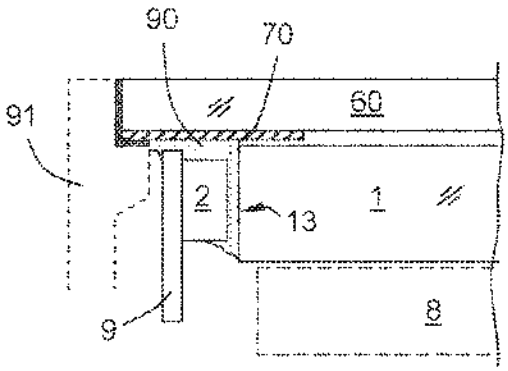


Fig. 9

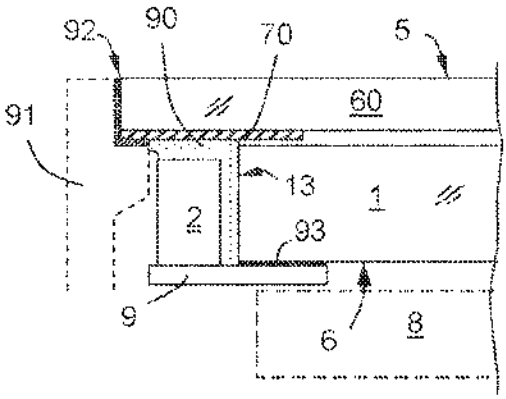


Fig. 10

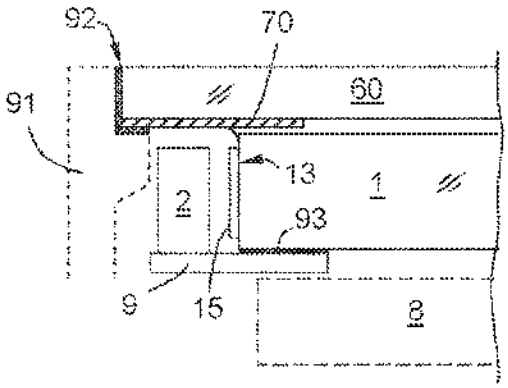


Fig. 11

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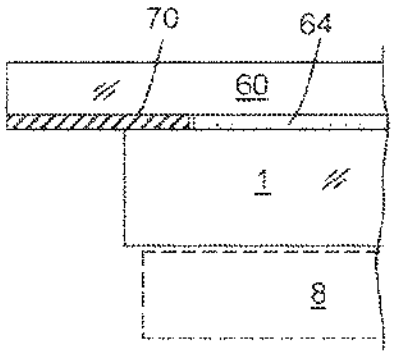


Fig. 12

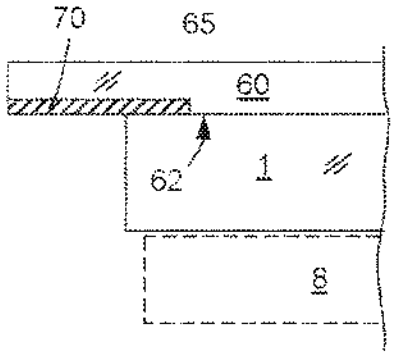


Fig. 13

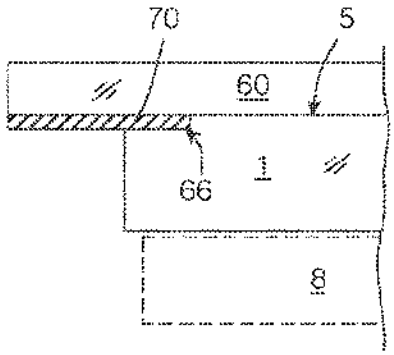


Fig. 14

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2013/051534

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 20060114237 A1 (CROCKETT TIMOTHY W ET AL), 1 June 2006 (2006-06-01); paragraphs [0024]-[0041]; figures 1 7 ---	1-20
Y	US 20080007541 A1 (ELIASSON JONAS OVE PHILIP ET AL), 10 January 2008 (2008-01-10); figures 3A 3B ---	1-20
A	US 20110043490 A1 (POWELL KARLTON ET AL), 24 February 2011 (2011-02-24); paragraph [0044]; figures 2 11 --	1-20
A	WO 2012105893 A1 (FLATFROG LAB AB ET AL), 9 August 2012 (2012-08-09); figure 2 --	19, 20

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06-05-2014	06-05-2014
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Patrik Rydman Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2013/051534

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International Patent Classification (IPC)

G06F 3/042 (2006.01)

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				US	20080252619	A1	16/10/2008
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				WO	2013014534	A3	21/03/2013
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				WO	2013165749	A1	07/11/2013

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(74) Agent: **SCHAEBERLE, Timothy M**; Corning Incorporated, Intellectual Property Department, SP-TI-03-01, Corning, New York 14831 (US).

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Published:

— *with international search report (Art. 21(3))*

(54) Title: METHODS FOR MEASURING THE ASYMMETRY OF A GLASS-SHEET MANUFACTURING PROCESS

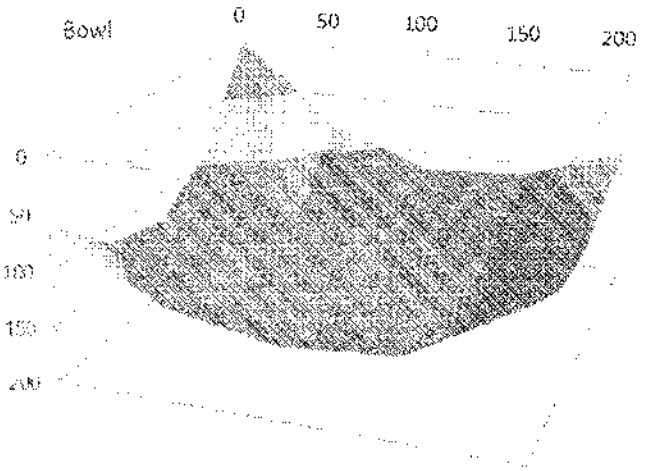


FIG. 1

(57) Abstract: Methods are provided for measuring the asymmetry of glass-sheet manufacturing processes. The methods include subjecting glass sheets or test samples taken from glass sheets to an ion-exchange process and measuring warp values. Metrics for the asymmetry of the glass-sheet manufacturing process are then obtained from the warp values. In one embodiment, the metric is independent of the geometry of the glass sheets or the test samples (the *SM1* metric); in another embodiment, the metric is independent of the geometry of the glass sheets or the test samples and substantially independent of the ion-exchange process used in the testing (the *ASYM* metric).

WO 2014/130515 A1

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METHODS FOR MEASURING THE ASYMMETRY OF A GLASS-SHEET MANUFACTURING PROCESS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 61/768822 filed on February 25, 2013 the content of which is relied upon and incorporated herein by reference in its entirety.

FIELD

[0002] This disclosure relates to processes for manufacturing glass sheets and, in particular, to processes for manufacturing glass sheets that will subsequently be subjected to ion-exchange strengthening. Even more particularly, the disclosure relates to methods for measuring (quantifying) the asymmetry, specifically, the front/back (Z-axis) asymmetry, of such a manufacturing process. Among other things, the disclosed measuring techniques can be used to control (reduce) the magnitude of warp that glass sheets produced by the manufacturing process exhibit after undergoing ion-exchange strengthening.

DEFINITIONS

[0003] As used herein, the phrase "process for manufacturing glass sheets" and similar phrases, e.g., "glass-sheet manufacturing process," "sheet manufacturing process," "manufacturing process," etc., refer to the steps performed to convert batch materials into glass sheets, as well as any subsequent steps performed on the glass sheets prior to their being subjected to an ion-exchange process.

[0004] As used herein, the phrases "two major surfaces of a glass sheet," "front and back surfaces," "front and back sides," and "first and second sides" are used interchangeably and refer to the two surfaces of a glass sheet that have the largest areas. The phrases are used without regard to the orientation of the glass sheet relative to vertical.

[0005] As used herein, the phrase "Z-axis asymmetry" (also referred to herein as "front/back asymmetry" or simply as "asymmetry") of a process for manufacturing glass sheets refers to an asymmetry in the conditions to which the two major surfaces of the glass sheet are exposed during the manufacturing process, where the conditions are

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capable of affecting ion-exchange through the surfaces during an ion-exchange process (hereinafter referred to as "ion-exchange-affecting conditions"). The converse of Z-axis asymmetry is referred to herein as "Z-axis symmetry" or simply as "symmetry". A manufacturing process with perfect Z-axis symmetry (zero Z-axis asymmetry) would expose both major surfaces of the glass sheets to the identical conditions during manufacture. As discussed below, although low levels of Z-axis asymmetry are achievable in practice, zero Z-axis asymmetry is not achievable because of, among other things, random variations in process conditions, which are inevitable. As will be evident, the conditions to which a glass sheet is exposed includes, but is not limited to, the conditions to which the sheet's parent glass ribbon is exposed.

[0006] As used herein, the phrase "warp as a number" means the maximum out-of-plane displacement from highest to lowest on a glass sheet or glass sample that was nominally flat prior to ion exchange. If the sheet or sample possessed some warp prior to ion exchange, then the pre-existing warp is subtracted off to obtain the net warp resulting from ion exchange, and the numerical value of the warp, i.e., the "warp as a number" for the sheet or sample, is the net warp thus obtained. The letter "W" is used herein to represent "warp as a number."

BACKGROUND

[0007] Ion-exchanged glass sheets, also known as chemically-strengthened or ion-strengthened glass sheets, are used in a variety of applications. For example, ion-exchanged glass sheets are widely used as touch screens for hand-held consumer electronics such as smart phones and tablets. Perhaps the best-known example of an ion-exchanged glass sheet is the scratch-resistant faceplate of the iPhone® made from Corning Incorporated's Gorilla® Glass.

[0008] In broad overview, ion-exchanged glass sheets are made by forming a glass having a composition suitable for chemical strengthening into a glass ribbon from which individual glass sheets are cut, and then subjecting the glass sheets to chemical strengthening through an ion-exchange (IOX) process, e.g., a treatment in which the glass sheet is submersed in a salt bath at an elevated temperature for a predetermined period of time.

[0009] The IOX process causes ions from the salt bath, e.g., potassium ions, to diffuse into the glass while ions from the glass, e.g., sodium ions, diffuse out of the glass.

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Because of their different ionic radii, this exchange of ions between the glass and the salt bath results in the formation of a compressive layer at the surface of the glass which enhances the glass's mechanical properties, e.g., its surface hardness. The effects of the ion exchange process are typically characterized in terms of two parameters: (1) the depth of layer (DOL) produced by the process and (2) the final maximum surface compressive stress (CS). Values for these parameters are most conveniently determined using optical measurements, and commercial equipment is available for this purpose, e.g., instruments sold by Frontier Semiconductor and Orihara Industrial Company, Ltd.

[0010] Although glass sheets can be produced by a variety of glass-sheet manufacturing processes, the two main processes that are currently in commercial use to produce glass sheets that are to be subjected to an IOX process are the float process and the overflow downdraw fusion process (hereinafter referred to as the "fusion process"). The present disclosure will thus focus on these processes, it being understood that the methods for quantifying Z-axis asymmetries disclosed herein are also applicable to other glass-sheet manufacturing processes now known or subsequently developed.

[0011] In the case of the fusion process, a glass ribbon is formed by passing molten glass around the outside of a forming structure (known in the art as an "isopipe") to produce two layers of glass that fuse together at the bottom of the forming structure (the root of the isopipe) to form the glass ribbon. The glass ribbon is pulled away from the isopipe by pulling rollers and cooled as it moves vertically downward through a temperature-controlled housing. At, for example, the bottom of the housing (bottom of the draw), individual glass sheets are cut from the ribbon. In the case of the float process, a glass ribbon is formed on the surface of a molten metal bath, e.g., a molten tin bath, and after being removed from the bath is passed through an annealing lehr before being cut into individual sheets.

[0012] In both processes, the glass ribbon and/or the glass sheets cut from the ribbon are exposed to conditions that may be asymmetric with respect to the front and back sides of the glass and thus may affect the results of an ion-exchange process subsequently applied to the glass sheets. For example, the process of removing glass sheets from a glass ribbon is normally asymmetric, with scoring taking place on only one side of the ribbon followed by separation of the glass sheet by rotation in a direction which opens the score line (i.e., if the score line is formed in the front surface of the glass ribbon, then the rotation takes

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place towards the back surface as seen from the side of the ribbon). See, for example, Andrewlavage, Jr., U.S. Patent No. 6,616,025.

[0013] Because sheet removal in the float process normally occurs after the ribbon has passed through an annealing lehr and because sheets are cut from the ribbon while the ribbon is supported horizontally, the conditions associated with sheet removal normally do not constitute ion-exchange-affecting conditions for the float process. However, for the fusion process, the glass ribbon hangs vertically and forces applied to the ribbon during the sheet removal process can propagate upward through the ribbon thus affecting the ribbon's position and shape at locations where, for example, the glass is passing through its glass transition temperature range. Consequently, conditions associated with sheet removal can constitute asymmetric ion-exchange-affecting conditions for the fusion process.

[0014] Various approaches have been disclosed for reducing movement of a glass ribbon and/or changes in the ribbon's shape during sheet removal in the fusion process. See, for example, Chalk et al., U.S. Patent No. 7,895,861; Abbott, III et al., U.S. Patent Application Publication No. 2006/0042314; Kirby et al., U.S. Patent Application Publication No. 2007/0095108; and Kirby et al., U.S. Patent Application Publication No. 2010/0043495. Moreover, in some situations, especially when dealing with thin and/or wide glass ribbons, it may be desirable to intentionally introduce a bow into the glass ribbon. See, for example, Burdette et al., U.S. Patent Application Publication No. 2008/0131651; and Burdette, U.S. Patent No. 8,113,015. Such bowing can cause the concave and convex sides of the ribbon to experience somewhat different thermal conditions as the ribbon moves through the fusion draw machine. Such different thermal histories for the two major surfaces of a glass sheet can constitute asymmetric ion-exchange-affecting conditions for a fusion process.

[0015] As noted above, the float process does not normally suffer from asymmetries associated with sheet removal. However, the float process has a basic asymmetry that arises from the fact that only one surface of the glass ribbon contacts the molten metal bath. This asymmetry is known to result in different ion-exchange properties for the two sides of the sheet. In particular, after undergoing an IOX process, glass sheets produced by the float process exhibit warp, with the surface that was not in contact with the molten metal bath becoming a convex surface. See, for example, U.S. Patent No. 4,859,636.

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[0016] Various process steps have been added to the basic float process so that the ion-exchange-affecting conditions for the overall glass-sheet manufacturing process are less asymmetric. For example, the above-referenced U.S. Patent No. 4,859,636 adds the step of contacting the surface of the glass sheet that was in contact with the molten metal with a source of sodium ions prior to ion-exchange strengthening, while PCT Patent Publication No. WO 2012/005307 and U.S. Patent Application Publication No. US 2012/0196110 respectively describe plasma treating and forming a film of SiO_2, TiO_2, NESA, ITO, AR, or the like on one of the surfaces of the glass sheet prior to ion exchange strengthening. In addition to adding process steps, changes to the basic float process with or without additional process steps, have also been disclosed. See International Publication Numbers WO 2013/005588 and WO 2013/005608.

[0017] A common characteristic of the approaches used to deal with asymmetric ion-exchange-affecting conditions of a glass-sheet manufacturing process, whether it be a float process or a fusion process, has been their ad hoc nature. Put simply, other than through trial and error or complex and difficult measurements performed on glass samples (see, for example, International Publication Number WO 2013/005588), there has been no way to quantify whether a particular manufacturing process has or does not have sufficient Z-axis symmetry to be suitable for producing glass sheets that are to be subjected to an IOX process.

[0018] This is especially so when it is considered that IOX processes in and of themselves have numerous variables (e.g., time-temperature profiles, bath compositions, use of multiple ion-exchange stages each with its own time-temperature profile and bath composition, etc.). The ad hoc process is thus even more challenging when trying to determine if a particular manufacturing process or particular additions to a basic manufacturing process (e.g., the addition of a plasma treatment) will provide a sufficiently low level of Z-axis asymmetry for more than one possible IOX treatment of the glass sheets produced by the process. Along these same lines, it has not been possible to predict whether a particular manufacturing process or particular additions to a basic manufacturing process provide sufficient Z-axis symmetry to be used in producing a specified product, e.g., glass sheets having a specified size/thinness combination.

[0019] As discussed fully below, in accordance with certain of its aspects, the present disclosure addresses the above-described deficiencies in the art by providing methods for

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measuring (quantifying) the intrinsic (native) Z-axis asymmetry of a glass-sheet manufacturing process. The quantification is in terms of an asymmetry value, i.e., an "*ASYM*" value, which is a dimensionless number, or a BM_Z value, which has the dimensions of distance. Using either or both of these asymmetry values, comparisons can be made between a given glass-sheet manufacturing process operated under various conditions or between glass-sheet manufacturing processes of various types.

SUMMARY

[0020] In accordance with a first aspect, a method is disclosed for measuring the asymmetry of a glass-sheet manufacturing process which includes:

(I) producing a glass sheet using the glass-sheet manufacturing process;

(II) measuring the mass M_0 of the glass sheet or a test sample from the glass sheet;

(III) subjecting the glass sheet or the test sample to an ion-exchange process;

(IV) measuring the change in mass ΔM of the glass sheet or the test sample as a result of step (III);

(V) measuring a warp value W for the glass sheet or the test sample after step (III); and

(VI) computing an *ASYM* value for the glass sheet or the test sample using an equation of the form:

$$ASYM = \frac{2R^2}{3}\left(\frac{2}{L_x}+\frac{2}{L_y}-\frac{2}{L_z}\right)\frac{W}{\Delta M}\frac{2M_0(W_{in}-W_{out})}{W_{Glass}}$$

where W_{Glass} is the molecular weight in grams/mole of the glass making up the glass sheet or the test sample prior to step (III), W_{in} and W_{out} are, respectively, the molecular weights in grams/mole of the ions being exchanged into and out of the glass in step (III), taken singly, such as K and Na, and not taken as oxides, such as K_2O and Na_2O, R is the glass sheet's or the test sample's thickness-to-diagonal ratio, and L_x, L_y, and L_z are, respectively, the length, width, and thickness of the glass sheet or the test sample in the same units as the warp value W;

where the *ASYM* value calculated in step (VI) is a measure of the asymmetry of the glass-sheet manufacturing process.

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[0021] In accordance with a second aspect, a method is disclosed for measuring the asymmetry of a glass-sheet manufacturing process which includes:

(I) producing a glass sheet using the glass-sheet manufacturing process;

(II) subjecting the glass sheet or a test sample from the glass sheet to an ion-exchange process;

(III) measuring a warp value W for the glass sheet or the test sample after step (II); and

(IV) computing a BM_1 value for the glass sheet or the test sample using an equation of the form:

$$BM_1 = K \cdot W \cdot R^2$$

where K is a constant (e.g., $K = 2/3$) and R is the glass sheet's or the test sample's thickness-to-diagonal ratio;

where the BM_1 value calculated in step (IV) is a measure of the asymmetry of the glass-sheet manufacturing process.

[0022] The asymmetric metries determined by the above methods (i.e., the *ASYM* and/or BM_1 values) can be used to identify glass-sheet manufacturing processes having sufficient Z-axis symmetry for use in producing particular products. For example, in accordance with an embodiment, glass-sheet manufacturing processes having *ASYM* values less than or equal to 1,500 ppm and/or BM_1 values ($K = 2/3$) less than or equal to 0.002 microns can be used to produce ion-exchange strengthened glass sheets having R values less than or equal to 2.5×10^{-4}. The *ASYM* metric is particularly valuable in this regard because it is predictive of the warp that will be exhibited by ion-exchange strengthened glass sheets not only for the IOX process used in measuring the *ASYM* value, but also for other IOX processes applied to glass sheets of similar composition produced by the glass-sheet manufacturing process.

[0023] The above summaries of the various aspects of the disclosure are not intended to and should not be interpreted as limiting the scope of the invention. More generally, it is to be understood that both the foregoing general description and the following detailed description are merely exemplary of the invention and are intended to provide an overview or framework for understanding the nature and character of the invention.

[0024] Additional features and advantages of the invention are set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art

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from that description or recognized by practicing the invention as exemplified by the description herein. The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. It is to be understood that the various features of the invention disclosed in this specification, the drawings, and the claims can be used in any and all combinations.

Brief Description of the Drawings

[0025] FIG. 1 is a graph illustrating the type of warp observed after ion exchange of a glass sheet (glass plate) produced by a manufacturing process, e.g., a float process, having a high level of Z-axis asymmetry.

[0026] FIG. 2 is a graph showing concentration versus distance-from-surface after ion exchange for a glass sheet produced by a float process. The upper curve is for the air side of the sheet and the lower curve is for the tin side.

[0027] FIG. 3 is a plot of warp in millimeters predicted by Eq. (5) for a representative BM_1 value of 0.003 microns and a sheet thickness of 0.5 mm.

[0028] FIG. 4 is a plot of warp in millimeters predicted by Eq. (5) for a representative BM_1 value of 0.003 microns and a sheet size of 2000 mm x 1500 mm.

Detailed Description

[0029] As discussed above, the present disclosure relates to quantifying intrinsic asymmetry (Z-axis asymmetry) in the manufacture of ion-exchangeable glass which results in warping or curvature of a glass sheet as a consequence of asymmetric ion distribution through the thickness of the sheet after ion exchange. The quantification provided herein serves as a guide to the manufacture of low-warp, ion-exchangeable glass through the creation and/or maintenance of low asymmetry in the manufacturing process.

[0030] The warp resulting from performing ion exchange on a glass sheet produced by a manufacturing process having a high level of Z-axis asymmetry is more severe when the glass sheets are larger in length and width and/or when thinner. As the marketplace evolves toward larger displays that use cover glass (such as pad sizes, notebook sizes, laptop, and TV cover glass) and as the marketplace evolves toward thinner cover glass thicknesses, the problem of warping becomes aggravated.

[0031] Glass sheets that develop warp through ion exchange are difficult to handle on removal from a salt bath and difficult to transport within a manufacturing plant, as warp

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can cause glass sheets to touch each other or to touch parts of cassettes or transport devices with consequent damage to the glass. Thus, even if the warp in a final product might be small due to small product dimensions, when large glass sheets are being processed prior to cutting into small individual products, warp can still be a problem because it can interfere with the overall process for making the product. Processing of larger sheets is a commercial trend and thus the need to control (reduce) warp is an ever pressing problem in the art.

[0032] FIGS. 1 and 2 provide background for the analysis presented below. FIG. 1 shows an example of the warp observed for a typical glass plate produced by a manufacturing process, e.g., a float process, having a high level of Z-axis asymmetry and subsequently ion exchanged. For a float process, the sense of warp is concave towards the side of the sheet that was exposed to the molten metal bath (molten tin bath) and persists even when the metal (tin) is removed by grinding and polishing or by etching. The bowl shape seen in FIG. 1 is the shape predicted by the gravity-free analysis used in the equations presented below.

[0033] FIG. 2 shows an example of the asymmetry in potassium concentration that can be observed after Na/K ion exchange performed on a glass sheet produced by a manufacturing process having a high level of Z-axis asymmetry, specifically, in this figure, a float process. As can be seen, the difference in ion penetration is rather small, i.e., about 1 micron, with the air side of the glass sheet exhibiting a slightly greater diffusivity. The non-zero asymmetry seen in FIG. 2 creates a non-zero value for the intrinsic asymmetry integral of Eq. (1) discussed below.

[0034] It should be noted that the asymmetry shown in FIG. 2 is not always detectable even when warp in a full size sheet is clearly present. This is so because the magnitude of the asymmetry in concentration can be so small that it is nearly within the noise of the measurement. A benefit of the quantification (measurement) techniques of the present disclosure is that they do not depend on the direct measurement of such small concentration differences, but rather employ warp and overall weight change measurements that can be readily and accurately performed using commonly-available laboratory equipment. These easily-performed measurements are in direct comparison to the complex measurement techniques used in, for example, the above-referenced International Publication Number WO 2013/005588.

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[0035] With the foregoing as background, we now turn to the problem of identifying and quantifying asymmetries of physical properties that give rise to warp after ion exchange. To simplify the analysis, we focus on nominally flat glass sheets of rectangular shape and uniform thickness, it being understood that the processing of other shapes can also have trouble with systematic warp from ion exchange.

[0036] The asymmetry of interest is intrinsic (native) asymmetry of physical properties through the thickness dimension of the glass sheet as a result of Z-axis asymmetries in the glass-sheet manufacturing process. We identify two main sources of warp from asymmetric physical properties: (1) asymmetry of the diffusivity (such as can arise from asymmetry of the thermal history of the glass) and (2) asymmetry of the surface chemistry of the glass. The former influences how far and how many ions enter each surface during ion exchange, while the latter affects both how many ions enter and the magnitude of exchanged ion concentration at each surface. Warp results when either or both of these quantities are asymmetric. Other sources of asymmetry of physical properties, such as asymmetry of lattice dilation coefficient (discussed below), asymmetry of Young's modulus, or asymmetry of the Poisson ratio, are also included as these also induce warp during ion exchange.

[0037] We denote the concentration of the exchanged ion (e.g., the concentration of K_2O that replaces Na_2O in a K/Na ion exchange) by $C(z)$ where z is the dimension through the thickness. This can be expressed in concentration units such as mole%. In accordance with an embodiment, we represent the intrinsic asymmetry by a concentration integral of the following form, which can be thought of as a "bending moment per unit length" concentration integral in view of the multiplication of the concentration difference by z:

$$M_1 = \frac{1}{L_z} \int_{-L_z/2}^{L_z/2} \left(C(z) - C_{base}\right) z\, dz \qquad (1)$$

[0038] In this expression L_z is the thickness of the glass sheet, $C(z)$ is the concentration of the larger ion after ion exchange, and C_{base} is the concentration of the larger ion in the base glass prior to ion exchange. The bottom surface is at $z = -L_z/2$ and the top surface is at $z = L_z/2$. The M_1 integral has dimensions of mole% times distance. Thus, the M_1 intrinsic asymmetry value can be thought of as a measure of the asymmetry of the concentration through the thickness times the asymmetry of the ion penetration depth through the

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thickness, giving rise to concentration times thickness. This integral would be zero if the concentration profile were perfectly symmetric because the value of z would take on equal but opposite values between the center and each respective surface while the concentrations above baseline would be the same.

[0039] We denote the top and bottom *surface* concentration values above baseline by:

$$\Delta C_t = C_{surf\,t} - C_{bulk} \tag{2}$$

and

$$\Delta C_b = C_{surf\,b} - C_{bulk} \tag{3}$$

[0040] These two values may or may not be identical; when they differ they constitute another source of intrinsic asymmetry of the glass sheet. This intrinsic asymmetry is only revealed by performing ion exchange but it is intrinsic to the glass because the surface concentration is the result of a dynamic equilibrium between the salt bath and the glass, so when the two surfaces reach a different equilibrium it reflects a fundamental difference of the glasses near the top and bottom surfaces.

[0041] We denote the surface compressive stress, as measured by, for example, a FSM instrument such as that manufactured by Orihara Industrial Company, by *CS*. Since this will differ on the top and bottom surfaces in the presence of intrinsic asymmetry, we denote the top and bottom surface values by CS_t and CS_b respectively. As shown below, a surprisingly small difference in *CS* values can give rise to substantial warp. Because small differences are difficult to determine accurately, in accordance with the present disclosure, intrinsic asymmetry is quantified using a warp measurement rather than by trying to measure a difference in *CS*.

[0042] In accordance with the present disclosure, the difference in *CS* from the top to bottom surfaces, where each is taken as a positive number representing the magnitude of compressive stress, is related to the M_1 intrinsic asymmetry value by the following equation:

$$CS_t - CS_b = \frac{BE}{1-\nu}\left[\Delta C_t - \Delta C_b - \frac{12M_1}{L_z}\right] \tag{4}$$

[0043] In Eq. (4), B represents the "lattice dilation coefficient", E is Young's modulus, ν is the Poisson ratio of the glass, and L_z is again the glass thickness. As used herein, the lattice dilation coefficient is defined as a coefficient that converts concentration above

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baseline into strain, i.e., $B\Delta C_t$ gives the ion exchange-induced free strain on the top surface and $B\Delta C_b$ gives the ion exchange-induced free strain on the bottom surface. As shown in Eq. (4), when these differ, their difference contributes directly to a difference in CS between top and bottom surfaces.

[0044] The other term in Eq. (4) involves the bending moment integral of Eq. (1), i.e., the M_1 asymmetry value. When more ions enter say the top surface than the bottom surface, then $M_1>0$. This contributes to CS_b being larger than CS_t from Eq. (4). Physically, added strain in the top half of a glass plate bends the plate in a concave sense toward the bottom half; this introduces increased compressive stress (higher CS_b) on the bottom surface and reduced compressive stress (lower CS_t) on the top surface. Thus warp and differences in CS are correlated.

[0045] Using the above definition of warp as a number, the overall warp W in terms of the bending moment integral M_1 can be written as:

$$W = -\frac{6}{L_z}\left(\left(\frac{L_x}{2}\right)^2 + \left(\frac{L_y}{2}\right)^2\right) BM_1 \qquad (5)$$

where the sheet length and width are L_x and L_y, the thickness is still L_z, and B is again the lattice dilation coefficient.

[0046] Because M_1 has units of concentration times distance, BM_1 is dimensionless strain times distance, so overall W has the dimension of distance as it should. Like M_1, BM_1 constitutes an intrinsic asymmetry value in accordance with the present disclosure.

[0047] As can be seen from Eq. (5), for a given intrinsic asymmetry expressed as a M_1 value or a BM_1 value, the warp is worse for a larger sheet size (larger L_x and/or L_y value) and for a thinner sheet (smaller L_z value). FIGS. 3 and 4 illustrate the rapid rise in gravity-free warp values with sheet size and sheet thickness as predicted by Eq. (5) for a BM_1 value of 0.003 microns, a typical value for a float process. In FIG. 3, sheet thickness is held constant at 0.5 mm, while in FIG. 4, sheet size is held fixed at 2000 mm x 1500 mm. Table 1 tabulates typical warp values for a few representative sheets sizes and thicknesses. The connection between (1) sheet size and thickness and (2) resulting warp that is illustrated in these figures and table is critical for controlling warp for larger and thinner parts.

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[0048] To simplify the analysis, the warp of Eq. (5) is gravity-free warp. Gravity will tend to flatten a warped glass sheet that is laid out horizontally but the underlying warp of the sheet is still problematic due to the possibility of edge curl or other warp-induced effects such as ripple in the sheet. As discussed below, gravity-free warp values can be obtained from warp values measured under gravity conditions by multiplying the measured value by a correction factor, e.g., by 1.13 if the warp is measured with the sheet in a dome orientation (i.e., concave down) and 1.07 if the warp is measured with the sheet in a bowl orientation (i.e., concave up), which makes the latter configuration the preferred orientation for the warp measurement.

[0049] It should be noted that when the lattice dilation coefficient is not known, Eq. (4) can be used to estimate B from an equation of the form

$$B = \frac{1-\nu}{E}\left[\frac{(CS_t - CS_b)}{\Delta C_t - \Delta C_b - \frac{12M_1}{L_z}}\right] \tag{6}$$

[0050] This equation allows us to relate warp directly to the difference in CS values by substituting Eq. (6) in Eq. (5) to get

$$W = -\frac{6}{L_z^2}\left(\left(\frac{L_x}{2}\right)^2 + \left(\frac{L_y}{2}\right)^2\right) M_1 \frac{1-\nu}{E}\left[\frac{(CS_t - CS_b)}{\Delta C_t - \Delta C_b - \frac{12M_1}{L_z}}\right] \tag{7}$$

When the surface concentrations are symmetric, this expression simplifies to

$$W = \frac{1}{2L_z}\left(\left(\frac{L_x}{2}\right)^2 + \left(\frac{L_y}{2}\right)^2\right)\frac{1-\nu}{E}(CS_t - CS_b) \tag{8}$$

[0051] This last equation is convenient because M_1 divides out and we have a simple way to relate CS differences to warp. To provide a specific example, we assume that the glass sheet is produced by a float glass process for which a typical observed warp after ion-exchange is approximately -0.63 mm for a part with L_x=182 mm, L_y=237 mm, and L_z=0.8 mm. The negative sign indicates that the warp is concave "down" or concave toward the tin side of the glass. The Young's modulus for such a glass is roughly 70 GPa and the Poisson ratio roughly 0.2.

[0052] Using these values, Eq. (8) gives an estimate for CS_t–CS_b of 3.95 MPa. This shows that a surprisingly small difference in surface compressive stress, generally too low

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to measure accurately, results in a substantial degree of warp that is readily observed. From Eq. (5), we can estimate BM_1 for such a glass sheet to be approximately 3.0×10^{-6} mm. Taking the lattice dilation coefficient to be approximately 0.001/mole%, we can then estimate M_1 to be approximately 0.0030 mm mole%.

[0053] In terms of average diffusivities D_t and D_b of the top and bottom halves of the plate, M_1 can be expressed by integrating an erfc-shaped concentration profile to get

$$M_1 \approx \Delta C_t\left(\sqrt{\frac{D_t t}{\pi}}\right) - \Delta C_b\left(\sqrt{\frac{D_b t}{\pi}}\right) \tag{9}$$

where t is the time of diffusion. When characterizing the depth of penetration of ions using for example a FSM instrument manufactured by Orihara, this expression, when written in terms of FSM DOL values for the sheet's top and bottom surfaces, takes the form

$$M_1 \approx \frac{1}{2.8\sqrt{\pi}}\left[\Delta C_t\left(DOL_t\right) - \Delta C_b\left(DOL_b\right)\right] \tag{10}$$

where DOL_t is the DOL measured for the top half and DOL_b is the DOL measured for the bottom half.

[0054] If the surface concentrations above baseline are the same for top and bottom, and are equal to about 12 mole%, we can estimate the difference in penetration depths DOL for the above M_1 value of approximately 0.0030 mm mole% to be about 1.2 μm. This is again a barely measureable difference in diffusivity or ion penetration depth, but it gives rise to readily observable warp.

[0055] The above analysis illustrates 1) the substantial amount of warp that can be observed on larger and thinner parts and 2) the difficulties associated with directly measuring the asymmetry of the physical properties that gives rise to warp after ion exchange. In view of these considerations, in accordance with the present disclosure, direct measurement of warp is used as the experimental starting point for characterizing intrinsic asymmetry of the glass-sheet manufacturing process that produced the warped glass sheet. In some cases, when intrinsic asymmetry is large enough, the integral of Eq. (1) can be evaluated using directly measured concentration profiles from, for example, an electron probe micro-analyzer (EPMA) measurement. However, even in these cases, direct experimental observation of warp is generally more sensitive.

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[0056] By choosing a piece size (L_x,L_y) that is large enough and a thickness L_z that is thin enough, a consistently large warp value can be observed after ion exchange when a glass manufacturing process produces glass with intrinsic asymmetry. Equation (5) is then the primary equation for transforming such measured values of warp into an asymmetry value (asymmetry metric) for the glass-sheet manufacturing process. In particular, the glass' intrinsic asymmetry (native asymmetry) as revealed by a given ion exchange process can be characterized by the BM_1 value of Eq. (5), independent of the length and width of a given glass plate.

[0057] Once a BM_1 value is known for a given glass produced by a given glass-sheet manufacturing process and a given ion exchange process (e.g., time, temperature, and salt quality), the expected gravity-free warp for any glass geometry produced by that manufacturing process can be estimated by Eq. (5) for the same or substantially the same ion exchange process. BM_1 is thus a valuable measure of the intrinsic (native) asymmetry of a glass-sheet manufacturing process and when coupled with a defined ion exchange process, provides a useful method for comparing sheet manufacturing processes and for tracking the effects on warp of changes to such processes.

[0058] From the above, it can be seen that the BM_1 metric is of the form:

$$BM_1 = K \cdot W \cdot R^2$$

where R is the ratio of the glass sheet's thickness to its diagonal given by:

$$R = \frac{L_z}{\sqrt{L_x^2 + L_y^2}} \qquad (11)$$

In Eq. (5) above, K equals 2/3.

[0059] Although a single test sample can be used, the final result is normally obtained by averaging BM_1 values for a plurality of test samples, e.g., four or more samples. As a general guide, a BM_1 value (e.g., an average BM_1 value) less than or equal to 0.002 microns, (for example, $BM_1 \leq 0.001$ microns or $BM_1 \leq 0.0005$ microns), obtained using a commercially viable ion-exchange process and calculated for K equal to 2/3, is indicative of a glass-sheet manufacturing process that has intrinsic (native) symmetry, and thus glass sheets produced by the process can be expected not to encounter warp problems. In particular, these values are applicable to glass sheets having R values that are less than or equal to 2.5×10^{-4} (for example, $R \leq 2.0 \times 10^{-4}$ or $R \leq 1.5 \times 10^{-4}$).

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[0060] As indicated above BM_1 values depend on the ion exchange conditions used in the measurement process. Specifically, ion exchange conditions can make the warp more or less severe depending on the resulting surface boundary concentrations above baseline, i.e., AC_f and AC_b, and the depth of penetration of the concentration profile that occurs in Eq. (1).

[0061] In accordance with a further embodiment, the effects of ion exchange conditions on the measurement of Z-axis asymmetry for a glass-sheet manufacturing process are minimized through the evaluation of the process' $ASYM$ value. That is, while both BM_1 and $ASYM$ values measure the intrinsic (native) asymmetry of a glass-sheet manufacturing process, $ASYM$ values have the advantage of being substantially independent of ion exchange conditions, provided the ion exchange conditions are sufficient to produce ion exchange strengthening of glass sheets, i.e., although not wedded to any particular ion exchange conditions, an $ASYM$ measurement does assume the use of ion exchange conditions that are reasonable, e.g., ion exchange conditions suitable for use commercially for the glass sheets of interest.

[0062] In general terms, an $ASYM$ value is a normalization of a BM_1 value by the number of atoms exchanged. The normalization is achieved by a measurement of fractional mass difference before and after ion exchange, with the fractional mass difference being itself normalized using molecular weights and sample size. While BM_1 values have the units of length, e.g., microns or nanometers, $ASYM$ values are dimensionless, e.g., of the order of a few hundred to a few thousand ppm.

[0063] In particular, in accordance with an embodiment, $ASYM$ values are determined using an equation of the form:

$$ASYM = BM_1 \left(\frac{2}{L_x} + \frac{2}{L_y} + \frac{2}{L_z} \right) \frac{M_0}{\Delta M} \frac{2\left(W_{fo} - W_{ino}\right)}{W_{glass}} \tag{12}$$

or upon using Eq. (5) for BM_1 and Eq. (11) for R:

$$ASYM = \frac{2R^2}{3} \left(\frac{2}{L_x} + \frac{2}{L_y} - \frac{2}{L_z} \right) \frac{W}{\Delta M} \frac{2M_0\left(W_{fo} - W_{ino}\right)}{W_{glass}} \tag{13}$$

where W, BM_1, L_x, L_y, and L_z are as defined above and are all expressed in the same units, e.g., microns, M_0 is the mass of the sample (i.e., the sample whose warp was measured) just before ion exchange, ΔM is the change in sample mass as a result of the ion exchange

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and is obtained by using the mass just after ion exchange and cleaning minus M_0, W_{Glass} is the molecular weight of the base glass prior to ion exchange in grams/mole, W_{in} represents the molecular weight of the ion (e.g., K^+, not K_2O) being exchanged into the glass in grams/mole, and W_{out} represents the molecular weight of the ion (e.g., Na^+, not Na_2O) being exchanged out of the glass in grams/mole. The molecular weight of the base glass is obtained by taking the molecular weights of the components of the glass (e.g., SiO_2, Al_2O_3, etc.), multiplying each molecular weight by the component's mole fraction in the glass, and then summing the results.

[0064] Although a single test sample can be used, the final result is normally obtained by averaging *ASYM* values for a plurality of test samples, e.g., four or more samples. As a general guide, an *ASYM* value (e.g., an average *ASYM* value) less than or equal to 1,500 ppm, (for example, $ASYM \leq 1{,}000$ ppm or $ASYM \leq 500$ ppm), obtained using a commercially viable ion-exchange process and evaluated for K equal to 2/3 in the BM_1 calculation if Eq. (12) is used, is indicative of a glass-sheet manufacturing process that has intrinsic (native) symmetry, and thus glass sheets produced by the process can be expected not to encounter warp problems. This is especially so for glass sheets having R values that are less than or equal to 2.5×10^{-4} (for example, $R \leq 2.0\times10^{-4}$ or $R \leq 1.5\times10^{-4}$).

[0065] Eqs. (12) and (13) are based on the observation that the measured native asymmetry grows in proportion to the number of ions exchanged. Accordingly, normalization can be performed using the number of ions exchanged, i.e., by the fractional mass increase produced by an ion exchange process, a readily measurable value. Fractional mass increase is proportional to the average of the top and bottom depths of layer (*DOLs*), while the native asymmetry is proportional to the difference in the depths of layer. Since both grow with sqrt(time), there is no need to explicitly divide by sqrt(t).

[0066] Accordingly, in general terms, based on the above observation, the *ASYM* value can be expressed as:

$$ASYM = B\frac{\Delta C_t\left(\sqrt{D_t t}\right) - \Delta C_b\left(\sqrt{D_b t}\right)}{\Delta C_t\left(\sqrt{D_t t}\right) + \Delta C_b\left(\sqrt{D_b t}\right)} \qquad (14)$$

where D_t and D_b are the diffusivities for the top and bottom of the glass sheet. This equation shows how *ASYM* is a measure of the difference in number of ions that have crossed the two surfaces normalized by the total number of ions that have crossed the two

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surfaces. This equation includes the glass' lattice dilation coefficient B since larger B gives larger warp in proportion and thus plays a role in the asymmetry of strain and thus warp, but, as will now be shown, its effects are automatically included in the warp measurement and thus a value for B is not needed to evaluate $ASYM$.

[0067] We begin by assuming a single erfc concentration profile on each side of the glass so that warp can be expressed as

$$W = -\frac{3B\sqrt{t}}{2\sqrt{\pi}}\left[\Delta C_s\left(\sqrt{D_s}\right) - \Delta C_b\left(\sqrt{D_b}\right)\right]\frac{\left(L_x^2 + L_y^2\right)}{L_z^2} \tag{15}$$

We also have from Eq. (5) above

$$W = -\frac{3}{2}\frac{\left(L_x^2 + L_y^2\right)}{L_z^2}BM_1 \tag{16}$$

which implies

$$BM_1 = -\frac{B}{\sqrt{\pi}}\left[\Delta C_s\left(\sqrt{D_s t}\right) - \Delta C_b\left(\sqrt{D_b t}\right)\right] \tag{17}$$

which corresponds to Eq. (9) above.

[0068] Again assuming a single erfc concentration profile, an analysis of mass difference during ion exchange gives the following relationship:

$$\frac{\Delta M(t)}{M_0} = \left(\frac{2}{\sqrt{\pi}}\right)\left(\frac{1}{L_x} + \frac{1}{L_y} + \frac{1}{L_z}\right)\left[\Delta C_s\left(\sqrt{D_s t}\right) + \Delta C_b\left(\sqrt{D_b t}\right)\right]\left[\frac{2\left(W_{ion} - W_{out}\right)}{W_{Glass}}\right] \tag{18}$$

[0069] Substituting Eqs. (17) and (18) into Eq. (14) then gives Eq. (13), with the dependence on B removed and the resulting asymmetry value (asymmetry metric) normalized by the molecular weight of the glass, the masses of exchanging atoms, and the sample geometry.

[0070] To summarize, in outline, $ASYM$ values are obtained by:

[0071] (A) Measuring fractional mass difference on a plurality of samples before and after ion exchange and calculating for each sample

$$\frac{\frac{\Delta M(t)}{M_0}}{\left(\frac{2}{L_x} + \frac{2}{L_y} + \frac{2}{L_z}\right)\left[\frac{\left(W_{K_2O} - W_{Na_2O}\right)}{W_{Glass}}\right]} = \left(\frac{1}{\sqrt{\pi}}\right)\left[\Delta C_s\left(\sqrt{D_s t}\right) - \Delta C_b\left(\sqrt{D_b t}\right)\right] \tag{19}$$

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(Note that the samples' edges may need to be polished prior to testing to avoid errors due to edge chipping.)

[0072] (B) On the same samples, measuring warp magnitudes W, including correction for gravity, and calculate for each sample

$$BM_1 = \frac{2}{3\left(L_x^2 + L_y^2\right)} W = \frac{B}{\sqrt{\pi}} \left[\Delta C_x\left(\sqrt{D_1 t}\right) - \Delta C_x\left(\sqrt{D_2 t}\right) \right] \tag{20}$$

[0073] (C) Forming the ratio

$$\frac{B\left[\Delta C_x\left(\sqrt{D_1 t}\right) - \Delta C_x\left(\sqrt{D_2 t}\right)\right]}{\Delta C_x\left(\sqrt{D_1 t}\right) + \Delta C_x\left(\sqrt{D_2 t}\right)} = \frac{\frac{2}{3\left(L_x^2 + L_y^2\right)} W}{\frac{\Delta M(t)}{M_0}} = \frac{W}{\left(\frac{2}{L_x} + \frac{2}{L_y} + \frac{2}{L_z}\right)\left[\frac{2(W_{in} - W_{out})}{W_{Glass}}\right]} \tag{21}$$

$$= \frac{2}{3}\frac{L_z^2}{\left(L_x^2 + L_y^2\right)}\left(\frac{2}{L_x} \frac{2}{L_y} \frac{2}{L_z}\right)\frac{W}{\Delta M}\frac{2M_0(W_{in} - W_{out})}{W_{Glass}}$$

the last expression in Eq. (21) being the *ASYM* value of Eq. (13).

[0074] As a more specific, non-limiting, example, BM_1 and *ASYM* values are determined by the following procedure:

[0075] (1) From one or more glass sheets manufactured using the glass-sheet manufacturing process whose asymmetry is to be measured, cut or extract at least 4 square test samples (test pieces) of size 100mm on each edge. The thickness is set by the target thickness of the glass sheet to be tested.

[0076] (2) Accurately measure the initial mass M_0 of each test sample just before ion exchange in preparation for tracking the change in mass that occurs as a result of ion exchange. Also measure the sample dimensions L_x, L_y, and thickness L for later use in calculations.

[0077] (3) Subject the test samples to an ion exchange process that is identical to or at least similar to that which is to be used on parts manufactured using the glass-sheet manufacturing process whose asymmetry is being measured.

[0078] As used in this step, a "similar" ion exchange process means subjecting the test samples to similar conditions of time in the salt bath, temperature of the salt bath, and purity or composition of the salt bath, with the same heating up and cooling down before

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and after immersion in the salt bath. If any polishing or etching is done before or after ion exchange in the manufactured part, the same should be done to the test sample. The resulting surface compressive stress CS, which can be measured by the optical measurement instrument FSM-6000 by Orihara, or measured by any other means, is preferably within 10% of the highest CS observed on manufactured parts. This implies that the salt bath should be "fresh", i.e. relatively pure, and not contaminated by the exchanged ion. High CS is a sensitive measure of the purity of the salt bath. In order to partly remove the influence of asymmetry of the salt bath itself, half the test samples are preferably placed in one orientation of the salt bath relative to the glass manufacturing orientation and half placed in the opposite orientation (see discussion of extrinsic asymmetry below).

[0079] Note that if only *ASYM* values are of interest, the ion-exchange conditions need not be based on those used or to be used on parts manufactured using the glass-sheet manufacturing process of interest, but can be based on other considerations, e.g., easy of use in a testing setting.

[0080] (4) Accurately measure the mass just after ion exchange and after cleaning the sample so that only glass remains in the mass measurement.

[0081] (5) After all steps of the ion exchange process are completed, including any cleaning and polishing that is intended for the commercial object of interest, measure the maximum warp of the test sample using any of several instruments capable of measuring surface profiles. An example of one such instrument is the KLA Tencor P16 Profilometer, which uses a stylus. Another example is the Tropel Flatmaster MSP-150, which is a non-contact interferometer. Measure the maximum vertical difference from center to edge or corner. Perform the measurement with the part held horizontally.

[0082] If there is a detectable curvature to the part, measure it in the "bowl" orientation (see FIG. 1), i.e. with the center lower than the edges, in order to minimize the influence of gravity. If curvature is not readily detectable then measure both bowl and "dome" (center higher than edges) orientations. If those measurements reveal which orientation corresponds with the bowl shape then use the maximum vertical difference from that measurement, otherwise use the smaller of the two maximum vertical differences for the two orientations. Express the result in, for example, microns.

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[0083] (6) Apply a correction for the influence of gravity by taking each warp value from the previous step and multiplying by a correction factor of 1.07. This correction factor approximately accounts for the flattening influence of gravity on a bowl-shaped piece of glass of the chosen size.

[0084] The correction factor of 1.07 (a 7% increase in warp) has been found to be appropriate over the full range of thicknesses from 1 mm to 0.2 mm for square plates of 100mm on an edge. Density and Young's modulus also affect the gravity correction but these influences are approximately at the 1% level so they can be ignored. In the dome orientation the correction factor is about 1.13 (a 13% increase in warp). The bowl orientation has less impact from gravity and thus is preferred, although the dome orientation and its correction factor can be used if desired.

[0085] (7) For each test sample, calculate the value of BM_1 by using a ratio R of thickness to diagonal given by $R = \frac{L_z}{\sqrt{L_x^2 + L_y^2}}$ where L_z is the thickness in the expression

$$BM_1 = 2/3\ W R^2$$

where W (the warp in microns) is the warp corrected for gravity of step 6. (Note that if only $ASYM$ values are desired, Eq. (13) can be used and a separate calculation of BM_1 values need not be performed.)

[0086] (8) For each test sample, calculate a native (intrinsic) asymmetry $ASYM$ value using Eq. (12) or Eq. (13) above. The final result is obtained by averaging the $ASYM$ values (and BM_1 values, if determined) for the various test samples.

[0087] With regard to step (6) of the above procedure, i.e., correction for gravity, it should be noted that there is a trade-off between the sheet size (where larger sheets have more warp) and the impact of gravity on sheet shape (where larger sheets have their shape more influenced by gravity). By keeping the size of the sheet smaller, one also has recourse to various commercial instruments that are capable of highly accurate measurements of the sheet shape. These include the use of interferometry such as the Tropel Flatmaster referred to above. A part size of up to about 200 mm on a side should have an easily detectable warp if there is intrinsic asymmetry in the manufacturing process used to produce the part, and should have little influence of gravity on its shape. Smaller sizes can also be used if the measurement equipment is sensitive enough.

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[0088] Instead of measuring warp, it may be more convenient to measure an average radius of curvature near the center of the sheet. This radius of curvature C is related to the warp W discussed above by the relation

$$W = \frac{1}{2C}\left(\left(\frac{L_x}{2}\right)^2 - \left(\frac{L_y}{2}\right)^2\right) \tag{22}$$

[0089] If it is desired to measure the warp or radius of curvature of a larger sheet and obtain the gravity-free result, then an apparatus such as is described in U.S. Patent No. 7,225,665, entitled "Process and apparatus for measuring the shape of an article", which describes a measurement method that incorporates immersing the sheet in a fluid to approximate neutral buoyancy, may be used.

[0090] It should be noted that even a glass sheet manufactured to have no intrinsic asymmetry of its physical properties through the thickness of the sheet will generally have some nonzero warp after being ion exchanged. This can occur through either slight variations in the manufacturing process or slight asymmetry of the ion exchange process itself. Fortunately, intrinsic (native) asymmetry can be separated from extrinsic (random) asymmetry by performing repeated measurements and averaging.

[0091] In particular, extrinsic asymmetry produced by the ion exchange process itself can be eliminated by varying the orientation of the glass sheets within the salt bath relative to their orientation during manufacturing. Using "top" and "bottom" to denote the two sides of the manufactured sheet, and "left" and "right" to denote the two possible orientations in a salt bath, ion exchanges can be performed both with the top side facing left and also with the top side facing right. When these are compared, extrinsic asymmetry from the salt bath will tend to make the warp have the same orientation relative to the salt bath (left and right) but it will have a different orientation relative to the manufacturing process (top and bottom). Intrinsic asymmetry from the manufacturing process will always have the same warp orientation relative to the manufacturing process (top and bottom), but as a result of flipping, it will have different orientations relative to the salt bath (left and right). Random warp will have values (typically small) that are random relative to the manufacturing process orientation. Accordingly, when multiple sheets are ion exchanged with both orientations of top and bottom relative to left and right of the salt bath, the sign of the observed warp will flip when the top and bottom sides are exchanged, but not when left

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and right are exchanged. Averaging will then tie any remaining nonzero value to systematic warp that is intrinsic to the glass prior to ion exchange. That is, averaging will help remove extrinsic warp from the ion exchange process itself and will average over random warp that could arise from the warp measurement gauge or from random (small) variations in the manufacturing process. The choice of how many sheets to average depends on how sensitively the warp can be measured.

[0092] Using an eight-step measurement procedure of the type described above with flipping and a typical, commercially-acceptable ion exchange process, BM_1 and $ASYM$ values were determined for glass sheets produced by a fusion process and glass sheets produced by a float process. The results are shown in Table 2, where samples 1-9 are fusion glass samples and samples 10-22 are float glass samples. W_{Glass} for the fusion and float samples were 63.88 grams/mole and 63.18 grams/mole, respectively; W_{ion} (K^+) was 39.09831 grams/mole and W_{ion} (Na^+) was 22.98977 grams/mole. The column labeled "Corrected Warp" in Table 2 refers to measured warp values corrected for the effects of gravity as described above.

[0093] As can be seen in Table 2, the fusion glass had substantially smaller BM_1 and $ASYM$ values than the float glass, the average over all of the samples of the BM_1 values being ~0.0005 microns for the fusion process and ~0.003 microns for the float process, and the average over all of the samples of the $ASYM$ values being ~240 ppm for the fusion process and ~2080 ppm for the float process. Consequently, the float glass can be expected to exhibit warp problems when used in various applications for chemically-strengthened glass sheets.

[0094] Using BM_1 and/or $ASYM$ values as a guide, the intrinsic (native) asymmetry of the float process can be reduced so as to minimize its warp problems. Likewise, one or both of these values can be used as a guide to maintain the high level of symmetry of the fusion process. In connection with both processes, the techniques disclosed herein can be used to monitor Z-axis asymmetry during on-going production and/or to track changes in Z-axis asymmetry associated with changes to existing processes. In these ways, thin and large glass sheets with low warp after ion exchange can be produced by achieving and/or maintaining the intrinsic symmetry of the physical properties of the glass through the thickness direction, including its thermal history.

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[0095] In particular, based on the *ASYM* and the BM_f metrics disclosed herein, as well as the analysis of the physical processes underlying warp discussed above, novel, low-warp, glass sheets are produced which, in an embodiment, have *R* values that are less than or equal to 2.5×10^{-4} and have *ASYM* values that are less than or equal to 1,500 ppm (BM_f values ($K = 2/3$) that are less than or equal to 0.002 microns). In other embodiments, the glass sheets have *R* values that are less than or equal to 2.0×10^{-4} and *ASYM* values that are less than or equal to 1,000 ppm (BM_f values ($K = 2/3$) that are less than or equal to 0.001 microns), while in still further embodiments, the glass sheets have *R* values that are less than or equal to 1.5×10^{-4} and *ASYM* values that are less than or equal to 500 ppm (BM_f values ($K = 2/3$) that are less than or equal to 0.0005 microns).

[0096] For these novel glass sheets, the *ASYM* and the BM_f values are determined for the sheets in question or test samples taken from the sheets in question, while the *R* values are for the full sheets. For example, for a glass sheet having a thickness of 0.5 mm, an *R* value of 2.5×10^{-4} corresponds to a sheet diagonal of 2000 mm, an *R* value of 2.0×10^{-4} corresponds to a sheet diagonal of 2500 mm, and an *R* value of 1.5×10^{-4} corresponds to a sheet diagonal of 3333 mm. For a sheet thickness of 0.7 mm, the diagonals are larger, being 2800 mm, 3500 mm, and 4667 mm for *R* values of 2.5×10^{-4}, 2.0×10^{-4}, and 1.5×10^{-4}, respectively.

[0097] In view of their low *ASYM* (BM_f) values, the full sheets exhibit gravity-free warp values (*W* values) that are less than or equal to 48 mm for the $R = 2.5\times10^{-4}$, *ASYM* = 1,500 ppm (or $BM_f = 0.002$ microns) combination, full sheet *W* values that are less than or equal to 37.5 mm for the $R = 2.0\times10^{-4}$, *ASYM* = 1,000 ppm (or $BM_f = 0.001$ microns) combination, and full sheet *W* values that are less than or equal to 33 mm for the $R = 1.5\times10^{-4}$, *ASYM* = 500 ppm (or $BM_f = 0.0005$ microns) combination. Full sheets having such low warp values facilitate handling of the sheets during manufacture and use. The ultimate product also benefits from such reduced warp, especially where the chemically-strengthened glass incorporated in the ultimate product has a large surface area.

[0098] A variety of modifications that do not depart from the scope and spirit of the invention will be evident to persons of ordinary skill in the art from the foregoing disclosure. The following claims are intended to cover the specific embodiments set forth herein as well as modifications, variations, and equivalents of those embodiments.

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Table 1

Representative Calculated Gravity-Free Warp Values for Float Glass

Lx(mm)	Ly(mm)	Lz(mm)	(Lx^2+Ly^2)/Lz^2	R x 10^3	Warp(mm)
60	44	0.5	22144	6.71	0.10
1910	1575	1.1	5065062	0.44	22.79
136	170	0.8	74056	3.68	0.33
182	237	0.8	139520	2.67	0.63
500	500	0.5	2000000	0.71	9.00
2000	1500	3	694444	1.20	3.13
2000	1500	1	6250000	0.40	28.13

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Table 2

Representative *ASYM* and BM_1 Values
For Glasses With and Without Intrinsic (Native) Asymmetry

Sample Number	Thickness (mm)	ΔM/M0	Warp (mm)	Corrected Warp (microns)	R	BM_1 (microns)	ASYM (ppm)
1	0.55	0.00393	0.0485	51.895	0.003889	0.000523	247
2	0.55	0.00308	0.048	51.36	0.003889	0.000518	312
3	0.55	0.00461	0.059	63.13	0.003889	0.000637	256
4	0.55	0.00381	0.033	35.31	0.003889	0.000356	173
						Average	247
5	1	0.00202	0.014	14.98	0.007071	0.000499	254
6	1	0.00195	0.013	13.91	0.007071	0.000464	245
7	1	0.00197	0.0125	13.375	0.007071	0.000446	233
8	1	0.00197	0.014	14.98	0.007071	0.000499	261
9	1	0.00201	0.0115	12.305	0.007071	0.00041	210
						Average	241
10	0.55	0.00264	0.2245	240.215	0.003889	0.002422	1722
11	0.55	0.00279	0.2855	305.485	0.003889	0.00303	2070
12	0.55	0.00267	0.2705	289.435	0.003889	0.002918	1908
13	0.55	0.00292	0.242	258.94	0.003889	0.002611	1676
14	0.55	0.00288	0.304	325.28	0.003889	0.00328	2137
15	0.55	0.00308	0.2715	290.505	0.003889	0.002929	1784
16	0.55	0.00278	0.2515	269.105	0.003889	0.002713	1828
						Average	1875
17	1.1	0.001194	0.072	77.04	0.007778	0.003107	2467
18	1.1	0.001383	0.0845	90.415	0.007778	0.003647	2499
19	1.1	0.001414	0.081	86.67	0.007778	0.003496	2343
20	1.1	0.001459	0.0785	83.995	0.007778	0.003388	2200
21	1.1	0.001305	0.0765	81.855	0.007778	0.003301	2397
22	1.1	0.001386	0.067	71.69	0.007778	0.002891	1976
						Average	2314

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What is claimed is:

1. A method for measuring the asymmetry of a glass-sheet manufacturing process comprising:

(I) producing a glass sheet using the glass-sheet manufacturing process;

(II) measuring the mass M_0 of the glass sheet or a test sample from the glass sheet;

(III) subjecting the glass sheet or the test sample to an ion-exchange process;

(IV) measuring the change in mass ΔM of the glass sheet or the test sample as a result of step (III);

(V) measuring a warp value W for the glass sheet or the test sample after step (III); and

(VI) computing an $ASYM$ value for the glass sheet or the test sample using an equation of the form:

$$ASYM = \frac{2R^2}{3}\left(\frac{2}{L_x}+\frac{2}{L_y}-\frac{2}{L_z}\right)\frac{W}{\Delta M}\frac{2M_0\left(W_{in}-W_{out}\right)}{W_{Glass}}$$

where W_{Glass} is the molecular weight in grams/mole of the glass making up the glass sheet or the test sample prior to step (III), W_{in} and W_{out} are, respectively, the molecular weights in grams/mole of the ions being exchanged into and out of the glass in step (III), taken singly and not as oxides, R is the glass sheet's or the test sample's thickness-to-diagonal ratio, and L_x, L_y, and L_z are, respectively, the length, width, and thickness of the glass sheet or the test sample in the same units as the warp value W;

wherein the $ASYM$ value calculated in step (VI) is a measure of the asymmetry of the glass-sheet manufacturing process.

2. The method of Claim 1 wherein the warp value of step (V) is determined for the glass sheet or the test sample in a bowl configuration.

3. The method of Claim 1 wherein the warp value of step (V) is corrected for the effects of gravity.

4. The method of Claim 1 wherein the $ASYM$ value computed in step (VI) is an average value based on measurements made on multiple glass sheets or multiple test samples.

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5. The method of Claim 4 wherein:

(a) step (III) comprises submerging multiple glass sheets or multiple test samples in a salt bath;

(b) each glass sheet or each test sample has a first side and a second side;

(c) the multiple glass sheets or multiple test samples are submerged in the salt bath with some of the first sides oriented in a first direction and some of the first sides oriented in a second direction, which is opposite to the first direction; and

(d) the average value computed in step (VI) includes *ASYM* values for glass sheets or test samples oriented in the first direction and glass sheets or test samples oriented in the second direction.

6. A method for producing low warp, ion-exchanged, glass sheets comprising:

(a) producing a population of glass sheets using a glass-sheet manufacturing process, each glass sheet in the population having an *R* value that is less than or equal to 2.5×10^{-4}, where the *R* value is the ratio of the thickness of the glass sheet to the length of the glass sheet's diagonal; and

(b) ion exchange strengthening the population of glass sheets produced in step (a);

wherein the glass-sheet manufacturing process has an *ASYM* value that is less than or equal to 1,500 ppm, where the *ASYM* value is determined using the method of Claim 4.

7. The method of Claim 6 wherein:

(a) the *R* value of the glass sheets is less than or equal 2.0×10^{-4} and the *ASYM* value of the glass-sheet manufacturing process is less than or equal to 1,000 ppm; or

(b) the *R* value of the glass sheets is less than or equal 1.5×10^{-4} and the *ASYM* value of the glass-sheet manufacturing process is less than or equal to 500 ppm.

8. A low warp, ion-exchanged glass sheet produced by the process of Claim 6.

9. A low warp, ion-exchanged glass sheet produced by the process of Claim 7.

10. A method for measuring the asymmetry of a glass-sheet manufacturing process comprising:

(I) producing a glass sheet using the glass-sheet manufacturing process;

(II) subjecting the glass sheet or a test sample from the glass sheet to an ion-exchange process;

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(III) measuring a warp value W for the glass sheet or the test sample after step (II); and

(IV) computing a BM_I value for the glass sheet or the test sample using an equation of the form:

$$BM_I = K \cdot W \cdot R^2$$

where K is a constant and R is the glass sheet's or the test sample's thickness-to-diagonal ratio;

wherein the BM_I value calculated in step (IV) is a measure of the asymmetry of the glass-sheet manufacturing process.

11. The method of Claim 10 wherein the warp value of step (III) is determined for the glass sheet or the test sample in a bowl configuration.

12. The method of Claim 10 wherein the warp value of step (III) is corrected for the effects of gravity.

13. The method of Claim 10 wherein the BM_I value computed in step (IV) is an average value based on measurements made on multiple glass sheets or multiple test samples.

14. The method of Claim 13 wherein:

(a) step (II) comprises submerging multiple glass sheets or multiple test samples in a salt bath;

(b) each glass sheet or each test sample has a first side and a second side;

(c) the multiple glass sheets or multiple test samples are submerged in the salt bath with some of the first sides oriented in a first direction and some of the first sides oriented in a second direction, which is opposite to the first direction; and

(d) the average value computed in step (IV) includes BM_I values for glass sheets or test samples oriented in the first direction and glass sheets or test samples oriented in the second direction.

15. The method of Claim 13 where $K = 2/3$.

16. A method for producing low warp, ion-exchanged, glass sheets comprising:

(a) producing a population of glass sheets using a glass-sheet manufacturing process, each glass sheet in the population having an R value that is less than or equal to 2.5×10^{-3}, where the R value is the ratio of the thickness of the glass sheet to the length of the glass sheet's diagonal; and

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(b) ion exchange strengthening the population of glass sheets produced in step (a);

wherein the glass-sheet manufacturing process has a BM_f value that is less than or equal to 0.002 microns, where the BM_f value is determined using the method of Claim 15.

17. The method of Claim 16 wherein:

(a) the R value of the glass sheets is less than or equal 2.0×10^{-4} and the BM_f value of the glass-sheet manufacturing process is less than or equal to 0.001 microns; or

(b) the R value of the glass sheets is less than or equal 1.5×10^{-4} and the BM_f value of the glass-sheet manufacturing process is less than or equal to 0.0005 microns.

18. A low warp, ion-exchanged glass sheet produced by the process of Claim 16.

19. A low warp, ion-exchanged glass sheet produced by the process of Claim 17.

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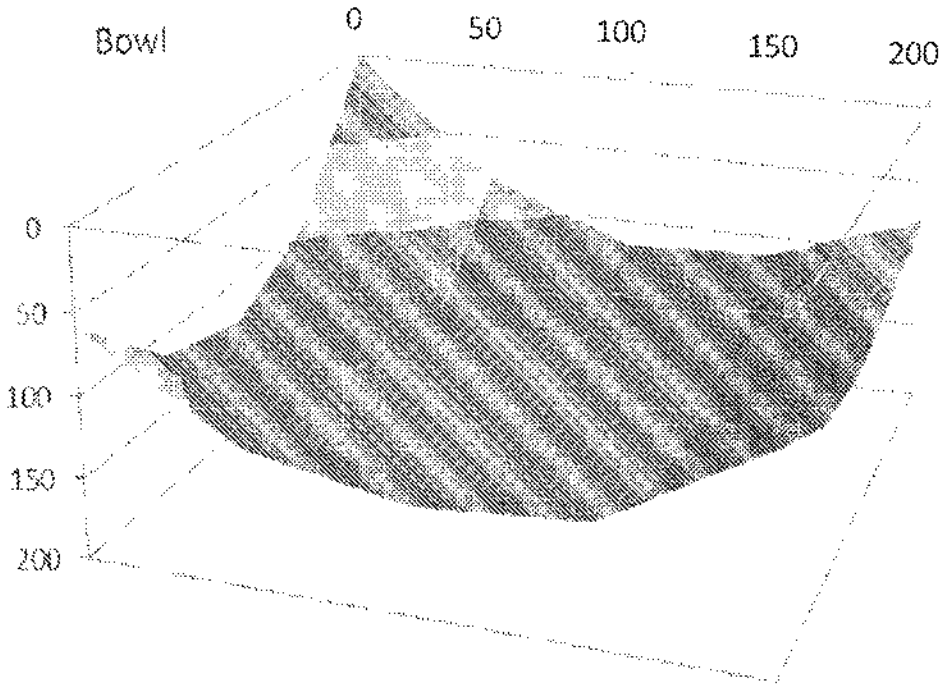


FIG. 1

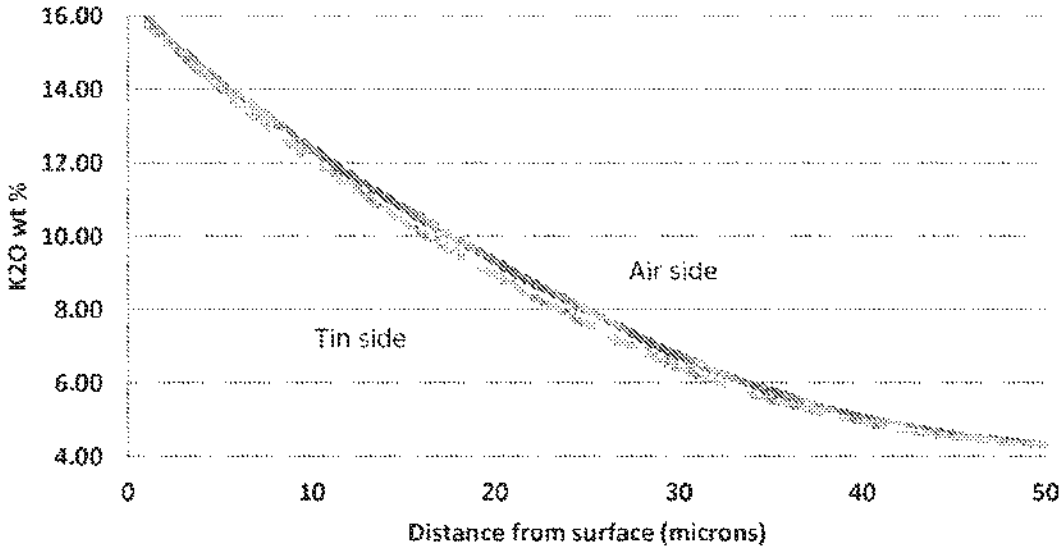


FIG. 2

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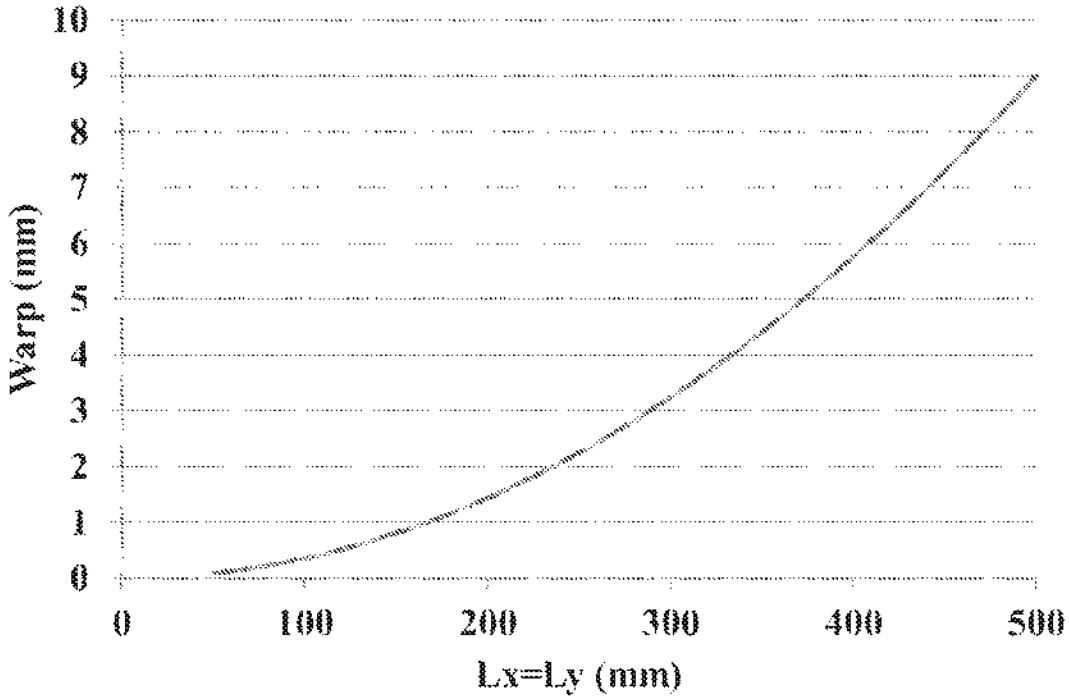


FIG. 3

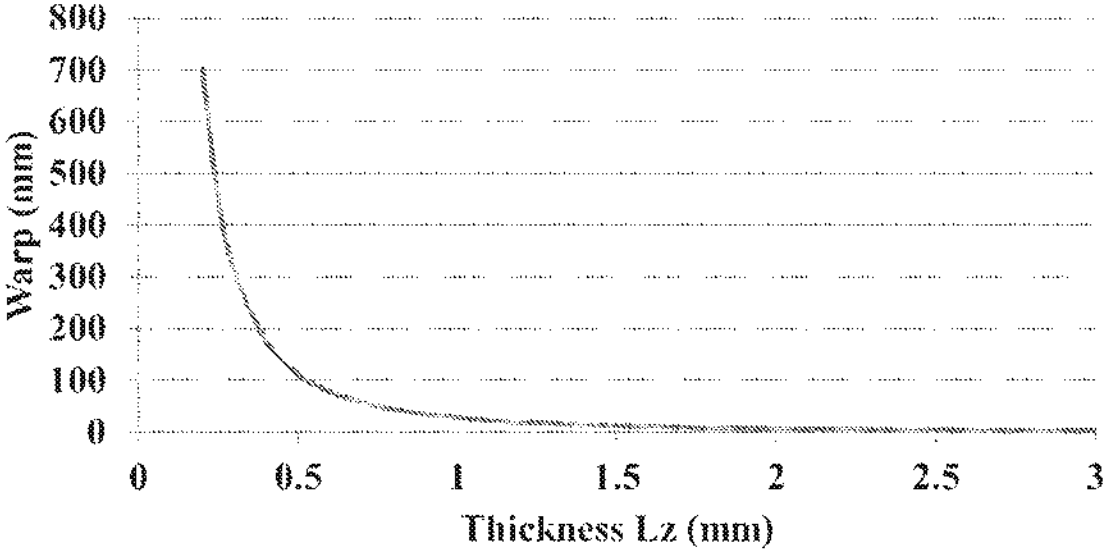


FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/017062

A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01B C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/135281 A1 (GODA TAKUJI [JP] ET AL) 26 September 2002 (2002-09-26)	10-19
A	paragraphs [0011] - [0020]; figure 1	1-9
A	JP 2000 264681 A (ASAHI TECHNO GLASS CORP) 26 September 2000 (2000-09-26) abstract	1,6,10, 16
A	US 2012/134025 A1 (HART SHANDON DEE [US]) 31 May 2012 (2012-05-31) paragraphs [0016], [0033], [0070] - [0072]; figure 1	1,6,10, 16
A	US 2007/028681 A1 (GOFORTH DOUGLAS E [US] ET AL GOFORTH DOUGLAS EDMON [US] ET AL) 8 February 2007 (2007-02-08) cited in the application paragraphs [0032] - [0035]; figure 2	1,6,10, 16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 May 2014	30/05/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Trique, Michael

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/017062

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(74) Agent: **EVENT HORIZON IP**; Bergsmedjegatan 16b, 21117 Malmö (SE).

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(54) Title: IMPROVED STYLUS IDENTIFICATION

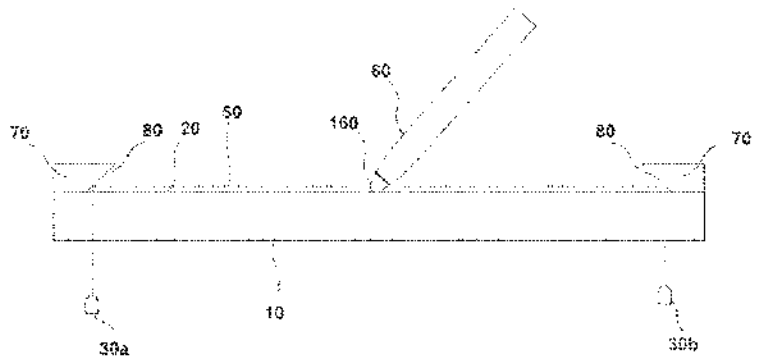


Figure 2

(57) Abstract: An optical IR touch sensing apparatus configured to determine, based on output signals of light detectors, a light energy value for each light path across a touch surface, and generate a transmission value for each light path based on the light energy value. A processor is then configured to operate an image reconstruction algorithm on at least part of the thus-generated transmission values and determine a position of a touching object on the touch surface, and an attenuation value corresponding to the attenuation of the light resulting from the object touching the touch surface. Using these values, the processor is configured to identify the type of object.

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IMPROVED STYLUS IDENTIFICATION

Technical Field

The present invention relates to techniques for detecting and identifying objects on a touch surface.

Background Art

To an increasing extent, touch-sensitive panels are being used for providing input data to computers, electronic measurement and test equipment, gaming devices, etc. The panel may be provided with a graphical user interface (GUI) for a user to interact with using e.g. a pointer, stylus or one or more fingers. The GUI may be fixed or dynamic. A fixed GUI may e.g. be in the form of printed matter placed over, under or inside the panel. A dynamic GUI can be provided by a display screen integrated with, or placed underneath, the panel or by an image being projected onto the panel by a projector.

There are numerous known techniques for providing touch sensitivity to the panel, e.g. by using cameras to capture light scattered off the point(s) of touch on the panel, by using cameras to directly observe the objects interacting with the panel, by incorporating resistive wire grids, capacitive sensors, strain gauges, etc. into the panel.

In one category of touch-sensitive panels known as 'above surface optical touch systems' and known from e.g. US patent 4,459,476, a plurality of optical emitters and optical receivers are arranged around the periphery of a touch surface to create a grid of intersecting light paths above the touch surface. Each light path extends between a respective emitter/receiver pair. An object that touches the touch surface will block or attenuate some of the light paths. Based on the identity of the receivers detecting a blocked light path, a processor can determine the location of the intercept between the blocked light paths.

US patent publication 2004/0252091 discloses an alternative technique which is based on frustrated total internal reflection (FTIR). Light is coupled into a panel to propagate inside the panel by total internal reflection. Arrays of light sensors are located around the perimeter of the panel to detect the light. When an object comes into contact with a surface of the panel, the light will be locally attenuated at the

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point of touch. The location of the object is determined by triangulation based on the attenuation of the light from each source at the array of light sensors.

For most touch systems, a user may place a finger onto the surface of a touch panel in order to register a touch. Alternatively, a stylus may be used. A stylus is typically a pen shaped object with one end configured to be pressed against the surface of the touch panel. An example of a stylus according to the prior art is shown in figure 3. Use of a stylus 60 may provide improved selection accuracy and pointer precision over a simple finger touch. This can be due to the engineered stylus tip 160 providing a smaller and/or more regular contact surface with the touch panel than is possible with a human finger. Also, muscular control of an entire hand in a pen holding position can be more precise than a single finger for the purposes of pointer control due to lifelong training in the use of pens and pencils.

Two types of stylus exist for touch systems. An active stylus is a stylus typically comprising some form of power source and electronics to transmit a signal to the host touch system. The type of signal transmitted can vary but may include position information, pressure information, tilt information, stylus ID, stylus type, ink colour etc. The source of power for an active stylus may include a battery, capacitor, or an electrical field for providing power via inductive coupling. Without power, an active stylus may lose some or all of its functionality.

An active stylus may be readily identified by a host system by receiving an electronic stylus ID from the active stylus and associating the stylus ID with position information relating to the contact position between the stylus and the touch surface of the host system.

A passive stylus has no power source and does not actively communicate with the host system. Therefore, a passive stylus is cheaper to manufacture than an active stylus and does not require maintenance. However, advanced information like application pressure, tilt information, stylus ID, stylus type, ink colour etc. can be significantly more difficult to obtain from a passive stylus than from an active stylus.

US patent 6,567,078 describes a method of marking a plurality of passive styluses with one or more colour films in a pattern unique to each stylus. A camera is arranged to record the colour markings on the stylus and identify the passive stylus in

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use in order to determine the appropriate choice of ink colour to be displayed on the screen.

For optical touch systems such as those described in US patent publication 2004/0252091 and US patent 4,459,476, it can be difficult to identify an object with a tip as small as a stylus. In particular, stylus tips are typically small (i.e smaller than 4mm in diameter) and provide a relatively small amount of attenuation of the light signals compared with a finger or other large object. The stylus tip may also have a smaller diameter than the resolution of the touch system is able to resolve

Furthermore, the low signal-to-noise of such systems makes identification of each of a plurality of passive styluses using unique retro-reflective material arrangements difficult and unreliable.

Therefore, what is needed is a way of identifying objects touching an optical touch system which does not suffer from the above problem.

Summary

It is an objective of the invention to at least partly overcome one or more of the above-identified limitations of the prior art.

One or more of these objectives, as well as further objectives that may appear from the description below, are at least partly achieved by means of a method for data processing, a computer readable medium, devices for data processing, and a touch-sensing apparatus according to the independent claims, embodiments thereof being defined by the dependent claims.

Brief Description of Drawings

Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.

Figure 1 is a top plan view of an optical touch apparatus.

Figure 2 shows a cross-section of an IR optical touch apparatus according to the prior art.

Figure 3 shows a cross-section of an FTIR-based touch apparatus according to the prior art.

Figure 4 shows a light field of an IR optical touch apparatus.

Figure 5 is a flow chart showing a touch determination process.

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Figure 6 is a histogram showing measured attenuation of light beams from eight unique objects applied to the touch surface.

Figure 7 is a histogram showing measured attenuation of light beams from two objects applied to the touch surface, a stylus and a finger.

Figure 8 is a histogram showing measured attenuation of light beams from three objects applied to the touch surface, a first stylus, a second stylus, and a finger

Figure 9 shows an object entering a light field.

Figure 10 shows an attenuation value of an object during a 'touch down' and a 'touch up' event.

Figure 11 is a graph showing measured attenuation of light beams by an object in proportion to the object's distance from a corner of the touch surface.

Figure 12 is an attenuation map showing the relative attenuation of an object at each location on a corner portion of the touch surface.

Figure 13 is a graph showing measured attenuation of light beams by an object in proportion to speed at which the object is moving across the touch surface.

Figure 14 shows a cross-section of a stylus having a flat end being applied to a touch surface.

Figure 15 shows an end view of the stylus from figure 14.

Figure 16 shows a tilted view of the stylus from figure 14.

Figure 17 is a top plan view of an optical touch apparatus with the stylus of figure 14 applied to the touch surface without any tilt from the normal of the touch surface.

Figure 18 is a cross-section of the arrangement shown in figure 17 showing the x-axis.

Figure 19 is a cross-section of the arrangement shown in figure 17 showing the y-axis.

Figure 20 is a top plan view of an optical touch apparatus with the stylus of figure 14 applied at an angle from the normal of the touch surface

Figure 21 is a cross-section of the arrangement shown in figure 20 showing the x-axis.

Figure 22 is a cross-section of the arrangement shown in figure 20 showing the y-axis.

Figure 23 is a zoomed view of figure 21 showing a cross-section of the light field along a single light path and the area of the light blocked by the stylus tip.

Figure 24 is a zoomed view of figure 22 showing a cross-section of the light field along a single light path and the area of the light blocked by the stylus tip.

Figure 25 is a top plan view of a stylus tip being applied to a touch surface.

Figure 26 is a graph showing attenuation of light along different light paths by a particular stylus tip.
Figure 27 is a graph showing attenuation of light along different light paths by a particular stylus tip orientated in a different direction to that of figure 26.
Figure 28 is a graph showing attenuation of a flat ended stylus tip relative to the angle at which the stylus is applied to the touch surface.
Figure 29 is a graph showing attenuation of a dome ended stylus tip relative to the angle at which the stylus is applied to the touch surface.
Figure 30 shows a dome ended stylus tip applied to a touch surface.
Figures 31a-c show a stylus tip having a spherically-shaped portion.
Figures 32a-e show a stylus tip having a drop-shaped portion.
Figures 33a-b show a stylus tip having another drop-shaped portion
Figure 34 show a stylus tip having two different drop-shaped portions, in a vertical and tilted configuration.

Detailed Description of Embodiments

The present invention relates to optical touch panels and the use of techniques for providing touch sensitivity to a display apparatus. Throughout the description the same reference numerals are used to identify corresponding elements.

Before describing embodiments of the invention, a few definitions will be given.
A "touch object" or "touching object" is a physical object that touches, or is brought in sufficient proximity to, a touch surface so as to be detected by one or more sensors in the touch system. The physical object may be animate or inanimate.
An "interaction" occurs when the touch object affects a parameter measured by the sensor.
A "touch" denotes a point of interaction as seen in the interaction pattern.
Throughout the following description, the same reference numerals are used to identify corresponding elements.
A "light field" is the light flowing between an emitter and a corresponding detector. Although an emitter may generate a large amount of light in many directions, only the light measured by a detector from an emitter defines the light field for the emitter and detector.

Figure 1 is a top plan view of an optical touch apparatus which may correspond to the FTIR-based touch apparatus of figure 3 or the IR optical touch apparatus of figure 2. Emitters 30a are distributed around the periphery of touch surface 20, to

project light across the touch surface 20 of touch panel 10. Detectors 30b are distributed around the periphery of touch surface 20, to receive part of the propagating light. The light from each of emitters 30a will thereby propagate to a number of different detectors 30b on a plurality of light paths 50.

Figure 3 shows a cross-section of an FTIR-based touch apparatus according to the prior art and herein referred to as an 'in-glass' system. Figure 2 shows a cross-section of an IR optical touch apparatus according to the prior art and herein referred to as an 'above-surface' system. In each of the example apparatus shown in figures 3 and 2, object 60 will attenuate light propagating along at least one light path 50. In the example shown of figure 2, object 60 may even fully occlude the light on at least one light path 50.

Light paths 50 may conceptually be represented as "detection lines" that extend across the touch surface 20 to the periphery of touch surface 20 between pairs of emitters 30a and detectors 30b, as shown in figure 1. Thus, the detection lines 50 correspond to a projection of the light paths 50 onto the touch surface 20. Thereby, the emitters 30a and detectors 30b collectively define a grid of detection lines 50 ("detection grid") on the touch surface 20, as seen in a top plan view. The spacing of intersections in the detection grid defines the spatial resolution of the touch-sensitive apparatus 100, i.e. the smallest object that can be detected on the touch surface 20. The width of the detection line is a function of the width of the emitters and corresponding detectors. A wide detector detecting light from a wide emitter provides a wide detection line with a broader surface coverage, minimising the space in between detection lines which provide no touch coverage. A disadvantage of broad detection lines may be the reduced touch precision and lower signal to noise ratio.

As used herein, the emitters 30a may be any type of device capable of emitting radiation in a desired wavelength range, for example a diode laser, a VCSEL (vertical-cavity surface-emitting laser), an LED (light-emitting diode), an incandescent lamp, a halogen lamp, etc. The emitters 30a may also be formed by the end of an optical fibre. The emitters 30a may generate light in any wavelength range. The following examples presume that the light is generated in the infrared (IR), i.e. at wavelengths above about 750 nm. Analogously, the detectors 30b may be any device capable of converting light (in the same wavelength range) into an electrical signal, such as a photo-detector, a CCD device, a CMOS device, etc

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The detectors 30b collectively provide an output signal, which is received and sampled by a signal processor 130. The output signal contains a number of sub-signals, also denoted "transmission values", each representing the energy of light received by one of light detectors 30b from one of light emitters 30a. Depending on implementation, the signal processor 130 may need to process the output signal for separation of the individual transmission values. The transmission values represent the received energy, intensity or power of light received by the detectors 30b on the individual detection lines 50. Whenever an object touches a detection line 50, the received energy on this detection line is decreased or "attenuated". Where an object blocks the entire width of the detection line of an above-surface system, the detection line will be fully attenuated or occluded.

In the preferred embodiment, the touch apparatus is arranged according to figure 2. A light emitted by emitters 30a is transmitted through transmissive panel 10 in a manner that does not cause the light to TIR within transmissive panel 10. Instead, the light exits transmissive panel 10 through touch surface 20 and is reflected by reflector surface 80 of edge reflector 70 to travel along a path 50 in a plane parallel with touch surface 20. The light will then continue until deflected by reflector surface 80 of the edge reflector 70 at an opposing edge of the transmissive panel 10, wherein the light will be deflected back down through transmissive panel 10 and onto detectors 30b. An object 60 (optionally having object tip 160) touching surface 20 will occlude light paths 50 that intersect with the location of the object on the surface resulting in an attenuated light signal received at detector 30b.

Figure 4 shows the manner in which light travelling from emitters 30a to detectors 30b will form a light field 90 between reflector surfaces 80. In the preferred embodiment, the top edge of reflector surface 80 is 2mm above touch surface 20. This results in a light field 90 which is 2mm deep. A 2mm deep field is advantageous for this embodiment as it minimizes the distance that the object needs to travel into the light field to reach the touch surface and to maximally attenuate the light. The smaller the distance, the shorter time between the object entering the light field and contacting the surface. This is particularly advantageous for differentiating between large objects entering the light field slowly and small objects entering the light field quickly. A large object entering the light field will initially cause a similar attenuation as a smaller object fully extended into the light field. The shorter distance for the objects to travel, the fewer frames are required before a representative

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attenuation signal for each object can be observed. This effect is particularly apparent when the light field is between 0.5mm and 2mm deep.

The arrangement shown in figure 3 is an alternative embodiment but the concepts of stylus differentiation described below are similarly applied. The apparatus operates by transmitting light inside a transmissive panel 10, from light emitters 30a to light sensors or detectors 30b, so as to illuminate a touch surface 20 from within the transmissive panel 10. The transmissive panel 10 is made of solid material in one or more layers and may have any shape. The transmissive panel 10 defines an internal radiation propagation channel, in which light propagates by internal reflections along paths 50. An object touching the surface of the transmissive panel 10 causes frustration of the internal reflection effect at the location of the touch and a portion of the light travelling through the panel via total internal reflection is scattered or absorbed by the object. In this way, light beams travelling through the panel are attenuated at the position of the touch.

Unless otherwise stated, the embodiments described in the specification apply to the arrangement shown in figure 2. However, some of these embodiments may also be applied to an arrangement shown in figure 3

The signal processor 130 may be configured to process the transmission values so as to determine a property of the touching objects, such as a position (e.g. in a x,y coordinate system), a shape, or an area. This determination may involve a straight-forward triangulation based on the attenuated detection lines, e.g. as disclosed in US7432893 and WO2010/015408, or a more advanced processing to recreate a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 20, where each attenuation value represents a local degree of light attenuation. The attenuation pattern may be further processed by the signal processor 130 or by a separate device (not shown) for determination of a position, shape or area of touching objects. The attenuation pattern may be generated e.g. by any available algorithm for image reconstruction based on transmission values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the attenuation pattern may be generated by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of such reconstruction functions designed for use in touch determination are found in WO2009/077962,

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WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

For the purposes of brevity, the term 'signal processor' is used throughout to describe one or more processing components for performing the various stages of processing required between receiving the signal from the detectors through to outputting a determination of touch including touch co-ordinates, touch properties, etc. Although the processing stages of the present disclosure may be carried out on a single processing unit (with a corresponding memory unit), the disclosure is also intended to cover multiple processing units and even remotely located processing units.

In the illustrated example, the apparatus 100 also includes a controller 120 which is connected to selectively control the activation of the emitters 30a and, possibly, the readout of data from the detectors 30b. Depending on implementation, the emitters 30a and/or detectors 30b may be activated in sequence or concurrently, e.g. as disclosed in US8581884. The signal processor 130 and the controller 120 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 130 and the controller 120 may be at least partially implemented by software executed by a processing unit 140.

Figure 5 shows a flow diagram according to a preferred embodiment.

In step 510 of figure 5, the signal processor 130 receives and samples output signals from derectors 30b.

In step 520, the output signals are processed for determination of the transmission values (or 'transmission signals'). As described above, the transmission values represent the received energy, intensity or power of light received by the detectors 30b on the individual detection lines 50.

In step 530, the signal processor 130 is configured to process the transmission values to determine the presence of one or more touching objects on the touch surface. In the preferred embodiment, the signal processor 130 is configured to process the transmission values to generate a two-dimensional estimation of the attenuation field across the touch surface, i.e. a spatial distribution of attenuation values, in which each touching object typically appears as a region of changed attenuation. From the

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attenuation field, two-dimensional touch data may be extracted and one or more touch locations may be identified. The transmission values may be processed according to a tomographic reconstruction algorithm to generate the two-dimensional estimation of the attenuation field.

In one embodiment, the signal processor 130 maybe configured to generate an attenuation field for the entire touch surface. In an alternative embodiment, the signal processor 130 maybe configured to generate an attenuation field for a sub-section of the touch surface, the sub-section being selected according to one or more criteria determined during processing of the transmission values.

In step 540, the signal processor 130 determines properties of the object at each touch location, including an attenuation value corresponding to the attenuation of the beams of light resulting from the object touching the touch surface.

In one embodiment, the attenuation value is determined in the following manner: First, the attenuation pattern is processed for detection of peaks, e g. using any known technique. In one embodiment, a global or local threshold is first applied to the attenuation pattern, to suppress noise. Any areas with attenuation values that fall above the threshold may be further processed to find local maxima. The identified maxima may be further processed for determination of a touch shape and a center position, e.g. by fitting a two-dimensional second-order polynomial or a Gaussian bell shape to the attenuation values, or by finding the ellipse of inertia of the attenuation values. There are also numerous other techniques as is well known in the art, such as clustering algorithms, edge detection algorithms, standard blob detection, water shedding techniques, flood fill techniques, etc. Step 540 results in a collection of peak data, which may include values of position, attenuation, size, and shape for each detected peak. The attenuation value may be calculated from a maximum attenuation value or a weighted sum of attenuation values within the peak shape.

The attenuation value recorded for an object may vary due to noise, object angle, object material, or a number of other reasons. Figure 6 is a histogram showing a count of attenuation values for each of eight unique objects applied to the touch surface. Each object demonstrates a roughly bell-shaped distribution of frequency of recorded attenuation values. It is clear from figure 6 that it is possible to differentiate

between different object from recorded attenuation values, particularly where multiple attenuation values for each object are recorded.

Certain objects may provide a wider distribution of attenuation values than others. Figure 7 is a histogram showing measured attenuation of light beams from two objects applied to the touch surface, a stylus and a finger. Bell-shaped distribution of values 710 represents attenuation values for a specially designed stylus tip applied to the touch surface. Distribution 720 represents attenuation values for a population of different fingers applied to the touch surface. As people have different sized fingers and some fingers may be more oily that others, the range of possible attenuation values from objects in distribution 720 is much wider than the possible attenuation values for a specially designed stylus tip. Zone 730 represents attenuation values which are too small for the system to reliably record. In a typical example, zone 730 covers attenuation values smaller than $1.8 * 10^{-3}$ (Note: All attenuation values described in the present specification have units of mm^{-1} but it is understood that attenuation may be measured in a number of different ways.) Depending on the touch resolution of the system, this may translate to objects smaller than 0.5mm. Therefore, a preferred embodiment of the invention comprises a stylus tip configured to provide attenuation values in a range greater than values in zone 730 but smaller than the range of attenuation values occupied by distribution 720. E.g. $1.8 * 10^{-3} <$ stylus tip attenuation $< 2.0 * 10^{-2}$

Figure 8 is a histogram showing measured attenuation of light beams from three objects applied to the touch surface, a first stylus, a second stylus, and a finger. An object 60 touching the touch surface in the examples of this disclosure may thus be a stylus, or a plurality of styluses, or parts of a human hand such as a finger or plurality of fingers. As in figure 7, bell-shaped distribution of values 810 represents attenuation values for a first specially designed stylus tip applied to the touch surface. Distribution 830 represents attenuation values for a finger applied to the touch surface. Zone 840 represents attenuation values which are too small for the system to reliably record. Bell-shaped distribution of values 820 represents attenuation values for a second specially designed stylus tip applied to the touch surface. Therefore, another embodiment of the invention comprises a first stylus tip configured to provide attenuation values in a range greater than values in zone 840 but smaller than the range of attenuation values 820 occupied by a second stylus tip. The second stylus tip is configured to provide attenuation values in a range greater than values occupied by distribution 810 but smaller than the range of attenuation

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values occupied by distribution 830. E g. $1.8 * 10^{-3} <$ first stylus tip attenuation $< 7.2 * 10^{-3} <$ second stylus tip attenuation $< 2.0 * 10^{-3}$

In the preferred embodiment, signal processor 130 is configured to store a plurality of object IDs in memory, each object ID having an associated attenuation value range. In the following example, three object types with associated Object IDs are shown.

Object ID:	001	002	003
Object type:	Stylus Thick	Stylus Thin	Finger
Output type:	Think Blue Ink	Thick Red Ink	Thick Black Ink
Attenuation Max:	$2.0 * 10^{-2}$	$7.2 * 10^{-3}$	
Attenuation Min:	$7.2 * 10^{-3}$	$1.8 * 10^{-3}$	$2.0 * 10^{-2}$

In the preferred embodiment, each Object ID has an attenuation value range, defined by an Attenuation Max value and an Attenuation Min value. The Object IDs may optionally comprise further values defining properties of an associated object, including a recognised object type, an output type (e.g. a brush type, ink colour, selection type, etc.)

In step 550, signal processor 130 matches each touch location to an Object ID. This is done by matching the attenuation value of each touch location to the range of the matching Object ID. I.e. A touch location with an attenuation value of $1.2 * 10^{-2}$ will be matched to Object ID 001. In one embodiment, an Object ID exists with a range for all values above a specific value. This allows all objects with an attenuation value above the usual ranges of the Object IDs to be identified using the same 'default large object' Object ID. Similarly, in one embodiment, an Object ID exists with a range for all values below a specific value allowing very low attenuation value objects to be identified with a generic 'default small object' Object ID.

In step 560, signal processor 130 outputs the touch data, including the touch locations and corresponding Object IDs for each location.

When matching an attenuation value of a touch to an object ID, it is important to use a stable attenuation value which correctly reflects the attenuation of the light caused by the object once it is in contact with the surface. In an 'above surface' system such as the embodiment shown in figure 2, light field 90 has a depth and so the object must travel a distance through the light field before contacting the touch surface. Consequently, a period of time between when the object enters the light field and when the object contacts the touch surface exists when the attenuation caused by the object is likely to be increasing. Any attenuation values measured during this period will likely not accurately reflect the light attenuation of the object once it is contacting the touch surface. In one embodiment of the invention, step 540 is delayed

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until an attenuation value of an object is determined to be stable. In one embodiment, the attenuation value of an object is determined to be stable once it has not changed greater than 10% each frame for at least three frames.

As an object is lowered into the light field, it occludes increasingly more light. As a consequence, the attenuation of light caused by the object increases until the object has hit the touch surface. The gradient of attenuation (i.e. the rate of change of the attenuation) is therefore positive as the object travels towards the touch surface until it flattens out when the object is in contact with the surface. Figure 9 shows an object 60 with tip 160 having travelled into light field 90 for a distance of h_{max} - h. Figure 10 shows an attenuation value 1020 of an object during a 'touch down' event 1040 (i.e the application of a touching object to the touch surface) and a 'touch up' event 1050 (i.e lifting the touching object off and away from the touch surface). A corresponding height h (shown as line 1010) of the object from the touch surface is also shown. The line 1030 showing the attenuation gradient (i.e. the rate of change of change of the attenuation value with respect to time) shows a typical attenuation gradient signature for both touch down and touch up events. An attenuation gradient signature is the shape of the attenuation gradient values during a touch down or touch up event

Therefore, in a preferred embodiment of the invention, signal processor 130 is configured to determine that an object attenuation value is stable and/or that a touch down event has occurred in dependence on an attenuation gradient signature (shown at time 1040 in figure 10) of an event. In a preferred embodiment, the attenuation gradient signature corresponding to a touch down event is a first period of a first attenuation gradient, a second period of higher attenuation gradient, and a third period of attenuation gradient lower than the second period.

In one embodiment, a touch down event determined to have occurred once object attenuation value has exceeded a first attenuation value threshold. However, a determination that a touch down event has occurred is possible before this threshold is met, using the above method. Where the object attenuation value is below the first attenuation value threshold but an attenuation gradient signature is observed having a higher attenuation gradient equal to or greater than 20% of the first attenuation value threshold over a single frame, the object attenuation value may be determined to be stable and/or that a touch down event has occurred.

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During a 'touch up' event, an attenuation value of the object decreases as the object is lifted out of the light field. Similarly to the above, the attenuation gradient signature of this event (shown at time 1050 in figure 10) can be recognized and actioned accordingly. Therefore, in a preferred embodiment of the invention, signal processor 130 is configured to determine that an object attenuation value is reduced to zero and/or that a touch up event has occurred in dependence on an attenuation gradient signature of an event. In a preferred embodiment, the attenuation gradient signature corresponding to a touch up event is a first period of a first attenuation gradient, a second period of negative attenuation gradient, and a third period of attenuation corresponding to the first attenuation gradient.

In one embodiment, a touch up event is determined to have occurred once the object attenuation value is determined to have dropped below a second attenuation value threshold. However, a determination that a touch up event has occurred is possible before this threshold is met, using the above method. Where the object attenuation value is above the second attenuation value threshold but an attenuation gradient signature is observed having a negative attenuation gradient equal to or greater than 20% of the second attenuation value threshold over a single frame, a touch up event may be determined to have occurred.

In a preferred embodiment, the attenuation gradient values required to trigger touch up/down events for an object may be scaled in dependence on the presence of other occluding objects in close proximity to the object. In a preferred example, the attenuation gradient of the second period of a signature is scaled up to require an even larger value to trigger a touch down event for an object in close proximity to other occluding objects on the touch surface. In one embodiment, the higher attenuation gradient is scaled linearly occurred to the number of additional touches within a radius of up to 10cm. The radius may be chosen in dependence on the screen size, touch resolution, and environmental noise.

'Hooks' are a problem observed in the flow of co-ordinates of user touch input over time when the user is providing rapidly changing touch input. E.g. When drawing or writing. An example of a 'hook' is where the user finishes drawing a stroke, lifts the touch object from the surface of the panel and rapidly changes the direction of movement of the touching object to begin drawing the next stroke. The 'hook' is a small artifact seen at the end of the stroke pointing in the new direction of the user's touch object. A method of minimizing hooks is proposed. In a preferred embodiment

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of the invention, once a negative attenuation gradient has been observed, the touch coordinates will not be updated with the object's position and the coordinates of the object's position are stored. If the object attenuation value drops below a threshold value, the stored coordinates are discarded and a 'touch up' event is signaled. If the object attenuation value does not drop below a threshold value and a positive attenuation gradient is subsequently observed, the stored touch coordinates for the intervening period will be output and the touch coordinates will continue to be output as before. In a preferred embodiment, the method is only used when the direction of movement of the object contacting the touch surface in the plane of the touch surface is changing. In this embodiment, a vector α from a last touch coordinate of the object to a current coordinate is determined. A second vector β from a touch coordinate previous to the last coordinate to the last coordinate is determined. Vectors α and β allow a determination of the direction the interaction is moving and how it is changing. A rapid change of direction of the object may result in $\alpha \; scalarproduct \; \beta < 0$. In one embodiment, if this condition is met, it may be determined that the direction of movement of the object contacting the touch surface has significantly changed and the above method for minimizing hooks is then applied.

Although the attenuation value of an object provides information regarding the light attenuated by the object touching the surface, some embodiments of the invention require that the attenuation value be compensated in order to provide a true reflection of the nature and/or position of the object.

In one embodiment of the invention, the attenuation value is determined in dependence on the attenuation of the light resulting from the object touching the touch surface and a compensation value. The attenuation value is determined as in step 540 above but wherein the attenuation value is calculated from the compensation value and a maximum attenuation value or a weighted sum of attenuation values within the peak shape.

In certain arrangements of the system shown figure 1, certain positions on the touch surface are likely to result in lower attenuation values than others. In particular, attenuation values towards the edge of the screen are likely to be lower than in the centre. A variety of factors may cause this to be the case. One is that efficient implementations of certain tomographic reconstruction algorithms make approximations resulting in lower reconstructed attenuation values towards the edges

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of the panel. In one example, attenuation values in a corner of a panel may be as low as 30% of attenuation values located at the centre of the panel. Figure 11 shows a graph of attenuation values (shown as relative attenuation) of an object touching a rectangular touch surface relative to the distance of the object from a corner of the touch surface. Consequently, a preferred embodiment of the invention provides that the compensation value is a function of at least the position of the object on the touch surface. In one embodiment, the compensation value is determined as a function of the distance from a central point on the touch surface to the touch position. Alternatively, the compensation value may be determined as a function of the distance from the nearest corner of the touch surface to the touch position.

The relationship between the position of the touch and a required compensation value may be a complex function of the geometry of the emitters and detectors. Figure 12 shows a heat map of a corner of a rectangular touch surface showing relative attenuation of a touching object. When touching at co-ordinate (0,0), the object generates relatively little attenuation. When touching at co-ordinate (10,15), a much larger amount of attenuation occurs.

Consequently, a preferred embodiment of the invention provides calculating a compensation value as a function of the position of the corresponding touch on the touch surface. An alternative embodiment describes using a compensation map to determine a compensation value given a position on the touch surface. The compensation map may comprise a 2D image corresponding to the dimensions of the touch surface with pixel values corresponding to compensation values. A touch position is then used to determine the corresponding pixel on the compensation map and the pixel value at that position provides the corresponding compensation value. In a preferred embodiment, the compensation map has a resolution lower than or equal to the touch resolution of the touch determination system. The compensation map is preferably generated in advance but may also be generated dynamically as a function of environmental and performance variables.

The signal processor 130 may be configured to determine the compensation value at a position on the compensation map by interpolation in the x- and y-direction of the compensation map between pre-defined compensation values in the compensation map. Thus, it is possible to have a coarse grid of compensation values, and subsequently use interpolation over the coarse grid to obtain the compensation values at a particular coordinate.

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The compensation value may be determined for each position in a grid of positions where the resolution of the compensation map is determined by the pitch of the grid, i.e. the dimensions of a cell in the grid. The pitch may vary as a function of the position in the compensation map. For example, bi-linear interpolation in a coarse grid, i.e. higher pitch, may work well in the center of the map, but near the edges and especially corners the pitch is may advantageously be decreased to correctly capture the attenuation variation.

Another variable which may affect the recorded attenuation of a touch object is the speed at which the touching object is moving across the touch surface. The light attenuation of each light path is recorded sequentially over a series of frames. Therefore, a sufficiently fast moving object may have moved away from a specific position before the attenuation of all light paths intersecting the position have been measured. Consequently, a moving object may generate a weaker attenuation signal. Figure 13 shows a graph of recorded attenuation values of an object relative to the speed of the object across the touch surface. A relationship can be seen showing that a faster moving object is likely to generate a weaker attenuation value. Therefore, a preferred embodiment of the invention provides calculating an attenuation value in dependence on a compensation value which is determined at least as a function of the speed of the object across the touch surface.

As the relationship between the speed of an object and the recorded attenuation value may also be complicated by the position of the moving object on the touch surface, an embodiment of the invention provides determining a compensation value as a function of both the position and speed of the object on the touch surface.

The compensation value may be a function of the depth of the light field (h_{max}). This provides for improving the classification of different objects used simultaneously. For example, if a cone-shaped stylus tip is used, the attenuation will be affected by the current lightfield height to a larger extent than a tip having a uniform thickness in the longitudinal direction. Thus, by compensating for the lightfield height differences, it will be easier to distinguish between styluses having different tips, since the influence of the field height is minimized.

The signal processor 130 may be configured to determine the depth of the light field (h_{max}) based on the output signals of the light detectors 30b. A more warped touch

surface 20, i.e. being more concave in the direction towards the user of the touch surface, may provide an increase in the signal strength detected by the light detectors 30b. Increased warp is also associated with increased height of the lightfield. Thus, by having the signal processor 130 configured to detect an increase or decrease of the output signal in response to touch surface warp, the height of the lightfield can be estimated. The estimate of the lightfield height may then be used as an input to the lightfield height compensation discussed above.

Another factor which may affect the light attenuation resulting from an object touching the touch surface is the shape of the object tip and the angle at which the tip is applied to the touch surface 20. Figure 14 shows a flat ended stylus 260 with a rounded cross-section. Figure 15 and figure 16 show stylus 260 having a flat ended tip 270 from an end-on and a tilted end-on perspective respectively. Figure 17 shows a top-down perspective of flat ended stylus 260 as applied to the touch surface 20 without any angle of tilt relative to the normal of the touch surface. Figure 18 and figure 19 show flat ended stylus tip 270 as viewed along the y and x-axis of surface 20 respectively. It is clear that the profile of flat ended stylus tip 270 is the same as viewed along the x-axis as when viewed along the y-axis. Therefore, light paths travelling along a path closely parallel to the x-axis (e.g. light paths originating from the left edge of the touch surface 20 from figure 17 and finishing on the right edge of the touch surface) intersecting with the object are likely to be attenuated to a similar degree as those light paths travelling along a path closely parallel to the y-axis (e.g. light paths originating from the bottom edge of the touch surface 20 from figure 17 and finishing on the top edge of the touch surface). The transmission values of said light paths will be affected accordingly.

However, as we can see from figures 20 to 22, this changes when stylus object 260 is tilted relative to the normal of the touch surface. The profile of the stylus tip 270 along the y-axis in figure 21 is different to the profile of stylus tip 270 along the x-axis in figure 22.

Figure 23 is a zoomed view of figure 21. In the zoomed view, light field 2310 of a light path between a single emitter and detector is shown. In this cross-section, stylus tip 270 blocks a portion of the light field 2310. This will be seen as an attenuation of the light signal recorded by the detector and a drop in the corresponding transmission value. In figure 23, the area of the light field blocked by the side profile (i.e. the profile of the stylus tip as viewed along of the y-axis) of the stylus tip is around 10%

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Figure 24 is a zoomed view of figure 22 similar to figure 23 but as viewed in a direction along the x-axis. In this direction, a rounded profile of the stylus tip 270 is seen. In this cross-section, stylus tip 270 blocks a larger portion of the light field 2410. In figure 24, the area of the light field 2410 blocked by the side profile (i.e. the profile of the stylus tip as viewed along the y-axis) of the stylus tip is around 25%.

Figure 25 is a top plan view of stylus tip 270 being applied to a touch surface 20. Detection lines L1, L2, and L3 are a subset of detection lines 50 which intersect with the contact point between the touch surface 20 and the stylus tip 270 and are therefore attenuated by the stylus. This angle of a detection line relative to vertical line 251 is defined as phi. Angles A1, A2, and A3 are the angles of the detection lines L1, L2, and L3 respectively relative to vertical line 251 respectively.

For a system having a large number of emitters and detectors, a number of detection lines are likely to intersect stylus tip 270. Figure 26 is a graph showing transmission values for different light paths intersected by the stylus tip of figure 21 relative to the angle phi of the light path. Minimum 2610 and maximum 2620 show minimum and maximum transmission values caused by the stylus tip across the full range of phi. For stylus tip 270, the minimum transmission value is likely to correspond to the light path 2410 shown in figure 24 and the maximum transmission value is likely to occur for the light path 2310 shown in figure 23, especially if the light paths have approximately 90 degrees of separation in phi. By measuring a ratio between the minimum and maximum transmission values of the light paths, the angle of the stylus from the normal of the touch surface maybe determined. The larger the ratio, the larger the tilt of the stylus from the normal. The closer the ratio is to 1.1, the closer the stylus axis is to the normal of the touch surface

Therefore, in a preferred embodiment of the invention, the signal processor 130 is configured to determine the angle of an axis of a stylus relative to the normal of the touch surface in dependence on a ratio between the minimum amount of attenuation and maximum amount of attenuation for the light paths intersecting the stylus.

Figure 28 is a graph showing an example of the measured attenuation of stylus tip 270 relative to the angle at which it is applied to the touch surface of an embodiment according to figure 2. As the angle relative to the normal of the touch surface increases, the attenuation value decreases. For a known stylus tip (such as that shown

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in figure 23), the angle of the axis of the stylus from the normal of the touch surface may be determined from the graph given the attenuation value of the stylus tip.

Furthermore, once the phi angles of detection lines having the minimum and maximum transmission values are identified, it is possible to determine the direction that the stylus is pointing in the phi plane. As the profile shown in figure 24 is likely to be responsible for the maximum attenuation and the lowest transmission value 2610, it can be determined that the stylus is likely pointed at an angle from the normal of the touch surface and in the same direction of the light path 2410 or 180 degrees to it. i.e. The minimum transmission value of figure 26 is located at 90 degrees (as well as 270 degrees) in phi and the maximum is located at 180 degrees (as well as 0 degrees). Therefore, it can be determined that the stylus is tilted away from the normal of the touch surface at an angle determined by the ratio between the minimum and maximum transmission values, and at an angle of 90 degrees or 270 degrees to the phi plane (as in figure 20).

In figure 27, the minimum transmission value of figure 26 is located at the 60 degrees (as well as 240 degrees) and the maximum transmission value is located at 150 degrees (as well as 330 degrees). Therefore, the stylus can be determined to be tilted in a direction of 60 degrees or 240 degrees in the phi plane. Consequently, a preferred embodiment of the invention provides determining the direction of a tilt of a stylus in the phi plane as a function of the phi value of the light path with the minimum amount of attenuation and the phi value of the light path having the maximum amount of attenuation. In an alternative embodiment, just the phi value of the light path having the maximum amount of attenuation is used to determine the orientation of a tilt of a stylus in the phi plane.

In one embodiment, information on the user's left or right handedness is used to select between which phi value to use to determine tilt orientation, due to the difference in typical stylus tilt orientation between left and right handed users. E.g. For figure 26, signal processor 130 is configured to determine that the stylus is orientated at a phi of 90 degrees for a right handed user and 270 degrees for a left handed user.

In one embodiment, the signal processor 130 is configured to determine that a tilt angle of the stylus relative to the normal of the touch surface has exceeded a threshold if the attenuation value begins to increase again whilst the ratio between

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the minimum and maximum transmission values remains high. Such a signal output would likely be caused by the stylus being tilted at such an angle to the normal of the touch surface that a section of the stylus casing has entered the light field and is having an effect on the attenuation value. Figure 29 shows a graph of attenuation relative to the stylus angle in such a scenario. Figure 30 shows the casing 380 of stylus 360 entering the light field 3010 and increasing the attenuation value.

The object touching the touch surface 20 may be a stylus 60, which may have a distal stylus tip 400 comprising a spherically-shaped portion 410, as illustrated in figures 31a-c. By having a spherically-shaped portion 410 the attenuation in the lightfield can be kept substantially constant when the stylus 60 is tilted. This is due to the symmetry of the spherical shape of the distal stylus tip 400, which does not change when the stylus is tilted. This will keep the effective width of the object as constant as possible, when tilted in various angles, which in turn makes it easier to distinguish several simultaneously used objects. For example, a plurality of different styluses 60 may be used simultaneously, where the dimensions of each stylus tip may be associated with particular stylus properties when used on the touch surface, such as varying drawing tools and colors. The spherically-shaped portion 410 may be a sphere that is arranged on a thin distal extension 411 that connects the sphere 410 with the remainder of the stylus 60. Reducing the cross-sectional dimension of the distal extension 411 will also minimize the variation of the attenuation when the stylus 60 is tilted, in particular when tilting the stylus with larger angles, since the area of the distal extension 411 in the lightfield will be minimized.

Figure 31c illustrates two different lightfields 3020 and 3030, having different heights h_{max} and h'_{max}, respectively. When the height of the lightfield is higher than the spherically-shaped portion 410, which is the case with lightfield 3030, it may be advantageous to have a drop-shaped stylus tip 600 to increase the attenuation. Figures 32a-c illustrate an object 60 having a distal stylus tip 600 comprising a drop-shape 610, 620, that tapers towards a proximal end 611 of the object 60, opposite the distal stylus tip 600, along a longitudinal object axis 612. Thus, the drop-shape narrows gradually in the longitudinal direction 612 towards the proximal end 611 of the stylus 60. Figure 32c illustrates the different cross-sections of the distal tips 400 and 600 in a high lightfield 3030. The drop-shaped tip 610 adds more area in the upper part of the lightfield compared to the spherically-shaped portion 410, which increases the attenuation. The drop-shape 610 minimizes at the same time the effective width increase when the stylus 60 is tilted.

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Figures 33a-b illustrate another drop-shaped stylus tip 600. The drop-shape may comprise an at least partly spherical surface 613. The at least partly spherical surface 613 may comprise a distal base portion 621 intersecting the longitudinal object axis 612 and having rotational symmetry around the same. The at least partly spherical surface 613 may further comprise an annular side 622, arranged proximally of the distal base portion 621, and defining the maximum circumference of the partly spherical surface 613 around the longitudinal object axis 612. The annular side 622 has rotational symmetry around the longitudinal object axis 612. The distal base portion 621 has a larger radius of curvature than the annular side 622, with respect to an imaginary circle center of a circle lying in a plane which is parallel to the longitudinal object axis 612. Since the distal base portion 621 has a larger radius of curvature than the side 622, i.e. being more flat or less convex towards a mass center point 616 of the distal tip 600, a part of the volume of the distal tip 600 will be shifted to a location above the light field when the distal tip 600 is tilted. This is schematically illustrated in Fig. 34, where parts of the volume that are shifted are denoted as 614, 614', when comparing to the distal tip 610 which has a distal base portion which has smaller radius of curvature. The shifted volume 614, 614', is instead positioned above the light field at 615. Thus, this compensates for the added volume of the proximal portion that enters the light field when the stylus is tilted. The drop-shape 620 thus improves the functionality in high lightfields while keeping the effective width of the object as constant as possible

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CLAIMS

1. A touch sensing apparatus, comprising:

a touch surface (20),

a set of emitters (30a) arranged around the periphery of the touch surface (20) to emit beams of light such that an object (60) touching the touch surface (20) causes an attenuation of the light;

a set of light detectors (30b) arranged around the periphery of the touch surface (20) to receive light from the set of emitters (30a) on a plurality of light paths, wherein each light detector (30b) is arranged to receive light from more than one emitter (30a); and

a signal processor (130) configured to:

determine, based on output signals of the light detectors (30b), a light energy value for each light path;

generate a transmission value for each light path based on the light energy value;

operate an image reconstruction algorithm on at least part of the thus-generated transmission values so as to determine;

- a position of the object (60) on the touch surface (20), and

- an attenuation value corresponding to the attenuation of the light resulting from the object (60) touching the touch surface (20),

determine a type of the object (60) in dependence on the attenuation value.

2. The touch sensing apparatus of claim 1, wherein the image reconstruction algorithm is an algorithm for transmission tomography.

3. The touch sensing apparatus of claims 1 or 2, further comprising a light transmissive panel (10) defining the touch surface (20) and an opposite surface, wherein the emitters (30a) are configured to introduce light into the panel for propagation by internal reflection between the touch surface and the opposite surface, and the detectors (30b) are configured to receive the light propagating in the panel.

4. The touch sensing apparatus of claims 1 or 2, wherein the emitters (30a) are configured to transmit the beams of light above the touch surface (20) and the detectors (30b) are configured to receive said beams of light travelling above the touch surface (20).

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5. The touch sensing apparatus of any preceding claim, wherein a determination of an interaction area between an object (60) and touch surface (1) is determined in dependence on the attenuation value.

6. The touch sensing apparatus of claim 4, wherein the beams of light transmitted by the emitters (30a) and received by the detectors (30b) extend no further than 5mm from the touch surface (20).

7. The touch sensing apparatus of any preceding claim, the signal processor (130) further configured to store a plurality of object IDs, each having an associated attenuation value range.

8. The touch sensing apparatus of claim 7, the signal processor (130) further configured to identify an object ID with an attenuation value range corresponding to the attenuation value of the object and associating the object ID with the object.

9. The touch sensing apparatus of claim 8, wherein the identifying step is not performed by the signal processor (130) until the attenuation value is determined to be stable.

10. The touch sensing apparatus of claim 9, wherein the attenuation value is determined to be stable when the rate of change of the attenuation value is below a predefined threshold.

11. The touch sensing apparatus of claim 9, wherein the attenuation value is determined to be stable when the rate of change of the attenuation value is determined to rise above a first threshold and then subsequently drop below a second threshold, wherein the second threshold is lower than the first threshold.

12. The touch sensing apparatus of any preceding claim, the attenuation value is generated in dependence on the attenuation of the light resulting from the object (60) touching the touch surface (20) and a compensation value.

13. The touch sensing apparatus of claim 12, wherein the compensation value is a function of at least the position of the object (60) on the touch surface (20).

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14. The touch sensing apparatus of claim 12, the compensation value being the value at a position on a compensation map corresponding to the position of the object (60) on the touch surface (20).

15. The touch sensing apparatus of claim 12, wherein object (60) has an object axis and wherein the compensation value is a function of at least an angle of the object axis relative to the normal of the touch surface (20).

16. The touch sensing apparatus of claim 15, wherein object (60) has a flat end and wherein the angle of the object axis relative to the normal of the touch surface (20) is determined as a function of the transmission value and geometry of each light path intersecting with object (60).

17. The touch sensing apparatus of claim 15, wherein the angle of the object axis relative to the normal of the touch surface (20) is determined as a function of the ratio between the minimum amount of attenuation and maximum amount of attenuation for the light paths intersecting the stylus

18. The touch sensing apparatus of claim 12, wherein the compensation value is a function of at least the speed of the object (60) across the touch surface (20).

19. The touch sensing apparatus of claim 18, wherein the compensation value is proportional to the speed of the object (60) across the touch surface (20).

20. The touch sensing apparatus of any preceding claim, wherein the object (60) has a distal stylus tip (400) comprising a spherically-shaped portion (410).

21. The touch sensing apparatus according to any of claims 1-19, wherein the object (60) has a distal stylus tip (600) comprising a drop-shape (610, 620) that tapers towards a proximal end (611) of the object, opposite the distal stylus tip, along a longitudinal object axis (612).

22. The touch sensing apparatus of claim 21, wherein the drop-shape comprises an at least partly spherical surface (613),

the at least partly spherical surface comprising

a distal base portion (621) intersecting the longitudinal object axis and having rotational symmetry around the same,

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an annular side (622), arranged proximally of the distal base portion, and defining the maximum circumference of the partly spherical surface around the longitudinal object axis, and having rotational symmetry around the same, whereby the distal base portion has a larger radius of curvature than the annular side, with respect to an imaginary circle lying in a plane being parallel to the longitudinal object axis.

23. The touch sensing apparatus of claim 14, wherein the signal processor is configured to determine the compensation value at a position on the compensation map by interpolation in the x- and y-direction of the compensation map between pre-defined compensation values in the compensation map.

24. The touch sensing apparatus of claim 23, wherein the compensation value is determined for each position in a grid of positions, where the resolution of the compensation map is determined by the pitch of the grid, and wherein the pitch varies as a function of the position in the compensation map.

25. The touch sensing apparatus of claim 12, wherein the compensation value is a function of the depth of the light field (h_{max}).

26. The touch sensing apparatus of claim 25, wherein the signal processor is configured to determine the depth of the light field (h_{max}) based on the output signals.

27. A method of determining a type of object in contact with a touch surface of a touch sensing apparatus, said touch sensing apparatus comprising:

a touch surface (20),

a set of emitters (30a) arranged around the periphery of the touch surface (20) to emit beams of light such that an object (60) touching the touch surface (20) causes an attenuation of the light;

a set of light detectors (30b) arranged around the periphery of the touch surface (20) to receive light from the set of emitters (30a) on a plurality of light paths, wherein each light detector (30b) is arranged to receive light from more than one emitter (30a); and

said method comprising the steps of:

determining, based on output signals of the light detectors (30b), a light energy value for each light path;

generating a transmission value for each light path based on the light energy value;

operating an image reconstruction algorithm on at least part of the thus-generated transmission values so as to determine;

- a position of the object (60) on the touch surface (20), and

- an attenuation value corresponding to the attenuation of the light resulting from the object (60) touching the touch surface (20),

determining a type of the object (60) in dependence on the attenuation value.

DRAWINGS

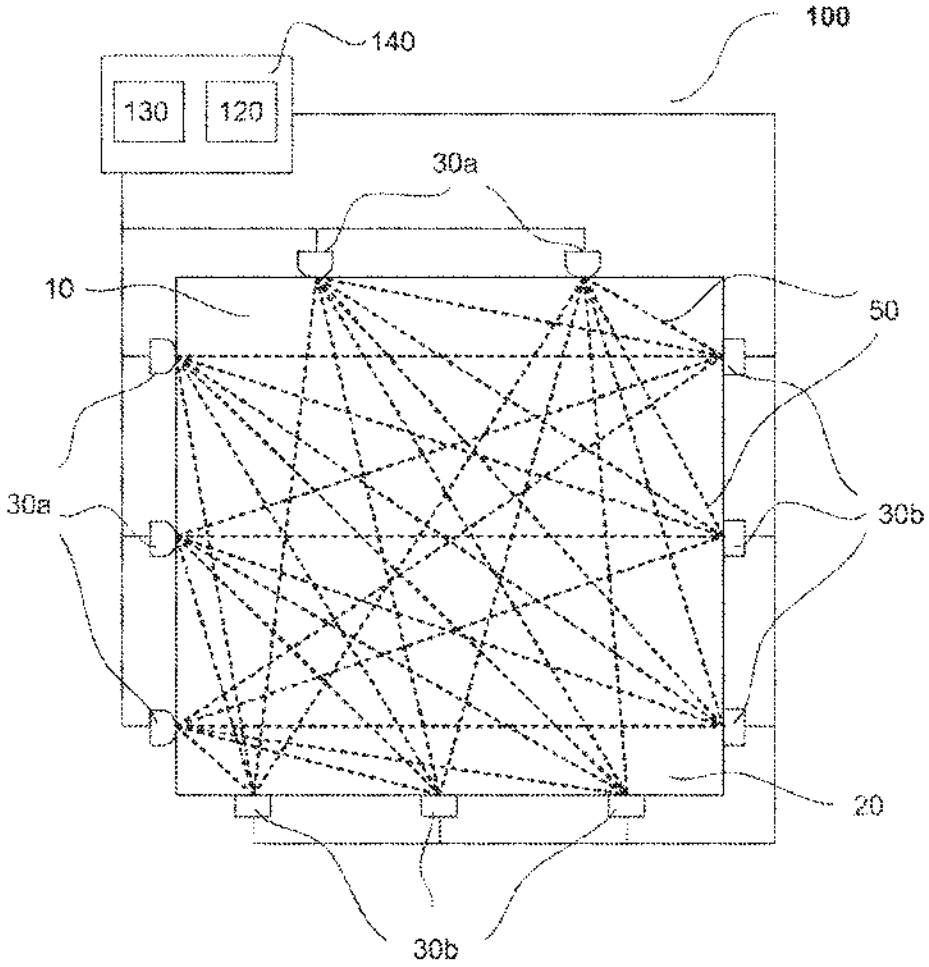


Figure 1

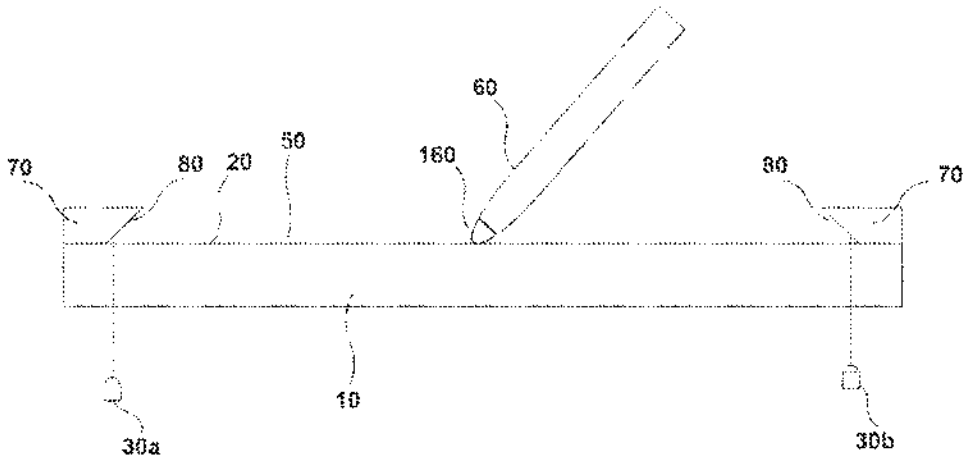


Figure 2

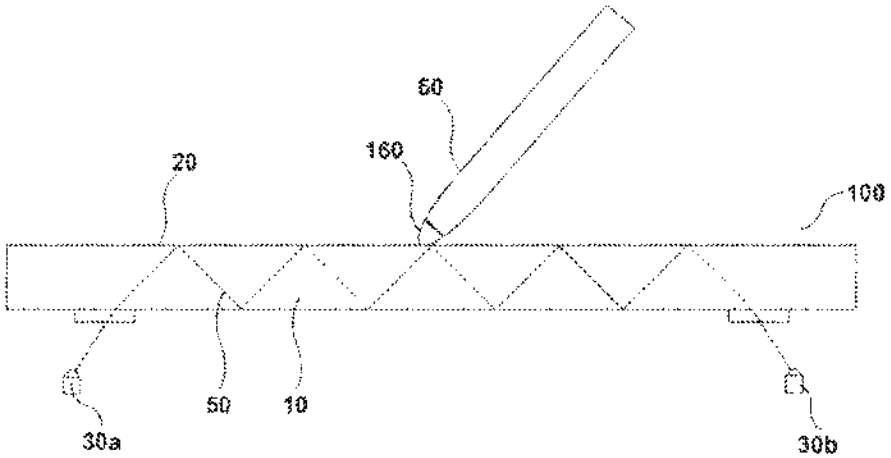


Figure 3

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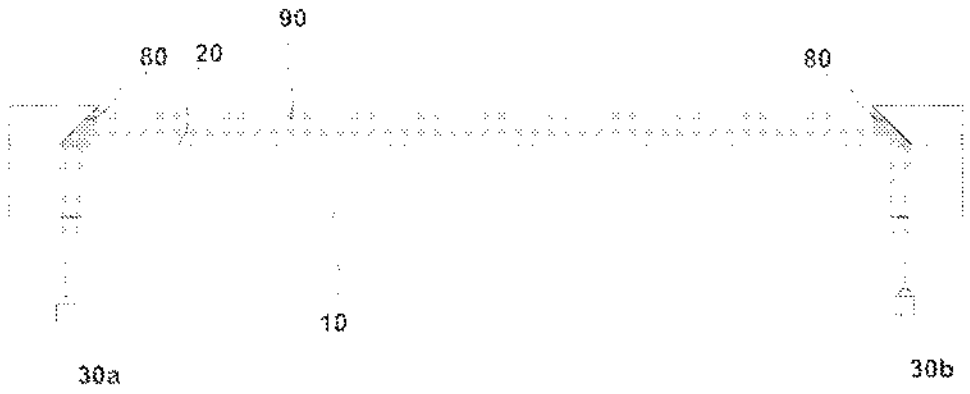


Figure 4

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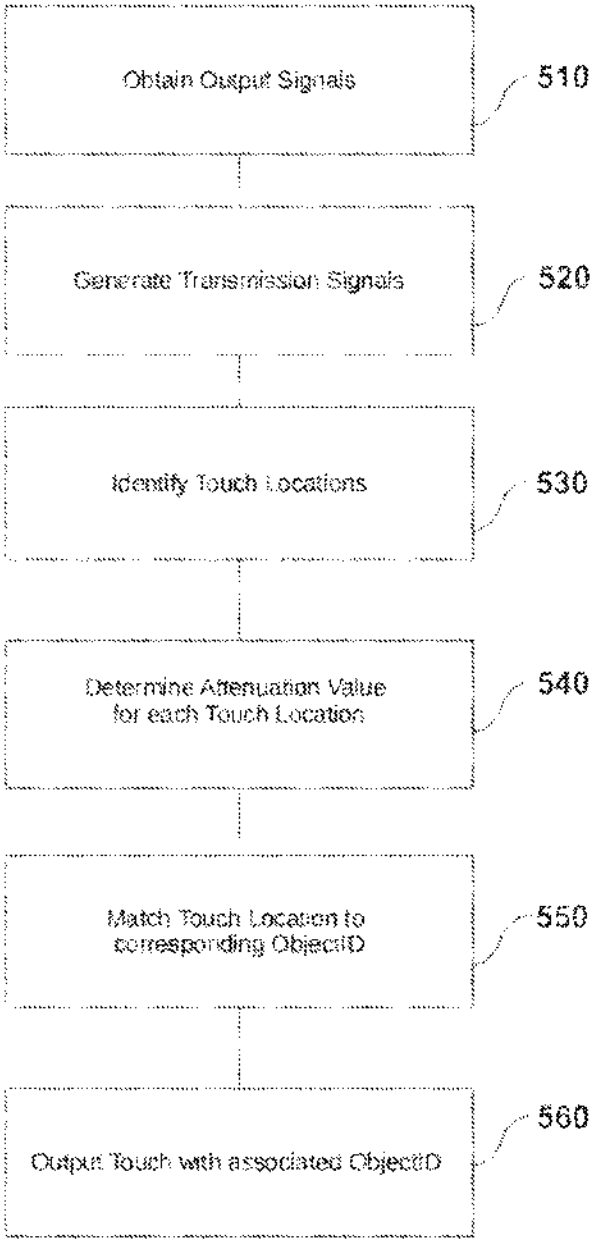

Obtain Output Signals
510
Generate Transmission Signals
520
Identify Touch Locations
530
Determine Attenuation Value for each Touch Location
540
Match Touch Location to corresponding ObjectID
550
Output Touch with associated ObjectID
560

Figure 5

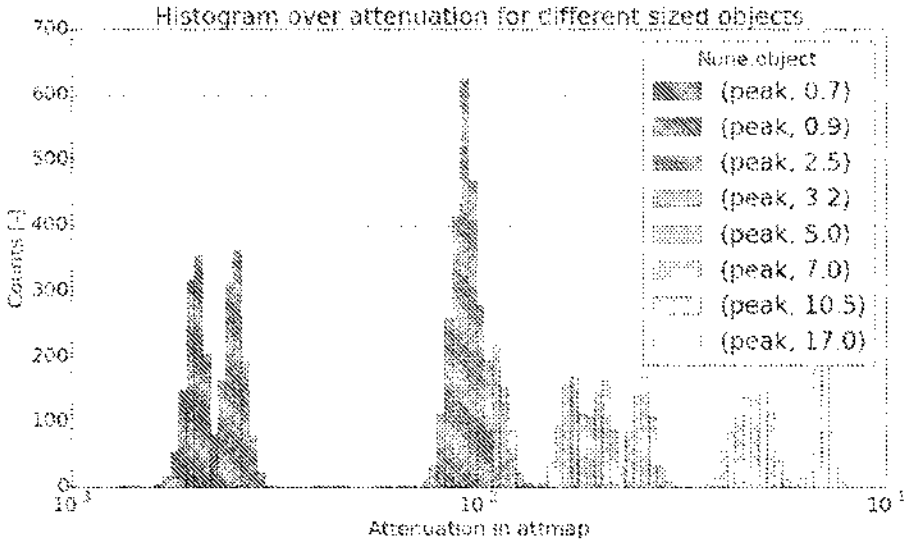


Figure 6

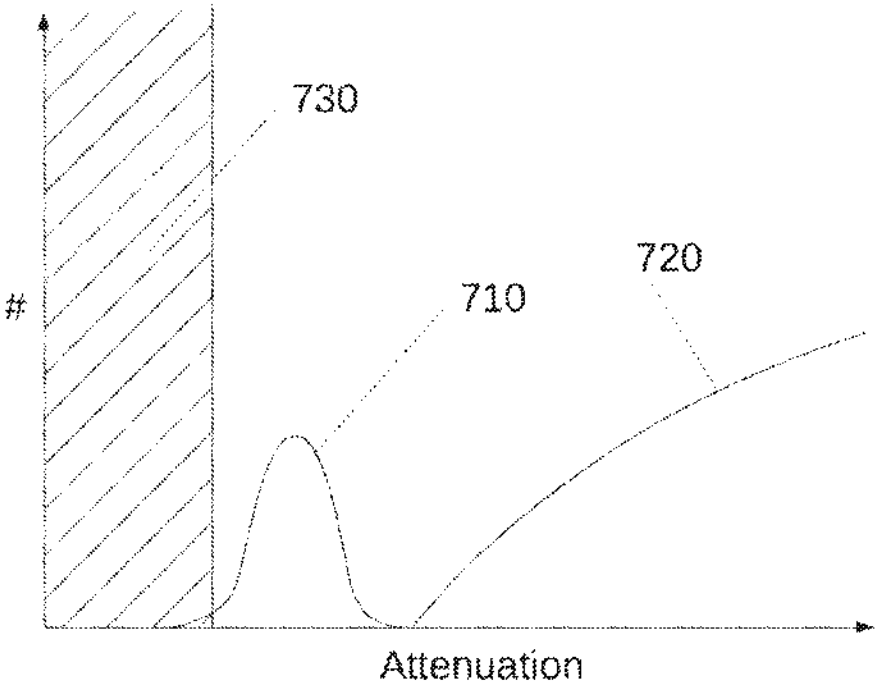


Figure 7

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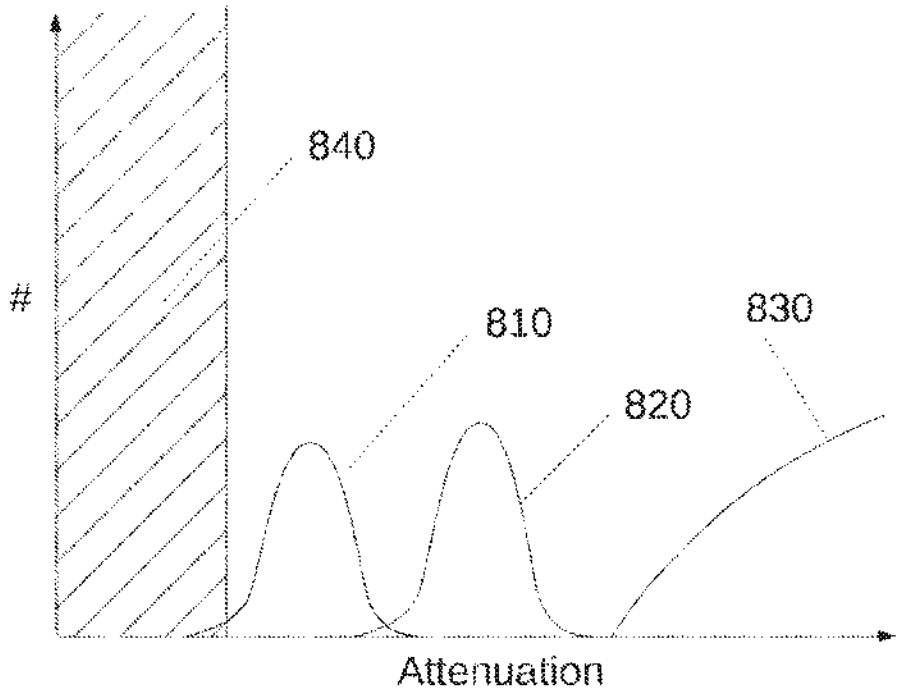


Figure 8

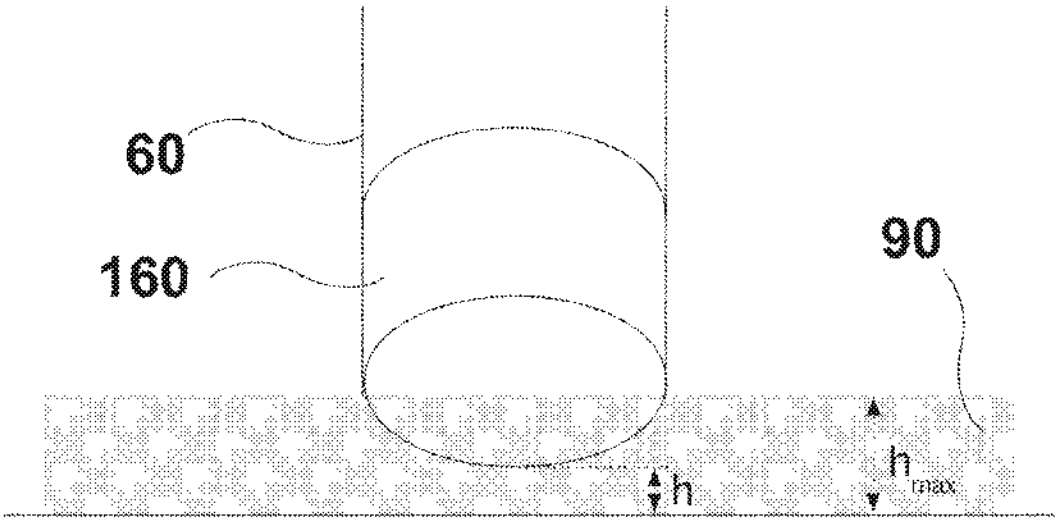


Figure 9

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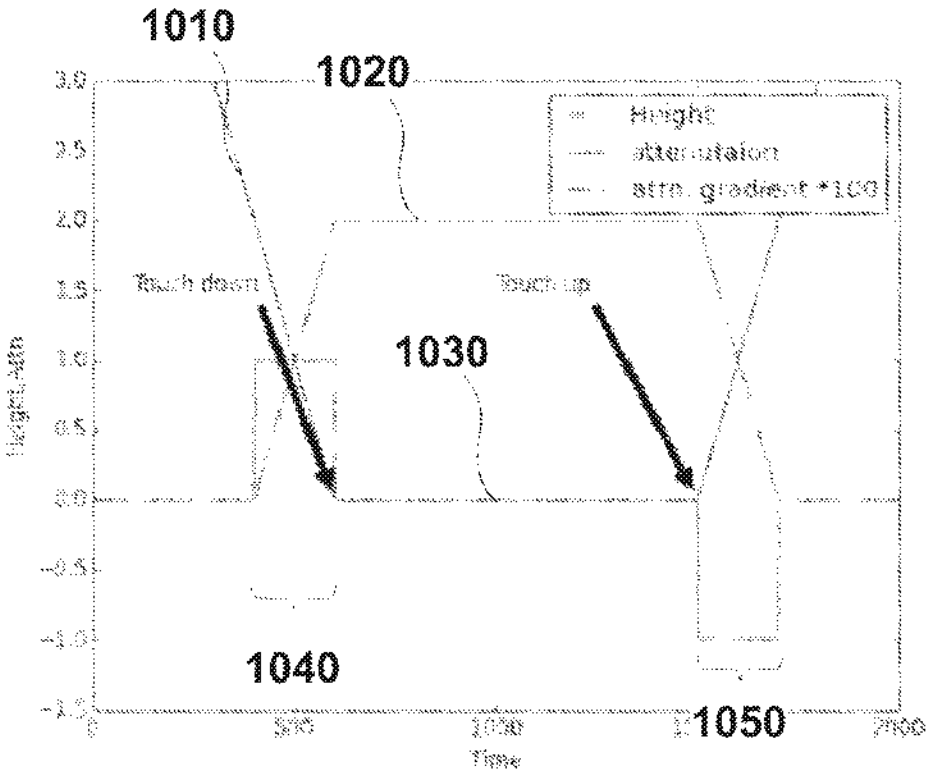


Figure 10

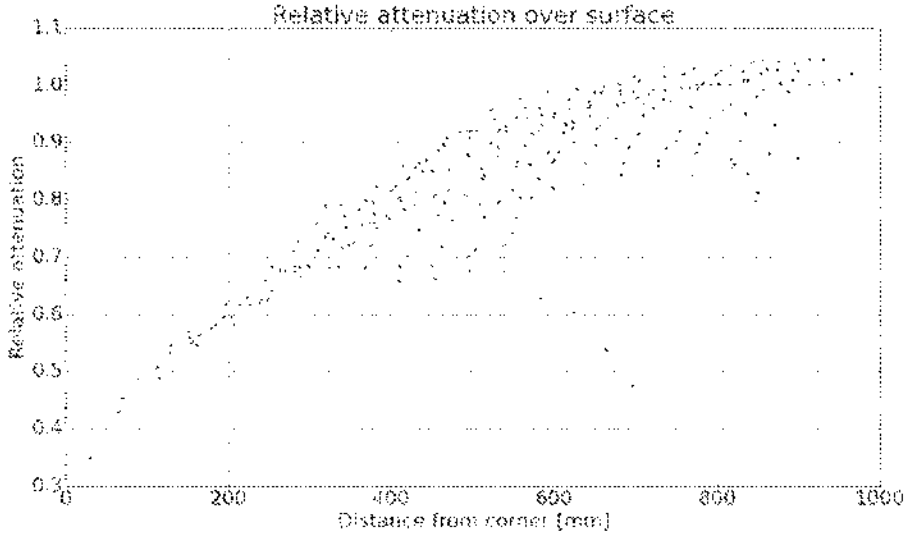


Figure 11

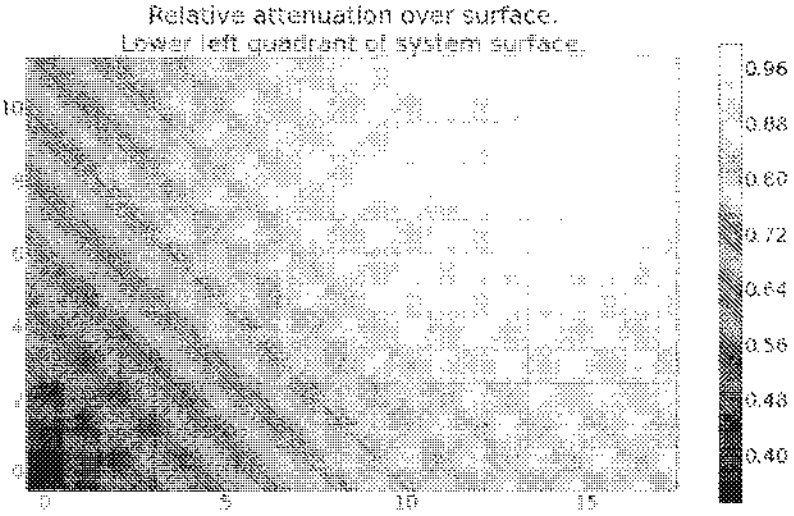


Figure 12

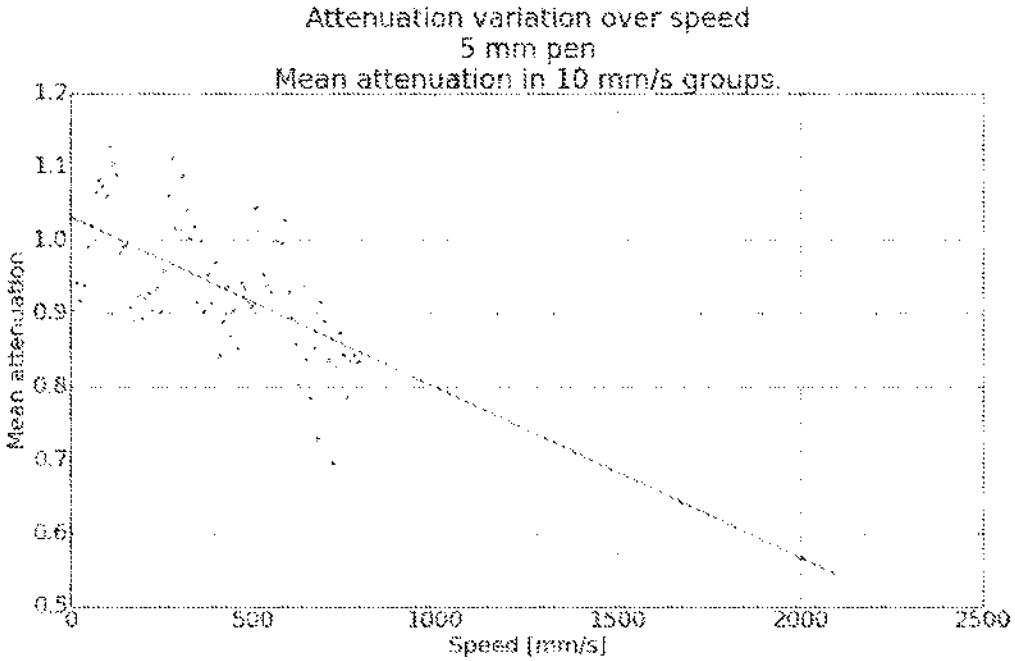


Figure 13

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DEF_00004514

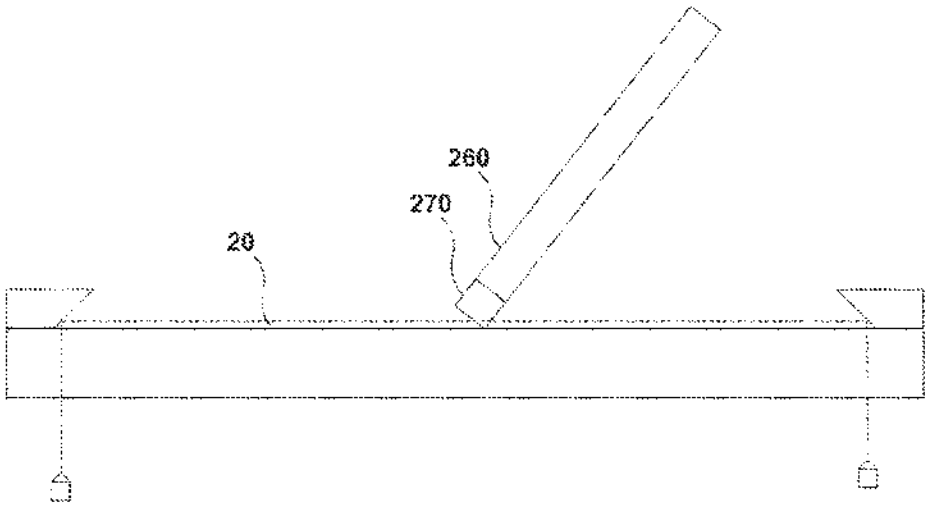


Figure 14

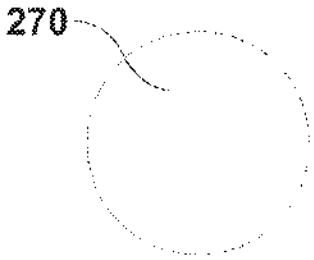


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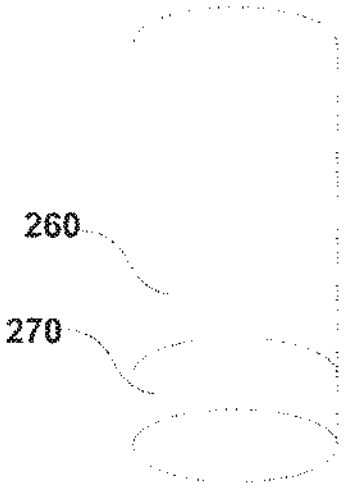


Figure 16

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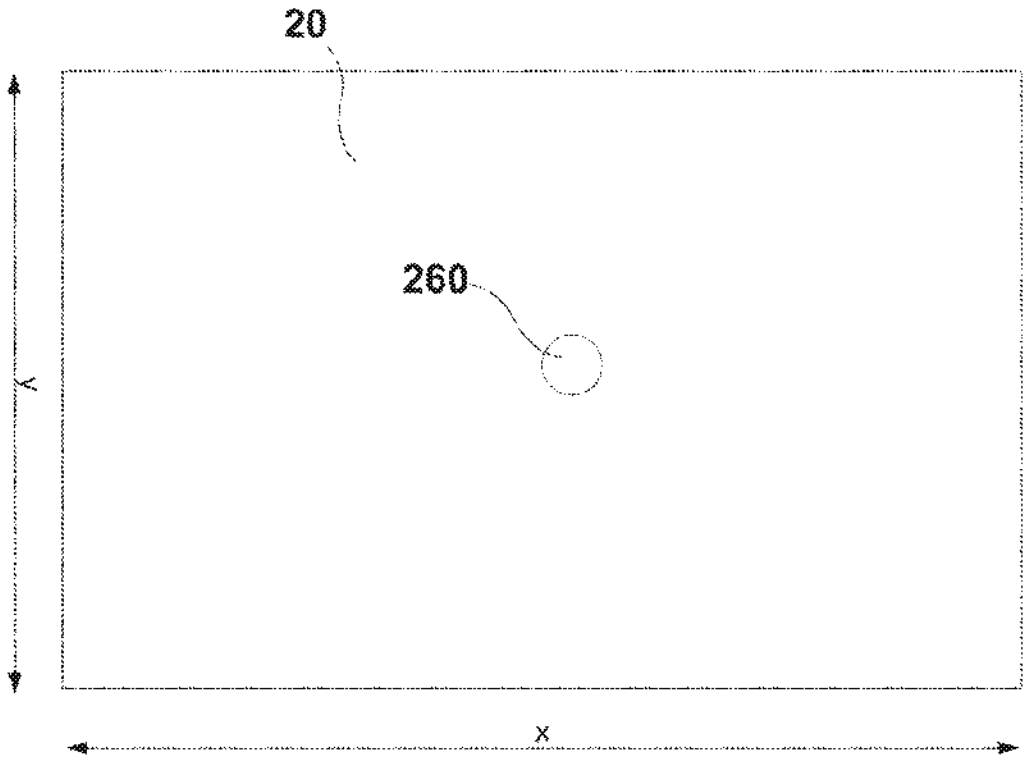


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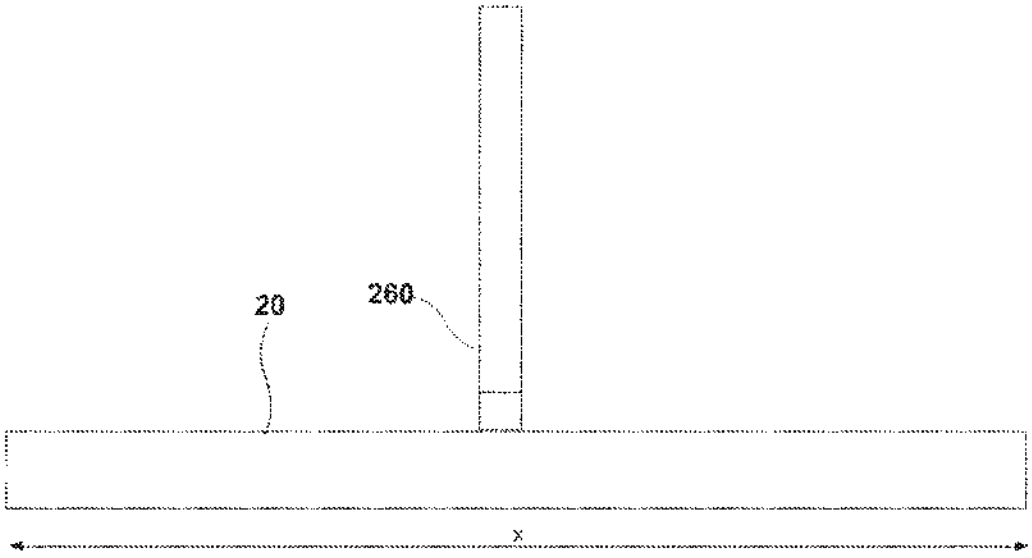


Figure 18

Chemtronics v. FlatFrog
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DEF_00004516

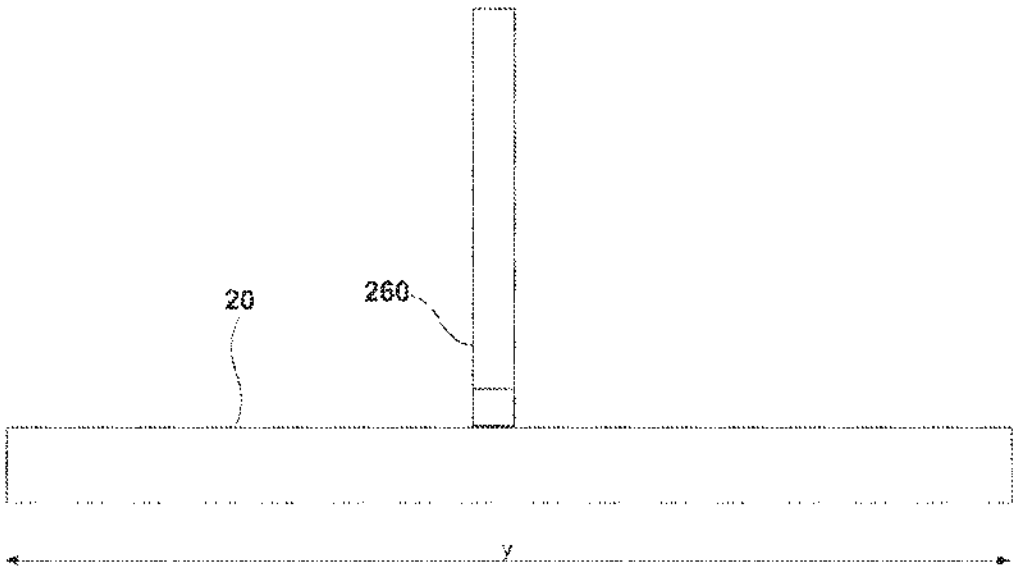


Figure 19

Chemtronics v. FlatFrog
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DEF_00004517

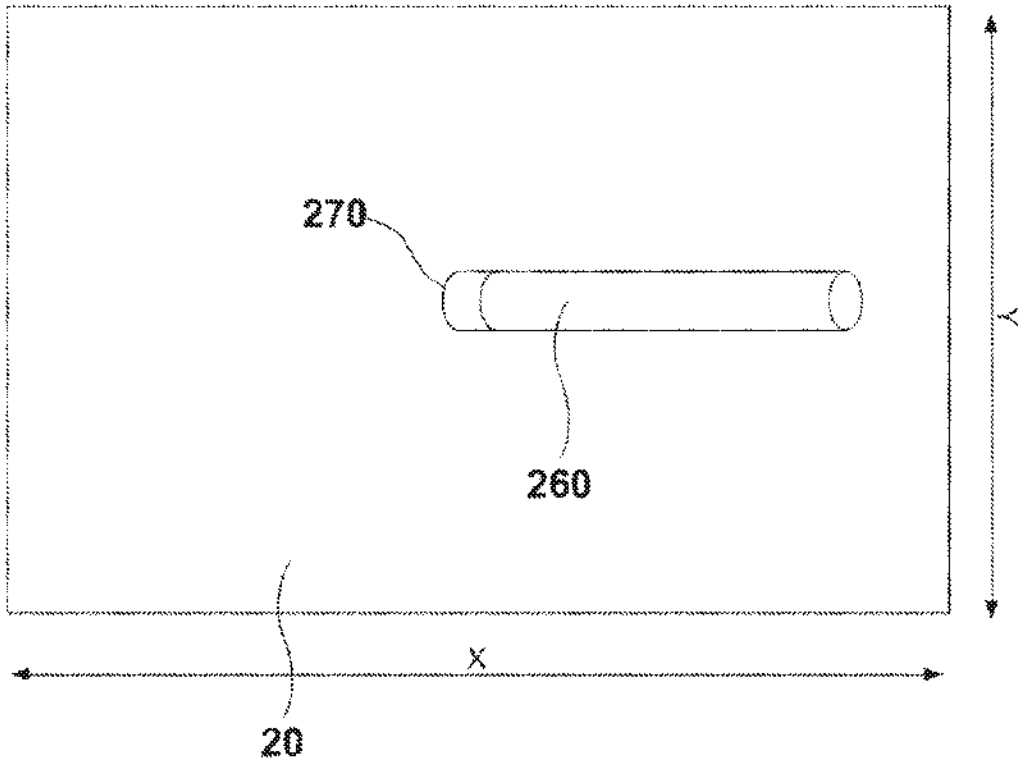


Figure 20

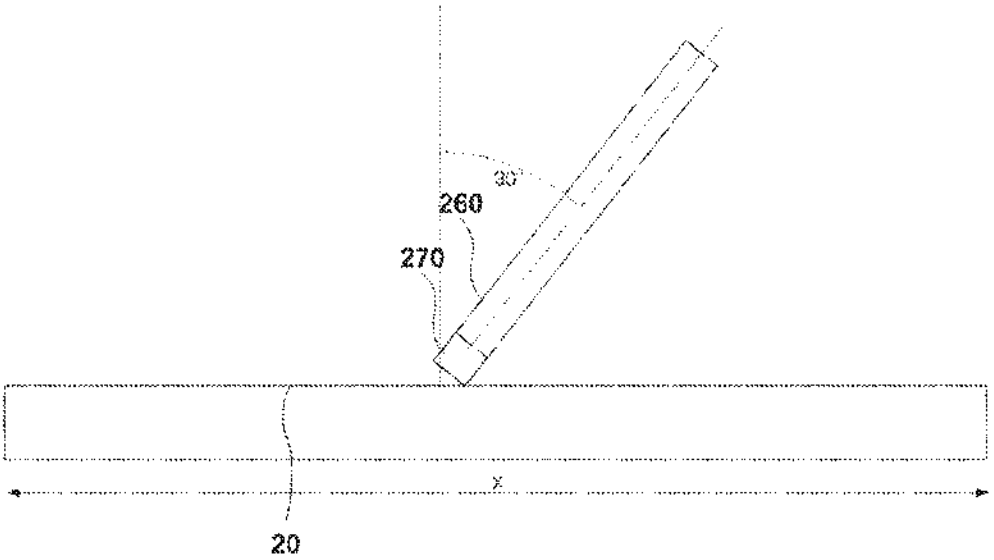


Figure 21

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Chemtronics Exhibit 1002 Page 458
DEF_00004518

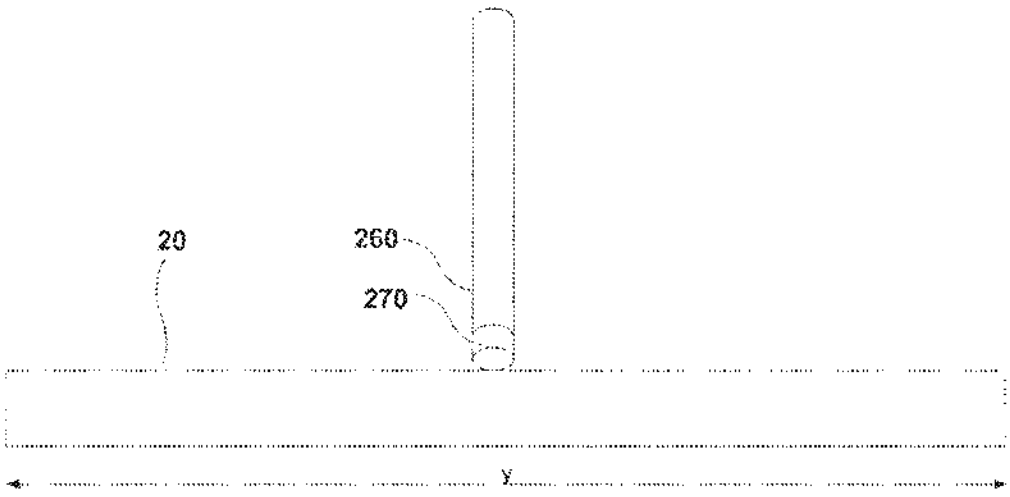


Figure 22

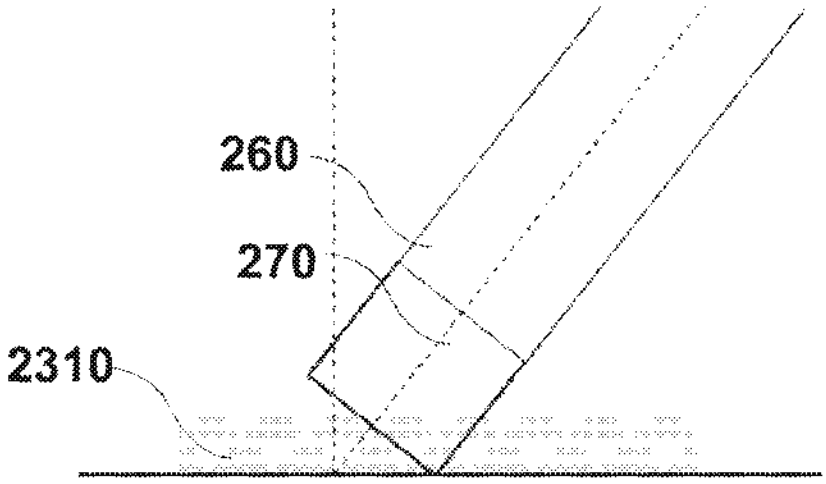


Figure 23

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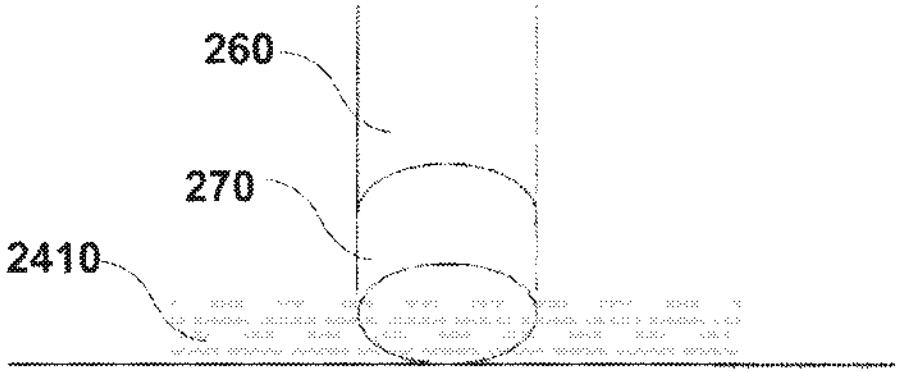


Figure 24

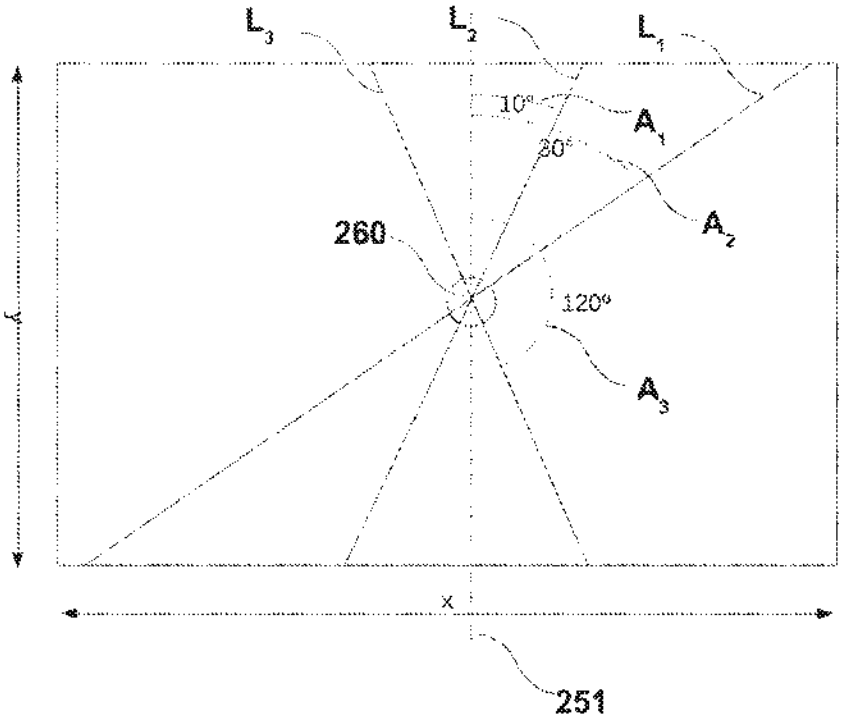


Figure 25

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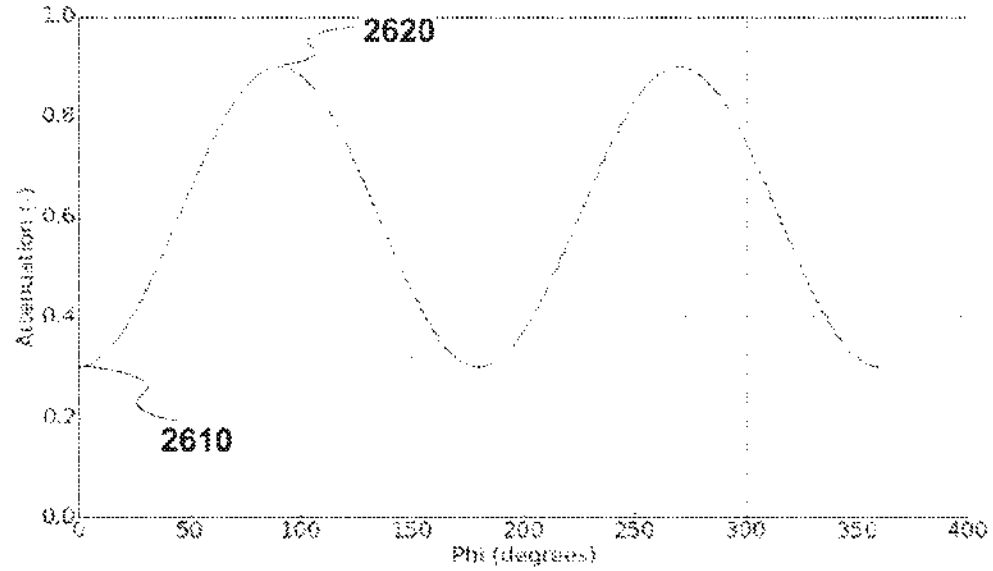


Figure 26

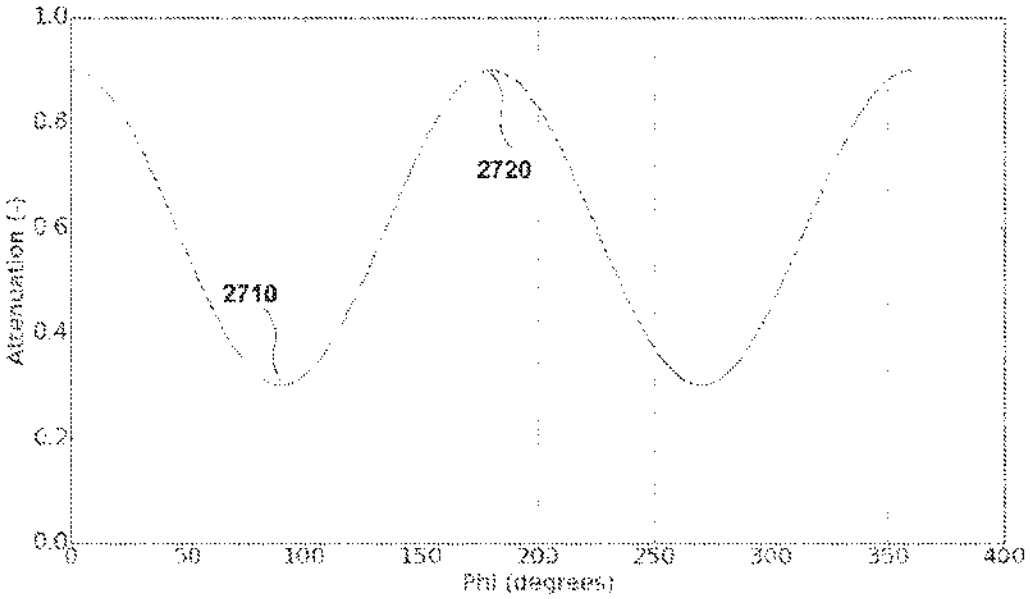


Figure 27

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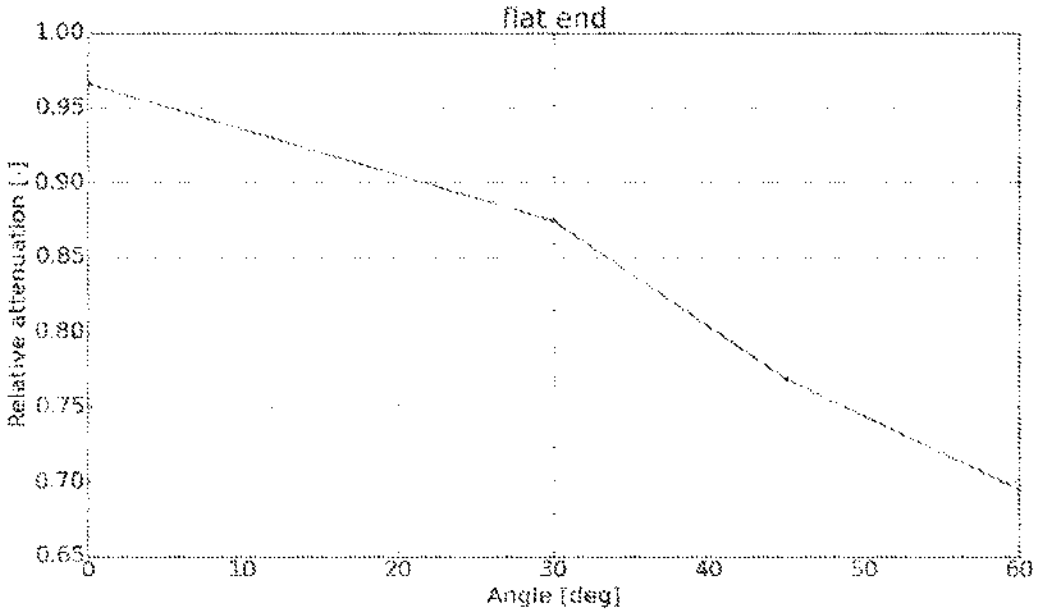


Figure 28

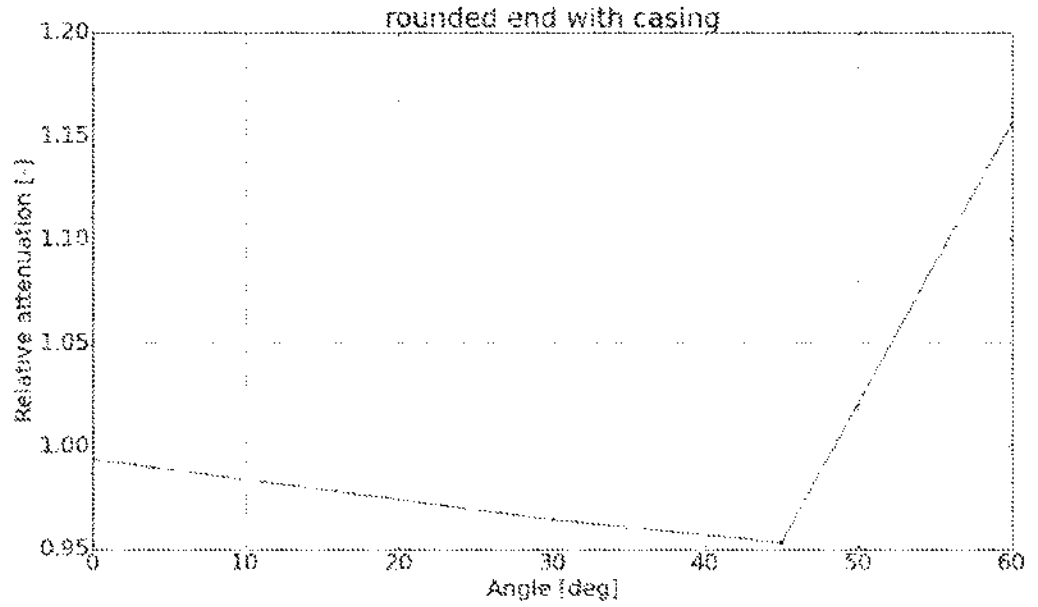


Figure 29

Chemtronics v. FlatFrog
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DEF_00004522

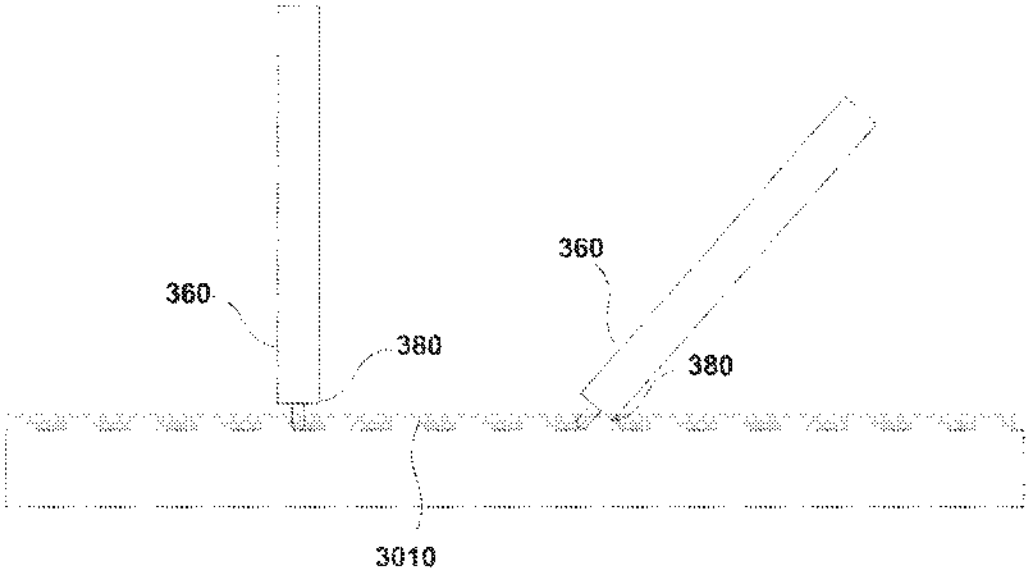


Figure 30

Chemtronics v. FlatFrog
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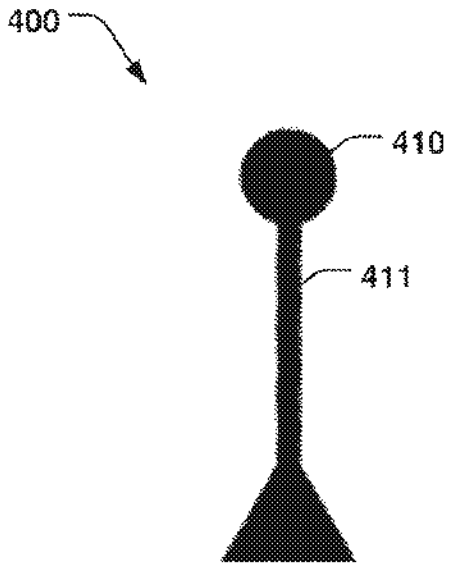


Figure 31a

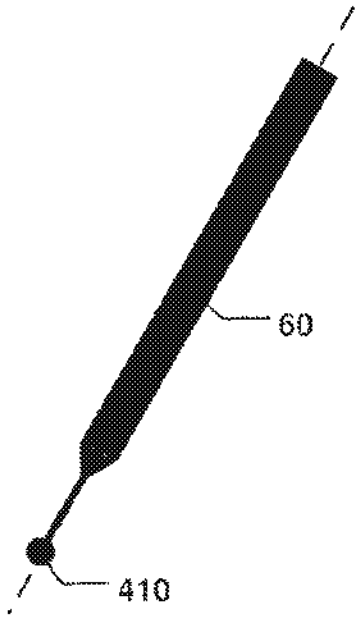


Figure 31b

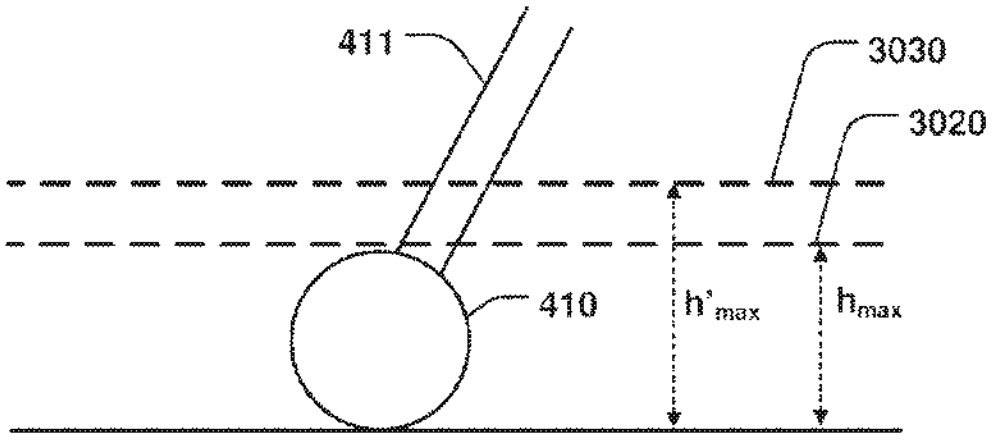


Figure 31c

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DEF_00004524

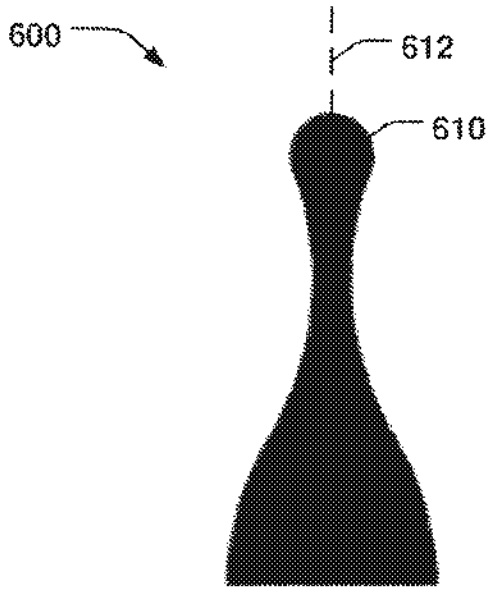


Figure 32a

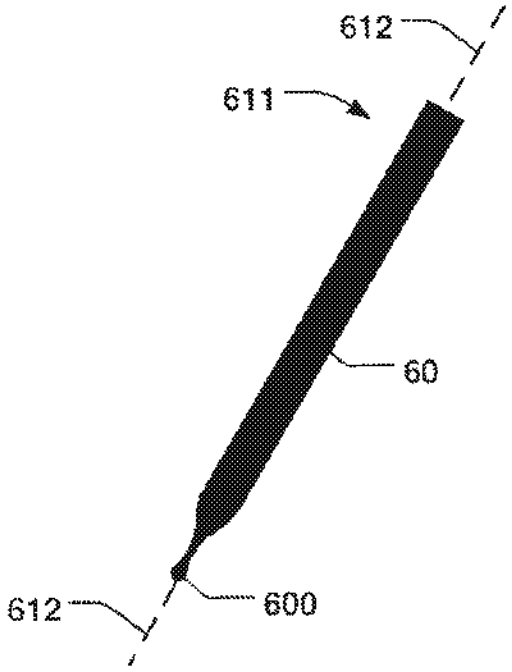


Figure 32b

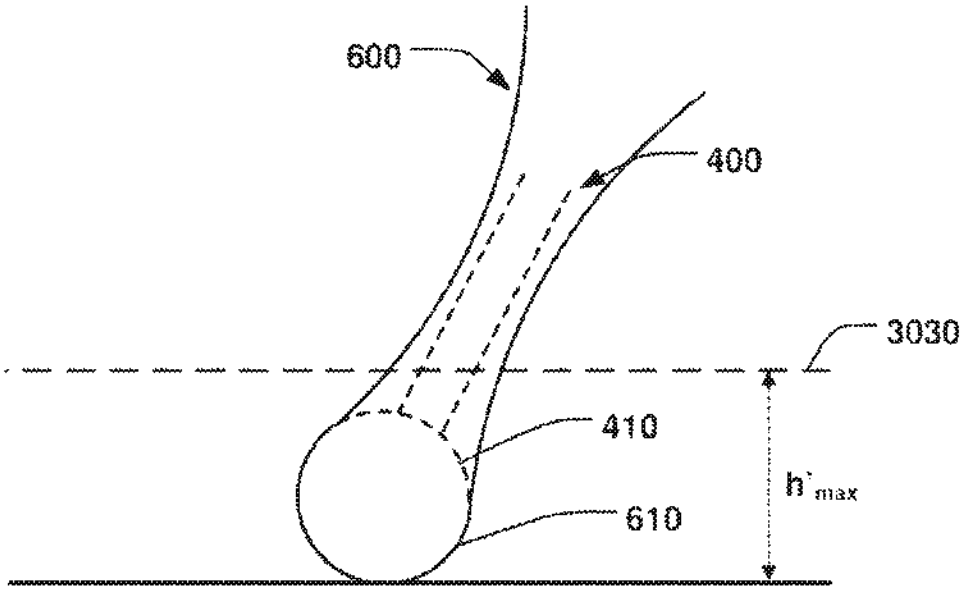


Figure 32c

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DEF_00004525

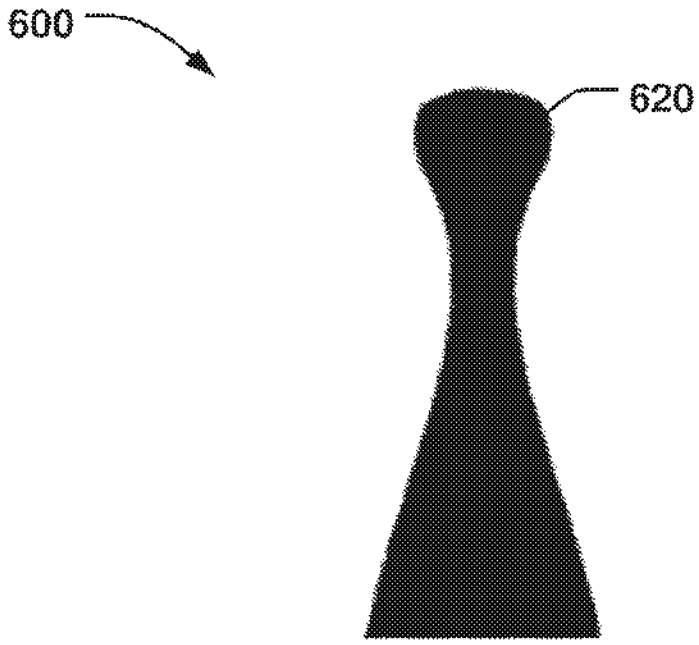


Figure 33a

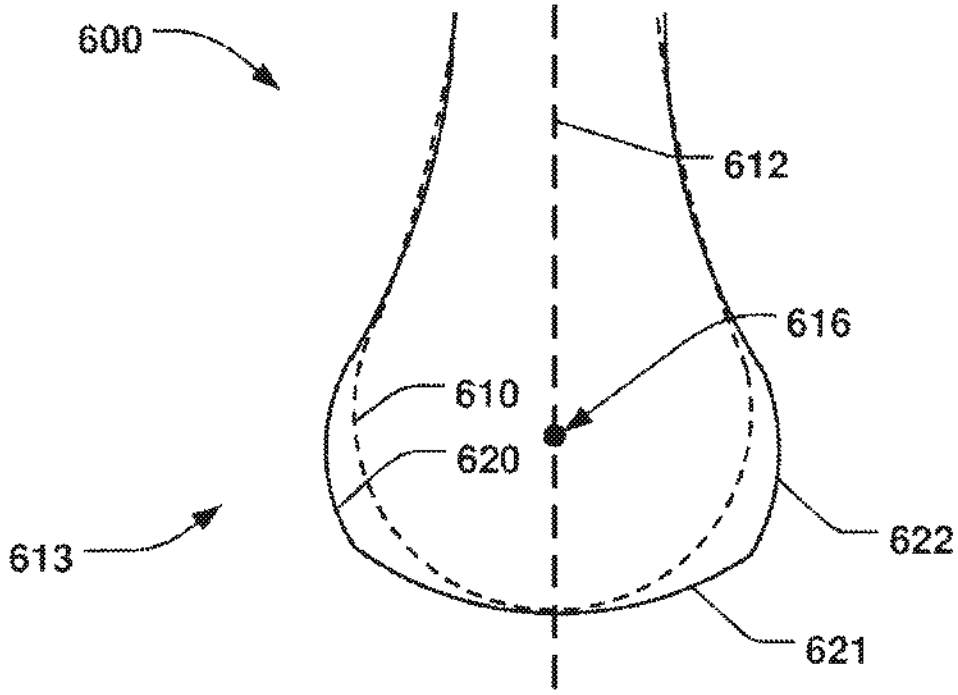


Figure 33b

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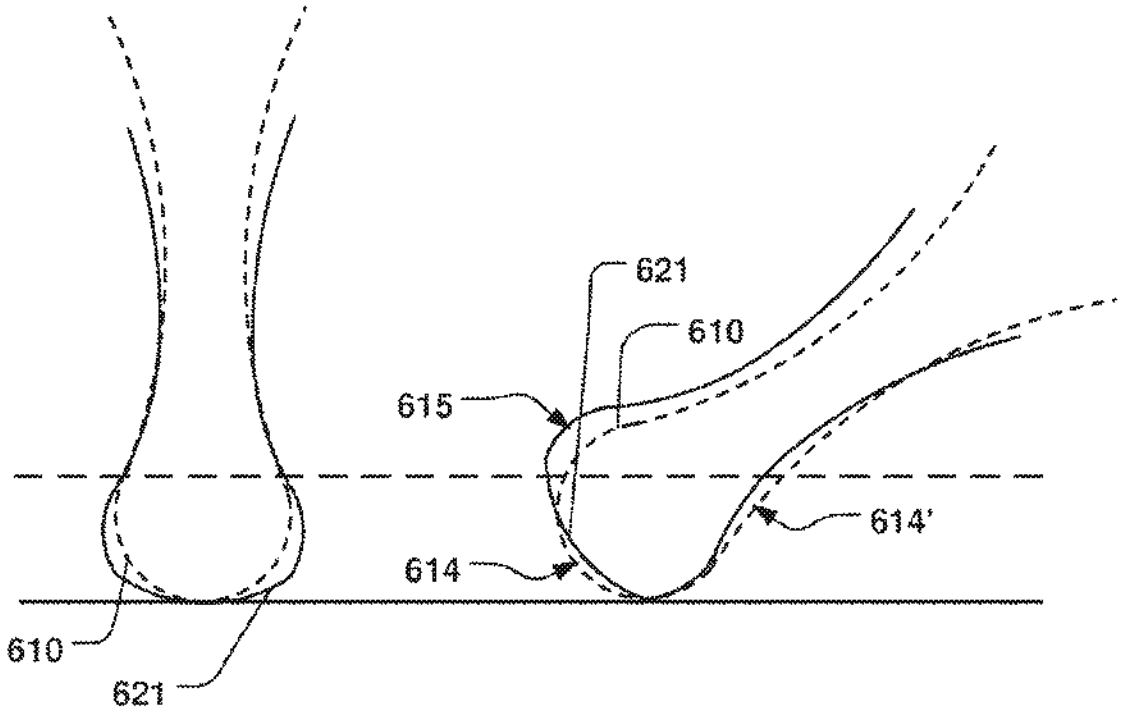


Figure 34

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DEF_00004527

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/051229

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010064983 A2 (FLATFROG LAB AB ET AL), 10 June 2010 (2010-06-10); abstract; page 2, line 35 - page 3, line 12; page 5, line 9 - page 5, line 17; page 16, line 11 - page 16, line 34; page 25, line 7 - page 25, line 19; page 26, line 26 - page 26, line 29; figures 1,8	1-6, 20-22, 27
Y	--	7-19, 23-26
Y	US 20150261375 A1 (LEIGH DARREN ET AL), 17 September 2015 (2015-09-17); abstract; paragraphs [0002], [0084]-[0085], [0258]-[0265]	7-19, 23-26
	--	

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier application or patent but published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
09-03-2017	10-03-2017

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Cao Cao Telephone No. + 46 8 782 28 00

Form PCT/ISA/210 (second sheet) (January 2015)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20130141397 A1 (DUNAGAN KELLY ALLAN), 6 June 2013 (2013-06-06); abstract; paragraphs [0030]-[0031]; claim 12	20-22
P, X	US 20160098152 A1 (DRUMM OWEN ET AL), 7 April 2016 (2016-04-07); abstract; paragraphs [0010]-[0012], [0140]-[0144], [0164], [0175]-[0176]	1-27
A	US 20110210946 A1 (GOERTZ MAGNUS ET AL), 1 September 2011 (2011-09-01); abstract; paragraphs [0210], [0346]-[0348], [0351]	1-27
A	US 20120146957 A1 (DUNAGAN KELLY ALLAN), 14 June 2012 (2012-06-14), abstract; paragraphs [0026]-[0029]; figures 5,6	20-22

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Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/042 (2006.01)
G06F 3/03 (2006.01)
G06F 3/033 (2013.01)
G06F 3/041 (2006.01)

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INFORMATION DISCLOSURE STATEMENT

First Inventor: Daniel Skagmo	**Conf. No.:** 8380
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Examiner: Giesy, Adam	**Art Unit:** 2694
Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Copies of any listed foreign and non-patent literature references are being submitted.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Notification of Related Litigation Filing

Submitted herewith in the above-identified application is an Information Disclosure Statement listing references for consideration. These references are being submitted pursuant to MPEP § 2001.06(c) in that U.S. Patent Nos. 10,282,035, 10,606,414, and 10,606,416, are currently or have been involved in litigation, namely, *FLATFROG LABORATORIES AB vs. PROMETHEAN LTD. AND PROMETHEAN INC.*, (C.A. No. 19-2246-MN). One or more of these patents may be related, or claimed as part of the priority claim of the present application, or may claim a priority benefit of applications and patents that are part of the present application's claim for priority under 35 U.S.C. § 120.

To the best of the undersigned's understanding, the references submitted herewith represent documents or document portions that are non-confidential as defined by any protective order governing information exchanged between the parties to the litigation mentioned above.

Timing of Disclosure

This Information Disclosure Statement is being filed after receipt of a First Office Action, but before the mailing date of a Final Action and before the mailing date of a Notice of Allowance.

This Statement is accompanied by the fees set forth in 37 CFR 1.17(p). The Commissioner is hereby authorized to charge any additional fees which may be required or to credit any overpayment to Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

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JEX-01

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(12) **United States Patent**
Kocovski et al.

(10) **Patent No.: US 10,775,935 B2**
(45) **Date of Patent: Sep. 15, 2020**

(54) **TOUCH DEVICE**

(71) Applicant: **FlatFrog Laboratories AB**, Lund (SE)

(72) Inventors: **Aleksander Kocovski**, Malmo (SE); **Hakan Bergstrom**, Torna-Hallestad (SE); **Jens Thorvinger**, Lund (SE)

(73) Assignee: **FlatFrog Laboratories AB**, Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(58) **Field of Classification Search**
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See application file for complete search history.

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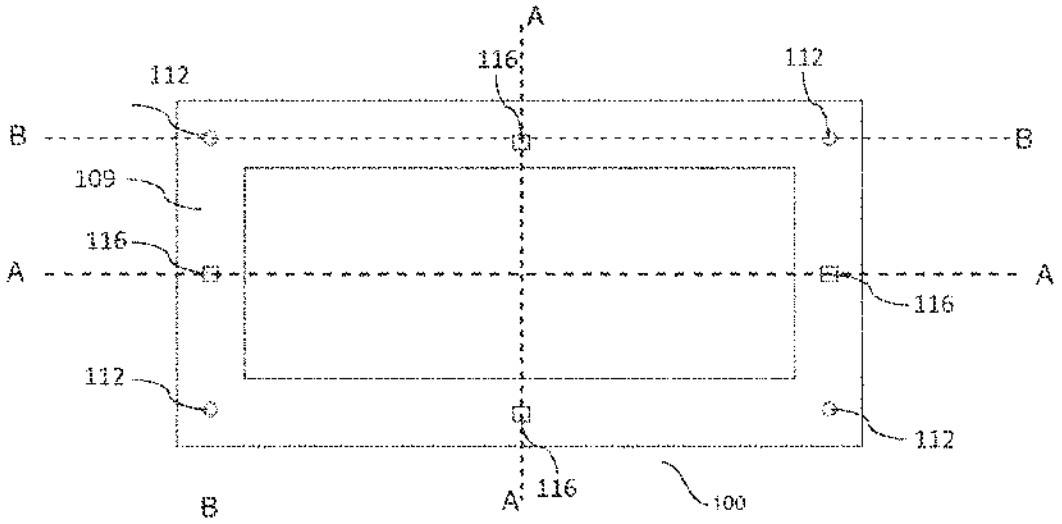
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(57) **ABSTRACT**

An assembly for holding and controlling curvature of a glass plate for an optical touch sensitive system is described. The assembly comprising a first frame element extending in a first plane and configured to extend at least partially around a panel; at least one second frame element extending in a second plane and forming a support portion for the plate; and at least one spacing element positioned at least partially between the support portion and the first frame element. The spacing element us configured to control a curvature of the first frame element and wherein the at least one second frame element is configured to engage the plate at the support portion, is attached to the first frame element, and is tiltable, by controlling the curvature of the first frame element with said spacing element, to control a curvature of the plate

14 Claims, 54 Drawing Sheets



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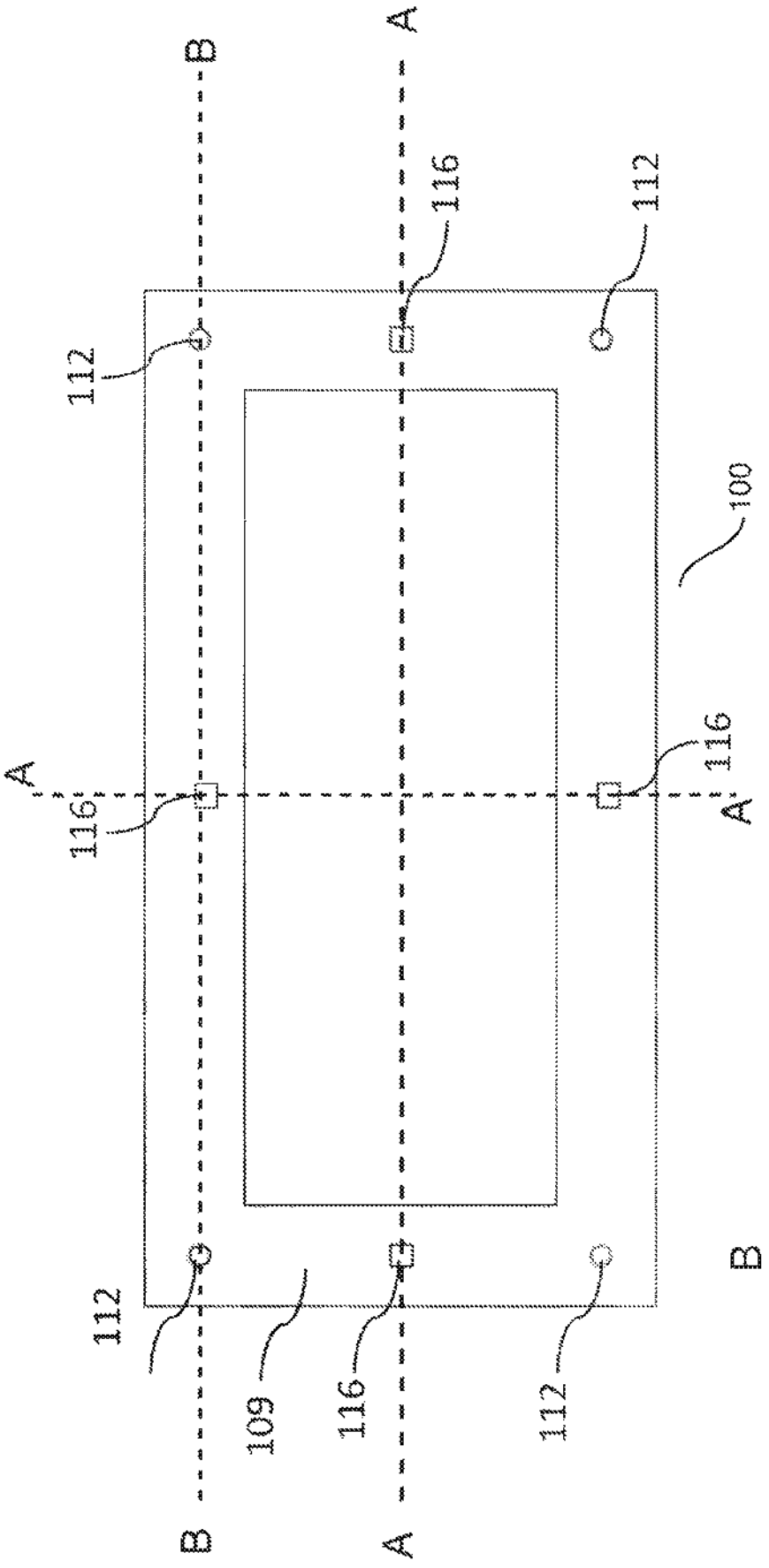


Figure 1

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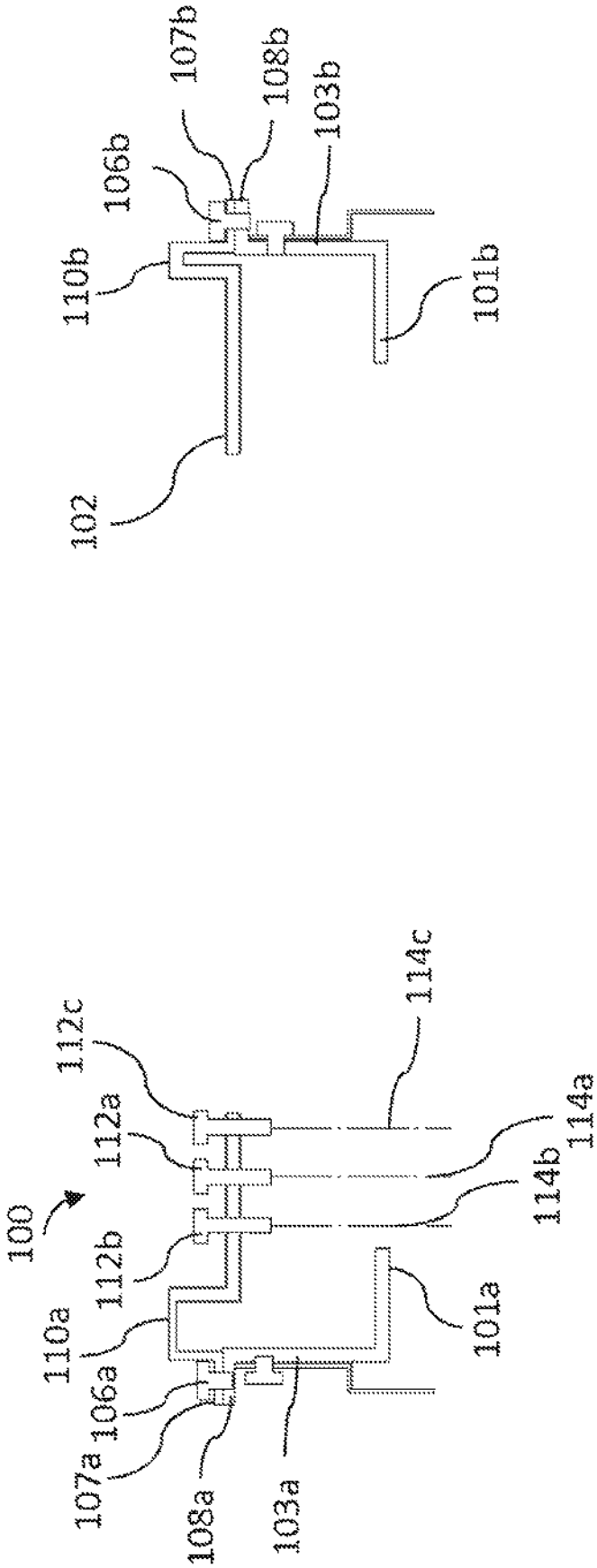

100
101a
101b
102
103a
103b
106a
106b
107a
107b
108a
108b
110a
110b
112a
112b
112c
114a
114b
114c

Figure 2a

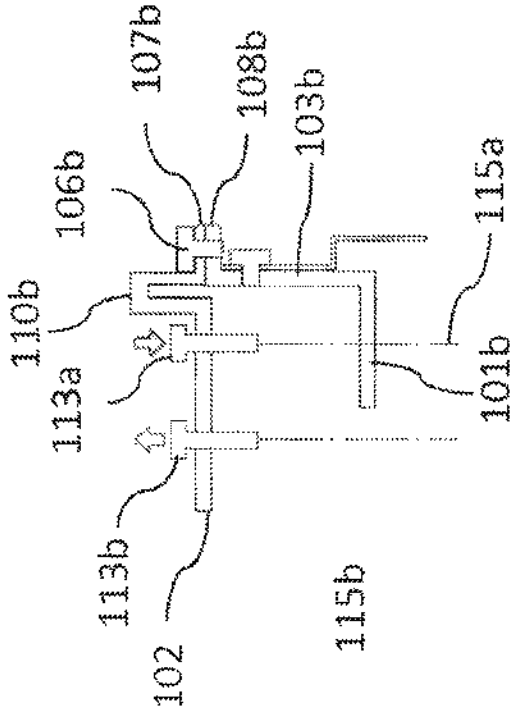
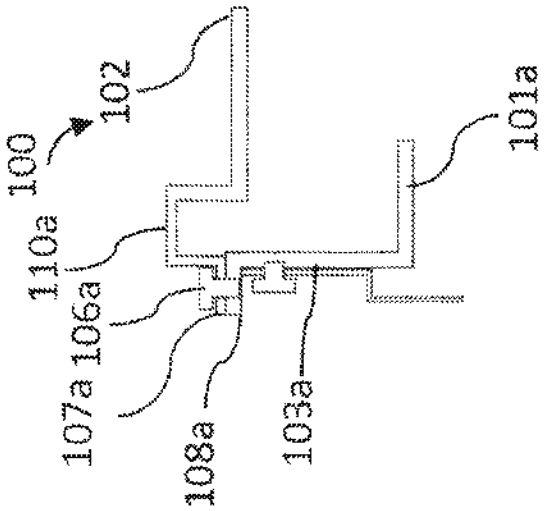

107b
108b
103b
106b
115a
110b
113a
101b
113b
102
115b

Figure 2b


102
100
101a
110a
106a
107a
108a
103a

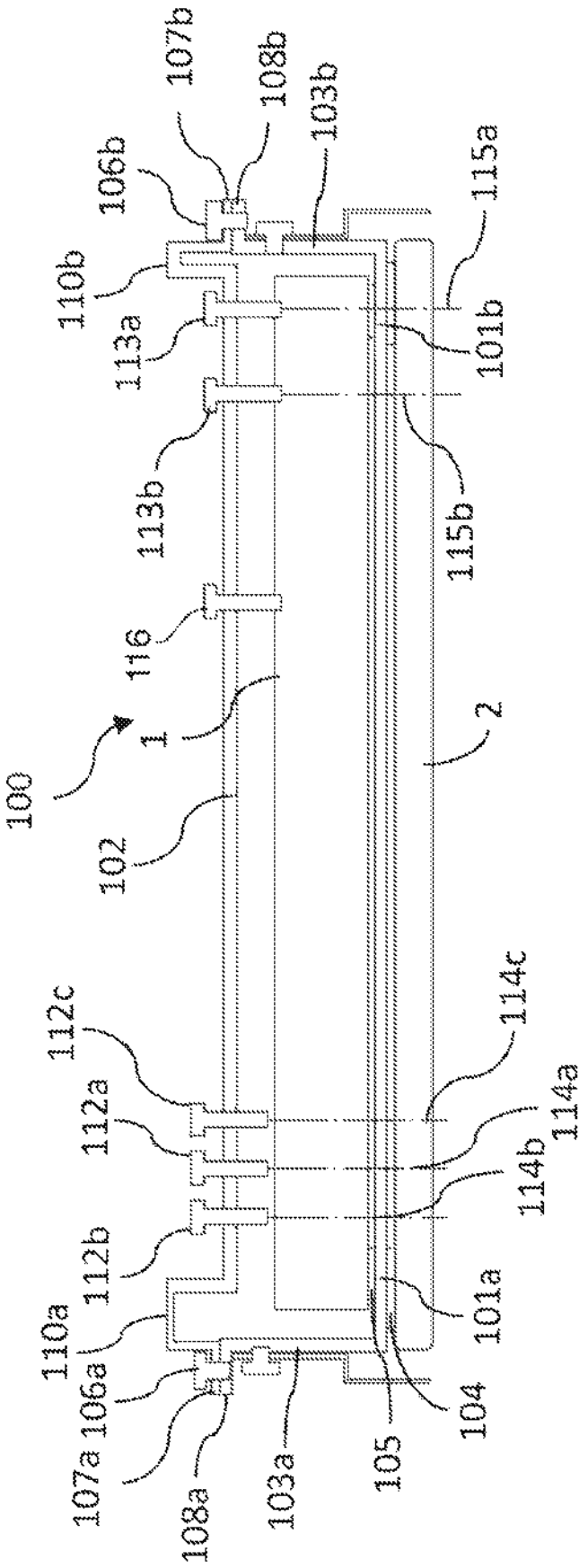


Figure 2c

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 485

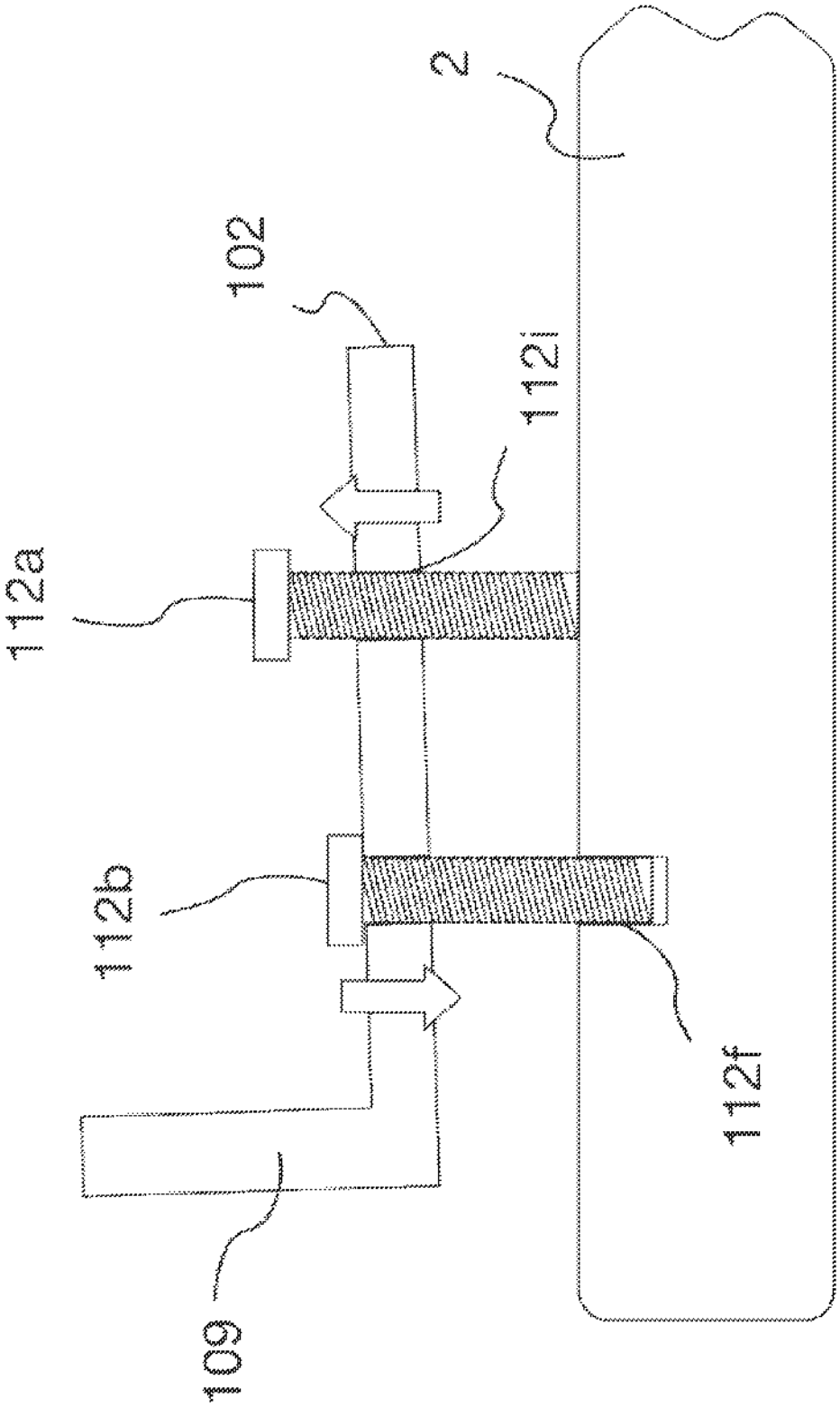


Figure 2d

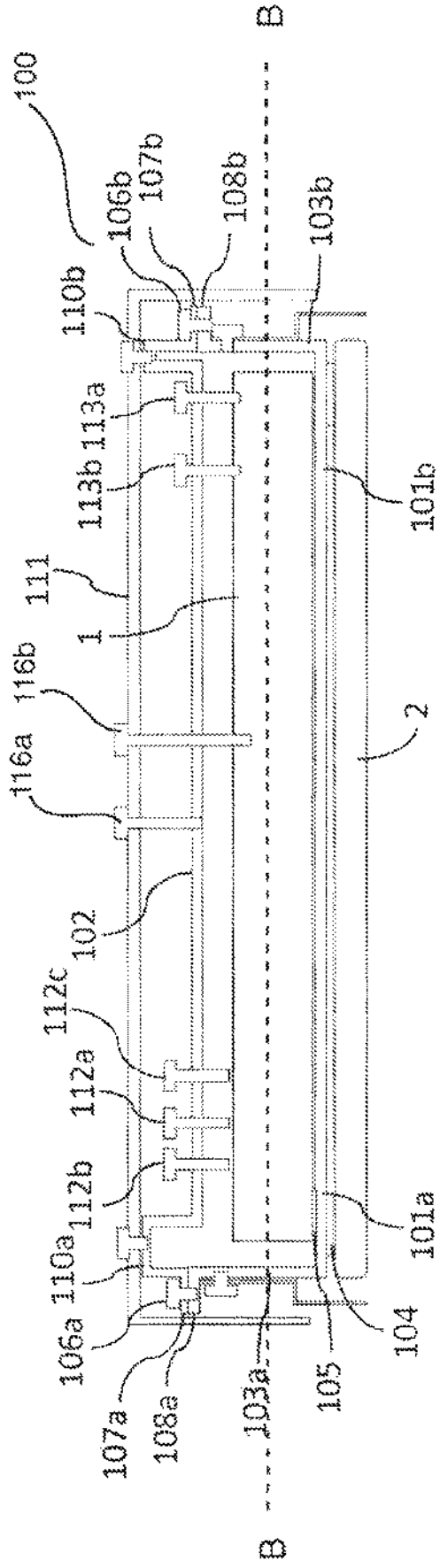


Figure 3a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 487

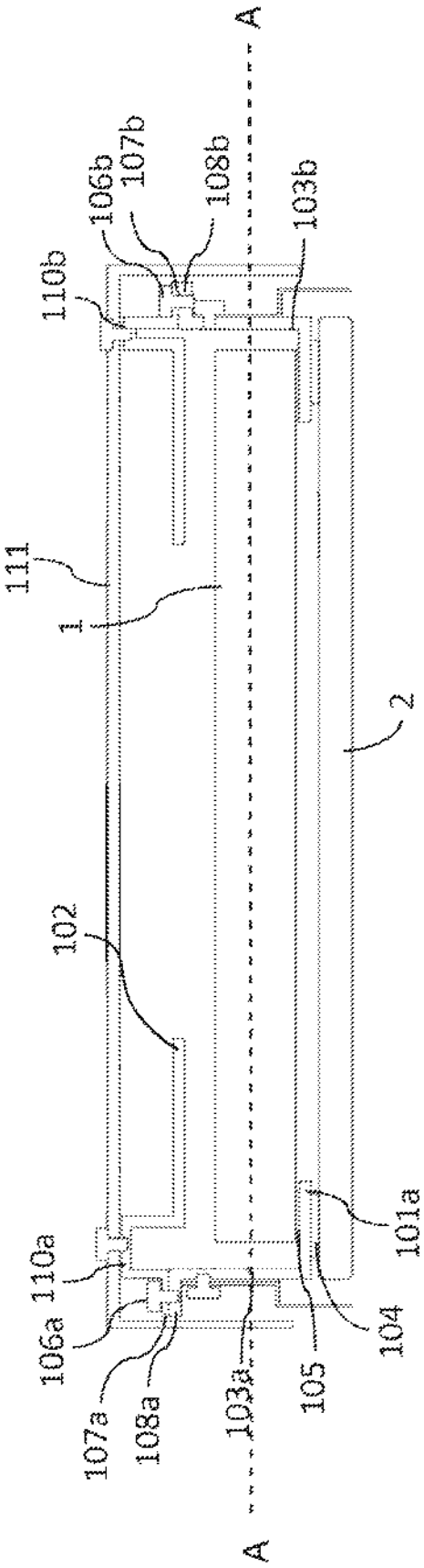


Figure 3b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 488

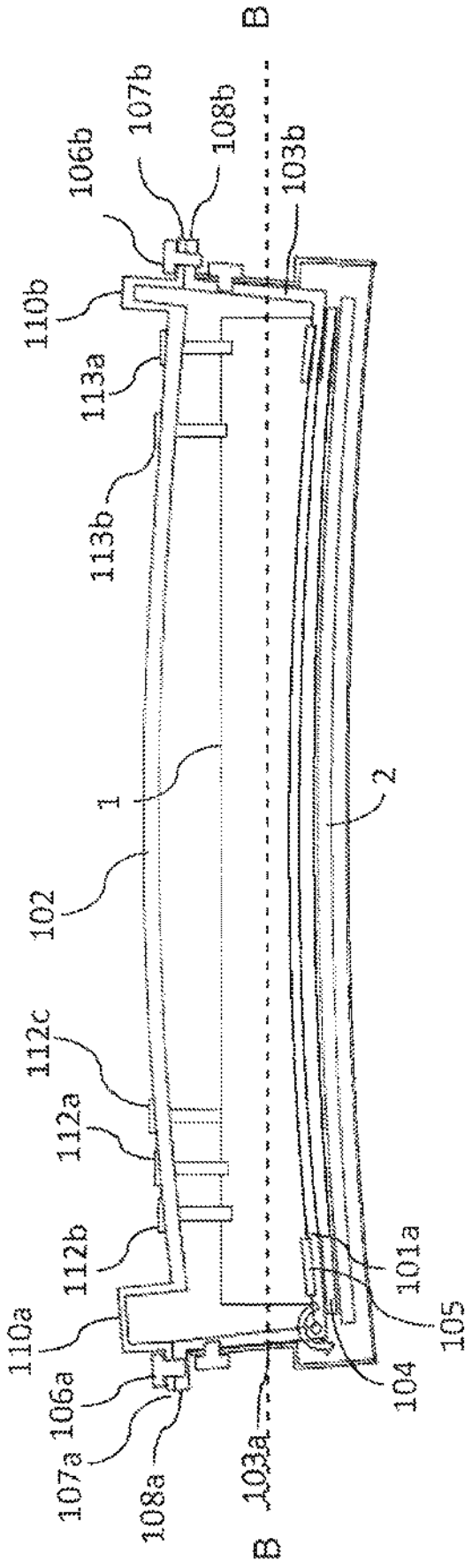


Figure 3c

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 489

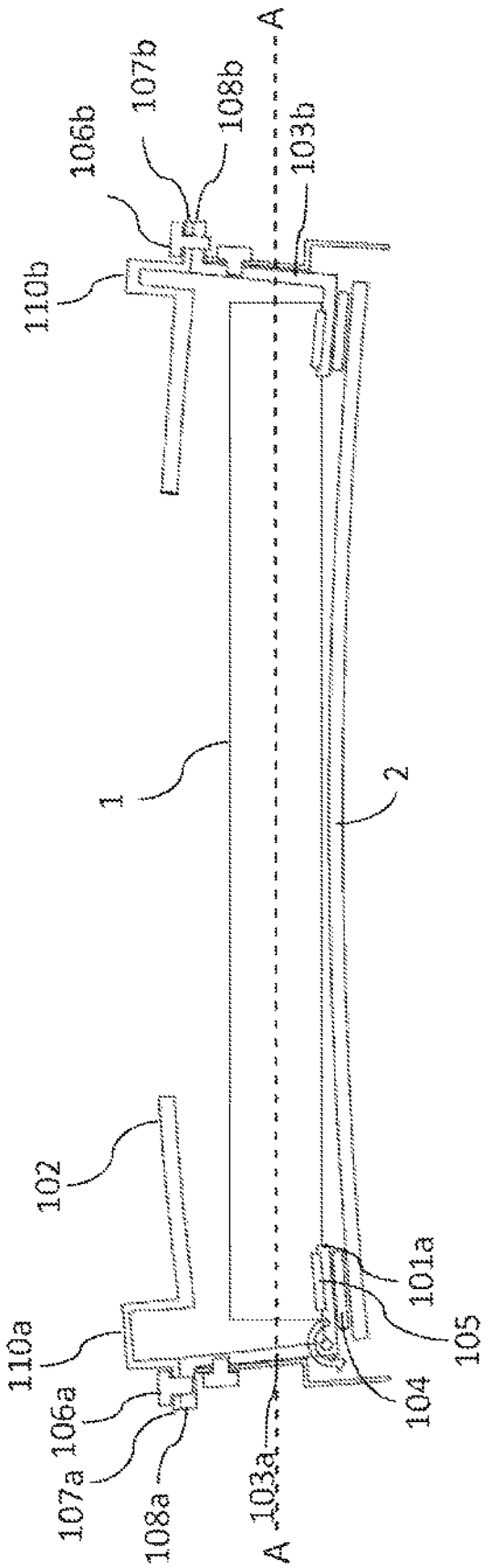


Figure 3d

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 490

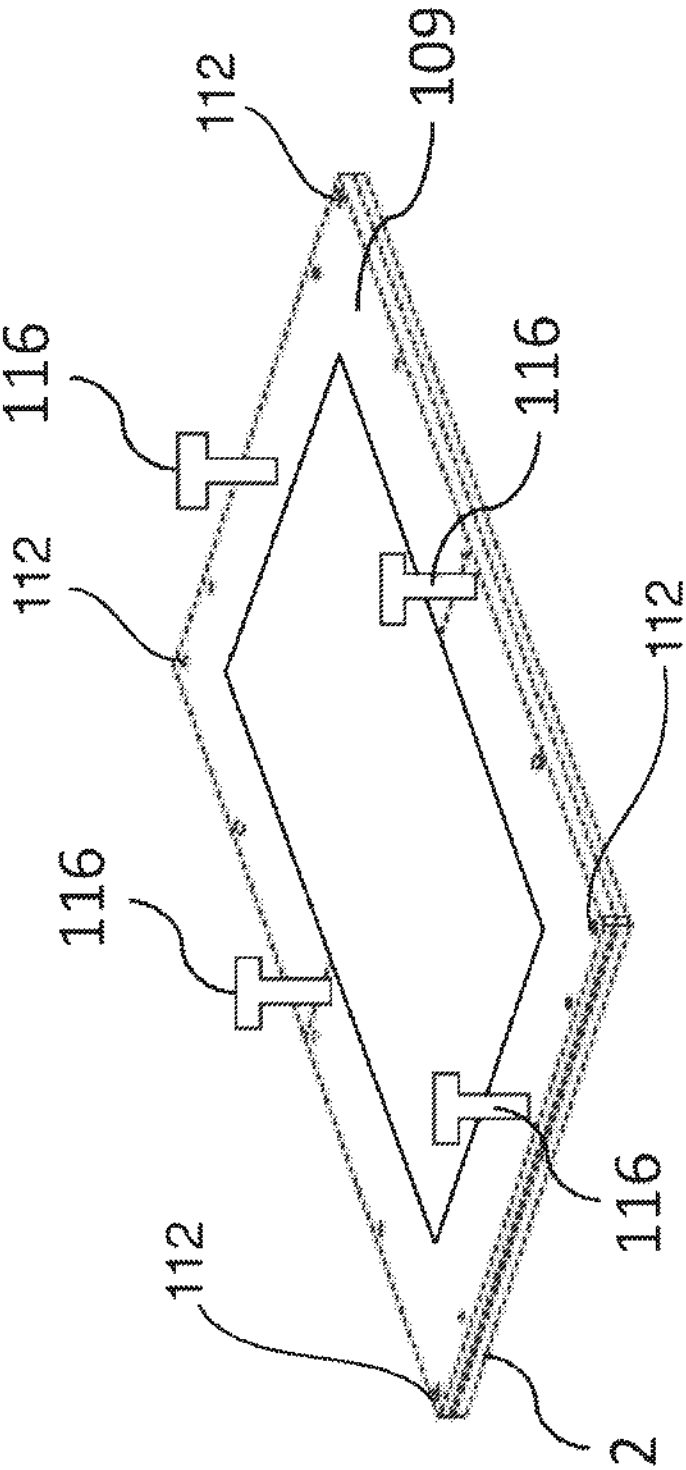


Figure 4a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 491

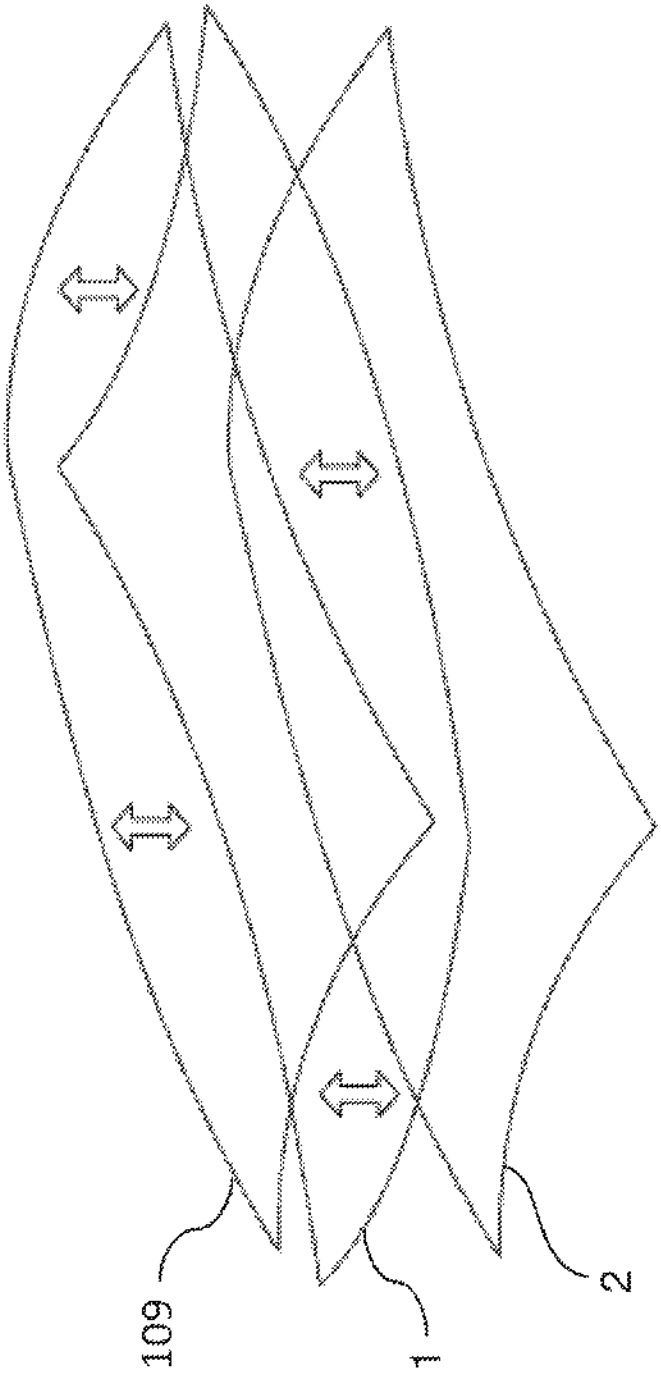


Figure 4b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 492

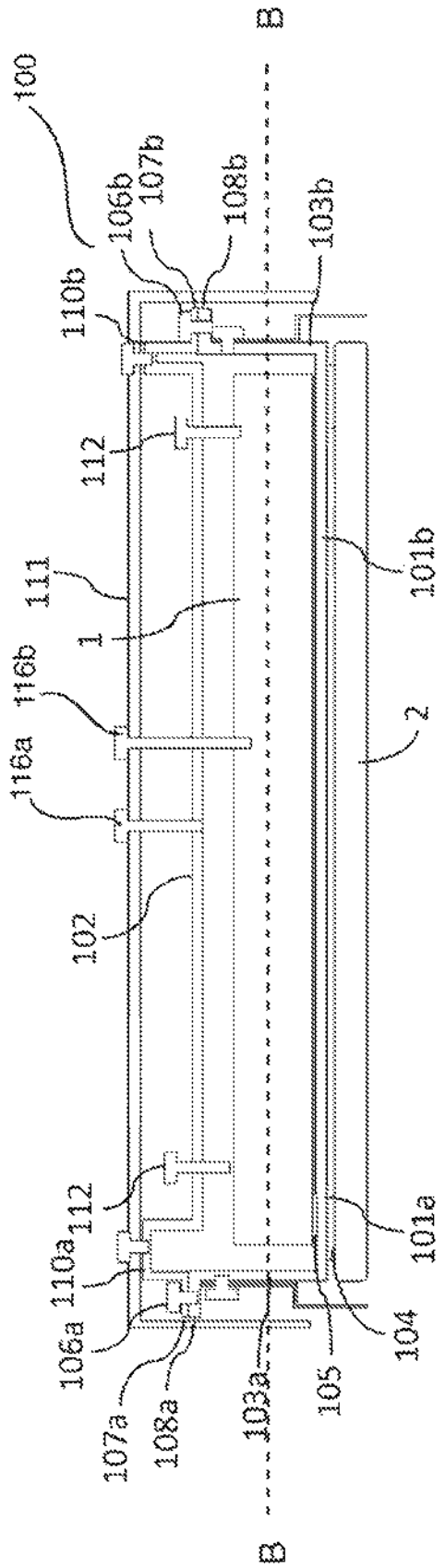


Figure 4c

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 493

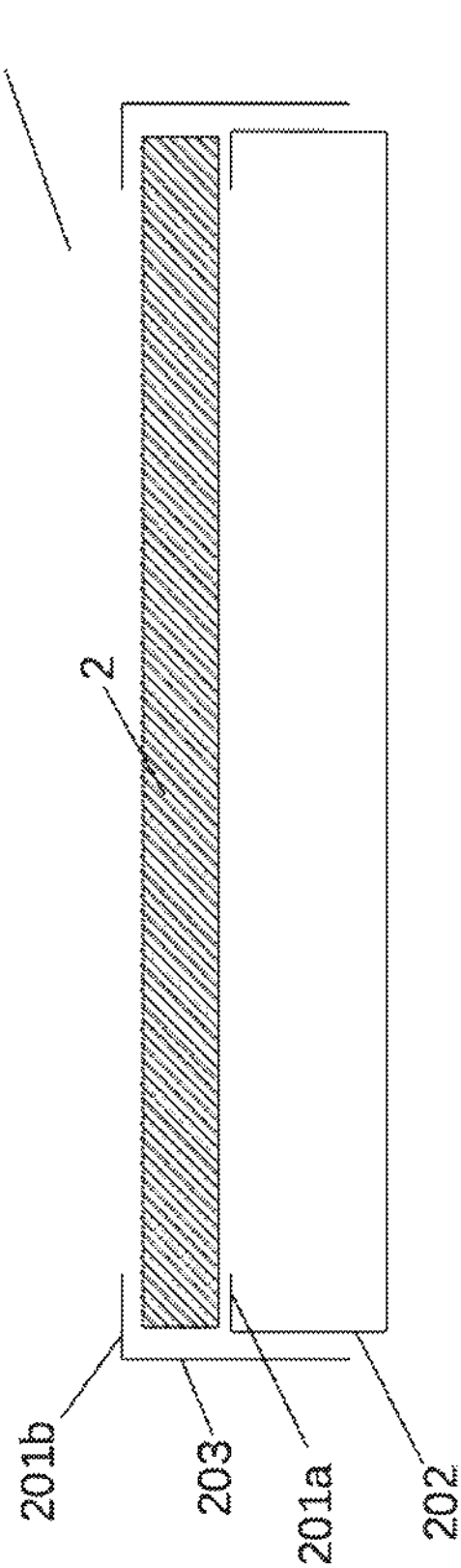


Figure 5a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 494

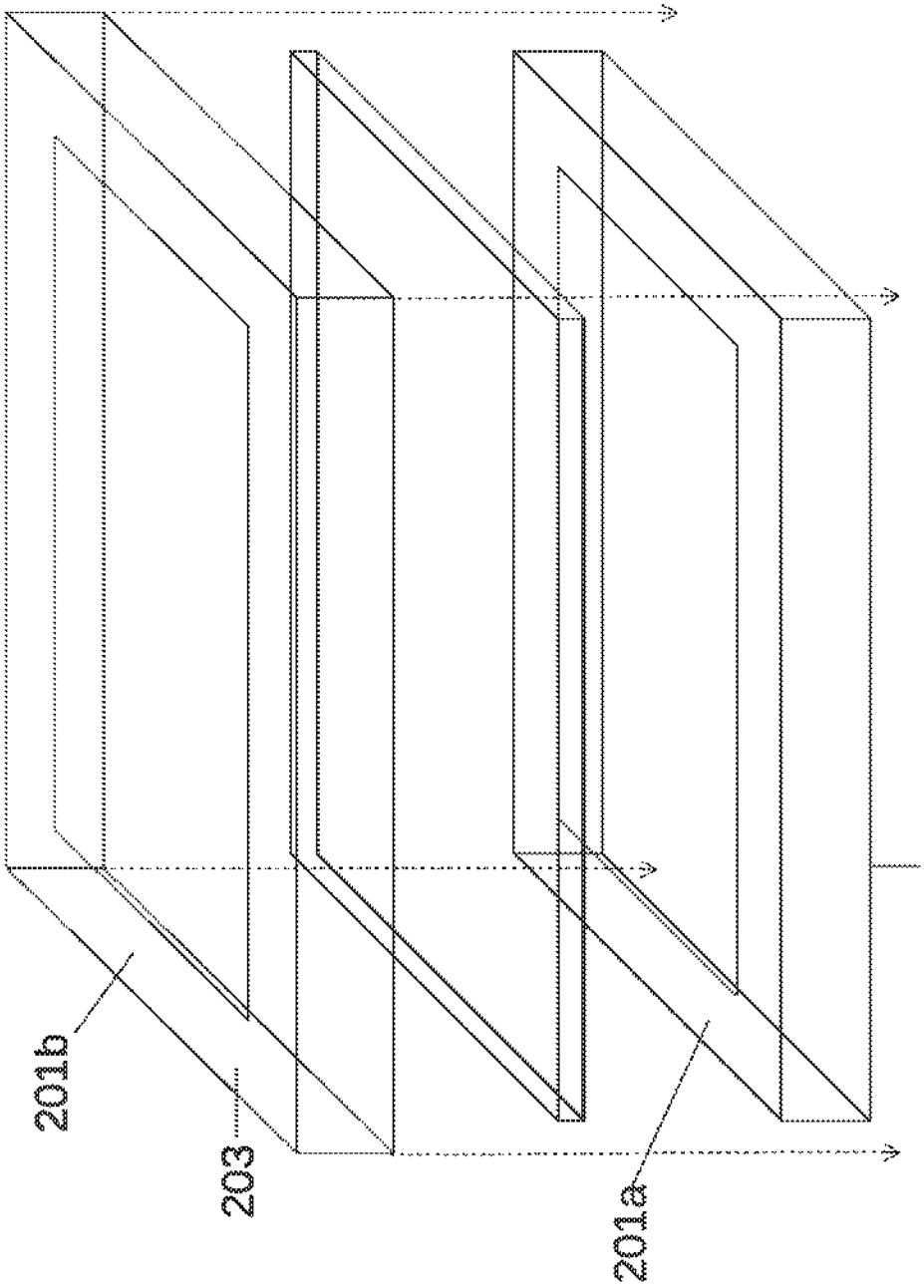


Figure 5b

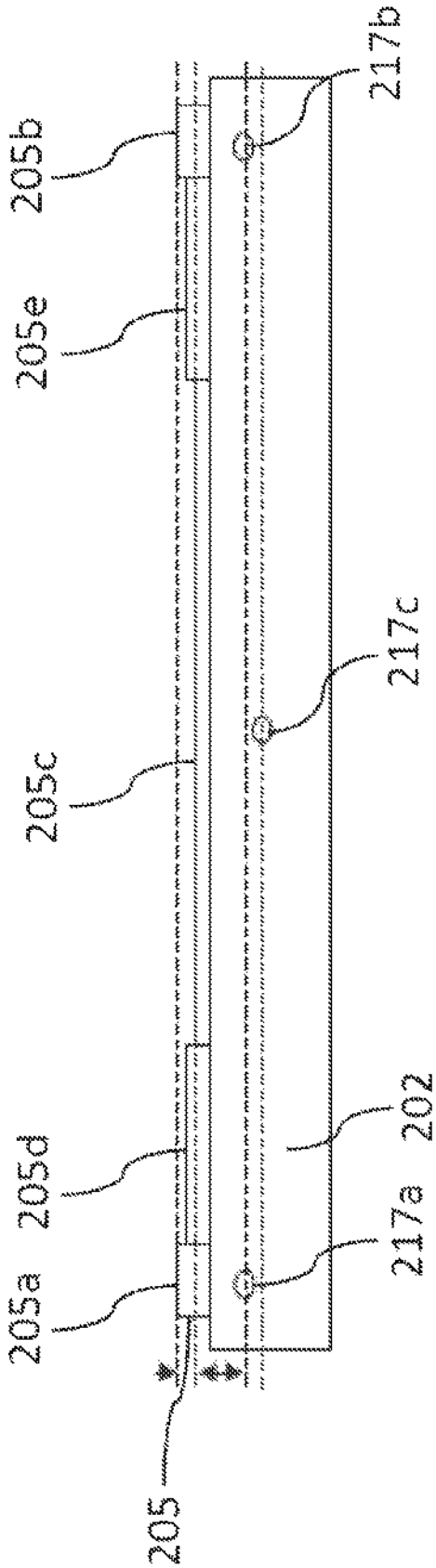


Figure 5c

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 496

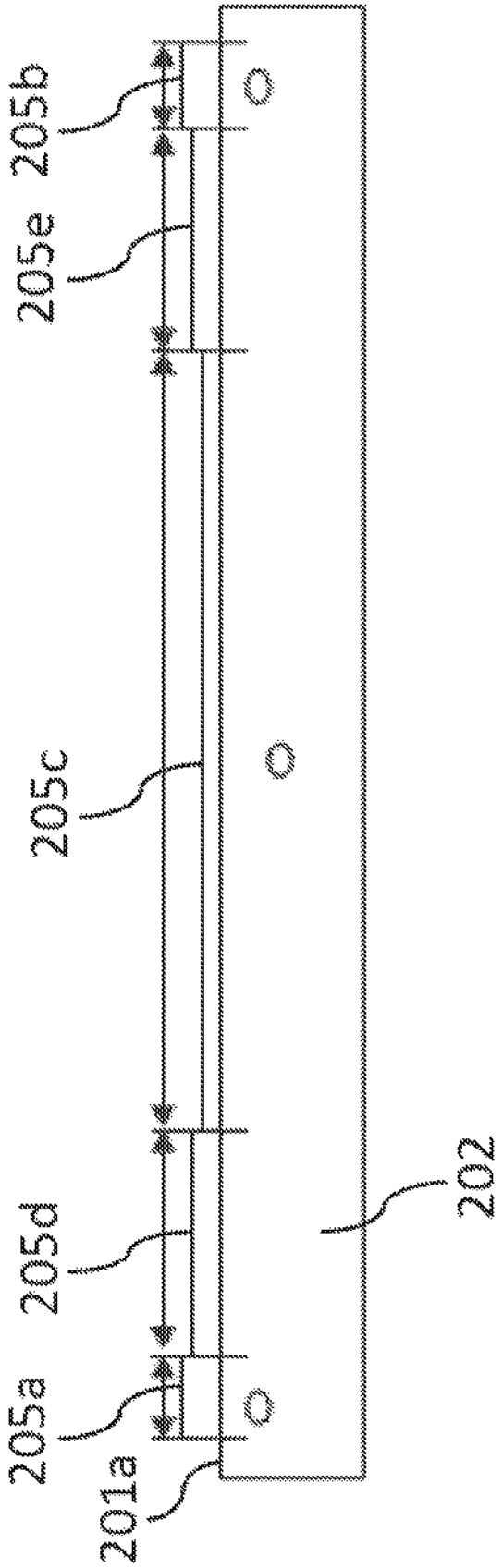


Figure 5d

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 497

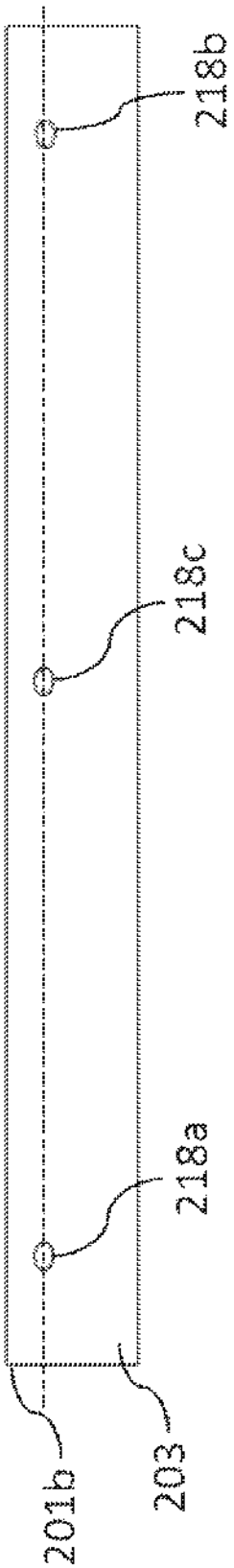


Figure 5e

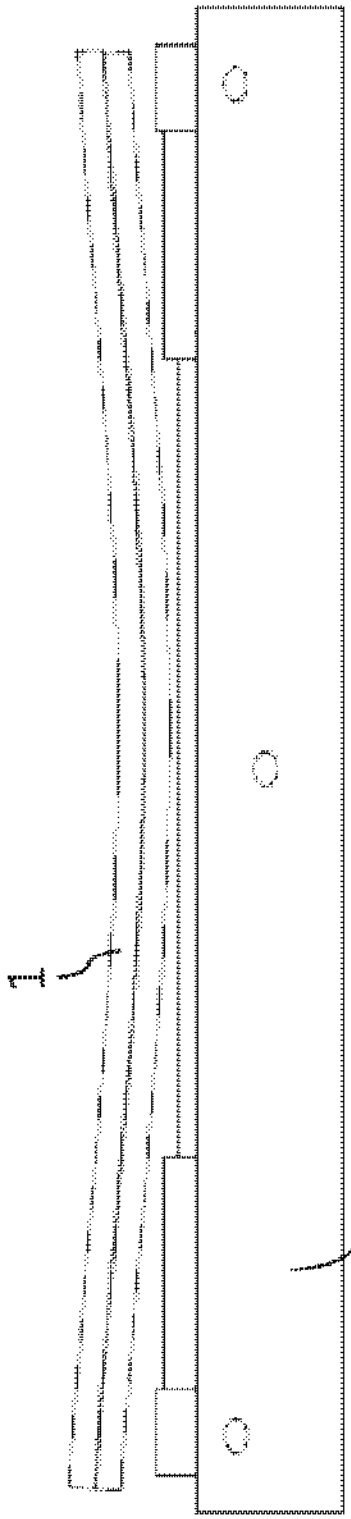


Figure 5f

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 499

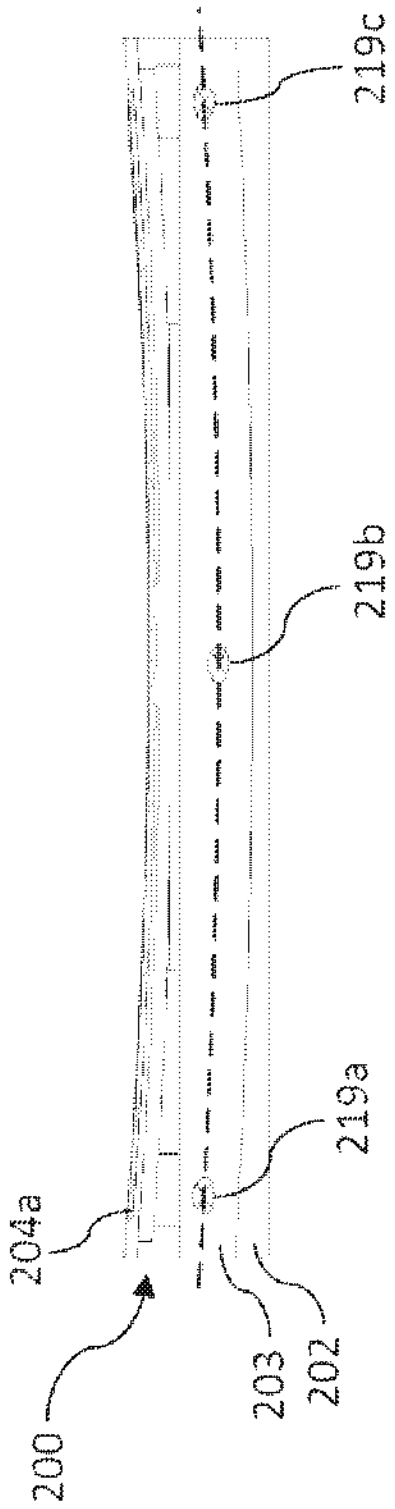


Figure 5g

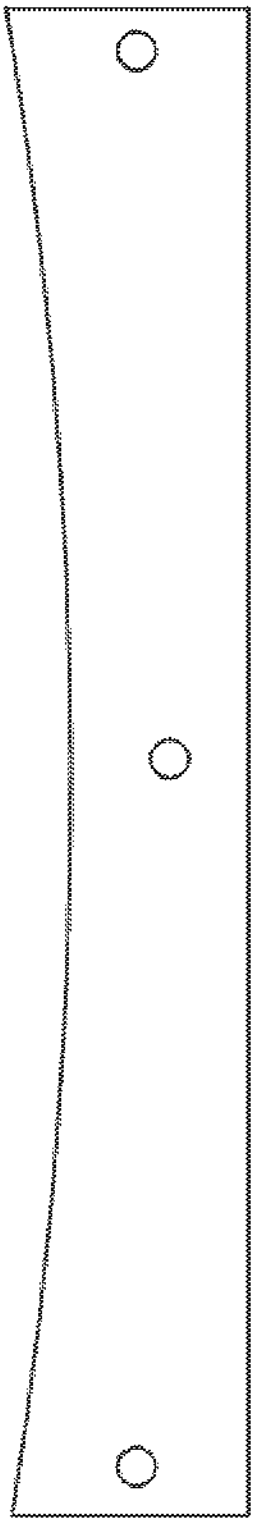


Figure 5h

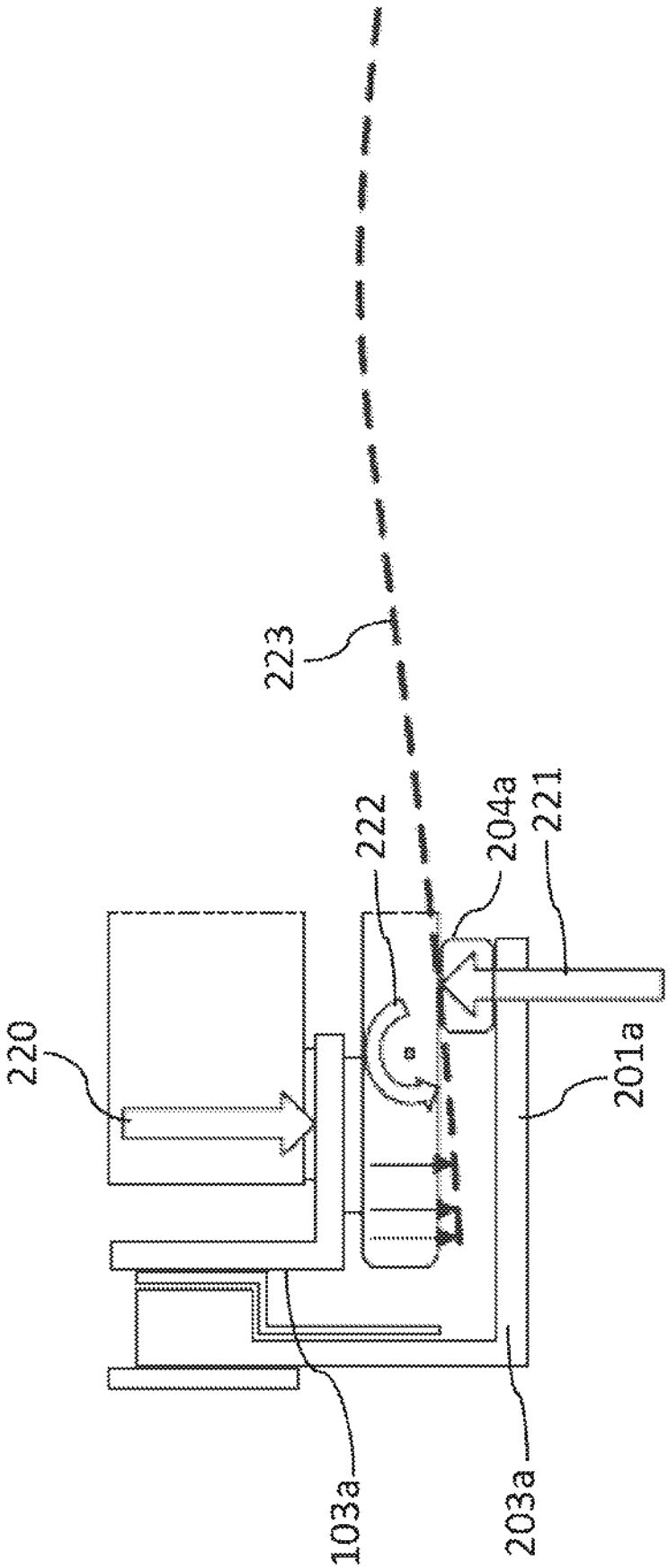


Figure 6

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 502

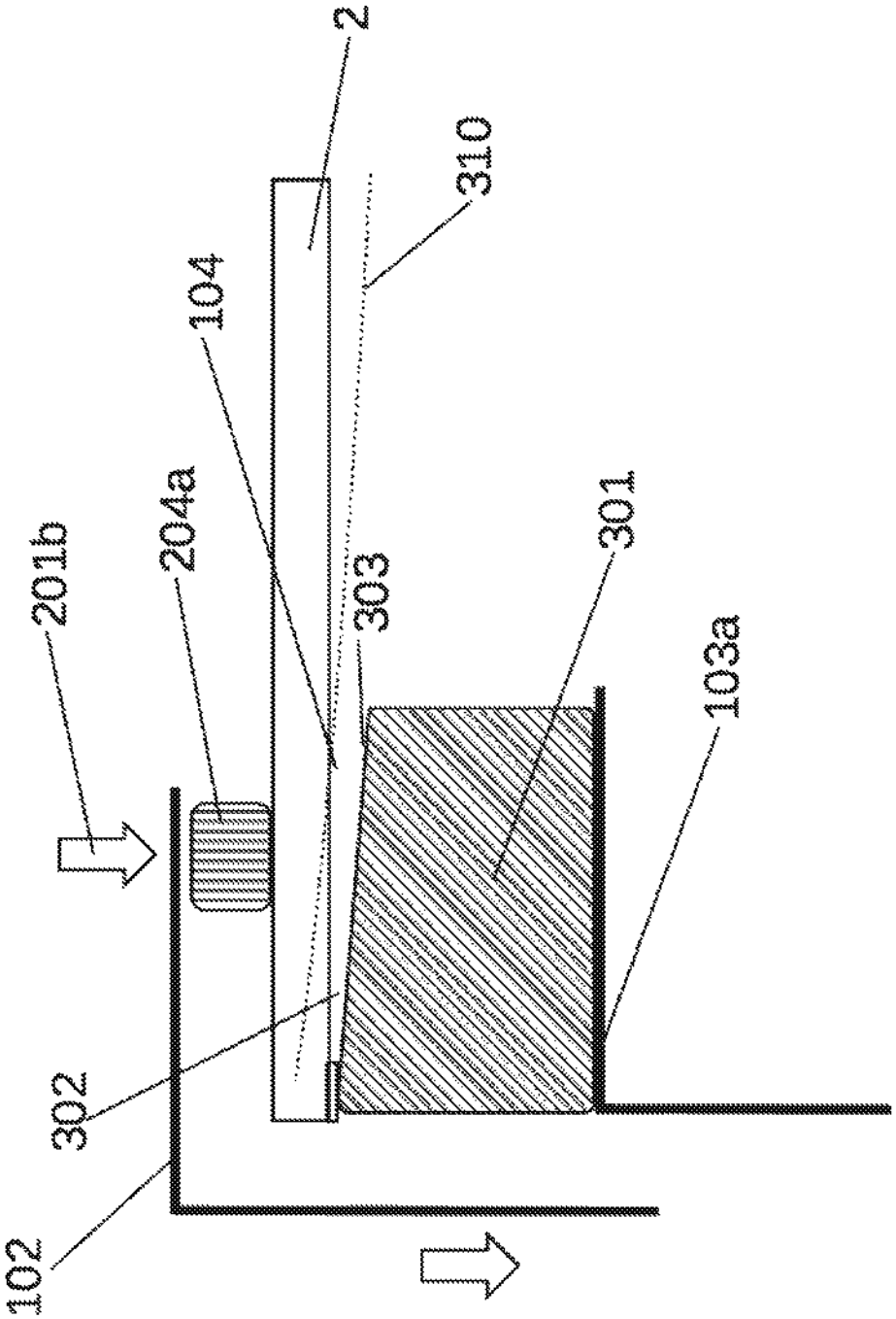


Figure 7

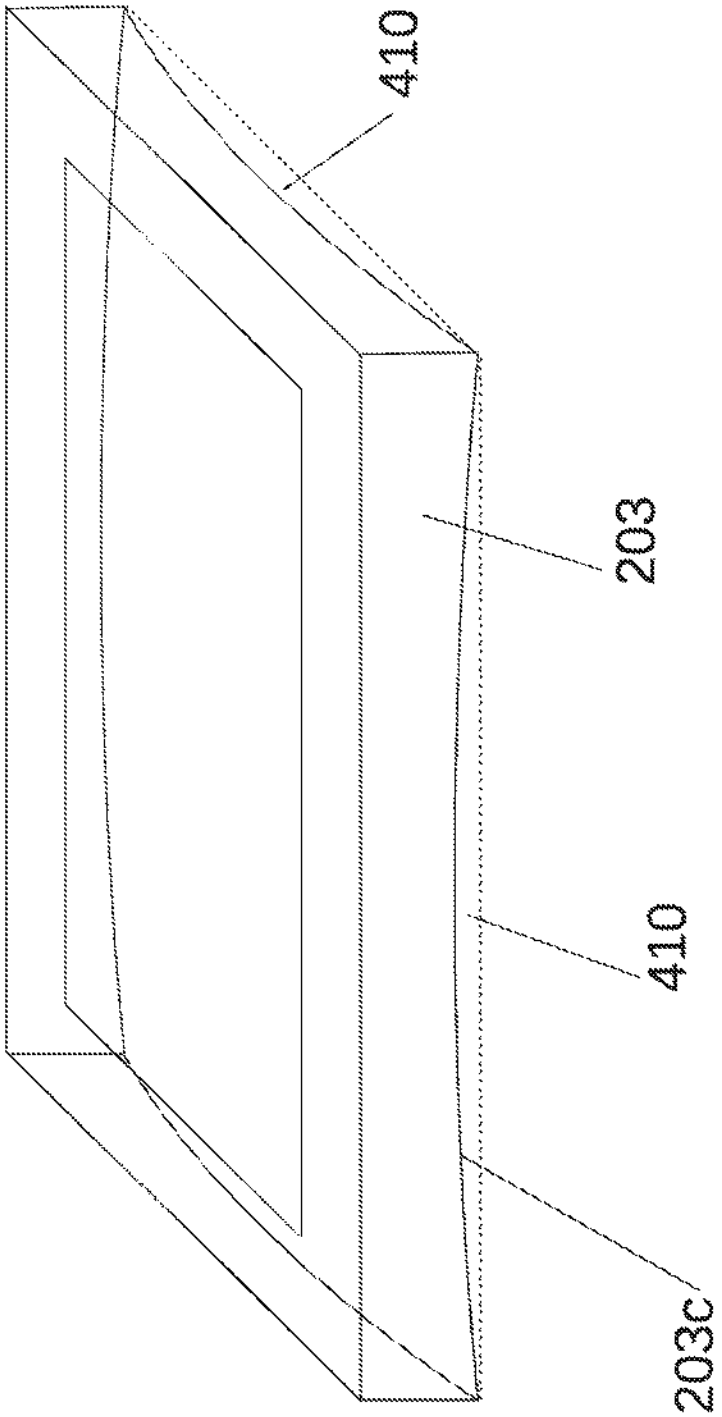


Figure 8

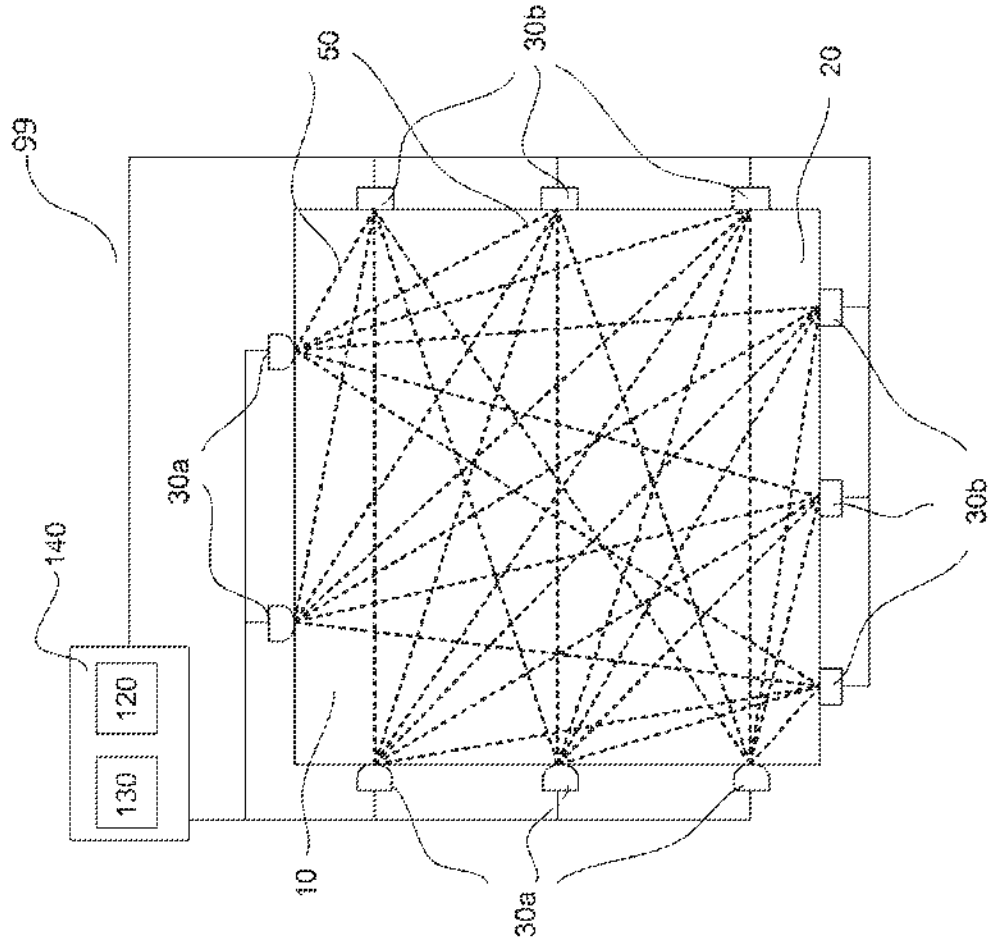


Figure 9

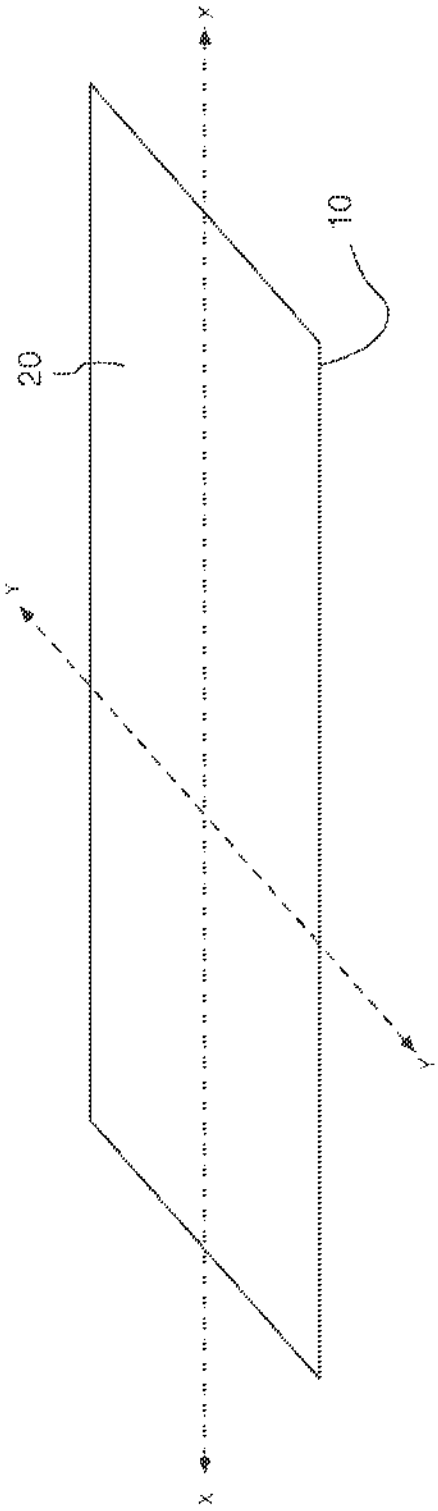


Figure 10a

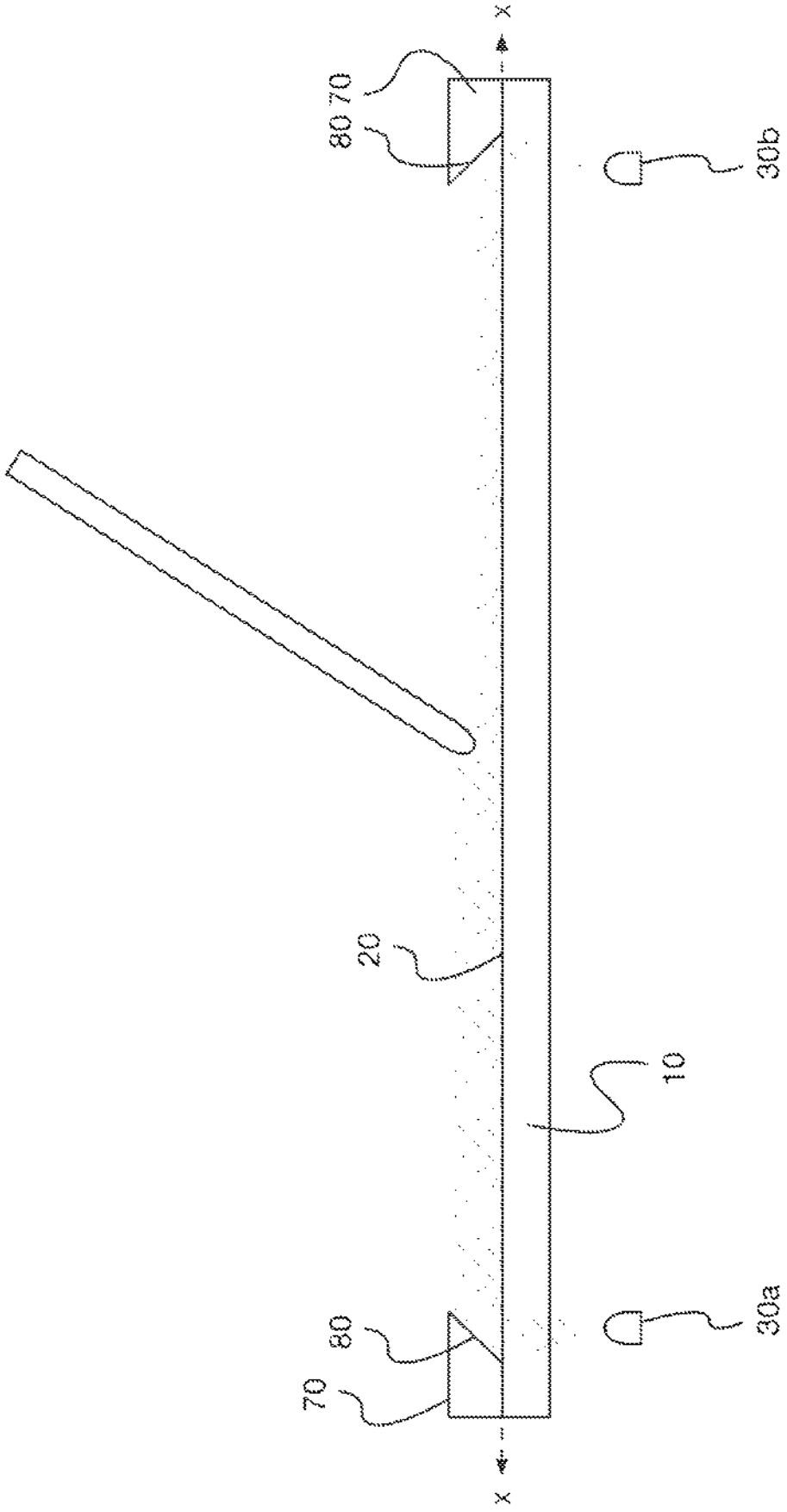


Figure 10b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 507

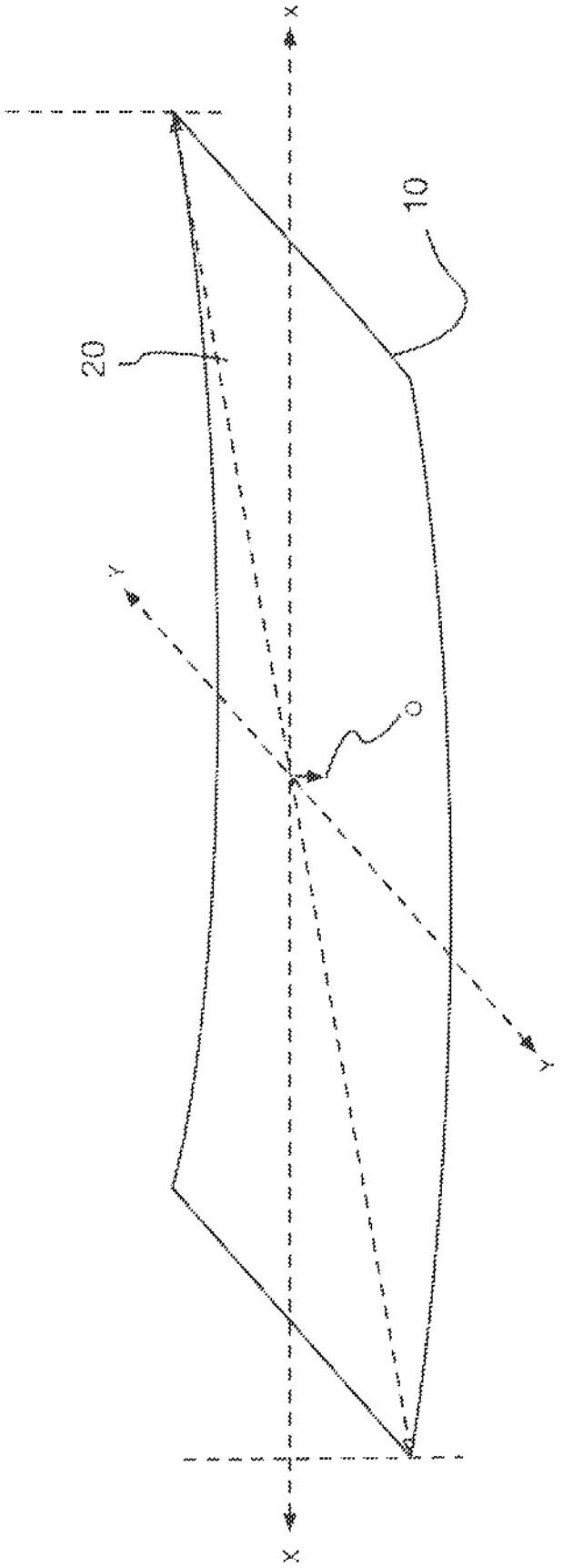


Figure 11a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 508

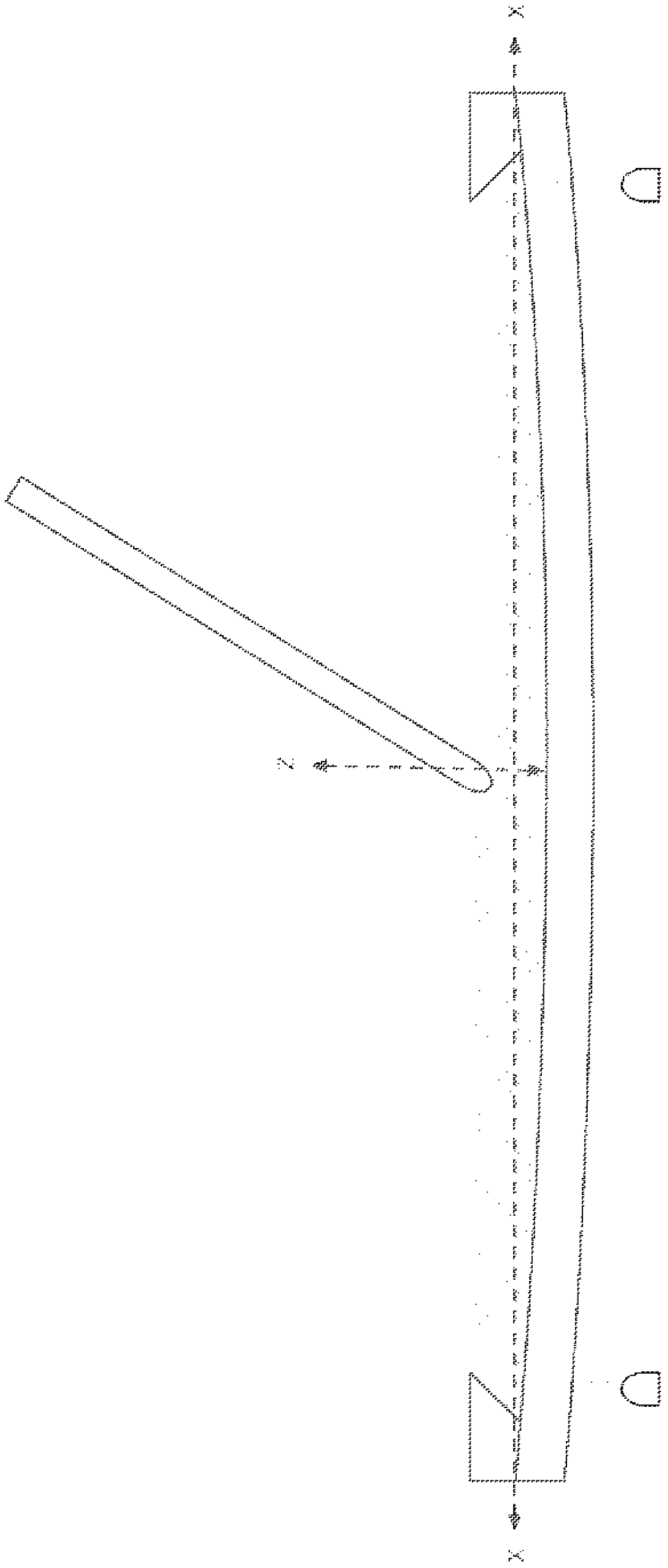


Figure 11b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 509

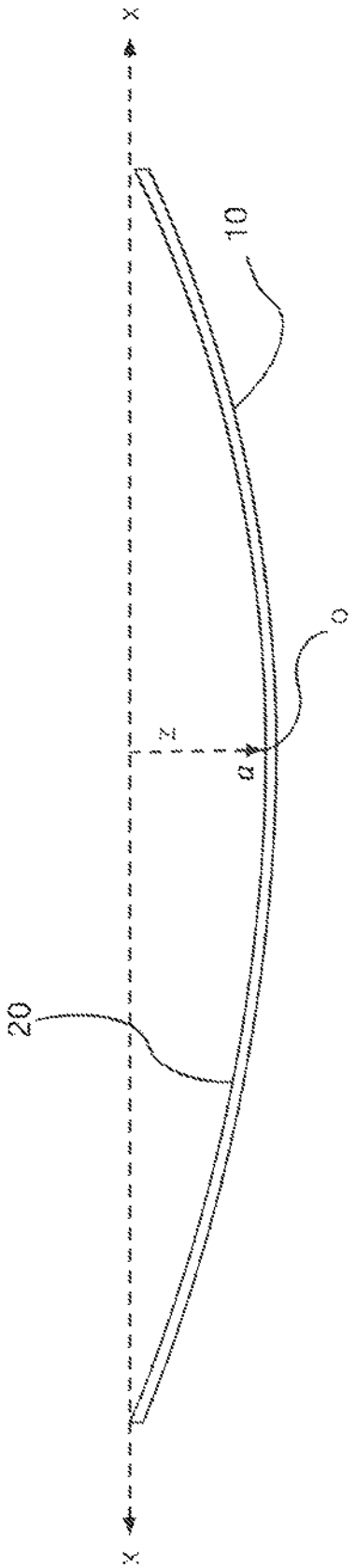


Figure 11c

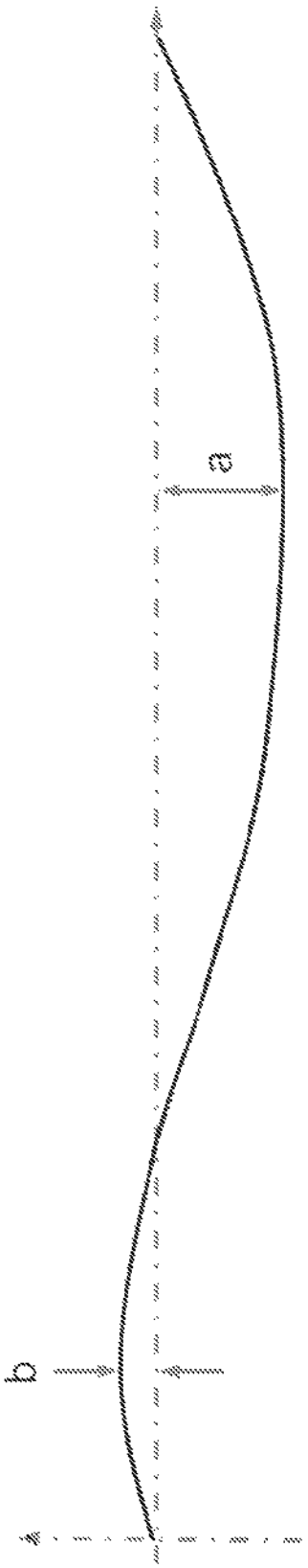


Figure 11d

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 510

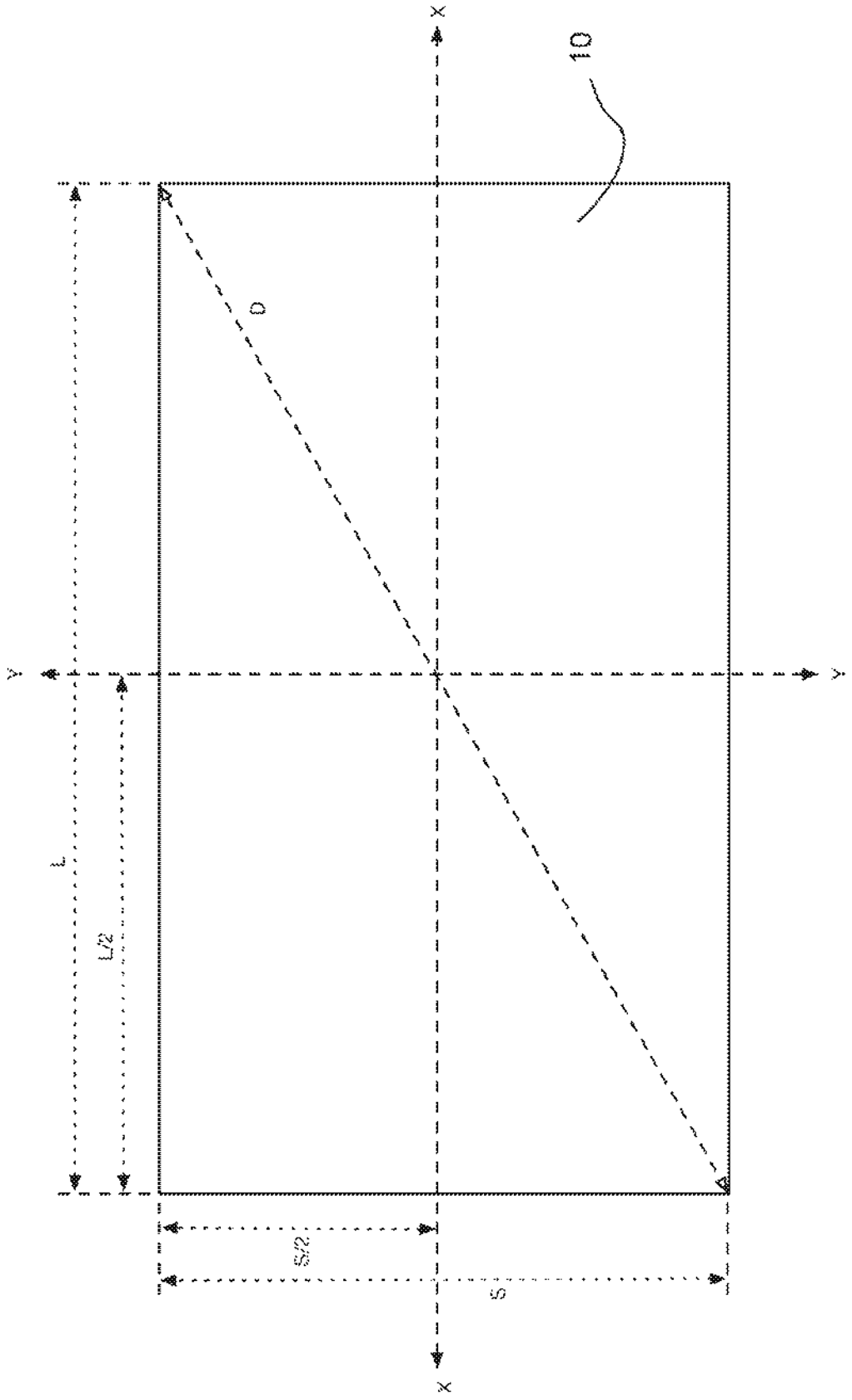


Figure 12a

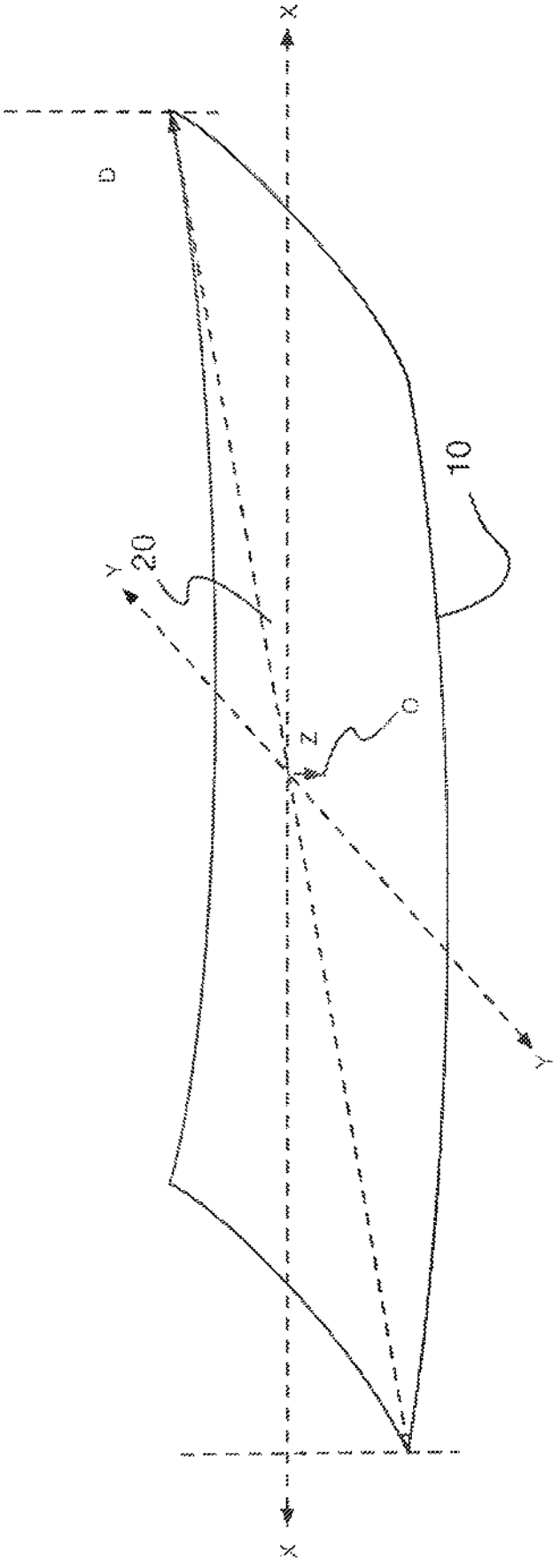


Figure 12b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 512

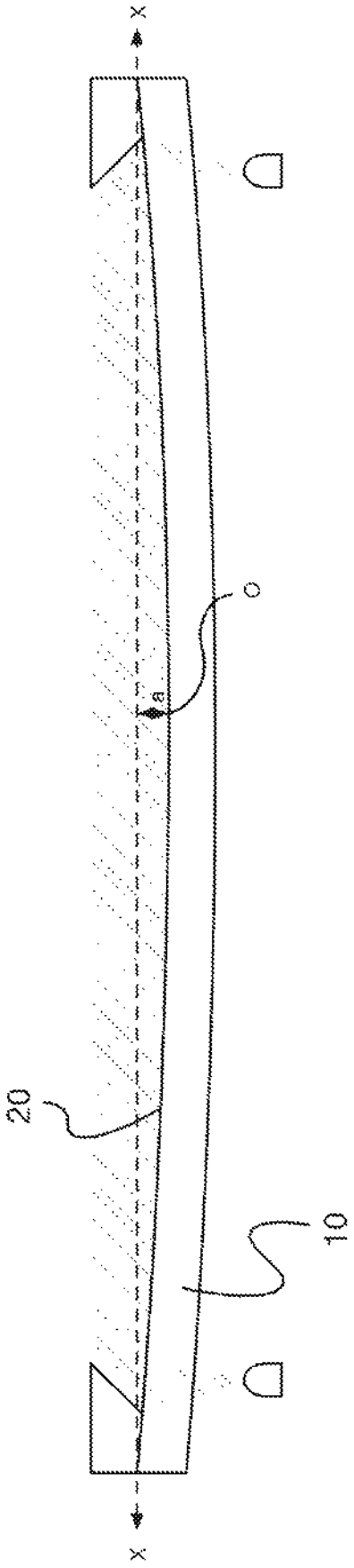


Figure 12c

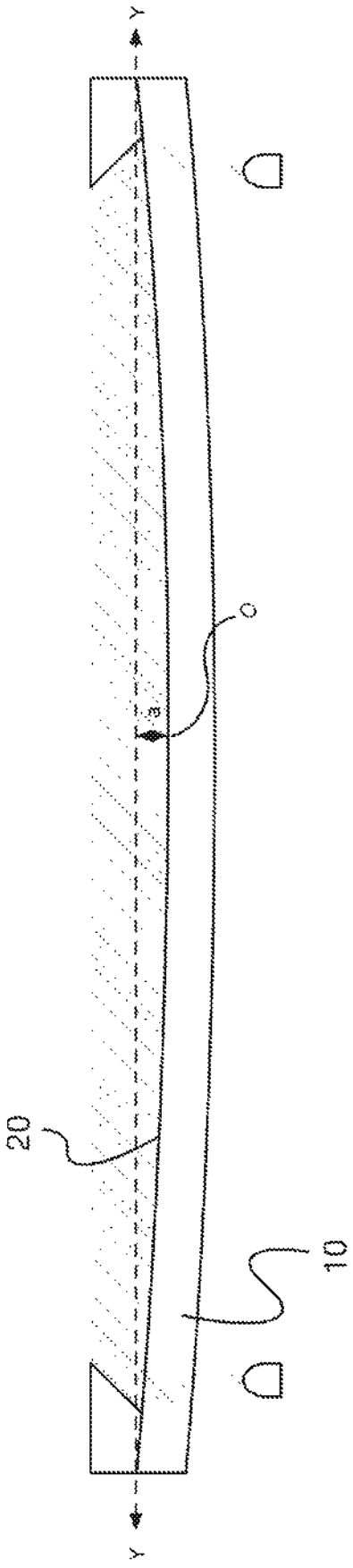


Figure 12d

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 513

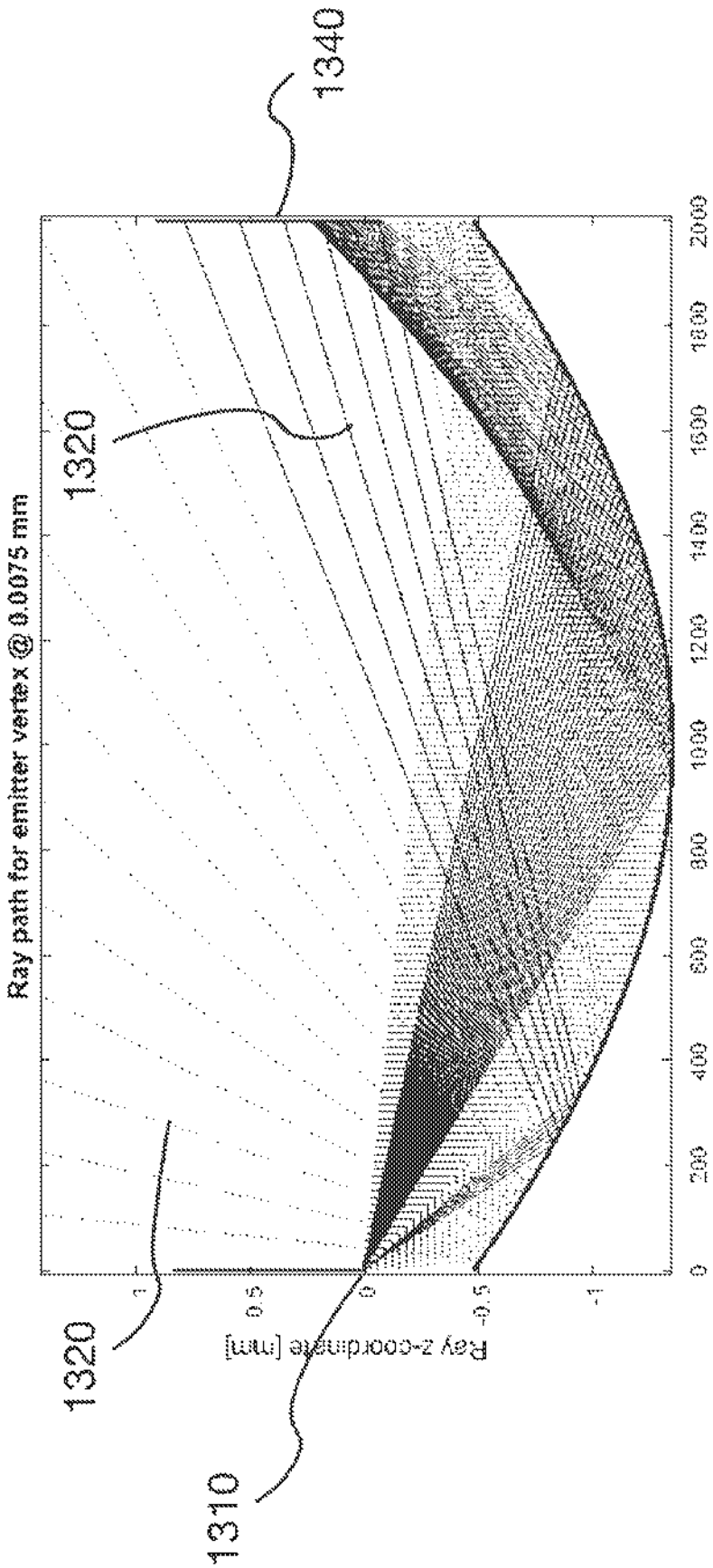


Figure 13a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 514

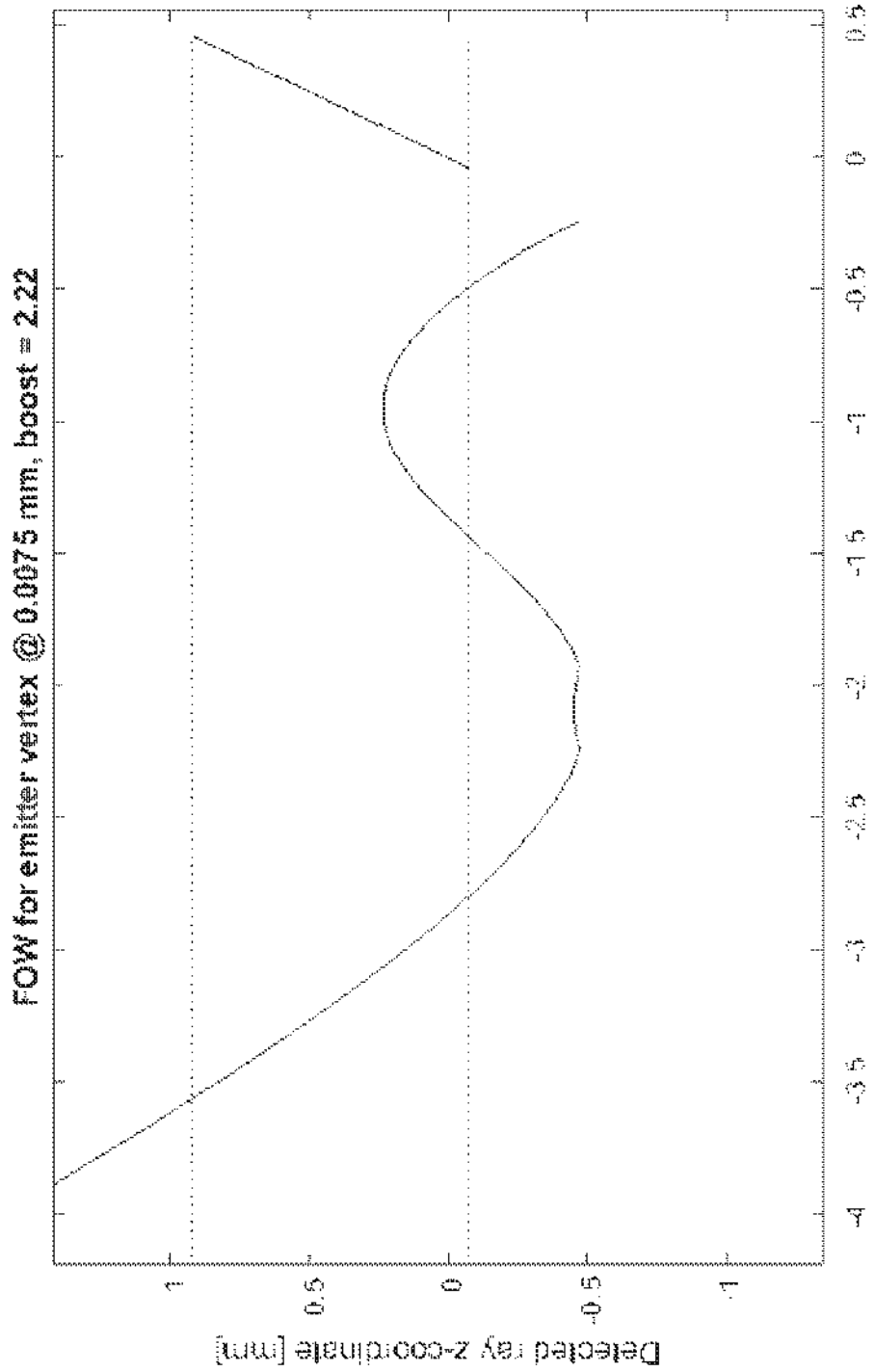


Figure 13b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 515

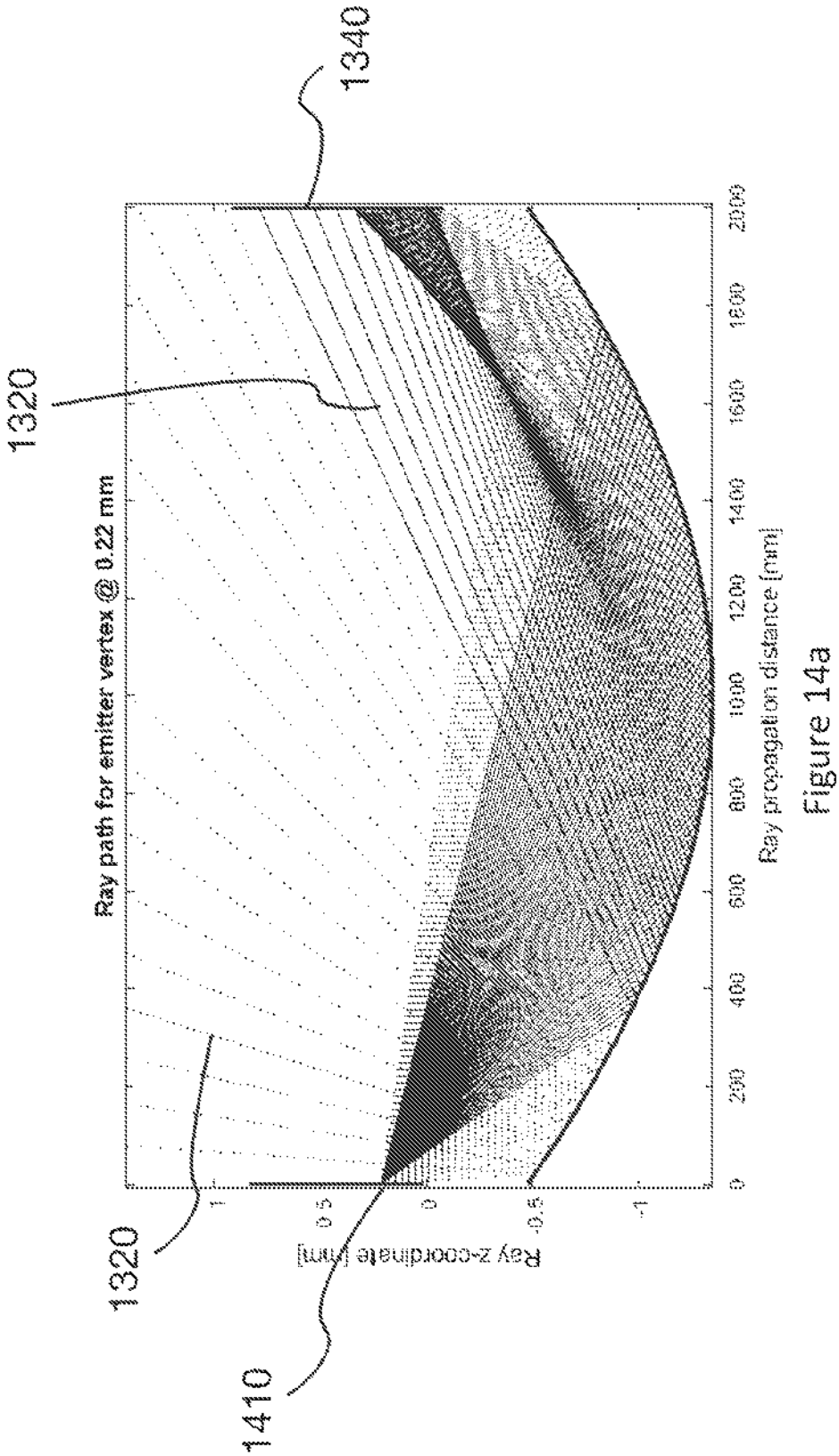


Figure 14a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 516

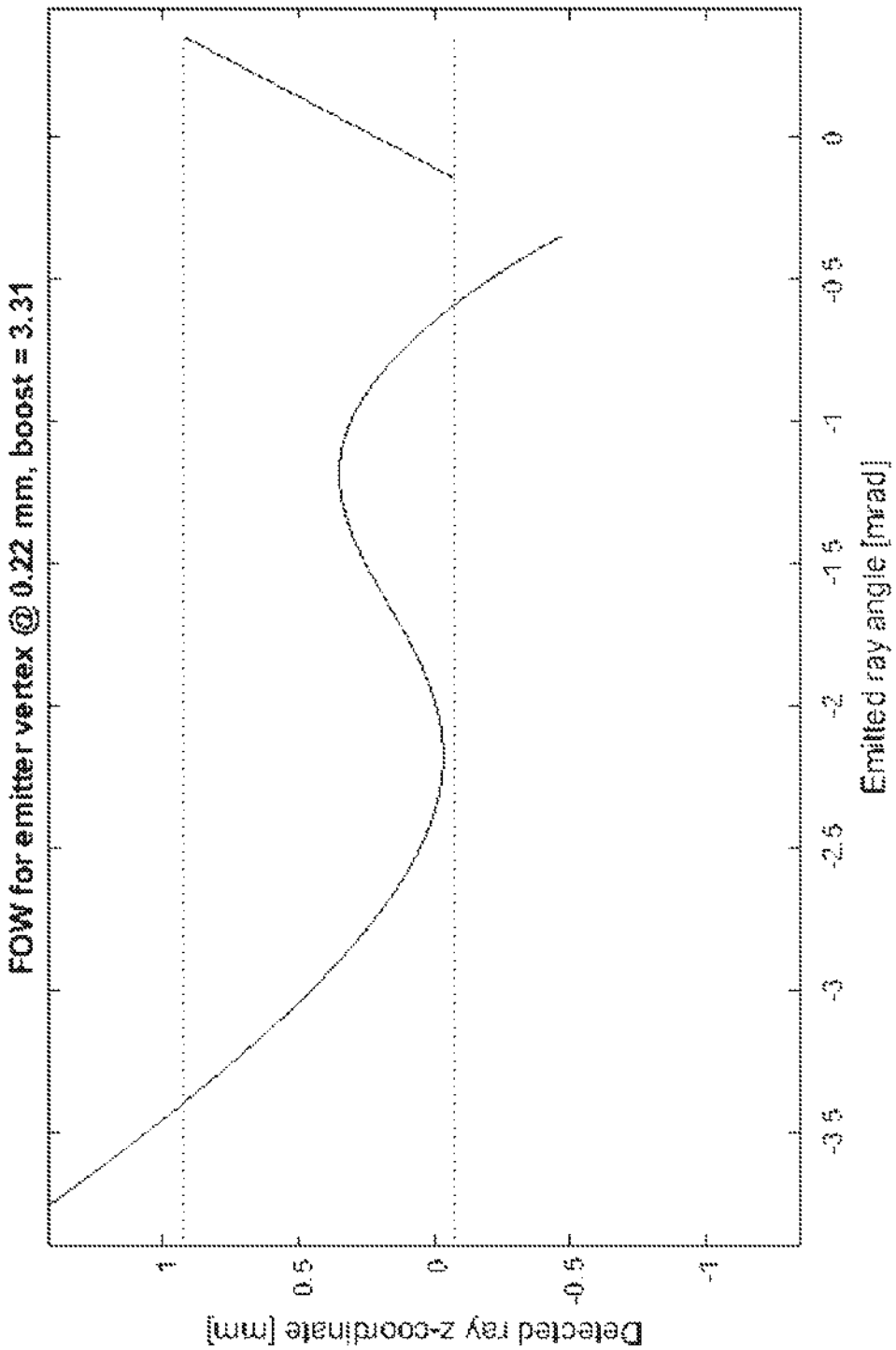


Figure 14b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 517

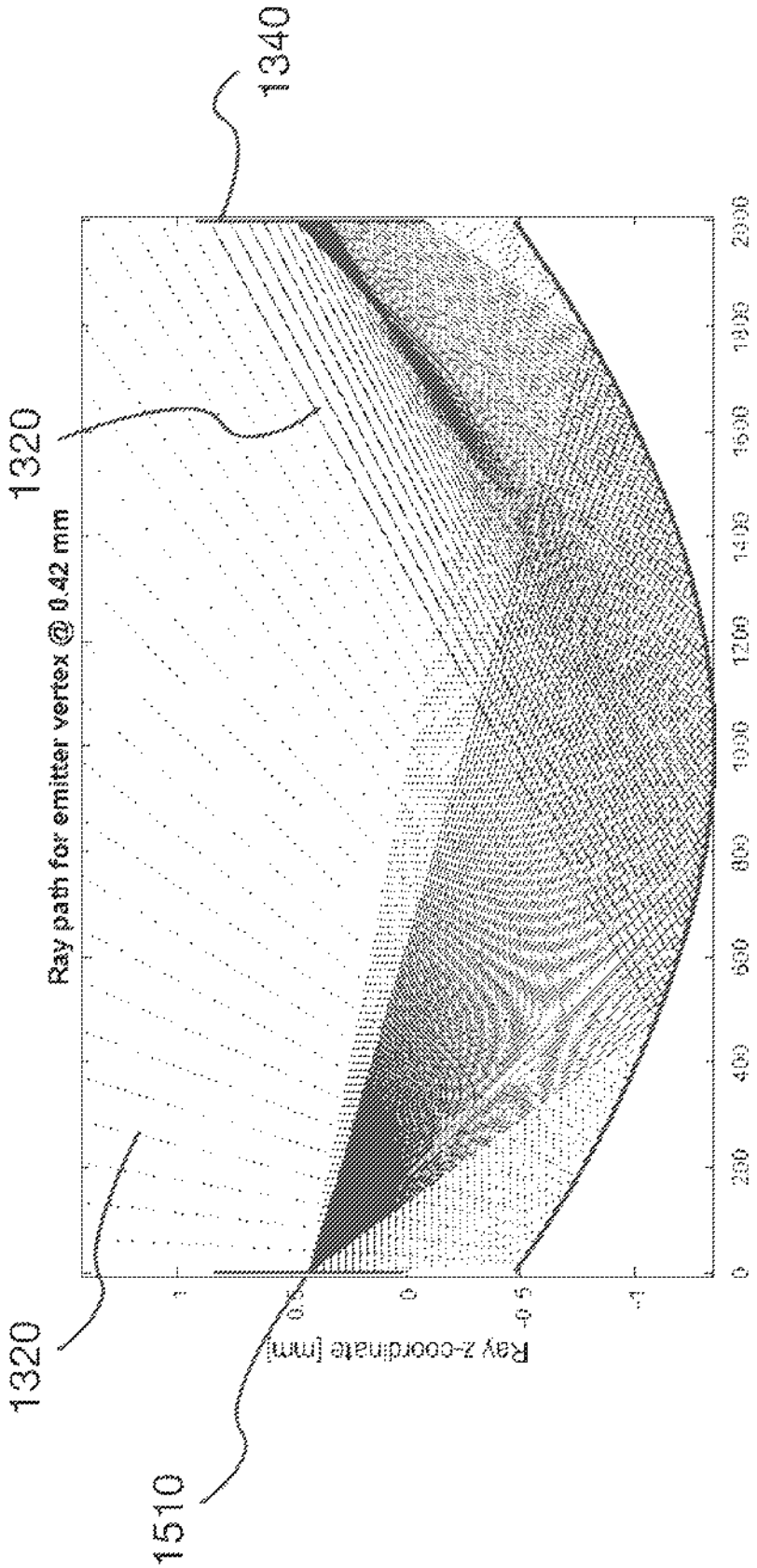


Figure 15a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 518

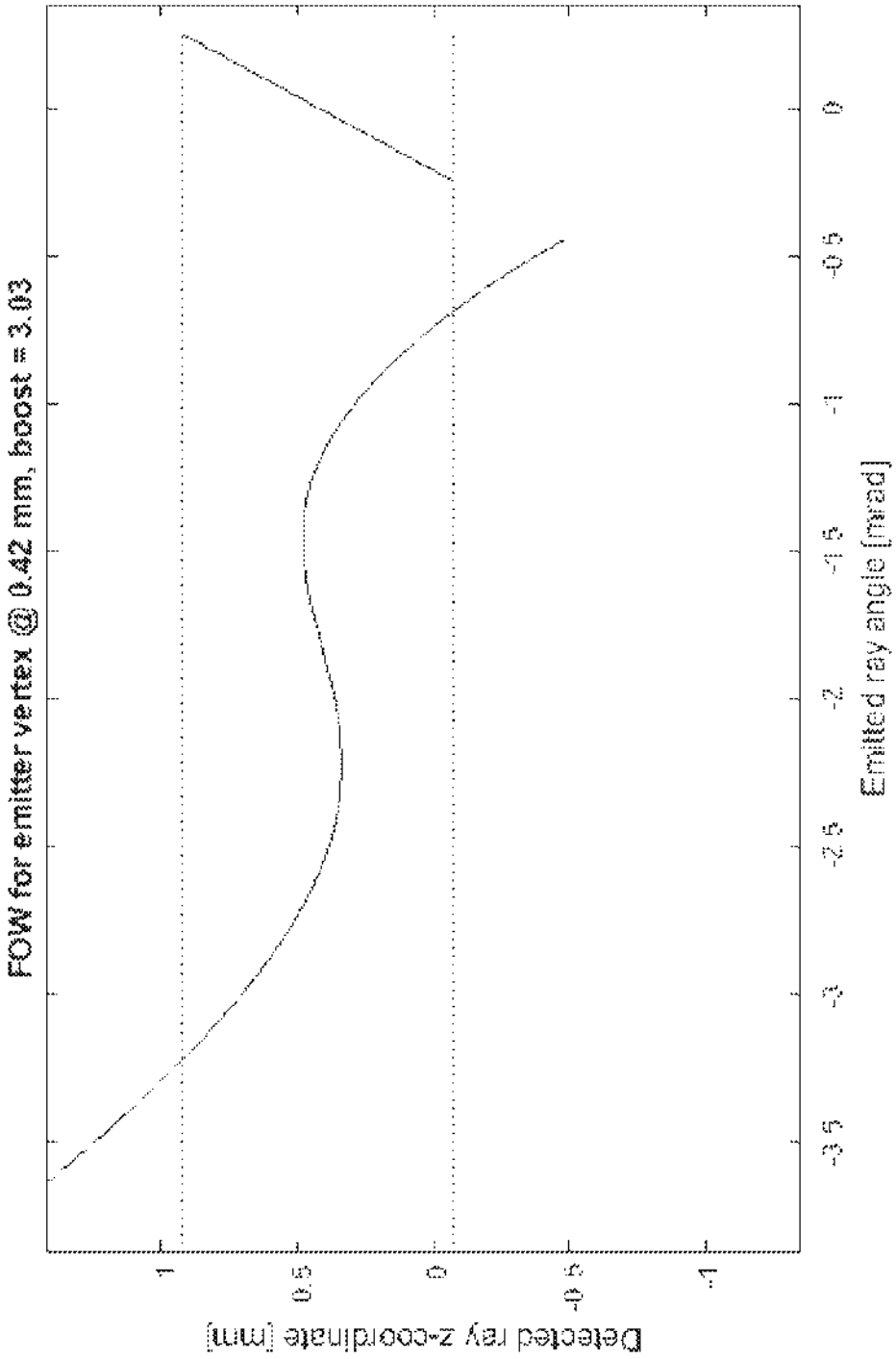

FOW for emitter vertex @ 0.42 mm, boost = 3.03
Detected ray z-coordinate [mm]
1
0.5
0
-0.5
-1
Emitted ray angle [mrad]
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0

Figure 15b

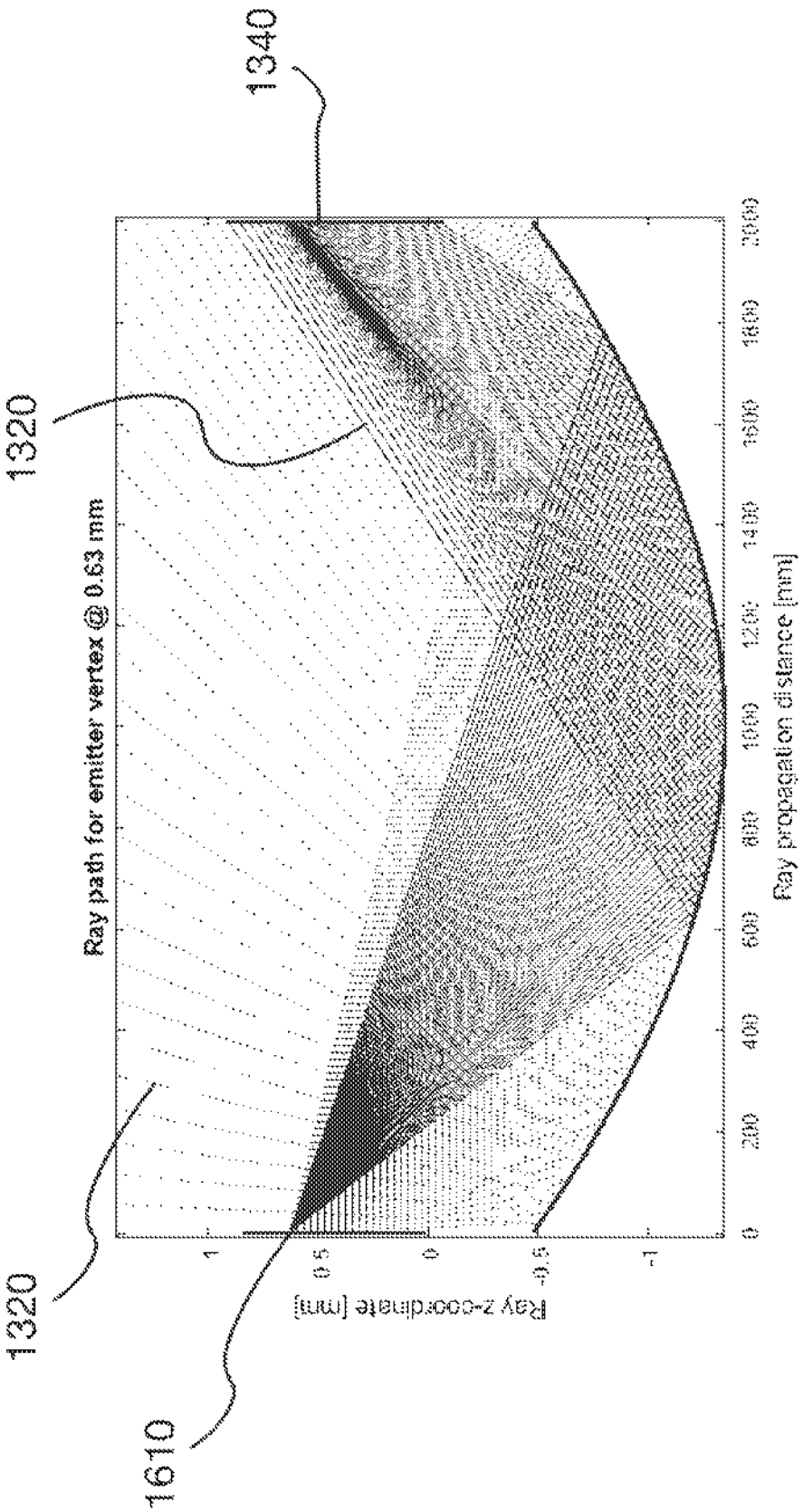


Figure 16a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 520

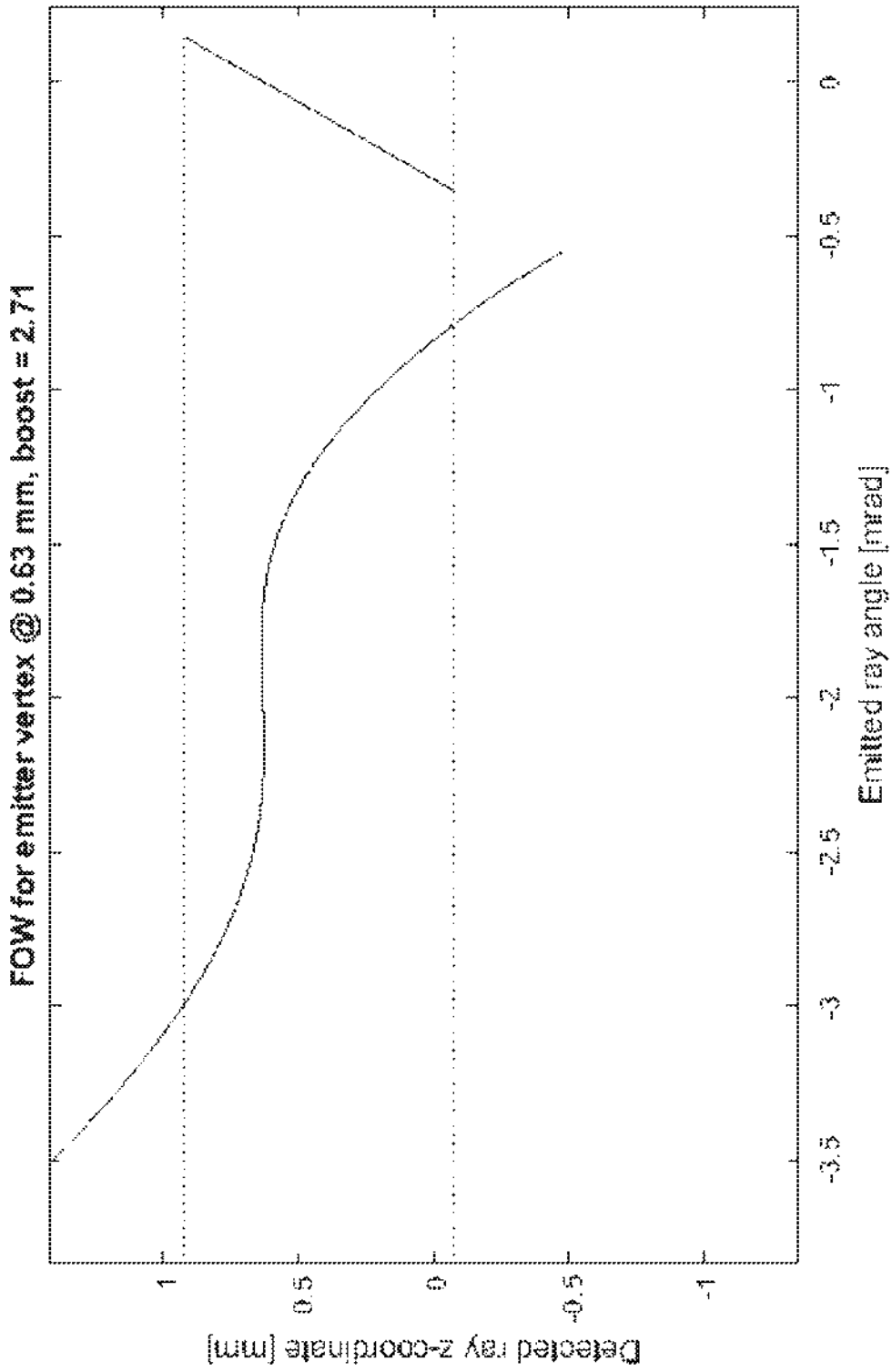


Figure 16b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 521

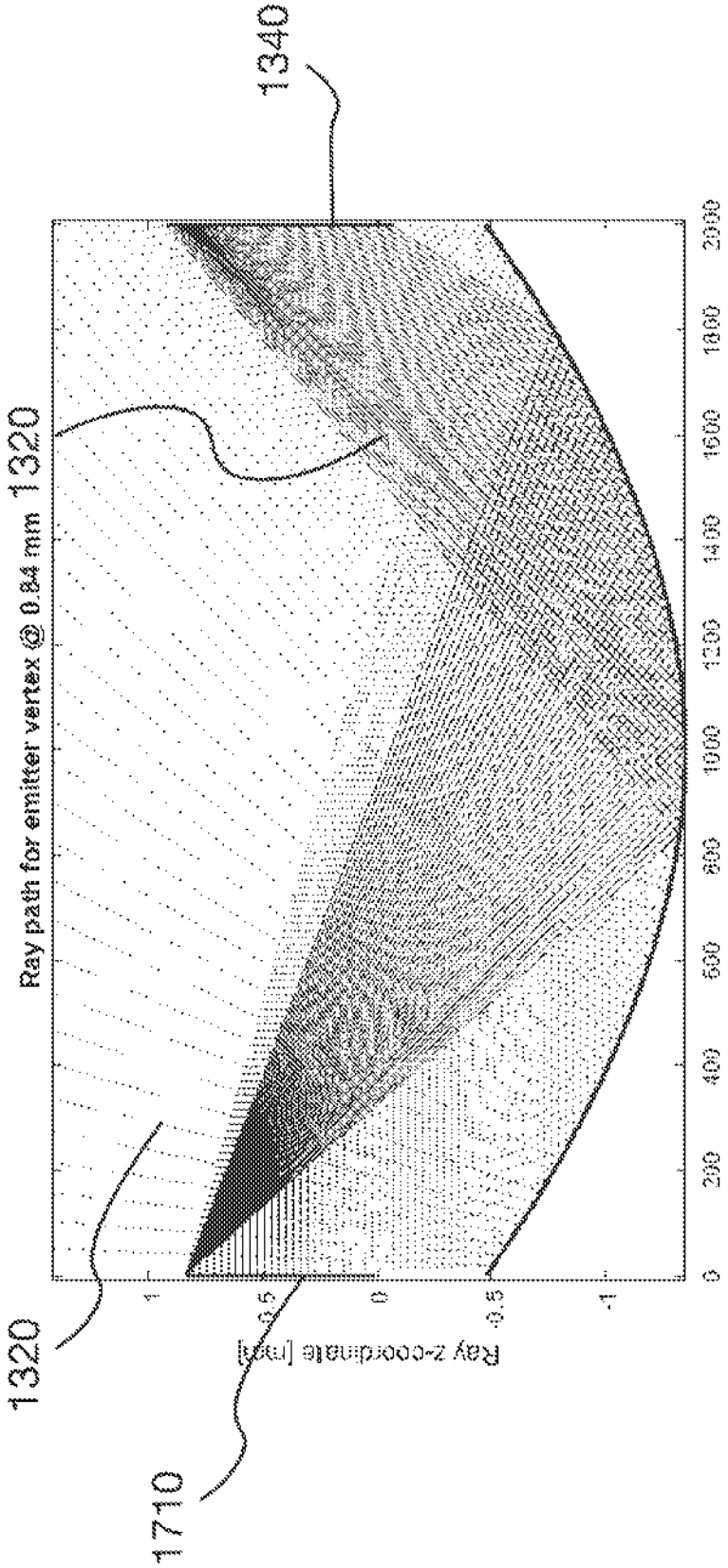


Figure 17a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 522

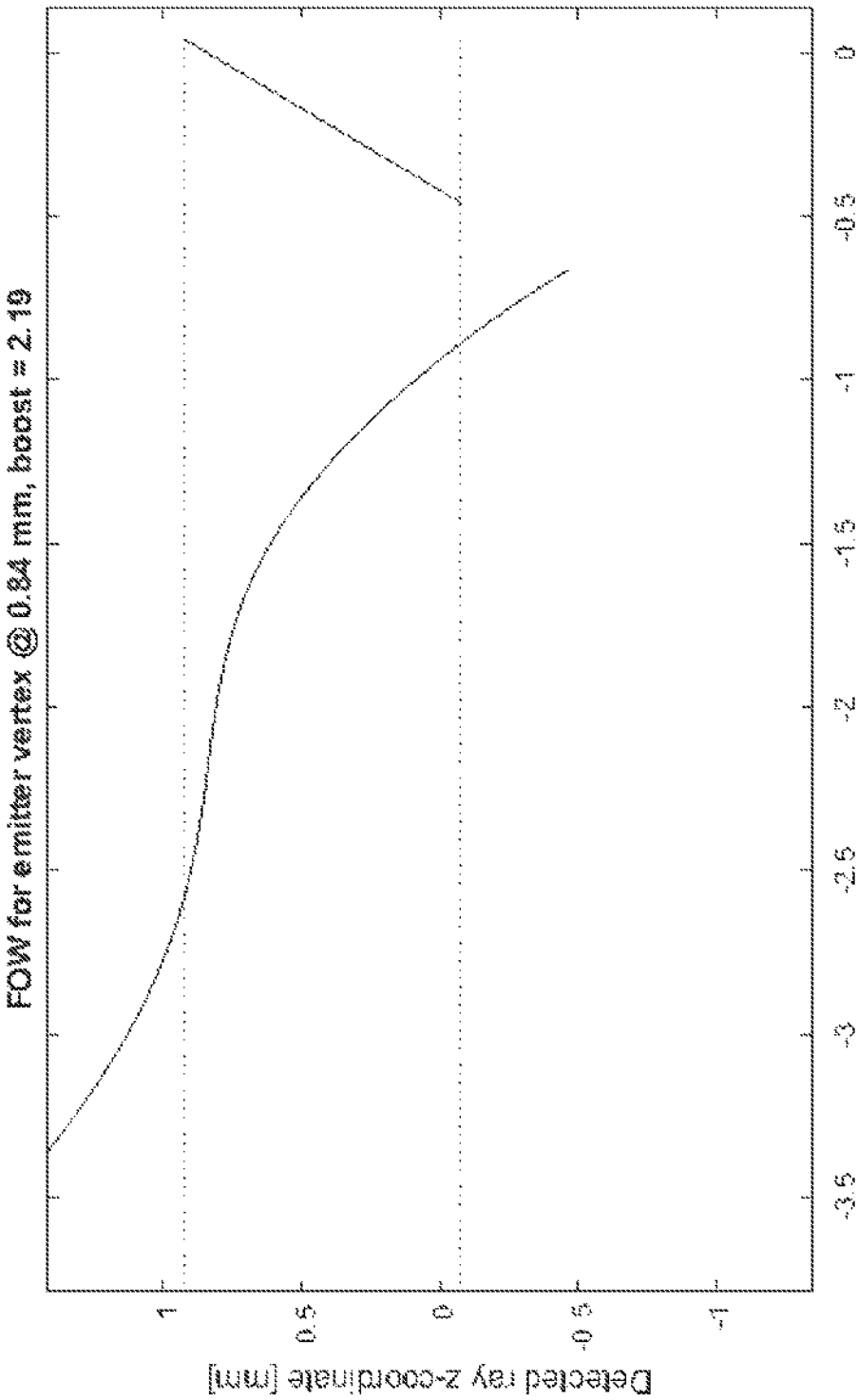


Figure 17b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 523

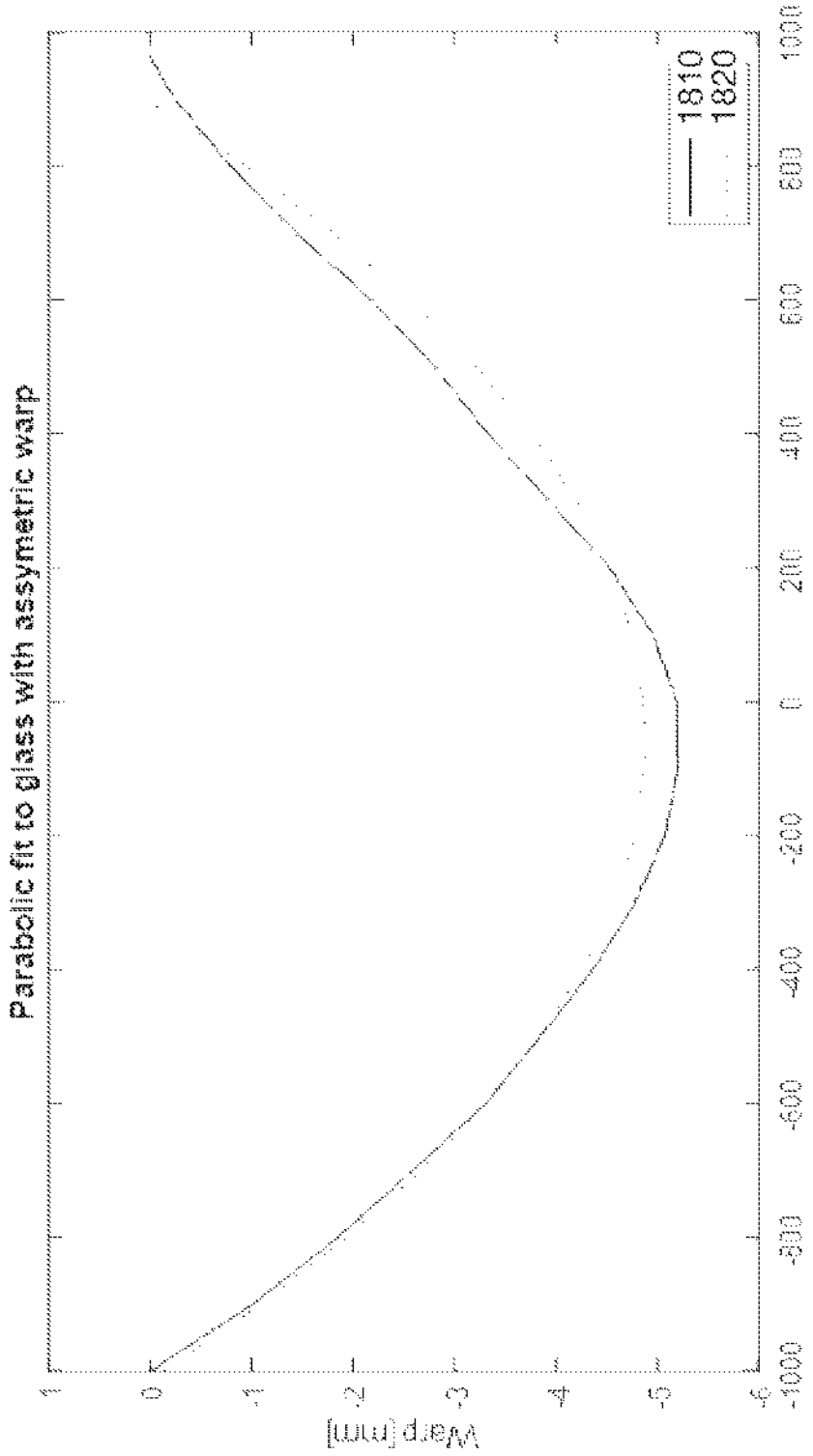


Figure 18a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 524

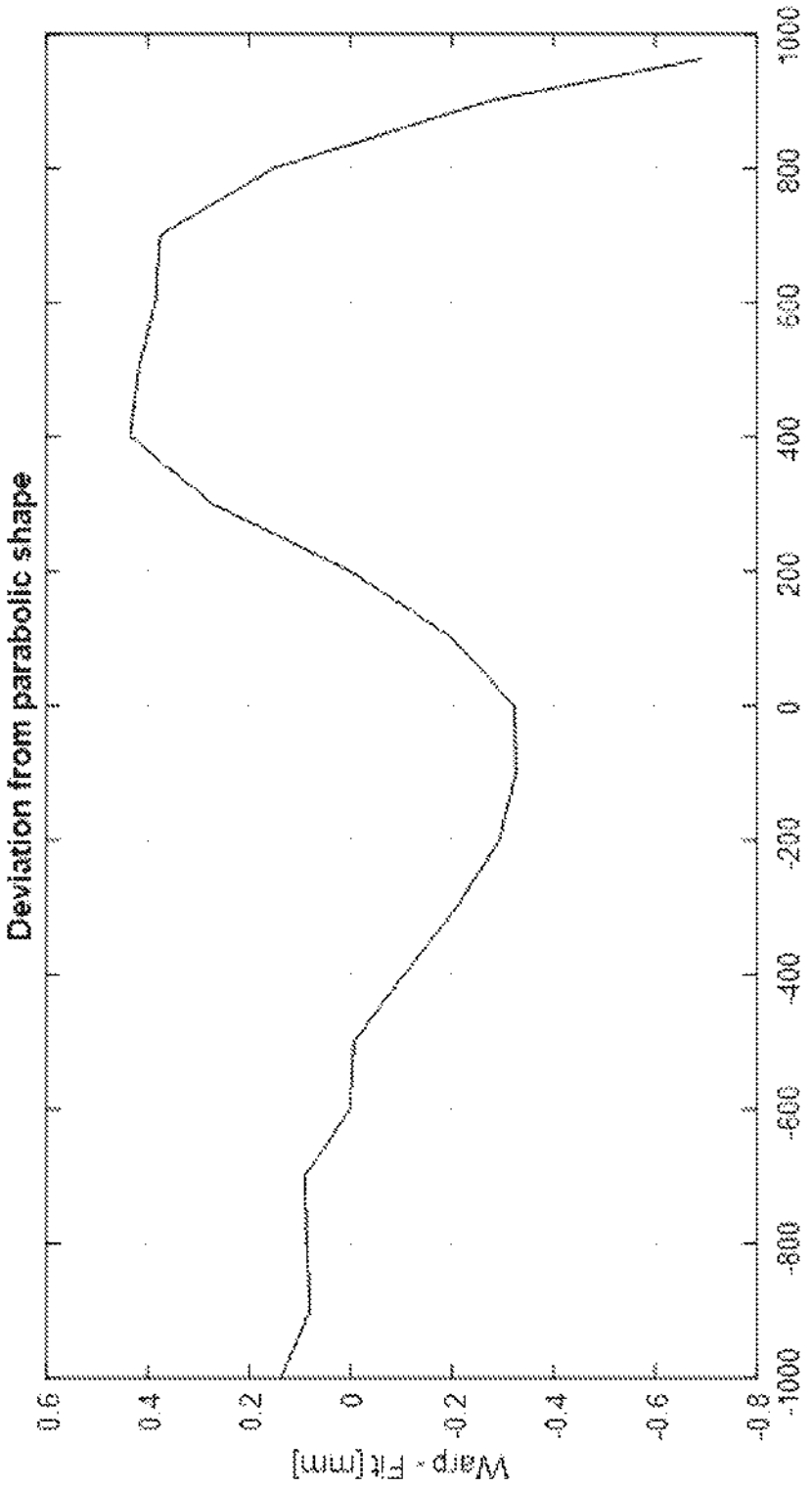


Figure 18b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 525

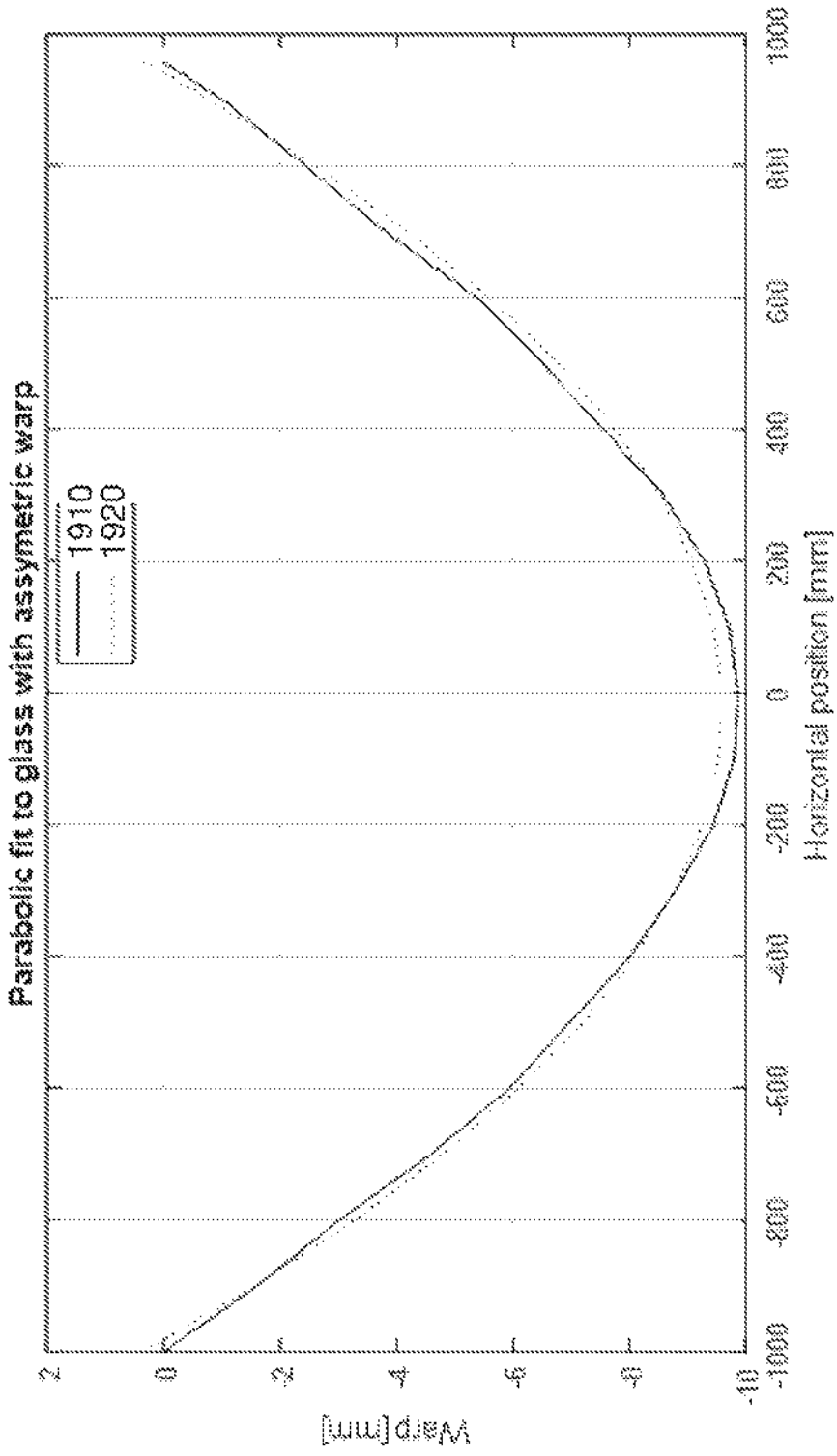


Figure 19a

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 526

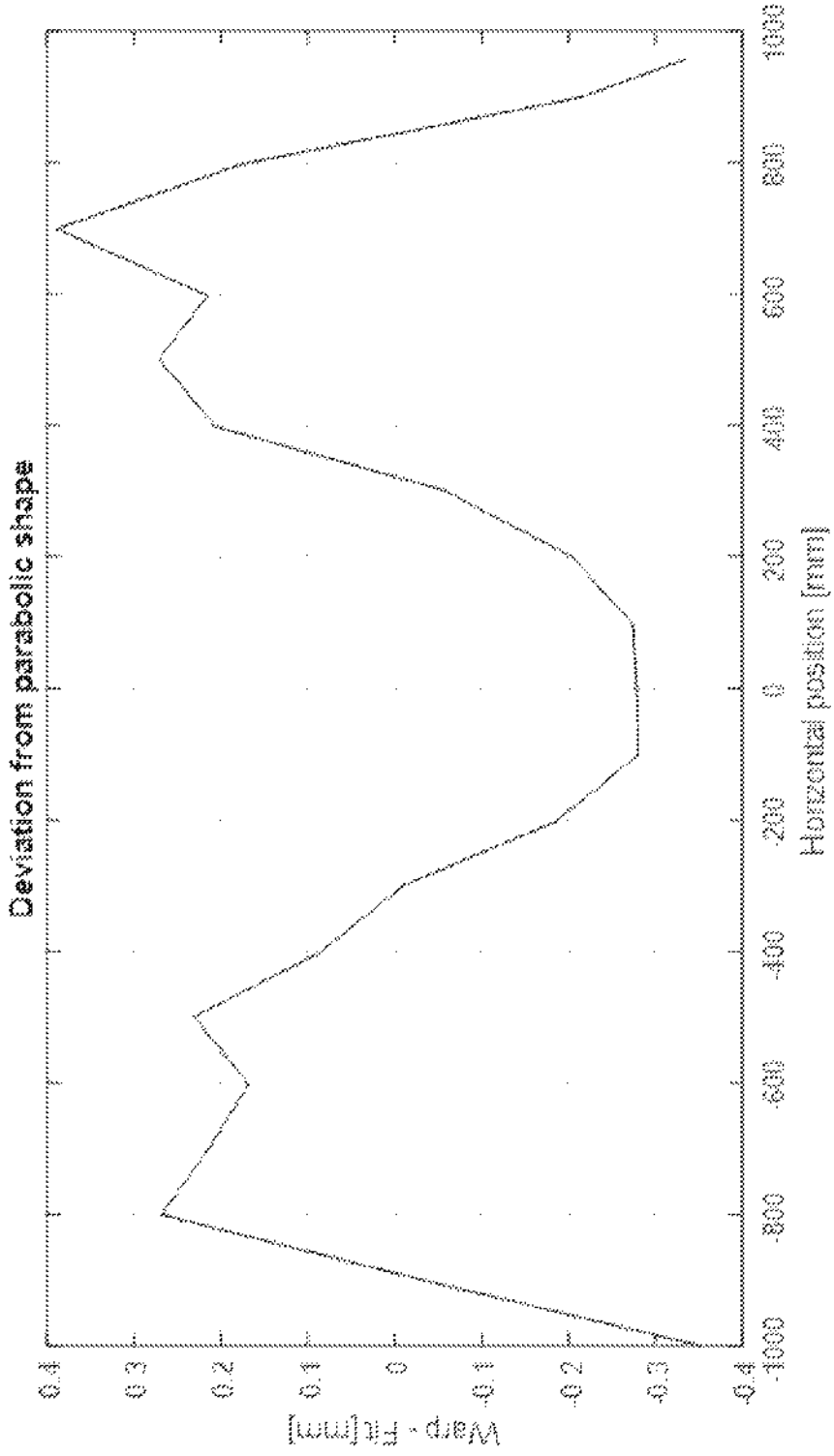


Figure 19b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 527

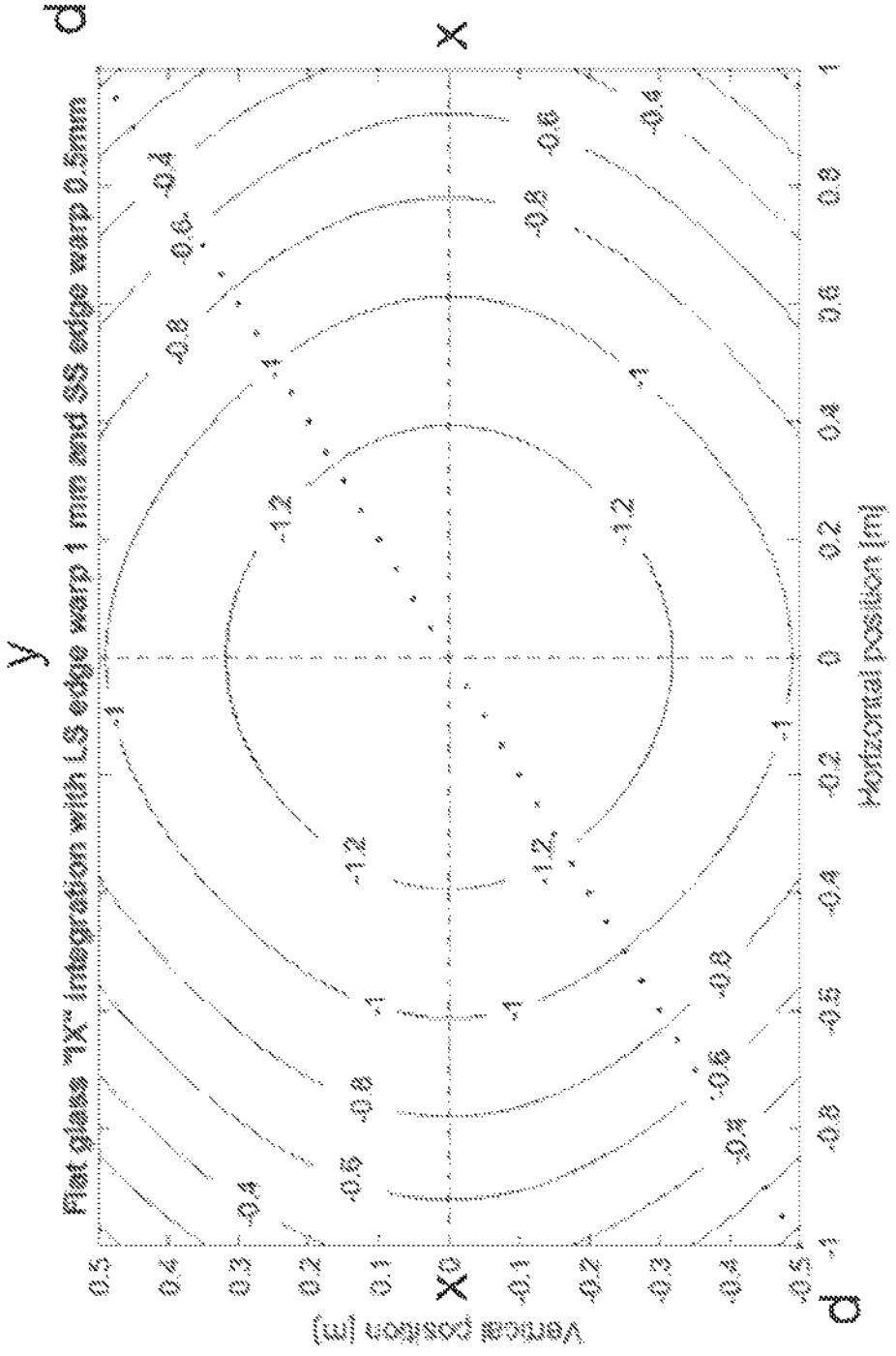

Flat glass "1X" integration with LS edge warp 1 mm and SS edge warp 0.5mm
Horizontal position (m)
Vertical position (m)
x
y
0
0.2
0.4
0.6
0.8
1
-0.2
-0.4
-0.6
-0.8
-1
-1.2
0.1
0.2
0.3
0.4
0.5
-0.1
-0.2
-0.3
-0.4
-0.5

Figure 20a

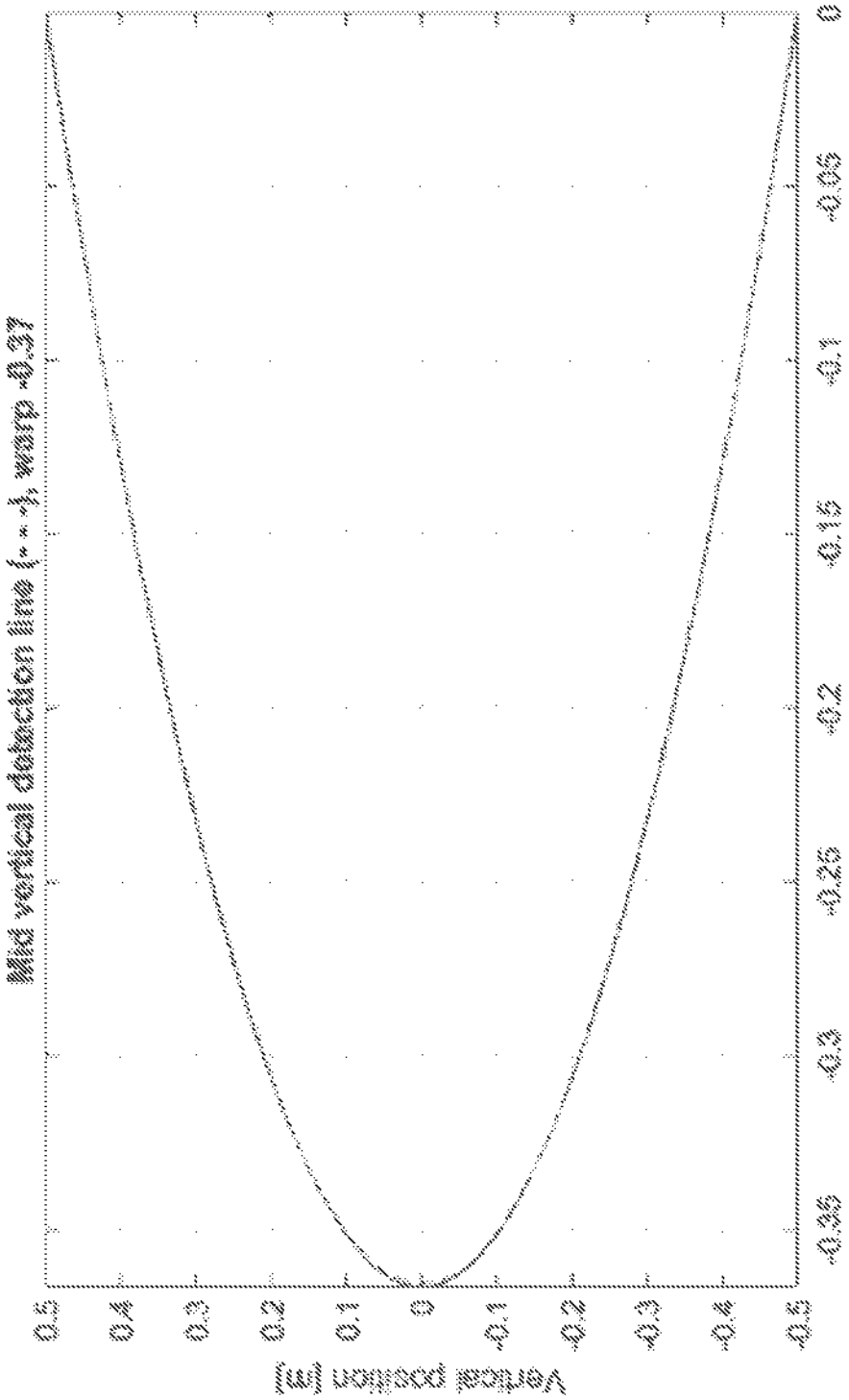

Mid vertical detection line (x = -1, wap 0.37
Vertical position (m)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
Warp (mm)
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35

Figure 20b

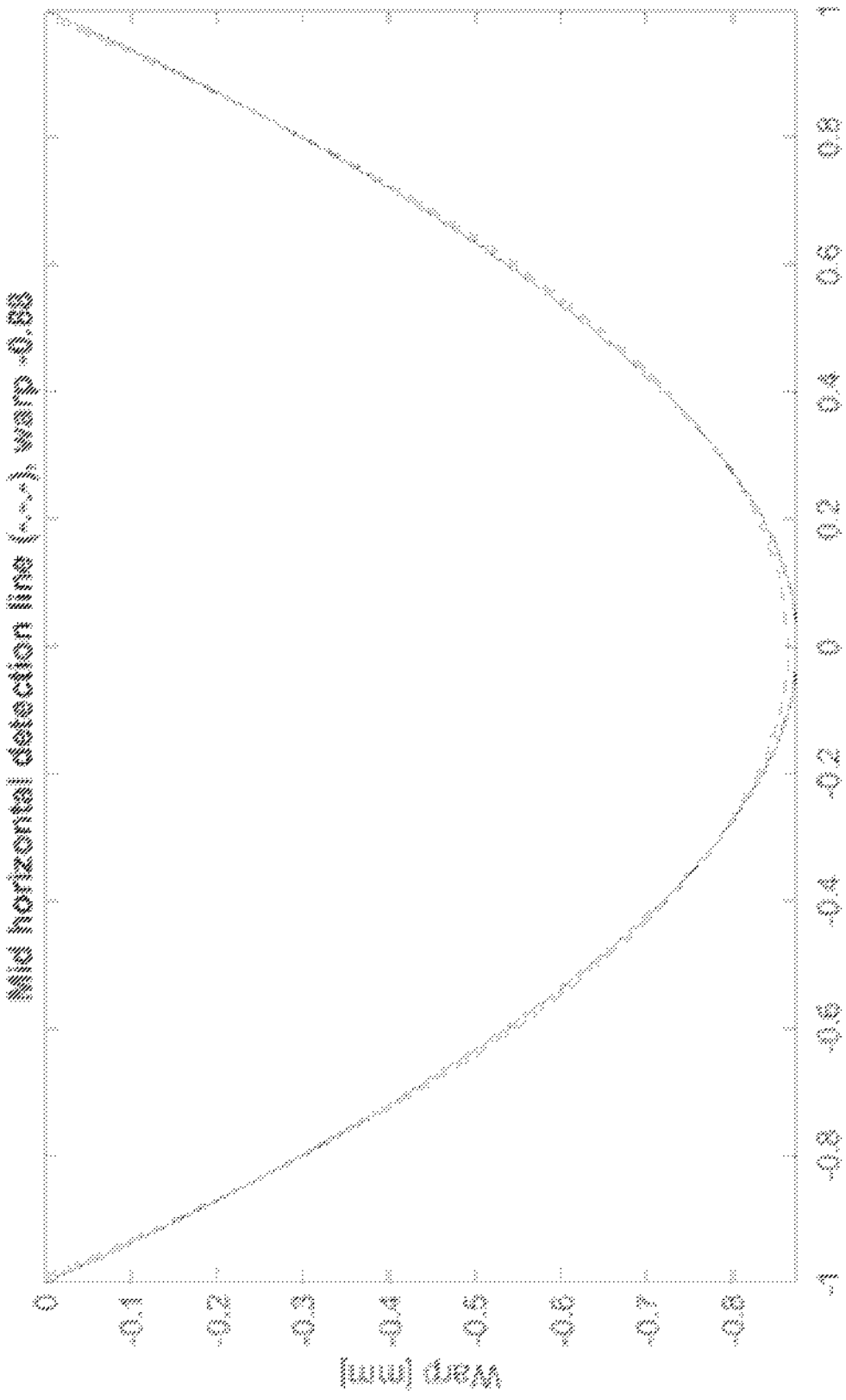


Figure 20c

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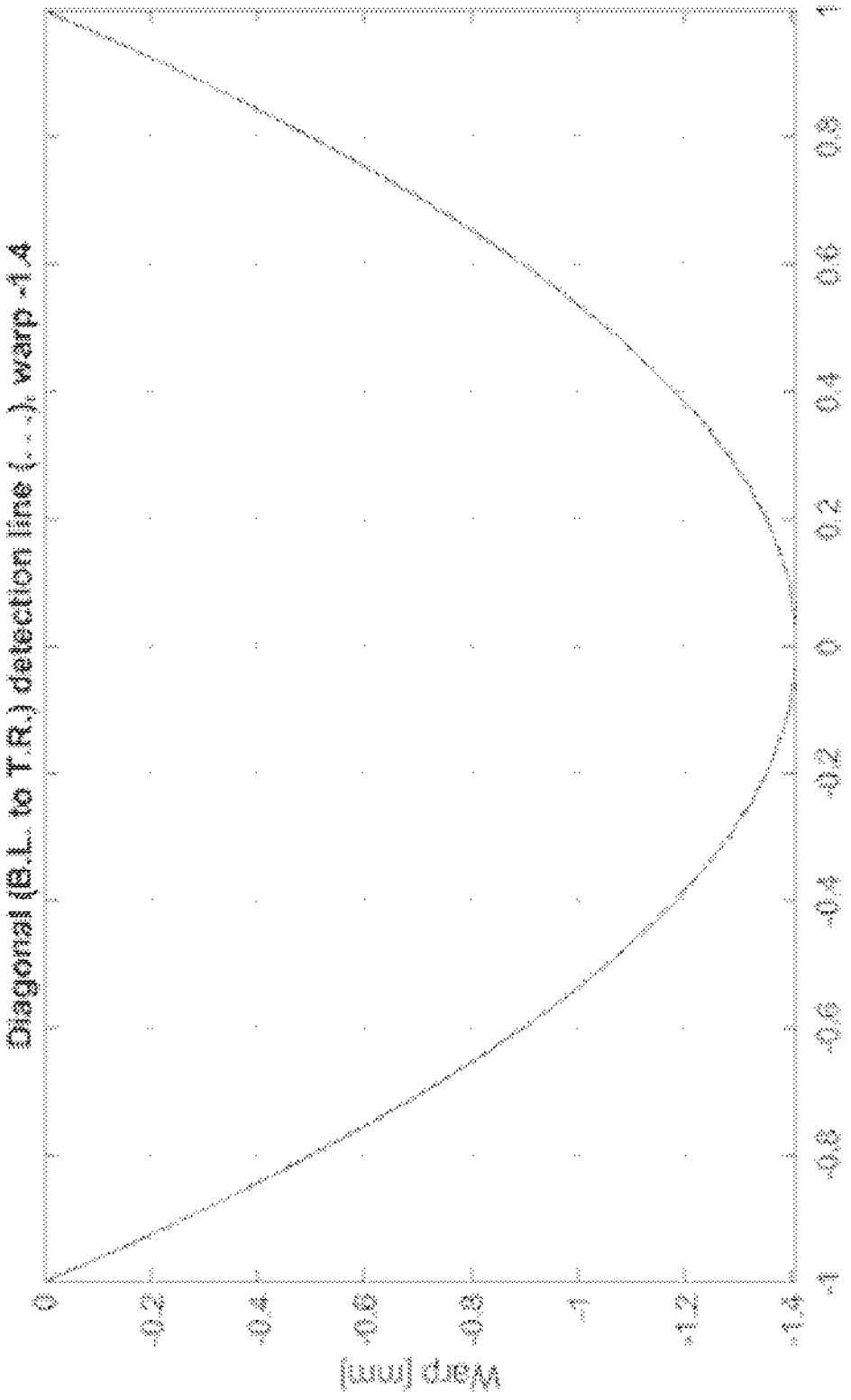


Figure 20d

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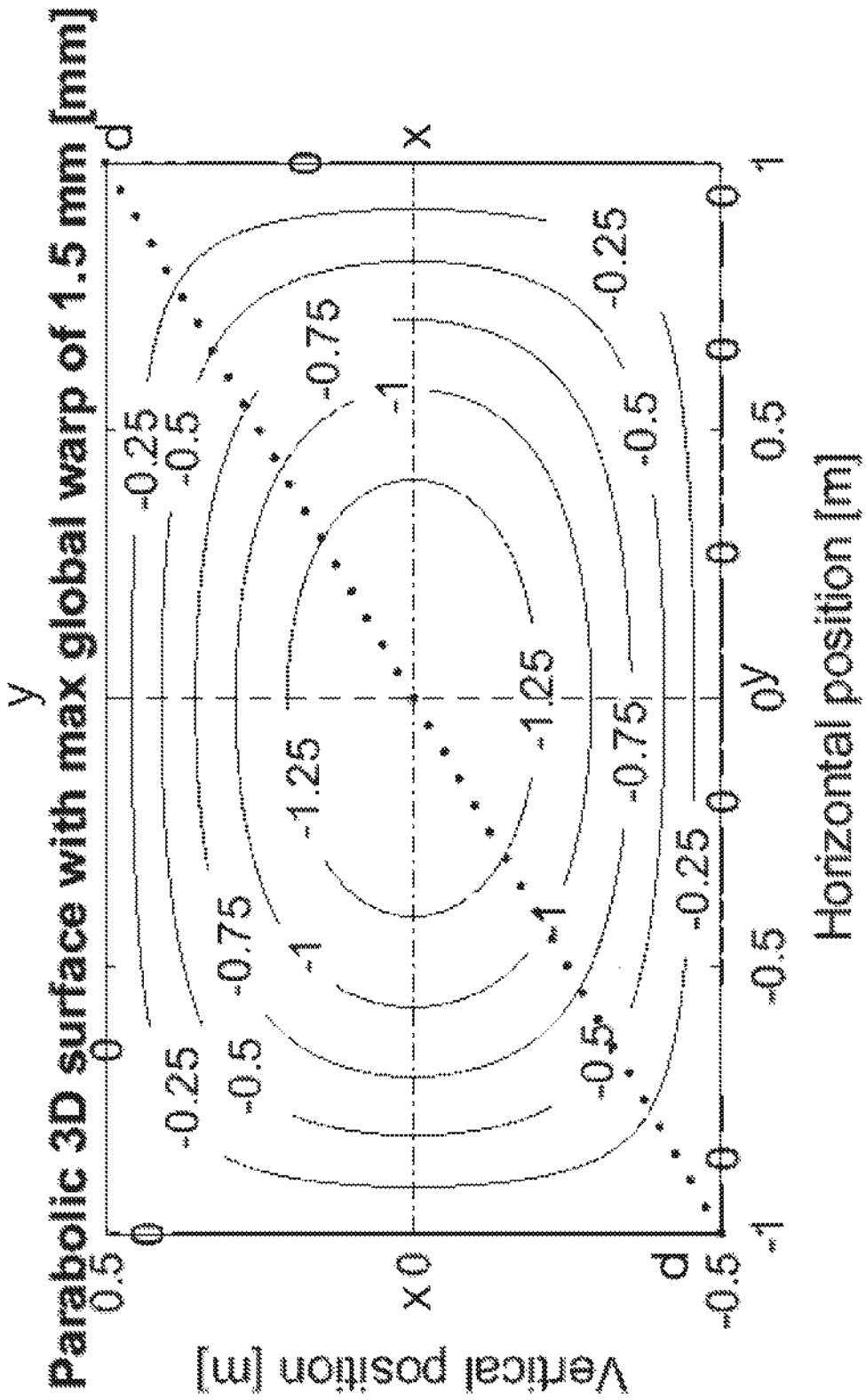


Figure 21a

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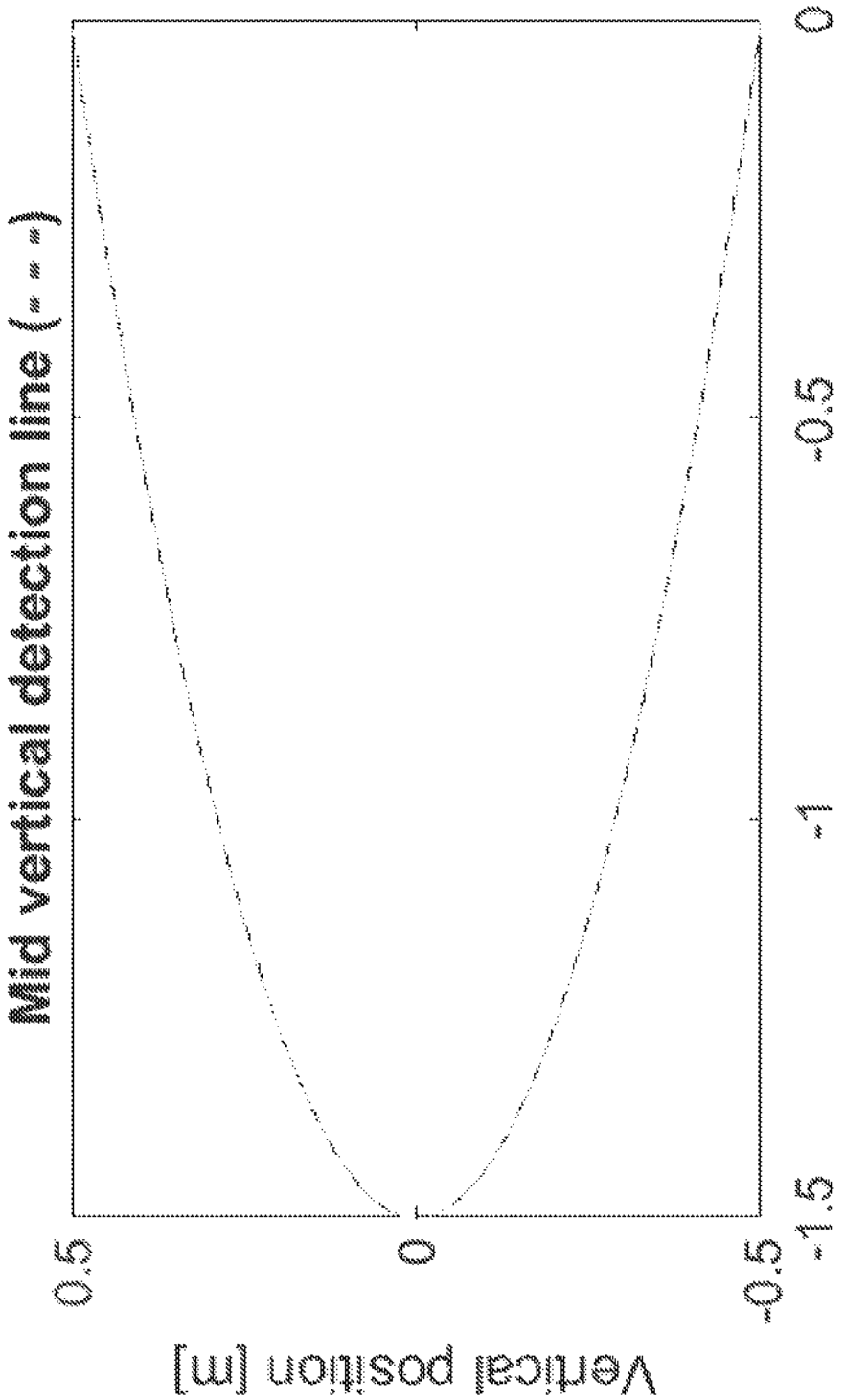


Figure 21b

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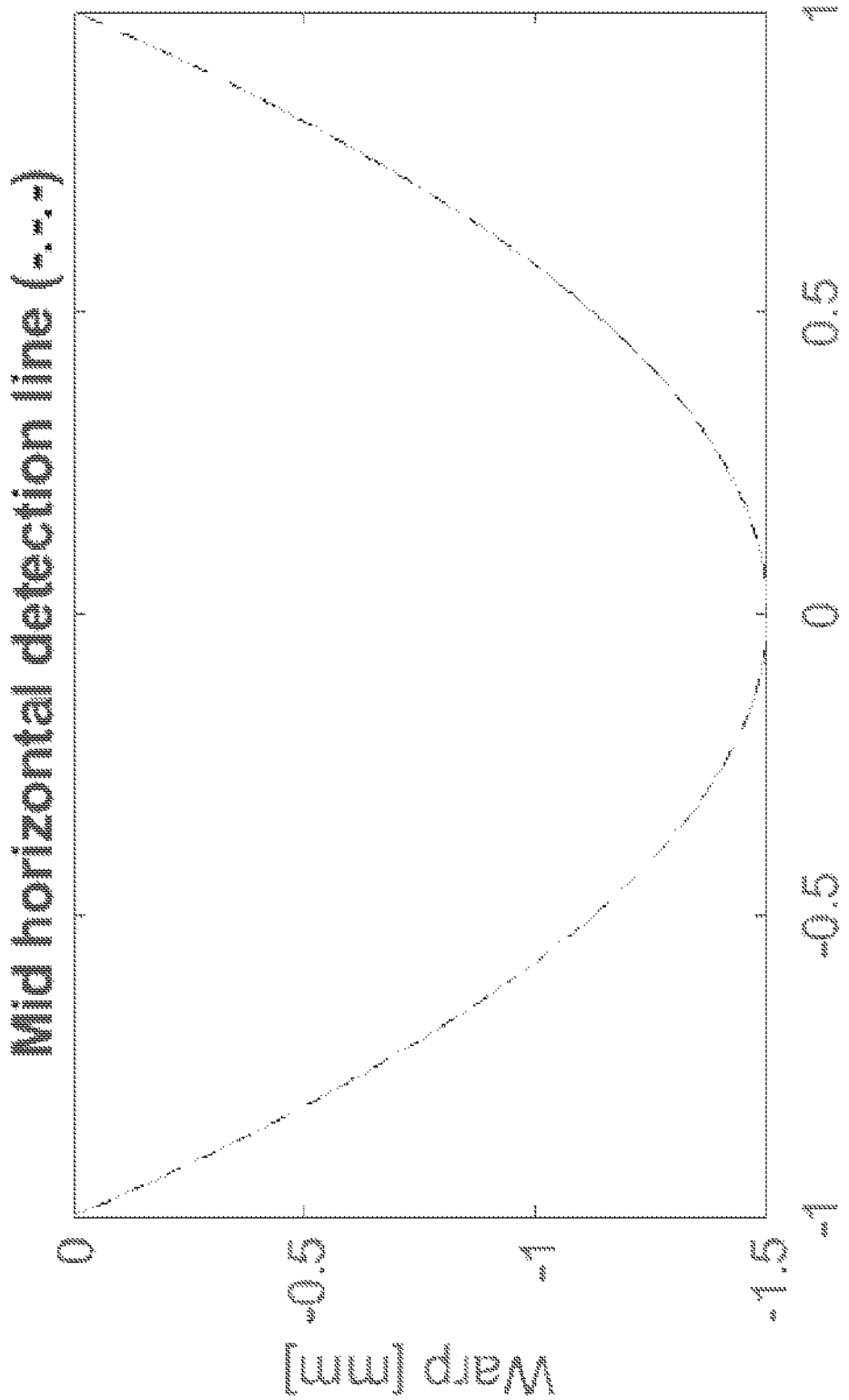


Figure 21c

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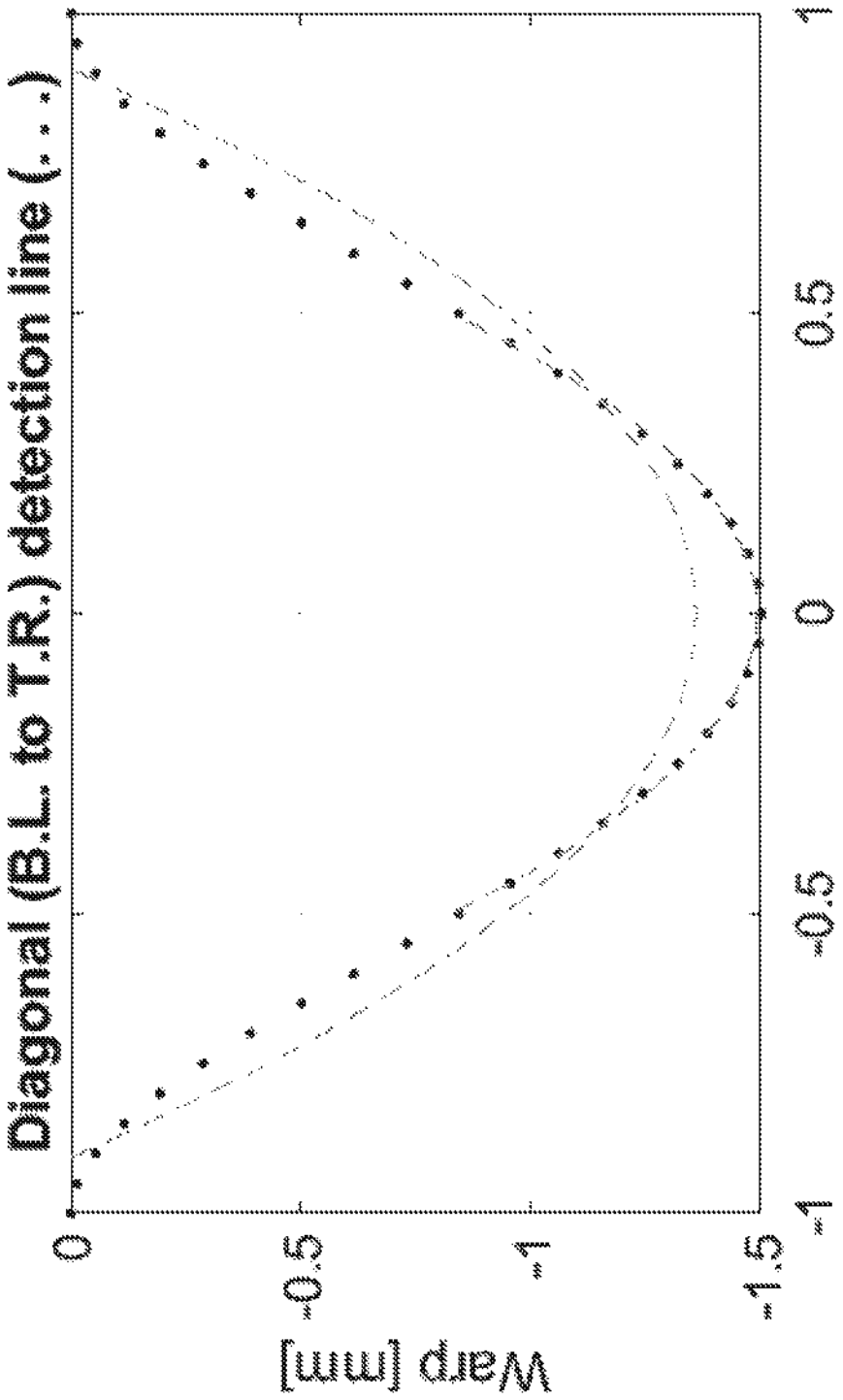


Figure 21d

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TOUCH DEVICE

INCORPORATION BY REFERENCE TO ANY PRIORITY APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57.

BACKGROUND

Field of the Invention

This invention relates in general to the field of optical touch sensitive systems. More particularly, the invention relates to a curved plate and an assembly for holding a plate of the system, such as a glass plate, relative to a panel such that curvature of the plate is controlled. The invention also relates to a method for assembling a plate of an optical touch sensitive system with a panel (such as a display panel) in such a way that curvature is controlled.

Background of the Invention

In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. U.S. Pat. No. 4,459,476, a plurality of optical emitters and optical receivers are arranged around the periphery of a touch surface to create a grid of intersecting light paths above the touch surface. Each light path extends between a respective emitter/receiver pair. An object that touches the touch surface will block certain ones of the light paths. Based on the identity of the receivers detecting a blocked light path, a processor can determine the location of the intercept between the blocked light paths. This type of system is only capable of reliably detecting the location of one object (single-touch detection). Further, the required number of emitters and receivers, and thus cost and complexity, increases rapidly with increasing surface area and/or spatial resolution of the touch panel.

In a variant, e.g. shown in WO2006/095320, each optical emitter emits a beam of light that diverges across the touch surface, and each beam is detected by more than one optical receiver positioned around the periphery of the touch surface.

These systems typically direct light to travel across the surface of the touch surface at a height of up to 5 mm.

Other above surface touch sensitive systems use tomographic touch imaging for sensing a touch, e.g. as described in WO2016/130074. Such systems allow for directing the light much closer to the touch surface, which in turn allows for significant improvements in accuracy and requires a lower light budget. The light is typically directed at a height of up to about 1 mm above the plate.

Typically, the touch surface is a glass plate. In systems where the light is directed closer to the touch surface, distortions in the plate have a disproportionally large effect on the light signal. Therefore, glass plates as used in previously known above surface optical touch systems are unsuitable when the light is transmitted closer to the plate, since the accuracy of the system is impaired by the distortions in the plate.

Additionally, a frame for assembly of the plate of the optical touch sensitive system and a panel, such as an LCD panel, may introduce distortion in the form of uncontrolled warpage, i.e. a twist or curve in the plate is introduced even if it is usually flat. The uncontrolled warpage may even block the light transmitted across the plate. This is due to uncontrolled twisting of the frame as such when it is attached to the panel.

Although not described in relation to touch systems, methods of minimizing glass warpage are known from the window industry and from the display panel industry. Such solutions include pre-bent glass in order to control warpage. However, such solutions are unsuitable/insufficient for touch sensitive systems since they typically require bulky frames at the border of the glass and/or pressure points closer to the center of the panel where force may be applied to control the shape of the glass. These solutions are unsuitable where a minimal/lightweight border bezel is required, and no supporting objects may touch the glass further in than at the borders. Additionally, pre-bent glass is expensive and fragile to transport.

Therefore, an improved frame assembly for holding a plate of an optical touch sensitive system relative to a panel would be advantageous and in particular allowing for improved precision, increased compactness, cost-effectiveness, and/or controlled curvature would be advantageous. Further, a touch panel having a shape conducive to transmitting as much light from the emitters as possible to the detectors is needed.

SUMMARY OF THE INVENTION

Accordingly, embodiments of the present invention preferably seek to mitigate, alleviate or eliminate one or more deficiencies, disadvantages or issues in the art, such as the above-identified, singly or in any combination by providing an assembly, a method for assembling, and a kit of frame elements according to the appended patent claims.

A first embodiment of the invention describes an assembly for holding and controlling curvature of a plate for an optical touch sensitive system, comprising a first frame element extending in a first plane and configured to extend at least partially around a panel; at least one second frame element extending in a second plane and forming a support portion for the plate, and at least one spacing element positioned at least partially between the support portion and the first frame element, the spacing element being configured to control a curvature of the first frame element, and wherein the at least one second frame element is configured to engage the plate at the support portion, is attached to the first frame element, and wherein the shape and/or position of the second frame element is controlled by the curvature of the first frame element with said spacing element, to control a curvature of the plate.

A second embodiment of the invention describes a method for assembling a panel and a plate for an optical touch sensitive system, comprising: providing a first frame element extending in a first plane and configured to extend at least partially around a panel; providing at least one second frame element forming a support portion for the plate; supporting the plate by the support portion; attaching the second frame element to the first frame element such that the support portion extends at least partially in a second plane generally opposite at least a portion of the first frame element and is spaced apart from the first plane; and controlling a curvature of the first frame element with a spacing element attached to the first frame element and thereby tilting the support portion to control a curvature of the plate.

A third embodiment of the invention describes a kit of frame elements for assembling a panel and a plate for a touch sensitive system, comprising: a first frame element

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extending in a first plane; at least one second frame element forming a support portion for the plate and being attachable to the first frame element, and a spacing element adjustably attachable to the first frame element; wherein at least a portion of the support portion is tiltable, by the spacing element, relative to the first frame element to extend in the second plane, which is curved.

Some embodiments of the invention provide for controlling curvature of a plate for an optical touch sensitive system such that it does not occur when the plate is assembled with a panel. This prevents distortion in the plane from affecting a light signal transmitted across the plate, which in turn allows improvements in accuracy and lower light budget of the system. Additionally, or alternatively, embodiments provide for controlling curvature such that the field of view, for a detector receiving light from a light emitter of the touch sensitive system, is increased compared to a substantially flat plate. Again, the improved field of view provides for improved accuracy of the touch sensitive system and allows for a better light budget. Furthermore, embodiments provide for an assembly that is compact at the same time as curvature may be controlled. Also, the curvature may be controlled without contacting the center of the plate.

A fourth embodiment of the invention describes a touch sensing apparatus, comprising a touch surface; a set of emitters arranged around the touch surface to emit first beams of light to propagate across the touch surface, a set of light detectors arranged around the touch surface to receive light from the first set of emitters, wherein each light detector is arranged to receive light from more than one emitter; a processing element configured to determine, based on output signals of the set of light detectors, the position of an object on the touch surface, wherein the touch surface is curved in a first axis according to a first parabola.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects, features and advantages of which embodiments of the invention are capable of will be apparent and elucidated from the following description of embodiments of the present invention, reference being made to the accompanying drawings, in which:

FIG. **1** is a top view of the first frame element showing cross-sectional axes A-A and B-B;

FIGS. **2***a*-**2***d* are cross-sectional views of embodiments of assemblies;

FIG. **3***a* is a schematic illustration showing the cross-section axis B-B of FIG. **1** of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

FIG. **3***b* is a schematic illustration showing the cross-section axis A-A of FIG. **1** of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

FIG. **3***c* is a schematic view (cross section) showing the cross-section axis B-B of FIG. **1** of the assembly with the second frame element warped relative to the first frame element and holding the plate in a curved plane that is concave;

FIG. **3***d* is a schematic view (cross section) showing the cross-section axis A-A of FIG. **1** of the assembly with the second frame element warped relative to the first frame element and holding the plate in a curved plane that is concave;

FIG. **4***a* is a perspective view of the first frame element;

FIG. **4***b* is a schematic illustration of the panel in a convex shape and the frame of the first frame element in a concave shape, including plate **2** also controlled into a concave shape;

FIG. **4***c* is a side view showing screws **116***a* and **116***b*;

FIGS. **5***a*-**5***h* are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

FIG. **6** is a schematic cross section from a first direction of an embodiment of the assembly;

FIG. **7** is a schematic side-view of another embodiment for providing curvature of plate **2**;

FIG. **8** shows an isometric view of a variation of the embodiment of FIGS. **5***a*-**5***g*;

FIG. **9** is a diagram showing a top down view of an optical touch system and corresponding detection lines;

FIG. **10***a* shows an isometric view of a flat touch surface of an optical touch system;

FIG. **10***b* shows a section view of an optical touch system with a flat touch surface;

FIG. **11***a* shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

FIG. **11***b* shows a section view along the x-axis of an optical touch system with a touch surface having a curved profile in the x-axis;

FIG. **11***c* shows a section view along the x-axis of an optical touch system with a touch surface having a curved profile in the x-axis;

FIG. **11***d* shows an example of types of warpage that a touch panel may exhibit.

FIG. **12***a* shows top view of a touch surface of an optical touch system.

FIG. **12***b* shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis and a curved profile in the y-axis;

FIG. **12***c* shows a section view along the x-axis of an optical touch system with a touch surface having a curved profile in the x-axis and a curved profile in the y-axis;

FIG. **12***d* shows a section view along the y-axis of an optical touch system with a touch surface having a curved profile in the x-axis and a curved profile in the y-axis;

FIG. **13***a* shows a section render of light emitted from a point at an edge of a curved touch surface and propagating across the curved touch surface to be received at a detector at an opposite edge of the touch surface;

FIG. **13***b* shows a graph of light emitted from a point at an edge of a curved touch surface and received at a detector at an opposite edge of the touch surface with respect to the angle of the emitter light;

FIG. **14***a* shows a section render of light emitted from a point at an edge of a curved touch surface and propagating across the curved touch surface to be received at a detector at an opposite edge of the touch surface;

FIG. **14***b* shows a graph of light emitted from a point at an edge of a curved touch surface and received at a detector at an opposite edge of the touch surface with respect to the angle of the emitter light;

FIG. **13***a* shows a section render of light emitted from a point at an edge of a curved touch surface and propagating across the curved touch surface to be received at a detector at an opposite edge of the touch surface.

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FIG. **15***b* shows a graph of light emitted from a point at an edge of a curved touch surface and received at a detector at an opposite edge of the touch surface with respect to the angle of the emitter light;

FIG. **16***a* shows a section render of light emitted from a point at an edge of a curved touch surface and propagating across the curved touch surface to be received at a detector at an opposite edge of the touch surface;

FIG. **16***b* shows a graph of light emitted from a point at an edge of a curved touch surface and received at a detector at an opposite edge of the touch surface with respect to the angle of the emitter light;

FIG. **17***a* shows a section render of light emitted from a point at an edge of a curved touch surface and propagating across the curved touch surface to be received at a detector at an opposite edge of the touch surface;

FIG. **17***b* shows a graph of light emitted from a point at an edge of a curved touch surface and received at a detector at an opposite edge of the touch surface with respect to the angle of the emitter light;

FIG. **18***a* shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

FIG. **18***b* shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

FIG. **19***a* shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

FIG. **19***b* shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

FIG. **20***a* shows top view of displacement contours for a touch surface according to an embodiment;

FIG. **20***b* shows curvature of a touch surface along an x-axis according to the embodiment of FIG. **20***a*;

FIG. **20***c* shows curvature of a touch surface along a y-axis according to the embodiment of FIG. **20***a*;

FIG. **20***d* shows curvature of a touch surface along a diagonal line according to the embodiment of FIG. **20***a*;

FIG. **21***a* shows top view of displacement contours for a touch surface according to another embodiment;

FIG. **21***b* shows curvature of a touch surface along an x-axis line according to the embodiment of FIG. **21***a*;

FIG. **21***c* shows curvature of a touch surface along a y-axis line according to the embodiment of FIG. **21***a*;

FIG. **21***d* shows curvature of a touch surface along a diagonal line according to the embodiment of FIG. **21***a*.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Specific embodiments of the invention will now be described with reference to the accompanying drawings. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. The terminology used in the detailed description of the embodiments illustrated in the accompanying drawings is not intended to be limiting of the invention. In the drawings, like numbers refer to like elements.

In optical touch sensitive systems, a plate **2** of the system, such as a glass plate may be arranged opposite a panel **1**, such as an LCD panel or additional frame. The plate **2** is normally substantially flat. The perimeter of the plate **2** after integration is a concern: the four sides/edges of the plate **2** must all be plane or slightly concave as seen from the touch surface, i.e. the side of the plate **2** above which light is transmitted. An aspect of this is to ensure that the mechanical parts that hold or support the perimeter of the plate **2** are free from convexity. Sometimes, there are several components that are involved in holding the plate **2** (back cover, carriers, edge cover, screw bosses etc.) The stiffer component of the assembly, the more it will govern the final shape of the plate **2**.

In prior art solutions, the frame that holds the plate **2** at the edge/perimeter may introduce some twist (the corners will not lay perfectly on a flat plane) to the plate. Twist may induce convexity along the plate diagonals and should thus be minimized or avoided. The twist tolerance depends, e.g., on glass specification, product, size, shape of integrated glass perimeter, and on how a VESA mount is attached.

FIG. **1** shows an embodiment of a frame assembly **100**, **200** that prevents inducement of convexity along the plate, such as along the plate edges and/or diagonals. Some embodiments avoid convexity and may even induce concavity to further improve the touch system. Frame **109** is formed from first frame element **102**. Attachment element **112** and spacing element **116** are described in the embodiments below.

According to some embodiments of the invention, an assembly **100**, **200**, which is configured to hold or support the plate **2** and the panel **1**, applies a controlled force to the plate **2** such that curvature of the plate **2** is controlled. In the embodiments illustrated in FIGS. **2***a*-**2***c* and **3***a*-**3***d*, the force applies a torque to a support portion **101***a*, **101***b* for the plate **2**. In the embodiments of FIGS. **4***a*-**4***c*, the force is substantially straight and perpendicular to the plate **2**. In the following, the embodiments of FIGS. **2***a*-**2***c*, **3***a*-**3***d*, **4***a*-**4***c*, and **5***a*-**5***g* will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in FIGS. **6***a*-**6***c*.

FIGS. **2***a*-**2***d* illustrate embodiments wherein the frame assembly **100** comprises a first frame element **102** and at least one second frame element **103***a*, **103***b*. The first frame element **102** may form a rear bracket frame that extends at least partially over the backside of the panel **1**. The second frame element **103***a*, **103***b* may form a holder or support bracket. Furthermore, second frame element **103***a*, **103***b* may extend along at least a portion of a perimeter of the plate **2** and/or the panel **1**. Separate second frame elements **103***a*, **103***b* may extend at least partially along the perimeter of different sides of the plate **2** and/or panel **1**. For example, two second frame elements **103***a*, **103***b* may extend along opposing perimeters of the plate **2** and/or panel **1**. Alternatively, four second frame elements **103***a*, **103***b* may extend along the perimeter of the plate **2** and/or panel **1**, i.e. one along each side of a rectangular plate **2** and/or panel **1**.

As is illustrated in FIGS. **4***a*-**4***c*, the panel **1** may be held between the first frame element **102** and the second frame element **103***a*, **103***b*. The plate **2** may be supported or held at a first side of a portion of the second frame element **103***a*, **103***b* forming the support portion **101***a*, **101***b*. The panel **1** may be held or supported by a second side of the support portion **101***a*, **101***b*, which forms a support portion for the panel **1**. An adhesive **104**, such as an adhesive tape, may be arranged between the support portion **101***a*, **101***b* and the plate **2**. A gasket **105** may be arranged between the support portion **101***a*, **101** *b* and the panel **1**.

In one embodiment, elements **102**, **103** (shown in the figure as comprising elements **103***a* and **103***b*) are formed from a single piece.

The second frame element **103***a*, **103***b* may be attached to the first frame element **102**.

In the embodiments of FIGS. **2***a*-**2***c* and **3***a*-**3***d*, the second frame element **103***a*, **103***b*, is attached to the first frame

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element **102** by at least one attachment member **106***a*, **106***b*, such as a screw, a weld, a rivet etc. Therefore, the second frame element **103***a*, **103***b* may be rigidly attached to the first frame element **102**.

The first frame element **102** may comprise a flange **107***a*, **107***b* that extends at the perimeter of the first frame element **102**. Similarly, the second frame element **103***a*, **103***b* may comprise a flange **108***a*, **108***b*. When assembled, the flange **107***a*, **107***b* of the first frame element **102** may be arranged in abutment with the flange **108***a*, **108***b* of the second frame element **103***a*, **103***b*. The flange **107***a*, **107***b* of the first frame element **102** may be held together with the flange **108***a*, **108***b* of the second frame element **103***a*, **103***b* by the attachment member **106***a*, **106***b*.

The first frame element **102** may form a frame **109** (shown in FIG. **1**) that extends in a first plane. The frame **109** is configured to extend at least partially around a first side of a panel **1**. The first side of the panel **1** may be the backside of the panel **1**. In some embodiments, the frame **109** has a width, such as 3-10 cm. The frame **109** may extend from the edges of the first side towards the center of the first side of the panel **1**. Therefore, the frame **109** may be rectangular, and made from a single piece of material.

As is illustrated in FIGS. **3***a* and **3***b*, the assembly **100** may comprise at least one support area **110***a*, **110***b* for supporting a back cover **111**. The support area **110***a*, **110***b*) may extend in a plane that is substantially parallel to the first plane, in which the frame **109** extends. The support area **110***a*, **110***b* may be located further away from the support portion **101***a*, **101***b* of the second frame element **103***a*, **103***b* than the frame **109**, such that the frame **109** and the back cover **111** are spaced apart. In the illustrated embodiment, the support area **110***a*, **110***b* is provided between the flange **107***a*, **107***b* and the frame **109** of the first frame element **102**. The back cover **111** may be attached to the support area **110***a*, **110***b*, e.g. by attachment elements, such as screws.

In other embodiments, the support area **110***a*, **110***b* is provided by the flange **108***a*, **108***b* of the second frame element **103***a*, **103***b*. The flange **107***a*, **107***b* of the first frame element **102** may be connected to the second frame element **103***a*, **103***b* between the flange **108***a*, **108***b* and the support portion **101***a*, **101***b* of the second frame element **103***a*, **103***b*.

The second frame element **103***a*, **103***b* may form the support portion **101***a*, **101** *b*. For example, the second frame element **103***a*, **103***b* may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element **103***a*, **103***b* may extend along the perimeter of the panel **1**, and wrap around the perimeter of the panel such that the support portion **101***a*, **101***b* extends at least partially in a second plane generally opposite the frame **109** and spaced apart from the first plane. Thereby the second frame element **103***a*, **103***b* is configured to extend at least partially at a second side of the panel **1**, e.g. at a front side of the panel **1**.

In some embodiments, the second frame element **103***a*, **103***b* has a first portion and a second portion. The first portion may be provided at an angle relative to the second portion. The second portion may form the support portion **101***a*, **101***b* and be configured to extend in the second plane opposite the frame **109**. The first portion may extend between the second portion and the first frame element **102**. Also, the first portion may extend along the edge or side surface of the plate **2** when assembled. The first frame element **102** may be connected to the first portion of the second frame element **103***a*, **103***b*. The first portion may be substantially perpendicular to the second portion.

As is illustrated in FIGS. **3***a*-**3***d*, the first frame element **102** may be attached to the first portion of the second frame element **103***a*, **103***b* such they are fixed relative to each other. Furthermore, the second frame element **103** is tiltable relative to the first frame element **102**. A force applied to the first frame element **102** is transferred to the second frame element **103** such that the support portion **101***a*, **101***b* is tilted towards the first frame element **102**. Thus, a torque may control tilt of the second portion of the second frame element **103***a*, **103***b*, i.e. the support portion **101***a*, **101***b* that supports the plate **2**, relative to the first frame element **102**, which is illustrated with a curved arrow in FIGS. **3***c* and **3***d*. In some embodiments, the angle of tilt of the support portion **101***a*, **101***b* is controlled to be neutral, i.e. the angle of tilt of the support portion **101***a*, **101***b* is controlled such that it is substantially parallel with the panel **1** and/or controls the plate **2** to be in a flat plane, as is illustrated in FIGS. **3***a* and **3***b*. In other embodiments, the angle of tilt of the support portion **101***a*, **101***b* is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion **101***a*, **101***b* is controlled such that the free end of the support portion **101***a*, **101***b* is tilted towards the frame **109**, as is illustrated in FIGS. **3***c* and **3***d*. In the latter case, the plate **2** is given a slightly concave shape, i.e. in the direction from the touch surface of the plate **2** towards the panel **1**. In each of these cases curvature is controlled such that the field of view, for a detector receiving light from a light emitter of the touch sensitive system, is improved since convexity in the plate is avoided. Again, improved field of view provides for improved accuracy of the touch sensitive system and allows for lower light budget. Furthermore, since the support portion **101***a*, **101***b* only needs to extend a short distance over the plate **2** at the perimeter the assembly is compact at the same time as curvature may be controlled. Also, curvature may be controlled without contacting the center of the plate. When the concavity is applied, the sensitivity of the system may be even further improved.

FIGS. **2***a*-**2***d* and **3***a*-**3***d* illustrate embodiments of an attachment element **112** for attaching the first frame element **102** to the panel. A plurality of attachment elements **112** (e.g. as shown in triplicate as elements **112***a*, **112***b*, and **112***c*) may be arranged around the frame **109**, such as at each corner of the frame **109**, which is illustrated as circles in FIG. **4***a*. Each attachment element may comprise a group of screws **112***a*, **112***b*, **112***c*, **113***a*, **113***b*. Each screw may be arranged in a hole of the frame **109**, which may be threaded. Each attachment element may comprise at least two screws **112***a*, **112***b*, **112***c*, **113***a*, **113***b*. At least one of the screws **112***a*, **113***a* may be arranged to displace the frame **109** away from panel **1**, which is indicated with an arrow in FIG. **2***d* e.g. by having a thread in the frame **109** and pushing on the panel **1**. At least one other of the screws **112***b*, **112***c*, **113***b* may be arranged to displace the frame **109** towards the panel **1**, which is also indicated with an arrow in FIG. **2***d*, e.g. by having a thread in the panel and a hole in frame **109**.

FIG. **2***a* illustrates an embodiment wherein each attachment element comprises at least three screws **112***a*, **112***b*, **112***c*. All three screws **112***a*, **112***b*, **112***c* are arranged closer to a center of the first frame element **102** than a perimeter of the support portion **101***a*, **101***b*, i.e. an imaginary extension **114***a*, **114***b*, **114***c* of the longitudinal axis of each screw **112***a*, **112***b*, **112***c* passes outside the support portion **101***a*, **101***b* when viewed in cross-section, as is illustrated in FIG. **2***a*. In the illustrated embodiment, a first screw **112***a* is arranged between a second screw **112***b* and a third screw **112***c*. FIG. **2***a* only illustrates one group of screws. However, a group of

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screws may be arranged at any location around the frame **109** to attach the first frame element **102** to the panel **1**.

FIG. **2***b* illustrates an embodiment wherein each group of screws consists of only two screws **113***a*, **113***b*. A first screw **113***a* is arranged opposing the support portion **101***a*, **101***b*, i.e. an imaginary extension **115***a* of the longitudinal axis of the first screw **113***a* passes through the support portion **101***b* when viewed in cross-section, such as through the center thereof, as is illustrated in FIG. **2***b*. A second screw **113***b* of the two screws is arranged closer to a center of the first frame element **102** than a perimeter of the support portion **101***b*, i.e. an imaginary extension **115***b* of the longitudinal axis of the first screw **113***b* passes outside the support portion **101***b* when viewed in cross-section, as is illustrated in FIG. **2***b*.

As shown in FIG. **2***d*, the first screw **112***a* is arranged to displace the frame **109** away from panel **1**. This may be enabled by a threaded hole **112***i* in the frame **102** which the first screw engages while a head of the screw abuts the panel **1**. The second screw **112***b* is arranged to displace the frame **109** towards the panel. This may be enabled by a threaded hole **112***f* in the panel **1**, which the second screw **112***b* engages while the head of the second screw **112***b* abuts the surface of the frame. By using screw **112***a* and/or **112***b*, forces may be applied to frame **102** and/or panel **2** to control bending or rotation of the frame/panel.

Since the first screw **113***b* is aligned over the support portion **101***a*, **101***b* in the embodiment of FIG. **2***b*, only two screws are required to control bending or rotation of the frame.

In FIGS. **2***a*-**2***b*, only one group of screws is illustrated. However, a group of screws may be arranged at any location around the frame **109** to support the plate **2** and the panel **1**.

FIG. **2***c* illustrates that a combination the embodiment of FIGS. **2***a* and **2***b*, i.e. groups of screws with two as well as three screws may be arranged around the frame **109**. Therefore, flexibility is provided for.

As is illustrated in FIGS. **2***a*-**2***c* and **3***c* and **3***d*, each group of screws **112***a*, **112***b*, **112***c*, **113***a*, **113***b* may apply a force to the frame **109**. Therefore, a torque may be applied at the second frame element **103***a*, **103***b* via controlling the curvature of the frame **109** such that tilt of the support portion **101***a*, **101***b*, and thereby curvature of the plate, is controlled. In the assembly illustrated in FIG. **3***a*, a net force is applied such that the frame is substantially flat and parallel with the panel **1**. In the assembly illustrated in FIGS. **3***c* and **3***d*, a net force away from the support portion **101***a*, **101***b* is provided to the frame **109**, which will be slightly concave when viewed from the touch surface of the plate **2**. As a consequence, a torque will be provided at to the second frame element **103***a*, **103***b*, which will tilt the support portion **101***a*, **101***b* along the edge or perimeter of the plate **2**. Therefore, controlling the curvature of the first frame element **109** may control curvature of the plate. The plate **2** may become concave as viewed from the touch surface of the plate **2**.

FIGS. **4***a*-**4***c*, **5***a*-**5***g* and **6***a*-**6***c* illustrate embodiments wherein an alternative or additional control of the shape of the frame **109** may be introduced. As shown in FIG. **4***a*, attachment elements **112** may be arranged at the corners of the frame **109**. The attachment elements **112** may comprise the group of screws **112***a*, **112***b*, **112***c*, **113***a*, **113***b* as described above with regard to FIGS. **2***a*-**2***c* and **3***a*-**3***d*. The attachment elements **112** may be arranged to pull the panel **1** towards the frame **109**. This may be done with or without tilting the support portion **101***a*, **101***b* as described above. At least one spacing element **116** (where spacing element **116** may comprise screw **112** and a separate spacing component) may be arranged along the perimeter of the frame **109** between two attachment elements **112**. The spacing element **116** is arranged in the assembly to apply a force to the frame **109** directed away from the panel **1**. Thereby, a force applied by the spacing element **112** may be transferred to the second frame element **103***a*, **103***b* such that the support **101***a*, **101***b* is tilted as described above, whereby curvature of the plate **2** is controlled.

As is illustrated in FIG. **4***b*, the general shape of the frame **109** will be concave, whereas the general shape of the panel **1** may be convex. The panel may also remain substantially plane depending on its rigidity. The resulting shape of the plate **2** will be concave. Therefore, each side of the frame **109** may be controlled to follow a curved path. The curvature may be controlled by adjusting the force applied by each spacing element **116** and/or via the number of spacing elements **116** along each side of the frame **109**. As a result, the support portion **101***a*, **101***b*, at least at the free end of the support portion **101***a*, **101***b*, may also follow a curved path. Therefore, at least a portion of the support portion **101***a*, **101***b* may extend in a plane that is curved.

When the second frame element **103***a*, **103***b* is disassembled or only attached to the first frame element **102**, it may have a relaxed state. In the relaxed state, the support portion **101***a*, **101***b* extends in a plane that is substantially flat. The second frame element **103***a*, **103***b* may be deflectable from the relaxed state to a deflected state or stressed state, such as by the attachment elements **112** and spacing elements **116**. The level of tilt at the opposing ends of the support **101***a*, **101***b* where the attachment elements **112** are provided may be less than the level of tilt between the ends where spacing element(s) **116** is/are provided. As consequence, the second frame element **103***a*, **103***b* may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion **101***a*, **101***b* extends, along its length, in a plane that is curved. A cross section of this plane taken along the support portion **101***a*, **101***b*, such as at the free end or tip of the support portion **101***a*, **101***b* may form a parabolic concave curve along at least a portion of the length of the support portion **101***a*, **101***b*. A combination of the attachment element **112** and the spacing element **116**, that together may form a screw arrangement, may hold the second frame element **103***a*, **103***b* in the deflected or stressed state when assembled with the first frame element **102**.

The spacing element **116** may be provided by a single screw that engages a thread in the frame **109** while its tip engages or abuts a surface on panel **1**. Alternatively, panel **1** comprises a threaded hole into which spacing element **116** is threaded so that spacing element **116** can be used to displace the frame **109** towards panel **11**. Additionally, element **116** may comprise a spacer component such as a washer, spacer, etc. In FIGS. **3***a* and **3***b* and FIG. **6***a*, two spacing elements **116***a*, **116***b* are shown for illustrative purposes and may form separate embodiments. A single-spacing element **116***a*, **116***b* may be used in other embodiments. The head of the spacing element **116***a*, **116***b* may abut the back cover **111** while the spacing element **116***a*, **116***b* may engage the frame **109**, wherein the frame **109** may be pulled towards the back cover **111**. As a result, the frame **109** becomes concave. In some embodiments, the spacing element **116***a* does not abut or engage the panel **1**, wherein the panel **1** may be unaffected by the force applied to the frame **109**. In other embodiments, the spacing element **116***b* is sufficiently long such that a tip of the spacing element **116***b* abuts a surface of the panel **1**. This adds further control of the shape of the plate **2**.

In some of the embodiments, the frame assembly **100** comprises a plurality of spacing elements **116** arranged spaced apart from corners of the frame **109**. One or several

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spacing elements **116** may be arranged along each perimeter or side of the frame **109**. If a single spacing element **116** is arranged along each side, it is preferably centered between the corners of the frame **109**.

Each spacing element **116** may comprise a screw with a predefined length. This means that the screw can be fully seated such that the head and tip abut respective surfaces, whereby a predefined curvature of the plate **2** is obtained. The level of curvature may be adjusted by one or several spacers arranged between the head and the surface which the head engages. This is particularly useful if multiple spacing elements **116** are arranged along a single side, or if different sides have different lengths. The more spacers provided, the less force will be applied to the frame **109**. Alternatively, as shown in FIG. **5***h*, predefined height differences may be generated via other methods, e.g. by milling the frame to the predefined heights, allowing a more continuous support structure.

FIGS. **5***a*-**5***h* illustrate embodiments of an assembly **200**, which may be combined with the first frame element **102** described above. The embodiments shown in FIGS. **5***a*-**5***h* are shown inverted relative to the embodiments shown previously, with the plate **2** at the top.

As shown in FIGS. **5***a* and **5***b*, the frame assembly **200** may comprise a first frame element **202**, and a second frame element **203**. The first frame element **202** and the second frame element **203** may be elongated members, each having a support portion **201***a*, **201***b*. The first frame element **202** and the second frame element **203** may e.g. be L-shaped in cross section. A first portion of each of the first frame element **202** and the second frame element **203** may be configured to extend along the edge of the panel **1**. A second portion of each of the first frame element **202** and the second element **203** forms the support portion **201***a*, **201***b*, and may be configured to extend from the perimeter of the plate **2** a short distance, such as a 1-3 cm, over the surface of the plate **2** when assembled. Furthermore, the second frame element **203** may be arranged on top of the first frame element **202** and such that the perimeter of the plate **2** is arranged between the second portion of each of the frame elements **202**, **203** when assembled. Therefore, each support portion **201***a*, **201***b* may support or engage opposing surfaces of the plate **2**, such as is illustrated in FIG. **5***g*.

In some embodiments, such as illustrated in FIGS. **5***c*-**5***d*, a gasket **205** (e.g. gaskets **205***a*, **205***b*, **205***c*, **205***d*, **205***e*) is arranged between the first frame element **202** and the second frame element **203**. The gasket may e.g. be arranged on the support portion **201***a* of the first frame element **202**. Also, a sealing **204***a* may be arranged on the support portion **201***b* of the second frame element **203**.

The gasket **205** may have a varying thickness along its length, i.e. also along the length of the first frame element **202**. This provides for obtaining a desired curved shape of the perimeter of the plate **2** when captured between the first frame element **202** and the second frame element **203**, as is illustrated in FIGS. **5***f*-**5***g*. For example, the gasket **205** has opposing ends and may be thinner between the opposing ends than at said ends. This provides for obtaining a predefined concavity of the perimeter of the plate **2**. The gasket is sufficiently stiff that it is thicker at the ends even when compressed. The gasket **205** may be about 1.5-2.0 mm at the ends and about 1 mm thinner at the center.

In some embodiments, the gasket **205** has a plurality of sections along its length. The thickness of each section may vary. For example, a first section **205***a* of the gasket is provided at one of its ends and a second section **205***b* of the gasket at the other of its ends. The first section **205***a* and the second section **205***b* may have a first thickness that may be equal at each section. At least a third section **205***c* of the gasket is arranged between the first section **205***a* and the second section **205***b*. The third section **205***c* has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2 mm, preferably about 1.0 mm. The difference in thickness may vary depending on the length of the gasket **205** and the edge of the plate **2** at which the concavity is to be introduced. In some embodiments, fourth and fifth sections **205***d*, **205***e* may be provided between the first and second sections **205***a*, **205***b* and the third section **205***c*, respectively. The fourth and fifth sections **205***d*, **205***e* may add further control of the shape of the concave curve provided by the arrangement **200**. The length of each the first and second sections **205***a*, **205***b* may be about 2-20% of the total length of the gasket **205**. The length of the third section may be about 60-96% of the total length of the gasket **205**. The length of each of the fourth and fifth sections **205***d*, **205***e* may be about 10-20% of the total length of the gasket **205**. In some embodiments the total length of the fourth and fifth sections **205***d*, **205***e* is shorter than the length of the third section **205***c*, and the total length of the first and second sections **205***a*, **205***a* is shorter than total length of the fourth and fifth sections **205***d*, **205***e*. This provides for a parabolic concave curve along the length of the frame assembly **200**.

A distance between the support portion **201***a* of the first frame element **202** and the support portion **201***b* of the second frame element **203** may be discontinuous in an assembled state, as can be seen in FIG. **5***e*.

In order to maintain the concavity of the plate **2**, the first frame element **202** and the second frame element **203** may be held together such that the distance between the support portions **201***a*, **201***b* is maintained in the assembled state. The first frame element **202** has a first hole **217***a* and a second hole **217***b* arranged at opposing ends of the first frame element **202**, such as at the second portion of the first frame element **202**. The first and the second hole **217***a*, **217***b* are arranged in a first plane. A third hole **217***c* is arranged between the first hole **217***a* and the second hole, such as centered between the first hole **217***a* and the second hole **217***b*. The third hole **217***c* is provided in a plane that is different from the first plane. The distance or offset between the plane in which the first and second holes **217***a*, **217***b* are arranged and the plane in which the third hole **217***c* is arranged may be substantially the same as the difference in thickness between the first and second sections **205***a*, **205***b* and the third section **205***c*, i.e. about 0.5-2 mm. In some embodiments the first and second holes **217***a*, **217***b* are centered in each of the first and second sections **205***a*, **205***b* of the gasket **205** along the length of the first frame element **202**.

Similarly, the second frame element **203** may comprise a first hole **218***a* and a second hole **218***b* arranged at opposing ends of the second frame element **203**. A third hole **218***c* may be arranged between the first hole **218***a* and the second hole **218***b* of the second frame element **203**. The first hole **218***a*, the second hole **218***b*, and the third hole **218***c* of the second frame element **203** is generally arranged in the same plane when the second frame element **203** is disconnected from the first frame element **202**. The second frame element **203** may be less stiff or weaker than the first frame element **202** and be deflectable such that each hole **218***a*, **218***b*, **218***c* of the second frame element **203** is aligned with the holes **217***a*, **217***b*, **217***c* of first frame element **202**. Therefore, the support portion **201***b* of the second frame element **203** may be deflected such that it extends in plane, which is curved in

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the assembled state of the frame assembly **200**. Screws **219***a*, **219***b*, **219***c* may be inserted through the aligned holes **217***a*, **217***b*, **217***c*, **218***a*, **218***b*, **218***c* and may directly engage the panel or engage a threaded hole in the panel **1**, which will hold the frame elements **202**, **203** in the assembled state. Other relative arrangements of the holes **217***a*, **217***b*, **217***c*, **218***a*, **218***b*, **218***c* are foreseen, wherein the center holes **217***c*, **218***c* of each frame element **202**, **203** are misaligned in the relaxed state of the second frame element **203** but aligned in the deflected or stressed state of the second frame element **203**.

In some embodiments, the first frame element **202** forms a frame side, and the second frame element **203** forms an edge cover. If used together with the frame **109** discussed with regard to FIGS. **4***a*-**4***c*, the frame side may replace the second frame element of the embodiments of FIGS. **4***a*-**4***c*. Therefore, the frame side comprises the support portion **201***a* with a support surface generally opposing the frame **109** and is configured to support the gasket **205**.

As illustrated in FIG. **6**, a component (e.g. a sealing component **204***a*) may be provided between the support portion **201***a* and the plate **2**. FIG. **6** illustrates the resulting forces and torque generated when a force **220** is applied to second frame element **203***a*. A second force **221** is applied to support portion **201**. Therefore, a net torque **222** is generated, i.e. counter-clockwise in the illustrated arrangement. The plate **2** will assume a curved path, as is illustrated with dotted line **223**.

In an embodiment shown in FIG. **7**, an alternative arrangement is provided for providing curvature of plate **2**. In this embodiment, support block **301** is arranged to support glass plate **2**. Support block **301** has a surface portion comprising a tapered edge **303** at an angle from second frame element **103**A. Plate **2** is pressed against the top surface of support block **301** from pressure **201***b* from first frame element **102** and sealing **204***a*. Pressure **201***b* causes plate **2** to follow the contour of the top surface of block **301** and plate **2** is forced into a curving plane at an angle to the plane of second frame element **103**A. The resulting path of plate **2** is shown by curvature path **310**. Tapered surface portion **303** is angled between 0.5 degrees and 3 degrees from second frame element **103**A.

In an embodiment shown in FIG. **8**, a variation of the embodiment shown in FIGS. **5***a*-**5***g* is provided. In this embodiment, second frame element **203** has been modified, such that a portion **410** has been removed from the edge portion **203***c* of second frame element **203**. This reduces the force required to bend second frame element **203** in a manner that results in a curvature of plate **2**. Portion **410** may be removed by a milling process, by a carving or cutting process, or second frame element **203** may be formed without portion **410** via a molding process or similar. Portion **410** preferably reduces the depth of second frame element **203** at the narrowest point by between 5-20%.

The frame elements of the embodiments of the assembly may be made from sheet metal and given a desired design, thickness, and/or be made from different materials such that the forces, shapes, torques, etc. discussed above are obtained.

Embodiments comprise a method for assembling the panel **1** and the plate **2** for the optical touch sensitive system. The method may comprise providing the frame elements according to the embodiments presented herein. The method further comprises attaching the first frame element to the second frame element, supporting the plate at a support portion of the assembly, and attaching at least one of the first frame assembly and the second frame assembly to the panel such that the support portion extends in flat or curved plane. Also, the method comprises attaching the second frame element to the first frame element such that the support portion extends at least partially in a second plane generally opposite at least a portion of the first frame element and is spaced apart from the first plane. A curvature of the first frame element may be controlled with a spacing element attached to the first frame element and may thereby tilt the support portion to control a curvature of the plate.

FIG. **9** illustrates a top plan view of an example of a touch-sensitive apparatus **99**. Emitters **30***a* are distributed around the periphery of touch plate **10**, to propagating light across touch surface **20**. Detectors **30***b* are distributed around the periphery of touch surface **20**, to receive part of the propagating light. The light from each of emitters **30***a* will propagate to a number of different detectors **30***b* on a plurality of light paths **50**.

The embodiments above describe methods of achieving control of plate shape and curvature. The following embodiments describe desirable shapes of the plate for achieving improved performance of a touch sensor system. Light paths **50** may conceptually be represented as "detection lines" that extend across the touch surface **20** between pairs of emitters **30***a* and detectors **30***b*. The emitters **30***a* and detectors **30***b* collectively define a grid of detection lines **50** ("detection grid") on the touch surface **20**, as seen in a top plan view. The spacing of intersections in the detection grid define the spatial resolution of the touch-sensitive apparatus **99**, i.e. the smallest object that can be detected on the touch surface **20**. The width of the detection line is a function of the width of the emitters and corresponding detectors. A wide detector detecting light from a wide emitter provides a wide detection line with a broader surface coverage, minimizing the space in between detection lines which provide no touch coverage. A disadvantage of broad detection lines may be a reduced ability to differentiate between separate objects and a lower signal to noise ratio.

As used herein, the emitters **30***a* may be any type of device capable of emitting radiation in a desired wavelength range, for example a diode laser, a VCSEL (vertical-cavity surface-emitting laser), an LED (light-emitting diode), an incandescent lamp, a halogen lamp, etc. The emitters **30***a* may also be formed by the end of an optical fiber. The emitters **30***a* may generate light in any wavelength range. The following examples presume that the light is generated in the infrared (IR), i.e. at wavelengths above about 750 nm. Analogously, the detectors **30***b* may be any device capable of converting light (in the same wavelength range) into an electrical signal, such as a photo-detector, a CCD device, a CMOS device, etc.

The detectors **30***b* collectively provide an output signal, which is received and sampled by a signal processor **130**. The output signal contains a number of sub-signals, also denoted "projection signals", each representing the energy of light received by one of light detectors **30***b* from one of light emitters **30***a*. Depending on implementation, the signal processor **130** may need to process the output signal for separation of the individual projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors **30***b* on the individual detection lines **50**. Whenever an object partially or completely occludes detection line **50**, the received energy on this detection line is decreased or "attenuated".

The signal processor **130** may be configured to process the projection signals so as to determine a property of the touching objects, such as a position (e.g. in a x, y coordinate system), a shape, or an area. This determination may involve

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a straight-forward triangulation based on the attenuated detection lines, e.g. as disclosed in U.S. Pat. No. 7,432,893 and WO2010/015408, or a more advanced processing to recreate a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface **20**, where each attenuation value represents a local degree of light attenuation. The attenuation pattern may be further processed by the signal processor **130** or by a separate device (not shown) for determination of a position, shape or area of touching objects. The attenuation pattern may be generated e.g. by any available algorithm for image reconstruction based on projection signal values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the attenuation pattern may be generated by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of such reconstruction functions designed for use in touch determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

In the illustrated example, the apparatus **99** also includes a controller **120** which is connected to selectively control the activation of the emitters **30***a* and, possibly, the readout of data from the detectors **30***b*. Depending on implementation, the emitters **30***a* and/or detectors **30***b* may be activated in sequence or concurrently, e.g. as disclosed in U.S. Pat. No. 8,581,884. The signal processor **130** and the controller **120** may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor **130** and the controller **120** may be at least partially implemented by software executed by a processing unit **140**.

FIG. **10***a* illustrates a substantially flat rectangular touch plate **10** according to the prior art. In this example, the touch plate is made of glass, plastic, or any other materials such as PMMA (Poly(methyl methacrylate)). Two axes are defined in FIG. **10***a*. The x-axis is defined as the axis running parallel to and equidistant from the pair of long edges of the rectangle and along the flat surface of the touch surface. The y-axis is defined as the axis running parallel to and equidistant from the pair of short edges of the rectangle and along the flat surface of the touch surface. At least a portion of the top surface of touch plate **10** comprises touch surface **20**.

FIG. **10***b* illustrates an example of a touch apparatus according to the prior art. FIG. **10***b* shows the touch apparatus in cross section wherein the cross section runs along the x-axis of the plate **10**. Light is emitted by emitter **30***a*, passes through transmissive plate **10** through touch surface **20** and is reflected by reflector surface **80** of edge reflector **70** to travel in a plane substantially parallel with touch surface **20**. The light will then continue until deflected by reflector surface **80** of the edge reflector **70** at an opposing edge of the transmissive plate **10**, wherein the light will be deflected back down through transmissive plate **10** and onto detectors **30***b*. Where an object is applied to touch surface **20**, some of the light above the touch surface **20** is occluded. This occlusion is detected by the touch apparatus and used to determine the presence, size, and/or shape of the object. The emitters and detectors may be arranged in a number of other configurations such that the light from the emitters is delivered to the touch surface and delivered from the touch surface to the detectors. Other known arrangements are that of arranging the emitters and detectors above the touch surface and transmitting and receiving the light directly without the use of reflecting surfaces. The light may also be delivered to the touch surface by means of a wave guide, fiber optic cable, or other optical component.

FIG. **11***a* illustrates an embodiment of touch plate **10** similar to that shown in FIG. **10***a* but wherein the touch plate **10** is curved. In this embodiment, the plate remains substantially flat in the direction of the y-axis but is curved in a concave direction relative to the x-axis. In this embodiment, the x-axis is defined as the axis running parallel to and equidistant from the pair of long edges of the rectangle. The vertex of the parabola or paraboloid of the touch surface is where the touch surface is deepest relative to the edges of the touch plate. Where the x-axis is positioned at the height of the edge of the touch plate, the curvature of the plate can be measured using the distance of the touch surface from the x-axis. FIG. **11***b* shows a cross-section view along the x-axis of the touch plate **10** of FIG. **11***a*.

FIG. **11***c* shows an example embodiment of a curved touch plate **10**. The touch plate **10** has a width of 1900 mm along the x-axis and a height of 1070 mm along the y-axis. In this example embodiment, the glass is shaped such that the touch surface follows a parabolic curve relative to the x-axis. The midpoint O of touch surface **20** is the center of the touch surface and the midpoint of the x-axis. Where the curvature of the touch surface **20** is parabolic, the maximum distance a between the touch surface and the x-axis is at the center point O of the touch surface.

FIG. **11***d* shows the maximum allowed concave distance a and maximum allowed convexity b. The maximum allowed convexity b may be a significant consideration as a portion of the touch surface that is substantially convex may result in occlusion of the light between the emitters and detectors and significant loss of touch signal. The maximum allowed convexity b is a negative number in the present examples.

In one embodiment, the range of the distance a for vertically orientated touch plate is limited in order to improve the yield and performance of touch systems. The range is set dependent on the size of the touch system. A smallest value is needed to assure that non-parabolic deviations in the glass shape and convexity in the integration doesn't result in a convex integrated touch surface. A largest value is needed in order to assure that the height of the light field for the final touch system is kept reasonably low in order to enable better contact detection and lift-off detection for touch objects. Preferably, range of the distance a is 0-2.5 mm.

The maximum distance a is a positive number for a concave glass in the present examples. The curvature of the touch surface may therefore be modelled as:

$$F(x) = -a+cx^2$$

In the present example embodiment, a maximum distance a between the 1900 mm long cross section of the touch surface in FIG. **11***c* and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface **20** may be:

$$F(x) = 5.5*10^{-4}x^2-2.0$$

where F(x) is the distance between the x-axis and the touch surface at position x wherein F(x) is zero at the mid points of the edges, i.e. where the x-axis intersects the perimeter.

FIGS. **12***a* and **12***b* illustrates an embodiment of touch plate **10** similar to that shown in FIG. **11***a* but wherein the touch plate **10** is curved in two axes. FIG. **12***a* shows a top plan view and FIG. **12***b* shows an isometric view of touch plate **10**. In this embodiment, the plate is curved in a concave

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direction relative to the x-axis and is also curved in a concave direction relative to the y-axis. As with the embodiment shown in FIG. **11***a*, the x-axis is defined as the axis running parallel to and equidistant from the pair of long edges of the rectangle and passing over the center point 0 on the touch surface. Therefore, the curvature of the plate can be measured from the distance of the touch surface from the x-axis. Similarly, the y-axis is defined as the axis running parallel to and equidistant from the pair of short edges of the rectangle and passing over the center point 0 on the touch surface. Therefore, the curvature of the plate along this axis can be measured from the distance of the touch surface from they-axis.

FIGS. **12***c* and **12***d* shows respective section views along the x-axis and y-axis of the touch plate **10** of FIGS. **12***a* and **12***b*. In an example embodiment of a curved touch plate **10**. The touch plate **10** has a width of 1900 mm along the x-axis and a height of 1070 mm along the y-axis. In this example embodiment, the glass is shaped such that the touch surface follows a parabolic curve relative to the x-axis. The center point O of touch surface **10** is the center of the touch surface and parallel with midpoint of the x-axis. Where the curvature of the touch surface **10** is parabolic, the maximum distance a between the touch surface and the x-axis is at the center point O. The maximum distance a is a positive number for a concave glass in the present examples. The curvature of the touch surface may therefore be modelled as:

$$z(x,y) = a+b*x^2+c*x^2y^2+d*y^2$$

where z is the distance between the plane defined by the x-axis and y-axis and the touch surface, and x and y are co-ordinates in the plane of the glass.

In an example embodiment having a flat perimeter around the plate with a max distance of 2.0 mm measured along the x-direction for y 0 (i.e. middle of plate):

$$z(x,y) = -2+5.56e-006*x^2-4.73e-011*x^2y^2+1.73e-005*y^2$$

In another example embodiment having a concave perimeter around the plate with a max distance of 2.0 mm measured along the x-direction for y 0 (mid short to short of screen) and with a max distance of 1.5 mm measured along the y-direction for x 0 (mid long to long of screen). Where the top and bottom edges have 1.0 mm max distance and the left and right edges have 0.5 mm max distance:

$$z(x,y) = -2.5+5.56e-006*x^2-2.37e-011*x^2y^2+1.28e-005*y^2$$

FIG. **13***a* shows a section view along the x-axis of light propagating across an example embodiment of a curved touch plate **10** touch surface having a curved profile in the x-axis. In the section view, the propagation paths of light from a point light source **1310** are shown. Dotted lines **1320** show propagation paths of light emitted from point light source **1310***a* that are not received by detector surface **1340**. Solid lines **1330** show propagation paths of light emitted from point light source **1310** that are received by detector surface **1340**. As shown in the figure, a portion of the light is lost above the detector, a portion is lost below the detector, and a portion of the light is received at the detector surface. A person looking from the emitter point towards the mirror image of the detector (mirrored in the touch surface) will perceive the detector size as 2.2 times larger than the real detector. This magnification effect is an effect of using an off axis parabolic mirror. In the specific case of touch systems, this results in a detection signal boost of a factor of 2.2, when comparing to a flat touch surface. This boost applies only to the signal and not significantly to the ambient light otherwise received by the detectors. In a preferred embodiment, the detectors and emitters of the touch system are 3 mm or less above the touch surface (either directly or indirectly) and the length of the detection lines being in the range from 100 to 2500 mm, the angle of incidence is extremely close to 90 degrees. With this, grazing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

FIG. **13***b* provides a graph of the angle of the emitted light from the point light source **1310** with respect to the z-coordinate of the light path at the edge of the model of FIG. **13***a*. The detector surface z-coordinate range is shown by the vertical axis. Light emitted by point light source **1310** received at a z-coordinate within that range is received by the detector.

FIG. **14***a* shows a section view of the embodiment of FIG. **13***a*. In the section view, the propagation paths of light from a second point light source **1410** are shown. In this example, the detection signal boost is approximately 3.3. FIG. **14***b* shows the corresponding graph of FIG. **13***b* for the second point light source **1410**.

FIG. **15***a* shows a section view of the embodiment of FIG. **13***a*. In the section view, the propagation paths of light from a third point light source **1510** are shown. FIG. **15***b* shows the corresponding graph of FIG. **13***b* for the third point light source **1510**. In this example, the detection signal boost is approximately 3.03.

FIG. **16***a* shows a section view of the embodiment of FIG. **13***a*. In the section view, the propagation paths of light from a fourth point light source **1610** are shown. FIG. **16***b* shows the corresponding graph of FIG. **13***b* for the fourth point light source **1610**. In this example, the detection signal boost is approximately 2.71.

FIG. **17***a* shows a section view of the embodiment of FIG. **13***a*. In the section view, the propagation paths of light from a fifth point light source **1710** are shown. FIG. **17***b* shows the corresponding graph of FIG. **13***b* for the fifth point light source **1710**. In this example, the detection signal boost is approximately 2.19.

FIGS. **13***a*-**17***b* demonstrate that different emitter positions utilize different parts of the touch surface. The parts of the touch surface that work as reflectors will depend on the actual shape of the glass and the placement and sizes of the emitter and detector apertures surface **1340**.

However, the touch plate **10** cannot be manufactured, positioned, or held in shape perfectly. Consequently, a certain amount of deviation can be expected between the curve followed by the touch surface and an ideal parabolic curve.

FIG. **18***a* shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of FIG. **18***a*, a curved touch plate **10** has a width of 1900 mm along the x-axis and a height of 1070 mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in FIG. **12***a*,**4***b*). In this example embodiment, the glass is shaped such that the touch surface follows parabolic curve **1810** relative to the x-axis. The maximum distance a between the touch surface and the x-axis is 10 mm. The mathematically defined parabolic curve is defined as **1820**. The graph shows the deviation between the mathematically defined parabolic curve represented by dotted line **1820** and real touch surface **1810**. Here, the real touch surface is asymmetrically warped. FIG. **10***b* shows the short to short mid cross section of a 2180 mm diagonal, 16:9 ratio, thermally tempered glass that is just within or at the maximum limit of concave distance <6 mm as well as parabolic deviation <0.5 mm.

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The parabolic fit of the touch surface **1810** has an s-shaped residual. Such asymmetrical warping may be the result of problems with transport rollers or an uneven temperature distribution during the rapid cooling phase of tempering process during manufacture.

FIG. **18***b* shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of FIG. **18***a*.

The following table defines a preferred set of restrictions on the shape of the touch surface in order to achieve an optimal touch surface shape. The term 'warp' defines the distance of the touch surface from the respective axis intersecting the center point O in the direction of the z-axis.

Glass size	Min x-axis warp (mm)	Max x-axis warp (mm)	Min y-axis warp (mm)	Max y-axis warp (mm)	Max convexity* (mm)	Max parabolic deviation (mm)
55"	1.0	3.50	0.0	1.35	0.1	0.5
65"	1.0	4.50	0.0	1.65	0.1	0.5
70"	1.0	5.10	0.0	1.85	0.1	0.5
75"	1.0	5.70	0.0	2.00	0.1	0.5
84"-86"	1.0	6.60	0.0	2.30	0.1	0.5

Convexity b is shown in FIG. **18***a*. Parabolic deviation is shown in FIG. **1.8***b*.

FIG. **19***a* shows another graph of a mathematically defined parabolic curve and a similar glass to that of FIG. **18***a* but wherein the glass of FIG. **19***a* is out of range and not recommended for touch system production. One reason for the large concavity shown in FIG. **19***a* may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacuring. The mathematically defined parabolic curve is defined as **1920**. The graph shows the deviation between the mathematically defined parabolic curve and real touch surface **1910**.

FIG. **19***b* shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of FIG. **19***a*. The real-world parabolic touch surface of FIG. **19***a* is an example of a symmetrical but higher order warping (e.g. W shaped). Such warping may significantly reduce signal boost and may be caused by symmetrical temperature problems (e.g. too hot in center or edge of glass) during the manufacturing tempering process.

FIG. **20***a* shows an embodiment in which the touch surface forms a paraboloid. In FIG. **20***a*, a top plan view of the touch surface is shown with contour lines showing the depth of the touch surface relative to a flat plane intersecting the four corners of the touch surface. The numbers shown on each contour represents the depth of the contour. The x-axis, y-axis, and diagonal-axis d are all shown. The x-axis is defined as an axis running parallel to and equidistant from the pair of long edges of the rectangle. The y-axis is defined as an axis running parallel to and equidistant from the pair of short edges of the rectangle. Diagonal-axis d is defined as an axis running diagonally from one corner to a diagonally opposite corner. In this embodiment, the x-axis, y-axis, and diagonal axis d of touch surface **10** each describe a parabola with respect to the depth of the touch surface. In FIG. **20***b*, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of FIG. **20***a*, the curved touch plate **10** has a width of 1900 mm along the x-axis and a height of 1070 mm along the y-axis.

FIGS. **20***b*-**20***d* show optional parabola configurations for the embodiment shown in FIG. **20***a*. FIG. **20***b* shows a graph of the desired parabola of the touch surface underneath the x-axis and relative to the x-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the x-axis. FIG. **20***c* shows a graph of the desired parabola of the touch surface underneath the y-axis and relative to the y-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the y-axis. FIG. **20***d* shows a graph of the desired parabola of the touch surface underneath the diagonal-axis and relative to the diagonal-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the diagonal-axis.

The embodiments shown in FIG. **20***a*-**20***d* describe a touch surface providing substantial signal boost for signals travelling between most emitters and detectors. However, the non-flat perimeter of the touch surface makes manufacture and assembly of such a system more complex.

FIG. **21***a* shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in FIG. **20***a*. As with FIG. **20***a*, FIG. **21***a* provides a top plan view of the touch surface is shown with contour lines showing the depth of the touch surface relative to a flat plane intersecting the four edges of the touch surface **10**. The numbers shown on each contour represents the depth of the contour. X-axis, y-axis, and diagonal-axis d are all shown. The x-axis is defined as an axis running parallel to and equidistant from the pair of long edges of the rectangle. In this embodiment, the x-axis of touch surface **10** describes a parabola with respect to the depth of the touch surface. The y-axis is defined as an axis running parallel to and equidistant from the pair of short edges of the rectangle. In this embodiment, the y-axis of touch surface **10** also describes a parabola with respect to the depth of the touch surface. Diagonal-axis d is defined as an axis running diagonally from one corner to a diagonally opposite corner. In FIG. **21***b*, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of FIG. **21***a*, the curved touch plate **10** has a width of 1900 mm along the x-axis and a height of 1070 mm along the y-axis. The perimeter of the touch surface of this embodiment is flat or close to flat. In embodimens where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect paraboloas. Even for an almost perfect integrated glass shape with a warp in the range of 1-2.5 mm some detection lines (a very small portion) will actually have less signal than for a flat glass. This small drawback is counter balanced by the significant overall signal improvements. Furthermore, touch systems where the perimeter of the touch surface is flat or close to flat can be easier to manufacture and assemble.

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FIG. 21*b* shows a graph of the desired parabola of the touch surface underneath the x-axis and relative to the x-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the x-axis. FIG. 21*c* shows a graph of the desired parabola of the touch surface underneath the y-axis and relative to the y-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the y-axis. FIG. 21*d* shows a graph of the desired parabola of the touch surface underneath the diagonal-axis and relative to the diagonal-axis. The deviation (bottom axis) from the x-axis is shown relative to the position (left axis) along the diagonal-axis.

As will be apparent, the features and attributes of the specific embodiments disclosed above may be combined in different ways to form additional embodiments, all of which fall within the scope of the present disclosure.

Conditional language used herein, such as, among others, "can," "could," "might," "may," "e.g.," and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or states. Thus, such conditional language is not generally intended to imply that features, elements and/or states are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without author input or prompting, whether these features, elements and/or states are included or are to be performed in any particular embodiment.

The present invention has been described above with reference to specific embodiments. However, other embodiments than the above described are equally possible within the scope of the invention. Different method steps than those described above may be provided within the scope of the invention. The different features and steps of the invention may be combined in other combinations than those described. The scope of the invention is only limited by the appended patent claims.

What is claimed is:

1. A method for assembling a touch sensing apparatus, the touch sensing apparatus comprising a display panel, a plate including a touch surface, and a frame assembly,

wherein the frame assembly includes:

a first edge extending between a first end point and an opposite second end point; and

a second edge extending between the second end point and a third end point;

the method comprising:

configuring the frame assembly to support the display panel;

arranging a plurality of emitters adjacent to a periphery of the plate, said plurality of emitters configured to emit light to propagate over the touch surface;

arranging a plurality of detectors arranged adjacent to the periphery of the plate, said plurality of detectors configured to receive light from the set of emitters; and

configuring the frame assembly to support the plate;

wherein configuring the frame assembly to support the plate includes inducing a parabolic curvature in the touch surface relative to a first axis and relative to a second axis perpendicular to the first axis, said first axis is parallel to a line between the first end point and the second end point and said second axis is parallel to a line between the second end point and the third end point.

2. The method of claim **1**, wherein the first edge is curved and the second edge is curved.

3. The method of claim **1**, wherein the plate has a first curvature when not configured in the frame assembly, and wherein the plate has a second curvature greater than the first curvature after the plate is configured in the frame assembly.

4. The touch sensing apparatus of claim **3**, wherein the first curvature and second curvature are defined along an edge of the plate.

5. The touch sensing apparatus of claim **3**, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

6. The touch sensing apparatus of claim **3**, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

7. A touch sensing apparatus comprising:

a display panel;

a plate having a width, a length and a periphery, the plate further including a touch surface;

one or more emitters arranged adjacent to the periphery of the plate and configured to emit light across the touch surface of the plate;

a set of detectors arranged adjacent to the periphery of the plate and configured to receive light from the set of emitters; and

a frame assembly, the frame assembly comprising:

a first frame element configured to support the display panel; and

a second frame element arranged around at least a portion of the periphery of the plate, the second frame element having a first portion extending along an edge of the plate and a second portion opposed to the touch surface;

wherein the plate has a first curvature in the touch surface when not installed in the frame assembly, and wherein the plate has a second curvature along the width and along the length in the touch surface when the plate is installed in the frame assembly, said second curvature is parabolic; and

wherein the first curvature is concave.

8. The touch sensing apparatus of claim **7**, further comprising a processing element configured to determine, based on output signals of the set of detectors, a position of an object proximate to the touch surface.

9. The touch sensing apparatus of claim **7**, wherein the first curvature and second curvature are measured along an edge of the plate.

10. The touch sensing apparatus of claim **7**, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

11. The touch sensing apparatus of claim **7**, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

12. The touch sensing apparatus of claim **7**, further comprising a gasket, wherein the plate is supported by the gasket proximate to an edge of the plate.

13. The apparatus of claim **12**, wherein the gasket is configured to have varying thickness to match a curvature of the plate along the edge.

14. The apparatus of claim **7**, wherein the second frame element is curved.

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JEX-02

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(12) **United States Patent**
Skagmo et al.

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(54) **TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY**

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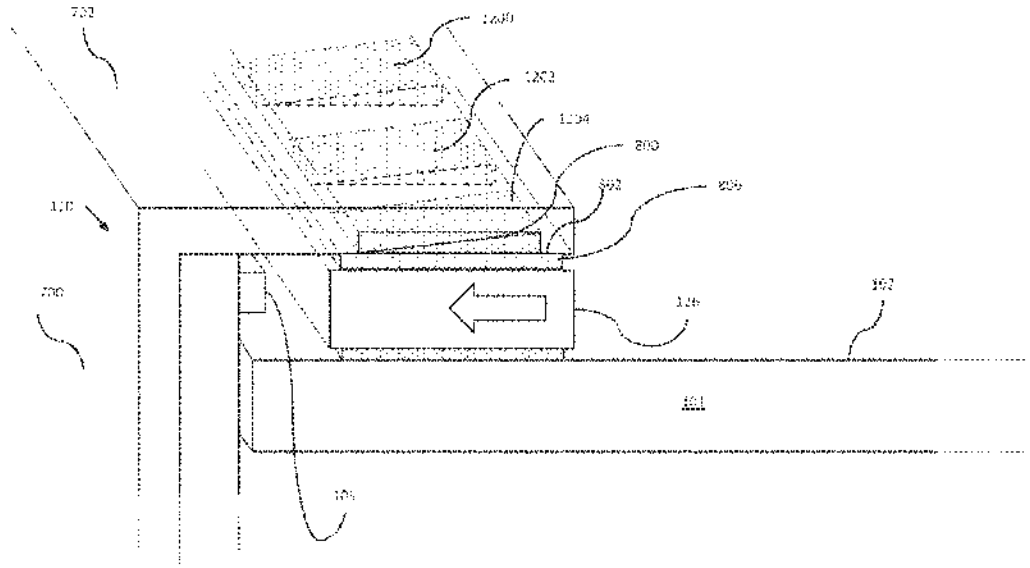
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(57) **ABSTRACT**

A touch sensing apparatus is disclosed comprising a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel. The light emitters are arranged to emit a respective beam of emitted light that travels above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are arranged above the touch surface and are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the panel extends. A method of assembling a touch sensing apparatus is also disclosed.

9 Claims, 18 Drawing Sheets



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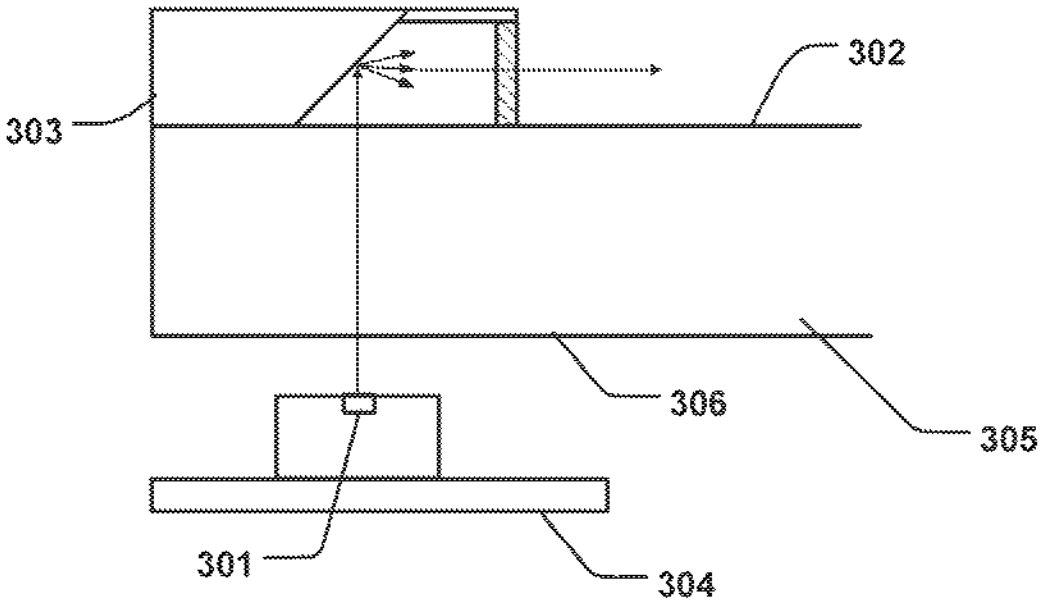


FIG. 1A

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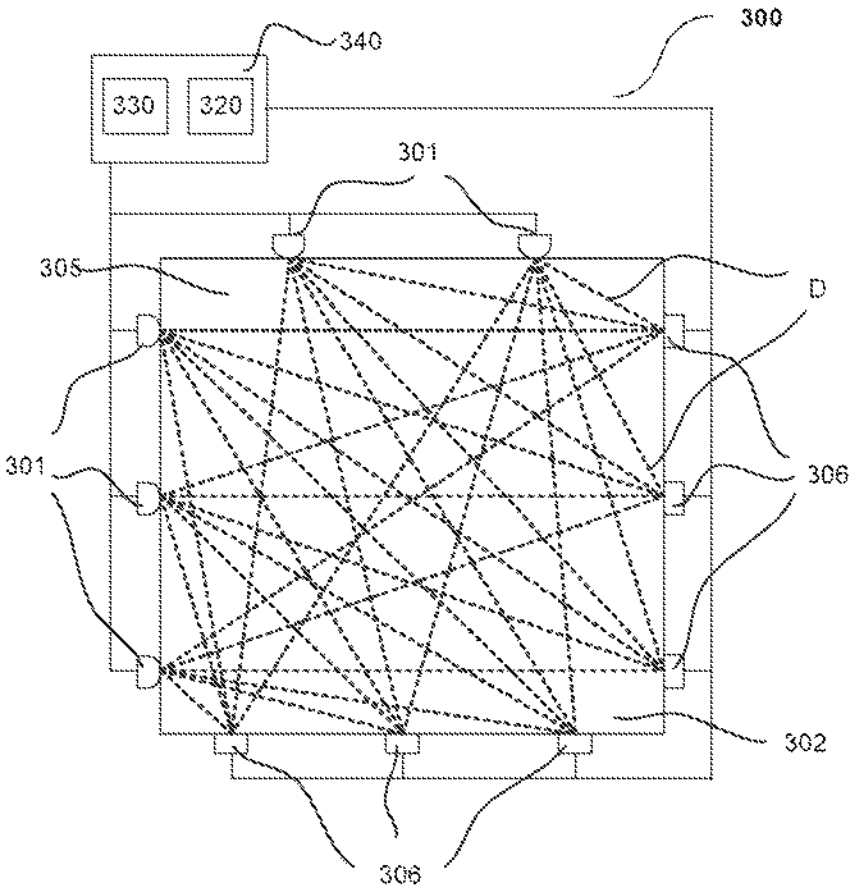


FIG. 1B

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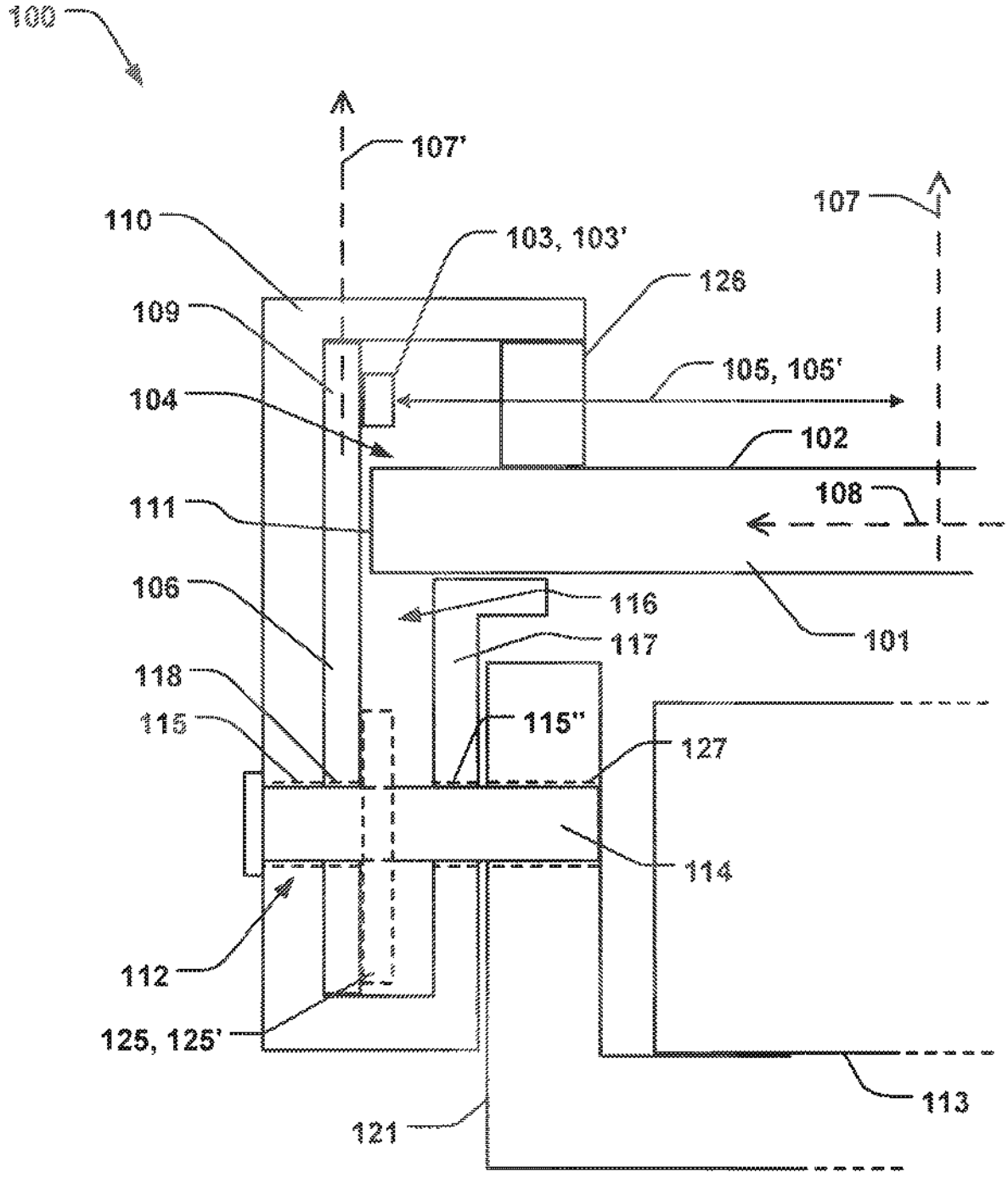


FIG. 2

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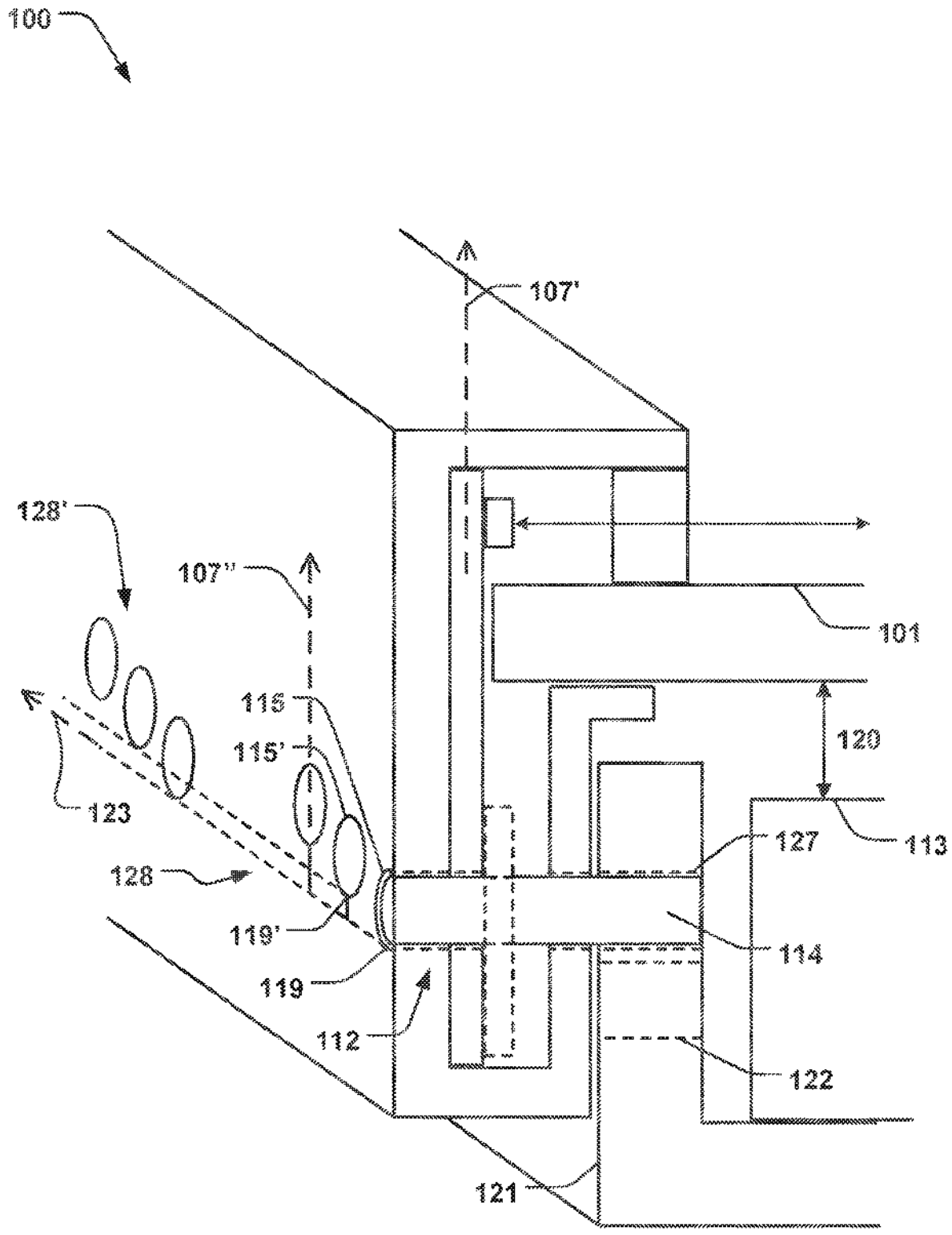


FIG. 3

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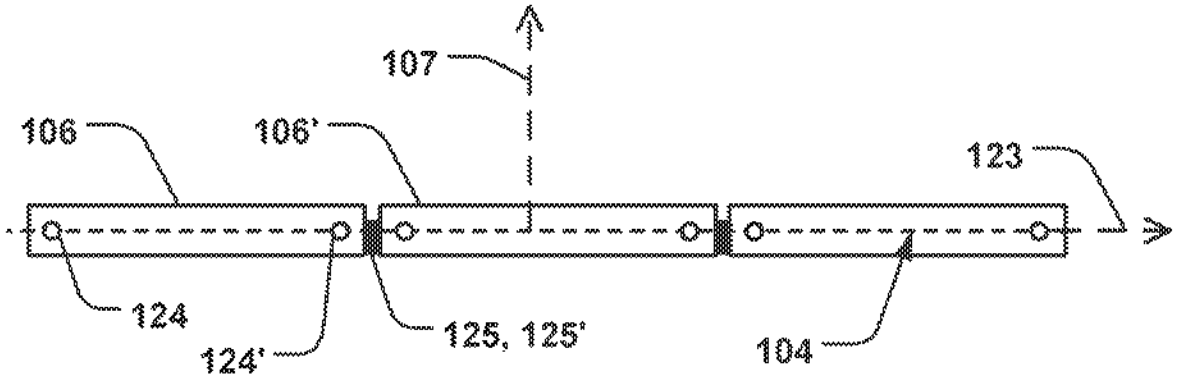


FIG. 4A

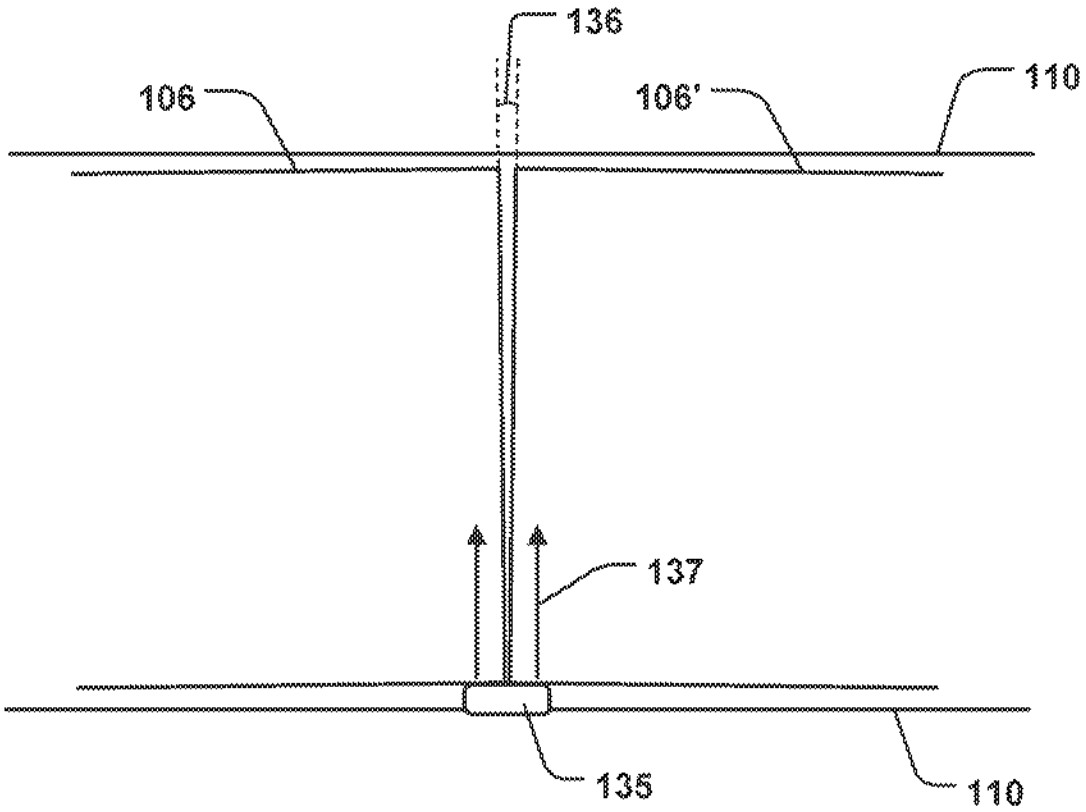


FIG. 4B

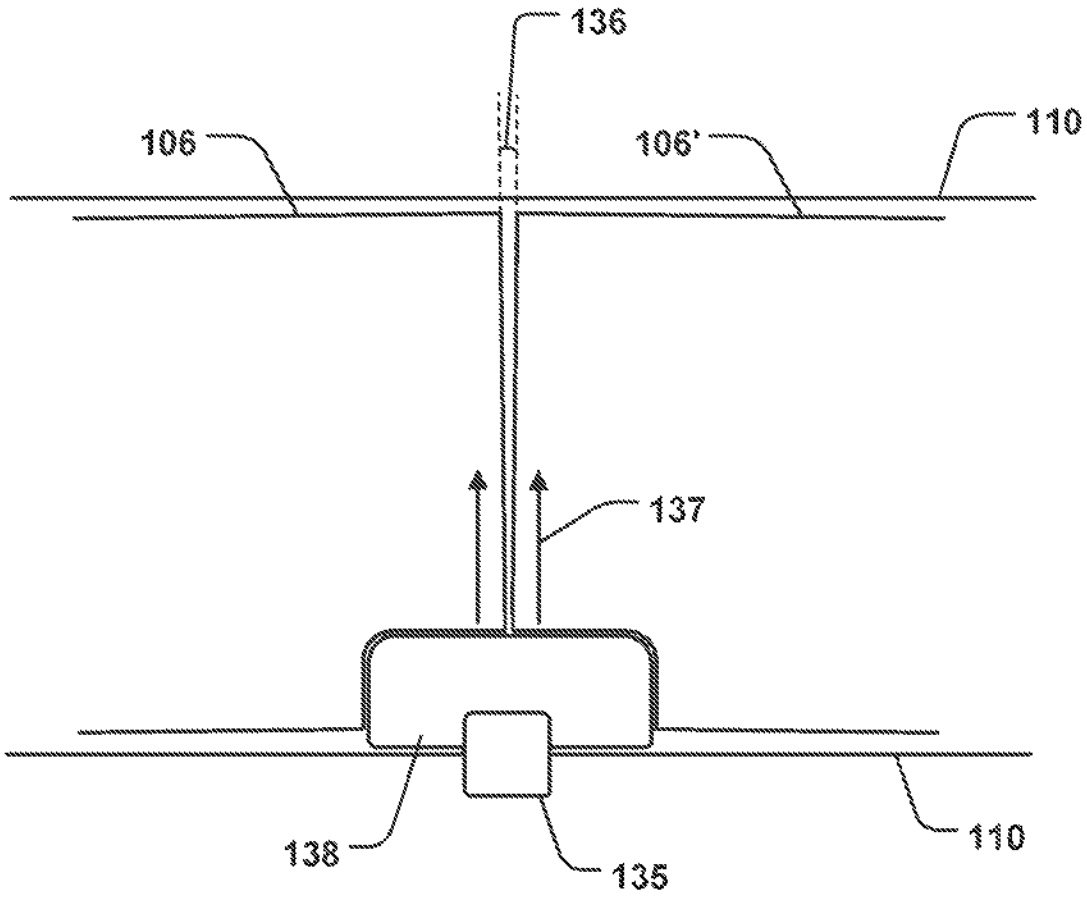


FIG. 4C

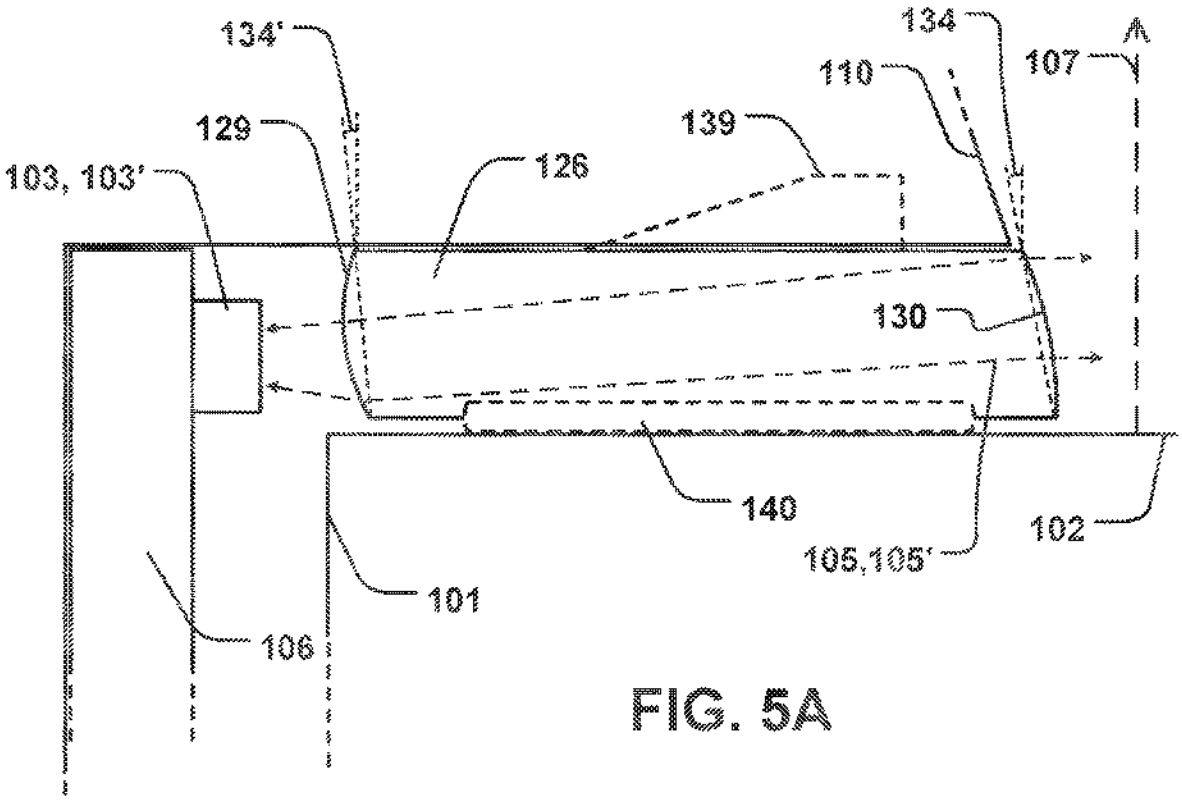

134'
134
107
110
129
139
103, 103'
126
130
140
102
105,105'
101
106

FIG. 5A

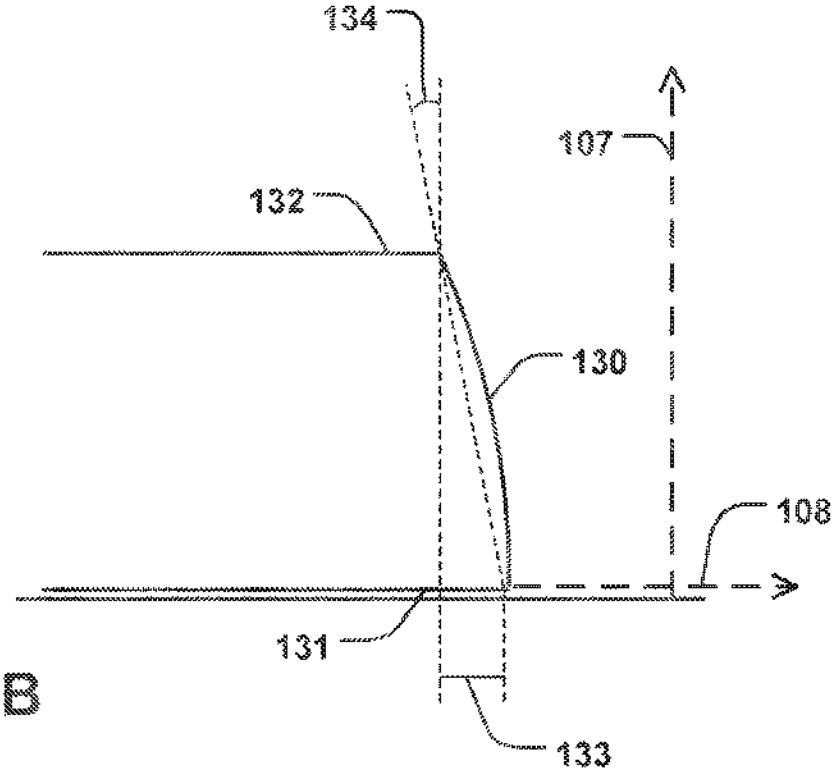

134
107
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131
133

FIG. 5B

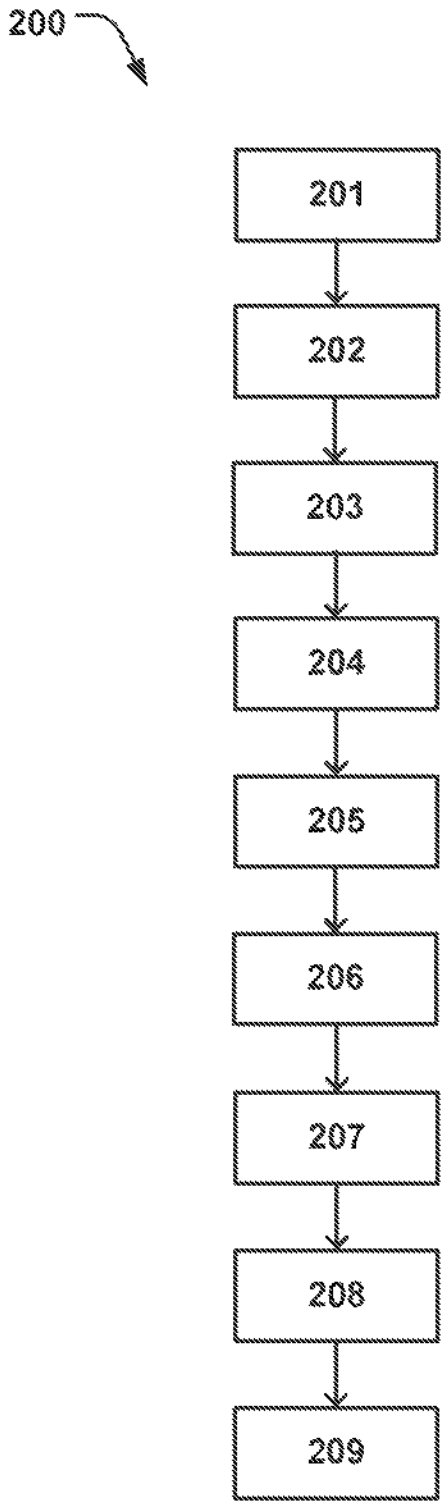


FIG. 6

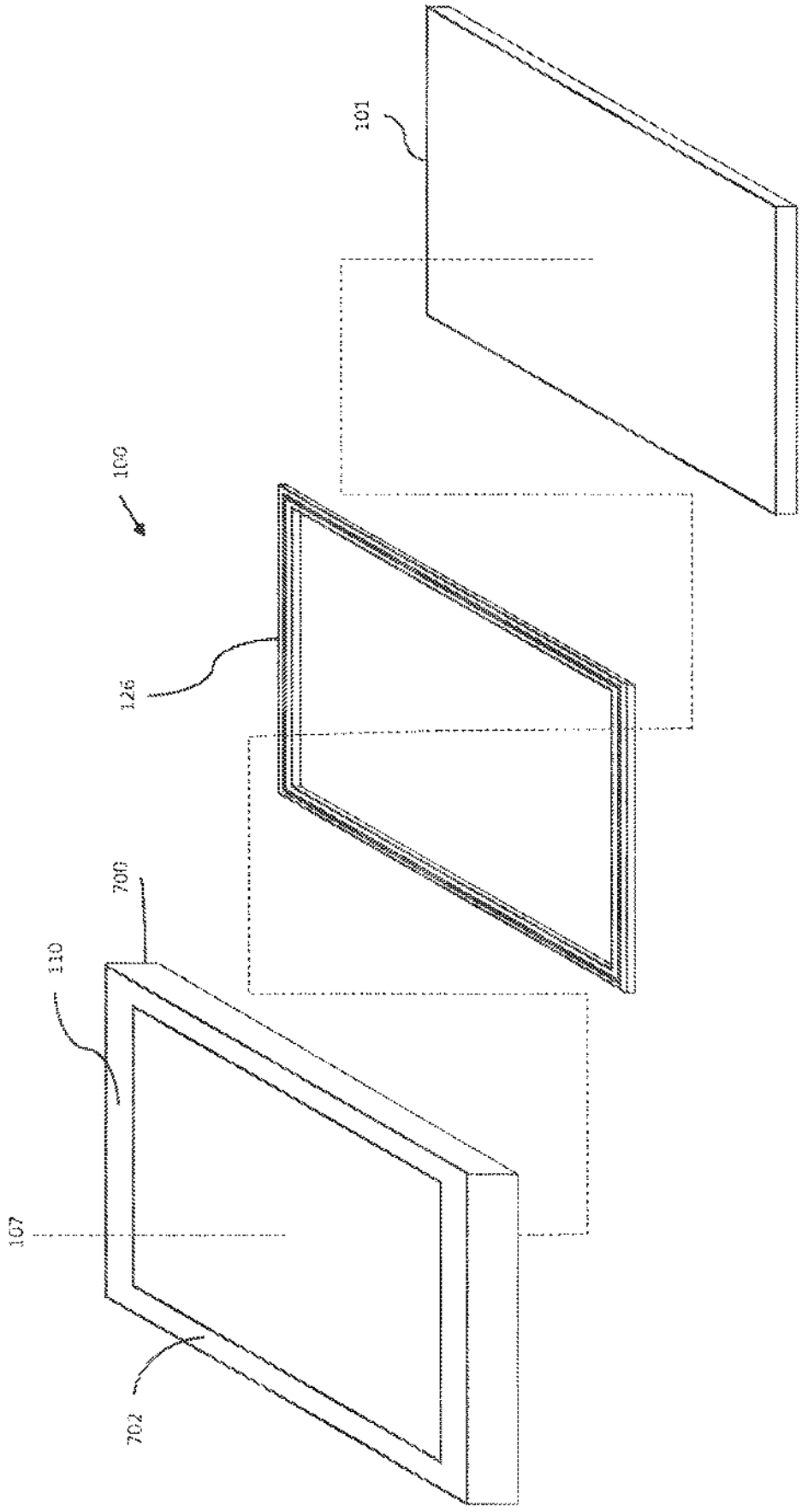


FIG. 7

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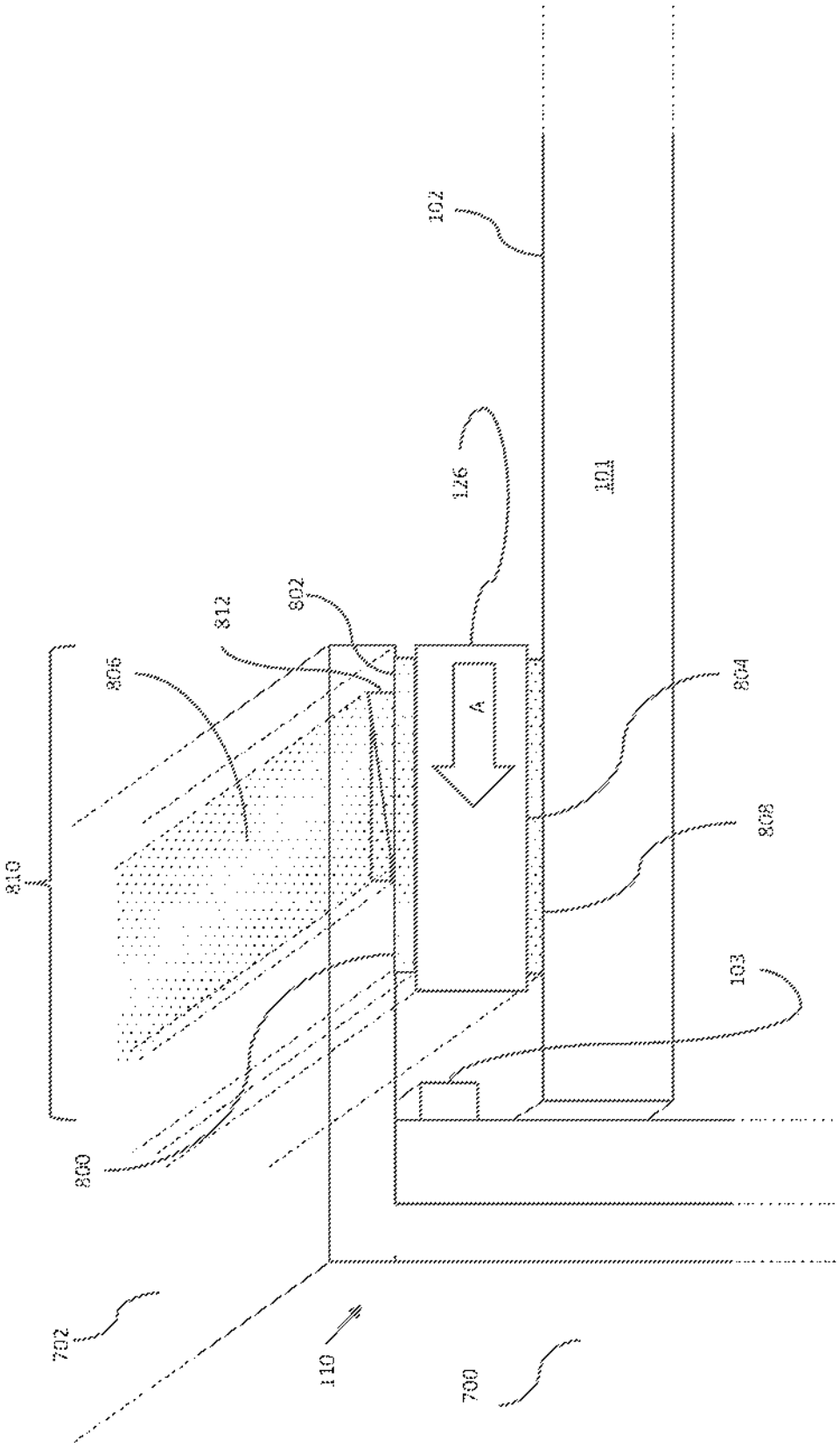


FIG. 8

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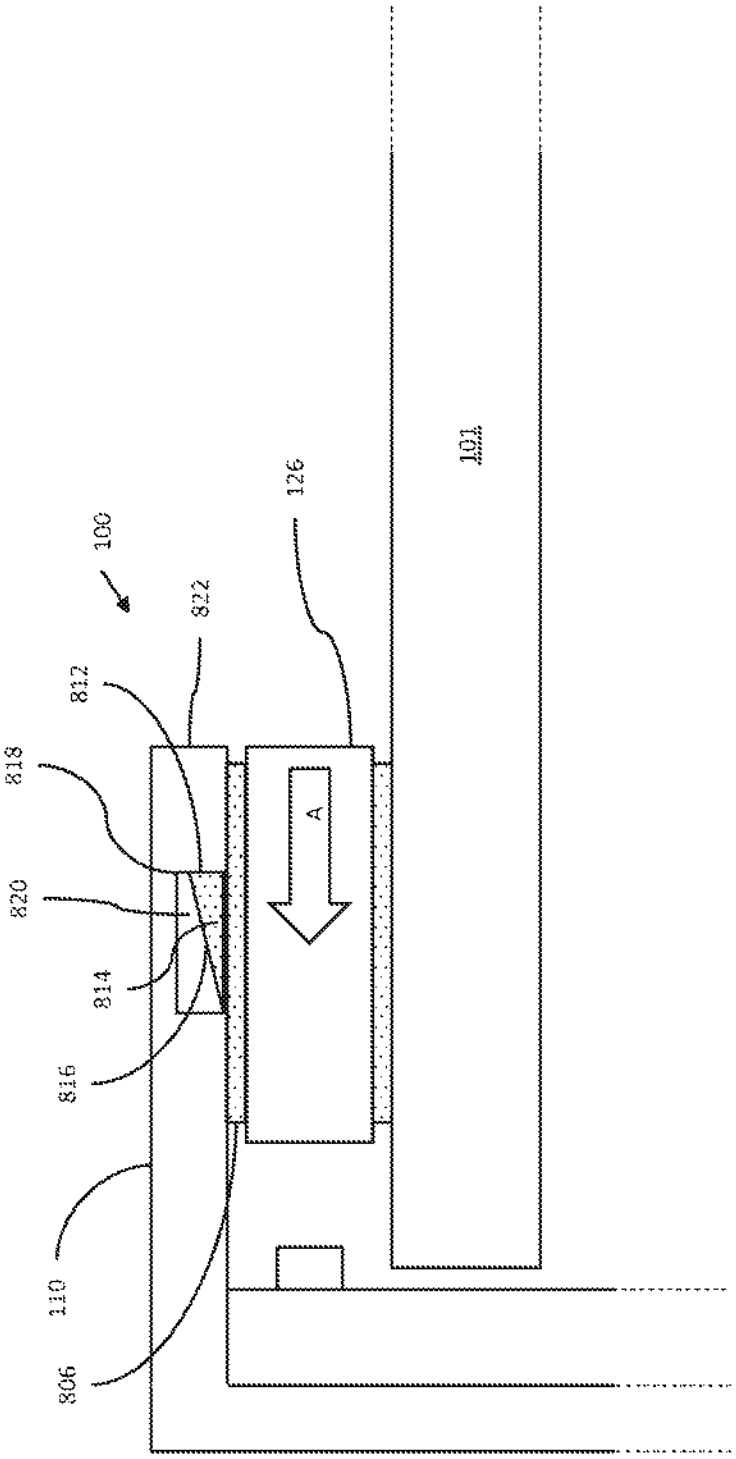


FIG. 9

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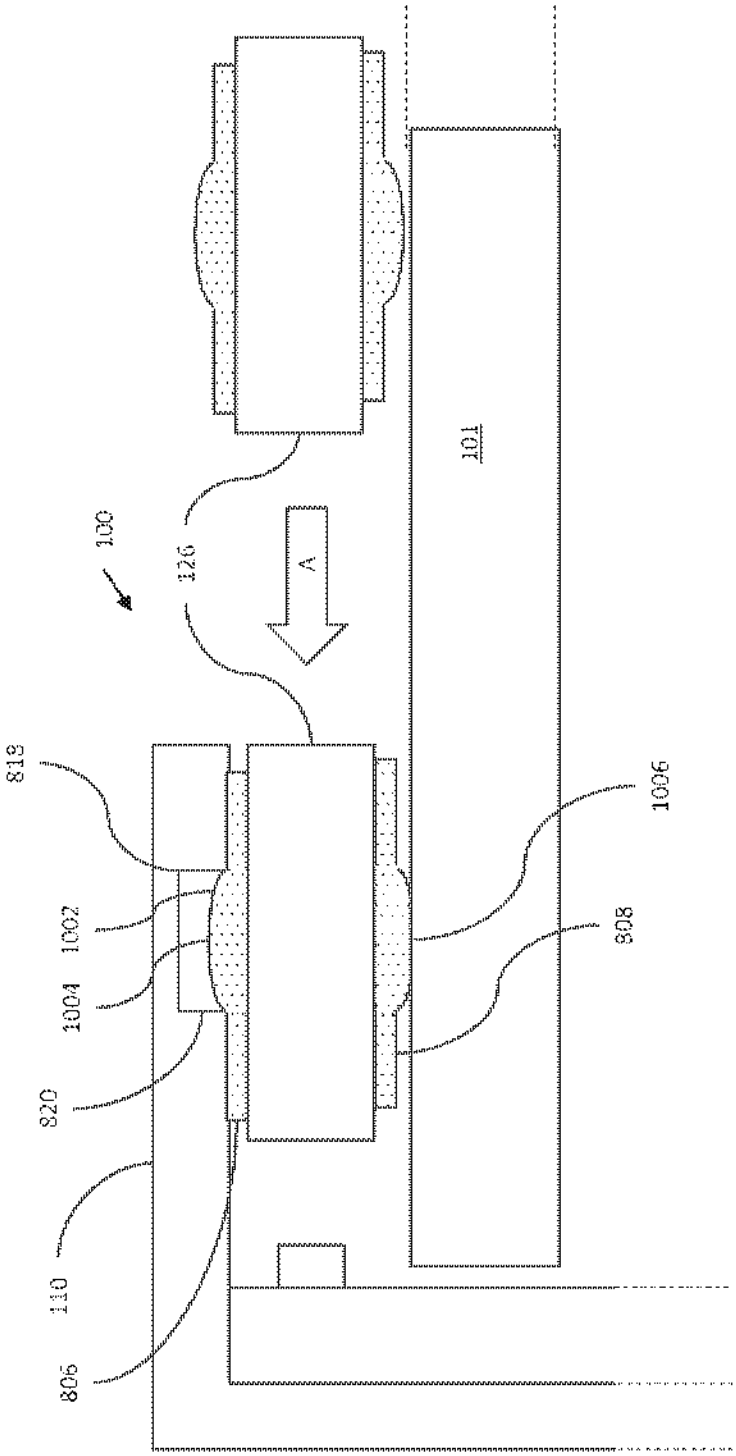


FIG. 8

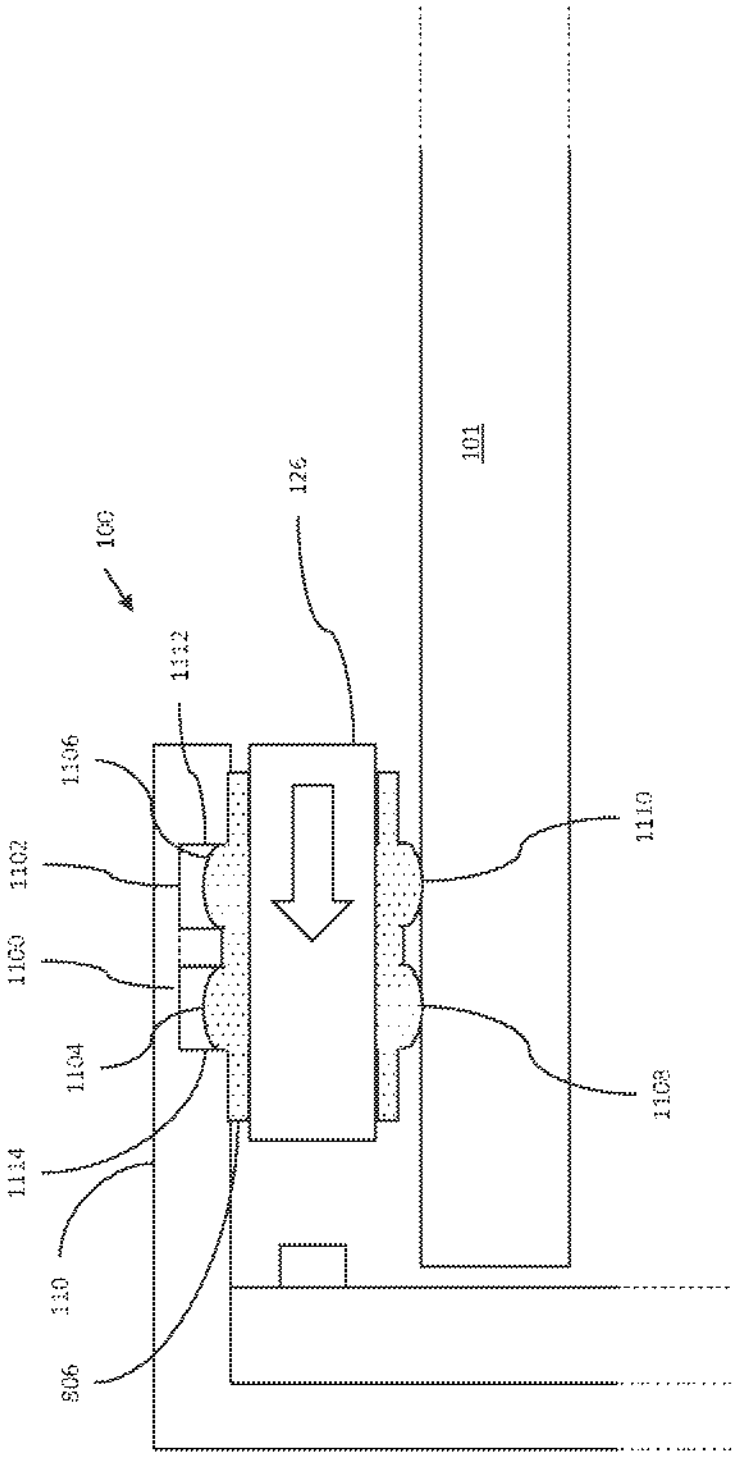


FIG. 11

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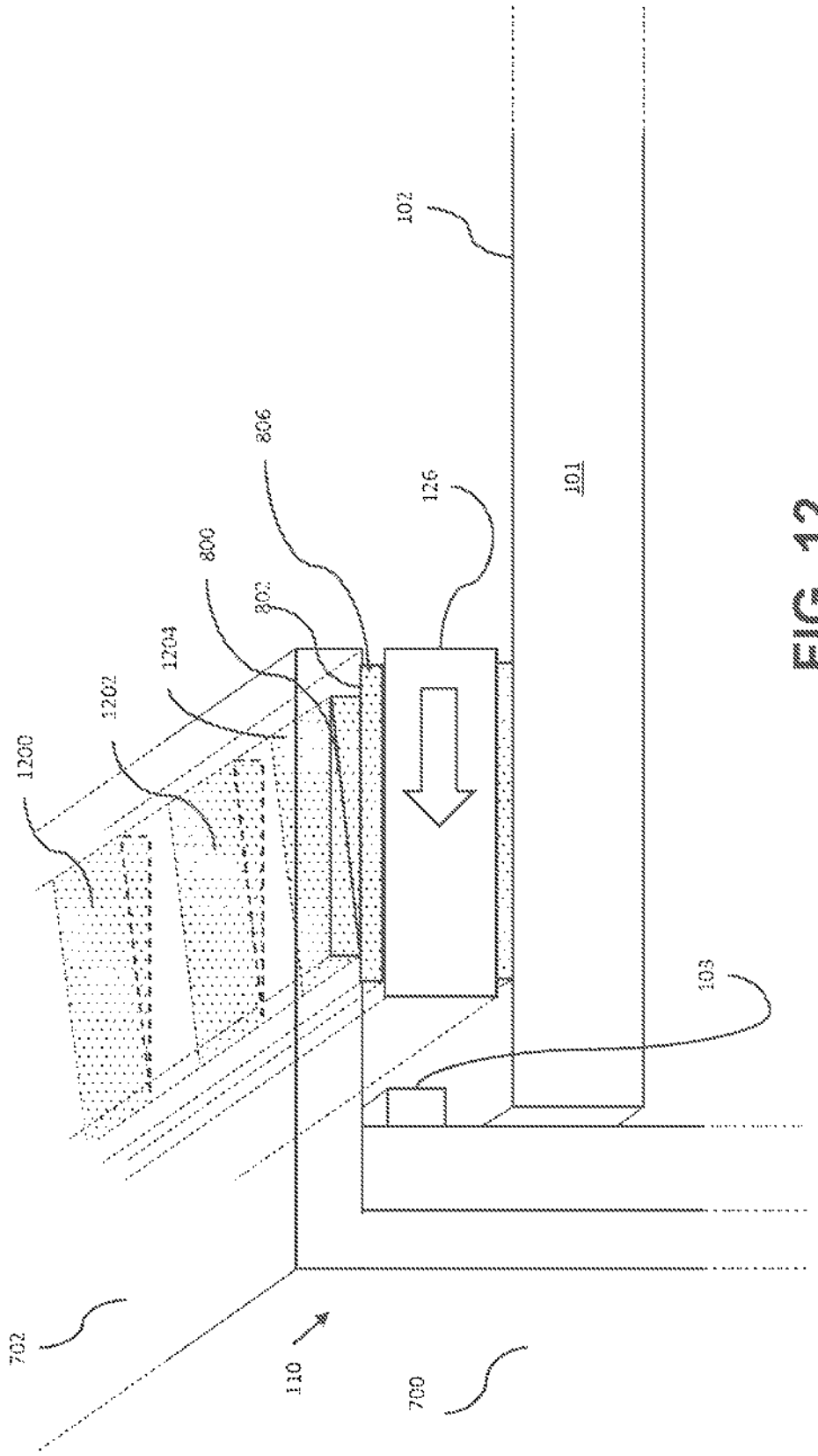


FIG. 12

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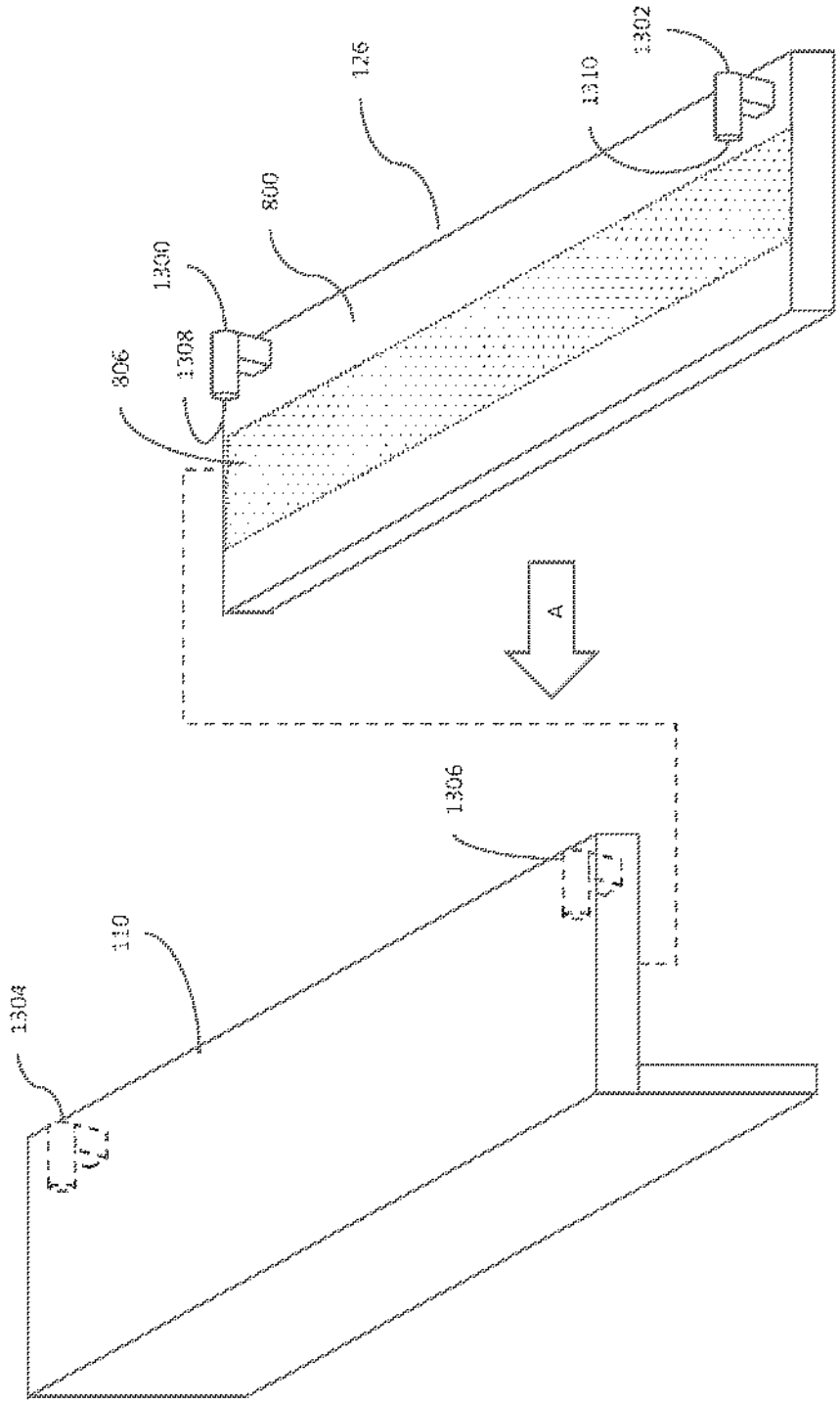


FIG. 13

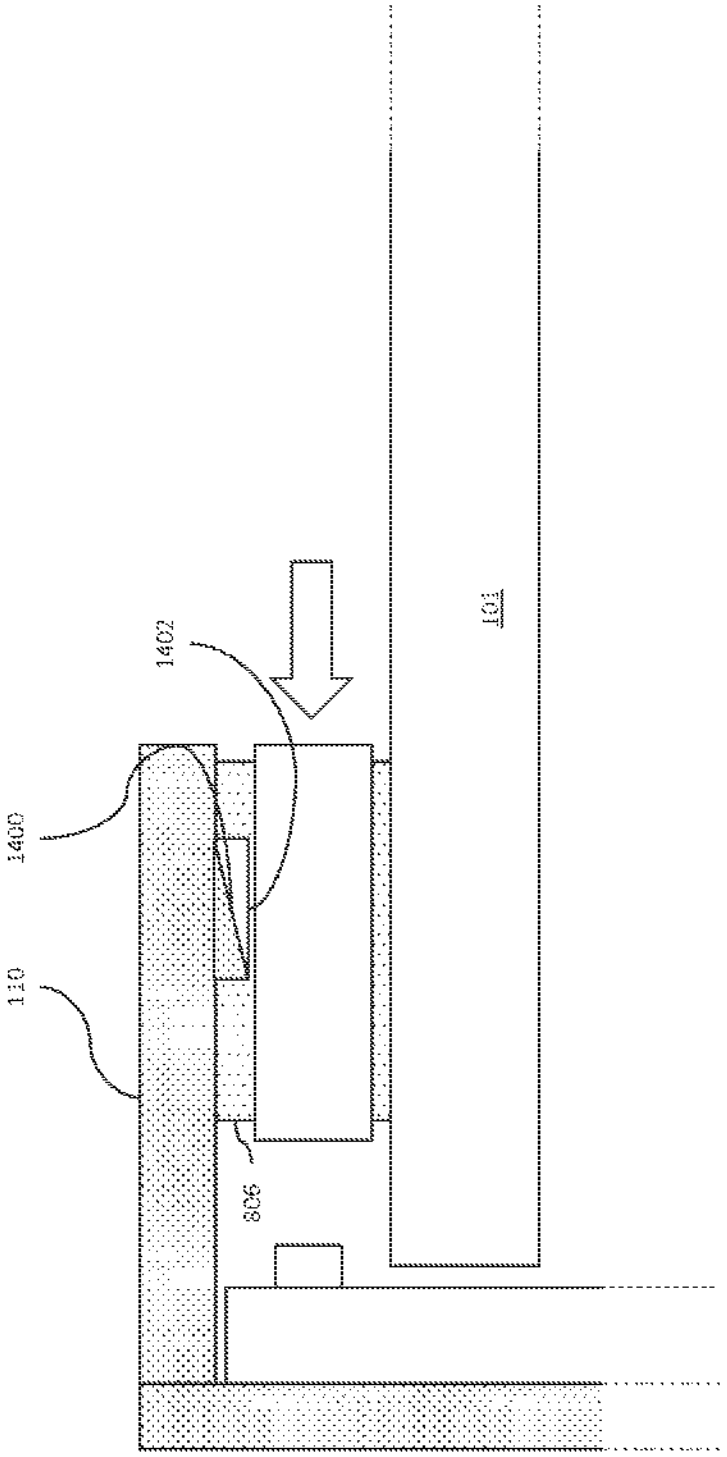


FIG. 14

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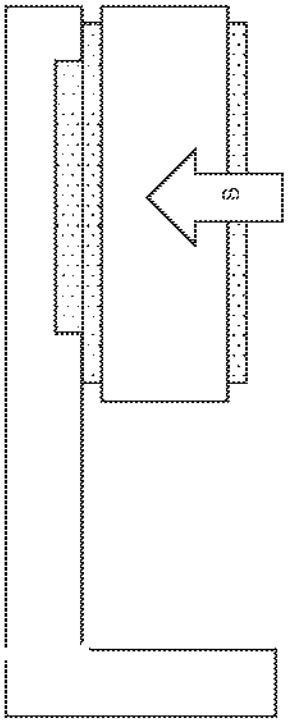


FIG. 15B

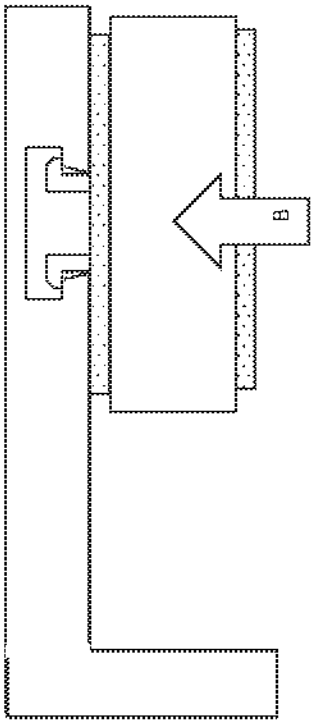


FIG. 15D

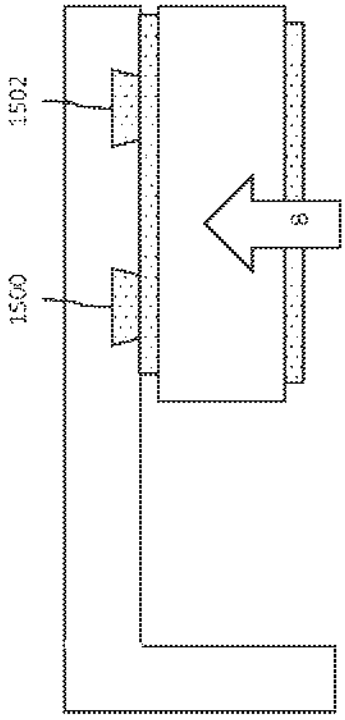


FIG. 15A

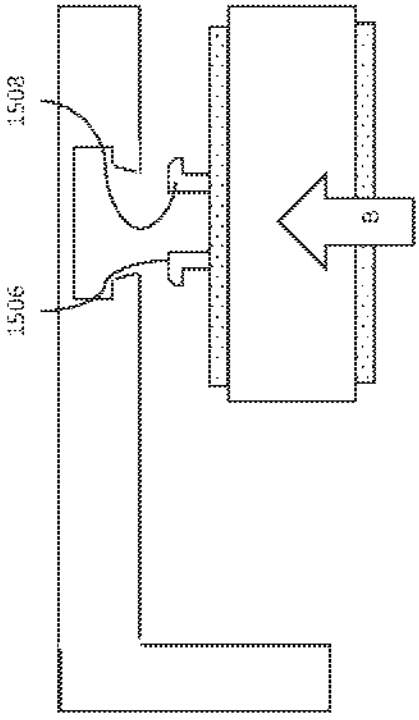


FIG. 15C

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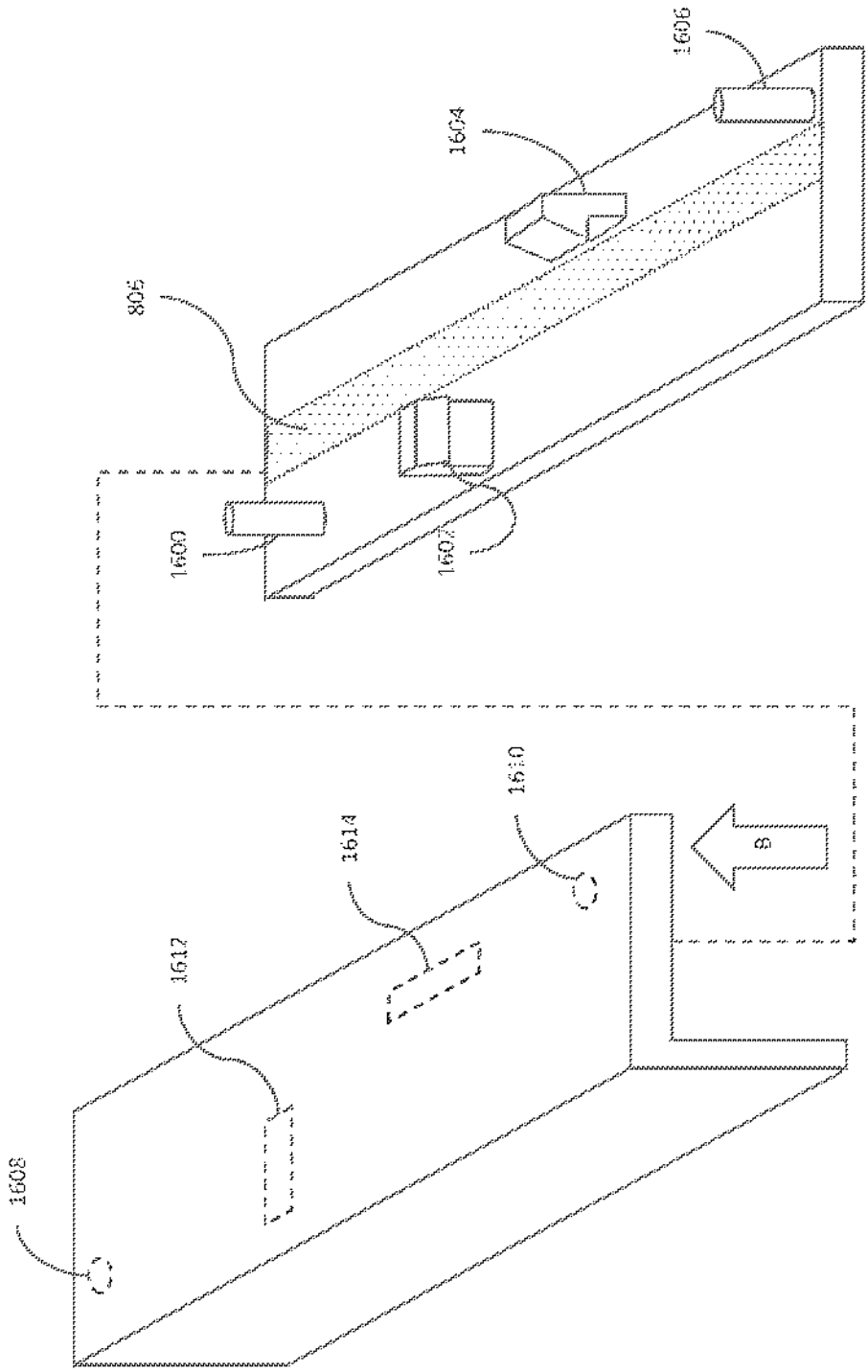


FIG. 16

TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

INCORPORATION BY REFERENCE TO ANY PRIORITY APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57.

BACKGROUND

Field of the Invention

The present invention relates to touch-sensing apparatus that operate by propagating light by diffusive light scattering above a panel, and in particular to optical and mechanical solutions for defining the light paths and control of curvature of the panel. The present invention relates furthermore to a method of assembling a touch sensing apparatus.

Background of the Invention

In one category of touch-sensitive panels known as 'above surface optical touch systems', a set of optical emitters are arranged around the periphery of a touch surface to emit light that is reflected to travel above the touch surface. A set of light detectors are also arranged around the periphery of the touch surface to receive light from the set of emitters from above the touch surface. An object that touches the touch surface will attenuate the light on one or more propagation paths of the light and cause a change in the light received by one or more of the detectors. The location (coordinates), shape or area of the object may be determined by analysing the received light at the detectors.

In a variant of such 'above surface optical touch system', illustrated in FIG. *1a* in cross-section, the emitters **301** are arranged on a substrate **304**, and light from the emitters travel above the touch surface **302** of the panel **305** via reflection or scattering on an edge reflector or diffuser **303**. As shown in top-down view FIG. *1b*, the light will then continue until deflected by a corresponding edge reflector at an opposing edge of the light transmissive panel, where the light will be scattered back down through the transmissive panel and onto the detectors **306**.

Detectors **306** are distributed around the periphery of touch surface **302**, to receive part of the propagating light. The light from each of emitters **301** will thereby propagate inside the transmissive panel **305** to a number of different detectors **306** on a plurality of light paths D. In the illustrated example, the apparatus **300** also includes a controller **320** which is connected to selectively control the activation of the emitters **301** and, possibly, the readout of data from the detectors **306**. Depending on implementation, the emitters **301** and/or detectors **306** may be activated in sequence or concurrently. The signal processor **330** and the controller **320** may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor **330** and the controller **320** may be at least partially implemented by software executed by a processing unit **340**.

A problem with such previous systems is the cumbersome alignment between the components thereof, which makes assembly more difficult and costly. Sub-optimal alignment results in signal loss, which moreover is an inherent problem in previous solutions due to the multiple components involved in the light scattering process. Another issue affecting the signal and scattering of the light in the touch sensing apparatus is uncontrolled glass warpage, i.e. distortions of the curvature of the light transmissive panel which will affect the light path and the detection process. While it is critical to accurately control such distortions, previous solutions incorporate complex solutions that may not allow to fully optimize glass warpage control in a mass production line without limiting the throughput of the production.

Some prior art systems rely on coupling and propagation of collimated light across the light transmissive panel. Such systems are however cumbersome to reliably implement due to the small tolerances with respect to the alignment of the components thereof. E.g. the light emitters- and detectors need to be precisely aligned in relation to various lenses and reflect the light via concave and/or convex reflection and/or refraction to get the desired collimation. Such precise alignment may be difficult to achieve in mass production. The use of collimated light, or light reflected by means of specular reflection, also adds to this complexity, which in turn results in a more expensive and less compact system. Furthermore, to reduce system cost, it may be desirable to minimize the number of electro-optical components.

SUMMARY OF THE INVENTION

An objective is to at least partly overcome one or more of the above identified limitations of the prior art.

One objective is to provide a touch-sensitive apparatus based on "above-surface" light propagation which is robust and easy to assemble.

Another objective is to provide an "above-surface"-based touch-sensitive apparatus with efficient use of light.

One or more of these objectives, and other objectives that may appear from the description below, are at least partly achieved by means of touch-sensitive apparatuses according to the independent claims, embodiments thereof being defined by the dependent claims.

According to a first aspect, a touch sensing apparatus is provided comprising a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel. The light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the panel extends.

Preferably the plurality of light emitters and detectors are arranged above the touch surface.

Preferably the substrate extends at least partly above the touch surface, whereby the plurality of light emitters and detectors are connected to a portion of the substrate extending above the touch surface.

Preferably the substrate is fixed to a carrier mounted around the perimeter of the panel.

Preferably the carrier is arranged to at least partly enclose edges the panel.

Preferably the carrier comprises fixing elements configured to attach the carrier to a display unit.

Preferably the fixing elements are configured to attach the position of the substrate in relation to the carrier and/or in relation to the display unit.

Preferably the fixing elements are configured to interlock with a mounting element for locking the position of the carrier and/or the substrate to the display unit.

Preferably the fixing elements comprise openings, wherein the carrier forms a cavity having walls at least partly

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enclosing the substrate, and wherein at least one of the walls comprises at least one of said openings.

Preferably the fixing elements comprise openings arranged in the carrier and in the substrate, wherein first openings of the carrier are aligned with second openings of the substrate, the first and second openings being configured to receive a mounting element configured to lock the position of the carrier and/or the substrate to the display unit.

Preferably the carrier is configured to be attachable to the display unit at an adjustable position along a direction parallel to the normal axis, whereby a distance between the panel and the display unit along the normal axis is variable upon attaching the carrier to the display unit at at least two different adjustable positions.

Preferably the fixing elements are configured to attach the carrier to the display unit at the adjustable positions along the direction parallel to the normal axis.

Preferably the openings are separated along a direction parallel to the normal axis, and/or wherein the carrier is attachable to a plurality of second openings in a display support of the display unit, the plurality of second openings being separated along the normal axis.

Preferably the carrier is formed from a single monolithic piece of material.

Preferably the substrate extends in a longitudinal direction along the perimeter of the panel, the substrate comprising secondary fixing units configured for variably attaching the position of the substrate on the carrier along the longitudinal direction and/or in the direction of the normal axis.

Preferably vertical alignment units are arranged between adjacent substrates extending in a longitudinal direction along the perimeter of the panel, wherein the vertical alignment units are configured to variably position the adjacent substrates in the direction of the normal axis so that an angle between the adjacent substrates is adjustable.

Preferably a plurality of substrates extend in a longitudinal direction along the perimeter of the panel, wherein a first substrate of said plurality of substrates comprises a connection unit configured to directly interlock with a subsequent connection unit of a subsequent substrate when arranged adjacent said subsequent substrate.

Preferably a sealing window is arranged around the perimeter of the panel, wherein the sealing window comprises a first surface facing the light emitters or the light detectors and an opposite second surface arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, and wherein at least one of the first and second surfaces comprises a light collimating surface configured to collimate light propagating above the touch surface.

Preferably the second surface extends in the direction of the normal axis between a base surface of the sealing window, facing the panel, and an opposite top surface of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance so that the second surface forms an angle relative the normal axis, and wherein the second surface comprises a light collimating surface.

According to a second aspect, a touch sensing apparatus is provided comprising a panel extending in a plane having a normal axis, the panel defining a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel, wherein the light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The touch sensing apparatus comprises a sealing window arranged around the perimeter, wherein the sealing window comprises a first surface facing the light emitters or the light detectors and an opposite second surface arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface of the sealing window, facing the panel, and an opposite top surface of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance so that the second surface forms an angle relative the normal axis, and wherein the second surface comprises a light collimating surface configured to collimate light propagating above the touch surface.

Preferably the first surface and/or second surface form a curved edge convex to the sealing window.

According to a third aspect, a method of assembling a touch sensing apparatus is provided comprising: attaching a substrate having a plurality of light emitters and detectors to a carrier; attaching the carrier around a perimeter of a panel and arranging the substrate to extend in a direction parallel with a normal axis of a plane in which the panel extends.

Preferably the plurality of light emitters and detectors are arranged above the touch surface.

Preferably the carrier if formed from a single monolithic piece of material, the carrier forming a cavity having walls at least partly enclosing the substrate, wherein at least one of the walls comprise openings, the method comprising fixing the carrier to a display unit by fixing mounting elements through said openings.

Preferably the method comprises adjusting a distance between the panel and a display unit along the normal axis by attaching the carrier to the display unit at at least two different adjustable positions along a direction parallel to the normal axis.

Preferably the method comprises adjusting a radius of curvature of the panel in the direction of the normal axis by attaching the carrier to a display unit at at least two different adjustable positions along a direction parallel to the normal axis.

According to a fourth aspect there is provided a touch sensing apparatus, comprising: a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel and the light emitters are arranged to emit a respective beam of emitted light above the touch surface, and the light emitters are arranged to receive detection light from the emitted light, a substrate on which the plurality of light emitters and detectors are mountable; and a sealing window sealable against at least one surface of the touch sensing apparatus for sealing a cavity around the plurality of light emitters and detectors wherein the sealing window comprises at least one reference surface for aligning the substrate with respect to the sealing window.

Preferably the sealing window is sealable between the touch surface and a surface of the substrate.

Preferably the surface of substrate is a surface of a carrier for protecting components of the touch sensing apparatus.

Preferably the carrier comprises an upper portion which overlaps a portion of the perimeter of the panel and the sealing window is sealable between the touch surface and the underside of the overlapping upper portion.

Preferably the at least one reference surface is arranged to engage with a reciprocal reference surface on the substrate.

Preferably the at least one reference surface comprises a first portion for aligning in a first direction and a second portion for aligning in a second direction.

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Preferably the at least one reference surface aligns the sealing window with respect to the substrate in a plane parallel with the touch surface.

Preferably the at least one reference surface aligns the sealing window with respect to the substrate at a height above the touch surface.

Preferably the sealing window comprises at least one resiliently deformable seal engagable with the substrate.

Preferably the resiliently deformable seal comprises the at least one reference surface.

Preferably the seal is extrudable along one or more surfaces of the sealing window.

Preferably the at least one reference surface substantially extends the entire length of the sealing window.

Preferably the sealing window and/or the substrate comprise a projection having a cross-sectional shape for positive engagement with a reciprocal hole in the substrate and/or sealing window and the at least one reference surface is part of the projection.

Preferably the sealing window and/or the substrate comprise a resiliently deformable projection wherein the projection comprises the at least one reference surface comprises and the projection is deformable on engagement with the substrate and/or sealing window and forms a snap-fit engagement therebetween.

Preferably the sealing window comprises a plurality of reference surfaces.

Preferably the at least one reference surface comprises at least one discrete upstanding projection for engagement with reciprocal hole in the substrate

Preferably the at least one upstanding projection is one or more of: pegs, hooks, latches, clamps or fasteners.

According to a fifth aspect there is provided a method of manufacture of the touch sensing apparatus comprising: mounting a plurality of light emitters and detectors to a substrate, attaching the substrate around a perimeter of a panel; and mounting a sealing window against at least one surface of the touch sensing apparatus for sealing a cavity around the plurality of light emitters and detectors wherein the sealing window comprises at least one reference surface for aligning the substrate with respect to the sealing window.

Further examples of the invention are defined in the dependent claims, wherein features for the second aspect of the disclosure are as for the first aspect mutatis mutandis.

Some examples of the disclosure provide for a touch sensing apparatus that is easier to manufacture and assemble.

Some examples of the disclosure provide for a touch sensing apparatus with fewer steps of assembly.

Some examples of the disclosure provide for a touch sensing apparatus that is less costly to manufacture.

Some examples of the disclosure provide for a facilitated alignment of emitters and detectors of touch sensing apparatus.

Some examples of the disclosure provide for facilitated control of the curvature of the touch surface of a touch sensing apparatus.

Some examples of the disclosure provide for a more robust touch sensing apparatus.

Some examples of the disclosure provide for a touch sensing apparatus that is more reliable to use.

Some examples of the disclosure provide for a touch sensing apparatus that has a better signal-to-noise ratio of the detected light.

Some examples of the disclosure provide for a more compact touch sensing apparatus.

Still other objectives, features, aspects and advantages of the present disclosure will appear from the following detailed description, from the attached claims as well as from the drawings.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects, features and advantages of which examples of the invention are capable of will be apparent and elucidated from the following description of examples of the present invention, reference being made to the accompanying drawings, in which:

FIG. **1***a* is a section view of a touch sensing apparatus according to the prior art;

FIG. **1***b* is a top-down view of a touch sensing apparatus according to the prior art;

FIG. **2** is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

FIG. **3** is a schematic illustration, in a perspective side view, of a touch sensing apparatus according to one example.

FIG. **4***a* is a schematic illustration, in a side view of FIG. **2**, of a touch sensing apparatus according to one example;

FIG. **4***b* is a schematic illustration of a magnified section of FIG. **4***a*, according to one example;

FIG. **4***c* is a schematic illustration of a magnified section of FIG. **4***a*, according to one example;

FIG. **5***a* is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

FIG. **5***b* is a schematic illustration of a magnified section of FIG. **5***a*, according to one example;

FIG. **6** is a flow chart of a method of assembling a touch sensing apparatus according to one example;

FIG. **7** is a schematic exploded perspective view of different layers of the touch-sensing apparatus according to one example;

FIG. **8** is a perspective schematic view of through a cross section of the touch sensing apparatus according to one example;

FIG. **9** is a cross sectional view of the touch sensing apparatus according to one example;

FIG. **10** is a cross sectional view of the touch sensing apparatus according to one example;

FIG. **11** is a cross sectional view of the touch sensing apparatus according to one example;

FIG. **12** is a perspective schematic view of through a cross section of the touch sensing apparatus according to one example;

FIG. **13** is a schematic perspective view of the touch sensing apparatus according to one example;

FIG. **14** is a cross sectional view of the touch sensing apparatus according to one example;

FIGS. **15***a*, **15***b*, **15***c*, and **15***d* show magnified cross-sectional views of the touch sensing apparatus according to different examples; and

FIG. **16** is a schematic perspective view of the touch sensing apparatus according to one example.

DETAILED DESCRIPTION

In the following, embodiments of the present invention will be presented for a specific example of a touch-sensitive

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apparatus **100**. Throughout the description, the same reference numerals are used to identify corresponding elements.

FIG. **1***a* schematically illustrates a variant of an 'above surface optical touch system', as discussed in the Background Art section above, where the light from the emitters **301** travel above the touch surface **302** of the panel **305** via reflection on an edge reflector **303**. FIG. **1***b* illustrates a top plan view of FIG. **1***a* in an example of a touch-sensitive apparatus **100**.

FIG. **2** schematically illustrate a touch sensing apparatus **100** comprising a light transmissive panel **101** that defines a touch surface **102**. In some embodiments the light transmissive panel **101** is located above a display **130** and permits light generated by the display **130** to propagate therethrough. However in other embodiments the light transmissive panel **101** can comprise light blocking material and does not permit the transmission of light therethrough. For example, the touch sensing apparatus **100**, can be a trackpad or another touch interface which is remote from the display unit **130**. Hereinafter the term "light transmissive panel" **101** will be used to describe either a light transmissive panel **101** or a solid, opaque panel **101**.

A plurality of light emitters **103** and detectors **103'** are arranged along a perimeter **104** of the light transmissive panel **101**. The light emitters **103** are arranged to emit a respective beam of emitted light **105** above the touch surface **102**. I.e. while the touch surface **102** extends along a plane **108**, having a normal axis **107** directed towards a user performing touch operations on the touch surface **102**, the emitted light **105** travels parallel with plane **108** and at a certain distance from the touch surface **102** in the direction of the normal axis **107**, as schematically illustrated with respect to light beam **105**, **105'**, in e.g. FIG. **2**. Light **105**, **105'**, can thus travel across the touch surface **102**, between opposite sides thereof, without being reflected inside the light transmissive panel **101** itself.

In other embodiments, the plurality of light emitters **103** and detectors **103'** are optionally arranged along a perimeter **104** of the light transmissive panel **101** at a different height. In some embodiments, the light emitters **103** and/or detectors **103'** are arranged to emit a respective beam of emitted light **105** below the touch surface **102** and the light beams are guided around the light transmissive panel **101**. The light beams can be guided around the light transmissive panel **101** with additional reflective components (not shown). For the purposes of brevity, the embodiments discussed hereinafter refer to the plurality of light emitters **103** and detectors **103'** being arranged above the touch surface **102**, but the embodiments also include the arrangement where the plurality of light emitters **103** and detectors **103'** are mounted below the touch surface **102**.

The light detectors **103'** are arranged to receive detection light **105'** from the emitted light **105**. FIG. **2** illustrates a section of the touch sensing apparatus **100** adjacent the perimeter **104** of the light transmissive panel **101**. In this section, the emitters and detectors **103**, **103'**, are shown in the same view, as well as the emitted and detected light **105**, **105'**, for clarity of presentation. The plurality of light emitters and detectors **103**, **103'**, are arranged above the touch surface **102** and are connected to a substrate **106** extending in a direction **107'** parallel with a normal axis **107** of a plane **108** in which the light transmissive panel extends. By having the substrate **106** extending in parallel with the normal axis **107**, the plurality of emitters and detectors **103**, **103'** are conveniently arranged, above the touch surface **102** to achieve a compact footprint in the direction of the plane **108** of the touch sensing apparatus **100** around the perimeter **104**, while achieving a direct light path for the emitted or detected light **105**, **105'**, above and across and touch surface **102**. Thus, the emitted light **105** does not have to be reflected in order to diffusively spread above and across the touch surface **102**, and a detector **103'** may directly receive detection light **105'** by being correspondingly positioned above the touch surface **102** at an opposite position anywhere around the perimeter **104**. The amount of available light that can be utilized for the detection and characterization of an object touching the touch surface **102** can thus be maximized, and the signal to noise ratio can be improved. The touch sensing apparatus **100** may comprise a sealing window **126** as illustrated in FIG. **2**, shielding the emitters and detectors **103**, **103'**, from the outside. The emitted and detected light **105**, **105'**, may thus only have to propagate through the sealing window **126** along the light path between the emitters and detectors **103**, **103'**. The sealing window **126** provides sealing around the perimeter **104** of the light transmissive panel **101** and protects the emitters and detectors **103**, **103'** and the display.

Having the substrate extending in the direction **107'** being parallel with the normal axis **107** and the emitters and detectors **103**, **103'**, arranged above the touch surface **102** provides for a less complex alignment to maximize the detection performance of the touch sensing apparatus **100**. The position of the substrate **106** in the direction of the normal axis **107** can be accurately varied to achieve optical alignment with respect to the emitters and detectors **103**, **103'**. The ability to achieve an accurate positioning of the substrate **106**, and consequently the emitters and detectors **103**, **103'**, attached thereto, is also due to the increased accuracy by which the dimensions of the substrate **106** can be defined along the direction of the substrate **106** aligned with the normal axis **107** in FIG. **2**. I.e. the substrate **106** is elongated and extends in a longitudinal direction **123** (FIG. **4***a*) around the perimeter **104** of the light transmissive panel **101**, and it has a short-side extending in parallel with the normal axis **107**. The short-side of the substrate **106**, illustrated in the cross-sectional view of FIG. **2**, may be manufactured to smaller tolerances, and by aligning this side with the normal axis **107**, the tolerances for the alignment of the emitters and detectors **103**, **103'**, along the normal axis **107** can be improved. The alignment can thus be both improved, and facilitated as discussed above. The latter advantage also provides for facilitated and less costly mass production of the touch sensing apparatus **100** and the various touch base display systems in which it may be implemented.

The substrate **106** may extend at least partly above the touch surface **102**, whereby the plurality of light emitters and detectors **103**, **103'**, are connected to a portion **109** of the substrate extending above the touch surface **102**. This further provides for achieving a more robust alignment of the emitters and detectors **103**, **103'**, relative to the light transmissive panel **101**, by being directly joined to the substrate **106**, and thereby simultaneously arranged above the touch surface **102**. It may be conceivable however that the emitters and detectors **103**, **103'**, are connected to the substrate **106** via connection elements (not shown) extending between the substrate **106** and to a position above the touch surface **102**.

The substrate **106** may be fixed to a carrier **110** mounted around the perimeter **104** of the light transmissive panel **101**, as schematically illustrated in FIGS. **1***a*, **1***b* and **2**. By directly joining the substrate **106** to the carrier **110** provided around the perimeter **104**, the assembly of the touch sensing apparatus **100** may be further facilitated, as the amount of components can be kept at a minimum. For example, the substrate **106** can be accurately fixed in relation to the carrier

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110, due to the small tolerances possible in the direction of the substrate 106 aligned in parallel with the normal axis 107 in FIG. 2, as discussed above. The carrier 110 may for example comprise a cavity 116, as discussed further below, being precisely dimensioned to accommodate the width of the substrate 106 along the direction 107', i.e. the short-side of the substrate 106. Then, accurate positioning of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 is possible as the carrier 110 is mounted around the perimeter 104 thereof. The carrier 110 may extend substantially in the direction 107' parallel with the normal axis 107, as with the substrate 107, to achieve a compact mounting around the perimeter 104. In some embodiments the carrier 110 may also be the substrate 106 or the emitters and detectors 103, 103' are mounted directly to the carrier 110.

Having the substrate 106 fixed to the carrier 110 allows also for having the carrier 110 wired as an electrical ground reference layer of the substrate 106.

The carrier 110 may be arranged to at least partly enclose edges 111 of the light transmissive panel 101, as shown in the example of FIG. 2. This provides for further increasing the robustness of the touch sensing apparatus 100, and improving the accuracy of the alignment of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 since the carrier 110, having the emitters and detectors 103, 103', fixed thereto, may also be directly supporting the light transmissive panel 101 around the perimeter 104. The carrier 110 may comprise a slot in which the light transmissive panel 101 is fitted around the perimeter 104.

The carrier 110 may comprise fixing elements 112 configured to attach the carrier 110 to a display unit 113, 121. The display unit may comprise a display support 121 and a display panel 113, which collectively is referred to as a display unit in the present disclosure. Having the carrier 110 attachable to the display unit 113, 121, by fixing elements 112, advantageously provides for further facilitating the assembly of the touch sensing apparatus 100 to a display unit, since the carrier 110 can be directly joined to the latter. Alignment is thus facilitated, due to the minimum amount of components needing such alignment to each other. The robustness of the touch sensing apparatus 100 is further improved, while mass production is made less complex due the minimized number of assembly steps. The fixing elements 112 may comprise any elements configured to provide for fixing of the position of the carrier 110 to the display unit 113, 121. In the example shown in FIG. 2, the carrier 110 has openings 115, 115', 115", discussed further below, which may be aligned with corresponding openings 127 of a support of the display unit 121, through which mounting elements 114 may be positioned for the fixing. It is conceivable however that the carrier 110 has other types of recesses or protrusions which may interlock with a corresponding mating surface of the display unit 113, 121.

The fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the carrier 110. Thus, besides from fixing the position of the carrier 110 relative to the display unit 113, 121, the fixing elements 112 may also fix or at least support the position of the substrate 106 in relation to the carrier 110. It is conceivable that the substrate 106 may first be arranged in relation to the carrier 110, and the fixing elements 112 may be arranged to support and strengthen the fixing therebetween, while simultaneously fixing the carrier 110 to the display unit 113, 121. This may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100. From a similar aspect, the fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the display unit 113, 121. This may be seen as a consequence from the above, i.e. the fixing elements 112 contributing to the fixing of the substrate 106 to the carrier 110, which in turn is fixed to the display unit 113, 121. It is however conceivable that the fixing elements 112 may fix the substrate 106 directly to the display unit 113, 121, in which case the carrier 110 may act as a further support for the substrate 106.

In one example, as discussed further below, the substrate 106 may comprise second openings 118 which provides for such fixing or support. As mentioned, this may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100.

The fixing elements 112 may be configured to interlock with a mounting element 114 for locking the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. FIGS. 2-3 show examples of having an elongated mounting element 114 joining the carrier 110 and/or the substrate 106 to the display unit 113, 121. The mounting element 112 may however comprise any fastening element configured to exert a force between the carrier 110 and/or the substrate 106 to the display unit 113, 121, such as pins, bolts, screws, clips, clamps, locks, bars, rods, anchors, latches, clasps.

The fixing elements 112 may comprise openings 115, 115', 115", as illustrated in FIGS. 2-3. The carrier 110 may form a cavity 116 having walls 117 at least partly enclosing the substrate 106, illustrated in the example of FIG. 2. This may provide for increased stability of the fixing of the position of the substrate 106 in relation to the carrier 110. At least one of the walls 117 may comprise at least one of the openings 115, 115', 115", as further illustrated in FIG. 2. Being able to directly fix the walls 117 of the carrier 110 enclosing the substrate 106 to the display unit 121, 113, provides for further simplifying manufacturing, and at the same time further increase the accuracy of the alignment of e.g. the emitters and detectors 103, 103', in relation to the light transmissive panel 101, since the minimized number of intermediate mounting components improves tolerance control, i.e. build-up of mounting errors in each assembly step is reduced and controlled. It is conceivable that the walls 117 may be fixed to the display unit 113, 121, by other fixing elements 112, such as recesses or protrusions interlocking with correspondingly mating surfaces of the display unit 113, 121, and/or fastening elements as exemplified above.

The fixing elements 112 may comprise openings 115, 115', 115", 118, arranged in the carrier 110 and in the substrate 106. First openings 115, 115', 115" of the carrier 110 may be aligned with second openings 118 of the substrate 106, as illustrated in the example of FIG. 2. The first and second openings 115, 115', 115", 118 may be configured to receive a mounting element 114 configured to lock the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. This provides for further facilitated and improved alignment and assembly, and increased robustness. In the example of FIG. 2, the carrier 110 encloses the substrate 106 such that two opposite openings 115, 115", of the carrier are arranged on either side of the substrate 106, but it is conceivable that the carrier 110 may be arranged on one side only of the substrate 106.

The carrier 110 may be configured to be attachable to the display unit 121, 113, at an adjustable position 119, 119', along a direction 117" parallel to the normal axis. A distance 120 between the light transmissive panel 101 and the display unit 113 along the normal axis 107 may thus be variable upon attaching the carrier to the display unit 113, 121 at at least two different adjustable positions 119, 119'. For

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example, turning to FIG. **3**, the carrier **110** is attached at a first position **119** to the support of the display unit **121**, via fixing unit **112**. The first position **119** provides for the given distance **120** between the panel of the display unit **113**. The distance **120** may then be decreased by instead attaching the carrier **110** at a second position **119'** which is off-set with respect to the first position **119** in the positive direction of the normal axis **107**, or the direction **107"** as illustrated in FIG. **3**. If the fixing point to the support of the display unit **121** remains constant, e.g. at the opening **127** of a support **121** as illustrated, the carrier **110** will be moved in the opposite direction to the normal axis **107** and the distance **120** will be decreased. Having the carrier **110** being attachable to the display unit **121**, **113**, at an adjustable position **119**, **119'**, along a direction **117"** parallel to the normal axis **107**, thus provides for simple and efficient adjustment of the position of the light transmissive panel **101**.

Besides from overall controlling the distance **120**, as discussed, such adjustment provides for efficiently controlling and varying the curvature of the light transmissive panel **101**, i.e. varying the distance **120** as discussed at a second intermediate location **128'**, between opposite ends of the carrier **110**, along the longitudinal direction **123**, while maintaining the distance **120** at the opposite ends, such as at a first location **128**, will affect the curvature of the carrier **110**, and thereby the curvature of the light transmissive panel **101**. E.g. decreasing the distance **120** at the second location **128'** can produce a more concave shape, i.e. a decreased radius of curvature, of the carrier **110** and the light transmissive panel **101**, in the direction of the normal axis **107**. Increasing the distance **120** between the mentioned opposite ends can instead increase the radius of curvature in the direction of the normal axis **107**. The curvature or warping of the light transmissive panel **101** can thus be controlled efficiently an in a facilitated manner, which is advantageous for increasing throughput in mass-production of displays incorporating the touch sensing apparatus **100** while keeping the warp of the light transmissive panel **101** under control. An optimized curvature of the light transmissive panel **101** increases the reliability and accuracy of the touch sensing apparatus **100**.

The fixing elements **112** may be configured to attach the carrier **110** to the display unit **121** at the adjustable positions **119**, **119'**, along the direction **117"** parallel to the normal axis **107**. Thus, the fixing units **112** be arranged at the different adjustable positions **119**, **119'**, to adjust the distance **120** and the curvature of the a light transmissive panel **101** while providing for securely attaching the carrier to the display unit **113**, **121**. The fixing elements **112** may thus be arranged at least at the first and second locations **128**, **128'**, along the longitudinal direction **123** as discussed above, where each of the locations in the longitudinal direction **123** may have at least two adjustable positions **119**, **119'**, as illustrated in the example of FIG. **3**.

The openings **115**, **115'**, of the carrier **110** may be separated along a direction **117"** parallel to the normal axis **107**, as illustrated in FIG. **3**. Alternatively, or in addition, the carrier **110** may be attachable to a plurality of second openings **122** in a display support **121** of the display unit, where the plurality of second openings **122** are separated along the normal axis **107**. Thus, the position **119**, **119'**, may be remained fixed while the carrier **110** is attached to the support **121** at the various second openings **122**, to adjust the curvature of the light transmissive panel **101** and/or the distance **120** as discussed above. Although the examples in FIGS. **2-3**, show openings **115**, **115'**, **115"**, **127**, it is conceivable that the attachment between the carrier **110** and the display unit **121**, **113**, is provided by other fixing elements **112** as exemplified above.

The carrier **110** may be formed from a single monolithic piece of material. The structural integrity and the stability of the carrier **110** can thereby be increased, which further optimizes the parameters discussed above with respect to alignment, robustness, ease of assembly etc. One example of a possible process by which the carrier can be formed as a single piece of material is an extrusion process, but it is conceivable that the carrier **110** may be formed from other hot or cold metal or polymer working processes such as drawing, rolling, or molding processes.

The substrate **106** may extend in a longitudinal direction **123** along the perimeter **104** of the light transmissive panel **101**. FIG. **4***a* illustrates a view of a plurality of substrates **106**, **106'**, extending along the longitudinal direction **123**. The light transmissive panel **101** and the carrier **110** holding the substrates have been excluded in the view for clarity of presentation. The substrates **106**, **106'**, may comprise secondary fixing units **124**, **124'**, configured for variably attaching the position of each of the substrates **106**, **106'**, on the carrier **110** along the longitudinal direction **123** and/or in the direction of the normal axis **107**. This provides for more accurately adjusting the position of the substrates **106**, **106'**, in relation to the light transmissive panel **101**. While each of the substrates **106**, **106'**, may be within tolerances, the accumulated error obtained when several substrates **106**, **106'** are connected along the longitudinal direction **123** may exceed the total tolerance of the full length of the light transmissive panel **101**. Such accumulation of errors may be effectively prevented by having secondary fixing units **124**, **124'**, as elucidated above. The secondary fixing units **124**, **124'**, may be provided on various locations on the substrates **106**, **106'**, to allow for adjusting the position, such as on opposite ends thereof.

The touch sensing apparatus **100** may comprise vertical alignment units **135** arranged between adjacent substrates **106**, **106'**, extending in a longitudinal direction **123** along the perimeter **104** of the light transmissive panel **101**. The vertical alignment units **135** are configured to variably position the adjacent substrates **106**, **106'**, in the direction of the normal axis **107** so that an angle **136** between the adjacent substrates **106**, **106'**, can be adjusted. FIG. **4***b* schematically illustrates a vertical alignment unit **135** positioned between adjacent substrates **106**, **106'**, to vary the position thereof in the direction of the normal axis **107**, i.e. along arrows **137**, so that the angle **136** may be set to a desired value. The vertical alignment unit **135** thus provides for facilitating the alignment of the plurality of substrates **106**, **106'**, to e.g. the curvature of the light transmissive panel **101**. For example, if the light transmissive panel **101** is concave in the direction of the normal axis **107**, initially parallel substrates **106**, **106'**, may be angled to closely follow the concave shape of the light transmissive panel **101** by increasing the angle **136** between the substrates **106**, **106'**, as schematically illustrated in FIG. **4***b*. The position of the emitters and detectors **103**, **103'**, on the substrates **106**, **106'**, may thus remain at an optimized vertical position relative the light transmissive panel **101** for various curvatures thereof. The vertical alignment unit **135** may comprise various units configured to change the position of the adjacent substrates **106**, **106'**, in the direction of the normal axis **107**, such as bolts, screws, pins, or any other elements that can provide an offset at the ends of the substrates **106**, **106'**.

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The touch sensing apparatus **100** may comprise force distributing units **138** positioned between adjacent substrates **106**, **106'**, configured to provide a fixing force therebetween, as schematically illustrated in FIG. **4***c*. The force distributing units **138** may provide for improving and facilitating the fixing of the substrates **106**, **106'**, to the carrier, without the need for dedicated fixing elements such as screws, bolts, etc to each end of respective substrates **106**, **106'**, thereby reducing the amount of such fixing elements, which facilitates the assembly of the touch sensing apparatus **100**.

The touch sensing apparatus may thus comprise a plurality of substrates **106**, **106'**, extending in a longitudinal direction **123** along the perimeter **104** of the light transmissive panel **101**. A first substrate **106** of the plurality of substrates may comprises a connection unit **125** configured to directly interlock with a subsequent connection unit **125'** of a subsequent substrate **106'** when arranged adjacent said subsequent substrate, as schematically illustrated in FIG. **4***a*. It is thereby possible to directly connect subsequent substrates **106**, **106'**, and eliminate the need for intermediate connectors, which further provides for facilitating the assembly of the touch sensing apparatus **100**.

The touch sensing apparatus **100** may comprise a sealing window **126** as schematically illustrated in FIGS. **5***a-b*. The sealing window **126** may be arranged around the perimeter **104** of the light transmissive panel **101**. The sealing window **126** may comprise a first surface **129** facing the light emitters **103** or the light detectors **103'**, and an opposite second surface **130** arranged adjacent the touch surface **102**. Emitted or detected light thus propagates between the first and second surface **129**, **130**. At least one of the first and second surfaces **129**, **130**, may comprises a light collimating surface **129**, **130**, configured to collimate light propagating above the touch surface **102**. I.e. emitted light **105** will be collimated by the sealing window **126**, so that the light propagating above the touch surface **102** will be collimated. Detectors **103'** will receive the collimated light which will be focused through a corresponding sealing window **126**. As the emitters and detectors **103**, **103'**, are arranged above the touch surface **102** and are connected to a substrate **106** extending in a direction parallel with a normal axis **107**, it is possible to provide for a very precise and improved alignment thereof in relation to the sealing window **126**, which allows for achieving collimated light in a highly optimized manner, and an associated increase in signal strength since more of the emitted light can be collected by the detectors **103'**. The emitted light is collimated in a direction parallel with the plane **108** in which the light transmissive panel **101** extends. Collimating the light with sealing window **126** also allows for reducing the aperture of the sealing window **126**, i.e. the thickness of the sealing window **126** in the direction of the normal axis **107**, while still detecting a sufficient amount of light. This provides for reducing the amount of ambient light reaching the detectors **103'**, thus improving the signal to noise ratio.

Turning to FIG. **5***b*, the second surface **130** may extend in the direction of the normal axis **107** between a base surface **131** of the sealing window **126**, facing the light transmissive panel **101**, and an opposite top surface **132** of the sealing window **126**. The base surface **131** may be offset from the top surface **132** along the direction of the plane **108** with an offset distance **133** so that the second surface **130** forms an angle **134** relative the normal axis **107**. As further illustrated in FIG. **5***b*, the second surface may comprises the light collimating surface **130**. Thus, in addition to having a convex shape as illustrated in FIG. **5***b*, the second surface **130** is arranged to assume a tilted configuration as provided by the offset distance **133**. Having such angled configuration provides for reducing the impact of Fresnel reflexes. The Fresnel reflexes otherwise generate additional unwanted light paths that will reduce the apparent attenuation on some detection lines, especially when they run parallel to and near a sealing window **126**. These Fresnel reflexes may also result in artifacts and false touch information. By having an angled and/or curved second surface **130** of the sealing window **126**, the light may instead bounce off the second surface **130** with such an angle so that it leaves the plane **108**, and thereby not interfere with the detection of the remaining light.

A sealing window **126** as described above can provide for the advantageous effects as described for touch sensing apparatuses having a plurality of light emitters and detectors arranged in a multitude of configurations, not limited to the configurations described in relation to FIGS. **2** and **3** exemplified above. A touch sensing apparatus **100** is thus provided comprising a light transmissive panel **101** extending in a plane **108** having a normal axis **107**, wherein the light transmissive panel defines a touch surface **102**. The touch sensing apparatus **100** comprises a plurality of light emitters **103** and detectors **103'** arranged along a perimeter **104** of the light transmissive panel, wherein the light emitters are arranged to emit a respective beam of emitted light **105** above the touch surface, wherein the light detectors are arranged to receive detection light **105'** from the emitted light. The touch sensing apparatus **100** comprises a sealing window **126** arranged around the perimeter, wherein the sealing window comprises a first surface **129** facing the light emitters or the light detectors and an opposite second surface **130** arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface **131** of the sealing window, facing the light transmissive panel, and an opposite top surface **132** of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance **133** so that the second surface forms an angle **134** relative the normal axis, and wherein the second surface comprises a light collimating surface **130** configured to collimate light propagating above the touch surface.

The first surface **129**, facing the emitters or detectors **103**, **103'**, may also be angled, with an angle **134'**, as schematically illustrated in FIG. **5***a*, to provide for the desired light path from or towards the emitters or detectors **103**, **103'**, respectively. The first surface **129** may also comprise a light collimating surface and have a convex shape towards the emitters or detectors **103**, **103'**, as illustrated in FIG. **5***a*, in addition to being arranged at an angle **134'**. The angles **134**, **134'**, may be in the range of 2-10 degrees relative to the normal axis **107** to provide for a particularly advantageous reduction of Fresnel reflexes. An angle greater than 2 degrees avoids Fresnel reflexes and an angle of less that 10 degrees reduces the light field height.

The sealing window **126** may comprise a fixing element **139** configured to interlock to carrier **110**. In the example in FIG. **5***a*, the fixing element comprises a protrusion **139** arranged to interlock with a corresponding recess in the carrier **110**. Mounting and fixing of the sealing window **126** may thus be facilitated and improved since the fixing element **139** may snap into the carrier **110**, without needing to have separate fixing units or adhesives joining the sealing window **126** to the carrier **110**. In some circumstances, it is preferable not to use an adhesive because the adhesive may

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not be resilient in high temperatures. Use of an adhesive for fixing the sealing window **126** can be problematic because the uncured adhesive allows for relative movement between the components and precise alignment may be difficult. It is conceivable that the fixing element **139** may comprise any other shape, such as a recess, for interlocking with a corresponding mating surface of the carrier **110**.

Alternative embodiments of the sealing window **126** will now be described in reference to FIGS. **7** to **16**.

FIG. **7** shows an exploded perspective schematic view of the touch sensing apparatus **100**. The dotted line shows the normal axis **107** of the touch surface **102** at the center of the light transmissive panel **101**. For the purposes of clarity, the exploded perspective view in FIG. **7** shows the separate components side by side, but the dotted line of the normal axis **107** represents the order of how the components stack together. As mentioned previously the carrier **110** may extend substantially in the direction parallel with the normal axis **107**. In this way the carrier **110** comprises a downwardly projecting skirt **700** from the upper surface **702**.

The sealing window **126** is mountable on the carrier **110** and this will be discussed in further detail below. The sealing window **126** comprises a similar shape to the arrangement of the plurality of light emitters **103** and detectors **103'** (not shown in FIG. **7** for the purposes of clarity). The sealing window **126** is mounted such that the plurality of light emitters **103** and detectors **103'** are between the sealing window **126** and the skirt **700**. As shown in FIG. **7**, the sealing window **126** is a rectangular loop structure.

In some embodiments, the sealing window **126** may be formed from a single monolithic piece of material, thus providing for a robust sealing window **126** and a stable attachment to the carrier **110** and the light transmissive panel **101**. The sealing window **126** may be formed by an extrusion process. In one embodiment, the sealing window is formed from two separate materials. A first material, such as a dyed PMMA or similar NIR transparent material, is used for a transparent section and a second material, such as a compressible light blocking material, is used for sealing off the I/O compartment. This may be achieved by e.g. using a co-extrusion process

In other embodiments, the sealing window **126** is formed from a plurality of longitudinal pieces (not shown) and joined together to form a rectangular arrangement. Each longitudinal piece may be a single monolithic piece of material. Considering the sealing window **126** in FIG. **7**, the arrangement as shown in FIG. **7** is formed from four pieces of extruded sealing window material **126**. The four pieces are then joined together to construct the rectangular loop as shown in FIG. **7**. The four pieces of the extruded sealing window **126** can be adhered together with glue, or fastened together with screws, clips, clamps or any other suitable fastener. The glue can be applied and cured before the sealing window **126** is slid into the carrier **110** or the glue can be left to cure once the sealing window **126** is positioned in the carrier **110**. Alternatively the four pieces are not fastened or glued together and are held in position with a friction fit.

The sealing window **126**, once assembled, is sandwiched between the upper surface **702** of the carrier **110** and the light transmissive panel **101**. In some embodiments, the sealing window **126** is slid into position between the carrier **110** and the light transmissive panel **101**. FIG. **8** shows the direction A in which the sealing window **126** is moved with respect to the carrier **110** and the light transmissive panel **101**. In this embodiment the sealing window **126** is slid in a direction parallel with the plane of the light transmissive panel **101**. In other embodiments, discussed in more detail below, the sealing window **126** can be inserted into the carrier **110** in a different direction such as parallel to the normal axis **107** and perpendicular to the touch surface **102**.

In some embodiments the light transmissive panel **101** is not required to be light transmissive. For example the touch surface **102** can be on a medium through which light does not propagate. In some embodiments the touch surface **102** can be part of a surface which does not require light from a display unit **113**, **121** to be visible there through. That is, the touch sensing apparatus **100** is remote from the display unit **113**, **121** and the display unit **113**, **121** is not stacked together with the other components as shown in FIG. **7**. In this way the light transmissive panel **101** can be considered to be a panel **101**. For the purposes of clarity, the panel **101** has been referred to as a light transmissive panel **101**, but all the embodiments are also applicable to a panel comprising an opaque or light blocking material

Turning to FIG. **8**, the construction of the carrier **110**, the sealing window **126** and the light transmissive panel will now be discussed in more detail. FIG. **8** shows a partial perspective cross-sectional view of the touch sensing apparatus **100**. In particular FIG. **8** is magnified to show the arrangement between the carrier **110**, the sealing window **126** and the light transmissive panel **101**.

The sealing window **126** comprises a dual purpose. Firstly, the sealing window **126** provides sealing around the perimeter **104** of the light transmissive panel **101** and protects the emitters and detectors **103**, **103'** and the edge of the light transmissive panel **101**. This means that the sealing window **126** prevents ingress of dirt, water and other contaminants into the interior of the touch sensing apparatus **100**. This helps protect the internal components such as the plurality of emitters and detectors **103**, **103'**. Secondly, the sealing window **126** allows light from the emitters and detectors **103**, **103'** to propagate therethrough. In some embodiments, as discussed in reference to FIG. **5***a*, the sealing window can optionally comprise optical elements for refracting, deflecting, diverting or focusing the light beams therethrough. However in other embodiments, the sealing window is optically passive and does not comprise any optical elements for refracting, deflecting, diverting or focusing the light beams therethrough.

As can be seen from FIG. **8**, an upper sealing surface **800** of the sealing window **126** engages with an interior underside surface **802** of the carrier **110**. The upper surface **702** of the carrier **110** is arranged to project over the light transmissive panel **101**. In this way the carrier **110** overlaps a portion of the light transmissive panel **101** around the perimeter of the light transmissive panel **101**. The portion **810** of the upper surface **702** that overlaps with the light transmissive panel **101** is indicated by a bracket in FIG. **8**. The overlapping portion **810** of the carrier **110** provides protection for the perimeter light transmissive panel **101** from shock and other physical forces. The overlapping portion **810** also provides an overhang on which the sealing window **126** can be mounted. The interior underside surface **802** of the carrier is an opposite face to the upper surface **702**. A lower sealing surface **804** of the sealing window **126** engages with the touch surface **102**.

In order to aid the sealing, the sealing window **126** optionally comprises one or more deformable seals or integral gaskets **806**, **808** mounted on the upper sealing surface **800** and the lower sealing surface **804** respectively. The deformable seals **806**, **808** are arranged to deform when the light transmissive panel **101** is urged towards the carrier **110**. The deformable seals **806**, **808** are extruded along the

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longitudinal length of the sealing window **126**. In some embodiments the deformable seals **806**, **808** are integral with the sealing window **126**. As mentioned previously, in some embodiments the deformable seals **806**, **808** can be manufactured at the same time as the sealing window **126** in a co-extrusion process. Alternatively the deformable seals **806**, **808** are mounted and adhered to the sealing window **126** after the sealing window **126** has been extruded. In some embodiments the deformable seals **806**, **808** are made from a thermoplastic elastomer (TPE). The deformable seals **806**, **808** can be colored black to block transmission of light from the sealing window **126**. The deformable seals **806**, **808** can be any suitable color or material for absorbing light and minimizing light in-coupling.

In some embodiments the sealing window **126** is configured to be mounted between two surfaces for sealing and protecting the emitters and detectors **103**, **103'** from the outside environment. In some embodiments the sealing window **126** is arranged to seal against the touch surface **102** and the interior underside surface **802** of the carrier **110**. In other embodiments the sealing window **126** can be mounted between any other surface to provide a sealed cavity **116** around the emitters and detectors **103**, **103'**. In some embodiments the sealing window **126** seals between the interior underside surface **802** and other surface. The other surface does not need to be the touch surface **102**. Instead the other surface is another interior surface of the carrier **110** such as a surface on which the substrate **106** is mounted on. In some other embodiments the sealing window **126** is mounted and sealed against another components and neither of the touch surface **102** and the interior underside surface **802**. In some embodiments the sealing window **126** is sealable against at least one surface of the touch sensing apparatus **100** for sealing a cavity **116** around the plurality of light emitters and detectors **103**, **103'**. In some embodiments the carrier **110** may also be the substrate **106** or the emitters and detectors **103**, **103'** are mounted directly to the carrier **110**.

In some embodiments the sealing window **126** comprises at least one reference surface **812** for aligning the sealing window **126** with respect to the carrier **110**. The reference surface **812** will be discussed in further detail with respect to FIG. **9** for the purposes of clarity.

FIG. **9** is a schematic cross-sectional view of the touch sensing apparatus **100**. The sealing window **126** is inserted between the light transmissive panel **101** and the carrier **110**. The upper deformable seal **806** comprises a reference surface **812** for aligning the sealing window **126** with respect to the carrier **110**. The upper deformable seal **806** comprises a projection **814** which projects upwardly from the upper deformable seal **806** and the sealing window **126**. In this way, the reference surface **812** is upright with respect to the sealing window **126**. The projection **814** also optionally comprises a chamfer **816** in addition to the reference surface **812**.

The chamfer **816** means that the deformable upper seal **806** does not snag on the carrier **110** when the sealing window **126** is inserted between the carrier **110** and the light transmissive panel **101**. Accordingly as the sealing window **126** is pushed into place, the chamfer **816** urges against the interior underside surface **802** of the carrier **110**. Initially, the deformable upper seal **806** is squashed between the carrier **110** and the light transmissive panel **101** when the sealing window **126** is being forced between the carrier **110** and the light transmissive panel **101**.

The sealing window **126** is pushed towards a notch **820** located in the interior underside surface **802** of the carrier **110**. In some embodiments, the notch **820** is a groove that extends around the periphery of the carrier **110**. The notch **820** comprises a reciprocal reference surface **818** for aligning with the reference surface **812** of the projection **814**. In particular, the notch **820** is a reference point for indicating that the sealing window **126** is inserted underneath the overlapping portion **810** sufficiently to form a seal and protect the internal components of the touch sensing apparatus **100**. The notch **820** is positioned a predetermined distance from the edge **822** of the carrier **110**. In some embodiments the predetermined distance is at least half the width of the sealing window **126**.

When the sealing window **126** pushed sufficiently between the carrier **110** and the light transmissive panel **101**, the deformed projection **814** is located within the notch **820**. At this point when the sealing window **126** is located in the correct position with respect to the carrier **110**, the reference surface **812** abuts against a reciprocal reference surface **818** in the notch **820** in the carrier **110**.

The compressed projection **814** resizes and expands once located in the notch **820**. In this way, the project **814** snaps into position and positively engages with the notch **820**. When the sealing window **126** is located and the projection **814** snaps into place, the sealing window **126** makes an audible "click". Additionally or alternatively the snapping of the projection **814** into position provides a tactile feedback during assembly that the sealing window **126** is seated correctly.

The size of the notch **820** is slightly larger than the dimensions of the projection **814**. Accordingly the projection **814** fits snugly within the notch **820**. This means that the frictional forces between the carrier **110**, the light transmissive panel **101** and the sealing window **126** are sufficient to hold the sealing window **126** in place. Adhesive is not required to fix the sealing window **126** in place. However in some embodiments adhesive is optionally used in addition to the snap-fit positive engagement.

In some embodiments the reference surface **812** abuts against the reciprocal reference surface **818**. This means that the sealing window **126** opposes the direction A by virtue of the engaged reference surfaces **812**, **818**. Removal of the sealing window **126** may only be achieved with a special tool which compresses the projection **814**.

Once the sealing window **126** has been seated correctly in the carrier **110**, the reference surfaces **812**, **818** maintain the alignment between the carrier **110** and the sealing window **126**. The deformable seals **806**, **808** maintain the relative position of the sealing window **126** with respect to the carrier and prevents lateral movement in a plane parallel to the light transmissive panel **101**. Furthermore, the reference surfaces **812**, **818** ensure that the sealing window **126** is maintained at a certain height above the touch surface **102**.

The shape and size of the deformable seal **806**, **808** can be varied. Another embodiment with such a variation is shown in FIG. **10**. FIG. **10** shows a cross sectional side view of the touch sensing apparatus **100**. The arrangement is the same as shown in reference to FIGS. **8** and **9**, except the cross sectional shape of the deformable seal **806**, **808** is different. In this embodiment the projection **1002** comprises a curved upwardly projecting bulge **1002** on the upper deformable seal **806**. The bulge **1002** comprises a curved reference surface **1004** which engages with one or more reciprocal reference surfaces **818** of the notch **820**. The curved reference surface **1004** functions in a similar way to the chamfer **814** as described in reference to the previous embodiment when inserting the sealing window **126** between the light transmissive panel **101** and the carrier **110**. The bulge **1002**

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has dimensions which are substantially the same width as the width of the notch **820** so that the sealing window **126** does not experience lateral movement in a direction parallel with the plane of the light transmissive panel **101**. The lower seal **808** optionally comprises a similar bulge **1006** for engaging and sealing against the touch surface **102**. By making the upper seal **806** and the lower seal **808** have the same cross section, manufacture can be simplified because the same die (not shown) can be used during extrusion of the deformable seals **806**, **808**.

Advantageously the shape of the projection **1002** means that the sealing window **126** can be removed with a similar magnitude of force to the force needed for insertion during assembly. Accordingly removal of the sealing window **126** may not require a tool. This can make maintenance which requires removal of the sealing window **126** easier.

Another embodiment is shown in FIG. **11**. FIG. **11** shows a cross sectional side view of the touch sensing apparatus **100**. FIG. **11** is the same as shown in FIG. **10** except that there is an additional projection and notch. The first notch **1100** and first bulge **1104** are substantially the same as the notch **820** and the bulge **1002** as discussed in reference to FIG. **10**. In addition, there is a second notch **1102** and a second bulge **1106**. Likewise the lower seal **808** comprises similar first and second bulges **1108**, **1110**. Having two projecting bulges **1104**, **1106** means that there are two points of sealing engagement between the sealing window **126** and the light transmissive panel **101** and the carrier **110** respectively. This means that there will be less rotation of the sealing window **126** about the deformable seal **806**, **808**. Accordingly, the tolerances needed to accommodate rotational movement of the sealing window about the longitudinal axis of the sealing window can be lower. There is also an increased surface area of the deformable seals **806**, **808** and therefore the deformable seals will cool quicker during manufacture.

In another embodiment, the first and second bulges **1104**, **1106** engage with a single notch **820** as shown in FIG. **10**. The dotted line between the first and second notches **1100**, **1102** represents a single notch, similar to the notch **820** in FIG. **10**. In this case the first bulge **1104** engages a first reciprocal reference surface **1114** and the second bulge **116** engages with a second reciprocal reference surface **1112**. The first and second reciprocal reference surfaces **1114**, **1112** are walls of the notch **820**.

Another embodiment will now be discussed in reference to FIG. **12**. FIG. **12** shows a schematic perspective and cross-sectional view of the touch sensing apparatus **100**. The arrangement as shown in FIG. **12** is the same as shown in FIGS. **8** and **9** except that the deformable seal **806** comprises a plurality of discrete projections **1200**, **1202**, **1204**. Each of the projections is deformable and is inserted between the light transmissive panel **101** and the carrier **110** in the same way as described with respect to the previous embodiments. The carrier **110** comprises a serious of reciprocal recesses (not shown for clarity) to receive a respective projection **1200**, **1202**, **1204**. In this way less deformable material is required to perform the alignment function. The projections may be adhered to the deformable seal material **806** or the projections can be extruded. Each of the projections **1200**, **1202**, **1204** comprise a reference surface for aligning the projection and the sealing window **126** with the reciprocal recess in the carrier **110**. In some embodiments the projections **1200**, **1202**, **1204** can comprise any suitable cross sectional shape. For example, the projections can comprise an oval curved cross section, similar to the bulges shown in the embodiments discussed in reference to FIGS. **10** and **11**.

FIG. **13** shows yet another embodiment. FIG. **13** shows a schematic exploded perspective view of the touch sensing apparatus **100**. For the purposes of clarity the light transmissive panel **101** is not shown. The sealing window **126** is the same as described in reference to the previous embodiments. The upper deformable seal **806** is mounted on the upper sealing surface **800**. In contrast to the previous embodiments, the deformable seal **806** does not comprise upward projections comprising a reference surface. Instead the sealing window **126** comprises positioning pegs **1300**, **1302** for engagement in the reciprocal positioning holes **1304**, **1306** located in the carrier **110**. In this way the reference surfaces are separate from the deformable seal **806**. Each of the positioning pegs **1300**, **1302** comprises a reference surface **1308**, **1310** for aligning the sealing window **126**. In this way as the sealing window is slid underneath the carrier **110** in the direction A, the pegs **1300**, **1302** slot into the positioning holes **1304**, **1306**. The holes **1304**, **1306** are blind holes and when the reference surfaces **1308**, **1310** abut the end of the blind holes **1304**, **1306**, the sealing window **126** is in the correct position. The holes **1304**, **1306** are deep enough such that the sealing window **126** is completely under the carrier **110**, similar to the arrangement shown in the previous embodiments.

FIG. **14** shows another embodiment. FIG. **14** shows a cross sectional side view of the touch sensing apparatus **100**. The arrangement as shown in FIG. **14** is the same as shown in FIGS. **8** and **9** except that the projection **1400** is formed on the carrier **110** and the notch **1402** is formed in the upper deformable seal **806**. In this embodiment the projection **1400** is rigid and downwardly projects from the carrier **110**. The notch **1402** is deformable and snaps into position when the notch **1402** is in positive engagement with the projection **1400** and reference surfaces are in engagement. The sealing window **126** is inserted between the carrier and the light transmissive panel **101** in the same way as discussed previously.

In alternative embodiments, the carrier **110**, the light transmissive panel **101** and the sealing window **126** are assembled in a different order. The components are the same as described in reference to the previous embodiments. Turning to FIGS. **15***a*-**15***d* and FIG. **16** the alternative method of assembly will now be discussed.

FIGS. **15***a*-**15***d* show a side cross section of the touch sensing apparatus **100**. The light transmissive panel **101** has been omitted for clarity. The sealing window **126** is pushed towards the carrier **110** in direction B. That is, a direction which is parallel to normal axis **107**. FIG. **15***a* shows two deformable projections **1500**, **1502** which have a snap-fit engagement with reciprocal grooves in the carrier. The deformable projections **1500**, **1502** have a cross sectional shape that snaps into the reciprocal holes when the sealing window is seated correctly in the carrier **110**.

FIG. **15***b* shows a similar arrangement to FIG. **15***a* except that there is a single projection **1504** which does not have a snap-fit engagement. Optionally, positive engagement is provided by the projection **1504** having a snug friction fit. When the sealing window **126** cannot move any further with respect to the carrier **110**, the projection **1504** will abut the reciprocal surface of the hole in the carrier **110** and the sealing window will be seated correctly.

FIGS. **15***c* and **15***d* show stepwise engagement of the same arrangement. The deformable seal **806** comprises snap-fit latches **1506**, **1508** which bend and snap into place once the sealing window is fully seated in the carrier **110**.

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Once the sealing window **126** and the carrier **110** are assembled, then the light transmissive panel **101** is mounted in the carrier **110**.

FIG. **16** shows a schematic exploded perspective view of the carrier **110** and the sealing window **126**. The arrangement as shown in FIG. **16** is the same as shown in FIG. **13**, except that the relative movement of the sealing window **126** with the respect to the carrier **110** during assembly is perpendicular. That is, along direction B parallel with the normal axis **107**. Similar to the embodiment as shown in FIG. **13**, the sealing window **126** comprises a plurality of reference surfaces which are not part of the deformable seal **806**. Each of pegs **1600**, **1606** and snap-fit latches **1602**, **1604** comprises a reference surface for alignment. FIG. **16** shows pegs **1600**, **1606** for engagement with holes **1608**, **1610**. FIG. **16** also shows resiliently deformable latches **1604**, **1602** for snap-fit engagement with holes **1612** and **1614**.

A further mounting unit **140** may be provided between the sealing window **126** and the light transmissive panel **101**, as schematically illustrated in FIG. **5***a*. The mounting unit **140** may comprise a resilient material that allows the sealing window **126** to assume a secure fixed position relative the light transmissive panel **101**. The sealing window **126** may have a corresponding groove into which the mounting unit **140** may be securely positioned.

A method **200** of assembling a touch sensing apparatus **100** is provided. FIG. **6** illustrates steps of the method **200**. The order in which the steps of the method **200** are described and illustrated should not be construed as limiting and it is conceivable that the steps can be performed in varying order. The method **200** comprises fixing **201** a substrate **106** having a plurality of light emitters **103** and detectors **103'** to a carrier **110**, and attaching **202** the carrier **110** around a perimeter **104** of a light transmissive panel **101**. The method further comprises arranging **203** the substrate to extend in a direction **107'** parallel with a normal axis **107** of a plane **108** in which the light transmissive panel **101** extends, whereby the plurality of light emitters and detectors **103**, **103'**, are arranged above the touch surface **102**. The method **200** thus provides for a facilitated assembly of the touch sensing apparatus **100** while achieving optimal alignment, robustness, and accuracy as described above in relation to FIGS. **2-3**.

As mentioned, the carrier **110** may be formed from a single monolithic piece of material, and the carrier may form a cavity **116** having walls **117** at least partly enclosing the substrate **106**. At least one of the walls **117** may comprise openings **115**, **115'**, **115"**. The method **200** may comprise fixing **204** the carrier **106** to a display unit **121**, **113**, by fixing mounting elements **114** through the openings **115**, **115'**, **115"**, thereby providing for the above mentioned advantages.

The method **200** may comprise adjusting **205** a distance **120** between the light transmissive panel **101** and a display unit **113**, **121**, along the normal axis **107** by attaching **207** the carrier **110** to the display unit **113**, **121**, at at least two different adjustable positions **119**, **119'**, along a direction **117"** parallel to the normal axis **107**. Control of the distance **120** is improved and facilitated, and may thereby be more easily optimized to various applications of the touch sensing apparatus **100**.

The method **200** may comprise adjusting **208** a radius of curvature of the light transmissive panel **101** in the direction of the normal axis **107** by attaching **209** the carrier **110** to a display unit **113**, **121**, at at least two different adjustable positions **119**, **119'**, along a direction **117"** parallel to the normal axis **107**. Control of the curvature of the light transmissive panel **101** is thus improved as described above.

The invention has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope and spirit of the invention, which is defined and limited only by the appended patent claims.

For example, the specific arrangement of emitters and detectors as illustrated and discussed in the foregoing is merely given as an example. The inventive coupling structure is useful in any touch-sensing system that operates by transmitting light, generated by a number of emitters, inside a light transmissive panel and detecting, at a number of detectors, a change in the received light caused by an interaction with the transmitted light at the point of touch.

What is claimed is:

1. A touch sensing apparatus, comprising:

a panel that defines a touch surface;

a plurality of light emitters and detectors arranged along a perimeter of the panel;

a support structure comprising a first portion that is parallel to the touch surface and separated by a space from the panel, said first portion including a first projection extending downwards from said first portion and a second projection extending downwards from said first portion, wherein a gap between the first projection and the second projection forms a receptacle having a first cross-sectional shape; and

an optical element fitted in the space between the panel and the first portion and configured to seal the plurality of light emitters from contaminants from the touch surface, said optical element comprises a mating portion having a second cross-section shape that is substantially reciprocal to the first cross-sectional shape, said mating portion engaged with the receptacle of the first portion.

2. The touch sensing apparatus according to claim **1**, wherein the support structure further comprises a second portion extending from the first portion, wherein the second portion is configured to enable mounting of the plurality of emitters and wherein the second portion is oriented perpendicular to the first portion.

3. The touch sensing apparatus according to claim **2**, wherein the plurality of emitters are mounted on an electronics board that is supported by the second portion, said plurality of emitters configured to emit light above the touch surface.

4. The touch sensing apparatus according to claim **1**, wherein the optical element is configured to slide in a direction parallel to a plane of the touch surface.

5. The touch sensing apparatus according to claim **1**, wherein the optical element comprises a first surface facing the plurality of light emitters and a second surface opposite the first surface, said first surface angled between a top portion of the optical element and a base portion of the optical element and configured to form an offset between a first end of the top portion and a second end of the base portion.

6. The touch sensing apparatus according to claim **2**, wherein the support structure comprises an inner wall supporting the plate, and wherein the first portion, the second portion, a third portion extending from the second portion, and the inner wall of the support structure together form a cavity.

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Chemtronics Exhibit 1002 Page 583

7. The touch sensing apparatus according to claim 6, wherein the cavity secures an electronics substrate that mounts the plurality of light emitters.

8. The touch sensing apparatus according to claim 1, wherein the mating portion is engaged with the receptacle responsive to the optical element slidably fitted in a direction perpendicular to the first portion during assembly.

9. The touch sensing apparatus according to claim 1, wherein the mating portion is engaged with the receptacle responsive to the optical element slidably fitted in a direction parallel to the first portion during assembly.

* * * * *

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	16989292
Filing Date	10-Aug-2020
First Named Inventor	Daniel Skagmo
Attorney Docket Number	FFOG.054C6
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
FlatFrog Laboratories AB	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

10739916

10606416

10437389

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

○ Small Entity

○ Micro Entity

◉ Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 73097

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this request

Signature	/Harnik Shukla/
Name	Harnik Shukla

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16989292
Filing Date:	10-Aug-2020
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Filer:	Harnik Shukla/Jim Nyenhuis
Attorney Docket Number:	FFOG.054C6

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16989292

Filing Date: 10-Aug-2020

Applicant/Patent under Reexamination: Skagmo

Electronic Terminal Disclaimer filed on September 27, 2021

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	43879560
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Jim Nyenhuis
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.054C6
Receipt Date:	27-SEP-2021
Filing Date:	10-AUG-2020
Time Stamp:	20:04:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$170
RAM confirmation Number	E20219QK04441643
Deposit Account	111410
Authorized User	Jim Nyenhuis

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41539 fba7aceab535bf51c33d7788d9c723ec8daed707	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37913 66f70ab0747acf837df778c56178d57f461332d7	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	79452		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/989,292	Filing Date 08/10/2020	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/27/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/MONICA D FRANCIS/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/989,292	08/10/2020	Daniel Skagmo	FFOG.054C6	8380

20995 7590 07/22/2021
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER
GIESY, ADAM

ART UNIT	PAPER NUMBER
2694	

NOTIFICATION DATE	DELIVERY MODE
07/22/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

efiling@knobbe.com
jayna.cartee@knobbe.com

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 593

Office Action Summary	Application No. 16/989,292	Applicant(s) Skagmo et al.	
	Examiner ADAM R GIESY	Art Unit 2694	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 4/2/2021.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 6-22 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 6-8 is/are rejected.

8) ☑ Claim(s) 9-22 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 8/10/2020 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☑ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities

undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

3. Claims 6-8 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims of U.S. Patent Nos. 10739916, 10606416, and 10437389. Please see claim correspondence chart below.

16/989292	USPN 10739916 16/834905	USPN 10606416 16/191177	USPN 10437389 16/191251
6	3	1	6
7		3	
8		1	
9			
10			
11			
12			
13			
14			

15			
16			
17			
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19			
20			
21			
22			

Although the claims at issue are not identical, they are not patentably distinct from each other because:

The claims as shown above all recite similar features. It would have been obvious to one of ordinary skill in the art at the time that the invention was made to use the claimed features of the reference application/patent to arrive at the instant claims, yielding predictable results and no more than one of ordinary skill in the art would expect from such an arrangement.

Allowable Subject Matter

4. Claims 9-22 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ADAM R GIESY whose telephone number is (571)272-7555. The examiner can normally be reached on Mon-Fri 8-6.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an

interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Edouard can be reached on 5712727603. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ADAM R. GIESY/
Primary Examiner, Art Unit 2694

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/989,292	Skagmo et al.
	Examiner	Art Unit
	ADAM R GIESY	2694

CPC - Searched*		
Symbol	Date	Examiner
(G06F3/0428 or G06F3/0421 or G06F3/0412 or G06F2203/04103 or G06F2203/04107 or G06F2203/04108) + text	07/17/2021	ARG

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor search performed	07/17/2021	ARG
EAST search included	07/17/2021	ARG

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 599

Bibliographic Data

Application No: 16/989,292

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /ADAM R. GIESY/ Examiner's Signature [ ] Initials

Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/10/2020	345	2694	FFOG.054C6
RULE			

APPLICANTS

FlatFrog Laboratories AB, Lund, SWEDEN

INVENTORS

Daniel Skagmo, Malmo, SWEDEN

Robert Ehn, Lund, SWEDEN

Hakan Bergstrom, Torna-Hallestad, SWEDEN

CONTINUING DATA

This application is a CON of 16834905 03/30/2020 PAT 10739916

16834905 is a CON of 16191177 11/14/2018 PAT 10606416

16191177 is a CON of PCT/SE2018/050109 02/06/2018

FOREIGN APPLICATIONS

SWEDEN SE1730085-6 03/28/2017

IF REQUIRED, FOREIGN LICENSE GRANTED**

08/14/2020

STATE OR COUNTRY

SWEDEN

ADDRESS

KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614
UNITED STATES

FILING FEE RECEIVED

$2,460

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	3,440,426	04-22-1969	Bush	
	2	3,553,680	01-05-1971	Cooreman	
	3	3,673,327	06-27-1972	Johnson et al.	
	4	4,129,384	12-12-1978	Walker et al.	
	5	4,180,702	12-25-1979	Sick et al.	
	6	4,209,255	06-24-1980	Heynau et al.	
	7	4,213,707	07-22-1980	Evans, Jr.	
	8	4,254,333	03-03-1981	Bergström	
	9	4,254,407	03-03-1981	Tipon	
	10	4,294,543	10-13-1981	Apple et al.	
	11	4,346,376	08-24-1982	Mallos	
	12	4,420,261	12-13-1983	Barlow et al.	
	13	4,484,179	11-20-1984	Kasday	
	14	4,507,557	03-26-1985	Tsikos	
	15	4,521,112	06-04-1985	Kuwabara et al.	
	16	4,542,375	09-17-1985	Alles et al.	
	17	4,550,250	10-29-1985	Mueller et al.	
	18	4,593,191	06-03-1986	Alles	
	19	4,673,918	06-16-1987	Adler et al.	
	20	4,688,933	08-25-1987	Lapeyre	
	21	4,688,993	08-25-1987	Ferris et al.	
	22	4,692,809	09-08-1987	Beining et al.	
	23	4,710,760	12-01-1987	Kasday	
	24	4,736,191	04-05-1988	Matzke et al.	
	25	4,737,626	04-12-1988	Hasegawa	
	26	4,746,770	05-24-1988	McAvinney	
	27	4,751,379	06-14-1988	Sasaki et al.	
	28	4,752,655	06-21-1988	Tajiri et al.	
	29	4,772,763	09-20-1988	Garwin et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
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	Art Unit	2621
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U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	30	4,782,328	11-01-1988	Denlinger	
	31	4,812,833	03-14-1989	Shimauchi	
	32	4,837,430	06-06-1989	Hasegawa	
	33	4,868,912	09-19-1989	Doering	
	34	4,891,829	01-02-1990	Deckman et al.	
	35	4,916,712	04-10-1990	Bender	
	36	4,933,544	06-12-1990	Tamaru	
	37	4,949,079	08-14-1990	Loebner	
	38	4,986,662	01-22-1991	Bures	
	39	4,988,983	01-29-1991	Wehrer	
	40	5,065,185	11-12-1991	Powers et al.	
	41	5,073,770	12-17-1991	Lowbner	
	42	5,105,186	04-14-1992	May	
	43	5,159,322	10-27-1992	Loebner	
	44	5,166,668	11-24-1992	Aoyagi	
	45	5,227,622	07-13-1993	Suzuki	
	46	5,248,856	09-28-1993	Mallicoat	
	47	5,254,407	10-19-1993	Sergerie et al.	
	48	5,345,490	09-06-1994	Finnigan et al.	
	49	5,383,022	01-17-1995	Kaser	
	50	5,483,261	01-09-1996	Yasutake	
	51	5,484,966	01-16-1996	Segen	
	52	5,499,098	03-12-1996	Ogawa	
	53	5,502,568	03-26-1996	Ogawa et al.	
	54	5,525,764	06-11-1996	Junkins et al.	
	55	5,526,422	06-11-1996	Keen	
	56	5,539,514	07-23-1996	Shishido et al.	
	57	5,570,181	10-29-1996	Yasuo et al.	
	58	5,572,251	11-05-1996	Ogawa	

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U.S. PATENT DOCUMENTS					
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	59	5,577,501	11-26-1996	Flohr et al.	
	60	5,600,105	02-04-1997	Fukuzaki et al.	
	61	5,608,550	03-04-1997	Epstein et al.	
	62	5,672,852	09-30-1997	Fukuzaki et al.	
	63	5,679,930	10-21-1997	Katsurahira	
	64	5,686,942	11-11-1997	Ball	
	65	5,688,933	11-18-1997	Evans et al.	
	66	5,729,249	03-17-1998	Yasutake	
	67	5,736,686	04-07-1998	Perret, Jr. et al.	
	68	5,740,224	04-14-1998	Müller et al.	
	69	5,764,223	06-09-1998	Chang et al.	
	70	5,767,517	06-16-1998	Hawkins	
	71	5,775,792	07-07-1998	Wiese	
	72	5,945,980	08-31-1999	Moissev et al.	
	73	5,945,981	08-31-1999	Paull et al.	
	74	5,959,617	09-28-1999	Bird et al.	
	75	6,061,177	05-09-2000	Fujimoto	
	76	6,067,079	05-23-2000	Shieh	
	77	6,122,394	09-19-2000	Neukermans et al.	
	78	6,141,104	10-31-2000	Schulz et al.	
	79	6,172,667	01-09-2001	Sayag	
	80	6,175,999	01-23-2001	Sloan et al.	
	81	6,227,667	05-08-2001	Halldorsson et al.	
	82	6,229,529	05-08-2001	Yano et al.	
	83	6,333,735	12-25-2001	Anvekar	
	84	6,366,276	04-02-2002	Kunimatsu et al.	
	85	6,380,732	04-30-2002	Gilboa	
	86	6,380,740	04-30-2002	Laub	
	87	6,390,370	05-21-2002	Plesko	

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U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	88	6,429,857	08-06-2002	Masters et al.	
	89	6,452,996	09-17-2002	Hsieh	
	90	6,476,797	11-05-2002	Kurihara et al.	
	91	6,492,633	12-10-2002	Nakazawa et al.	
	92	6,495,832	12-17-2002	Kirby	
	93	6,504,143	01-07-2003	Koops et al.	
	94	6,529,327	03-04-2003	Graindorge	
	95	6,538,644	03-25-2003	Muraoka	
	96	6,587,099	07-01-2003	Takekawa	
	97	6,648,485	11-18-2003	Colgan et al.	
	98	6,660,964	12-09-2003	Benderly	
	99	6,664,498	12-16-2003	Forsman et al.	
	100	6,664,952	12-16-2003	Iwamoto et al.	
	101	6,690,363	02-10-2004	Newton	
	102	6,707,027	03-16-2004	Liess et al.	
	103	6,738,051	05-18-2004	Boyd et al.	
	104	6,748,098	06-08-2004	Rosenfeld	
	105	6,784,948	08-31-2004	Kawashima et al.	
	106	6,799,141	09-28-2004	Stoustrup et al.	
	107	6,806,871	10-19-2004	Yasue	
	108	6,927,384	08-09-2005	Reime et al.	
	109	6,940,286	09-06-2005	Wang et al.	
	110	6,965,836	11-15-2005	Richardson	
	111	6,972,753	12-06-2005	Kimura et al.	
	112	6,985,137	01-10-2006	Kaikuranta	
	113	7,042,444	05-09-2006	Cok	
	114	7,084,859	08-01-2006	Pryor	
	115	7,087,907	08-08-2006	Lalovic et al.	
	116	7,133,031	11-07-2006	Wang et al.	

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U.S. PATENT DOCUMENTS

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	117	7,176,904	02-13-2007	Satoh	
	118	7,199,932	04-03-2007	Sugiura	
	119	7,359,041	04-15-2008	Xie et al.	
	120	7,397,418	07-08-2008	Doerry et al.	
	121	7,432,893	10-07-2008	Ma et al.	
	122	7,435,940	10-14-2008	Eliasson et al.	
	123	7,436,443	10-14-2008	Hirunuma et al.	
	124	7,442,914	10-28-2008	Eliasson et al.	
	125	7,465,914	12-16-2008	Eliasson et al.	
	126	7,613,375	11-03-2009	Shimizu	
	127	7,629,968	12-08-2009	Miller et al.	
	128	7,646,833	01-12-2010	He et al.	
	129	7,653,883	01-26-2010	Hotelling et al.	
	130	7,655,901	02-02-2010	Idzik et al.	
	131	7,705,835	04-27-2010	Eikman	
	132	7,729,056	06-01-2010	Hwang et al.	
	133	7,847,789	12-07-2010	Kolmykov-Zotov et al.	
	134	7,855,716	12-21-2010	McCreary et al.	
	135	7,859,519	12-28-2010	Tulbert	
	136	7,924,272	04-12-2011	Boer et al.	
	137	7,932,899	04-26-2011	Newton et al.	
	138	7,969,410	06-28-2011	Kakarala	
	139	7,995,039	08-09-2011	Eliasson et al.	
	140	8,013,845	09-06-2011	Ostergaard et al.	
	141	8,031,186	10-04-2011	Ostergaard	
	142	8,077,147	12-13-2011	Krah et al.	
	143	8,093,545	01-10-2012	Leong et al.	
	144	8,094,136	01-10-2012	Eliasson et al.	
	145	8,094,910	01-10-2012	Xu	

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U.S. PATENT DOCUMENTS					
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	146	8,149,211	04-03-2012	Hayakawa et al.	
	147	8,218,154	07-10-2012	Østergaard et al.	
	148	8,274,495	09-25-2012	Lee	
	149	8,325,158	12-04-2012	Yatsuda et al.	
	150	8,339,379	12-25-2012	Goertz et al.	
	151	8,350,827	01-08-2013	Chung et al.	
	152	8,384,010	02-26-2013	Hong et al.	
	153	8,407,606	03-26-2013	Davidson et al.	
	154	8,441,467	05-14-2013	Han	
	155	8,445,834	05-21-2013	Hong et al.	
	156	8,466,901	06-18-2013	Yen et al.	
	157	8,482,547	07-09-2013	Cobon et al.	
	158	8,542,217	09-24-2013	Wassvik et al.	
	159	8,567,257	10-29-2013	Van Steenberge et al.	
	160	8,581,884	11-12-2013	Fåhraeus et al.	
	161	8,624,858	01-07-2014	Fyke et al.	
	162	8,686,974	04-01-2014	Christiansson et al.	
	163	8,692,807	04-08-2014	Føhraeus et al.	
	164	8,716,614	05-06-2014	Wassvik	
	165	8,727,581	05-20-2014	Saccomanno	
	166	8,745,514	06-03-2014	Davidson	
	167	8,780,066	07-15-2014	Christiansson et al.	
	168	8,830,181	09-09-2014	Clark et al.	
	169	8,860,696	10-14-2014	Wassvik et al.	
	170	8,872,098	10-28-2014	Bergström et al.	
	171	8,872,801	10-28-2014	Bergström et al.	
	172	8,884,900	11-11-2014	Wassvik	
	173	8,890,843	11-18-2014	Wassvik et al.	
	174	8,890,849	11-18-2014	Christiansson et al.	

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	175	8,928,590	01-06-2015	El Dokor	
	176	8,963,886	02-24-2015	Wassvik	
	177	8,982,084	03-17-2015	Christiansson et al.	
	178	9,024,896	05-05-2015	Chen	
	179	9,024,916	05-05-2015	Christiansson	
	180	9,035,909	05-19-2015	Christiansson	
	181	9,063,617	06-23-2015	Eliasson et al.	
	182	9,086,763	07-21-2015	Johansson et al.	
	183	9,134,854	09-15-2015	Wassvik et al.	
	184	9,158,401	10-13-2015	Christiansson	
	185	9,158,415	10-13-2015	Song et al.	
	186	9,207,800	12-08-2015	Eriksson et al.	
	187	9,213,445	12-15-2015	King et al.	
	188	9,274,645	03-01-2016	Christiansson et al.	
	189	9,317,168	04-19-2016	Christiansson et al.	
	190	9,323,396	04-26-2016	Han et al.	
	191	9,366,565	06-14-2016	Uvnäs	
	192	9,377,884	06-28-2016	Christiansson et al.	
	193	9,389,732	07-12-2016	Craven-Bartle	
	194	9,411,444	08-09-2016	Christiansson et al.	
	195	9,411,464	08-09-2016	Wallander et al.	
	196	9,430,079	08-30-2016	Christiansson et al.	
	197	9,442,574	09-13-2016	Fåhraeus et al.	
	198	9,547,393	01-17-2017	Christiansson et al.	
	199	9,552,103	01-24-2017	Craven-Bartle et al.	
	200	9,557,846	01-31-2017	Baharav et al.	
	201	9,588,619	03-07-2017	Christiansson et al.	
	202	9,594,467	03-14-2017	Christiansson et al.	
	203	9,618,682	04-11-2017	Yoon et al.	

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	204	9,626,018	04-18-2017	Christiansson et al.	
	205	9,626,040	04-18-2017	Wallander et al.	
	206	9,639,210	05-02-2017	Wallander et al.	
	207	9,678,602	06-13-2017	Wallander	
	208	9,684,414	06-20-2017	Christiansson et al.	
	209	9,710,101	07-18-2017	Christiansson et al.	
	210	9,874,978	01-23-2018	Wall	
	211	10,013,107	007-03-2018	Christiansson et al.	
	212	10,019,113	07-10-2018	Christiansson et al.	
	213	2001/0002694	06-07-2001	Nakazawa et al.	
	214	2001/0005004	06-28-2001	Shiratsuki et al.	
	215	2001/0005308	06-28-2001	Oishi et al.	
	216	2001/0030642	10-18-2001	Sullivan et al.	
	217	2002/0067348	06-06-2002	Masters et al.	
	218	2002/0075243	06-20-2002	Newton	
	219	2002/0118177	08-29-2002	Newton	
	220	2002/0158823	10-31-2002	Zavracky et al.	
	221	2002/0158853	10-31-2002	Sugawara et al.	
	222	2002/0163505	11-07-2002	Takekawa	
	223	2003/0016450	01-23-2003	Bluemel et al.	
	224	2003/0034439	02-20-2003	Reime et al.	
	225	2003/0034935	02-20-2003	Amanai et al.	
	226	2003/0048257	03-13-2003	Mattila	
	227	2003/0052257	03-20-2003	Sumriddetchkajorn	
	228	2003/0095399	05-22-2003	Grenda et al.	
	229	2003/0107748	06-12-2003	Lee	
	230	2003/0137494	07-24-2003	Tulbert	
	231	2003/0156100	08-21-2003	Gettemy	
	232	2003/0160155	08-28-2003	Liess	

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	233	2003/0210537	11-13-2003	Engelmann	
	234	2003/0214486	11-20-2003	Roberts	
	235	2004/0027339	02-12-2004	Schulz	
	236	2004/0032401	02-19-2004	Nakazawa et al.	
	237	2004/0090432	05-13-2004	Takahashi et al.	
	238	2004/0130338	07-08-2004	Wang et al.	
	239	2004/0174541	09-09-2004	Freifeld	
	240	2004/0201579	10-14-2004	Graham	
	241	2004/0212603	10-28-2004	Cok	
	242	2004/0238627	12-02-2004	Silverbrook et al.	
	243	2004/0239702	12-02-2004	Kang et al.	
	244	2004/0245438	12-09-2004	Payne et al.	
	245	2004/0252091	12-16-2004	Ma et al.	
	246	2004/0252867	12-16-2004	Lan et al.	
	247	2005/0012714	01-20-2005	Russo et al.	
	248	2005/0041013	02-24-2005	Tanaka	
	249	2005/0057903	03-17-2005	Choi	
	250	2005/0073508	04-07-2005	Pittel et al.	
	251	2005/0083293	04-21-2005	Dixon	
	252	2005/0128190	06-16-2005	Ryynanen	
	253	2005/0143923	06-30-2005	Keers et al.	
	254	2005/0156914	07-21-2005	Lipman et al.	
	255	2005/0162398	07-28-2005	Eliasson et al.	
	256	2005/0179977	08-18-2005	Chui et al.	
	257	2005/0200613	09-15-2005	Kobayashi et al.	
	258	2005/0212774	09-29-2005	Ho et al.	
	259	2005/0248540	11-10-2005	Newton	
	260	2005/0253834	11-17-2005	Sakamaki et al.	
	261	2005/0276053	12-15-2005	Nortrup et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 10 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	262	2006/0001650	01-05-2006	Robbins et al.	
	263	2006/0001653	01-05-2006	Smits	
	264	2006/0007185	01-12-2006	Kobayashi	
	265	2006/0008164	01-12-2006	Wu et al.	
	266	2006/0017706	01-26-2006	Cutherell et al.	
	267	2006/0017709	01-26-2006	Okano	
	268	2006/0033725	02-16-2006	Marggraff et al.	
	269	2006/0038698	02-23-2006	Chen	
	270	2006/0061861	03-23-2006	Munro et al.	
	271	2006/0114237	06-01-2006	Crockett et al.	
	272	2006/0132454	06-22-2006	Chen et al.	
	273	2006/0139340	06-29-2006	Geaghan	
	274	2006/0158437	07-20-2006	Blythe et al.	
	275	2006/0170658	08-03-2006	Nakamura et al.	
	276	2006/0202974	09-14-2006	Thielman	
	277	2006/0227120	10-12-2006	Eikman	
	278	2006/0255248	11-16-2006	Eliasson	
	279	2006/0256092	11-16-2006	Lee	
	280	2006/0279558	12-14-2006	Van Delden et al.	
	281	2006/0281543	12-14-2006	Sutton et al.	
	282	2006/0290684	12-28-2006	Giraldo et al.	
	283	2007/0014486	01-18-2007	Schiwietz et al.	
	284	2007/0024598	02-01-2007	Miller et al.	
	285	2007/0034783	02-15-2007	Eliasson et al.	
	286	2007/0038691	02-15-2007	Candes et al.	
	287	2007/0052684	03-08-2007	Gruhlke et al.	
	288	2007/0070056	03-29-2007	Sato et al.	
	289	2007/0075648	04-05-2007	Blythe et al.	
	290	2007/0120833	05-31-2007	Yamaguchi et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	291	2007/0125937	06-07-2007	Eliasson et al.	
	292	2007/0152985	07-05-2007	Ostergaard et al.	
	293	2007/0201042	08-30-2007	Eliasson et al.	
	294	2007/0296688	12-27-2007	Nakamura et al.	
	295	2008/0006766	01-10-2008	Oon et al.	
	296	2008/0007540	01-10-2008	Ostergaard	
	297	2008/0007541	01-10-2008	Eliasson et al.	
	298	2008/0007542	01-10-2008	Eliasson et al.	
	299	2008/0011944	01-17-2008	Chua et al.	
	300	2008/0029691	02-07-2008	Han	
	301	2008/0036743	02-14-2008	Westerman et al.	
	302	2008/0062150	03-13-2008	Lee	
	303	2008/0068691	03-20-2008	Miyatake	
	304	2008/0074401	03-27-2008	Chung et al.	
	305	2008/0088603	04-17-2008	Eliasson et al.	
	306	2008/0121442	05-29-2008	Boer et al.	
	307	2008/0122792	05-29-2008	Izadi et al.	
	308	2008/0122803	05-29-2008	Izadi et al.	
	309	2008/0130979	06-05-2008	Run et al.	
	310	2008/0150846	06-26-2008	Chung et al.	
	311	2008/0150848	06-26-2008	Chung et al.	
	312	2008/0151126	06-26-2008	Yu	
	313	2008/0158176	07-03-2008	Land et al.	
	314	2008/0189046	08-07-2008	Eliasson et al.	
	315	2008/0192025	08-14-2008	Jaeger et al.	
	316	2008/0238433	10-02-2008	Joutsenoja et al.	
	317	2008/0246388	10-09-2008	Cheon et al.	
	318	2008/0252619	10-16-2008	Crockett et al.	
	319	2008/0266266	10-30-2008	Kent et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	320	2008/0278460	11-13-2008	Arnett et al.	
	321	2008/0284925	11-20-2008	Han	
	322	2008/0291668	11-27-2008	Aylward et al.	
	323	2008/0297482	12-04-2008	Weiss	
	324	2008/0133265	06-05-2008	Silkaitis et al.	
	325	2009/0002340	01-01-2009	Van Genechten	
	326	2009/0006292	01-01-2009	Block	
	327	2009/0040786	02-12-2009	Mori	
	328	2009/0066647	03-12-2009	Kerr et al.	
	329	2009/0067178	03-12-2009	Huang et al.	
	330	2009/0073142	03-19-2009	Yamashita et al.	
	331	2009/0077501	03-19-2009	Partridge et al.	
	332	2009/0085894	04-02-2009	Gandhi et al.	
	333	2009/0091554	04-09-2009	Keam	
	334	2009/0115919	05-07-2009	Tanaka et al.	
	335	2009/0122020	05-14-2009	Eliasson et al.	
	336	2009/0122027	05-14-2009	Newton	
	337	2009/0128508	05-21-2009	Sohn et al.	
	338	2009/0135162	05-28-2009	Van De Wijdeven et al.	
	339	2009/0143141	06-04-2009	Wells et al.	
	340	2009/0153519	06-18-2009	Suarez Rovere	
	341	2009/0161026	06-25-2009	Wu et al.	
	342	2009/0168459	07-02-2009	Holman et al.	
	343	2009/0187842	07-23-2009	Collins et al.	
	344	2009/0189857	07-30-2009	Benko et al.	
	345	2009/0189874	07-30-2009	Chene et al.	
	346	2009/0189878	07-30-2009	Goertz et al.	
	347	2009/0219256	09-03-2009	Newton	
	348	2009/0229892	09-17-2009	Fisher et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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	349	2009/0251439	10-08-2009	Westerman et al.	
	350	2009/0256817	10-15-2009	Perlin et al.	
	351	2009/0259967	10-15-2009	Davidson et al.	
	352	2009/0267919	10-29-2009	Chao et al.	
	353	2009/0273794	11-05-2009	Østergaard et al.	
	354	2009/0278816	11-12-2009	Colson	
	355	2009/0297009	12-03-2009	Xu et al.	
	356	2010/0033444	02-11-2010	Kobayashi	
	357	2010/0045629	02-25-2010	Newton	
	358	2010/0060896	03-11-2010	Van De Wijdeven et al.	
	359	2010/0066016	03-18-2010	Van De Wijdeven et al.	
	360	2010/0066704	03-18-2010	Kasai	
	361	2010/0073318	03-25-2010	Hu et al.	
	362	2010/0078545	04-01-2010	Leong et al.	
	363	2010/0079407	04-01-2010	Suggs et al.	
	364	2010/0079408	04-01-2010	Leong et al.	
	365	2010/0097345	04-22-2010	Jang et al.	
	366	2010/0097348	04-22-2010	Park et al.	
	367	2010/0097353	04-22-2010	Newton	
	368	2010/0125438	05-20-2010	Audet	
	369	2010/0127975	05-27-2010	Jensen	
	370	2010/0134435	06-03-2010	Kimura et al.	
	371	2010/0142823	06-10-2010	Wang et al.	
	372	2010/0187422	07-29-2010	Kothari et al.	
	373	2010/0193259	08-05-2010	Wassvik	
	374	2010/0229091	09-09-2010	Homma et al.	
	375	2010/0238139	09-23-2010	Goertz et al.	
	376	2010/0245292	09-30-2010	Wu	
	377	2010/0265170	10-21-2010	Norieda	

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	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	378	2010/0277436	11-04-2010	Feng et al.	
	379	2010/0283785	11-11-2010	Satulovsky	
	380	2010/0284596	11-11-2010	Miao et al.	
	381	2010/0289754	11-18-2010	Sleeman et al.	
	382	2010/0295821	11-25-2010	Chang et al.	
	383	2010/0302196	12-02-2010	Han et al.	
	384	2010/0302209	12-02-2010	Large	
	385	2010/0302210	12-02-2010	Han et al.	
	386	2010/0302240	12-02-2010	Lettvin	
	387	2010/0315379	12-16-2010	Allard et al.	
	388	2010/0321328	12-23-2010	Chang et al.	
	389	2010/0322550	12-23-2010	Trott	
	390	2011/0043490	02-24-2011	Powell et al.	
	391	2011/0049388	03-03-2011	Delaney et al.	
	392	2011/0050649	03-03-2011	Newton et al.	
	393	2011/0051394	03-03-2011	Bailey	
	394	2011/0068256	03-24-2011	Hong et al.	
	395	2011/0069039	03-24-2011	Lee et al.	
	396	2011/0069807	03-24-2011	Dennerlein et al.	
	397	2011/0074725	03-31-2011	Westerman et al.	
	398	2011/0074734	03-31-2011	Wassvik et al.	
	399	2011/0074735	03-31-2011	Wassvik et al.	
	400	2011/0080361	04-07-2011	Miller et al.	
	401	2011/0090176	04-21-2011	Christiansson et al.	
	402	2011/0102374	05-05-2011	Wassvik et al.	
	403	2011/0115748	05-19-2011	Xu	
	404	2011/0121323	05-26-2011	Wu et al.	
	405	2011/0122075	05-26-2011	Seo et al.	
	406	2011/0122091	05-26-2011	King et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 15 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	407	2011/0122094	05-26-2011	Tsang et al.	
	408	2011/0134079	06-09-2011	Stark	
	409	2011/0147569	06-23-2011	Drumm	
	410	2011/0157095	06-30-2011	Drumm	
	411	2011/0157096	06-30-2011	Drumm	
	412	2011/0163996	07-07-2011	Wassvik et al.	
	413	2011/0163997	07-07-2011	Kim	
	414	2011/0163998	07-07-2011	Goertz et al.	
	415	2011/0169780	07-14-2011	Goertz et al.	
	416	2011/0175852	07-21-2011	Goertz et al.	
	417	2011/0205186	08-25-2011	Newton et al.	
	418	2011/0216042	09-08-2011	Wassvik et al.	
	419	2011/0221705	09-15-2011	Yi et al.	
	420	2011/0221997	09-15-2011	Kim et al.	
	421	2011/0227036	09-22-2011	Vaufrey	
	422	2011/0227874	09-22-2011	Fåhraeus et al.	
	423	2011/0234537	09-29-2011	Kim et al.	
	424	2011/0254864	10-20-2011	Tsuchikawa et al.	
	425	2011/0261020	10-27-2011	Song et al.	
	426	2011/0267296	11-03-2011	Noguchi et al.	
	427	2011/0291989	12-01-2011	Lee	
	428	2011/0298743	12-08-2011	Machida et al.	
	429	2011/0309325	12-22-2011	Park et al.	
	430	2011/0310045	12-22-2011	Toda et al.	
	431	2012/0019448	01-26-2012	Pitkanen et al.	
	432	2012/0026408	02-02-2012	Lee et al.	
	433	2012/0038593	02-16-2012	Rönkä et al.	
	434	2012/0062474	03-15-2012	Weishaupt et al.	
	435	2012/0068973	03-22-2012	Christiansson et al.	

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SHEET 16 OF 33	Attorney Docket No.	FFOG.054C6

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	436	2012/0086673	04-12-2012	Chien et al.	
	437	2012/0089348	04-12-2012	Perlin et al.	
	438	2012/0110447	05-03-2012	Chen	
	439	2012/0131490	05-24-2012	Lin et al.	
	440	2012/0141001	06-07-2012	Zhang et al.	
	441	2012/0146930	06-14-2012	Lee	
	442	2012/0153134	06-21-2012	Bergström et al.	
	443	2012/0154338	06-21-2012	Bergström et al.	
	444	2012/0162142	06-28-2012	Christiansson et al.	
	445	2012/0162144	06-28-2012	Fåhraeus et al.	
	446	2012/0169672	07-05-2012	Christiansson	
	447	2012/0181419	07-19-2012	Momtahan	
	448	2012/0182266	07-19-2012	Han	
	449	2012/0188206	07-26-2012	Sparf et al.	
	450	2012/0191993	07-26-2012	Drader et al.	
	451	2012/0200532	08-09-2012	Powell et al.	
	452	2012/0200538	08-09-2012	Christiansson et al.	
	453	2012/0212441	08-23-2012	Christiansson et al.	
	454	2012/0217882	08-30-2012	Wong et al.	
	455	2012/0249478	10-04-2012	Chang et al.	
	456	2012/0256882	10-11-2012	Christiansson et al.	
	457	2012/0268403	10-25-2012	Christiansson	
	458	2012/0268427	10-25-2012	Slobodin	
	459	2012/0274559	11-01-2012	Mathai et al.	
	460	2012/0305755	12-06-2012	Hong et al.	
	461	2013/0021300	01-24-2013	Wassvik	
	462	2013/0021302	01-24-2013	Drumm	
	463	2013/0027404	01-31-2013	Sarnoff	
	464	2013/0044073	02-21-2013	Christiansson et al.	

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	465	2013/0055080	02-28-2013	Komer et al.	
	466	2013/0076697	03-28-2013	Goertz et al.	
	467	2013/0082980	04-04-2013	Gruhlke et al.	
	468	2013/0107569	05-02-2013	Suganuma	
	469	2013/0113715	05-09-2013	Grant et al.	
	470	2013/0120320	05-16-2013	Liu et al.	
	471	2013/0125016	05-16-2013	Pallakoff et al.	
	472	2013/0127790	05-23-2013	Wassvik	
	473	2013/0135258	05-30-2013	King et al.	
	474	2013/0135259	05-30-2013	King et al.	
	475	2013/0141388	06-06-2013	Ludwig et al.	
	476	2013/0154983	06-20-2013	Christiansson et al.	
	477	2013/0155027	06-20-2013	Holmgren et al.	
	478	2013/0158504	06-20-2013	Ruchti et al.	
	479	2013/0181896	07-18-2013	Gruhlke et al.	
	480	2013/0187891	07-25-2013	Eriksson et al.	
	481	2013/0201142	08-08-2013	Suarez Rovere	
	482	2013/0222346	08-29-2013	Chen et al.	
	483	2013/0234991	09-12-2013	Sparf	
	484	2013/0241887	09-19-2013	Sharma	
	485	2013/0249833	09-26-2013	Christiansson et al.	
	486	2013/0269867	10-17-2013	Trott	
	487	2013/0275082	10-17-2013	Follmer et al.	
	488	2013/0285920	10-31-2013	Colley	
	489	2013/0285968	10-31-2013	Christiansson et al.	
	490	2013/0300716	11-14-2013	Craven-Bartle et al.	
	491	2013/0307795	11-21-2013	Suarez Rovere	
	492	2013/0321740	12-05-2013	An et al.	
	493	2013/0342490	12-26-2013	Wallander et al.	

Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	494	2014/0002400	01-02-2014	Christiansson et al.	
	495	2014/0028575	01-30-2014	Parivar et al.	
	496	2014/0028604	01-30-2014	Morinaga et al.	
	497	2014/0028629	01-30-2014	Drumm et al.	
	498	2014/0036203	02-06-2014	Guillou et al.	
	499	2014/0055421	02-27-2014	Christiansson et al.	
	500	2014/0063853	03-06-2014	Nichol et al.	
	501	2014/0071653	03-13-2014	Thompson et al.	
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	510	2014/0192023	07-10-2014	Hoffman	
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	512	2014/0237401	08-21-2014	Krus et al.	
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	514	2014/0237422	08-21-2014	Ohlsson et al.	
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	520	2014/0347325	11-27-2014	Wallander et al.	
	521	2014/0362046	12-11-2014	Yoshida	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 19 OF 33	Attorney Docket No.	FFOG.054C6

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	523	2014/0375607	12-25-2014	Christiansson et al.	
	524	2015/0002386	01-01-2015	Mankowski et al.	
	525	2015/0009687	01-08-2015	Lin	
	526	2015/0015497	01-15-2015	Leigh	
	527	2015/0035774	02-05-2015	Christiansson et al.	
	528	2015/0035803	02-05-2015	Wassvik et al.	
	529	2015/0053850	02-26-2015	Uvnäs	
	530	2015/0054759	02-26-2015	Christiansson et al.	
	531	2015/0083891	03-26-2015	Wallander	
	532	2015/0103013	04-16-2015	Huang	
	533	2015/0130769	05-14-2015	Björklund	
	534	2015/0138105	05-21-2015	Christiansson et al.	
	535	2015/0138158	05-21-2015	Wallander et al.	
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	539	2015/0242055	08-27-2015	Wallander	
	540	2015/0271481	09-24-2015	Guthrie et al.	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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PTO/SB/08 Equivalent

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
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U.S. PATENT DOCUMENTS					
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	575	2017/0010688	01-12-2017	Fahraeus et al.	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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PTO/SB/08 Equivalent

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 21 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
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	584	2017/0344185	11-30-2017	Ohlsson et al.	
	585	2018/0031753	02-01-2018	Craven-Bartle et al.	
	586	2018/0129354	05-10-2018	Christiansson et al.	
	587	2018/0210572	07-26-2018	Wallander et al.	
	588	2018/0225006	08-09-2018	Wall	
	589	2018/0267672	09-20-2018	Wassvik et al.	
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	602	2009/0000831	01-01-2009	Miller et al.	
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	605	2011/0084939	04-14-2011	Gepner et al.	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 22 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	610	2012/0170056	07-05-2012	Jakobsen et al.	
	611	2012/0212457	08-23-2012	Drumm, Owen	
	612	2012/0218229	08-30-2012	Drumm	
	613	2012/0223916	09-06-2012	Kukulj, Dax	
	614	2012/0313865	12-13-2012	Pearce	
	615	2013/0106709	05-02-2013	Simmons	
	616	2013/0141395	06-06-2013	Holmgren et al.	
	617	2013/0155655	06-20-2013	Lee et al.	
	618	2013/0181953	07-18-2013	Hinckley et al.	
	619	2013/0300714	11-14-2013	Goh et al.	
	620	2014/0015803	01-16-2014	Drumm, Owen	
	621	2014/0152624	06-05-2014	Piot et al.	
	622	2014/0226084	08-14-2014	Utukuri et al.	
	623	2014/0253520	09-11-2014	Cueto et al.	
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	625	2015/0121691	05-07-2015	Wang, Yun-Jun	
	626	2015/0131010	05-14-2015	Sugiyama, Koichi	
	627	2015/0199071	07-16-2015	Hou	
	628	2015/0261323	09-17-2015	Cui et al.	
	629	2016/0004898	01-07-2016	Holz	
	630	2016/0026297	01-28-2016	Shinkai et al.	
	631	2016/0041629	02-11-2016	Rao et al.	
	632	2016/0062549	03-03-2016	Drumm et al.	
	633	2016/0092021	03-31-2016	Tu et al.	
	634	2016/0103026	04-14-2016	Povazay et al.	
	635	2016/0117019	04-28-2016	Michiaki	
	636	2016/0179261	06-23-2016	Drumm, Owen	
	637	2016/0209886	07-21-2016	Suh et al.	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 23 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	639	2016/0295711	10-06-2016	Ryu et al.	
	640	2016/0299583	10-13-2016	Watanabe	
	641	2017/0031516	02-02-2017	Sugiyama et al.	
	642	2017/0160871	06-08-2017	Drumm, Owen	
	643	2017/0220204	08-03-2017	Huang et al.	
	644	2018/0107373	04-19-2018	Cheng, Kai-Yu	
	645	2018/0136788	05-17-2018	He et al.	
	646	2018/0149792	05-31-2018	Lee et al.	
	647	2018/0253187	09-06-2018	Christiansson et al.	
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	649	2019/0004668	01-03-2019	Jeong et al.	
	650	2019/0025984	01-24-2019	Weilbacher et al.	
	651	2019/0050074	02-14-2019	Kocovski	
	652	2019/0107923	04-11-2019	Drumm, Owen	
	653	2019/0146630	05-16-2019	Chen et al.	
	654	2019/0196657	10-08-2019	Skagmo et al.	
	655	2019/0196658	06-27-2019	Skagmo et al.	
	656	2019/0196659	06-27-2019	Skagmo et al.	
	657	2019/0227670	07-25-2019	O'Cleirigh et al.	
	658	2019/0258353	08-22-2019	Drumm et al.	
	659	2019/0324570	10-24-2019	Kolundzjia et al.	
	660	2019/0377431	12-12-2019	Drumm, Owen	
	661	2019/0377435	12-12-2019	Piot et al.	
	662	2020/0012408	01-09-2020	Drumm et al.	
	663	2020/0073509	03-05-2020	Shih et al.	
	664	2020/0098147	03-26-2020	Ha et al.	
	665	2020/0125189	04-23-2020	Kim et al.	
	666	2020/0159382	05-21-2020	Drumm, Owen	
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 24 OF 33	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	668	2020/0249777	08-06-2020	Hou et al.	
	669	2020/0310621	10-01-2020	Piot et al.	
	670	2020/0341587	10-29-2020	Drumm, Owen	
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Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
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	684	DE 102010000473 A1	08-26-2010	WERTH MESSTECHNIK GMBH		
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 25 OF 33	Attorney Docket No.	FFOG.054C6

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
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	691	EP 1512989 B1	09-02-2009	AVAGO TECHNOLOGIES ECBU IP SG PTE LTD		
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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SHEET 26 OF 33	Attorney Docket No.	FFOG.054C6

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Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 27 OF 33	Attorney Docket No.	FFOG.054C6

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Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
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	734	WO 2005/026938 A2	03-24-2005	O-PEN APS		
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	750	WO 2009/048365 A1	04-16-2009	FLATFROG LABORATORIES AB		
	751	WO 2009/077962 A2	06-25-2009	MARKUS		
	752	WO 2009/102681 A2	08-20-2009	NEXT HOLDINGS INC		
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Examiner Signature	/ADAM R. GIESY/	Date Considered	07/17/2021

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PTO/SB/08 Equivalent

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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 28 OF 33	Attorney Docket No.	FFOG.054C6

FOREIGN PATENT DOCUMENTS

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	756	WO 2010/006884 A2	01-21-2010	FLATFROG LABORATORIES AB		
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	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 29 OF 33	Attorney Docket No.	FFOG.054C6

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	777	WO 2012/010078 A1	01-26-2012	BEIJING IRTOUCH SYSTEMS CO LTD		
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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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SHEET 30 OF 33	Attorney Docket No.	FFOG.054C6

FOREIGN PATENT DOCUMENTS

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	795	WO 2014/055809 A1	04-10-2014	CORNING INC		
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	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 31 OF 33	Attorney Docket No.	FFOG.054C6

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Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	813	WO 2015/175586 A1	11-19-2015	MICROSOFT TECHNOLOGY LICENSING LLC		
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NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]
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NON PATENT LITERATURE DOCUMENTS			
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	831	Civil Cover Sheet FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., dated December 10, 2019, in 1 page.	
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	847	Extended European Search Report for European App. No. 18772178.2, dated December 10, 2020, in 8 pages.	

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U.S. PATENT DOCUMENTS

Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	5,515,083	05-07-1996	Casebolt et al.	
	2	7,528,898	05-05-2009	Hashimoto	
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	5	CN 203453994 U	02-26-2014	SHANDONG GETTOP ACOUSTIC CO., LTD.		X
	6	CN 205384833 U	07-13-2016	CHANGSHA ENVIRONMENTAL PROTECTION COLLEGE		X-Abs.
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	8	WO 2014/044181 A1	03-27-2014	BEIJING IRTOUCH SYSTEMS CO LTD		
	9	WO 2015/123322 A1	08-20-2015	APPLE INC		

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	16/989292	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:31
L2	40,347	(G06F3/0428 or G06F3/0421 or G06F3/0412 or G06F2203/04103 or G06F2203/04107 or G06F2203/04108).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:32
L3	70	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2021/07/17 22:33
L4	294	2 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3 fitted))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:36
L5	19	2 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:37
L6	34	2 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:37
L11	72	(US-8093545-$ | US-8094136-$ | US-8094910-$ | US-8149211-$ | US-8218154-$ | US-8274495-$ | US-8325158-$ | US-8339379-$ | US-8350827-$ | US-8384010-$ | US-8407606-$ | US-8441467-$ | US-8445834-$ | US-8466901-$ | US-8482547-$ | US-8542217-$ | US-8567257-$ | US-8581884-$ | US-8624858-$ | US-8686974-$ | US-8692807-$ | US-8716614-$ | US-8727581-$ | US-8745514-$ | US-8780066-$ | US-8830181-$ | US-8860696-$ | US-8872098-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:50

		8872801-$ | US-8884900-$ | US-8890843-$ | US-8890849-$ | US-8928590-$ | US-8963886-$ | US-8982084-$ | US-9001086-$ | US-9024896-$ | US-9024916-$ | US-9035909-$ | US-9063614-$ | US-9063617-$ | US-9086763-$ | US-9134854-$ | US-9158401-$ | US-9158415-$ | US-9201520-$ | US-9207800-$ | US-9213445-$ | US-9274645-$ | US-9280237-$ | US-9317168-$ | US-9323396-$ | US-9366565-$ | US-9377884-$ | US-9389732-$ | US-9411444-$ | US-9411464-$ | US-9430079-$ | US-9442574-$ | US-9547393-$ | US-9552103-$ | US-9557846-$ | US-9588619-$ | US-9594467-$ | US-9618682-$ | US-9626018-$ | US-9626040-$ | US-9639210-$ | US-9678602-$ | US-9684414-$ | US-9710101-$ | US-9874978-$).DID.				
L12	195	(US-0135258-$ | US-0135259-$ | US-0136788-$ | US-0137494-$ | US-0138105-$ | US-0138158-$ | US-0138161-$ | US-0139340-$ | US-0139467-$ | US-0139541-$ | US-0141001-$ | US-0141062-$ | US-0141388-$ | US-0141395-$ | US-0142823-$ | US-0143141-$ | US-0143923-$ | US-0146630-$ | US-0146930-$ | US-0147569-$ | US-0149792-$ | US-0150846-$ | US-0150848-$ | US-0151126-$ | US-0152624-$ | US-0152985-$ | US-0153134-$ | US-0153519-$ | US-0154338-$ | US-0154531-$ | US-0154532-$ | US-0154533-$ | US-0154983-$ | US-0155027-$ | US-0155655-$ | US-0156100-$ | US-0156914-$ | US-0157095-$ | US-0157096-$ | US-0158176-$ | US-0158437-$ | US-0158504-$ | US-0158823-$ | US-0158853-$ | US-0159382-$ | US-0160155-$ | US-0160762-$ | US-0160871-$ | US-0161026-$ | US-0162142-$ | US-0162144-$ | US-0162398-$ | US-0163505-$ | US-0163996-$ | US-0163997-$ | US-0163998-$ | US-0167033-$ | US-0168459-$ | US-0169672-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:51

0170056-$ | US-0170658-$ | US-
0174541-$ | US-0175852-$ | US-
0177163-$ | US-0179261-$ | US-
0179977-$ | US-0181419-$ | US-
0181896-$ | US-0181953-$ | US-
0182266-$ | US-0185230-$ | US-
0187422-$ | US-0187842-$ | US-
0187891-$ | US-0188206-$ | US-
0189046-$ | US-0189857-$ | US-
0189874-$ | US-0189878-$ | US-
0191993-$ | US-0192023-$ | US-
0192025-$ | US-0193259-$ | US-
0196657-$ | US-0196658-$ | US-
0196659-$ | US-0199071-$ | US-
0200532-$ | US-0200538-$ | US-
0200613-$ | US-0201042-$ | US-
0201142-$ | US-0201579-$ | US-
0202841-$ | US-0202974-$ | US-
0205186-$ | US-0205189-$ | US-
0205441-$ | US-0209886-$ | US-
0210537-$ | US-0210572-$ | US-
0212441-$ | US-0212457-$ | US-
0212603-$ | US-0212774-$ | US-
0214486-$ | US-0215450-$ | US-
0216042-$ | US-0216844-$ | US-
0217882-$ | US-0218229-$ | US-
0219256-$ | US-0220204-$ | US-
0221705-$ | US-0221997-$ | US-
0222346-$ | US-0223916-$ | US-
0224144-$ | US-0225006-$ | US-
0226084-$ | US-0227036-$ | US-
0227120-$ | US-0227670-$ | US-
0227874-$ | US-0229091-$ | US-
0229892-$ | US-0232669-$ | US-
0234537-$ | US-0234991-$ | US-
0235701-$ | US-0237401-$ | US-
0237408-$ | US-0237422-$ | US-
0238139-$ | US-0238433-$ | US-
0238627-$ | US-0239702-$ | US-
0241887-$ | US-0242055-$ | US-
0245292-$ | US-0245438-$ | US-
0246388-$ | US-0248540-$ | US-
0249478-$ | US-0249777-$ | US-
0249833-$ | US-0251439-$ | US-
0252091-$ | US-0252619-$ | US-
0252867-$ | US-0253187-$ | US-
0253520-$ | US-0253831-$ | US-
0253834-$ | US-0254864-$ | US-
0255248-$ | US-0255713-$ | US-
0256092-$ | US-0256817-$ | US-
0256882-$ | US-0258353-$ | US-
0259029-$ | US-0259967-$ | US-
0261020-$ | US-0261323-$ | US-

		0265170-$ | US-0266266-$ | US-0267124-$ | US-0267296-$ | US-0267672-$ | US-0267919-$ | US-0268403-$ | US-0268427-$ | US-0269867-$ | US-0271481-$ | US-0273794-$ | US-0274559-$ | US-0275082-$ | US-0275788-$ | US-0275830-$ | US-0275831-$ | US-0276053-$ | US-0277436-$ | US-0278460-$ | US-0278816-$ | US-0279558-$ | US-0281543-$ | US-0283785-$ | US-0284596-$ | US-0284925-$ | US-0285920-$ | US-0285968-$ | US-0286698-$ | US-0289754-$ | US-0290684-$).DID.				
L13	168	(US-0291668-$ | US-0291989-$ | US-0292701-$ | US-0293392-$ | US-0295711-$ | US-0295821-$ | US-0296688-$ | US-0297009-$ | US-0297482-$ | US-0298743-$ | US-0299583-$ | US-0299593-$ | US-0300572-$ | US-0300714-$ | US-0300716-$ | US-0302196-$ | US-0302209-$ | US-0302210-$ | US-0302240-$ | US-0305755-$ | US-0306501-$ | US-0307795-$ | US-0309325-$ | US-0310045-$ | US-0310621-$ | US-0313865-$ | US-0314206-$ | US-0315379-$ | US-0317036-$ | US-0320460-$ | US-0321328-$ | US-0321740-$ | US-0322550-$ | US-0324028-$ | US-0324570-$ | US-0328090-$ | US-0328091-$ | US-0331544-$ | US-0331545-$ | US-0331546-$ | US-0331547-$ | US-0332655-$ | US-0334942-$ | US-0339000-$ | US-0341587-$ | US-0342282-$ | US-0342490-$ | US-0344185-$ | US-0346856-$ | US-0346911-$ | US-0347325-$ | US-0348473-$ | US-0357348-$ | US-0362046-$ | US-0363042-$ | US-0368471-$ | US-0373864-$ | US-0375607-$ | US-0377431-$ | US-0377435-$ | US-0387237-$ | US-10013107-$ | US-10019113-$ | US-10282035-$ | US-10649585-$ | US-20010002694-$ | US-20010005004-$ | US-20010005308-$ | US-20010030642-$ | US-20020067348-$ | US-20020075243-$ | US-20020118177-$ | US-20020158823-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:51

		20020158853-$ | US-20020163505-$ | US-20030016450-$ | US-20030034439-$ | US-20030034935-$ | US-20030048257-$ | US-20030052257-$ | US-20030095399-$ | US-20030107748-$ | US-20030137494-$ | US-20030156100-$ | US-20030160155-$ | US-20030210537-$ | US-20030214486-$ | US-20040027339-$ | US-20040032401-$ | US-20040090432-$ | US-20040130338-$ | US-20040174541-$ | US-20040201579-$ | US-20040212603-$ | US-20040238627-$ | US-20040239702-$ | US-20040245438-$ | US-20040252091-$ | US-20040252867-$ | US-20050012714-$ | US-20050041013-$ | US-20050057903-$ | US-20050073508-$ | US-20050083293-$ | US-20050128190-$ | US-20050143923-$ | US-20050156914-$ | US-20050162398-$ | US-20050179977-$ | US-20050200613-$ | US-20050212774-$ | US-20050248540-$ | US-20050253834-$ | US-20050276053-$ | US-20060001650-$ | US-20060001653-$ | US-20060007185-$ | US-20060008164-$ | US-20060017706-$ | US-20060017709-$ | US-20060033725-$ | US-20060038698-$ | US-20060061861-$ | US-20060114237-$ | US-20060132454-$ | US-20060139340-$ | US-20060158437-$ | US-20060170658-$ | US-20060202974-$ | US-20060227120-$ | US-20060255248-$ | US-20060256092-$ | US-20060279558-$ | US-20060281543-$ | US-20060290684-$ | US-20070014486-$ | US-20070024598-$ | US-20070034783-$ | US-20070038691-$ | US-20070052684-$ | US-20070070056-$ | US-20070075648-$ | US-20070120833-$ | US-20070125937-$ | US-20070152985-$ | US-20070201042-$ | US-20070296688-$ | US-20080006766-$ | US-20080007540-$ | US-20080007541-$ | US-20080007542-$ | US-20080011944-$ | US-20080029691-$ | US-20080036743-$ | US-20080062150-$ | US-20080068691-$ | US-20080074401-$ | US-20080080811-$ | US-20080088603-$ | US-20080121442-$ | US-20080122792-$ | US-20080122803-$ | US-20080130979-$ | US-20080133265-$ | US-20080150846-$ | US-20080150848-$ |			

		US-20080151126-$ | US-20080158176-$).DID.				
L14	154	(US-20080189046-$ | US-20080192025-$ | US-20080238433-$ | US-20080246388-$ | US-20080252619-$ | US-20080266266-$ | US-20080278460-$ | US-20080284925-$ | US-20080291668-$ | US-20080297482-$ | US-20090000831-$ | US-20090002340-$ | US-20090006292-$ | US-20090040786-$ | US-20090066647-$ | US-20090067178-$ | US-20090073142-$ | US-20090077501-$ | US-20090085894-$ | US-20090091554-$ | US-20090115919-$ | US-20090122020-$ | US-20090122027-$ | US-20090128508-$ | US-20090135162-$ | US-20090143141-$ | US-20090153519-$ | US-20090161026-$ | US-20090168459-$ | US-20090187842-$ | US-20090189857-$ | US-20090189874-$ | US-20090189878-$ | US-20090219256-$ | US-20090229892-$ | US-20090251439-$ | US-20090256817-$ | US-20090259967-$ | US-20090267919-$ | US-20090273794-$ | US-20090278816-$ | US-20090297009-$ | US-20100033444-$ | US-20100045629-$ | US-20100060896-$ | US-20100066016-$ | US-20100066704-$ | US-20100073318-$ | US-20100073327-$ | US-20100078545-$ | US-20100079407-$ | US-20100079408-$ | US-20100097345-$ | US-20100097348-$ | US-20100097353-$ | US-20100103133-$ | US-20100125438-$ | US-20100127975-$ | US-20100134435-$ | US-20100142823-$ | US-20100187422-$ | US-20100193259-$ | US-20100229091-$ | US-20100238139-$ | US-20100245292-$ | US-20100265170-$ | US-20100277436-$ | US-20100283785-$ | US-20100284596-$ | US-20100289754-$ | US-20100295821-$ | US-20100302196-$ | US-20100302209-$ | US-20100302210-$ | US-20100302240-$ | US-20100315379-$ | US-20100321328-$ | US-20100322550-$ | US-20110043490-$ | US-20110049388-$ | US-20110050649-$ | US-20110051394-$ | US-20110068256-$ | US-20110069039-$ | US-20110069807-$ | US-20110074725-$ | US-20110074734-$ | US-20110074735-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:51

		$ | US-20110080361-$ | US-20110084939-$ | US-20110090176-$ | US-20110102374-$ | US-20110115748-$ | US-20110121323-$ | US-20110122075-$ | US-20110122091-$ | US-20110122094-$ | US-20110134079-$ | US-20110141062-$ | US-20110147569-$ | US-20110157095-$ | US-20110157096-$ | US-20110163996-$ | US-20110163997-$ | US-20110163998-$ | US-20110169780-$ | US-20110175852-$ | US-20110205186-$ | US-20110205189-$ | US-20110216042-$ | US-20110221705-$ | US-20110221997-$ | US-20110227036-$ | US-20110227874-$ | US-20110234537-$ | US-20110254864-$ | US-20110261020-$ | US-20110267296-$ | US-20110291989-$ | US-20110298743-$ | US-20110309325-$ | US-20110310045-$ | US-20120019448-$ | US-20120026408-$ | US-20120038593-$ | US-20120056807-$ | US-20120062474-$ | US-20120062492-$ | US-20120068973-$ | US-20120086673-$ | US-20120089348-$ | US-20120110447-$ | US-20120131490-$ | US-20120141001-$ | US-20120146930-$ | US-20120153134-$ | US-20120154338-$ | US-20120162142-$ | US-20120162144-$ | US-20120169672-$ | US-20120170056-$ | US-20120181419-$ | US-20120182266-$ | US-20120188206-$ | US-20120191993-$ | US-20120200532-$ | US-20120200538-$ | US-20120212441-$ | US-20120212457-$ | US-20120217882-$ | US-20120218229-$ | US-20120223916-$ | US-20120249478-$ | US-20120256882-$).DID.				
L15	154	(US-20120268403-$ | US-20120268427-$ | US-20120274559-$ | US-20120305755-$ | US-20120313865-$ | US-20130021300-$ | US-20130021302-$ | US-20130027404-$ | US-20130044073-$ | US-20130055080-$ | US-20130076697-$ | US-20130082980-$ | US-20130106709-$ | US-20130107569-$ | US-20130113715-$ | US-20130120320-$ | US-20130125016-$ | US-20130127790-$ | US-20130135258-$ | US-20130135259-$ | US-20130141388-$ | US-20130141395-$ | US-20130154983-$	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:51

| US-20130155027-$ | US-20130155655-$ | US-20130158504-$ | US-20130181896-$ | US-20130181953-$ | US-20130187891-$ | US-20130201142-$ | US-20130222346-$ | US-20130234991-$ | US-20130241887-$ | US-20130249833-$ | US-20130269867-$ | US-20130275082-$ | US-20130285920-$ | US-20130285968-$ | US-20130300714-$ | US-20130300716-$ | US-20130307795-$ | US-20130321740-$ | US-20130342490-$ | US-20140002400-$ | US-20140015803-$ | US-20140028575-$ | US-20140028604-$ | US-20140028629-$ | US-20140036203-$ | US-20140055421-$ | US-20140063853-$ | US-20140071653-$ | US-20140085241-$ | US-20140092052-$ | US-20140098032-$ | US-20140098058-$ | US-20140109219-$ | US-20140125633-$ | US-20140139467-$ | US-20140152624-$ | US-20140160762-$ | US-20140192023-$ | US-20140226084-$ | US-20140232669-$ | US-20140237401-$ | US-20140237408-$ | US-20140237422-$ | US-20140253520-$ | US-20140253831-$ | US-20140259029-$ | US-20140267124-$ | US-20140292701-$ | US-20140300572-$ | US-20140320460-$ | US-20140347325-$ | US-20140362046-$ | US-20140368471-$ | US-20140375607-$ | US-20150002386-$ | US-20150009687-$ | US-20150015497-$ | US-20150035774-$ | US-20150035803-$ | US-20150053850-$ | US-20150054759-$ | US-20150083891-$ | US-20150103013-$ | US-20150121691-$ | US-20150130769-$ | US-20150131010-$ | US-20150138105-$ | US-20150138158-$ | US-20150138161-$ | US-20150199071-$ | US-20150205441-$ | US-20150215450-$ | US-20150242055-$ | US-20150261323-$ | US-20150271481-$ | US-20150286698-$ | US-20150317036-$ | US-20150324028-$ | US-20150331544-$ | US-20150331545-$ | US-20150331546-$ | US-20150331547-$ | US-20150332655-$ | US-20150339000-$ | US-20150346856-$ | US-20150346911-$ | US-20150363042-$ | US-20150373864-$ | US-20160004898-$ | US-20160026297-$ | US-20160026337-$ | US-20160034099-

		$ | US-20160041629-$ | US-20160050746-$ | US-20160062549-$ | US-20160070415-$ | US-20160070416-$ | US-20160077616-$ | US-20160092021-$ | US-20160103026-$ | US-20160117019-$ | US-20160124546-$ | US-20160124551-$ | US-20160154531-$ | US-20160154532-$ | US-20160154533-$ | US-20160179261-$ | US-20160202841-$ | US-20160209886-$ | US-20160216844-$ | US-20160224144-$ | US-20160255713-$ | US-20160295711-$ | US-20160299583-$ | US-20160299593-$ | US-20160306501-$ | US-20160328090-$ | US-20160328091-$ | US-20160334942-$ | US-20160342282-$ | US-20160357348-$ | US-20170010688-$ | US-20170031516-$ | US-20170090090-$ | US-20170102827-$ | US-20170115235-$ | US-20170115823-$ | US-20170139541-$ | US-20170160871-$ | US-20170177163-$).DID.				
L16	185	(US-20170185230-$ | US-20170220204-$ | US-20170293392-$ | US-20170344185-$ | US-20180031753-$ | US-20180107373-$ | US-20180129354-$ | US-20180136788-$ | US-20180149792-$ | US-20180210572-$ | US-20180225006-$ | US-20180253187-$ | US-20180267672-$ | US-20180275788-$ | US-20180275830-$ | US-20180275831-$ | US-20180314206-$ | US-20190004668-$ | US-20190025984-$ | US-20190050074-$ | US-20190107923-$ | US-20190146630-$ | US-20190196657-$ | US-20190196658-$ | US-20190196659-$ | US-20190227670-$ | US-20190235701-$ | US-20190258353-$ | US-20190324570-$ | US-20190377431-$ | US-20190377435-$ | US-20200012408-$ | US-20200073509-$ | US-20200098147-$ | US-20200125189-$ | US-20200159382-$ | US-20200167033-$ | US-20200249777-$ | US-20200310621-$ | US-20200341587-$ | US-20200348473-$ | US-20200387237-$ | US-3440426-$ | US-3553680-$ | US-3673327-$ | US-4129384-$ | US-4180702-$ | US-4209255-$ | US-4213707-$ | US-4254333-$ | US-4254407-$ | US-4294543-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/07/17 22:52

4346376-$ | US-4420261-$ | US-
4484179-$ | US-4507557-$ | US-
4521112-$ | US-4542375-$ | US-
4550250-$ | US-4593191-$ | US-
4673918-$ | US-4688933-$ | US-
4688993-$ | US-4692809-$ | US-
4710760-$ | US-4736191-$ | US-
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4772763-$ | US-4782328-$ | US-
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4916712-$ | US-4933544-$ | US-
4949079-$ | US-4986662-$ | US-
4988983-$ | US-5065185-$ | US-
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5227622-$ | US-5248856-$ | US-
5254407-$ | US-5345490-$ | US-
5383022-$ | US-5483261-$ | US-
5484966-$ | US-5499098-$ | US-
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5577501-$ | US-5600105-$ | US-
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5679930-$ | US-5686942-$ | US-
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5764223-$ | US-5767517-$ | US-
5775792-$ | US-5945980-$ | US-
5945981-$ | US-5959617-$ | US-
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6067079-$ | US-6122394-$ | US-
6141104-$ | US-6172667-$ | US-
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6229529-$ | US-6333735-$ | US-
6366276-$ | US-6380732-$ | US-
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6587099-$ | US-6648485-$ | US-
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6664952-$ | US-6690363-$ | US-
6707027-$ | US-6738051-$ | US-
6748098-$ | US-6784948-$ | US-
6799141-$ | US-6806871-$ | US-
6927384-$ | US-6940286-$ | US-
6965836-$ | US-6972753-$ | US-
6985137-$ | US-7042444-$ | US-
7084859-$ | US-7087907-$ | US-

		7133031-$ | US-7176904-$ | US-7199932-$ | US-7359041-$ | US-7397418-$ | US-7432893-$ | US-7435940-$ | US-7436443-$ | US-7442914-$ | US-7465914-$ | US-7613375-$ | US-7629968-$ | US-7646833-$ | US-7653883-$ | US-7655901-$ | US-7705835-$ | US-7729056-$ | US-7847789-$ | US-7855716-$ | US-7859519-$ | US-7924272-$ | US-7932899-$ | US-7969410-$ | US-7995039-$ | US-8013845-$ | US-8031186-$ | US-8077147-$).DID.				
L18	4	(("5515083") or ("7528898") or ("9317146") or ("20110316005")).PN.	US-PGPUB; USPAT	OR	OFF	2021/07/17 23:00
L19	3	(("10739916") or ("10606416") or ("10437389")).PN.	US-PGPUB; USPAT	OR	OFF	2021/07/17 23:18
S1	0	16/191251	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/25 13:24
S2	28,284	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 08:33
S3	209	(("3440426") or ("3553680") or ("3673327") or ("4129384") or ("4180702") or ("4209255") or ("4213707") or ("4254333") or ("4254407") or ("4294543") or ("4346376") or ("4420261") or ("4484179") or ("4507557") or ("4521112") or ("4542375") or ("4550250") or ("4593191") or ("4673918") or ("4688933") or ("4688993") or ("4692809") or ("4710760") or ("4736191") or ("4737626") or ("4746770") or ("4752655") or ("4772763") or ("4782328") or ("4812833") or ("4837430") or ("4868912") or ("4891829") or ("4916712") or ("4933544") or ("4949079") or ("4986662") or ("4988983") or ("5065185") or ("5073770") or ("5105186") or ("5159322") or ("5166668") or ("5227622") or ("5248856") or ("5254407") or ("5345490") or ("5383022") or ("5483261") or ("5484966") or ("5499098") or ("5502568") or ("5525764") or ("5526422") or	US-PGPUB; USPAT	OR	OFF	2019/04/29 08:34

("5539514") or ("5570181") or
("5572251") or ("5577501") or
("5600105") or ("5608550") or
("5672852") or ("5679930") or
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		("20180210572") or ("20180225006") or ("20180267672") or ("20180275788") or ("20180275830") or ("20180275831")).PN.				
S5	4,272	(G06F3/0421).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 09:35
S6	260	S5 and (collimat$3 near2 beam)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 09:35
S7	65	S5 and ((collimat$3 near2 beam) same parallel same surface)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 09:48
S8	55	S5 and ((collimat$3 near2 beam) same (across parallel) with surface) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 10:51
S9	55	S5 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 10:51
S10	42	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/04/29 11:11
S11	56	S2 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 11:13
S12	1	S11 not S9	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/04/29 11:21
S13	4,289	(G06F3/0421).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 09:41
S14	49	S13 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and ((emitter light) near3 above near3 (surface plane))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 09:41
S16	50	S13 and ((emitter LED diode) near3 above near3 (surface plane))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:05
S17	5,480	(G06F3/0421 or G06F3/0428).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:15
S18	52	S17 and ((emitter LED diode) near3 above near3 (surface plane))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:15

S19	169	S17 and ((emitter LED diode) with (above near3 (surface plane)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:25
S20	121	S19 not S18	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:26
S21	190	S17 and ((emitter LED diode) with (above near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:54
S22	29,597	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412 or G06F3/0428).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:55
S23	21	S21 not S19	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:55
S24	266	S22 and ((emitter LED diode) with (above near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:59
S25	76	S24 not S21	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 10:59
S26	29,531	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412 or G06F3/0428).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 12:38
S27	274	S26 and ((emitter LED diode) with ((atop (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 12:38
S28	266	S26 and ((emitter LED diode) with (above near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 12:39
S29	8	S27 not S28	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 12:39
S31	146	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 14:16
S32	153	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:04

		diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))				
S33	7	S32 not S31	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:18
S34	1,879	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:23
S35	5,476	(G06F3/0421 or G06F3/0428).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:23
S36	1,313	S35 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:23
S37	1,440	S34 not S36	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:24
S38	346	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:27
S39	375	S35 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:27
S40	180	S39 not S38	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/05/16 16:28
S41	2	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and ((light beam) adj5 (over across atop) adj3 (surface plane cover panel))).clm.	US-PGPUB	OR	ON	2019/05/27 18:31
S42	1	16/191177	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:47

S43	3	(("9207800") or ("20150339000") or ("20160306501")).PN.	US-PGPUB; USPAT	OR	OFF	2019/12/23 05:52
S44	154	(US-20010002694-$ | US-20010005004-$ | US-20010005308-$ | US-20010030642-$ | US-20020067348-$ | US-20020075243-$ | US-20020118177-$ | US-20020158823-$ | US-20020158853-$ | US-20020163505-$ | US-20030016450-$ | US-20030034439-$ | US-20030034935-$ | US-20030048257-$ | US-20030052257-$ | US-20030095399-$ | US-20030107748-$ | US-20030137494-$ | US-20030156100-$ | US-20030160155-$ | US-20030210537-$ | US-20030214486-$ | US-20040027339-$ | US-20040032401-$ | US-20040090432-$ | US-20040130338-$ | US-20040174541-$ | US-20040201579-$ | US-20040212603-$ | US-20040238627-$ | US-20040239702-$ | US-20040245438-$ | US-20040252091-$ | US-20040252867-$ | US-20050012714-$ | US-20050041013-$ | US-20050057903-$ | US-20050073508-$ | US-20050083293-$ | US-20050128190-$ | US-20050143923-$ | US-20050156914-$ | US-20050162398-$ | US-20050179977-$ | US-20050200613-$ | US-20050212774-$ | US-20050248540-$ | US-20050253834-$ | US-20050276053-$ | US-20060001650-$ | US-20060001653-$ | US-20060007185-$ | US-20060008164-$ | US-20060017706-$ | US-20060017709-$ | US-20060033725-$ | US-20060038698-$ | US-20060061861-$ | US-20060114237-$ | US-20060132454-$ | US-20060139340-$ | US-20060158437-$ | US-20060170658-$ | US-20060202974-$ | US-20060227120-$ | US-20060255248-$ | US-20060256092-$ | US-20060279558-$ | US-20060281543-$ | US-20060290684-$ | US-20070014486-$ | US-20070024598-$ | US-20070034783-$ | US-20070038691-$ | US-20070052684-$ | US-20070070056-$ | US-20070075648-$ | US-20070120833-$ | US-20070125937-$ | US-20070152985-$ | US-20070201042-$ | US-20070296688-$ | US-20080006766-$ | US-20080007540-$ | US-20080007541-$ | US-20080007542-$ | US-20080011944-$ | US-20080029691-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:58

		$ | US-20080036743-$ | US-20080062150-$ | US-20080068691-$ | US-20080074401-$ | US-20080088603-$ | US-20080121442-$ | US-20080122792-$ | US-20080122803-$ | US-20080130979-$ | US-20080133265-$ | US-20080150846-$ | US-20080150848-$ | US-20080151126-$ | US-20080158176-$ | US-20080189046-$ | US-20080192025-$ | US-20080238433-$ | US-20080246388-$ | US-20080252619-$ | US-20080266266-$ | US-20080278460-$ | US-20080284925-$ | US-20080291668-$ | US-20080297482-$ | US-20090002340-$ | US-20090006292-$ | US-20090040786-$ | US-20090066647-$ | US-20090067178-$ | US-20090073142-$ | US-20090077501-$ | US-20090085894-$ | US-20090091554-$ | US-20090115919-$ | US-20090122020-$ | US-20090122027-$ | US-20090128508-$ | US-20090135162-$ | US-20090143141-$ | US-20090153519-$ | US-20090161026-$ | US-20090168459-$ | US-20090187842-$ | US-20090189857-$ | US-20090189874-$ | US-20090189878-$ | US-20090219256-$ | US-20090229892-$ | US-20090251439-$ | US-20090256817-$ | US-20090259967-$ | US-20090267919-$ | US-20090273794-$ | US-20090278816-$ | US-20090297009-$ | US-20100033444-$ | US-20100045629-$ | US-20100060896-$ | US-20100066016-$ | US-20100066704-$ | US-20100073318-$ | US-20100078545-$ | US-20100079407-$ | US-20100079408-$ | US-20100097345-$ | US-20100097348-$).DID.				
S45	154	(US-20100097353-$ | US-20100125438-$ | US-20100127975-$ | US-20100134435-$ | US-20100142823-$ | US-20100187422-$ | US-20100193259-$ | US-20100229091-$ | US-20100238139-$ | US-20100245292-$ | US-20100265170-$ | US-20100277436-$ | US-20100283785-$ | US-20100284596-$ | US-20100289754-$ | US-20100295821-$ | US-20100302196-$ | US-20100302209-$ | US-20100302210-$ | US-20100302240-$ | US-20100315379-$ | US-20100321328-$ | US-20100322550-$	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:58

		| US-20110043490-$ | US-20110049388-$ | US-20110050649-$ | US-20110051394-$ | US-20110068256-$ | US-20110069039-$ | US-20110069807-$ | US-20110074725-$ | US-20110074734-$ | US-20110074735-$ | US-20110090176-$ | US-20110102374-$ | US-20110115748-$ | US-20110121323-$ | US-20110122075-$ | US-20110122091-$ | US-20110122094-$ | US-20110134079-$ | US-20110147569-$ | US-20110157095-$ | US-20110157096-$ | US-20110163996-$ | US-20110163997-$ | US-20110163998-$ | US-20110169780-$ | US-20110175852-$ | US-20110205186-$ | US-20110216042-$ | US-20110221705-$ | US-20110221997-$ | US-20110227036-$ | US-20110227874-$ | US-20110234537-$ | US-20110254864-$ | US-20110261020-$ | US-20110267296-$ | US-20110291989-$ | US-20110298743-$ | US-20110309325-$ | US-20110310045-$ | US-20120019448-$ | US-20120026408-$ | US-20120038593-$ | US-20120062474-$ | US-20120068973-$ | US-20120086673-$ | US-20120089348-$ | US-20120110447-$ | US-20120131490-$ | US-20120141001-$ | US-20120146930-$ | US-20120153134-$ | US-20120154338-$ | US-20120162142-$ | US-20120162144-$ | US-20120169672-$ | US-20120181419-$ | US-20120182266-$ | US-20120188206-$ | US-20120191993-$ | US-20120200532-$ | US-20120200538-$ | US-20120212441-$ | US-20120217882-$ | US-20120249478-$ | US-20120256882-$ | US-20120268403-$ | US-20120268427-$ | US-20120274559-$ | US-20120305755-$ | US-20130021300-$ | US-20130021302-$ | US-20130027404-$ | US-20130044073-$ | US-20130055080-$ | US-20130076697-$ | US-20130082980-$ | US-20130107569-$ | US-20130113715-$ | US-20130120320-$ | US-20130125016-$ | US-20130127790-$ | US-20130135258-$ | US-20130135259-$ | US-20130141388-$ | US-20130154983-$ | US-20130155027-$ | US-20130158504-$ | US-20130181896-$ | US-20130187891-$ | US-20130201142-$ | US-20130222346-$ | US-20130241887-			

		$ | US-20130249833-$ | US-20130269867-$ | US-20130275082-$ | US-20130285920-$ | US-20130285968-$ | US-20130300716-$ | US-20130307795-$ | US-20130342490-$ | US-20140002400-$ | US-20140028575-$ | US-20140028604-$ | US-20140028629-$ | US-20140036203-$ | US-20140055421-$ | US-20140063853-$ | US-20140071653-$ | US-20140085241-$ | US-20140092052-$ | US-20140098032-$ | US-20140098058-$ | US-20140109219-$ | US-20140125633-$ | US-20140139467-$ | US-20140160762-$ | US-20140192023-$ | US-20140232669-$ | US-20140237401-$ | US-20140237408-$ | US-20140237422-$ | US-20140253831-$ | US-20140267124-$ | US-20140292701-$ | US-20140300572-$ | US-20140320460-$ | US-20140347325-$ | US-20140362046-$ | US-20140368471-$ | US-20140375607-$).DID.				
S46	179	(US-20150002386-$ | US-20150009687-$ | US-20150015497-$ | US-20150035774-$ | US-20150035803-$ | US-20150053850-$ | US-20150054759-$ | US-20150083891-$ | US-20150103013-$ | US-20150130769-$ | US-20150138105-$ | US-20150138158-$ | US-20150138161-$ | US-20150205441-$ | US-20150215450-$ | US-20150242055-$ | US-20150271481-$ | US-20150286698-$ | US-20150317036-$ | US-20150324028-$ | US-20150331544-$ | US-20150331545-$ | US-20150331546-$ | US-20150331547-$ | US-20150332655-$ | US-20150346856-$ | US-20150346911-$ | US-20150363042-$ | US-20160026337-$ | US-20160034099-$ | US-20160050746-$ | US-20160070415-$ | US-20160070416-$ | US-20160124546-$ | US-20160124551-$ | US-20160154531-$ | US-20160154532-$ | US-20160202841-$ | US-20160216844-$ | US-20160224144-$ | US-20160299593-$ | US-20160328090-$ | US-20160328091-$ | US-20160334942-$ | US-20160342282-$ | US-20160357348-$ | US-20170010688-$ | US-20170090090-$ | US-20170102827-$ | US-20170115235-$ | US-20170115823-$	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:58

| US-20170139541-$ | US-20170177163-$ | US-20170185230-$ | US-20170293392-$ | US-20170344185-$ | US-20180031753-$ | US-20180129354-$ | US-20180210572-$ | US-20180225006-$ | US-20180267672-$ | US-20180275788-$ | US-20180275830-$ | US-0001650-$ | US-0001653-$ | US-0002340-$ | US-0002386-$ | US-0002400-$ | US-0002694-$ | US-0005004-$ | US-0005308-$ | US-0006292-$ | US-0006766-$ | US-0007185-$ | US-0007540-$ | US-0007541-$ | US-0007542-$ | US-0008164-$ | US-0009687-$ | US-0010688-$ | US-0011944-$ | US-0012714-$ | US-0014486-$ | US-0015497-$ | US-0016450-$ | US-0017706-$ | US-0017709-$ | US-0019448-$ | US-0021300-$ | US-0021302-$ | US-0024598-$ | US-0026337-$ | US-0026408-$ | US-0027339-$ | US-0027404-$ | US-0028575-$ | US-0028604-$ | US-0028629-$ | US-0029691-$ | US-0030642-$ | US-0031753-$ | US-0032401-$ | US-0033444-$ | US-0033725-$ | US-0034099-$ | US-0034439-$ | US-0034783-$ | US-0034935-$ | US-0035774-$ | US-0035803-$ | US-0036203-$ | US-0036743-$ | US-0038593-$ | US-0038691-$ | US-0038698-$ | US-0040786-$ | US-0041013-$ | US-0043490-$ | US-0044073-$ | US-0045629-$ | US-0048257-$ | US-0049388-$ | US-0050649-$ | US-0050746-$ | US-0051394-$ | US-0052257-$ | US-0052684-$ | US-0053850-$ | US-0054759-$ | US-0055080-$ | US-0055421-$ | US-0057903-$ | US-0060896-$ | US-0061861-$ | US-0062150-$ | US-0062474-$ | US-0063853-$ | US-0066016-$ | US-0066647-$ | US-0066704-$ | US-0067178-$ | US-0067348-$ | US-0068256-$ | US-0068691-$ | US-0068973-$ | US-0069039-$ | US-0069807-$ | US-0070056-$ | US-0070415-$ | US-0070416-$ | US-0071653-$ | US-0073142-$ | US-0073318-$ | US-0073508-$ | US-0074401-$ | US-

		0074725-$ | US-0074734-$ | US-0074735-$ | US-0075243-$ | US-0075648-$ | US-0076697-$ | US-0077501-$ | US-0078545-$ | US-0079407-$ | US-0079408-$ | US-0082980-$ | US-0083293-$ | US-0083891-$ | US-0085241-$ | US-0085894-$ | US-0086673-$ | US-0088603-$ | US-0089348-$ | US-0090090-$ | US-0090176-$ | US-0090432-$ | US-0091554-$ | US-0092052-$ | US-0095399-$).DID.				
S47	194	(US-0097345-$ | US-0097348-$ | US-0097353-$ | US-0098032-$ | US-0098058-$ | US-0102374-$ | US-0102827-$ | US-0103013-$ | US-0107569-$ | US-0107748-$ | US-0109219-$ | US-0110447-$ | US-0113715-$ | US-0114237-$ | US-0115235-$ | US-0115748-$ | US-0115823-$ | US-0115919-$ | US-0118177-$ | US-0120320-$ | US-0120833-$ | US-0121323-$ | US-0121442-$ | US-0122020-$ | US-0122027-$ | US-0122075-$ | US-0122091-$ | US-0122094-$ | US-0122792-$ | US-0122803-$ | US-0124546-$ | US-0124551-$ | US-0125016-$ | US-0125438-$ | US-0125633-$ | US-0125937-$ | US-0127790-$ | US-0127975-$ | US-0128190-$ | US-0128508-$ | US-0129354-$ | US-0130338-$ | US-0130769-$ | US-0130979-$ | US-0131490-$ | US-0132454-$ | US-0133265-$ | US-0134079-$ | US-0134435-$ | US-0135162-$ | US-0135258-$ | US-0135259-$ | US-0137494-$ | US-0138105-$ | US-0138158-$ | US-0138161-$ | US-0139340-$ | US-0139467-$ | US-0139541-$ | US-0141001-$ | US-0141388-$ | US-0142823-$ | US-0143141-$ | US-0143923-$ | US-0146930-$ | US-0147569-$ | US-0150846-$ | US-0150848-$ | US-0151126-$ | US-0152985-$ | US-0153134-$ | US-0153519-$ | US-0154338-$ | US-0154531-$ | US-0154532-$ | US-0154983-$ | US-0155027-$ | US-0156100-$ | US-0156914-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:58

0157096-$ | US-0158176-$ | US-
0158437-$ | US-0158504-$ | US-
0158823-$ | US-0158853-$ | US-
0160155-$ | US-0160762-$ | US-
0161026-$ | US-0162142-$ | US-
0162144-$ | US-0162398-$ | US-
0163505-$ | US-0163996-$ | US-
0163997-$ | US-0163998-$ | US-
0168459-$ | US-0169672-$ | US-
0169780-$ | US-0170658-$ | US-
0174541-$ | US-0175852-$ | US-
0177163-$ | US-0179977-$ | US-
0181419-$ | US-0181896-$ | US-
0182266-$ | US-0185230-$ | US-
0187422-$ | US-0187842-$ | US-
0187891-$ | US-0188206-$ | US-
0189046-$ | US-0189857-$ | US-
0189874-$ | US-0189878-$ | US-
0191993-$ | US-0192023-$ | US-
0192025-$ | US-0193259-$ | US-
0200532-$ | US-0200538-$ | US-
0200613-$ | US-0201042-$ | US-
0201142-$ | US-0201579-$ | US-
0202841-$ | US-0202974-$ | US-
0205186-$ | US-0205441-$ | US-
0210537-$ | US-0210572-$ | US-
0212441-$ | US-0212603-$ | US-
0212774-$ | US-0214486-$ | US-
0215450-$ | US-0216042-$ | US-
0216844-$ | US-0217882-$ | US-
0219256-$ | US-0221705-$ | US-
0221997-$ | US-0222346-$ | US-
0224144-$ | US-0225006-$ | US-
0227036-$ | US-0227120-$ | US-
0227874-$ | US-0229091-$ | US-
0229892-$ | US-0232669-$ | US-
0234537-$ | US-0237401-$ | US-
0237408-$ | US-0237422-$ | US-
0238139-$ | US-0238433-$ | US-
0238627-$ | US-0239702-$ | US-
0241887-$ | US-0242055-$ | US-
0245292-$ | US-0245438-$ | US-
0246388-$ | US-0248540-$ | US-
0249478-$ | US-0249833-$ | US-
0251439-$ | US-0252091-$ | US-
0252619-$ | US-0252867-$ | US-
0253831-$ | US-0253834-$ | US-
0254864-$ | US-0255248-$ | US-
0256092-$ | US-0256817-$ | US-
0256882-$ | US-0259967-$ | US-
0261020-$ | US-0265170-$ | US-
0266266-$ | US-0267124-$ | US-
0267296-$ | US-0267672-$ | US-

		0267919-$ | US-0268403-$ | US-0268427-$ | US-0269867-$ | US-0271481-$ | US-0273794-$ | US-0274559-$ | US-0275082-$ | US-0275788-$ | US-0275830-$).DID.				
S48	196	(US-0276053-$ | US-0277436-$ | US-0278460-$ | US-0278816-$ | US-0279558-$ | US-0281543-$ | US-0283785-$ | US-0284596-$ | US-0284925-$ | US-0285920-$ | US-0285968-$ | US-0286698-$ | US-0289754-$ | US-0290684-$ | US-0291668-$ | US-0291989-$ | US-0292701-$ | US-0293392-$ | US-0295821-$ | US-0296688-$ | US-0297009-$ | US-0297482-$ | US-0298743-$ | US-0299593-$ | US-0300572-$ | US-0300716-$ | US-0302196-$ | US-0302209-$ | US-0302210-$ | US-0302240-$ | US-0305755-$ | US-0307795-$ | US-0309325-$ | US-0310045-$ | US-0315379-$ | US-0317036-$ | US-0320460-$ | US-0321328-$ | US-0322550-$ | US-0324028-$ | US-0328090-$ | US-0328091-$ | US-0331544-$ | US-0331545-$ | US-0331546-$ | US-0331547-$ | US-0332655-$ | US-0334942-$ | US-0342282-$ | US-0342490-$ | US-0344185-$ | US-0346856-$ | US-0346911-$ | US-0347325-$ | US-0357348-$ | US-0362046-$ | US-0363042-$ | US-0368471-$ | US-0375607-$ | US-1234567-$ | US-10013107-$ | US-10019113-$ | US-3440426-$ | US-3553680-$ | US-3673327-$ | US-4129384-$ | US-4180702-$ | US-4209255-$ | US-4213707-$ | US-4254333-$ | US-4254407-$ | US-4294543-$ | US-4346376-$ | US-4420261-$ | US-4484179-$ | US-4507557-$ | US-4521112-$ | US-4542375-$ | US-4550250-$ | US-4593191-$ | US-4673918-$ | US-4688933-$ | US-4688993-$ | US-4692809-$ | US-4710760-$ | US-4736191-$ | US-4737626-$ | US-4746770-$ | US-4752655-$ | US-4772763-$ | US-4782328-$ | US-4812833-$ | US-4837430-$ | US-4868912-$ | US-	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:59

4891829-$ | US-4916712-$ | US-
4933544-$ | US-4949079-$ | US-
4986662-$ | US-4988983-$ | US-
5065185-$ | US-5073770-$ | US-
5105186-$ | US-5159322-$ | US-
5166668-$ | US-5227622-$ | US-
5248856-$ | US-5254407-$ | US-
5345490-$ | US-5383022-$ | US-
5483261-$ | US-5484966-$ | US-
5499098-$ | US-5502568-$ | US-
5525764-$ | US-5526422-$ | US-
5539514-$ | US-5570181-$ | US-
5572251-$ | US-5577501-$ | US-
5600105-$ | US-5608550-$ | US-
5672852-$ | US-5679930-$ | US-
5686942-$ | US-5688933-$ | US-
5729249-$ | US-5736686-$ | US-
5740224-$ | US-5764223-$ | US-
5767517-$ | US-5775792-$ | US-
5945980-$ | US-5945981-$ | US-
5959617-$ | US-6061177-$ | US-
6067079-$ | US-6122394-$ | US-
6141104-$ | US-6172667-$ | US-
6175999-$ | US-6227667-$ | US-
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6664952-$ | US-6690363-$ | US-
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6748098-$ | US-6784948-$ | US-
6799141-$ | US-6806871-$ | US-
6927384-$ | US-6940286-$ | US-
6965836-$ | US-6972753-$ | US-
6985137-$ | US-7042444-$ | US-
7084859-$ | US-7087907-$ | US-
7133031-$ | US-7176904-$ | US-
7199932-$ | US-7359041-$ | US-
7397418-$ | US-7432893-$ | US-
7435940-$ | US-7436443-$ | US-
7442914-$ | US-7465914-$ | US-
7613375-$ | US-7629968-$ | US-
7646833-$ | US-7653883-$ | US-
7655901-$ | US-7705835-$ | US-
7729056-$ | US-7847789-$ | US-
7855716-$ | US-7859519-$).DID.

S49	73	(US-7924272-$ | US-7932899-$ | US-7969410-$ | US-7995039-$ | US-8013845-$ | US-8031186-$ | US-8077147-$ | US-8093545-$ | US-8094136-$ | US-8094910-$ | US-8149211-$ | US-8218154-$ | US-8274495-$ | US-8325158-$ | US-8339379-$ | US-8350827-$ | US-8384010-$ | US-8407606-$ | US-8441467-$ | US-8445834-$ | US-8466901-$ | US-8482547-$ | US-8542217-$ | US-8567257-$ | US-8581884-$ | US-8624858-$ | US-8686974-$ | US-8692807-$ | US-8716614-$ | US-8727581-$ | US-8745514-$ | US-8780066-$ | US-8830181-$ | US-8860696-$ | US-8872098-$ | US-8872801-$ | US-8884900-$ | US-8890843-$ | US-8890849-$ | US-8928590-$ | US-8963886-$ | US-8982084-$ | US-9024916-$ | US-9035909-$ | US-9063617-$ | US-9086763-$ | US-9134854-$ | US-9158401-$ | US-9158415-$ | US-9213445-$ | US-9274645-$ | US-9317168-$ | US-9323396-$ | US-9366565-$ | US-9377884-$ | US-9389732-$ | US-9411444-$ | US-9411464-$ | US-9430079-$ | US-9442574-$ | US-9547393-$ | US-9552103-$ | US-9557846-$ | US-9588619-$ | US-9594467-$ | US-9618682-$ | US-9626018-$ | US-9626040-$ | US-9639210-$ | US-9678602-$ | US-9684414-$ | US-9710101-$ | US-9874978-$).DID.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 05:59
S50	6	(("4751379") or ("6100538") or ("20070165008") or ("20130234991") or ("8913035") or ("20130300714")).PN.	US-PGPUB; USPAT	OR	OFF	2019/12/23 06:04
S51	32,685	(G06F3/0428 or G06F3/0421 or G06F2203/04108 or G06F2203/04107 or G06F2203/04103 or G06F3/0412).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:05
S52	5,737	(G06F3/0421 or G06F3/0428).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:58
S53	378	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:58

		frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))				
S54	397	S52 and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((light beam) near5 (over across atop) near3 (surface plane cover panel))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:58
S55	186	S54 not S53	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:58
S56	151	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:58
S57	31,612	(G06F3/0421 or G06F2203/04107 or G06F2203/04103 or G06F2203/04108 or G06F3/0412).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:59
S58	56	S57 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 06:59
S59	53	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/12/23 07:08
S60	56	S51 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 07:09
S61	158	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 07:09
S62	7	S61 not S56	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/23 07:09
S63	12	(US-20080080811-$ | US-20100315379-$ | US-20110134079-$ | US-20110141062-$ | US-20120170056-$ | US-20130300714-$ | US-20150131010-$ |	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:45

		US-20190025984-$ | US-20190196657-$ | US-20190196658-$ | US-20190196659-$ | US-9001086-$).DID.				
S64	152	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode) with (support frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:51
S65	33,069	(G06F3/0428 or G06F3/0421 or G06F2203/04108 or G06F2203/04107 or G06F2203/04103 or G06F3/0412).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:52
S66	56	S65 and ((collimat$3 near2 beam) same ((across parallel) with surface)) and (frame chasis bezel) and (glass plastic)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:52
S67	159	(optical near2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch near2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light near2 source)) with (support$3 frame mount$3)) and ((emitter LED diode) with ((atop over (on near2 top) above) near3 (surface plane panel)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:52
S68	7	S67 not S64	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/03 09:52
S69	2	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and ((light beam) adj5 (over across atop) adj3 (surface plane cover panel))).clm.	US-PGPUB	OR	ON	2020/02/03 09:55
S70	0	16/834905	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/26 22:26
S71	56	((("SKAGMO") near3 ("Daniel")) OR (("EHN") near3 ("Robert")) OR (("BERGSTROM") near3 ("Hakan"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2020/04/26 22:27
S72	34,265	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/26 22:32

S73	34,265	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 13:33
S74	30	S73 and (((optical near2 element) lens) same emitter same (surface)) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3 translat$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 13:38
S75	329	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) lens) same emitter) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3 translat$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:00
S76	148	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) lens) same emitter) and (((optical near2 element) lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) lens) same (slid$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:00
S77	198	(touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad))) and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:11
S78	30	S73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) and (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3 contamina$4 dust dirt)) and (((optical near2 element) (light near2 guide) light-guide lens) same (slid$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:13
S80	14	S73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (seal$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:28

S81	255	S73 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:29
S82	12	("20080080811" | "20100315379" | "20110134079" | "20110141062" | "20120170056" | "20130300714" | "20150131010" | "20190025984" | "20190196657" | "20190196658" | "20190196659" | "9001086").PN.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/04/27 14:33
S83	1	("20140210793").PN.	US-PGPUB; USPAT	OR	OFF	2020/06/03 12:48
S84	1	("20160224300").PN.	US-PGPUB; USPAT	OR	OFF	2020/06/11 09:44
S85	34,968	(G06F3/0428 or G06F3/0421 or G06F2203/04103 or G06F3/0412 or G06F2203/04108 or G06F2203/04107).cpc.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/22 13:03
S86	265	S85 and (((optical near2 element) (light near2 guide) light-guide lens) same emitter) same (((optical near2 element) (light near2 guide) light-guide lens) same (engag$5 coupl$3 mat$3 fitted))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/22 13:03
S87	33	((optical adj2 (touchscreen touchpanel touchpad touch-screen touch-pad touch-panel (touch adj2 (screen panel display sens$3 pad)))) and ((emitter LED diode (light adj2 source)) and (support$3 frame mount$3)) and (engag$5 coupl$3 mat$3 fitted)).clm.	US-PGPUB	OR	ON	2020/06/22 13:37

7/17/2021 11:45:15 PM
C:\Users\agiesy\Documents\EAST\Workspaces\16989292.wsp

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	First Named Inventor	Daniel Skagmo
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	3,440,426	04-22-1969	Bush	
	2	3,553,680	01-05-1971	Cooreman	
	3	3,673,327	06-27-1972	Johnson et al.	
	4	4,129,384	12-12-1978	Walker et al.	
	5	4,180,702	12-25-1979	Sick et al.	
	6	4,209,255	06-24-1980	Heynau et al.	
	7	4,213,707	07-22-1980	Evans, Jr.	
	8	4,254,333	03-03-1981	Bergström	
	9	4,254,407	03-03-1981	Tipon	
	10	4,294,543	10-13-1981	Apple et al.	
	11	4,346,376	08-24-1982	Mallos	
	12	4,420,261	12-13-1983	Barlow et al.	
	13	4,484,179	11-20-1984	Kasday	
	14	4,507,557	03-26-1985	Tsikos	
	15	4,521,112	06-04-1985	Kuwabara et al.	
	16	4,542,375	09-17-1985	Alles et al.	
	17	4,550,250	10-29-1985	Mueller et al.	
	18	4,593,191	06-03-1986	Alles	
	19	4,673,918	06-16-1987	Adler et al.	
	20	4,688,933	08-25-1987	Lapeyre	
	21	4,688,993	08-25-1987	Ferris et al.	
	22	4,692,809	09-08-1987	Beining et al.	
	23	4,710,760	12-01-1987	Kasday	
	24	4,736,191	04-05-1988	Matzke et al.	
	25	4,737,626	04-12-1988	Hasegawa	
	26	4,746,770	05-24-1988	McAvinney	
	27	4,751,379	06-14-1988	Sasaki et al.	
	28	4,752,655	06-21-1988	Tajiri et al.	
	29	4,772,763	09-20-1988	Garwin et al.	

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U.S. PATENT DOCUMENTS					
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	30	4,782,328	11-01-1988	Denlinger	
	31	4,812,833	03-14-1989	Shimauchi	
	32	4,837,430	06-06-1989	Hasegawa	
	33	4,868,912	09-19-1989	Doering	
	34	4,891,829	01-02-1990	Deckman et al.	
	35	4,916,712	04-10-1990	Bender	
	36	4,933,544	06-12-1990	Tamaru	
	37	4,949,079	08-14-1990	Loebner	
	38	4,986,662	01-22-1991	Bures	
	39	4,988,983	01-29-1991	Wehrer	
	40	5,065,185	11-12-1991	Powers et al.	
	41	5,073,770	12-17-1991	Lowbner	
	42	5,105,186	04-14-1992	May	
	43	5,159,322	10-27-1992	Loebner	
	44	5,166,668	11-24-1992	Aoyagi	
	45	5,227,622	07-13-1993	Suzuki	
	46	5,248,856	09-28-1993	Mallicoat	
	47	5,254,407	10-19-1993	Sergerie et al.	
	48	5,345,490	09-06-1994	Finnigan et al.	
	49	5,383,022	01-17-1995	Kaser	
	50	5,483,261	01-09-1996	Yasutake	
	51	5,484,966	01-16-1996	Segen	
	52	5,499,098	03-12-1996	Ogawa	
	53	5,502,568	03-26-1996	Ogawa et al.	
	54	5,525,764	06-11-1996	Junkins et al.	
	55	5,526,422	06-11-1996	Keen	
	56	5,539,514	07-23-1996	Shishido et al.	
	57	5,570,181	10-29-1996	Yasuo et al.	
	58	5,572,251	11-05-1996	Ogawa	

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	59	5,577,501	11-26-1996	Flohr et al.	
	60	5,600,105	02-04-1997	Fukuzaki et al.	
	61	5,608,550	03-04-1997	Epstein et al.	
	62	5,672,852	09-30-1997	Fukuzaki et al.	
	63	5,679,930	10-21-1997	Katsurahira	
	64	5,686,942	11-11-1997	Ball	
	65	5,688,933	11-18-1997	Evans et al.	
	66	5,729,249	03-17-1998	Yasutake	
	67	5,736,686	04-07-1998	Perret, Jr. et al.	
	68	5,740,224	04-14-1998	Müller et al.	
	69	5,764,223	06-09-1998	Chang et al.	
	70	5,767,517	06-16-1998	Hawkins	
	71	5,775,792	07-07-1998	Wiese	
	72	5,945,980	08-31-1999	Moissev et al.	
	73	5,945,981	08-31-1999	Paull et al.	
	74	5,959,617	09-28-1999	Bird et al.	
	75	6,061,177	05-09-2000	Fujimoto	
	76	6,067,079	05-23-2000	Shieh	
	77	6,122,394	09-19-2000	Neukermans et al.	
	78	6,141,104	10-31-2000	Schulz et al.	
	79	6,172,667	01-09-2001	Sayag	
	80	6,175,999	01-23-2001	Sloan et al.	
	81	6,227,667	05-08-2001	Halldorsson et al.	
	82	6,229,529	05-08-2001	Yano et al.	
	83	6,333,735	12-25-2001	Anvekar	
	84	6,366,276	04-02-2002	Kunimatsu et al.	
	85	6,380,732	04-30-2002	Gilboa	
	86	6,380,740	04-30-2002	Laub	
	87	6,390,370	05-21-2002	Plesko	

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U.S. PATENT DOCUMENTS					
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	88	6,429,857	08-06-2002	Masters et al.	
	89	6,452,996	09-17-2002	Hsieh	
	90	6,476,797	11-05-2002	Kurihara et al.	
	91	6,492,633	12-10-2002	Nakazawa et al.	
	92	6,495,832	12-17-2002	Kirby	
	93	6,504,143	01-07-2003	Koops et al.	
	94	6,529,327	03-04-2003	Graindorge	
	95	6,538,644	03-25-2003	Muraoka	
	96	6,587,099	07-01-2003	Takekawa	
	97	6,648,485	11-18-2003	Colgan et al.	
	98	6,660,964	12-09-2003	Benderly	
	99	6,664,498	12-16-2003	Forsman et al.	
	100	6,664,952	12-16-2003	Iwamoto et al.	
	101	6,690,363	02-10-2004	Newton	
	102	6,707,027	03-16-2004	Liess et al.	
	103	6,738,051	05-18-2004	Boyd et al.	
	104	6,748,098	06-08-2004	Rosenfeld	
	105	6,784,948	08-31-2004	Kawashima et al.	
	106	6,799,141	09-28-2004	Stoustrup et al.	
	107	6,806,871	10-19-2004	Yasue	
	108	6,927,384	08-09-2005	Reime et al.	
	109	6,940,286	09-06-2005	Wang et al.	
	110	6,965,836	11-15-2005	Richardson	
	111	6,972,753	12-06-2005	Kimura et al.	
	112	6,985,137	01-10-2006	Kaikuranta	
	113	7,042,444	05-09-2006	Cok	
	114	7,084,859	08-01-2006	Pryor	
	115	7,087,907	08-08-2006	Lalovic et al.	
	116	7,133,031	11-07-2006	Wang et al.	

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	117	7,176,904	02-13-2007	Satoh	
	118	7,199,932	04-03-2007	Sugiura	
	119	7,359,041	04-15-2008	Xie et al.	
	120	7,397,418	07-08-2008	Doerry et al.	
	121	7,432,893	10-07-2008	Ma et al.	
	122	7,435,940	10-14-2008	Eliasson et al.	
	123	7,436,443	10-14-2008	Hirunuma et al.	
	124	7,442,914	10-28-2008	Eliasson et al.	
	125	7,465,914	12-16-2008	Eliasson et al.	
	126	7,613,375	11-03-2009	Shimizu	
	127	7,629,968	12-08-2009	Miller et al.	
	128	7,646,833	01-12-2010	He et al.	
	129	7,653,883	01-26-2010	Hotelling et al.	
	130	7,655,901	02-02-2010	Idzik et al.	
	131	7,705,835	04-27-2010	Eikman	
	132	7,729,056	06-01-2010	Hwang et al.	
	133	7,847,789	12-07-2010	Kolmykov-Zotov et al.	
	134	7,855,716	12-21-2010	McCreary et al.	
	135	7,859,519	12-28-2010	Tulbert	
	136	7,924,272	04-12-2011	Boer et al.	
	137	7,932,899	04-26-2011	Newton et al.	
	138	7,969,410	06-28-2011	Kakarala	
	139	7,995,039	08-09-2011	Eliasson et al.	
	140	8,013,845	09-06-2011	Ostergaard et al.	
	141	8,031,186	10-04-2011	Ostergaard	
	142	8,077,147	12-13-2011	Krah et al.	
	143	8,093,545	01-10-2012	Leong et al.	
	144	8,094,136	01-10-2012	Eliasson et al.	
	145	8,094,910	01-10-2012	Xu	

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U.S. PATENT DOCUMENTS					
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	146	8,149,211	04-03-2012	Hayakawa et al.	
	147	8,218,154	07-10-2012	Østergaard et al.	
	148	8,274,495	09-25-2012	Lee	
	149	8,325,158	12-04-2012	Yatsuda et al.	
	150	8,339,379	12-25-2012	Goertz et al.	
	151	8,350,827	01-08-2013	Chung et al.	
	152	8,384,010	02-26-2013	Hong et al.	
	153	8,407,606	03-26-2013	Davidson et al.	
	154	8,441,467	05-14-2013	Han	
	155	8,445,834	05-21-2013	Hong et al.	
	156	8,466,901	06-18-2013	Yen et al.	
	157	8,482,547	07-09-2013	Cobon et al.	
	158	8,542,217	09-24-2013	Wassvik et al.	
	159	8,567,257	10-29-2013	Van Steenberge et al.	
	160	8,581,884	11-12-2013	Fåhraeus et al.	
	161	8,624,858	01-07-2014	Fyke et al.	
	162	8,686,974	04-01-2014	Christiansson et al.	
	163	8,692,807	04-08-2014	Føhraeus et al.	
	164	8,716,614	05-06-2014	Wassvik	
	165	8,727,581	05-20-2014	Saccomanno	
	166	8,745,514	06-03-2014	Davidson	
	167	8,780,066	07-15-2014	Christiansson et al.	
	168	8,830,181	09-09-2014	Clark et al.	
	169	8,860,696	10-14-2014	Wassvik et al.	
	170	8,872,098	10-28-2014	Bergström et al.	
	171	8,872,801	10-28-2014	Bergström et al.	
	172	8,884,900	11-11-2014	Wassvik	
	173	8,890,843	11-18-2014	Wassvik et al.	
	174	8,890,849	11-18-2014	Christiansson et al.	

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	175	8,928,590	01-06-2015	El Dokor	
	176	8,963,886	02-24-2015	Wassvik	
	177	8,982,084	03-17-2015	Christiansson et al.	
	178	9,024,896	05-05-2015	Chen	
	179	9,024,916	05-05-2015	Christiansson	
	180	9,035,909	05-19-2015	Christiansson	
	181	9,063,617	06-23-2015	Eliasson et al.	
	182	9,086,763	07-21-2015	Johansson et al.	
	183	9,134,854	09-15-2015	Wassvik et al.	
	184	9,158,401	10-13-2015	Christiansson	
	185	9,158,415	10-13-2015	Song et al.	
	186	9,207,800	12-08-2015	Eriksson et al.	
	187	9,213,445	12-15-2015	King et al.	
	188	9,274,645	03-01-2016	Christiansson et al.	
	189	9,317,168	04-19-2016	Christiansson et al.	
	190	9,323,396	04-26-2016	Han et al.	
	191	9,366,565	06-14-2016	Uvnäs	
	192	9,377,884	06-28-2016	Christiansson et al.	
	193	9,389,732	07-12-2016	Craven-Bartle	
	194	9,411,444	08-09-2016	Christiansson et al.	
	195	9,411,464	08-09-2016	Wallander et al.	
	196	9,430,079	08-30-2016	Christiansson et al.	
	197	9,442,574	09-13-2016	Fåhraeus et al.	
	198	9,547,393	01-17-2017	Christiansson et al.	
	199	9,552,103	01-24-2017	Craven-Bartle et al.	
	200	9,557,846	01-31-2017	Baharav et al.	
	201	9,588,619	03-07-2017	Christiansson et al.	
	202	9,594,467	03-14-2017	Christiansson et al.	
	203	9,618,682	04-11-2017	Yoon et al.	

Examiner Signature	Date Considered

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	204	9,626,018	04-18-2017	Christiansson et al.	
	205	9,626,040	04-18-2017	Wallander et al.	
	206	9,639,210	05-02-2017	Wallander et al.	
	207	9,678,602	06-13-2017	Wallander	
	208	9,684,414	06-20-2017	Christiansson et al.	
	209	9,710,101	07-18-2017	Christiansson et al.	
	210	9,874,978	01-23-2018	Wall	
	211	10,013,107	007-03-2018	Christiansson et al.	
	212	10,019,113	07-10-2018	Christiansson et al.	
	213	2001/0002694	06-07-2001	Nakazawa et al.	
	214	2001/0005004	06-28-2001	Shiratsuki et al.	
	215	2001/0005308	06-28-2001	Oishi et al.	
	216	2001/0030642	10-18-2001	Sullivan et al.	
	217	2002/0067348	06-06-2002	Masters et al.	
	218	2002/0075243	06-20-2002	Newton	
	219	2002/0118177	08-29-2002	Newton	
	220	2002/0158823	10-31-2002	Zavracky et al.	
	221	2002/0158853	10-31-2002	Sugawara et al.	
	222	2002/0163505	11-07-2002	Takekawa	
	223	2003/0016450	01-23-2003	Bluemel et al.	
	224	2003/0034439	02-20-2003	Reime et al.	
	225	2003/0034935	02-20-2003	Amanai et al.	
	226	2003/0048257	03-13-2003	Mattila	
	227	2003/0052257	03-20-2003	Sumriddetchkajorn	
	228	2003/0095399	05-22-2003	Grenda et al.	
	229	2003/0107748	06-12-2003	Lee	
	230	2003/0137494	07-24-2003	Tulbert	
	231	2003/0156100	08-21-2003	Gettemy	
	232	2003/0160155	08-28-2003	Liess	

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Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	233	2003/0210537	11-13-2003	Engelmann	
	234	2003/0214486	11-20-2003	Roberts	
	235	2004/0027339	02-12-2004	Schulz	
	236	2004/0032401	02-19-2004	Nakazawa et al.	
	237	2004/0090432	05-13-2004	Takahashi et al.	
	238	2004/0130338	07-08-2004	Wang et al.	
	239	2004/0174541	09-09-2004	Freifeld	
	240	2004/0201579	10-14-2004	Graham	
	241	2004/0212603	10-28-2004	Cok	
	242	2004/0238627	12-02-2004	Silverbrook et al.	
	243	2004/0239702	12-02-2004	Kang et al.	
	244	2004/0245438	12-09-2004	Payne et al.	
	245	2004/0252091	12-16-2004	Ma et al.	
	246	2004/0252867	12-16-2004	Lan et al.	
	247	2005/0012714	01-20-2005	Russo et al.	
	248	2005/0041013	02-24-2005	Tanaka	
	249	2005/0057903	03-17-2005	Choi	
	250	2005/0073508	04-07-2005	Pittel et al.	
	251	2005/0083293	04-21-2005	Dixon	
	252	2005/0128190	06-16-2005	Ryynanen	
	253	2005/0143923	06-30-2005	Keers et al.	
	254	2005/0156914	07-21-2005	Lipman et al.	
	255	2005/0162398	07-28-2005	Eliasson et al.	
	256	2005/0179977	08-18-2005	Chui et al.	
	257	2005/0200613	09-15-2005	Kobayashi et al.	
	258	2005/0212774	09-29-2005	Ho et al.	
	259	2005/0248540	11-10-2005	Newton	
	260	2005/0253834	11-17-2005	Sakamaki et al.	
	261	2005/0276053	12-15-2005	Nortrup et al.	

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	262	2006/0001650	01-05-2006	Robbins et al.	
	263	2006/0001653	01-05-2006	Smits	
	264	2006/0007185	01-12-2006	Kobayashi	
	265	2006/0008164	01-12-2006	Wu et al.	
	266	2006/0017706	01-26-2006	Cutherell et al.	
	267	2006/0017709	01-26-2006	Okano	
	268	2006/0033725	02-16-2006	Marggraff et al.	
	269	2006/0038698	02-23-2006	Chen	
	270	2006/0061861	03-23-2006	Munro et al.	
	271	2006/0114237	06-01-2006	Crockett et al.	
	272	2006/0132454	06-22-2006	Chen et al.	
	273	2006/0139340	06-29-2006	Geaghan	
	274	2006/0158437	07-20-2006	Blythe et al.	
	275	2006/0170658	08-03-2006	Nakamura et al.	
	276	2006/0202974	09-14-2006	Thielman	
	277	2006/0227120	10-12-2006	Eikman	
	278	2006/0255248	11-16-2006	Eliasson	
	279	2006/0256092	11-16-2006	Lee	
	280	2006/0279558	12-14-2006	Van Delden et al.	
	281	2006/0281543	12-14-2006	Sutton et al.	
	282	2006/0290684	12-28-2006	Giraldo et al.	
	283	2007/0014486	01-18-2007	Schiwietz et al.	
	284	2007/0024598	02-01-2007	Miller et al.	
	285	2007/0034783	02-15-2007	Eliasson et al.	
	286	2007/0038691	02-15-2007	Candes et al.	
	287	2007/0052684	03-08-2007	Gruhlke et al.	
	288	2007/0070056	03-29-2007	Sato et al.	
	289	2007/0075648	04-05-2007	Blythe et al.	
	290	2007/0120833	05-31-2007	Yamaguchi et al.	

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	291	2007/0125937	06-07-2007	Eliasson et al.	
	292	2007/0152985	07-05-2007	Ostergaard et al.	
	293	2007/0201042	08-30-2007	Eliasson et al.	
	294	2007/0296688	12-27-2007	Nakamura et al.	
	295	2008/0006766	01-10-2008	Oon et al.	
	296	2008/0007540	01-10-2008	Ostergaard	
	297	2008/0007541	01-10-2008	Eliasson et al.	
	298	2008/0007542	01-10-2008	Eliasson et al.	
	299	2008/0011944	01-17-2008	Chua et al.	
	300	2008/0029691	02-07-2008	Han	
	301	2008/0036743	02-14-2008	Westerman et al.	
	302	2008/0062150	03-13-2008	Lee	
	303	2008/0068691	03-20-2008	Miyatake	
	304	2008/0074401	03-27-2008	Chung et al.	
	305	2008/0088603	04-17-2008	Eliasson et al.	
	306	2008/0121442	05-29-2008	Boer et al.	
	307	2008/0122792	05-29-2008	Izadi et al.	
	308	2008/0122803	05-29-2008	Izadi et al.	
	309	2008/0130979	06-05-2008	Run et al.	
	310	2008/0150846	06-26-2008	Chung et al.	
	311	2008/0150848	06-26-2008	Chung et al.	
	312	2008/0151126	06-26-2008	Yu	
	313	2008/0158176	07-03-2008	Land et al.	
	314	2008/0189046	08-07-2008	Eliasson et al.	
	315	2008/0192025	08-14-2008	Jaeger et al.	
	316	2008/0238433	10-02-2008	Joutsenoja et al.	
	317	2008/0246388	10-09-2008	Cheon et al.	
	318	2008/0252619	10-16-2008	Crockett et al.	
	319	2008/0266266	10-30-2008	Kent et al.	

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	320	2008/0278460	11-13-2008	Arnett et al.	
	321	2008/0284925	11-20-2008	Han	
	322	2008/0291668	11-27-2008	Aylward et al.	
	323	2008/0297482	12-04-2008	Weiss	
	324	2008/0133265	06-05-2008	Silkaitis et al.	
	325	2009/0002340	01-01-2009	Van Genechten	
	326	2009/0006292	01-01-2009	Block	
	327	2009/0040786	02-12-2009	Mori	
	328	2009/0066647	03-12-2009	Kerr et al.	
	329	2009/0067178	03-12-2009	Huang et al.	
	330	2009/0073142	03-19-2009	Yamashita et al.	
	331	2009/0077501	03-19-2009	Partridge et al.	
	332	2009/0085894	04-02-2009	Gandhi et al.	
	333	2009/0091554	04-09-2009	Keam	
	334	2009/0115919	05-07-2009	Tanaka et al.	
	335	2009/0122020	05-14-2009	Eliasson et al.	
	336	2009/0122027	05-14-2009	Newton	
	337	2009/0128508	05-21-2009	Sohn et al.	
	338	2009/0135162	05-28-2009	Van De Wijdeven et al.	
	339	2009/0143141	06-04-2009	Wells et al.	
	340	2009/0153519	06-18-2009	Suarez Rovere	
	341	2009/0161026	06-25-2009	Wu et al.	
	342	2009/0168459	07-02-2009	Holman et al.	
	343	2009/0187842	07-23-2009	Collins et al.	
	344	2009/0189857	07-30-2009	Benko et al.	
	345	2009/0189874	07-30-2009	Chene et al.	
	346	2009/0189878	07-30-2009	Goertz et al.	
	347	2009/0219256	09-03-2009	Newton	
	348	2009/0229892	09-17-2009	Fisher et al.	

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	349	2009/0251439	10-08-2009	Westerman et al.	
	350	2009/0256817	10-15-2009	Perlin et al.	
	351	2009/0259967	10-15-2009	Davidson et al.	
	352	2009/0267919	10-29-2009	Chao et al.	
	353	2009/0273794	11-05-2009	Østergaard et al.	
	354	2009/0278816	11-12-2009	Colson	
	355	2009/0297009	12-03-2009	Xu et al.	
	356	2010/0033444	02-11-2010	Kobayashi	
	357	2010/0045629	02-25-2010	Newton	
	358	2010/0060896	03-11-2010	Van De Wijdeven et al.	
	359	2010/0066016	03-18-2010	Van De Wijdeven et al.	
	360	2010/0066704	03-18-2010	Kasai	
	361	2010/0073318	03-25-2010	Hu et al.	
	362	2010/0078545	04-01-2010	Leong et al.	
	363	2010/0079407	04-01-2010	Suggs et al.	
	364	2010/0079408	04-01-2010	Leong et al.	
	365	2010/0097345	04-22-2010	Jang et al.	
	366	2010/0097348	04-22-2010	Park et al.	
	367	2010/0097353	04-22-2010	Newton	
	368	2010/0125438	05-20-2010	Audet	
	369	2010/0127975	05-27-2010	Jensen	
	370	2010/0134435	06-03-2010	Kimura et al.	
	371	2010/0142823	06-10-2010	Wang et al.	
	372	2010/0187422	07-29-2010	Kothari et al.	
	373	2010/0193259	08-05-2010	Wassvik	
	374	2010/0229091	09-09-2010	Homma et al.	
	375	2010/0238139	09-23-2010	Goertz et al.	
	376	2010/0245292	09-30-2010	Wu	
	377	2010/0265170	10-21-2010	Norieda	

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	378	2010/0277436	11-04-2010	Feng et al.	
	379	2010/0283785	11-11-2010	Satulovsky	
	380	2010/0284596	11-11-2010	Miao et al.	
	381	2010/0289754	11-18-2010	Sleeman et al.	
	382	2010/0295821	11-25-2010	Chang et al.	
	383	2010/0302196	12-02-2010	Han et al.	
	384	2010/0302209	12-02-2010	Large	
	385	2010/0302210	12-02-2010	Han et al.	
	386	2010/0302240	12-02-2010	Lettvin	
	387	2010/0315379	12-16-2010	Allard et al.	
	388	2010/0321328	12-23-2010	Chang et al.	
	389	2010/0322550	12-23-2010	Trott	
	390	2011/0043490	02-24-2011	Powell et al.	
	391	2011/0049388	03-03-2011	Delaney et al.	
	392	2011/0050649	03-03-2011	Newton et al.	
	393	2011/0051394	03-03-2011	Bailey	
	394	2011/0068256	03-24-2011	Hong et al.	
	395	2011/0069039	03-24-2011	Lee et al.	
	396	2011/0069807	03-24-2011	Dennerlein et al.	
	397	2011/0074725	03-31-2011	Westerman et al.	
	398	2011/0074734	03-31-2011	Wassvik et al.	
	399	2011/0074735	03-31-2011	Wassvik et al.	
	400	2011/0080361	04-07-2011	Miller et al.	
	401	2011/0090176	04-21-2011	Christiansson et al.	
	402	2011/0102374	05-05-2011	Wassvik et al.	
	403	2011/0115748	05-19-2011	Xu	
	404	2011/0121323	05-26-2011	Wu et al.	
	405	2011/0122075	05-26-2011	Seo et al.	
	406	2011/0122091	05-26-2011	King et al.	

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	407	2011/0122094	05-26-2011	Tsang et al.	
	408	2011/0134079	06-09-2011	Stark	
	409	2011/0147569	06-23-2011	Drumm	
	410	2011/0157095	06-30-2011	Drumm	
	411	2011/0157096	06-30-2011	Drumm	
	412	2011/0163996	07-07-2011	Wassvik et al.	
	413	2011/0163997	07-07-2011	Kim	
	414	2011/0163998	07-07-2011	Goertz et al.	
	415	2011/0169780	07-14-2011	Goertz et al.	
	416	2011/0175852	07-21-2011	Goertz et al.	
	417	2011/0205186	08-25-2011	Newton et al.	
	418	2011/0216042	09-08-2011	Wassvik et al.	
	419	2011/0221705	09-15-2011	Yi et al.	
	420	2011/0221997	09-15-2011	Kim et al.	
	421	2011/0227036	09-22-2011	Vaufrey	
	422	2011/0227874	09-22-2011	Fåhraeus et al.	
	423	2011/0234537	09-29-2011	Kim et al.	
	424	2011/0254864	10-20-2011	Tsuchikawa et al.	
	425	2011/0261020	10-27-2011	Song et al.	
	426	2011/0267296	11-03-2011	Noguchi et al.	
	427	2011/0291989	12-01-2011	Lee	
	428	2011/0298743	12-08-2011	Machida et al.	
	429	2011/0309325	12-22-2011	Park et al.	
	430	2011/0310045	12-22-2011	Toda et al.	
	431	2012/0019448	01-26-2012	Pitkanen et al.	
	432	2012/0026408	02-02-2012	Lee et al.	
	433	2012/0038593	02-16-2012	Rönkä et al.	
	434	2012/0062474	03-15-2012	Weishaupt et al.	
	435	2012/0068973	03-22-2012	Christiansson et al.	

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	436	2012/0086673	04-12-2012	Chien et al.	
	437	2012/0089348	04-12-2012	Perlin et al.	
	438	2012/0110447	05-03-2012	Chen	
	439	2012/0131490	05-24-2012	Lin et al.	
	440	2012/0141001	06-07-2012	Zhang et al.	
	441	2012/0146930	06-14-2012	Lee	
	442	2012/0153134	06-21-2012	Bergström et al.	
	443	2012/0154338	06-21-2012	Bergström et al.	
	444	2012/0162142	06-28-2012	Christiansson et al.	
	445	2012/0162144	06-28-2012	Fåhraeus et al.	
	446	2012/0169672	07-05-2012	Christiansson	
	447	2012/0181419	07-19-2012	Momtahan	
	448	2012/0182266	07-19-2012	Han	
	449	2012/0188206	07-26-2012	Sparf et al.	
	450	2012/0191993	07-26-2012	Drader et al.	
	451	2012/0200532	08-09-2012	Powell et al.	
	452	2012/0200538	08-09-2012	Christiansson et al.	
	453	2012/0212441	08-23-2012	Christiansson et al.	
	454	2012/0217882	08-30-2012	Wong et al.	
	455	2012/0249478	10-04-2012	Chang et al.	
	456	2012/0256882	10-11-2012	Christiansson et al.	
	457	2012/0268403	10-25-2012	Christiansson	
	458	2012/0268427	10-25-2012	Slobodin	
	459	2012/0274559	11-01-2012	Mathai et al.	
	460	2012/0305755	12-06-2012	Hong et al.	
	461	2013/0021300	01-24-2013	Wassvik	
	462	2013/0021302	01-24-2013	Drumm	
	463	2013/0027404	01-31-2013	Sarnoff	
	464	2013/0044073	02-21-2013	Christiansson et al.	

Examiner Signature	Date Considered

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	465	2013/0055080	02-28-2013	Komer et al.	
	466	2013/0076697	03-28-2013	Goertz et al.	
	467	2013/0082980	04-04-2013	Gruhlke et al.	
	468	2013/0107569	05-02-2013	Suganuma	
	469	2013/0113715	05-09-2013	Grant et al.	
	470	2013/0120320	05-16-2013	Liu et al.	
	471	2013/0125016	05-16-2013	Pallakoff et al.	
	472	2013/0127790	05-23-2013	Wassvik	
	473	2013/0135258	05-30-2013	King et al.	
	474	2013/0135259	05-30-2013	King et al.	
	475	2013/0141388	06-06-2013	Ludwig et al.	
	476	2013/0154983	06-20-2013	Christiansson et al.	
	477	2013/0155027	06-20-2013	Holmgren et al.	
	478	2013/0158504	06-20-2013	Ruchti et al.	
	479	2013/0181896	07-18-2013	Gruhlke et al.	
	480	2013/0187891	07-25-2013	Eriksson et al.	
	481	2013/0201142	08-08-2013	Suarez Rovere	
	482	2013/0222346	08-29-2013	Chen et al.	
	483	2013/0234991	09-12-2013	Sparf	
	484	2013/0241887	09-19-2013	Sharma	
	485	2013/0249833	09-26-2013	Christiansson et al.	
	486	2013/0269867	10-17-2013	Trott	
	487	2013/0275082	10-17-2013	Follmer et al.	
	488	2013/0285920	10-31-2013	Colley	
	489	2013/0285968	10-31-2013	Christiansson et al.	
	490	2013/0300716	11-14-2013	Craven-Bartle et al.	
	491	2013/0307795	11-21-2013	Suarez Rovere	
	492	2013/0321740	12-05-2013	An et al.	
	493	2013/0342490	12-26-2013	Wallander et al.	

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U.S. PATENT DOCUMENTS					
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	494	2014/0002400	01-02-2014	Christiansson et al.	
	495	2014/0028575	01-30-2014	Parivar et al.	
	496	2014/0028604	01-30-2014	Morinaga et al.	
	497	2014/0028629	01-30-2014	Drumm et al.	
	498	2014/0036203	02-06-2014	Guillou et al.	
	499	2014/0055421	02-27-2014	Christiansson et al.	
	500	2014/0063853	03-06-2014	Nichol et al.	
	501	2014/0071653	03-13-2014	Thompson et al.	
	502	2014/0085241	03-27-2014	Christiansson et al.	
	503	2014/0092052	04-03-2014	Grunthaner et al.	
	504	2014/0098032	04-10-2014	Ng et al.	
	505	2014/0098058	04-10-2014	Baharav et al.	
	506	2014/0109219	04-17-2014	Rohrweck et al.	
	507	2014/0125633	05-08-2014	Fåhraeus et al.	
	508	2014/0139467	05-22-2014	Ghosh et al.	
	509	2014/0160762	06-12-2014	Dudik et al.	
	510	2014/0192023	07-10-2014	Hoffman	
	511	2014/0232669	08-21-2014	Ohlsson et al.	
	512	2014/0237401	08-21-2014	Krus et al.	
	513	2014/0237408	08-21-2014	Ohlsson et al.	
	514	2014/0237422	08-21-2014	Ohlsson et al.	
	515	2014/0253831	09-11-2014	Craven-Bartle	
	516	2014/0267124	09-18-2014	Christiansson et al.	
	517	2014/0292701	10-02-2014	Christiansson et al.	
	518	2014/0300572	10-09-2014	Ohlsson et al.	
	519	2014/0320460	10-30-2014	Johansson et al.	
	520	2014/0347325	11-27-2014	Wallander et al.	
	521	2014/0362046	12-11-2014	Yoshida	
	522	2014/0368471	12-18-2014	Christiansson et al.	

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	Art Unit	2621
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	523	2014/0375607	12-25-2014	Christiansson et al.	
	524	2015/0002386	01-01-2015	Mankowski et al.	
	525	2015/0009687	01-08-2015	Lin	
	526	2015/0015497	01-15-2015	Leigh	
	527	2015/0035774	02-05-2015	Christiansson et al.	
	528	2015/0035803	02-05-2015	Wassvik et al.	
	529	2015/0053850	02-26-2015	Uvnäs	
	530	2015/0054759	02-26-2015	Christiansson et al.	
	531	2015/0083891	03-26-2015	Wallander	
	532	2015/0103013	04-16-2015	Huang	
	533	2015/0130769	05-14-2015	Björklund	
	534	2015/0138105	05-21-2015	Christiansson et al.	
	535	2015/0138158	05-21-2015	Wallander et al.	
	536	2015/0138161	05-21-2015	Wassvik	
	537	2015/0205441	07-23-2015	Bergström et al.	
	538	2015/0215450	07-30-2015	Seo et al.	
	539	2015/0242055	08-27-2015	Wallander	
	540	2015/0271481	09-24-2015	Guthrie et al.	
	541	2015/0286698	10-08-2015	Gagnier et al.	
	542	2015/0317036	11-05-2015	Johansson et al.	
	543	2015/0324028	11-12-2015	Wassvik et al.	
	544	2015/0331544	11-19-2015	Bergström et al.	
	545	2015/0331545	11-19-2015	Wassvik et al.	
	546	2015/0331546	11-19-2015	Craven-Bartle et al.	
	547	2015/0331547	11-19-2015	Wassvik et al.	
	548	2015/0332655	11-19-2015	Krus et al.	
	549	2015/0339000	11-26-2014	Lee et al.	
	550	2015/0346856	12-03-2015	Wassvik	
	551	2015/0346911	12-03-2015	Christiansson	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	552	2015/0363042	12-17-2015	Krus et al.	
	553	2015/0373864	12-24-2015	Jung	
	554	2016/0026337	01-28-2016	Wassvik et al.	
	555	2016/0034099	02-04-2016	Christiansson et al.	
	556	2016/0050746	02-18-2016	Wassvik et al.	
	557	2016/0070415	03-10-2016	Christiansson et al.	
	558	2016/0070416	03-10-2016	Wassvik	
	559	2016/0077616	06-17-2016	Durojaiye et al.	
	560	2016/0124546	05-05-2016	Chen et al.	
	561	2016/0124551	05-05-2016	Christiansson et al.	
	562	2016/0154531	06-02-2016	Wall	
	563	2016/0154532	06-02-2016	Campbell	
	564	2016/0154533	06-02-2016	Eriksson et al.	
	565	2016/0202841	07-14-2016	Christiansson et al.	
	566	2016/0216844	07-28-2016	Bergström	
	567	2016/0224144	08-04-2016	Klinghult et al.	
	568	2016/0299593	10-13-2016	Christiansson et al.	
	569	2016/0306501	10-20-2016	Drumm et al.	
	570	2016/0328090	11-10-2016	Klinghult	
	571	2016/0328091	11-10-2016	Wassvik et al.	
	572	2016/0334942	11-17-2016	Wassvik	
	573	2016/0342282	11-24-2016	Wassvik	
	574	2016/0357348	12-08-2016	Wallander	
	575	2017/0010688	01-12-2017	Fahraeus et al.	
	576	2017/0090090	03-30-2017	Craven-Bartle et al.	
	577	2017/0102827	04-13-2017	Christiansson et al.	
	578	2017/0115235	04-27-2017	Ohlsson et al.	
	579	2017/0115823	04-27-2017	Huang et al.	
	580	2017/0139541	05-18-2017	Christiansson et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	581	2017/0177163	06-22-2017	Wallander et al.	
	582	2017/0185230	06-29-2017	Wallander et al.	
	583	2017/0293392	10-12-2017	Christiansson et al.	
	584	2017/0344185	11-30-2017	Ohlsson et al.	
	585	2018/0031753	02-01-2018	Craven-Bartle et al.	
	586	2018/0129354	05-10-2018	Christiansson et al.	
	587	2018/0210572	07-26-2018	Wallander et al.	
	588	2018/0225006	08-09-2018	Wall	
	589	2018/0267672	09-20-2018	Wassvik et al.	
	590	2018/0275788	09-27-2018	Christiansson et al.	
	591	2018/0275830	09-27-2018	Christiansson et al.	
	592	2018/0275831	09-27-2018	Christiansson et al.	
	593	2019/0235701	08-01-2019	Han et al.	
	594	6,031,524	02-29-2000	Kunert	
	595	9,001,086	04-07-2015	Saini, Amrinder Pal Singh	
	596	9,063,614	06-23-2015	Petterson et al.	
	597	9,201,520	10-03-2013	Benko et al.	
	598	9,280,237	03-08-2016	Kukulj	
	599	10,282,035	05-07-2019	Kocovksi et al.	
	600	10,649,585	05-12-2020	van Beek et al.	
	601	2008/0080811	04-03-2008	Deane, Peter	
	602	2009/0000831	01-01-2009	Miller et al.	
	603	2010/0073327	03-25-2010	Mau et al.	
	604	2010/0103133	04-29-2010	Park et al.	
	605	2011/0084939	04-14-2011	Gepner et al.	
	606	2011/0141062	06-16-2011	Yu et al.	
	607	2011/0205189	08-25-2011	Newton, John David	
	608	2012/0056807	03-08-2012	Chapman et al.	
	609	2012/0062492	03-15-2012	Katoh	

Examiner Signature	Date Considered

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	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	610	2012/0170056	07-05-2012	Jakobsen et al.	
	611	2012/0212457	08-23-2012	Drumm, Owen	
	612	2012/0218229	08-30-2012	Drumm	
	613	2012/0223916	09-06-2012	Kukulj, Dax	
	614	2012/0313865	12-13-2012	Pearce	
	615	2013/0106709	05-02-2013	Simmons	
	616	2013/0141395	06-06-2013	Holmgren et al.	
	617	2013/0155655	06-20-2013	Lee et al.	
	618	2013/0181953	07-18-2013	Hinckley et al.	
	619	2013/0300714	11-14-2013	Goh et al.	
	620	2014/0015803	01-16-2014	Drumm, Owen	
	621	2014/0152624	06-05-2014	Piot et al.	
	622	2014/0226084	08-14-2014	Utukuri et al.	
	623	2014/0253520	09-11-2014	Cueto et al.	
	624	2014/0259029	09-11-2014	Choi et al.	
	625	2015/0121691	05-07-2015	Wang, Yun-Jun	
	626	2015/0131010	05-14-2015	Sugiyama, Koichi	
	627	2015/0199071	07-16-2015	Hou	
	628	2015/0261323	09-17-2015	Cui et al.	
	629	2016/0004898	01-07-2016	Holz	
	630	2016/0026297	01-28-2016	Shinkai et al.	
	631	2016/0041629	02-11-2016	Rao et al.	
	632	2016/0062549	03-03-2016	Drumm et al.	
	633	2016/0092021	03-31-2016	Tu et al.	
	634	2016/0103026	04-14-2016	Povazay et al.	
	635	2016/0117019	04-28-2016	Michiaki	
	636	2016/0179261	06-23-2016	Drumm, Owen	
	637	2016/0209886	07-21-2016	Suh et al.	
	638	2016/0255713	09-01-2016	Kim et al.	

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	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
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U.S. PATENT DOCUMENTS					
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	639	2016/0295711	10-06-2016	Ryu et al.	
	640	2016/0299583	10-13-2016	Watanabe	
	641	2017/0031516	02-02-2017	Sugiyama et al.	
	642	2017/0160871	06-08-2017	Drumm, Owen	
	643	2017/0220204	08-03-2017	Huang et al.	
	644	2018/0107373	04-19-2018	Cheng, Kai-Yu	
	645	2018/0136788	05-17-2018	He et al.	
	646	2018/0149792	05-31-2018	Lee et al.	
	647	2018/0253187	09-06-2018	Christiansson et al.	
	648	2018/0314206	11-01-2018	Lee et al.	
	649	2019/0004668	01-03-2019	Jeong et al.	
	650	2019/0025984	01-24-2019	Weilbacher et al.	
	651	2019/0050074	02-14-2019	Kocovski	
	652	2019/0107923	04-11-2019	Drumm, Owen	
	653	2019/0146630	05-16-2019	Chen et al.	
	654	2019/0196657	10-08-2019	Skagmo et al.	
	655	2019/0196658	06-27-2019	Skagmo et al.	
	656	2019/0196659	06-27-2019	Skagmo et al.	
	657	2019/0227670	07-25-2019	O'Cleirigh et al.	
	658	2019/0258353	08-22-2019	Drumm et al.	
	659	2019/0324570	10-24-2019	Kolundzjia et al.	
	660	2019/0377431	12-12-2019	Drumm, Owen	
	661	2019/0377435	12-12-2019	Piot et al.	
	662	2020/0012408	01-09-2020	Drumm et al.	
	663	2020/0073509	03-05-2020	Shih et al.	
	664	2020/0098147	03-26-2020	Ha et al.	
	665	2020/0125189	04-23-2020	Kim et al.	
	666	2020/0159382	05-21-2020	Drumm, Owen	
	667	2020/0167033	05-28-2020	Kim et al.	

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U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	668	2020/0249777	08-06-2020	Hou et al.	
	669	2020/0310621	10-01-2020	Piot et al.	
	670	2020/0341587	10-29-2020	Drumm, Owen	
	671	2020/0348473	11-05-2020	Drumm, Owen	
	672	2020/0387237	12-10-2020	Drumm, Owen	

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Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	673	CN 101019071 B	06-13-2012	QUALCOMM MEMS TECHNOLOGIES INC		
	674	CN 101075168 B	04-02-2014	BEIJING IRTOUCH SYSTEMS CO LTD		
	675	CN 101206550B	06-20-2012	MITSUBISHI ELECTRIC CORP		
	676	CN 101644854 A	02-10-2010	HONGFUJIN PREC IND SHENZHEN		
	677	CN 201233592 Y	05-06-2009	BEIJING IRTOUCH SYSTEMS CO LTD		
	678	CN 201437963 U	04-14-2010	TAIWAN NANO ELECTRIC OPT TECH		
	679	DE 3511330 C2	05-26-1988	SIEMENS AG		
	680	DE 10026201 A1	12-14-2000	SAINT LOUIS INST		
	681	DE 19809934 A1	09-09-1999	ROBERT BOSCH GMBH		
	682	DE 68902419 T2	03-18-1993	PHOTONETICS		
	683	DE 69000920 T2	06-03-1993	PHOTONETICS		
	684	DE 102010000473 A1	08-26-2010	WERTH MESSTECHNIK GMBH		
	685	EP 0600576 B1	10-07-1998	MICROFIELD GRAPHICS INC		
	686	EP 0845812 B1	06-03-1998	CASIO COMPUTER CO LTD		
	687	EP 0897161 B1	10-10-2007	FUJITSU LTD		

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FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	688	EP 0931731 A1	07-28-1999	GPAX International, Inc.		
	689	EP 1126236 B1	12-15-2010	RICOH COMPANY LTD		
	690	EP 1457870 B1	08-22-2012	SMART TECHNOLOGIES INC		
	691	EP 1512989 B1	09-02-2009	AVAGO TECHNOLOGIES ECBU IP SG PTE LTD		
	692	EP 1798630 A2	06-20-2007	SONY CORP		
	693	EP 2077490 A3	01-13-2010	APPLE INC		
	694	EP 2088501 A1	08-12-2009	IDEAN ENTPRISES OY		
	695	EP 2314203 A1	04-27-2011	CANON INC		
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	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 26 OF 33	Attorney Docket No.	FFOG.054C6

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Espacenet

CN101882034A Device and method for discriminating color of touch pen of touch device

Applicants: GUANGDONG VTRON TECHNOLOGY CO

Inventors: GUOPING LIU,JIETING ZHONG,NIANHUA TANG

Classifications:
IPC ***G06F3/042;***

Priorities: CN201010237107A 2010-07-23

Application: CN201010237107A 2010-07-23

Publication: CN101882034A 2010-11-10

Published as: CN101882034A;**CN101882034B**

Device and method for discriminating color of touch pen of touch device

Abstract

The invention relates to a device and a method for discriminating the color of a touch pen of a touch device. The method mainly comprises the following steps of: determining the imaging position of the touch pen in an image shot by the color discrimination camera through an image subtraction method or by computing the position of the touch pen on a touch screen; selecting a sampling area by taking the position as a center; respectively solving the average values of R, G, B values of pixel points in the sampling area, and converting a result to an HSV (Hue Saturation Value) color space for adjustment; and converting the adjusted H, S V values back to RGB (Red-Green-Blue) formats, and outputting the RGB color values as ultimately determined colors to a display screen for display. The invention can more accurately discriminate the color of the touch pen of the touch device, effectively improves the condition that the display color is slant dark and has easy operation.

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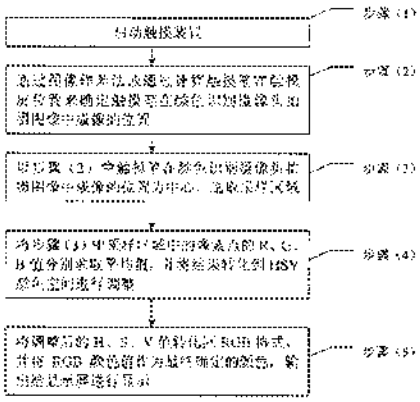
权利要求书 2 页 说明书 6 页 附图 3 页

(54)发明名称

触摸装置的触摸笔颜色识别装置及方法

(57)摘要

本发明涉及触摸装置的触摸笔颜色识别装置及方法，其方法主要步骤是：通过图像作差法或通过计算触摸笔在触摸屏位置来确定触摸笔的颜色识别摄像头所拍摄图像中成像的位置；以该位置为中心，选取采样区域；将采样区域中的像素点的R、G、B值分别求取平均值，并将结果转化到HSV颜色空间进行调整；将调整后的H、S、V值转化回RGB格式，并将RGB颜色值作为最终确定的颜色，输出给显示屏进行显示。本发明能够更准确的对触摸装置的笔色进行识别，且有效的改善了显示颜色偏暗的情况，运算简单。



CN 101882034 A

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1. 触摸装置的触摸笔颜色识别装置，其特征在于：包括用于确定触摸笔位置的定位摄像头，红外光源，用于拍摄触摸笔颜色的颜色识别摄像头，控制单元以及显示单元；其中，定位摄像头水平放置在屏幕的上边框，颜色识别摄像头倾斜放置在屏幕的上边框的左上角或右上角，定位摄像头的光轴与颜色识别摄像头的光轴在同一平面上，红外光源设在屏幕的上边框；控制单元分别与摄像头定位装置、颜色识别摄像头及显示单元连接；

所述控制单元用于通过图像作差法或通过计算触摸笔在触摸屏的位置来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，并用于以触摸笔在颜色识别摄像头所拍摄图像中成像的位置为中心来选取采样区域，然后将采样区域中像素点求 RGB 值的平均值，并将平均值转化到 HSV 颜色空间进行调整，最后再转化为 RGB 颜色值输出给显示屏进行显示。

2. 根据权利要求 1 所述的触摸笔颜色识别装置，其特征在于：所述定位摄像头包括与红外光源并排放置的第一定位摄像头和第二定位摄像头；第一定位摄像头和第二定位摄像头分别与控制单元连接，且均采用黑白摄像头；所述黑白摄像头的镜头配有红外滤光片。

3. 根据权利要求 1 所述的触摸笔颜色识别装置，其特征在于：所述颜色识别摄像头采用彩色摄像头，所述彩色摄像头配有闪光灯装置，所述彩色摄像头的镜头配有红外截止滤光片，所述闪光灯装置发出的光的波长小于红外波长。

4. 基于权利要求 1 所述触摸笔颜色识别装置的触摸装置的触摸笔颜色识别方法，其特征在于包括以下步骤：

(1) 启动触摸装置；

(2) 通过图像作差法或通过计算触摸笔在触摸屏的位置，来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置；

(3) 以步骤 (2) 中触摸笔在颜色识别摄像头所拍摄图像中成像的位置为中心，选取采样区域；

(4) 将步骤 (3) 中采样区域中的像素点的 R、G、B 值分别求取平均值，并将平均值转化到 HSV 颜色空间进行调整，得到调整后的 H、S、V 值；

(5) 将调整后的 H、S、V 值转化回 RGB 格式，并将 RGB 颜色值作为最终确定的颜色，输出给显示屏进行显示。

5. 根据权利要求 4 所述的触摸笔颜色识别方法，其特征在于，所述步骤 (2) 中，通过图像作差法来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，包括以下步骤：

(1-1) 在触摸装置上未放置触摸笔的情况下，通过颜色识别摄像头拍摄此时的图像并保存在控制单元的第一存储单元中，作为背景图像；

(1-2) 判断定位摄像头所拍摄的当前帧图像中是否有光斑，若否，进入步骤 (1-3)；若是，进入步骤 (1-4)；

(1-3) 更新第一存储单元中的背景图像：将颜色识别摄像头所拍摄的当前帧图像作为新的背景图像，替换掉步骤 (1-1) 中所保存的背景图像，然后返回步骤 (1-2)；

(1-4) 颜色识别摄像头启动闪光灯装置并进行拍摄，并保存所拍摄的当前帧图像在控制单元的第二存储单元中，作为前景图像；

(1-5) 将第一存储单元中的背景图像，以及第二存储单元中的前景图像都进行灰色世界法白平衡处理，并且进行复制，并对背景图像的复制图像、前景图像的复制图像都进行灰色世界法白平衡、彩色图像灰度化处理；

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(1-6) 对背景图像的复制图像、前景图像的复制图像进行逐像素作差运算，灰度值最大的像素点在图像中的坐标位置 (x, y) 作为触摸笔在图像上的位置。

6. 根据权利要求 4 所述的触摸笔颜色识别方法，其特征在于，所述步骤 (2) 中，通过计算触摸笔在触摸屏的位置来确定触摸笔在颜色识别摄像头拍摄图像中成像的位置，包括以下步骤：

(2-1) 启动定位摄像头进行拍摄；

(2-2) 判断所拍摄图像中是否有触摸点，若否，返回步骤 (2-1)，若有，进入步骤 (2-3)；

(2-3) 计算触摸点在触摸屏的位置 a(x1, y1)，同时启动颜色识别摄像头进行拍摄；

(2-4) 根据颜色识别摄像头的放置位置以及步骤 (2-3) 中计算出的触摸点在触摸屏位置 a(x1, y1)，确定触摸笔在颜色识别摄像头的拍摄图像中的成像位置。

7. 根据权利要求 1-6 中任一项所述的触摸笔颜色识别方法，其特征在于，所述步骤 (4) 中，在 HSV 颜色空间进行调整，包括以下步骤：

(4-1) 判断 S 值是否为非零值，若是，进入步骤 (4-2)，若否，进入步骤 (4-3)；

(4-2) 对 H 值进行非等间量化法调整；

(4-3) 判断 V 值是否小于 0.5，若是，将数值 0 赋值给 V，若否，整数值 1 赋值给 V。

8. 根据权利要求 7 所述的触摸笔颜色识别方法，其特征在于：所述步骤 (4-2) 中的非等间量化法为 6 级量化法、8 级量化法或者 16 级量化法。

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触摸装置的触摸笔颜色识别装置及方法

技术领域

[0001] 本发明涉及人机交互领域，特别涉及触摸装置的触摸笔颜色识别装置及方法。

背景技术

[0002] 现有的人机交互技术中，基于摄像头定位的触摸技术具有准确率高、能实现多点触摸、维护简单等优点，因此人们也越来越青睐于基于摄像头定位的触摸技术。基于摄像头定位触摸技术，如申请号为 200910039968.4、公开号为 CN101566898A 的中国发明专利申请"电子显示系统的定位装置及方法"，具有成本低、实现简单等特点。但是通常我们还需要反映出触摸笔的颜色，然后在显示屏上显示相应的颜色，便于区别不同颜色触摸笔的触摸操作，同时也使得触摸更具有直观性。但现有技术的颜色识别通常只是简单的从拍摄图像中提取触摸点处像素的灰度值直接作为显示颜色进行显示，使得显示的笔画颜色容易与实际触摸笔颜色出现偏差、且颜色偏暗。

发明内容

[0003] 本发明的首要目的在于克服现有技术的缺点与不足，提供触摸装置的触摸笔颜色识别装置，解决了现有颜色识别容易出现偏差，且显示颜色偏暗的技术问题。

[0004] 本发明的另一目的是提供触摸装置的触摸笔颜色识别方法，该方法基于上述触摸装置的触摸笔颜色识别装置。

[0005] 本发明的首要目的是通过下述技术方案实现：本触摸装置的触摸笔颜色识别装置，包括用于确定触摸笔位置的定位摄像头、红外光源，用于拍摄触摸笔颜色的颜色识别摄像头，控制单元以及显示单元；其中，定位摄像头水平放置在屏幕的上边框，颜色识别摄像头倾斜放置在屏幕的上边框的左上角或右上角，定位摄像头的光轴与颜色识别摄像头的光轴在同一平面上，红外光源设在屏幕的上边框；控制单元分别与摄像头定位装置、颜色识别摄像头及显示单元连接；所述控制单元用于通过图像作差法或通过计算触摸笔在触摸屏的位置来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，并用于以触摸笔在颜色识别摄像头所拍摄图像中成像的位置为中心来选取采样区域，然后将采样区域中像素点求 RGB 值的平均值，并将平均值转化到 HSV 颜色空间进行调整，最后再转化为 RGB 颜色值输出给显示屏进行显示。

[0006] 所述定位摄像头包括与红外光源并排放置的第一定位摄像头和第二定位摄像头；第一定位摄像头和第二定位摄像头分别与控制单元连接，且均采用黑白摄像头；所述黑白摄像头的镜头配有红外滤光片。

[0007] 所述颜色识别摄像头采用彩色摄像头，所述彩色摄像头配有闪光灯装置，所述彩色摄像头的镜头配有红外截止滤光片，所述闪光灯装置发出的光的波长小于红外波长。

[0008] 本发明的另一目的是通过下述技术方案实现：本触摸装置的触摸笔颜色识别方法，包括以下步骤：

[0009] (1) 启动触摸装置；

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[0010] (2) 通过图像作差法或通过计算触摸笔在触摸屏的位置，来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置；

[0011] (3) 以步骤 (2) 中触摸笔在颜色识别摄像头所拍摄图像中成像的位置为中心，选取采样区域；

[0012] (4) 将步骤 (3) 中采样区域中的像素点的 R、G、B 值分别求取平均值，并将平均值转化到 HSV 颜色空间进行调整，得到调整后的 H、S、V 值；

[0013] (5) 将调整后的 H、S、V 值转化回 RGB 格式，并将 RGB 颜色值作为最终确定的颜色，输出给显示屏进行显示。

[0014] 所述步骤 (2) 中，通过图像作差法来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，包括以下步骤：

[0015] (1-1) 在触摸装置上未放置触摸笔的情况下，通过颜色识别摄像头拍摄此时的图像并保存在控制单元的第一存储单元中，作为背景图像；

[0016] (1-2) 判断定位摄像头所拍摄的当前帧图像中是否有光斑，若否，进入步骤 (1-3)；若是，进入步骤 (1-4)；

[0017] (1-3) 更新第一存储单元中的背景图像：将颜色识别摄像头所拍摄的当前帧图像作为新的背景图像，替换掉步骤 (1-1) 中所保存的背景图象，然后返回步骤 (1-2)；

[0018] (1-4) 颜色识别摄像头启动闪光灯装置并进行拍摄，并保存所拍摄的当前帧图像在控制单元的第二存储单元中，作为前景图像；

[0019] (1-5) 将第一存储单元中的背景图像，以及第二存储单元中的前景图像都进行灰色世界法白平衡处理，并且进行复制，并对背景图像的复制图像、前景图像的复制图像都进行灰色世界法白平衡、彩色图象灰度化处理；

[0020] (1-6) 对背景图像的复制图像、前景图像的复制图像进行逐像素作差运算，将差值最大的像素点在图像中的坐标位置 (x, y) 作为触摸笔在图像上的位置。

[0021] 所述步骤 (2) 中，通过计算触摸笔在触摸屏的位置来确定触摸笔在颜色识别摄像头拍摄图像中成像的位置，包括以下步骤：

[0022] (2-1) 启动定位摄像头进行拍摄；

[0023] (2-2) 判断所拍摄图像中是否有触摸点，若否，返回步骤 (2-1)，若有，进入步骤 (2-3)；

[0024] (2-3) 计算触摸点在触摸屏的位置 a(x1, y1)，同时启动颜色识别摄像头进行拍摄；

[0025] (2-4) 根据颜色识别摄像头的放置位置以及步骤 (2-3) 中计算出的触摸点在触摸屏位置 a(x1, y1)，确定触摸笔在颜色识别摄像头的拍摄图像中的成像位置。

[0026] 所述步骤 (4) 中，在 HSV 颜色空间进行调整，包括以下步骤：

[0027] (4-1) 判断 S 值是否为非零值，若是，进入步骤 (4-2)，若否，进入步骤 (4-3)；

[0028] (4-2) 对 H 值进行非等间量化法调整；

[0029] (4-3) 判断 V 值是否小于 0.5，若是，将数值 0 赋值给 V，若否，将数值 1 赋值给 V。

[0030] 其中，所述步骤 (4-2) 中的非等间量化法为 6 级量化法、8 级量化法或者 16 级量化法。

[0031] 与现有技术相比，本发明具有如下的优点及有益效果：

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[0032] 1、在定位装置识别到有触摸时，才打开闪光灯，触发颜色识别摄像头进行拍摄，然后再进行后续的触摸笔颜色识别，不用对颜色识别摄像头拍摄的每一帧图像进行笔色识别处理，能有效提高图像处理速度，进而提高响应速度。

[0033] 2、能更准确的对触摸装置的触摸笔颜色进行识别，且有效的改善了显示颜色偏暗的情况，减少周围环境和触摸笔位置的不同导致的亮度变化影响到对触摸笔颜色的判断，有效减少误判、运算简单。

附图说明

[0034] 图 1 是本发明触摸装置的触摸笔颜色识别装置的结构示意图；

[0035] 图 2 是本发明触摸装置的触摸笔颜色识别方法的流程示意图；

[0036] 图 3 是本发明通过图像差法来确定触摸笔位置的流程示意图；

[0037] 图 4 是本发明通过计算触摸笔在触摸屏位置来确定触摸笔位置的流程示意图；

[0038] 图 5 是本发明的 HSV 颜色空间调整中非等间量化示意图。

具体实施方式

[0039] 下面结合实施例及附图，对本发明作进一步的详细说明，但本发明的实施方式不限于此。

[0040] 实施例 1

[0041] 参见图 1，本发明触摸装置的触摸笔颜色识别装置包括：两个用于确定触摸笔位置的第一定位摄像头 101 和第二定位摄像头 102，红外光源 106，一个用于拍摄触摸笔颜色的颜色识别摄像头 103，控制单元 104 以及显示屏 105；其中，颜色识别摄像头 103 为广角镜头，拍摄角度为 110°，将其倾斜放置在屏幕的上边框的左上角或右上角，使其能拍摄到除上边框之外的屏幕的其余三个边框；而定位摄像头 101、102 为鱼眼镜头，两者的拍摄角度都为 180°，将两者水平放置在屏幕的上边框，亦使其能拍摄到除上边框之外的屏幕的其余三个边框；101、102、103 三个摄像头的光轴需在同一平面上，该平面与屏幕平面平行，且二者间距（即光轴所在的平面与屏幕所在的平面的距离）不超过 2cm；红外光源 106 紧贴屏幕上边框，朝向均向下，其发射的红外光能散射照亮除屏幕上边框之外其余三个边框，控制单元 104 分别与第一定位摄像头 101、第二定位摄像头 102、颜色识别摄像头 103、显示屏 105 连接。

[0042] 所述用于确定触摸笔位置的第一定位摄像头 101 和第二定位摄像头 102 均采用镜头配有红外滤光片的黑白摄像头，拍摄的图像为黑白二值图像，且图像为帧图像，这样可以提高处理速度。通过该两个定位摄像头对触摸笔坐标位置进行定位的技术为现有技术，本专利不作详细展开描述。所述颜色识别摄像头 103 采用彩色摄像头，彩色摄像头配有闪光灯装置，且彩色摄像头的镜头配有红外截止滤光片。闪光灯装置发出的光的波长小于红外波长；由于红外波长约为 700nm，因此闪光灯装置所发出的光的波长小于 700nm。

[0043] 这样，配有红外滤光片的第一定位摄像头 101 和第二定位摄像头 102，可以忽略掉可见光的影响，进行对触摸笔的定位；配有上述闪光灯装置，且镜头配有红外截止滤光片的彩色摄像头，可以忽略掉红外光的影响，进而确保颜色识别摄像头所拍摄图像的颜色不受红外光影响，且闪光灯装置能确保在比较暗的环境下也能清晰的拍摄到触摸笔的颜色。

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[0044] 控制单元 104 用于通过图像作差法或通过计算触摸笔在触摸屏的位置，来确定触摸笔在颜色识别摄像头 103 所拍摄图像中成像的位置，并用于以触摸笔在颜色识别摄像头 103 所拍摄图像中成像的位置为中心来选取采样区域，然后将采样区域中像素点求 RGB 值的平均值，并将平均值转化到 HSV 颜色空间进行调整，最后再转化为 RGB 颜色值输出给显示屏 105 进行显示。

[0045] 参见图 2，本发明触摸装置的触摸笔颜色识别方法，包括以下步骤：

[0046] (1) 启动触摸装置；

[0047] (2) 通过图像作差法，来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置；

[0048] (3) 以步骤 (2) 中触摸笔在颜色识别摄像头所拍摄图像中成像的位置为中心，选取采样区域；例如，以 (x, y) 为中心，R 为半径选取区域作为采样区域，R 可以由用户根据实际情况进行定义；

[0049] (4) 将步骤 (3) 中采样区域中的像素点的 R、G、B 值分别求取平均值，并将平均值转化到 HSV 颜色空间进行调整，得到调整后的 H、S、V 值；

[0050] (5) 将调整后的 H、S、V 值转化回 RGB 格式，并将 RGB 颜色值作为最终确定的颜色，输出给显示屏进行显示。

[0051] 参见图 3，本实施例在所述步骤 (2) 中，采用通过图像作差法来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，包括以下步骤：

[0052] (1-1) 在触摸装置上未放置触摸笔的情况下，通过颜色识别摄像头拍摄此时的图像并保存在控制单元的第一存储单元中，作为背景图像；

[0053] (1-2) 判断定位摄像头所拍摄的当前帧图像（即判断第一定位摄像头或第二定位摄像头所拍摄的当前帧图像）中是否有光斑，若否，进入步骤 (1-3)；若是，进入步骤 (1-4)；

[0054] (1-3) 更新第一存储单元中的背景图像：将颜色识别摄像头所拍摄的当前帧图像作为新的背景图像，替换掉步骤 (1-1) 中所保存的背景图像，然后返回步骤 (1-2)；

[0055] (1-4) 颜色识别摄像头启动闪光灯装置并进行拍摄，并保存所拍摄的当前帧图像在控制单元的第二存储单元中，作为前景图像；

[0056] (1-5) 将第一存储单元中的背景图像，以及第二存储单元中的前景图像都进行灰色世界法白平衡处理，并且进行复制，并对背景图像的复制图像、前景图像的复制图像都进行灰色世界法白平衡、彩色图像灰度化处理；

[0057] (1-6) 对背景图像的复制图像、前景图像的复制图像进行逐像素作差运算，将差值最大的像素点在图像中的坐标位置 (x, y) 作为触摸笔在图像上的位置。

[0058] 所述步骤 (1-2) 中通过判断第一定位摄像头 101 或第二定位摄像头 102 所拍摄图像中是否有光斑，来确定是否有触摸笔放入触摸装置。具体判断可以通过设定像素灰度值阈值，若连续 n 个像素灰度值超过所设定的像素灰度值阈值，则认为存在光斑，n 可以由用户根据实际触摸笔大小情况进行设定，若不满足上述条件，则认为不存在光斑。

[0059] 所述步骤 (1-5) 中，进行的灰色世界法白平衡处理，可以有效改善偏色对图像色彩的影响，使得颜色的提取以及处理更加精确。

[0060] 所述步骤 (1) 中，将从步骤 (3) 中采样区域内所有像素点的 R、G、B 值分别求取平

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均值，将求取到的平均值R1、G1、B1代入RGB转化到HSV的公式里（该公式为公知算法，在此不作详述），可以得到相应的H、S、V值。

[0061] 所述步骤（4）中的在HSV颜色空间进行调整，包括以下步骤：

[0062] （4-1）判断S值是否为非零值，若是，进入步骤（4-2），若否，进入步骤（4-3）；

[0063] （4-2）对H值进行非等间量化法调整；

[0064] （4-3）判断V值是否小于0.5，若是，将数值0赋值给V，若否，将数值1赋值给V。

[0065] 其中，步骤（4-1）的作用在于通过饱和度S来区分识别彩色的触摸笔和非彩色（白、灰、黑）的触摸笔，S为零时，判断为非彩色的触摸笔，需要进一步判断V值；S为非零值时，判断为彩色的触摸笔，需要进行进一步的H值判断。

[0066] 所述步骤（4-3）中，V值小于0.5，则认为触摸笔是黑色，将数值0赋值给V；若V值大于或等于0.5，则认为触摸笔是白色，将数值1赋值给V。

[0067] 所述步骤（4-2）中的非等间量化法为6级量化法、8级量化法或者16级量化法。本实施例采用8级量化法。

[0068] 参见图5，在R、G、B分别相隔120度的圆环里，非等间量化成了8个区间，分别为：

[0069] 区间一（h <= 20° &&h > 315°）

[0070] 区间二（20° < h <= 40°）

[0071] 区间三（40° < h <= 75°）

[0072] 区间四（75° < h <= 155°）

[0073] 区间五（155° < h <= 190°）

[0074] 区间六（190° < h <= 270°）

[0075] 区间七（270° < h <= 295°）

[0076] 区间八（295° < h <= 315°）

[0077] 其中，h为本实施例中用平均值R1、G1、B1代入RGB转化到HSV的公式里得到相应的H值，若h值落到区间一，则h值调节为0°；若h值落到区间二，则h值调节为30°；若h值落到区间三，则h值调节为58°；若h值落到区间四，则h值调节为120°；若h值落到区间五，则h值调节为173°；若h值落到区间六，则h值调节为240°；若h值落到区间七，则h值调节为282°；若h值落到区间八，则h值调节为300°。即，一般判断h值落到哪个区间，就把哪个区间的中间值赋给h。

[0078] 实施例2

[0079] 本实施例的触摸装置的触摸笔颜色识别装置结构与实施例1相同，不同之处在于工作流程中的步骤（2），其余步骤均相同。本实施例的步骤（2），采用通过计算触摸笔在触摸屏位置，来确定触摸笔在颜色识别摄像头所拍摄图像中成像的位置，如图4所示，其包括以下步骤：

[0080] （2-1）启动定位摄像头进行拍摄；

[0081] （2-2）判断所拍摄图像中是否有触摸点（即是否有光斑），若否，返回步骤（2-1），若有，进入步骤（2-3）；

[0082] （2-3）计算触摸点在触摸屏位置a(x1，y1)，同时启动颜色识别摄像头进行拍摄（即触发颜色识别摄像头的闪光灯装置闪亮，从而促发颜色识别摄像头进行拍摄）；

[0083] （2-1）根据颜色识别摄像头的放置位置以及步骤（2-3）中计算出的触摸点在触摸

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屏位置 a(x1, y1)，确定步骤 (2-3) 触摸笔在颜色识别摄像头的拍摄图像中的成像位置。

[0084] 其中，所述步骤 (2-3) 计算触摸点在触摸屏的位置 a(x1, y1) 的计算方法为现有技术，本发明不作详述。

[0085] 所述步骤 (2-4) 中，根据颜色识别摄像头的放置位置以及步骤 (2-3) 中计算出的触摸点在触摸屏位置 a(x1, y1)，确定步骤 (2-3) 触摸笔在颜色识别摄像头的拍摄图像中的成像位置为：将 a(x1, y1) 代入颜色识别摄像头的成像公式（该公式为公知公式，本实施例不作详述），即可计算出所述步骤 (2-3) 触摸笔在颜色识别摄像头的拍摄图像中的成像位置。

[0086] 上述实施例为本发明较佳的实施方式，但本发明的实施方式并不受所述实施例的限制，其他的任何未背离本发明的精神实质与原理下所作的改变、修饰、替代、组合、简化，均应为等效的置换方式，都包含在本发明的保护范围之内。

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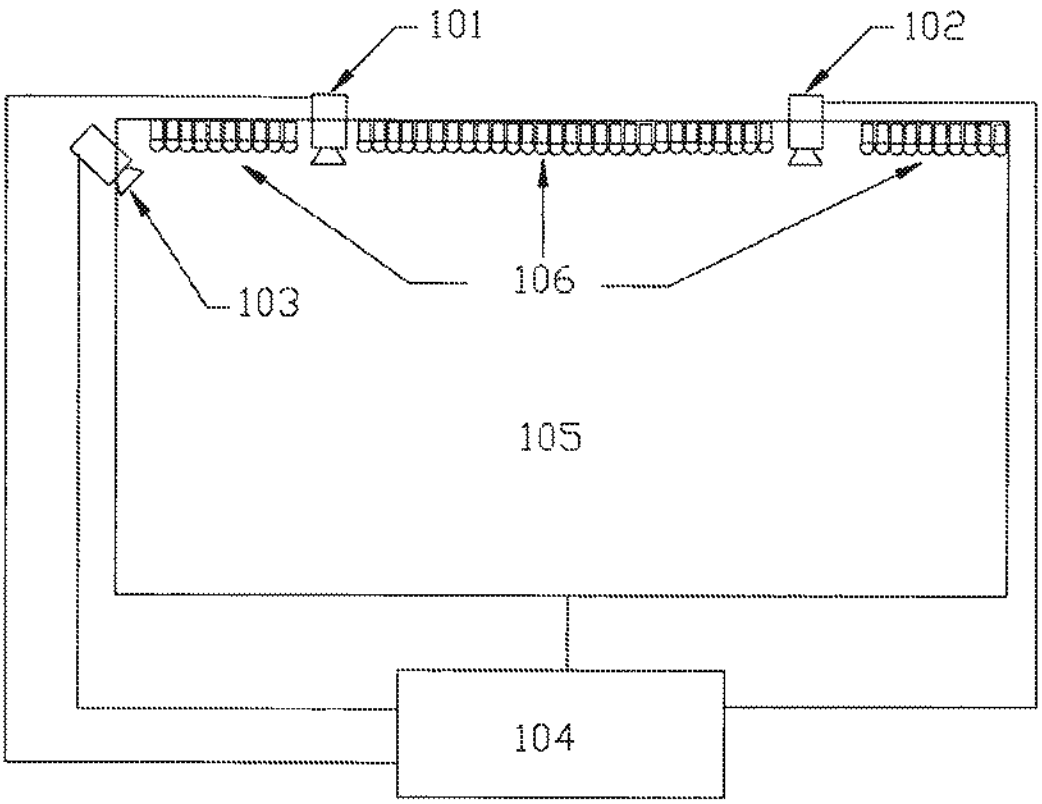


图 1

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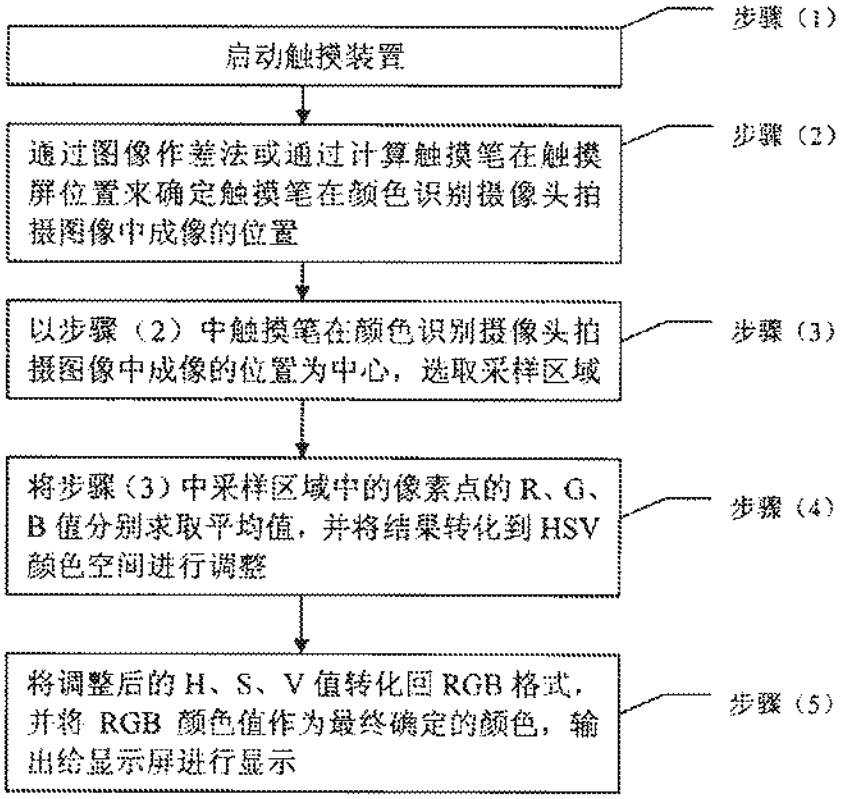


图 2

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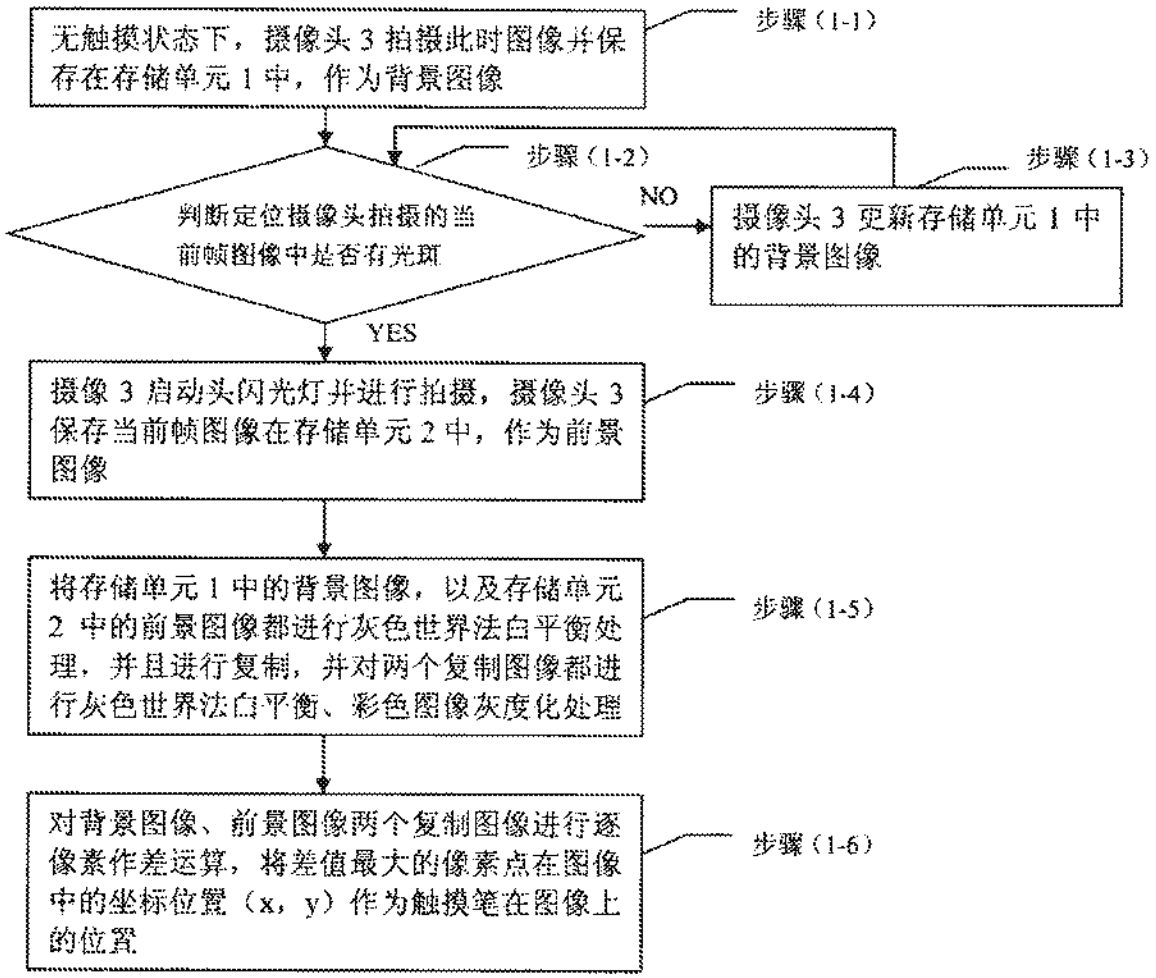


图 3

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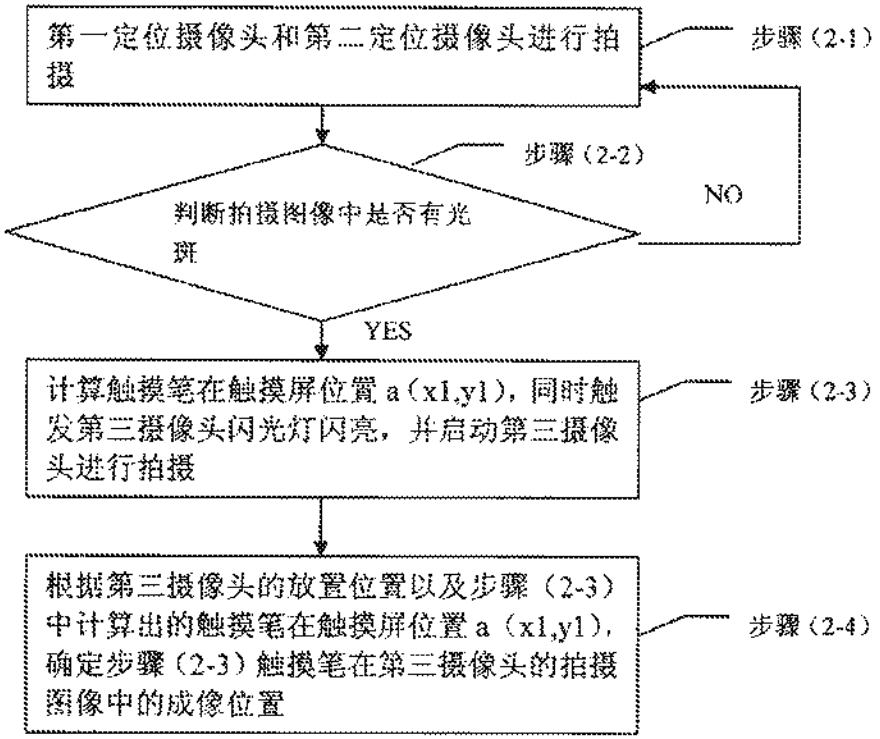


图 4

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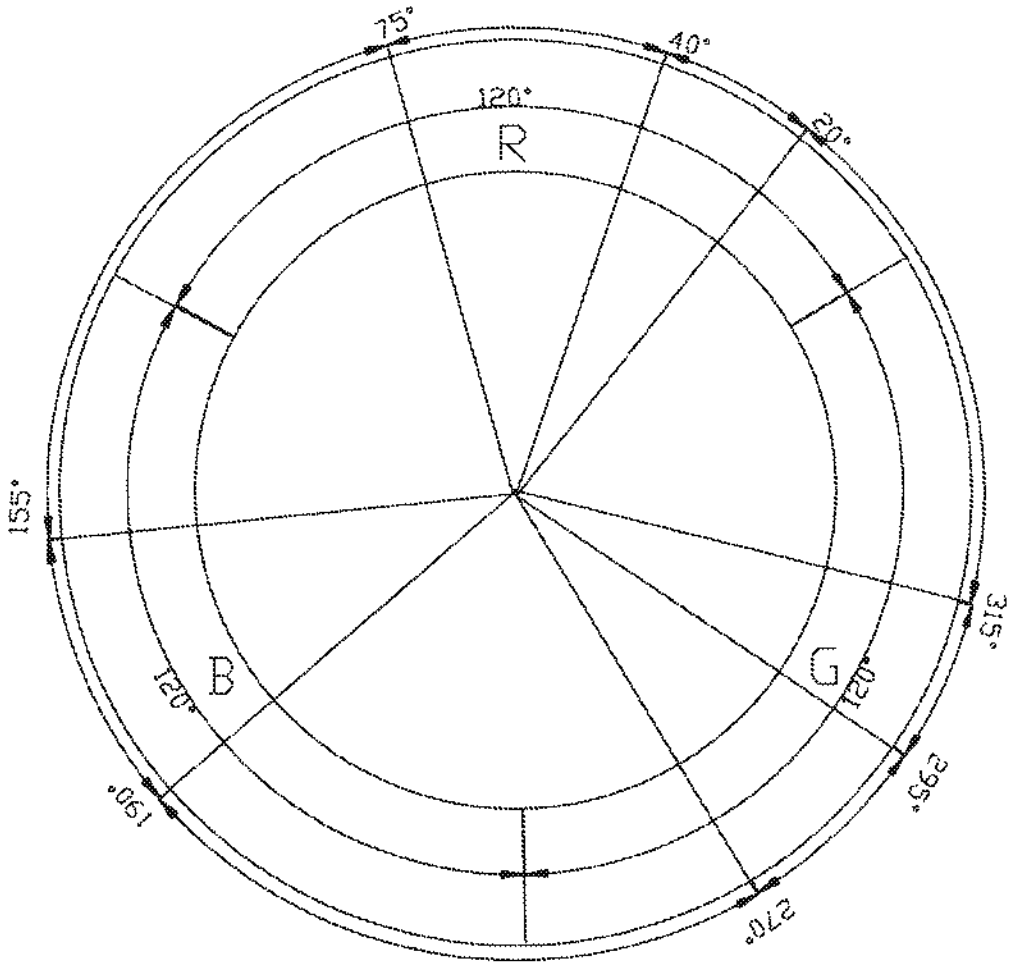


图 5

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Espacenet

Bibliographic data: CN203189466 (U) — 2013-09-11

Axial locking device

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Classification: **- international:** ***F16B21/10***
- cooperative:

Application number: CN20132107364U 20130310

Priority number(s): CN20132107364U 20130310

Abstract of CN203189466 (U)

The utility model relates to an axial locking device. The axial locking device comprises a steel shaft provided with a locating groove, a base, an axial locking ring and a locking bolt, and further comprises a locking ring, an internal thread gear ring and a locking sheet. The steel shaft penetrates through the base, the axial locking ring is fixed on the steel shaft in a matched mode through the locking bolt and the locating groove and closely adjacent to the base, and the locking ring and the steel shaft are fixedly connected to the other side of the base. The internal thread gear ring and the locking ring are matched and connected through threads and closely adjacent to the base, and the locking sheet is rotationally connected with the locking ring. After the axial locking device is installed, the internal thread gear ring is screwed, a gear of the internal thread gear ring is locked with the locking sheet so that the gear can not rotate, and then the locking operation of the axial locking device is completed.

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DESCRIPTION CN203189466

The utility model relates to an axial locking device, which comprises a steel shaft with a positioning groove, a base, an axial locking ring and a locking bolt, and further comprises a locking ring, an internal thread ring gear and a locking piece. The steel shaft passes through the base, and the axial locking ring is fixed on the steel shaft and abuts against the base by the locking bolt, and the locking ring is fixedly connected to the steel shaft at the base On the side, the internal thread ring gear is threadedly coupled to the locking ring and abuts against the base, and the locking piece is rotatably coupled to the locking ring. After the axial locking device of the utility model is installed, after the internal thread ring gear is tightened, the locking device is used to clamp the gear of the internal thread ring gear to make it unable to rotate, thereby completing the locking operation of the axial locking device.

Axial locking device

Technical field

The utility model relates to a locking device, in particular to an axial locking device.

Background technique

Axial locking devices are required for the installation of metal shafts and other components on large machines such as textile machines to ensure the stability of the machine during operation. Most of the locking devices for locking and fixing steel shafts on large machines such as textile machines are mostly constructed. It is complicated and difficult to adjust the position of the locking device, which is inconvenient to use.

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Summary of the invention

The purpose of the utility model is to provide an axial locking device which is simple in structure and convenient to use.

The technical solution for achieving the object of the present invention is as follows:

An axial locking device includes a base, an axial locking ring, a locking bolt, and a steel shaft passing through the base and having a positioning groove, and further includes a locking ring, an internal thread ring gear and a locking piece. The axial locking ring is fixed to the steel shaft by a locking bolt and a positioning groove, the axial locking ring abuts the base, and the locking ring is fixedly connected with the steel shaft on the other side of the base. The internal thread ring gear is threadedly engaged with the locking ring, the internal thread ring gear abuts against the base, one end of the locking piece is rotatably connected with the locking ring, and the other end of the locking piece is internally threaded The outer gear of the ring is in the tooth groove.

The axial locking device further includes a steel sleeve that is sleeved on the steel shaft and fixedly coupled to the steel shaft, and the locking ring is fixedly mounted on the steel sleeve.

The axial locking device further includes an inner ring needle bearing, the inner ring needle bearing is disposed in the base, and the inner ring needle bearing is sleeved on the steel sleeve.

The axial locking device further includes an inner thrust ball bearing and an outer thrust ball bearing, the inner thrust ball bearing is sleeved on the steel sleeve, and the inner thrust ball bearing is located between the inner thread ring gear and the base, The two ends of the inner thrust ball bearing are in close contact with the inner thread ring gear and the base respectively.

The axial locking device further includes an outer thrust ball bearing, the outer thrust ball bearing is sleeved on the steel shaft, and the outer thrust ball bearing is located between the axial locking ring and the base, and the outer thrust ball bearing The two ends are in close contact with the axial locking ring and the base respectively.

The axial locking device further includes an inner dustproof nylon ring, and the inner dustproof nylon ring is sleeved on the inner thrust ball bearing.

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The axial locking device further includes an outer dustproof nylon ring, and the outer dustproof nylon ring is sleeved on the outer thrust ball bearing.

After adopting the above structure, after the axial locking device of the utility model is installed, the locking effect of the steel shaft can be realized by rotating the internal thread ring gear and the locking piece, the structure is simple, the installation and disassembly are quick, convenient and reliable.

DRAWINGS

The present invention will be further described in detail below in conjunction with the drawings and specific embodiments.

Figure 1 is a schematic view showing the structure of the axial locking device of the present invention.

In the figure: 1 is the steel shaft, 2 is the base, 3 is the steel sleeve, 4 is the locking ring, 5 is the internal thread ring locking piece, 6 is the internal thread ring gear, 7 is the internal thrust ball bearing, 8 is External thrust ball bearings, 9 is the axial locking ring, 10 is the locking bolt, 11 is the positioning groove, 12 is the inner dustproof nylon ring, 13 is the fixing bolt, 14 is the connecting bolt, 15 is the inner ring needle bearing , 16 is the outer dustproof nylon ring.

Detailed ways

1 and 2, the axial locking device of the present invention comprises a steel shaft 1 with a positioning groove 11, a base 2, and further includes a steel sleeve 3, a locking ring 4, a locking piece 5, and an internal thread tooth, a ring 6, an inner thrust ball bearing 7, an outer thrust ball bearing 8, an axial locking ring 9, a locking bolt 10, and an inner ring needle bearing 15, the steel shaft 1 passing through the base 2, the axial direction The locking ring 9 is fixed on the steel shaft 1 by the locking bolt 10 and the positioning groove 11 . The outer thrust ball bearing 8 is sleeved on the steel shaft 1 and simultaneously contacts the axial locking ring 10 and the base 2 . The steel sleeve 3 is sleeved on the steel shaft 1 and is in contact with the outer thrust ball bearing 8 through the base 2, and the inner ringless needle bearing 15 is disposed in the base 2 and sleeved on the steel sleeve 3, the inner The thrust ball bearing 7 is sleeved on the steel sleeve 1 and is in contact with the base 2, and the locking ring 4 is fixed on the steel sleeve 3 by the fixing bolts 13, and the locking ring 4 and the locking piece 5 are rotated by the connecting

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bolts 14. When the connecting bolt 14 is tightened, the locking piece 5 can be fixed, and the internal thread ring gear 6 is screw-fitted with the locking ring 4, and the internal thread ring gear 6 is in contact with the inner thrust ball bearing 7. The axial locking device further comprises an inner dustproof nylon ring 12 and an outer dustproof nylon ring 16, the inner dustproof nylon ring 12 is set on the inner thrust ball bearing, and the outer dustproof nylon ring 16 is set on the outer thrust Ball bearing 8 on.

After the axial locking device of the utility model is installed, after the internal thread ring gear 6 is screwed, the rotary locking piece 5 is caught in the tooth groove of the external gear of the internal thread ring gear 6, and then the connecting bolt 14 is tightened to make the internal thread The locking operation of the axial locking device is completed when the ring gear 6 cannot be rotated.

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CLAIMS CN203189466

1.

An axial locking device comprising a base (2). an axial locking ring (9), a locking bolt (10) and a steel shaft with a positioning groove (11) passing through the base (2) 1), characterized in that it further comprises a locking ring (4), an internal thread ring gear (6) and a locking piece (5), the axial locking ring (9) being positioned by the locking bolt (10) The groove (11) is fixedly fixed to the steel shaft (1), the axial locking ring (9) abuts against the base (2), and the locking ring (4) is fixedly connected to the steel shaft (1) at the base On the other side of (2), the internal thread ring gear (6) is threadedly engaged with the locking ring (4), the internal thread ring gear (6) abuts against the base (2), the locking piece (5) One end is rotatably connected with the locking ring (4), and the other end of the locking piece (5) is caught in the external gear groove of the internal thread ring (6).

2.

The axial locking device according to claim 1, wherein the axial locking device further comprises a steel sleeve (3), the steel sleeve (3) is sleeved on the steel shaft (1) and is connected to the steel The shaft (1) is fixedly connected, and the locking ring (4) is fixedly mounted on the steel sleeve (3).

3.

The axial locking device according to claim 2, wherein said axial locking device further comprises an inner ring needle bearing (15), said inner ring needle bearing (15) being disposed at the base In the seat (2), the inner ring needle bearing (15) is sleeved on the steel sleeve (3).

4.

The axial locking device according to claim 2, wherein said axial locking device further comprises an inner thrust

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ball bearing (7) and an outer thrust ball bearing (8), said inner thrust ball bearing (7) Covered on a steel sleeve (3), the inner thrust ball bearing (7) is located in the middle of the inner thread ring gear (6) and the base (2), and the two ends of the inner thrust ball bearing (7) are respectively The internal thread ring (6) and the base (2) are in close contact.

5.

The axial locking device according to claim 1, wherein said axial locking device further comprises an outer thrust ball bearing (8), said outer thrust ball bearing (8) being sleeved on the steel shaft (2) The outer thrust ball bearing (8) is located between the axial locking ring (9) and the base (2), and the two ends of the outer thrust ball bearing (8) are respectively axially locked (9) And the base (2) is in close contact.

6.

The axial locking device according to claim 4, wherein the axial locking device further comprises an inner dustproof nylon ring (12), and the inner dustproof nylon ring (12) is sleeved inside the thrust ball. On the bearing (7).

7.

The axial locking device according to claim 5, wherein the axial locking device further comprises an outer dustproof nylon ring (16), and the outer dustproof nylon ring (16) is sleeved on the outer thrust ball bearing. (8) Upper.

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(19)中华人民共和国国家知识产权局

(12)实用新型专利

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(51)Int.Cl.
F16B 21/10(2006.01)

(ESM)同样的发明创造已同日申请发明专利

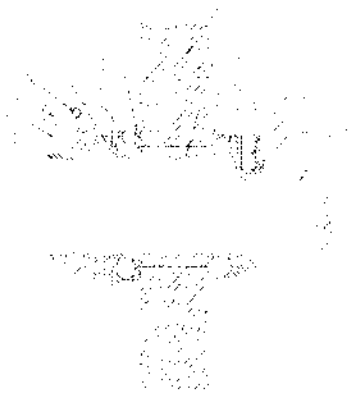
权利要求 1页 说明书2页 附图1页

(54)实用新型名称

轴向锁紧装置

(57)摘要

本实用新型涉及一种轴向锁紧装置，包括带有定位销的钢轴、基座、轴向锁紧圈以及锁紧螺栓，还包括锁紧圈、内螺纹齿圈以及锁紧片，所述钢轴穿过基座，所述轴向锁紧圈通过锁紧螺栓与定位销配合固定在钢轴上并紧靠基座，所述锁紧圈与钢轴固定连接在基座的另一侧，所述内螺纹齿圈与锁紧圈螺纹配合连接并紧靠基座，所述锁紧片与锁紧圈转动连接。本实用新型轴向锁紧装置安装完成后，将内螺纹齿圈旋紧后，用锁紧片卡住内螺纹齿圈的齿轮使其无法转动即完成了轴向锁紧装置的锁紧操作。



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1. 一种轴向锁紧装置，包括基座(2)、轴向锁紧圈(9)、锁紧螺栓(10)以及穿过基座(2)且带有定位槽(11)的钢轴(1)，其特征在于：还包括锁紧圈(4)、内螺纹齿圈(6)以及锁紧片(5)，所述轴向锁紧圈(9)通过锁紧螺栓(10)与定位槽(11)配合固定在钢轴(1)，所述轴向锁紧圈(9)紧靠基座(2)，所述锁紧圈(4)与钢轴(1)固定连接在基座(2)的另一侧，所述内螺纹齿圈(6)与锁紧圈(4)螺纹配合，所述内螺纹齿圈(6)紧靠基座(2)，所述锁紧片(5)一端与锁紧圈(4)转动连接，所述锁紧片(5)的另一端卡在内螺纹齿圈(6)的外齿轮齿槽里。

2. 根据权利要求 1 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括钢套(3)，所述钢套(3)套在钢轴(1)上并与钢轴(1)固定连接，所述锁紧圈(4)固定安装在钢套(3)上。

3. 根据权利要求 2 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括无内圈滚针轴承(15)，所述无内圈滚针轴承(15)设置在基座(2)内，所述无内圈滚针轴承(15)套在钢套(3)上。

4. 根据权利要求 2 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括内推力球轴承(7)以及外推力球轴承(8)，所述内推力球轴承(7)套在钢套(3)上，所述内推力球轴承(7)位于内螺纹齿圈(6)和基座(2)的中间，所述内推力球轴承(7)的两端分别与内螺纹齿圈(6)及基座(2)紧密接触。

5. 根据权利要求 1 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括外推力球轴承(8)，所述外推力球轴承(8)套在钢轴(2)上，所述外推力球轴承(8)位于轴向锁紧圈(9)与基座(2)中间，所述外推力球轴承(8)的两端分别与轴向锁紧圈(9)及基座(2)紧密接触。

6. 根据权利要求 4 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括内防尘尼龙圈(12)，所述内防尘尼龙圈(12)套在内推力球轴承(7)上。

7. 根据权利要求 5 所述的轴向锁紧装置，其特征在于：所述轴向锁紧装置还包括外防尘尼龙圈(16)，所述外防尘尼龙圈(16)套在外推力球轴承(8)上。

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轴向锁紧装置

技术领域

[0001] 本实用新型涉及一种锁紧装置，特别是一种轴向锁紧装置。

背景技术

[0002] 纺织机等大型机械上的金属轴等零件安装时都需要轴向锁紧装置以保证机器运行时的稳定性，目前由于纺织机等大型机械上的锁紧固定钢轴的锁紧装置大多结构复杂且不易调整锁紧装置的位置，使用很不方便。

发明内容

[0003] 本实用新型的目的是提供一种结构简单、使用方便的轴向锁紧装置。

[0004] 实现本实用新型目的的技术方案如下：

[0005] 一种轴向锁紧装置，包括基座、轴向锁紧圈、锁紧螺栓以及穿过基座且带有定位槽的钢轴，还包括锁紧圈、内螺纹齿圈以及锁紧片，所述轴向锁紧圈通过锁紧螺栓与定位槽配合固定在钢轴，所述轴向锁紧圈紧靠基座，所述锁紧圈与钢轴固定连接在基座的另一侧，所述内螺纹齿圈与锁紧圈螺纹配合，所述内螺纹齿圈紧靠基座，所述锁紧片一端与锁紧圈转动连接，所述锁紧片的另一端卡在内螺纹齿圈的外齿轮齿槽里。

[0006] 所述轴向锁紧装置还包括钢套，所述钢套套在钢轴上并与钢轴固定连接，所述锁紧圈固定安装在钢套上。

[0007] 所述轴向锁紧装置还包括无内圈滚针轴承，所述无内圈滚针轴承设置在基座内，所述无内圈滚针轴承套在钢套上。

[0008] 所述轴向锁紧装置还包括内推力球轴承以及外推力球轴承，所述内推力球轴承套在钢套上，所述内推力球轴承位于内螺纹齿圈和基座的中间，所述内推力球轴承的两端分别与内螺纹齿圈及基座紧密接触。

[0009] 所述轴向锁紧装置还包括外推力球轴承，所述外推力球轴承套在钢轴上，所述外推力球轴承位于轴向锁紧圈与基座中间，所述外推力球轴承的两端分别与轴向锁紧圈及基座紧密接触。

[0010] 所述轴向锁紧装置还包括内防尘尼龙圈，所述内防尘尼龙圈套在内推力球轴承上。

[0011] 所述轴向锁紧装置还包括外防尘尼龙圈，所述外防尘尼龙圈套在外推力球轴承上。

[0012] 采用上述结构后，本实用新型轴向锁紧装置安装完成后通过旋转内螺纹齿圈及锁紧片即可实现对钢轴的锁紧效果，结构简单、安装、拆卸迅速，方便可靠。

附图说明

[0013] 下面结合附图和具体实施方式对本实用新型作进一步详细的说明。

[0014] 图 1 为本实用新型轴向锁紧装置的结构示意图。

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[0015] 图中：1 为钢轴，2 为基座，3 为钢套，4 为锁紧圈，5 为内螺纹齿圈锁紧片，6 为内螺纹齿圈，7 为内推力球轴承，8 为外推力球轴承，9 为轴向锁紧圈，10 为锁紧螺栓，11 为定位槽，12 为内防尘尼龙圈，13 为固定螺栓，14 为连接螺栓，15 为无内圈滚针轴承，16 为外防尘尼龙圈。

具体实施方式

[0016] 由图 1 和图 2 可知，本实用新型轴向锁紧装置包括带有定位槽 11 的钢轴 1、基座 2，还包括钢套 3、锁紧圈 4、锁紧片 5、内螺纹齿圈 6、内推力球轴承 7、外推力球轴承 8、轴向锁紧圈 9、锁紧螺栓 10 以及无内圈滚针轴承 15，所述钢轴 1 穿过基座 2，所述轴向锁紧圈 9 通过锁紧螺栓 10 与定位槽 11 配合固定在钢轴 1 上，所述外推力球轴承 8 套在钢轴 1 上并同时与轴向锁紧圈 10 及基座 2 接触，所述钢套 3 套在钢轴 1 上并且穿过基座 2 与外推力球轴承 8 接触，所述无内圈滚针轴承 15 设置在基座 2 内并套在钢套 3 上，所述内推力球轴承 7 套在钢套 1 上并与基座 2 接触，所述锁紧圈 4 通过固定螺栓 13 固定在钢套 3 上，所述锁紧圈 4 与锁紧片 5 以连接螺栓 14 转动连接，当连接螺栓 14 拧紧后可使锁紧片 5 固定不动，所述内螺纹齿圈 6 与锁紧圈 4 螺纹配合连接，所述内螺纹齿圈 6 与内推力球轴承 7 接触。所述轴向锁紧装置还包括内防尘尼龙圈 12 和外防尘尼龙圈 16，所述内防尘尼龙圈 12 套在内推力球轴承上，所述外防尘尼龙圈 16 套在外推力球轴承 8 上。

[0017] 本实用新型轴向锁紧装置安装完成后，将内螺纹齿圈 6 旋紧后，旋转锁紧片 5 卡在内螺纹齿圈 6 的外齿轮的齿槽里后拧紧连接螺栓 14，使内螺纹齿圈 6 无法转动即完成了轴向锁紧装置的锁紧操作。

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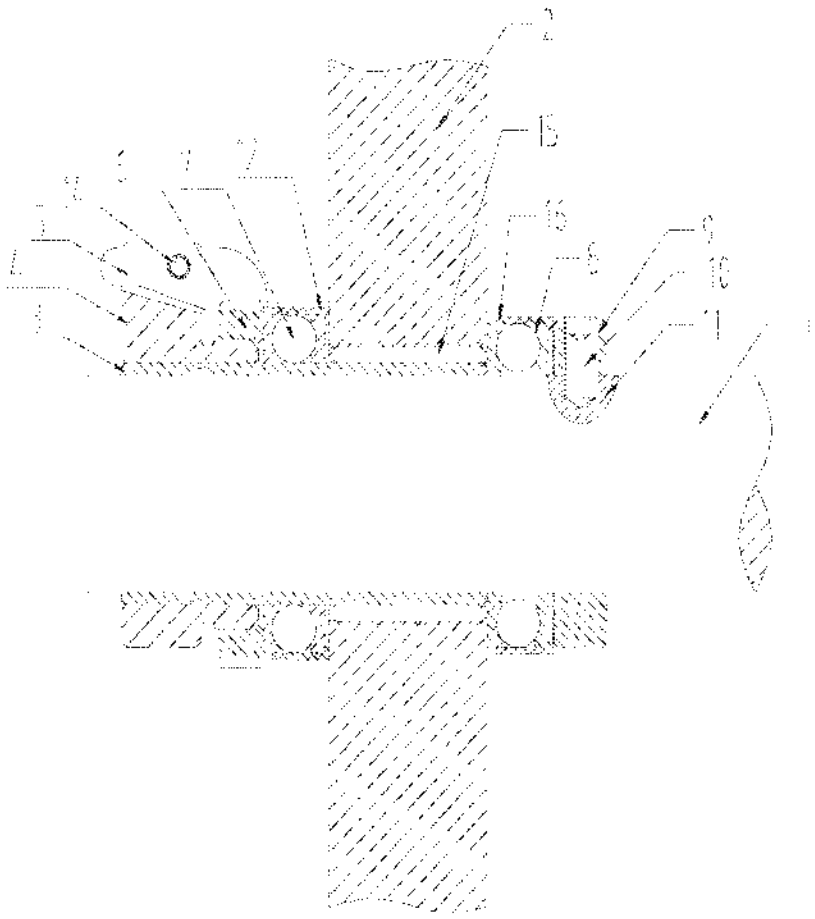


图 1

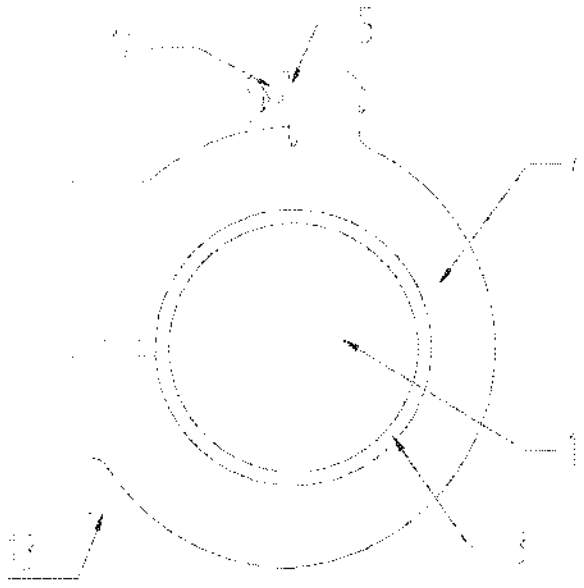


图 2

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[Continued on nextpage]

(54) **Title:** PERFORMANCE MONITORING AND CORRECTION IN A TOUCH-SENSITIVE APPARATUS

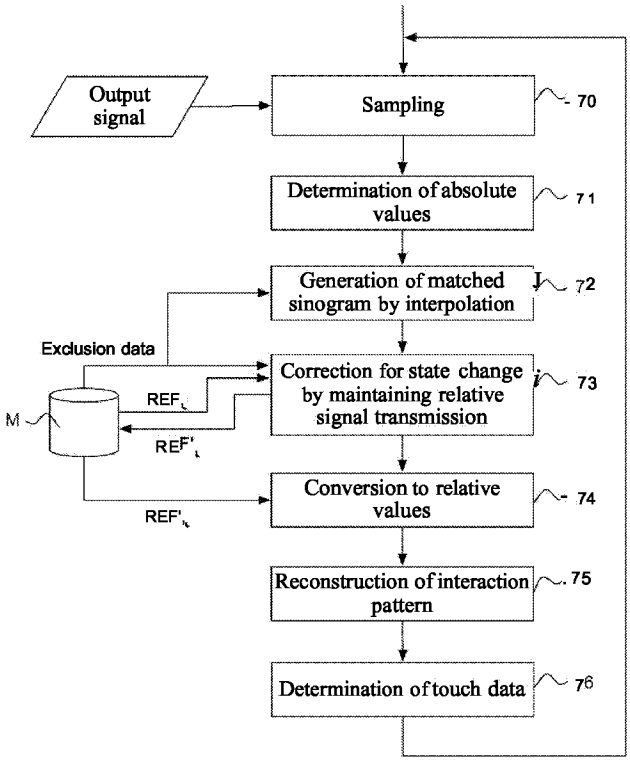


Fig. 7

(57) **Abstract:** Touch sensitivity is enabled using a touch system that comprises a panel configured to conduct signals, e.g. by TIR, along detection lines across a touch surface. A signal processor operates in a sequence of repetitions to: generate (70, 71) data samples that represent detected signal energy on the actual detection lines; generate (72, 74) based on the data samples, an interpolated sinogram comprising interpolation samples that represent fictitious detection lines which have a desired location on the touch surface; and reconstruct (75) a signal interaction pattern for the touch surface based on the interpolated sinogram. The signal processor implements an error correction (73) to counteract the influence of a change in validity status for a data sample among the data samples, by identifying interpolation samples affected by the change in validity status, and by setting each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

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TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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PERFORMANCE MONITORING AND CORRECTION IN A TOUCH-SENSITIVE APPARATUS

Cross-reference to Related Applications

The present application is related to the following applications, which are all incorporated herein in their entirety by this reference: WO2010/064983, WO2011/049512, WO2011/078769, WO2011/139213, WO2012/121652, WO2012/158105, PCT/SE2012/051006 filed on September 24, 2012, and PCT/SE2012/51073 filed on October 8, 2012.

The present application claims the benefit of Swedish patent application No. 1250064-1, filed 31 January 2012, and US provisional application No. 61/592641, filed 31 January 2012, both of which are incorporated herein by reference.

Technical Field

The present invention relates to touch sensing systems and data processing techniques in relation to such systems, and in particular to techniques for performance monitoring and correction.

Background Art

Touch sensing systems ("touch systems") are in widespread use in a variety of applications. Typically, the touch sensing systems are actuated by a touch object such as a finger or stylus, either in direct contact, or through proximity (i.e. without contact), with a touch surface. Touch sensing systems are for example used as touch pads of laptop computers, in control panels, and as overlays to displays on e.g. hand held devices, such as mobile telephones. A touch panel that is overlaid on or integrated in a display is also denoted a "touch screen". Many other applications are known in the art.

WO2010/064983 discloses a multi-touch system, which is based on frustrated total internal reflection (FTIR). Light sheets are coupled into a panel to propagate inside the panel by total internal reflection (TIR). When an object comes into contact with a touch surface of the panel, the propagating light will be attenuated at the point of touch. Arrays of light sensors are located around the perimeter of the touch surface to detect the received light for each light sheet and generate a signal value for each light path across the touch surface. The signal values of the light sensors are normalized by respective reference values and input into an image reconstruction algorithm that generates a two-dimensional distribution of attenuation values across the touch surface. This enables repeated determination of current position/size/shape of touches while one or more users interact with the touch surface.

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In FTIR systems, the touches need to be detected against a background of interferences, e.g. originating from fingerprints and other types of smear on the touch surface. The influence of interferences may vary not only over time but also across the touch surface, making it difficult to properly detect the touches on the touch surface at all times. WO201 1/028169 proposes manipulating the reference values to compensate for the influence of contaminations in the attenuation pattern, and WO201 1/049512 proposes tracking a two-dimensional background pattern of the contamination contribution and using the background pattern to generate an attenuation pattern that is compensated for contaminations.

FTIR systems often need to be designed with a high sensitivity, since a touching object may result in only a small attenuation of the propagating light, e.g. less than 1%. Certain systems may therefore be designed to detect attenuations on the order of 0.1% - 0.01 %. To ensure proper touch detection,WO20 11/078769 proposes monitoring the temporal variability of the signal values to identify potential causes for reduced performance of the touch system, e.g. due to component failure, and implementing corrective measures to account for unreliable signal values. WO201 1/139213 further proposes the corrective measure of removing unreliable signal values from an interpolation step, which is tailored to prepare the adequate input data for a tomographic reconstruction algorithm that generates the attenuation pattern.

In view of the required sensitivity of the FTIR system, there is a continued need to improve the quality of the attenuation pattern and suppress any errors that may affect the attenuation pattern.

Summary

It is an objective of the invention to at least partly overcome one or more limitations of the prior art.

Another objective is to provide an improved technique of handling signal values that are deemed unreliable in touch systems that operate by propagating signals across a touch surface.

One or more of these objectives, as well as further objects that may appear from the description below, are at least partly achieved by means of a method of enabling touch determination, a computer program product, devices for enabling touch determination, and a touch-sensitive apparatus according to the independent claims, embodiments thereof being defined by the dependent claims.

A first aspect of the invention is a method of enabling touch determination based on an output signal from a touch-sensitive apparatus. The touch-sensitive apparatus comprises a panel configured to conduct signals from a plurality of peripheral

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incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines that extend across a surface portion of the panel between pairs of incoupling and outcoupling points, at least one signal generator coupled to the incoupling points to generate the signals, and at least one signal detector coupled to the outcoupling points to generate the output signal. The method receives the output signal and operates in a sequence of repetitions to: process the output signal to generate a set of data samples, each data sample being generated to represent detected energy for one of the actual detection lines; generating an interpolated sinogram based on the data samples, the interpolated sinogram comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion; and operate an image reconstruction function on the interpolated sinogram to generate a signal interaction pattern within at least part of the surface portion. The method further comprises an error correction step which is responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples in a current repetition. The error correction step comprises: identifying interpolation samples affected by the change in validity status; and setting each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

The first aspect achieves a suppression of errors that otherwise might emerge in the signal interaction pattern as a result of the change in validity status of the data sample. The affected data sample may be a previously valid data sample which is deemed invalid in the sense that it cannot be trusted, or a previously invalid data sample which is deemed valid. As will be further explained below in relation to detailed examples, simply removing or adding a data sample based on the validity change is likely to cause local errors in the interpolated sinogram, which in turn may cause artifacts in the signal interaction pattern that are mistaken for touches. The first aspect is based on the insight that such local errors may be suppressed by stipulating that the relative signal transmission of each identified interpolation point (i.e. each affected fictitious detection line) should be unaffected by the validity change. The "relative signal transmission" or "relative transmission" is a conventional term that denotes the ratio of detected energy to a baseline or reference level. The relative signal transmission is representative of the signal interaction for the fictitious detection line, and may alternatively be expressed as an attenuation or a relative loss of energy. The first aspect thus operates to maintain the relative signal transmission (signal interaction, attenuation or loss of energy) between a current and a former repetition. It is to be noted, however, that the relative signal transmission need not be explicitly calculated, or even be known, for the error correction step to be able to manipulate the identified interpolation sample.

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According to the first aspect, the data samples represent detected energy, which infers that each data sample is a value of an energy parameter which is computable from the output signal only, such as a measure of the energy (or equivalently, power or intensity) of the light that is received by the at least one signal detector via the respective outcoupling point, or a logarithm of this measure. Thus, in one embodiment, each data sample in the set of data samples is generated by extracting the detected energy for the respective actual detection line from the output signal and, optionally, by computing the logarithm of the detected energy.

In one embodiment, the interpolated sinogram is generated to represent relative values between energy values and reference energy values for the fictitious detection lines. The relative values may, but need not, be equal to the relative signal transmission. In a specific embodiment, each relative value is given as an attenuation value, so as to enable the signal interaction pattern to represent a distribution of attenuation values.

The relative values may be obtained by interpolation of either relative or absolute values.

In one embodiment, the set of data samples are first converted to a set of relative values for the actual detection lines by means of a corresponding set of reference energy values for the actual detection lines, whereupon an interpolation function is operated on the relative values to generate the interpolation samples for the fictitious detection lines. In such an embodiment, the interpolation is thus performed on the relative values for the actual detection lines. As exemplified in the detailed description, the respective relative values that are input to the interpolation function may be computed as a ratio between a respective data sample in the set of data samples and a corresponding reference energy value, or as a logarithm of such a ratio, or, if the data samples are representative of logarithmic energy, as a difference between the data samples and logarithmic reference energy values.

In an alternative embodiment, the step of generating the interpolated sinogram comprises: operating an interpolation function on the data samples to generate the energy values for the fictitious detection lines, and converting the energy values to the relative values by means of the reference energy values for the fictitious detection lines. The interpolation is thus performed on absolute values. Such an approach has been found to be particularly sensitive to validity changes among the data samples. Again, the relative values may be computed as a ratio between a respective data sample in the set of data samples and a corresponding reference energy value, or as a logarithm of such a ratio, or, if the data samples as representative of logarithmic energy, as a difference between the data samples and logarithmic reference energy values.

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The time scale of the reference energy values may be set to achieve a desired property of the resulting signal interaction pattern. If the signal interaction pattern should represent interaction changes on a long time scale, the reference energy values may be given with respect to a calibration step performed at e.g. manufacture or start-up. If the signal interaction pattern should represent interaction changes on a shorter time scale, the reference energy values may be obtained as a function of energy values for the fictitious detection lines that were generated, by interpolation, in a preceding repetition with a given time difference to the current repetition.

Accordingly, in one embodiment that enables touch detection on a long time scale, the reference energy values for the fictitious detection lines are generated by operating the interpolation function on data samples obtained from the output signal in a calibration step without objects in contact with the surface portion, and the error correction step comprises manipulating the reference energy value of each identified interpolation sample so as to maintain the relative signal transmission of the corresponding fictitious detection line from the former repetition, which may (but need not) be the immediately preceding repetition. This is equivalent to assuming that the fictitious detection line (that corresponds to the identified interpolation sample) exhibits no change in interaction between the former repetition and the current repetition.

In an alternative embodiment that enables touch detection on a shorter time scale, the reference energy values are intermittently updated to represent the energy values in a preceding repetition, such that the relative values represent a change in the relative signal transmission between the current and the preceding repetition for each fictitious detection line. The reference energy values may e.g. be updated in each repetition. It is to be noted that the number of repetitions between the current repetition and the preceding repetition may be selected differently depending of the desired properties of the resulting signal interaction pattern.

To enable detection on the shorter time scale, the error correction step may operate in different ways to maintain the relative signal transmission. In one embodiment, the error correction step comprises setting the relative value of each identified interpolation sample to zero. This maintains the relative signal transmission, since the relative value represents a change in the relative signal transmission between the current and the preceding repetition. In an alternative embodiment, the error correction step comprises setting, for each identified interpolation sample, the reference energy value of the former repetition equal to the energy value of the current repetition. Both of these embodiments are capable of maintaining the relative signal transmission between the former repetition and the current repetition without requiring the relative signal transmission to be computed or tracked over time.

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In a first implementation, the former repetition is immediately preceding the current repetition. In a second implementation, the former repetition is separated from the current repetition by a number of intermediate repetitions. In the second implementation, the error correction step may further comprise setting the reference energy value for the number of intermediate repetitions equal to the energy value of the current repetition. This will enable detection of touches already in the signal interaction pattern generated in the next repetition.

Typically, but not necessarily, the time separation (number of repetitions) that is used by the error correction to maintain the relative signal transmission is equal to the time separation (number of repetitions) between the energy values and the reference energy values that are used for calculating the relative values.

In one embodiment, which is designed for a touch-sensitive apparatus that comprises a plurality of signal generators and a plurality of signal detectors and is operated to turn the signal generators ON and OFF during each repetition, such that the output signal is generated to comprise ON energy values for the actual detection lines and at least one OFF energy value for each signal detector, the method of the first aspect further comprises a validation process designating a detection line as valid or invalid and for generating the exclusion data, the validation process comprising: obtaining the OFF energy values from the output signal, generating a noise estimate for each actual detection line as a function of the OFF energy values, and validating the actual detection lines based on the noise estimate.

In one embodiment, the noise estimate is generated to represent the variability in a time sequence of OFF energy values for the signal detector associated with the actual detection line.

In one embodiment, an actual detection line is designated as invalid if the noise estimate exceeds a noise limit, and/or if the ON energy value of the actual detection line exceeds a saturation limit.

In one embodiment, the step of processing the output signal to generate the set of data samples comprises: obtaining the ON energy values from the output signal, obtaining an estimated ambient value for each actual detection line based on the OFF energy value for the signal detector associated with the actual detection line, and generating an ambient-compensated energy value by subtracting the estimated ambient value from the ON energy value for each actual detection line. In one embodiment, an actual detection line is designated as invalid if the ratio between the ambient-compensated energy value and the noise estimate is less than a minimum ratio limit, and/or if the ambient-compensated energy value is less than a minimum energy limit.

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In one embodiment, the validation process is configured to promote a change of designation from valid to invalid over a change of designation from invalid to valid. This provides a stabilization of the processing by reducing the need to activate the error correction.

A second aspect of the invention is a computer program product comprising computer code which, when executed on a data-processing system, is adapted to carry out the method of the first aspect.

A third aspect of the invention is a device for enabling touch determination based on an output signal from a touch-sensitive apparatus, the touch-sensitive apparatus comprising a panel configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines that extend across a surface portion of the panel between pairs of incoupling and outcoupling points, at least one signal generator coupled to the incoupling points to generate the signals, and at least one signal detector coupled to the outcoupling points to generate the output signal, said device comprising: an input for receiving the output signal; and a signal processor configured to, repeatedly in a sequence of repetitions: process the output signal to generate a set of data samples, each data sample being generated to represent detected energy for one of the actual detection lines; generate an interpolated sinogram based on the data samples, the interpolated sinogram comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion; and operate an image reconstruction function on the interpolated sinogram to generate a signal interaction pattern within at least part of the surface portion; wherein the signal processor is further configured to perform an error correction responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples in a current repetition, wherein said error correction comprises: identifying interpolation samples affected by the change in validity status; and setting each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

A fourth aspect of the invention is a device for enabling touch determination based on an output signal from a touch-sensitive apparatus, the touch-sensitive apparatus comprising a panel configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines that extend across a surface portion of the panel between pairs of incoupling and outcoupling points, at least one signal generator coupled to the incoupling points to generate the signals, and at least one signal detector coupled to the outcoupling points to generate the output signal, wherein the device is operable in a

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sequence of repetitions and comprises: means for processing, in each repetition, the output signal to generate a set of data samples, each data sample being generated to represent detected energy for one of the actual detection lines; means for generating, in each repetition, an interpolated sinogram based on the set of data samples, the interpolated sinogram comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion; and means for operating, in each repetition, an image reconstruction function on the interpolated sinogram to generate a signal interaction pattern within at least part of the surface portion; wherein the device further comprises means for error correction, which is responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples in a current repetition, said means for error correction being configured to identify interpolation samples affected by the change in validity status; and set each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

A fifth aspect of the invention is a touch-sensitive apparatus, comprising: a panel configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines that extend across a surface portion of the panel between pairs of incoupling and outcoupling points; means for generating the signals at the incoupling points; means for generating an output signal based on detected signals at the outcoupling points; and the device for enabling touch determination according to the third or fourth aspects.

Any one of the above-identified embodiments of the first aspect may be adapted and implemented as an embodiment of the second to fifth aspects to achieve the corresponding technical advantages.

Still other objectives, features, aspects and advantages of the present invention will appear from the following detailed description, from the attached claims as well as from the drawings.

Brief Description of Drawings

Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.

Figs 1A-1B are section and top plan views of a touch-sensing FTIR system.

Fig. 2 is a 3D plot of a total attenuation pattern.

Figs 3A-3B are plots of a difference pattern representing two moving objects.

Fig. 4 is a top plan view of an FTIR system with an interleaved arrangement of emitters and detectors.

Fig. 5 is a sinogram of sampling points defined by the interleaved arrangement in Fig. 4.

Fig. 6A is a graph of a 2D interpolation function for an interleaved arrangement, and Fig. 6B illustrates the generation of interpolation points using the interpolation function of Fig. 6A.

Fig. 7 is a flow chart of a touch determination method with an interpolation that handles occurrence of corrupt sampling points.

Figs 8A-8C are time-sequences of projection values, reference values and resulting relative values to exemplify the inventive handling of corrupt sampling points when the reference values are long-term values, given by the immediately preceding frame, and given two frames back in time, respectively.

Figs 9A-9B illustrate how a 2D interpolation function may be updated when sampling points are removed from reconstruction.

Fig. 10 is a flow chart of a method for validating sampling points.

Figs 11A-11B are block diagrams of devices that implement the methods of Fig. 7 and 10.

Figs 12A-12D illustrate different sequences of processing steps that involve an interpolation of relative values and that result in a signal interaction pattern being generated.

Figs 13A-13C illustrate different sequences of processing steps that involve an interpolation of absolute values and that result in a signal interaction pattern being generated.

Detailed Description of Example Embodiments

Below follows a description of example embodiments of a technique for enabling extraction of touch data for objects in contact with a touch surface of a touch-sensitive apparatus. Throughout the following description, the same reference numerals are used to identify corresponding elements.

1. Touch-sensitive apparatus

Embodiments of the inventions relate to signal processing in relation to a touch-sensitive apparatus which is based on the concept of transmitting energy of some form across a touch surface, such that an object that is brought into close vicinity of, or in contact with, the touch surface causes a local decrease in the transmitted energy. The apparatus may be configured to permit transmission of energy in one of many different forms. The emitted signals may thus be any radiation or wave energy that can travel in and across the touch surface including, without limitation, light waves in the visible or

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infrared or ultraviolet spectral regions, electrical energy, electromagnetic or magnetic energy, or sonic and ultrasonic energy or vibration energy. Example embodiments of the invention will be described in relation to a touch-sensitive apparatus 100, which is shown in Figs. 1A-1B and is based on the concept of FTIR (Frustrated Total Internal Reflection), also denoted "FTIR system". The apparatus 100 operates by transmitting light inside a panel 1, from light emitters 2 to light sensors or detectors 3, so as to illuminate a touch surface 4 from within the panel 1. The panel 1 is made of solid material in one or more layers and may have any shape. The panel 1 defines an internal radiation propagation channel, in which light propagates by internal reflections. In the example of Fig. 1, the propagation channel is defined between the boundary surfaces 5, 6 of the panel 1, where the top surface 5 allows the propagating light to interact with touching objects 7 and thereby defines the touch surface 4. This is achieved by injecting the light into the panel 1 such that the light is reflected by total internal reflection (TIR) in the touch surface 4 as it propagates through the panel 1. The light may be reflected by TIR in the bottom surface 6 or against a reflective coating thereon. It is also conceivable that the propagation channel is spaced from the bottom surface 6, e.g. if the panel comprises multiple layers of different materials. The apparatus 100 may be designed to be overlaid on or integrated into a display device or monitor.

The apparatus 100 allows an object 7 that is brought in contact with the touch surface 4 to interact with the propagating light at the point of touch. In this interaction, part of the light may be scattered by the object 7, part of the light may be absorbed by the object 7, and part of the light may continue to propagate in its original direction across the panel 1. Thus, the touching object 7 causes a local frustration of the total internal reflection, which leads to a decrease in the energy (or, equivalently, power or intensity) of the transmitted light, as indicated by the thinned lines downstream of the touching objects 7 in Fig. 1A.

The emitters 2 are distributed along the perimeter of the touch surface 4 to generate a corresponding number of light sheets inside the panel 1. In the example of Fig. IB, each emitter 2 generates a beam of light that expands in the plane of the panel 1 while propagating in the panel 1. Each beam propagates from one or more entry or incoupling points (ports) on the panel 1. The detectors 3 are distributed along the perimeter of the touch surface 4 to receive the light from the emitters 2 at a number of spaced-apart outcoupling points (ports) on the panel 1. It should be understood that the incoupling and outcoupling points merely refer to the position where the beam enters and leaves, respectively, the panel 1. Thus, although not shown in Fig. IB, one emitter/detector may be optically coupled to a number of incoupling/outcoupling points.

The detectors 3 collectively provide an output signal, which is received and samp-

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led by a signal processor 10. The output signal contains a number of sub-signals, also denoted "projection signals", each representing the energy of light emitted by a certain light emitter 2 and received by a certain detector 3. The projection values for all detection lines at time point t are collectively represented by I_t. Depending on implementation, the signal processor 10 may need to process the output signal for separation of the individual projection signals. Conceptually, the touch apparatus 100 is considered to define a grid of detection lines D on the touch surface 4, where each detection line D corresponds to a light propagation path from an emitter 2 to a detector 3, as projected onto the touch surface 4. Thus, the projection signals represent the received energy or power of light on the individual detection lines D. It is realized that the touching object 7 results in a decrease (attenuation) of the received energy on one or more detection lines D.

As will be explained below, the signal processor 10 may be configured to process the projection signals so as to determine a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 1, where each attenuation value represents a local attenuation of light. The attenuation pattern may be represented in many different ways, e.g. as attenuation values arranged in a regular x-y-grid, such as in an ordinary digital image, although other types of grids are conceivable, e.g. hexagonal patterns or triangular meshes. The attenuation pattern may be further processed by the signal processor 10 or by a separate device (not shown) for touch determination, which may involve extraction of touch data, such as a position (e.g. x,y coordinates), a shape or an area of each touching object. In the following, a "frame" denotes a repeated event starting with data collection and ending with determination of touch data.

In the illustrated example, the apparatus 100 also includes a controller 12 which is connected to selectively control the activation of the emitters 2 and, possibly, the readout of data from the detectors 3. The signal processor 10 and the controller 12 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 10 and the controller 12 may be at least partially implemented by software executed by a processing unit 14.

It is to be understood that Fig. 1 merely illustrates one example of an FTIR system. For example, the detection lines may instead be generated by sweeping or scanning one or more beams of light inside the panel 1, and the light may instead be coupled into and out of the panel 1 via the top and bottom surfaces 5, 6, e.g. by the use of dedicated coupling elements attached to the panel 1. Examples of alternative FTIR systems are e.g. disclosed in US6972753, US7432893, US2006/0 114237, US2007/0075648, WO2009/048365, WO20 10/0068 82, WO2010/006883,

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WO2010/006884, WO2010/006885, WO2010/006886, WO2010/064983, and WO2010/134865, which are all incorporated herein by this reference. The inventive concept may be applied to such alternative FTIR systems as well.

2. Signal processing

It is known in the art to operate an image reconstruction function or algorithm on current projection values in the output signal, so as to determine a current attenuation pattern on the touch surface 4. By repeatedly determining, in the above-mentioned "frames", the attenuation pattern and identifying presence of touches in the attenuation pattern, it is possible to track objects that interact with the touch surface.

Embodiments of the invention may use any available algorithm for image reconstruction based on projection signal values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the reconstruction function may generate the attenuation pattern by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of reconstruction functions designed for use in touch determination are found in WO2010/006883, WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and PCT/SE2012/051142 filed on October 24, 2012, all of which are incorporated herein by reference. Conventional image reconstruction techniques are found in the mathematical literature, e.g. "The Mathematics of Computerized Tomography" by Natterer, and "Principles of Computerized Tomographic Imaging" by Kak and Slaney.

The reconstruction function is designed based on the assumption that the input values $\boldsymbol{al}$ at time point t depend on the attenuation pattern, $\boldsymbol{A_t}$, according to a projection function $\mathcal{P}$, which reflects the properties of the physical touch system: $\boldsymbol{al} = \mathcal{P}(\boldsymbol{At})$. The reconstruction algorithm is thus designed to reconstruct $\boldsymbol{A_t}$ from $\boldsymbol{al}$ by use of a reconstruction function: $\boldsymbol{A_t} = \mathcal{P}'(\alpha \mathrm{I})$.

It is to be understood that the format of the input values $\boldsymbol{al}$ may be specific to the reconstruction function $\mathcal{P}'$. To enable reconstruction of an attenuation pattern, the input values $\boldsymbol{al}$ may be represented as attenuation values for individual detection lines. Such attenuation values may e.g. be based on transmission values obtained by dividing the projection value $\boldsymbol{l_k}$ of the k:th detection line by a respective reference value: $T_k = I_k/REF_k$. By proper choice of reference values, the transmission values may be generated to represent the fraction (e.g. in the range [0, 1]) of the available light energy that has been measured on each of the detection lines, i.e. the relative signal transmission of the detection line. The input value of each detection line may e.g. be given by: $\overline{\alpha_k}$ =

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$-\log(T_k)$ or an approximation thereof, e.g. $\overline{\alpha_k} = 1 - T_k$ (valid for T_k close to 1). This choice of input value format may be understood by considering that the transmission along a detection line D_k may be represented as: $T_k = I_k/REF_k = e^{-\int a(x,y)dl}$, where a(x, y) is the attenuation pattern along the detection line D_k. Thereby, $\overline{\alpha_k}$ represents an aggregation of the attenuation along the detection line: $\overline{\alpha_k} = -\log(T_k) = \int a(x,y)dl$.

The reference values for all detection lines at time point t are collectively represented by $\boldsymbol{REF_t}$. As will be explained, the choice of reference values $\boldsymbol{REF_t}$ will decide the time scale of the reconstructed attenuation pattern $\boldsymbol{A_t}$.

In a first embodiment, further discussed in WO20 10/064983 and WO201 1/049512, as well as WO2012/121652, the reference values are given by the output signal at a certain calibration time point when no touching object (finger, stylus, etc) is present on the touch surface, such as when the assembly of the apparatus 100 is finalized, at start-up, or when a user initiates a reset operation of the apparatus 100. These reference values, also denoted calibration values and represented by $\boldsymbol{I_0}$, may be stored in a memory unit of the device 10. By using $\boldsymbol{I_0}$, the reconstructed attenuation pattern $\boldsymbol{A_t}$ will represent the total accumulated attenuation on the touch surface since the calibration time point. Such an attenuation pattern $\boldsymbol{A_t}$ is illustrated in Fig. 2 as a 3D plot in the coordinate system X,Y of the touch surface (cf. Fig. IB).

In a second embodiment, the reference values are updated repeatedly during operation of the apparatus, e.g. at time intervals *At,* by setting the reference values equal to the current projection values and using the updated reference values in the next time interval. For reasons to become apparent, the resulting input values are denoted change values and are represented by $\overline{\boldsymbol{d\alpha_t}}$. The change values are thus given by: $\overline{\boldsymbol{d\alpha_t}} = -\log(I_t/I_{t-\Delta t}) = \log(I_{t-\Delta t}) - \log(I_t)$. This expression may be re-arranged and converted into the type of input values obtained in the first embodiment:

$$\overline{\boldsymbol{d\alpha_t}} = -\log\left(\frac{I_t}{I_{t-\Delta t}}\right) = -\log\left(\frac{I_t}{I_0}/\frac{I_{t-\Delta t}}{I_0}\right) = \log\left(\frac{I_{t-\Delta t}}{I_0}\right) - \log\left(\frac{I_t}{I_0}\right) = \overline{\boldsymbol{\alpha_t}} - \overline{\boldsymbol{\alpha_{t-\Delta t}}}.$$

As seen, the change values $\overline{\boldsymbol{d\alpha_t}}$ represent the change in relative signal transmission for each detection line during the time interval *At.* It is also realized that the change values $\overline{\boldsymbol{d\alpha_t}}$ result in an attenuation pattern, denoted difference pattern $\boldsymbol{dA_t}$, which corresponds to the difference in attenuation patterns between time points t and t —*At,* provided that the reconstruction is at least approximately linear:

$$\boldsymbol{dA_t = \mathcal{P}'(\overline{d\alpha_t}) = \mathcal{P}'(\overline{\alpha_t}) - \mathcal{P}'(\overline{a_{t-\Delta t}}) = A_t - A_{t-\Delta t}}.$$

The time interval *At* may be set to different values depending on implementation.

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In a first implementation of the second embodiment, disclosed in further detail in PCT/SE2012/51073, filed on October 8, 2012, a first and a second attenuation pattern are reconstructed on different time scales. The first attenuation pattern may be the total pattern A_t generated by the first embodiment, and the second interaction pattern may be a difference pattern dA_t generated by the second embodiment, e.g. with At in the approximate range of 5 ms - 5 s. The time interval may thus range from 1 frame to several frames. The use of a difference pattern dA_t may improve detection of fast moving objects compared to objects that move slowly or not at all on the touch surface, while also reducing the impact of contaminations on the touch surface. The difference pattern dA_t mainly indicates the temporal change in attenuation caused by moving objects in contact with the touch surface, as well as objects that are removed from or added to the touch surface during At. A moving object generally appears as a "dipole peak" in the difference pattern, i.e. a combination of a positive peak and a negative peak. Fig. 3A is a 3D plot of a difference pattern dA_t containing two dipole peaks γ_1^+, γ_1^- and γ_2^+, γ_2^-. Fig. 3B is a plan view of the difference pattern dA_t in Fig. 3A. When an object is moved during At, the corresponding touch occupies new pixels, resulting in a positive peak, and leaves old pixels, resulting in a negative peak. If an object is removed from the touch surface, the removed touch will be represented by a single negative peak in the difference pattern, and if an object is brought into contact with the touch surface, the new touch will be represented by a single positive peak. In Fig. 3B, it is realized that the objects have moved away from each other during At. In a variation of the first implementation, the change values $\overline{d\alpha_t}$ that are obtained based on the output signal are deliberately distorted, before being input to the reconstruction function, so as to enhance weakly interacting touches over strongly interacting touches and interferences (reconstruction artifacts) in the resulting difference pattern dA_t. In a further variation of the first implementation, the reference values are updated to factor in projection values from more than one time point. For example, the change values $\overline{d\alpha_t}$ may be generated as a function of a current projection value I_t and a temporally low-pass filtered projection value $\overline{I_{t-m}}$, e.g. $\overline{da_t} = log(\overline{I_{t-m}}) - log(I_t)$, where $\overline{I_{t-m}}$ or $log(\overline{I_{t-m}})$ may be computed using any temporal low-pass filter. One such example is an exponential forget filter, such as: $\overline{I_{t-m}} = \overline{I_{t-m-1}} - \varepsilon \cdot (I_{t-m} - \overline{I_{t-m-i}})$, or $log(\overline{I_{t-m}}) = log(\overline{I_{t-m-1}}) - \varepsilon \cdot (log(I_{t-m}) - log(\overline{I_{t-m-1}}))$, where $0 < \varepsilon \leq 1$. It is also possible to compute $\overline{I_{t-m}}$ or $log(\overline{I_{t-m}})$ using a moving average, etc. In all of these examples, m denotes frames and may have any suitable number, including 0.

In a second implementation of the second embodiment, disclosed in further detail in PCT/SE2012/051006, filed on September 24, 2012, the total attenuation pattern A_t is generated by accumulating the difference pattern across the time intervals At: $A_t =$

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$A_{t-\Delta i} + dA_t$. In a variant of the second implementation, a total pattern, which is compensated for the influence of contaminations on the touch surface and denoted an offset pattern o_t, is generated by accumulating the difference pattern across the time intervals *At:* $o_t = o'_{t-\Delta t} + dA_t$. Before being used for accumulation in the next time interval, each pixel in the offset pattern o_t is compensated for contamination, e.g. according to an exponential forget algorithm:

$$o'_t = (1-\varepsilon)\cdot o_t \begin{cases} \varepsilon = 0, \text{if touch in pixel of } o_t \\ \varepsilon = 0.1, \text{if no touch in pixel of } o_t \end{cases}$$

which will cause the offset pattern o_t to gradually approach zero attenuation in regions without touch interaction, while other pixels/regions will have a value representative of the local touch interaction. In the second implementation, it is currently preferred that the time interval At is a single frame, i.e. that the reference values are set equal to the current projection vales and are used in the next frame.

As shown in aforesaid WO201 1/139213, the image reconstruction processing may require a transformation of the sampling points by means of interpolation to enable use of existing image reconstruction techniques, such as tomographic processing. Each sampling point corresponds to a detection line of the apparatus and may be defined by two dimensions or parameter values that represent the unique location of the detection line on the touch surface. In the following example, the dimensions are given by an angle ϕ in relation to a reference line on the touch surface and a distance s from the reference line. To further explain this concept, Fig. 4 is a top plan view of an apparatus with an "interleaved arrangement" in which the emitters 2 and detectors 3 are alternated along the perimeter of the touch surface 4 . Fig. 5 illustrates the sampling points (corresponding to detection lines, and thus to measured projection values) in the ϕ-*s*-plane for the interleaved arrangement. The data in Fig. 5 is conventionally denoted a "sinogram" and is represented by g herein. To facilitate and/or improve image reconstruction, interpolation is applied to generate a "matched sinogram", represented by g' herein, in which new sampling points are generated with a placement in the ϕ-*s*-plane that matches a standard geometry for tomographic processing. The new sampling points generated by interpolation are denoted "matched sampling points" or "interpolation points" herein. The interpolation in the sinogram corresponds to calculating projection values for fictitious detection lines with desired locations on the touch surface. Fig. 6A is an example of an interpolation function in the φ-s-plane for use in generating matched sampling points (interpolation points) for the data in Fig. 5. The interpolation function is based on Delaunay triangulation and comprises a mesh of

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non-overlapping triangles adapted to the sampling points. Fig. 6B is a close-up of the rectangular region in Fig. 6A to illustrate the sampling points (stars), the Delaunay triangulation (dotted lines extending between the sampling points), and the interpolation points (circles). Thus, the values of the interpolation points are calculated by operating the Delaunay triangulation on the projection values in the sampling points. The interpolation points typically replace the sampling points in the subsequent calculations, although it is possible that a subset of the sampling points are retained to form part of the matched sampling points. As explained in aforesaid WO201 1/139213, there are a multitude of alternative interpolation techniques that may be used, including Fourier transformation and weighted average interpolation.

A further alternative is disclosed in US61/552024, filed on October 27, 201 1, in which the matched sinogram is generated, e.g. by any of the above-mentioned interpolation techniques, such that the matched sampling points transform to Fourier coefficients arranged as data points on a pseudo-polar grid in a Fourier domain.

3. Handling of faulty detection lines

As suggested in aforesaid WO201 1/139213, the apparatus may be provided with an ability of identifying faulty detection lines (also denoted "invalid" or "corrupt" detection lines), i.e. detection lines that are deemed to cause problems in the reconstruction process and/or introduce major errors in reconstructed attenuation pattern. For example, if an emitter or a detector starts to perform badly, or not at all, during operation of the apparatus, this may have a significant impact on the attenuation pattern. The apparatus may implement an error handling that validates the detection lines, e.g. every n:th frame ($n \geq 1$), and dynamically assigns a valid or invalid state to each detection line (sampling point) depending on the outcome of the validation. Different examples of validation criteria are given below in Chapter 4.

When a sampling point is set to an invalid state, it may be removed from the interpolation, at least until the sampling point is again set to the valid state. Such removal is exemplified in Fig. 6B, in which a square designates a sampling point (star) that is deemed corrupt. In the illustrated example, using the Delaunay triangulation shown by dotted lines, a removal of the corrupt sampling point will affect the values of the interpolation points marked by filled circles. It should be noted there is no direct link between the states of the sampling points and the states of the affected interpolation points. If a sampling point is set to invalid state, this does not mean that every affected interpolation point also should be set to the invalid state, but instead a value of the affected interpolation point(s) is computed by interpolation of other sampling points in the neighborhood. However, as will be further exemplified below, the removal may

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cause a distortion of the values of the affected interpolation points, since the interpolation is now based on a different combination of sampling points. Thus, a state change of a detection line (sampling point) is not unlikely to result in a disruption of the matched sinogram, which in turn may lead to artifacts in the reconstructed pattern that are mistaken for touches.

3.1. Interpolation of relative values

The interpolation operates on the values of the sampling points. These values may be given as *relative values* (normalized values) for the respective detection line. As indicated above in Chapter 2, the relative values may be calculated by normalizing the projection values I_t by reference values, REF_t which may be given as calibration values I_0, recently measured energy values $I_{t-\Delta t}$, or an average $\overline{I_{t\_m}}$ of recently measured energy values for the respective detection line. Thus, the sampling points in relative format may, e.g., be given as input values al or $\overline{da_t}$, or as transmission values e.g. given by I_t/REF_t. Figs 12A-12C illustrate different processing pipelines for generating an attenuation pattern based on the projection values I_t, by operating the interpolation on relative values.

In Figs 12A-12B, the values of the sampling points are formatted as input values $\overline{\alpha_t}$ or change values $\overline{da_t}$, whereby the resulting values of the interpolation points in the matched sinogram may be directly processed for reconstruction of an attenuation pattern, $A_t = \mathcal{P}'(\overline{al})$, and a difference pattern, $dA_t = \mathcal{P}'(\overline{\alpha_t})$, respectively. In Fig. 12A, the input or change values al, $\overline{da_t}$ are generated by dividing the respective projection value by the respective reference value and taking the logarithm of the result, e.g. $-\boldsymbol{logiJt/REFt)}$. In Fig. 12B, the input or change values al, $\overline{da_t}$ are generated by taking the logarithm of the projection values and subtracting the resulting values from corresponding logarithmic reference values, e.g. $\boldsymbol{log(REF_t) - log(I_t)}$.

In Fig. 12C, the values of the sampling points are formatted as $\boldsymbol{I_t/REF_t}$, by dividing the respective projection value by the respective reference value. The resulting interpolation values are converted, by operating a logarithm function on the interpolation values, into input values al or change values $\overline{da_t}$ which are then processed for reconstruction of A_t or dA_t.

It should be noted that a difference pattern dA_t may alternatively be obtained by generating the matched sinogram to represent input values al, e.g. according to any one of the techniques in Figs 12A-12C, and then subtracting the matched sinogram by a matched sinogram obtained in a preceding frame $al - \overline{a_{t-\Delta t}}$. The difference pattern is then obtained by operating the reconstruction function on the result: $dA_t = \mathcal{P}'(\overline{al - a_{t-\Delta t}})$. This alternative is schematically depicted in Fig. 12D.

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To illustrate the errors that may occur when a sampling point is removed, consider the simplified example that an interpolation point is given as the average of two sampling points (with equal weight), represented by indices A and B. Assume that the sampling points have the following calibration values $/_0{}^A, /_0{}^B$ and energy values $I_t{}^A, I_t{}^B$ at time t: $/_t{}^A = 44, /_o{}^A = 50, l_t{}^B = 91, I_0{}^B = 100$]. Such variations, both between sampling points and over time for an individual sampling point, may occur as a result of imperfections in the FTIR system. Based on these example values, the weighted average interpolation computes the value of the interpolation point AB as: $\overline{\alpha^{AB}} = 0.5 \cdot$ (—log(0.88) —log(0.91)) ≈ 0.111. If sampling point B is deemed corrupt and therefore eliminated, the value of the interpolation point AB is instead computed as: $\overline{\alpha_{AB}} = (-\log(0.88)) \approx 0.128$. The removal of sampling point B results in a change of slightly more than 10% in the value of the interpolation point AB. This seemingly small change may be sufficient to generate artefacts in the A_t or dA_t that disrupt the touch determination.

Assuming instead that the processing aims at reconstructing a difference pattern between two consecutive frames, using the values: $/_t{}^A = 50, /_{t\_1}{}^A = 50, I_t{}^B = 100, l_{t\_1}{}^B = 100$], yields $\overline{d\alpha^{AB}} = 0.5 \cdot$ (- log(l) - log(l)) = 0 with both sampling points A, B present at time t, and $\overline{da^{AB}} =$ (—log(l)) = 0 if sampling point B is eliminated at time t (and not at time t —1). In this particular situation, the elimination of the sampling point does not introduce any errors in the resulting difference pattern dA_t.

3.2 Interpolation of absolute values

For various reasons, it may be desirable to operate the interpolation function on *absolute values* instead of relative values. As used herein, "absolute values" refer to non-normalized values, as a distinction to relative values, which are normalized. If the interpolation function is (approximately) linear, it is possible to convert the absolute values of the interpolation points into (approximately) correct relative values after the interpolation. One reason for operating on absolute values might be to reduce the amount of memory and/or processing power required for the interpolation. The absolute values may, e.g., be given as energy I_t or logarithmic energy $log(I_t)$. Figs 13A-13C illustrate different processing pipelines for generating an attenuation pattern based on the projection values I_t, by operating the interpolation on absolute values.

In Figs 13A-13B, the values of the sampling points are given as projection values I_t (energy values). In Fig. 13A, the input or change values $\overline{\alpha_t}$, $\overline{d\alpha_t}$ are then generated by dividing the values of the interpolation points in the matched sinogram, generated in the interpolation, by a respective reference value and by taking the logarithm of the

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result. The input or change values $\overline{\alpha_t}$, $\overline{d\alpha_t}$ are then processed for reconstruction of A_t or dA_t. In Fig 13B, the input or change values $\overline{\alpha_t}$, $\overline{d\alpha_t}$ are generated by taking the logarithm of the values of the interpolation points in the matched sinogram, generated in the interpolation, and by subtracting the resulting values from corresponding logarithmic reference values, e.g. $log(REF_t) - log(I_t)$.

In Fig. 13C, the values of the sampling points are formatted as logarithmic energy $log(I_t)$, by taking the logarithm of the respective projection value. The input values $\overline{\alpha_t}$ or change values $\overline{d\alpha_t}$ are then generated by a simple subtraction operation that subtracts the values of the interpolation points from a respective logarithmic reference value, e.g. $log(REF_t) - log(I_t)$.

In Figs 13A-13C, the normalization is performed after the interpolation, and the reference values are therefore given for the fictitious detection lines (i.e. the interpolation points).

The alternative for generating the difference pattern dA_t as described above in relation to Fig. 12D is equally applicable when operating on absolute values.

The removal of sampling points may introduce large errors when absolute values are interpolated. This will now be illustrated by re-visiting the simplified numeric examples presented in Chapter 3.1. Operating on $[I_t^A, I_0^A, I_t^B, I_0^B]$ yields $log(I_t^{AB}) = 0.5 \cdot (log(44) + log(91)) \approx 4.148$, and $log(I_0^{AB}) = 0.5 \cdot (log(50) + log(100)) \approx 4.259$ when both sampling points A, B are present, resulting in $\overline{\alpha^{AB}} = log(I_0^{AB}) - log(I_t^{AB}) \approx 0.111$. If sampling point B is eliminated, the value of the interpolation point AB is instead computed as: $log(I_t^{AB}) = log(44) \approx 3.874$. Since $log(I_0^{AB}) = \log(50) \approx 4.259$, the input value of the interpolation point is calculated to $\overline{\alpha^{AB}} \approx 0.385$. Clearly, the removal of sampling point B results in a significantly incorrect input value $\overline{\alpha^{AB}}$ of the affected interpolation point AB.

When a difference pattern is reconstructed by operating on $[I_t^A, I_{t-1}^A, I_t^B, I_{t-1}^B]$, with both sampling points A, B present at t and t —1, the value of the interpolation point AB is $log(I_{t-1}^{AB}) = 0.5 \cdot (\log(50) + \log(100)) \approx 4.259$, and $log(I_t^{AB}) = 0.5 \cdot (\log(50) + \log(100)) \approx 4.259$, which in turn yields $\overline{d\alpha^{AB}} = log(I_{t-1}^{AB}) - log(I_t^{AB}) = 0$. Eliminating sampling point B at time t yields $log(I_t^{AB}) = \log(50) \approx 3.912$, which in turn results in $\overline{d\alpha^{AB}} = log(I_{t-1}^{AB}) - log(I_t^{AB}) \approx 0.347$. Hence, in contrast to Chapter 3.1, the differential computation produces a significantly incorrect change value $\overline{d\alpha^{AB}}$ of the interpolation point AB, since the change value $\overline{d\alpha^{AB}}$ should be zero.

Generally, interpolation of absolute values, and subsequent conversion of the interpolated absolute values into relative values for input to an image reconstruction function, as exemplified in Figs 13A-13C, is vulnerable to removal of sampling points,

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if the signal levels (absolute values) differ between the detection lines. This is typically the case in a commercially viable product, since it may be difficult/costly to produce a touch-sensitive apparatus with well-balanced detection lines. It is to be noted that even a small imbalance in signal levels may cause state changes of sampling points to result in interpolation errors that have a significant impact on the reconstructed pattern.

3.3 Detailed example of a process for handling state changes

A state change refers to an action of changing a sampling point from a valid state to an invalid state, or from an invalid state to a valid state. As seen in the foregoing, such a state change may cause an undesired disruption of the interpolated values in the matched sinogram. In various embodiments, the impact of state changes is addressed by an error correction step in the touch determination process. The error correction is responsive to data indicative of state changes for the sampling points in the current frame, this data being denoted "exclusion data" herein. Generally, the error correction operates to identify the interpolation points that are affected by the state change, and then actively modifies each affected interpolated point so as to ensure that the affected interpolation point has the same relative signal transmission as before the state change. In other words, the error correction operates to maintain the relative loss of power/energy/intensity for each fictitious detection line that is affected by the state change.

If the reconstruction function $\mathcal{P}'$ operates on input values $\overline{\alpha_t}$, which are given with respect to calibration values I_0, the error correction operates to maintain the input value from a preceding frame. It should be recalled that the input values may be regarded to represent the relative signal transmission. The error correction may be implemented in different ways depending the format of the values of the sampling points, i.e. the values that are interpolated. If the interpolation operates on absolute values, the error correction may operate to maintain the current value of the affected interpolation point and modify the calibration value of the affected interpolation point, so as to maintain the relative signal transmission. This means that the error correction treats the current interpolation values that are disrupted by the state change as correct values, and instead manipulates the calibration values that are used for generating the relative values for input to the reconstruction function. If the interpolation instead operates directly on relative values, the error correction may operate to set the current value of an affected interpolation point equal to the preceding value of the affected interpolation point.

If the reconstruction function $\mathcal{P}'$ operates on change values $\overline{d\alpha_t}$, which are given with respect to recently measured energy values $I_{t-\Delta t}$, $\overline{I_{t-m}}$, the error correction

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operates to set the change values for the affected interpolation values to zero in the frame that is affected by the state change. This may be achieved either by directly setting the change value to zero, or by setting the reference value of the affected interpolation point equal to the current value of the affected interpolation point.

In general, only a small part of all interpolation points are affected by a state change, and the remaining interpolation points contain sufficient information to allow the resulting pattern to be processed for touch determination.

It should be emphasized that the error correction is not dependent on how the state changes are identified and how the exclusion data is generated. Examples of techniques for identifying state changes are given below in Chapter 4.

The underlying principle will now be further explained with reference to the flow chart in Fig. 7, which represents an exemplifying touch determination method in a touch-sensitive apparatus, such as the above-described FTIR system. The method uses interpolation of absolute values to generate a matched sinogram.

The method involves a sequence of steps 70-76 that are repeatedly executed, typically by the signal processor 10 (Fig. 1). In the context of this description, each sequence of steps 70-76 is denoted a frame or a repetition.

Each frame starts by a data collection step 70, in which measurement values are obtained from the detectors 3 in the FTIR system, e.g. by sampling a value from each of the aforesaid projection signals. The data collection step 50 results in one projection value for each detection line. For the purpose of the following discussion, the current projection value is generally denoted I_t, although it is realized that there is one such value for each of k detection lines. It may be noted that the data may, but need not, be collected for all available detection lines in the FTIR system. The data collection step 50 may also include pre-processing of the measurement values, e.g. filtering for noise reduction, compensation for ambient light, etc.

In step 71, the projection values I_t are processed for generation of the absolute values used in the subsequent interpolation step 72, specifically logarithmic values $log(I_t)$, cf. Fig. 13C. As used herein, a "logarithm" is intended to also encompass functions approximating a true logarithmic function, in any base. In a variant, step 71 is omitted and the projection values I_t obtained in step 70 are used in the interpolation step 72, cf. Figs 13A-13B. Irrespective of implementation, the absolute values form a sinogram g.

In interpolation step 72, a matched sinogram g' is generated by interpolation of the absolute values in the sinogram g, e.g. according to any of the techniques described in Chapter 2. In the illustrated example, step 72 accesses the exclusion data, from computer memory M (as shown) or directly from a validation process, to identify state

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changes. Based on the state changes, step 72 operates to remove and add sampling points, respectively, before the interpolation. Depending on interpolation function, the state changes may also cause step 72 to modify the interpolation function. As an example, Fig. 9A shows a 2D interpolation function based on Delaunay triangulation for a complete set of sampling points. If the sampling point indicated by a square in Fig. 9A is deemed invalid and removed, the 2D interpolation function may need to be updated or recomputed based on the remaining sampling points. As shown in Fig. 9B, this results in a local change of the triangles closest to the removed sampling point.

In correction step 73, the exclusion data is processed to identify all interpolation points that are affected by the respective state change. Step 73 also obtains current reference values $\boldsymbol{REF}_t$ of the ***interpolation points*** (which thus form a "reference sinogram"), or at least the reference values of the affected interpolation points. As explained in Chapter 2, the reference values may take different forms, depending on the desired properties of the reconstructed pattern. For example, the current reference values $\boldsymbol{REF}_t$ may be given as interpolated calibration values $\boldsymbol{log(I_0)}$, values of the interpolation points computed in a preceding frame $\boldsymbol{log(I_{t-\Delta t})}$ or averages of values of interpolation points computed in a number of preceding frames $\boldsymbol{log(\overline{I_{t-m}})}$. The reference values of the affected interpolation points are then actively modified to maintain the relative signal transmission of the affected interpolation points, e.g. as discussed in the foregoing. The ensemble of reference values $\boldsymbol{REF'}_t$ after modification form a "modified reference sinogram".

Step 73 is followed by a conversion step 74 which uses the modified reference sinogram $\boldsymbol{REF'}_t$ to generate the relative values for input to the reconstruction step 75, i.e. interpolated input values $\overline{\alpha_t}$ or change values $\overline{\boldsymbol{d\alpha}_t}$, depending on implementation. Reverting to the processing pipelines in Figs. 13A-13C, the conversion step 74 corresponds to the processing steps that are preformed between the interpolation and the reconstruction, if $\boldsymbol{REF}_t$ is replaced by $\boldsymbol{REF'}_t$.

If step 74 is designed to generate change values $\overline{\boldsymbol{d\alpha}_t}$, step 72 may be modified to omit the sub-step of generating the modified reference sinogram, and step 74 may instead be designed to modify the change values $\overline{\boldsymbol{d\alpha}_t}$ that are supplied to the reconstruction process by setting $\overline{d\alpha_t} = 0$ for all affected interpolation points.

Steps 73-74 will be further explained with reference to Figs 8A-8C for different choices of reference values. Figs 8A-8C illustrate, at a sequence of time steps (frames) and for a specific fictitious detection line, current interpolation values I_t, current (interpolated) reference values (I_t, I_{t-1} and I_{t-2}, respectively), as well current input values $\overline{\alpha_t}$ and change values $\overline{\boldsymbol{d\alpha}_t}$, as applicable, which are computed from the current interpolation values and the current reference values. A state change is indicated by

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"X", and the modified reference values that are generated by the error correction as a result of the state change are indicated by circles. The uncorrected input and change values are shown within parenthesis, and each corrected input and change value is reproduced below the corresponding uncorrected input or change value. It should be noted that there is no change in signal interaction during the illustrated time period, i.e. the input values $\overline{\alpha_t}$ should not change over time and change values $\overline{d\alpha_t}$ should be zero.

Fig. 8A represents a process that operates on projection values to generate interpolated input values $\overline{\alpha_t}$ that represent the relative signal transmission of the fictitious detection lines. As seen, a first state change results in $I_t = 50$, which yields $\overline{\alpha_t} = -\log(I_t/I_0) \approx 0.51$. To counteract this disruption, the calibration value I_0 is modified to 55.3, so that the relative change is the same as in the immediately preceding frame. It is to be noted that a true touch affecting I_t in the next frame would be seen in the input value $\overline{\alpha_t}$, and thus the touch determination process is largely unaffected by the state change. A second state change results in $I_t = 75$, whereby the error correction sets the calibration value I_0 to 83 to maintain the relative signal transmission.

Fig. 8B represents a process that operates on projection values to generate interpolated change values $\overline{d\alpha_t}$ that represent the change in relative signal transmission from the immediately preceding frame, as indicated by the double ended arrows: $\overline{d\alpha_t} = \overline{\alpha_t} - \overline{\alpha_{t-1}}$. In the illustrated example, the interpolated change values may be calculated with respect to the preceding interpolation values: $\overline{d\alpha_t} = \log(I_{t-1}) - \log(I_t)$. As seen, a first state change results in $I_t = 50$, which yields $\overline{d\alpha_t} \approx 0.41$. To counteract this disruption, the error correction operates to set the change in relative signal transmission to zero, either by directly setting $\overline{d\alpha_t} = 0$, or by setting $I_{t-1} = I_t = 50$. It is to be noted that a true touch affecting I_t in the next frame will be seen in the change value $\overline{d\alpha_t}$, and thus the touch determination process is largely unaffected by the state change. A second state change results in $I_t = 75$, whereby the error correction again ensures that $\overline{d\alpha_t} = 0$.

Fig. 8C represents a process that operates on projection values to generate interpolated change values $\overline{d\alpha_t}$ that represent the change in relative signal transmission from two frames back in time, as indicated by the double ended arrows: $\overline{d\alpha_t} = \overline{\alpha_t} - \overline{\alpha_{t-2}}$. The interpolated change values are calculated with respect to the preceding interpolation values: $\overline{d\alpha_t} = \log(I_{t-2}) - \log(I_t)$. As seen, a first state change results in $I_t = 50$, which yields $\overline{d\alpha_t} \approx 0.41$. To counteract this disruption, the error correction operates to modify the reference value by setting $I_{t-2} = I_t = 50$, so that the change in relative signal transmission is zero. Since the change in relative signal transmission is given with respect to interpolation values two frames back in time, the error correction may also operate to set the reference value for the next frame equal to the projection

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value of the current frame. This ensures that a touch will show up in $\overline{d\alpha_t}$ even if it occurs in the next frame that follows after a state change. In an alternative implementation, the error correction operates to set the reference value for the next frame equal to the projection value for the next frame, which will cause a touch to show up in $\overline{d\alpha_t}$ two frames after the state change. In a further alternative implementation, the error correction does not operate to modify the reference values, but instead directly sets $\overline{d\alpha_t} = 0$ for two frames: the current frame and the next frame.

Fig. 8C may also serve to illustrate the process that operates on projection values to generate interpolated change values with respect to averages of preceding interpolation values: $\overline{d\alpha_t} = log(\overline{I_{t\_m}}) - log(I_t)$. Consider the example that $\overline{I_{t-m}}$ represents current averages of the interpolation values at four frames back in time, generated by an exponential forget function: $\overline{7_{t-4}} = \overline{I_{t-5}} - \varepsilon \cdot (7_{t-4} - \overline{7_{t-5}})$. To counteract a state change at time t, the error correction may operate to set $\overline{/_{t-4}} = \overline{/_{t-3}} = \overline{/_{t-2}} = \overline{It\text{-}i} = I_t$ for the affected interpolation point. In an equivalent implementation, the error correction sets $\overline{/_{t-4}} = l_t$ in the current frame and then sets $\varepsilon = 0$ during the next three frames. Either implementation ensures that a touch will show up in $\overline{d\alpha_t}$ even if it occurs in the next frame that follows after the state change.

Reverting to Fig. 7, step 74 is followed by the reconstruction step 75 which operates an image reconstruction function on the interpolated input values $\overline{\alpha_t}$ or $\overline{d\alpha_t}$ to generate a current interaction pattern, e.g. an attenuation pattern A_t or a difference pattern dA_t, e.g. to any of the techniques described in Chapter 2.

In a subsequent determination step 76, the interaction pattern is processed for identification of touch-related features and extraction of touch data. Any known technique may be used for isolating touches within the interaction pattern. For example, ordinary blob detection and tracking techniques may be used for finding the touches. In one embodiment, a threshold is first applied to the interaction pattern, to remove noise. Any areas with interaction values that fall below or above (depending on implementation) the threshold may be further processed to find the center and shape by fitting for instance a two-dimensional second-order polynomial or a Gaussian bell shape to the attenuation values, or by finding the ellipse of inertia of the attenuation values. There are also numerous other techniques as is well known in the art, such as clustering algorithms, edge detection algorithms, etc. Step 76 may be concluded by outputting the extracted touch data.

After step 76, the process returns to the data collection step 70.

It is to be understood that one or more of steps 70-76 may be effected concurrently. For example, the data collection step 70 of a subsequent frame may be initiated concurrently with any one of steps 71-75. In another example, steps 70-74, and

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possibly also step 75, may be repeated sequentially for each projection value in the output signal within a frame.

It is also to be understood that certain steps may be combined or intermixed. For example, instead of first generating a matched sinogram by interpolation (step 72) and then correcting certain interpolation values in the matched sinogram (step 73) based on the exclusion data, the error correction may be implemented as part of the interpolation in step 72, such that the interpolation directly generates a matched sinogram with corrected interpolation values.

The skilled person now realizes that the touch determination process in Fig. 7 may be modified to operate the interpolation step 72 on relative values, e.g. as shown in Figs 12A-12C. For example, step 71 may be modified to generate relative values, e.g. input values al or change values $\overline{da_t}$, or alternatively I_t/REF_t, based on the projection values I_t and corresponding reference values REF_t, e.g. represented by any of I_0, $I_{t-\Delta t}$ and $\overline{I_{t-m}}$. In contrast to the above-described example, the reference values are given for the sampling points (not the interpolation points). Further, step 73 is modified to, for all affected interpolation points, set the current relative value equal to the relative value in a preceding frame or set the current relative value to zero, in analogy with Figs 8A-8C. Still further, step 74 may be omitted if the interpolation values are given as al or $\overline{da_t}$, cf. Figs 12A-12B. If the interpolation values are given as I_t/REF_t, step 74 may be modified to convert the interpolation values into al or $\overline{da_t}$, cf. Fig. 12C.

In all embodiments disclosed herein, to increase the robustness of the error correction, it is conceivable to let a state change not only affect a current frame but also a given number of subsequent frames. For example, every state change in the exclusion data may cause step 73 to perform the error correction for a given number of consecutive frames, e.g. 2-3 frames, in which the relative signal transmission is maintained according to the principles described in the foregoing.

4. Detecting invalid detection lines

The above-mentioned error handling for validation of detection lines may be implemented to detect potentially faulty detection lines by processing the projection signals, e.g. by detecting if the projection values exceed a saturation limit, if the projection values are too weak, if the noise level in the projection signal is too high, if the signal-to-noise level in the projection signal is too low, etc. Alternatively, the validation process may detect a faulty emitter or detector based on the power signal supplied to the emitter/detector. It is also conceivable that the validation process designates all affected detection lines as "invalid" for a given number of frames whenever an operating parameter of an emitter or a detector is changed, so as to prevent

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that the change in operating parameter introduces errors in the touch determination. Such an operating parameter may be the power supplied to the emitter or the gain of the detector. The power to the emitter may be changed to increase/decrease the energy of the light that is emitted when the emitter is active, and the gain of the detector may be changed to increase/decrease the sensitivity of the detector.

Further examples of validation processes are given in WO201 1/078769, WO201 1/139213 and WO2012/158105.

Embodiments of an alternative or supplement to the above-mentioned validation processes are described in the following. These embodiments utilize the energy values measured by the detectors 3 while the emitters 2 are OFF, i.e. not activated to emit a signal (light). In the following, an "ON value" denotes detected energy when a signal is conducted from the incoupling point to the outcoupling point of a detection line, and an "OFF value" denotes detected energy without a signal being conducted from the incoupling point to the outcoupling point.

The OFF values are conventionally used for so-called ambient compensation, which aims at removing or at least suppressing signal components originating from ambient light and detector dark level, including any analog-to-digital conversion (ADC) offset. Ambient light refers to light that is received by a detector while not originating from the emitters. The ON/OFF activation scheme of the emitters may enable each detector to measure an OFF value one or several times during a frame. An ambient-compensated energy value I_k for detection line k may then be obtained as: $I_k = Iraw,k \sim Iamb,k$, where $I_{raw,k}$ is the ON value or an average of ON values, i.e. the energy measured by the detector associated with detection line k when the emitter associated with detection line k is ON, and $I_{amb,k}$ is the OFF value or an average of OFF values, i.e. the energy measured by the detector associated with detection line k when all emitters are OFF. It is to be understood that the touch determination method may operate on I_k instead of $I_{raw,k}$ to improve its robustness to ambient light.

In the various embodiments, the OFF values, obtained during one or plural frames, are processed to generate a current estimate of the noise level for each individual detector, and hence for each detection line. By using the ambient measurements for validation, all influence from touching objects on the estimated noise level is avoided. Furthermore, the validation process may be designed to operate on the same data as the ambient compensation.

Fig. 10 is a flowchart of an exemplifying validation process, which involves a sequence of steps 120-124 that are executed during a frame, e.g. by the signal processor 10 (Fig. 1). The validation process is illustrated for a single detector, but it is understood that a similar process is executed for each detector in the touch-sensitive apparatus.

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In step 120, one or more ON values are obtained from the detector. In step 121, one or more OFF values are obtained from the detector. As indicated by the dashed arrow, steps 120 and 121 may be repeated one or more times during a frame, depending on implementation. It is also conceivable that step 121 is performed before step 120, or that step 121 is performed both before and after step 120. In step 122, an ambient-compensated ON value is computed, e.g. as described above. In step 123, a noise estimate is computed based on OFF values obtained in the current frame, and possibly in one or more preceding frames. In step 124, the detector and/or its detection lines are validated based on the noise estimate. Any detection lines that do not pass the validation may be indicated an "invalid" in the exclusion data, while other detection lines may be indicated as "valid". The exclusion data may be stored in computer memory M for retrieval by the correction step 73 (Fig. 7) in the same or in a forthcoming frame. Alternatively, the exclusion data may be directly supplied to step 73.

Step 123 may compute the noise estimate as a standard deviation or variance of the OFF values. It is conceivable that only a subset of the OFF values measured by the detector is included in the noise estimation. For example, OFF values that are measured after ON values that are saturated to such an extent that the OFF value is likely to contain a residual signal caused by the preceding saturation, may be omitted from the noise estimation. Such OFF values may also be omitted from the ambient compensation in step 122.

In one embodiment, the noise estimate is continuously updated using the N latest OFF values. In another embodiment, the noise estimate is given by an exponential forget estimation of the variance (standard deviation) of the OFF values.

Any known algorithm for computing variance or standard deviation may be used. In certain implementations, it may be advantageous to use an online algorithm. An example of such an algorithm, which allows variance to be computed "on the fly" using two accumulators, is:

$$\widetilde{i_{noise}} \sim \frac{\Sigma(I_{amb,n})^2 - (\Sigma I_{amb,n})^2/N}{N},$$

where $I_{amb,n}$ is the n:th OFF value for a detector, and N is the total number of OFF values used for computation of variance.

A different approach may be used if there are strong low-frequency noise components present in the signals, e.g. influence of residential lighting at a frequency of 100 Hz. Depending on the ON/OFF activation scheme of the touch-sensitive apparatus, such noise components may produce high values of variance (or standard deviation),

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unless care is taken. This may be avoided, e.g., by estimating the noise level based on the absolute difference between consecutive OFF values for each detector, e.g. $\widetilde{I_{noise}} = \sum|\Delta I_{amb,n}|/N$, or $\widetilde{I_{noise}} = \sqrt{\sum(\Delta I_{amb,n})^2}/N$.

The validation step 124 may apply any one of several different validation criteria, or a combination thereof.

One validation criterion stipulates that a valid detection line must fulfill: $(I_{raw,k} < Saturation)$ and $(I_k > T_{CNR} \cdot \widetilde{I_{noise}})$, where ***Saturation*** is a saturation limit (global or for each detector) and T_{CNR} is a carrier-to-noise (CNR) limit. This criterion ensures that saturated detection lines are excluded from further processing, and that only detection lines with a sufficient CNR is used in the touch determination process. The CNR limit is given by the magnitude of attenuation changes that needs to be detected. In one implementation, the CNR limit is set in the range of about 100-300. It is understood that a lower or higher CNR limit may be used. It should also be noted that saturation is evaluated for the ON value without ambient compensation, while CNR is evaluated for the ambient-compensated ON value.

Another validation criterion stipulates that the noise estimate should not exceed a maximum noise limit to be deemed valid: $\widetilde{I_{noise}} < T_{noise}$. This criterion, in contrast to the CNR criterion, identifies all of the detector's detection lines as invalid, even if one or more detection lines have a high ON value.

Another validation criterion stipulates that detection lines with $\widetilde{I_{noise}} \approx 0$ are deemed invalid. Almost zero noise may indicate that the detector is faulty or that the received energy is too low.

Another validation criterion stipulates that the ambient-compensated ON value should exceed a minimum signal limit to be deemed valid: $I_k > I_{min}$. Such a validation criterion may even replace the use of the noise estimate if the touch-sensitive apparatus is known to exhibit low noise levels.

It is to be understood that the above validation limits ***Saturation***, T_{CNR}, T_{NOISE}, I_{min} may be set individually for each detector and/or detection line.

If the evaluation parameter is close to the validation limit, the validation process may cause frequent state changes, which in turn may disturb the touch determination process. In one embodiment, one or more hysteresis windows are used in the validation step to ameliorate this problem. This means that one or more of the validation criteria has a first limit value for invalidation and a second limit value for validation. Suitably, the first and second limit values are set to promote invalidation over validation, i.e. making it harder for an invalid sampling point to be deemed valid than for a valid

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sampling point to be deemed invalid. The skilled person realizes that there are many equivalent techniques to promote invalidation over validation.

It is to be understood that the validation process may be generally combined with any touch determination process that is designed to be responsive to exclusion data. Thus, the validation process may be seen as a method for processing an output signal from a touch-sensitive apparatus, which comprises a plurality of signal generators and a plurality of signal detectors that are operable to define actual detection lines that extend across a surface portion of a panel, and a controller operable to repeatedly turn the signal generators ON and OFF such that the output signal of the signal generators comprise ON energy values for the actual detection lines and OFF energy values for each signal detector. The method comprises the steps of: obtaining the OFF energy values from the output signal; generating a noise estimate for each actual detection line as a function of the OFF energy values; and validating the actual detection lines based on the noise estimate.

5. Hardware implementations

The touch determination process and the validation process according to the various embodiments disclosed herein may be implemented by a data processing device (cf. 10 in Fig. 1) which is connected to sample measurement values from the detectors 3 in the FTIR system. Fig. 11A shows an example of a data processing device 10 configured to implement the process in Fig. 7. The device 10 includes an input 10A for receiving the output signal. The device 10 further includes a data collection element (or means) 200 for obtaining the current projection values, a generation element (or means) 201 for generating absolute values, an interpolation element (or means) 202 for generating a matched sinogram with absolute values, an error correction element 203 for maintaining the relative signal transmission of affected interpolation points, a conversion element (or means) 204 for converting the absolute values of the interpolation points into relative values, a reconstruction element (or means) 205 for generating a current interaction pattern, and an output 10B for outputting the current interaction pattern. In the example of Fig. 11A, the actual extraction of touch data is carried out by a separate device 10' which is connected to receive the interaction pattern from the data processing device 10. Fig. 1IB shows an example of a data processing device 10 configured to implement the process in Fig. 10. The device 10 includes an input 10B for receiving the output signal. The device 10 further includes an element (or means) 210 for obtaining the ON values, an element (or means) 211 for obtaining the OFF values, a compensation element (or means) 212 for generating ambient-compensated ON values, a noise estimation element (or means) 213 for computing a

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noise estimate based on OFF values, and a validation element 214 for validating the detection lines and generating the exclusion data for storage in memory M.

The device 10 may be implemented by special-purpose software (or firmware) run on one or more general-purpose or special-purpose computing devices. In this context, it is to be understood that each "element" or "means" of such a computing device refers to a conceptual equivalent of a method step; there is not always a one-to-one correspondence between elements/means and particular pieces of hardware or software routines. One piece of hardware sometimes comprises different means/elements. For example, a processing unit may serve as one element/means when executing one instruction, but serve as another element/means when executing another instruction. In addition, one element/means may be implemented by one instruction in some cases, but by a plurality of instructions in some other cases. Naturally, it is conceivable that one or more elements (means) are implemented entirely by analog hardware components.

The software controlled device 10 may include one or more processing units (cf. 14 in Fig. 1), e.g. a CPU ("Central Processing Unit"), a DSP ("Digital Signal Processor"), an ASIC ("Application-Specific Integrated Circuit"), discrete analog and/or digital components, or some other programmable logical device, such as an FPGA ("Field Programmable Gate Array"). The device 10 may further include a system memory and a system bus that couples various system components including the system memory to the processing unit. The system bus may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory may include computer storage media in the form of volatile and/or non-volatile memory such as read only memory (ROM), random access memory (RAM) and flash memory. The special-purpose software, the exclusion data, the reference values, and any other data needed during execution, may be stored in the system memory, or on other removable/non-removable volatile/non-volatile computer storage media which is included in or accessible to the computing device, such as magnetic media, optical media, flash memory cards, digital tape, solid state RAM, solid state ROM, etc. The data processing device 10 may include one or more communication interfaces, such as a serial interface, a parallel interface, a USB interface, a wireless interface, a network adapter, etc, as well as one or more data acquisition devices, such as an A/D converter. The special-purpose software may be provided to the device 10 on any suitable computer-readable medium, including a record medium, and a read-only memory.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary,

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is intended to cover various modifications and equivalent arrangements included within the spirit and the scope of the appended claims.

For example, the reconstructed pattern need not strictly represent attenuation, but could be generated in any format that enables detection of interaction on the touch surface. Thus, the reconstructed pattern may represent local attenuation or local transmission in a broad sense and may be generally referred to as an "signal interaction pattern". With respect to the specific formats of input values $\overline{\alpha_t}$ and change values $\overline{d\alpha_t}$ used in the foregoing examples, modifications may be made, e.g., to sign, scaling or offset, without impeding the ability for touch determination.

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CLAIMS

1. A method of enabling touch determination based on an output signal from a touch-sensitive apparatus (100), the touch-sensitive apparatus (100) comprising a panel (1) configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines (D) that extend across a surface portion (4) of the panel (1) between pairs of incoupling and outcoupling points, at least one signal generator (2) coupled to the incoupling points to generate the signals, and at least one signal detector (3) coupled to the outcoupling points to generate the output signal, the method operating in a sequence of repetitions, each repetition comprising the steps of:

processing (70, 71) the output signal to generate a set of data samples $(I_t; log(I_t))$, each data sample being generated to represent detected energy for one of the actual detection lines (D);

generating (72, 74) an interpolated sinogram (g') based on the set of data samples $(I_t; log(I_t))$, the interpolated sinogram (g') comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion (4); and

operating (75) an image reconstruction function on the interpolated sinogram (g') to generate a signal interaction pattern (A_t, dA_t) within at least part of the surface portion (4);

said method further comprising an error correction step (73) which is responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples $(I_t; log(I_t))$ in a current repetition, said error correction step (73) comprising: identifying interpolation samples affected by the change in validity status; and setting each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

2. The method of claim 1, wherein the interpolated sinogram (g') is generated to represent relative values $(\overline{\alpha_t}; \overline{d\alpha_t})$ between energy values $(7_t; log(I_t))$ and reference energy values $(REF_t; log(REF_t))$ for the fictitious detection lines.

3. The method of claim 2, wherein the step of generating (72, 74) the interpolated sinogram (g') comprises: operating (72) an interpolation function on the data samples $(7_t; log(I_t))$ to generate the energy values $(7_t, log(I_t))$ for the fictitious detection lines, and converting (74) the energy values $(7_t; log(I_t))$ to the relative values $(\overline{\alpha_t}; \overline{d\alpha_t})$ by means of the reference energy values $(REF_t; log(REF_t))$ for the fictitious detection lines.

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4. The method of claim 2 or 3, wherein the reference energy values $(REF_t; log(REF_t))$ for the fictitious detection lines are generated by operating the interpolation function on data samples $(I_0; log(I_0))$ obtained from the output signal in a calibration step without objects in contact with the surface portion (4), and wherein the error correction step comprises manipulating the reference energy value of each identified interpolation sample so as to maintain the relative signal transmission of the corresponding fictitious detection line from the former repetition.

5. The method of claim 2 or 3, wherein the reference energy values $(REF_t; log(REF_t))$ are intermittently updated to represent the energy values $(I_{t-\Delta t}; log(I_{t-\Delta t}))$ in a preceding repetition, such that the relative values $(\overline{d\alpha_t})$ represent a change in the relative signal transmission between the current and the preceding repetition for each fictitious detection line.

6. The method of claim 5, wherein the reference energy values $(REF_t; log(REF_t))$ are updated in each repetition.

7. The method of claim 5 or 6, wherein the error correction step (73) comprises setting the relative value $(\overline{d\alpha_t})$ of each identified interpolation sample to zero.

8. The method of claim 5 or 6, wherein the error correction step (73) comprises setting, for each identified interpolation sample, the reference energy value of the former repetition equal to the energy value of the current repetition.

9. The method of claim 8, wherein the former repetition is immediately preceding the current repetition.

10. The method of claim 9, wherein the former repetition is separated from the current repetition by a number of intermediate repetitions.

11. The method of claim 10, wherein the error correction step (73) further comprises setting the reference energy value for the number of intermediate repetitions equal to the energy value of the current repetition.

12. The method of any preceding claim, wherein each data sample in the set of data samples $(log(I_t))$ is generated by extracting the detected energy for the respective actual detection line (D) from the output signal and computing the logarithm of the detected energy.

13. The method of any preceding claim, wherein the touch-sensitive apparatus (100) comprises a plurality of signal generators (2) and a plurality of signal detectors (3) and is operated to turn the signal generators (2) ON and OFF during each repetition, such that the output signal is generated to comprise ON energy values for the actual detection lines (D) and at least one OFF energy value for each signal detector (3), wherein said method further comprises a validation process (120-124) for designating an actual detection line (D) as valid or invalid and generating the exclusion data, the

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validation process (120-124) comprising: obtaining (121) the OFF energy values from the output signal, generating (123) a noise estimate for each actual detection line (D) as a function of the OFF energy values, and validating (124) the actual detection lines (D) based on the noise estimate.

14. The method of claim 13, wherein the noise estimate is generated to represent a variability in a time sequence of OFF energy values for the signal detector (3) associated with the actual detection line (D).

15. The method of claim 13 or 14, wherein an actual detection line (D) is designated as invalid if the noise estimate exceeds a noise limit (T_{noise}).

16. The method of any one of claims 13-15, wherein an actual detection line (D) is designated as invalid if the ON energy value of the actual detection line (D) exceeds a saturation limit *(Isaturation)*.

17. The method of any one of claims 13-16, wherein the step of processing (70, 71) the output signal to generate the set of data samples (I_t; $log(I_t)$) comprises: obtaining the ON energy values from the output signal, obtaining an estimated ambient value for each actual detection line (D) based on the OFF energy value for the signal detector (3) associated with the actual detection line (D), and generating an ambient-compensated energy value by subtracting the estimated ambient value from the ON energy value for each actual detection line (D).

18. The method of claim 17, wherein an actual detection line (D) is designated as invalid if the ratio between the ambient-compensated energy value and the noise estimate is less than a minimum ratio limit (T_{CNR}).

19. The method of claim 17 or 18, wherein an actual detection line (D) is designated as invalid if the ambient-compensated energy value is less than a minimum energy limit (I_{min}).

20. The method of any one of claims 13-19, wherein the validation process (120-124) is configured to promote a change of designation from valid to invalid over a change of designation from invalid to valid.

21. A computer program product comprising computer code which, when executed on a data-processing system, is adapted to carry out the method of any one of claims 1-20.

22. A device (10) for enabling touch determination based on an output signal from a touch-sensitive apparatus (100), the touch-sensitive apparatus (100) comprising a panel (1) configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines (D) that extend across a surface portion (4) of the panel (1) between pairs of incoupling and outcoupling points, at least one signal generator (2) coupled to the incoupling points

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to generate the signals, and at least one signal detector (3) coupled to the outcoupling points to generate the output signal, said device comprising:

an input (10A) for receiving the output signal, and

a signal processor (14) configured to, repeatedly in a sequence of repetitions:

process the output signal to generate a set of data samples $(I_t; \boldsymbol{log(I_t)})$, each data sample being generated to represent detected energy for one of the actual detection lines (D);

generate an interpolated sinogram $\boldsymbol{(g')}$ based on the set of data samples $(I_t; \boldsymbol{log(I_t)})$, the interpolated sinogram $\boldsymbol{(g')}$ comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion (4); and

operate an image reconstruction function on the interpolated sinogram $\boldsymbol{(g')}$ to generate a signal interaction pattern (A_t, dA_t) within at least part of the surface portion (4);

wherein the signal processor (14) is further configured to perform an error correction responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples $(I_t; \boldsymbol{log(I_t)})$ in a current repetition, wherein said error correction comprises: identifying interpolation samples affected by the change in validity status; and setting each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

23. A device (10) for enabling touch determination based on an output signal from a touch-sensitive apparatus (100), the touch-sensitive apparatus (100) comprising a panel (1) configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines (D) that extend across a surface portion (4) of the panel (1) between pairs of incoupling and outcoupling points, at least one signal generator (2) coupled to the incoupling points to generate the signals, and at least one signal detector (3) coupled to the outcoupling points to generate the output signal, wherein the device is operable in a sequence of repetitions and comprises:

means (200, 201) for processing, in each repetition, the output signal to generate a set of data samples $(7_t; \boldsymbol{log(I_t)})$, each data sample being generated to represent detected energy for one of the actual detection lines (D);

means (202, 204) for generating, in each repetition, an interpolated sinogram $\boldsymbol{(g')}$ based on the set of data samples $(7_t; \boldsymbol{log(I_t)})$, the interpolated sinogram $\boldsymbol{(g')}$ comprising interpolation samples which represent fictitious detection lines that have a desired location on the surface portion (4); and

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means (205) for operating, in each repetition, an image reconstruction function on the interpolated sinogram $\{g'\}$ to generate a signal interaction pattern (A_t, dA_t) within at least part of the surface portion (4);

wherein the device (10) further comprises means (203) for error correction, which is responsive to exclusion data that identifies a change in validity status for a data sample among the set of data samples $(I_t; log(I_t))$ in a current repetition, said means (203) for error correction being configured to identify interpolation samples affected by the change in validity status; and set each identified interpolation sample to a value that maintains a relative signal transmission of the fictitious detection line from a former repetition.

24. A touch-sensitive apparatus (100), comprising:

a panel (1) configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points, thereby defining actual detection lines (D) that extend across a surface portion (4) of the panel (1) between pairs of incoupling and outcoupling points;

means (2, 12) for generating the signals at the incoupling points;

means (3) for generating an output signal based on detected signals at the outcoupling points; and

the device (10) for enabling touch determination according to claim 22 or 23.

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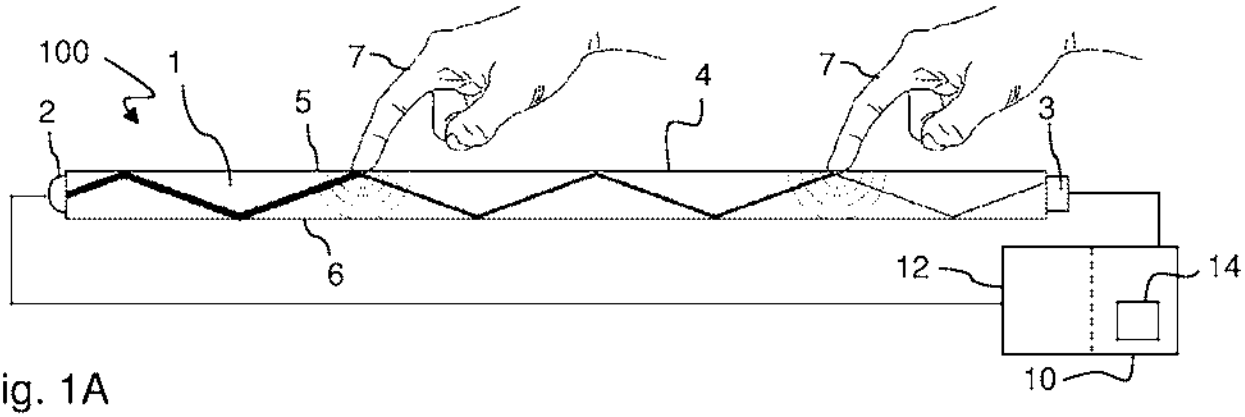


Fig. 1A

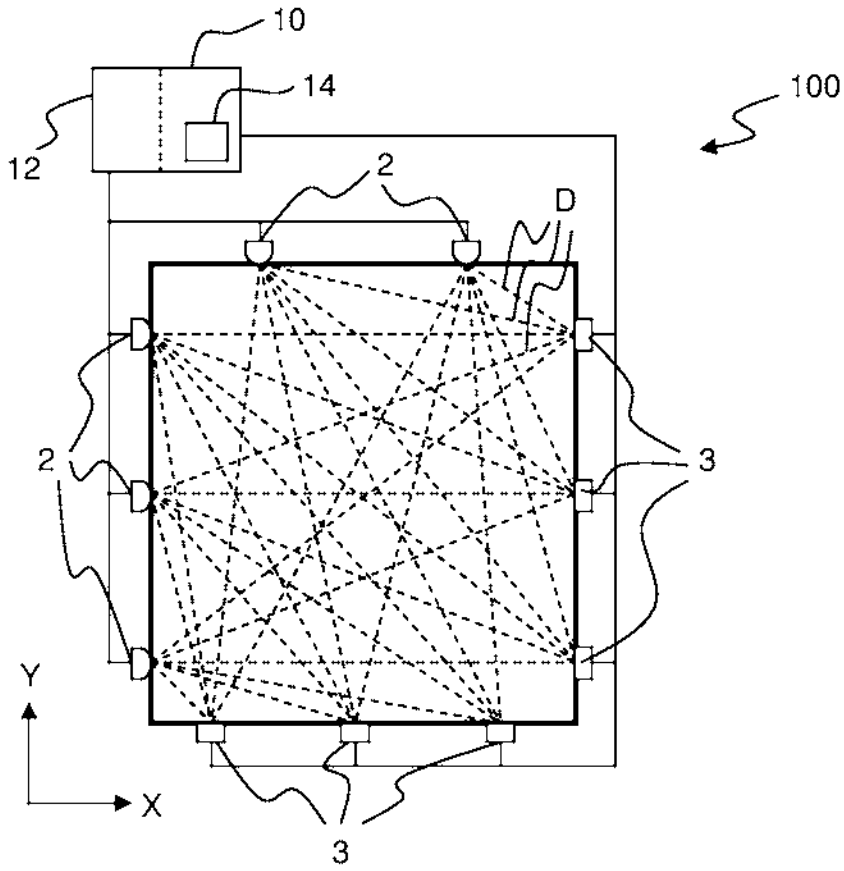


Fig. 1B

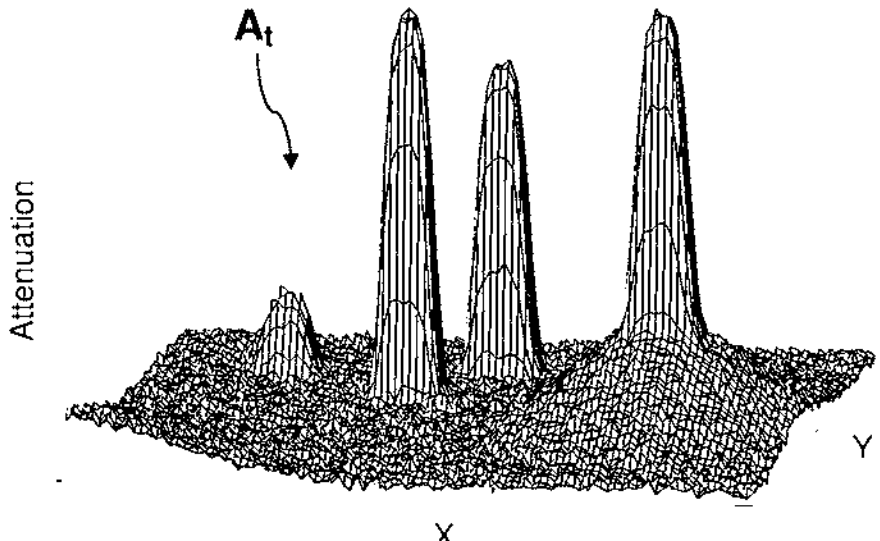


Fig. 2

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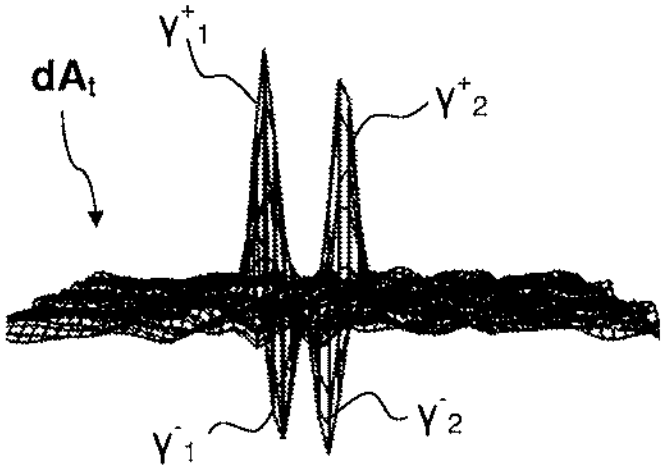


Fig. 3A

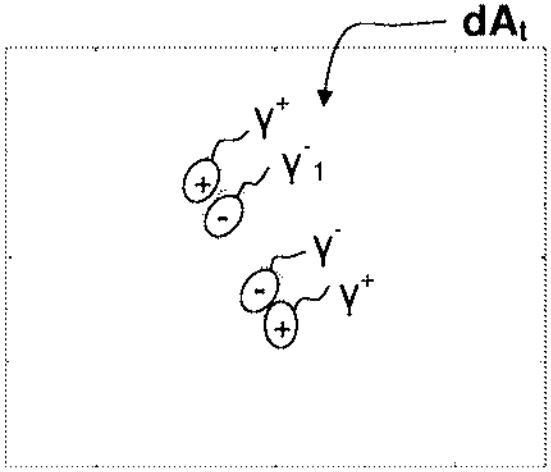


Fig. 3B

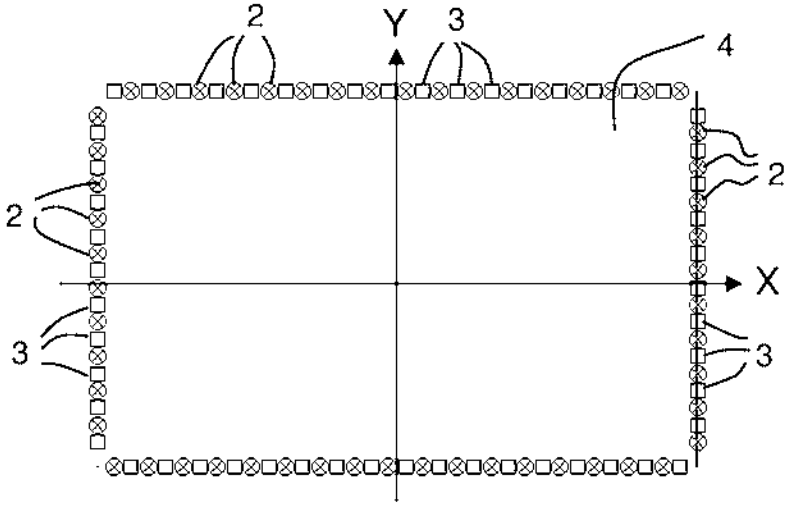


Fig. 4

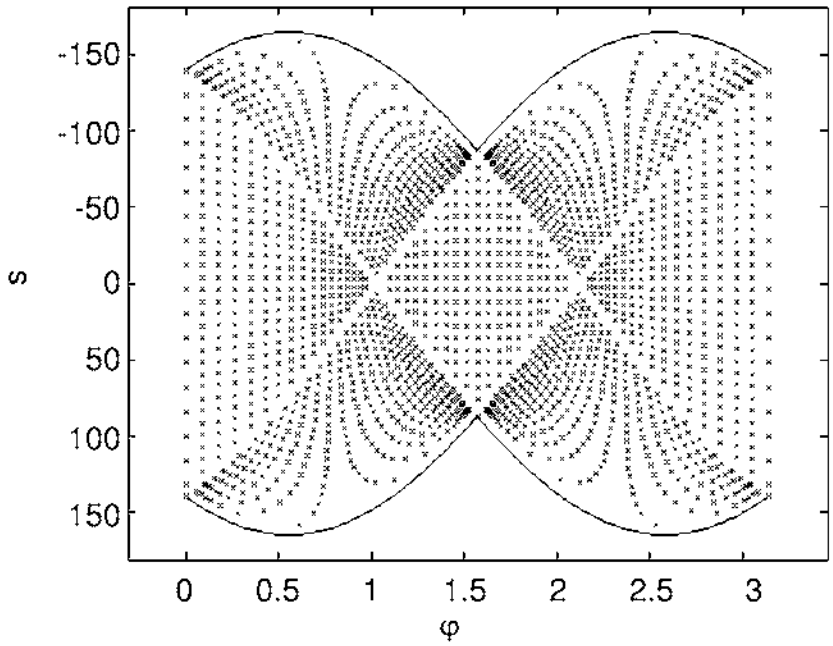


Fig. 5

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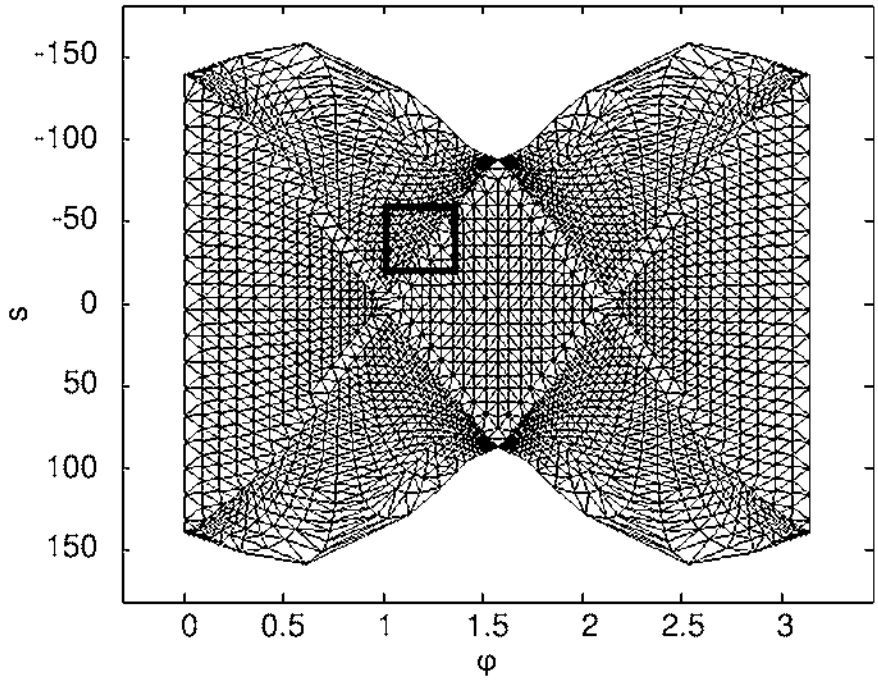


Fig. 6A

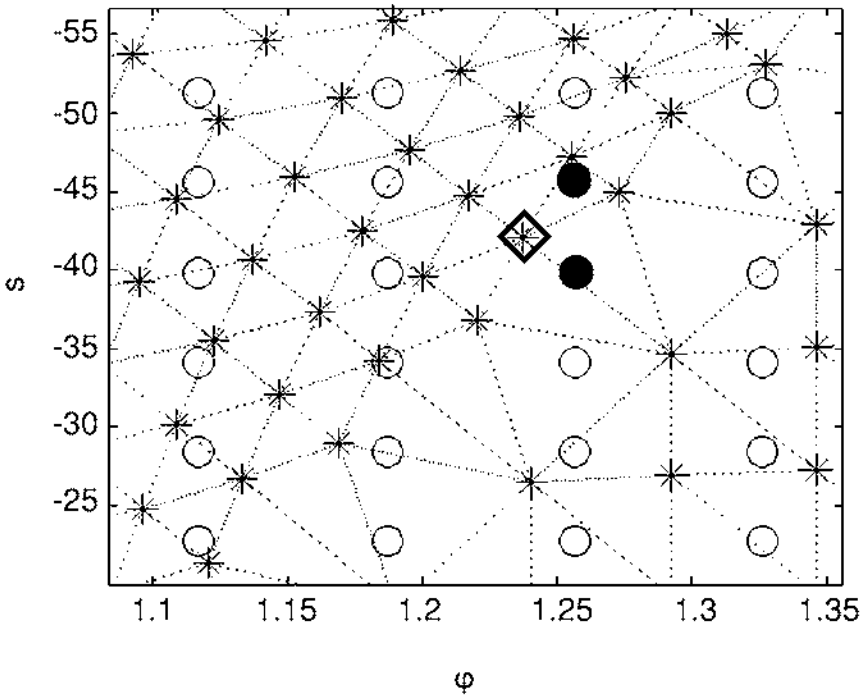


Fig. 6B

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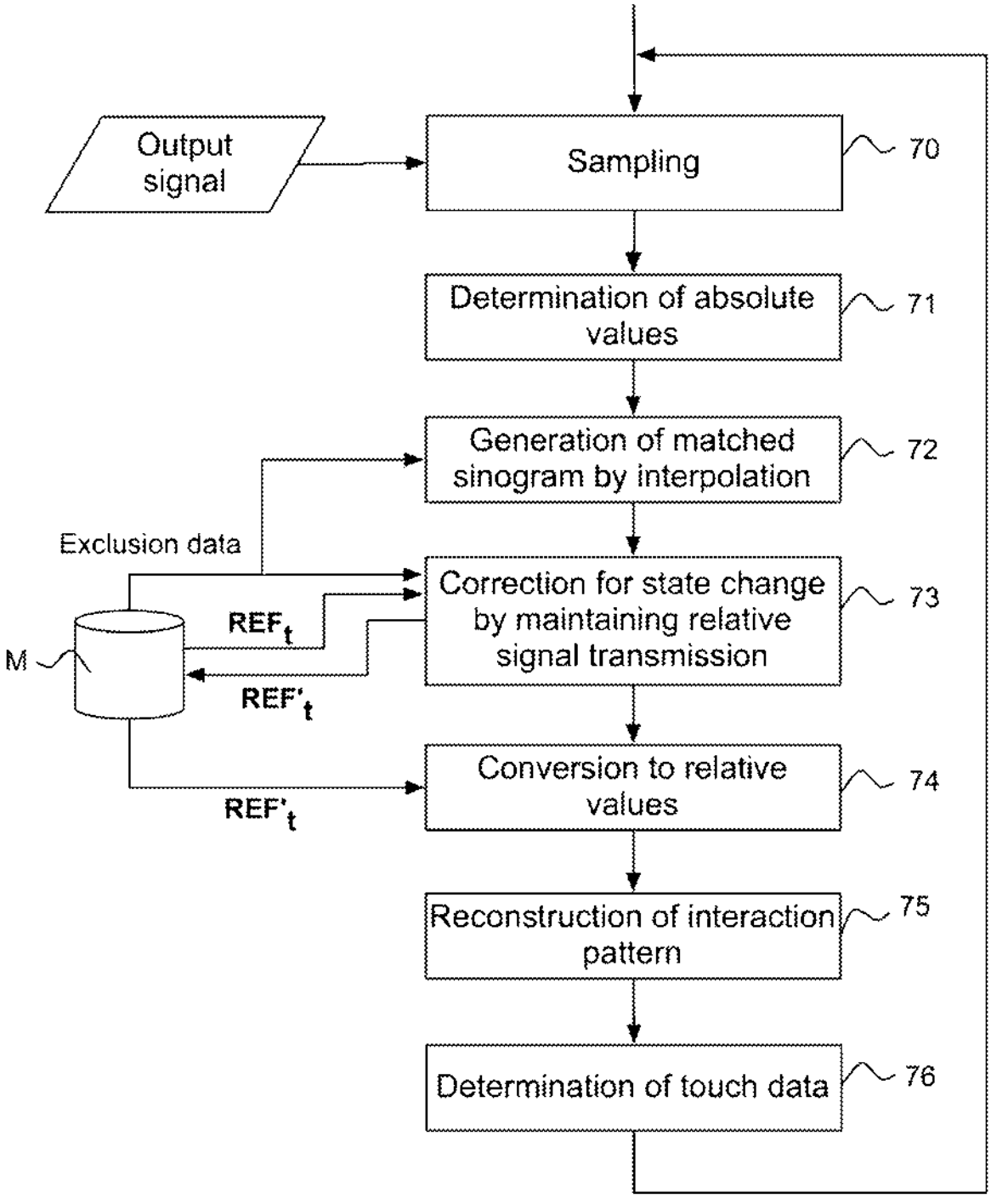


Fig. 7

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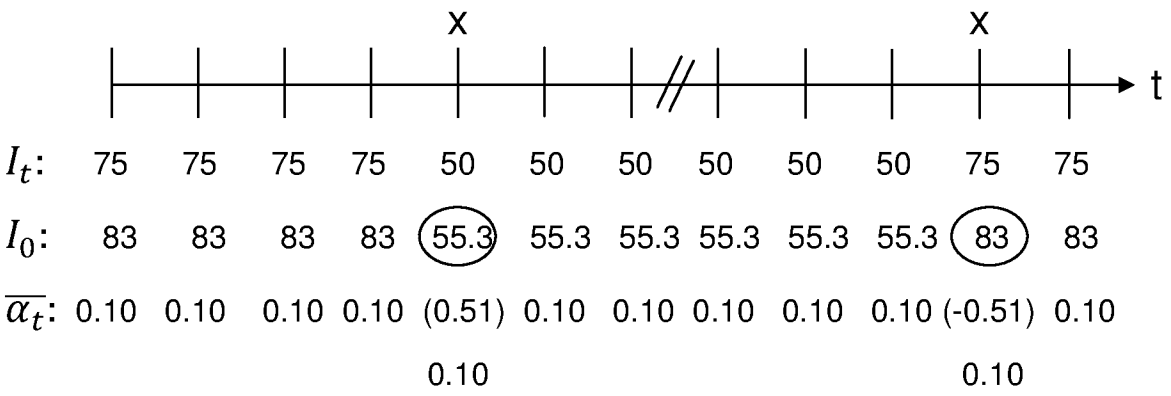


Fig. 8A

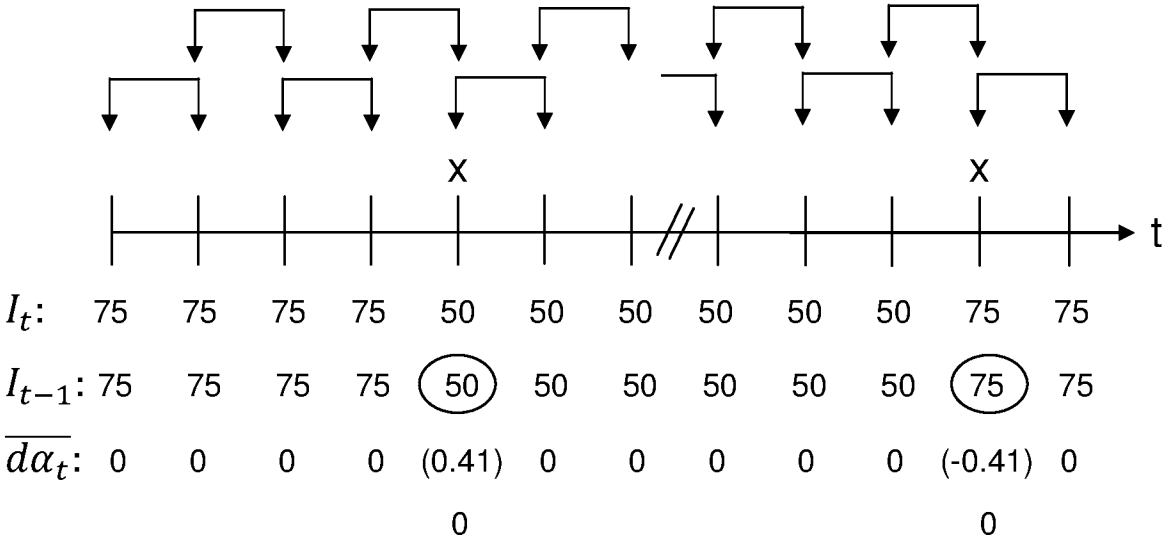


Fig. 8B

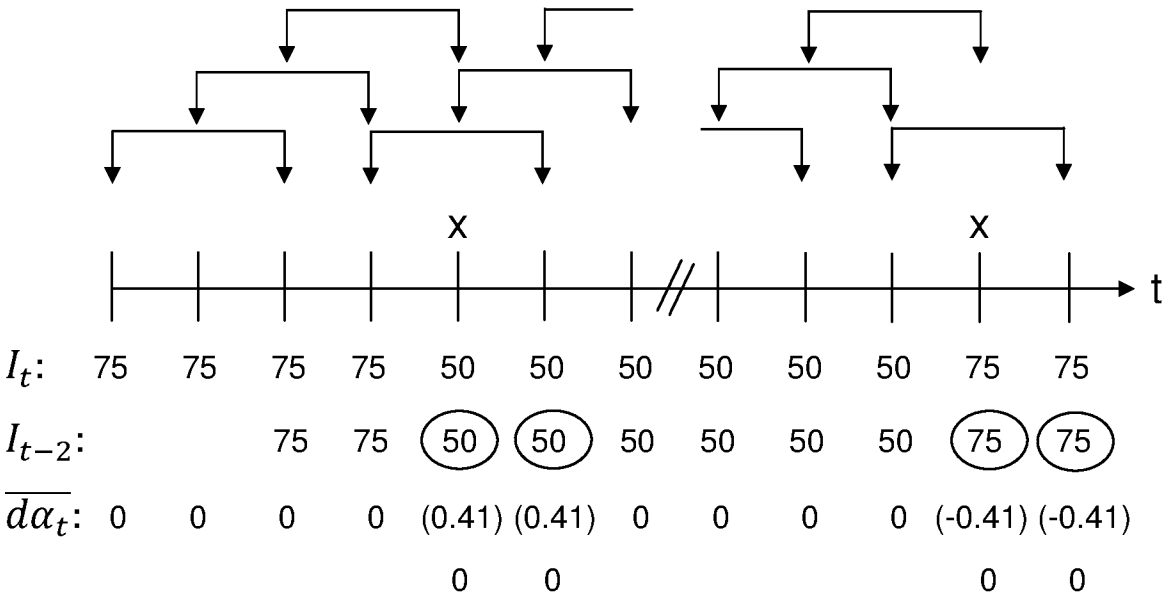


Fig. 8C

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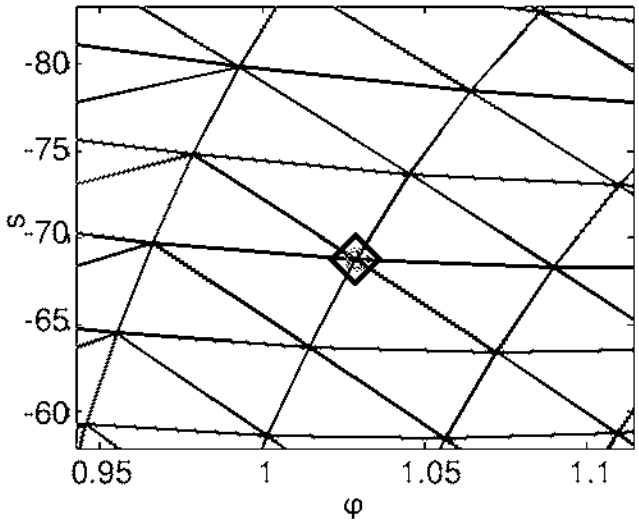


Fig. 9A

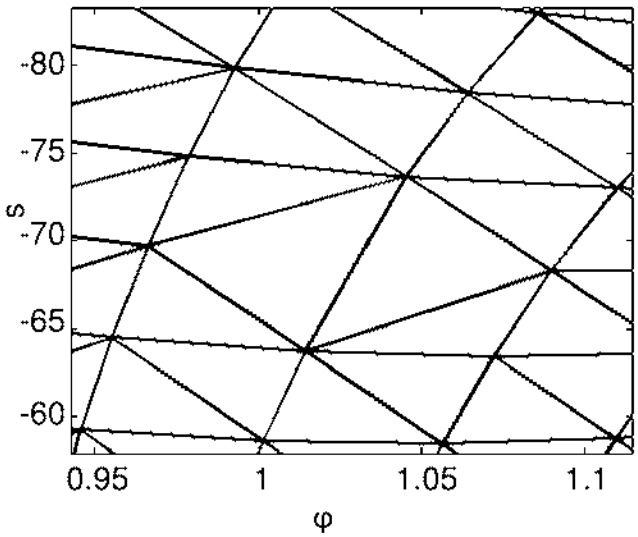


Fig. 9B

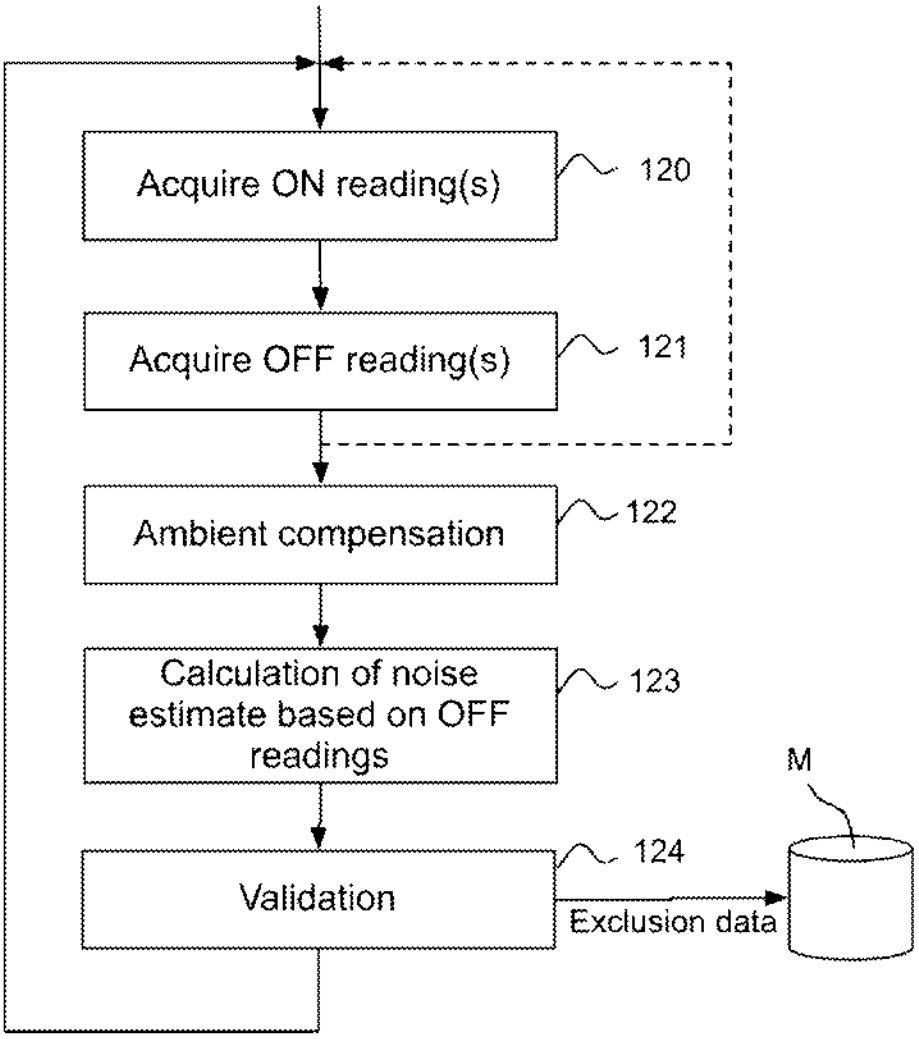


Fig. 10

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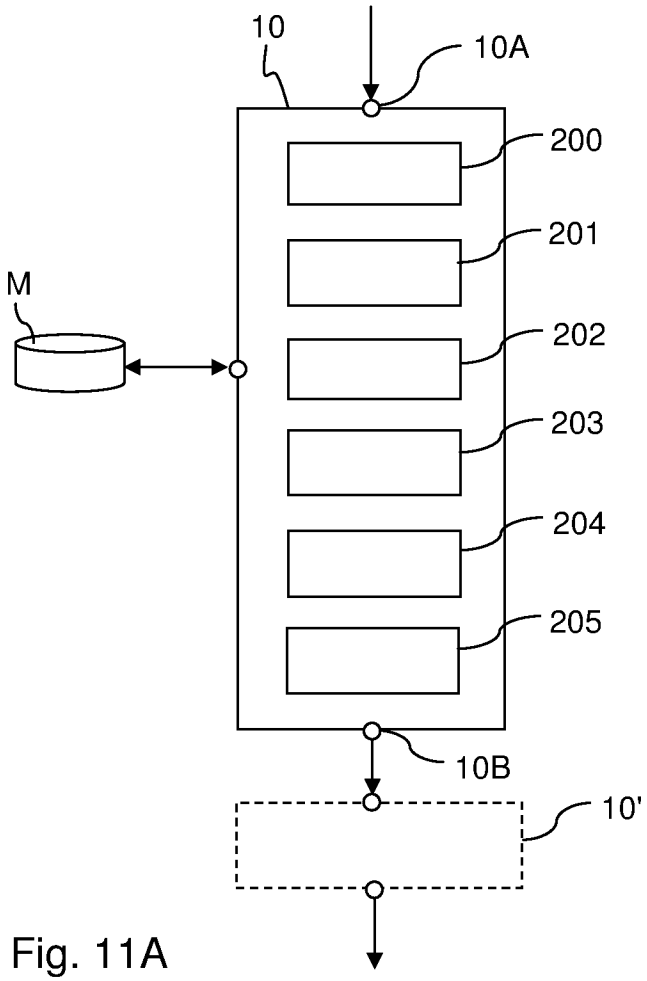


Fig. 11A

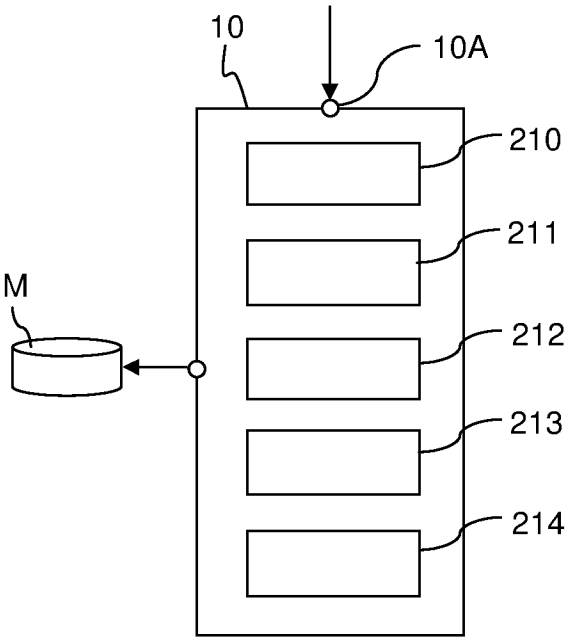


Fig. 11B

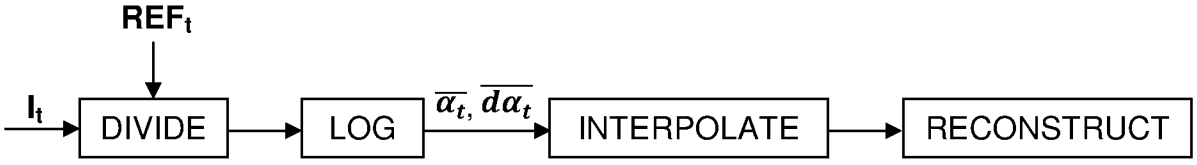


Fig. 12A

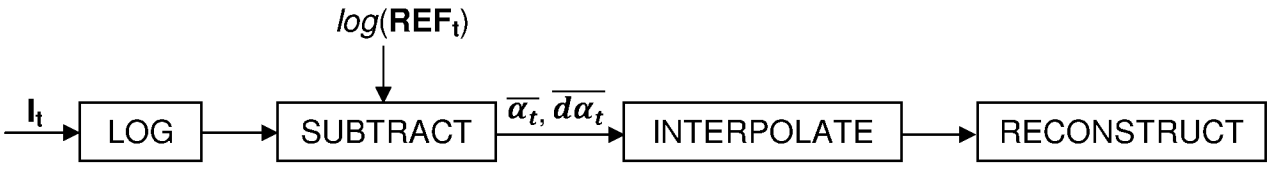


Fig. 12B

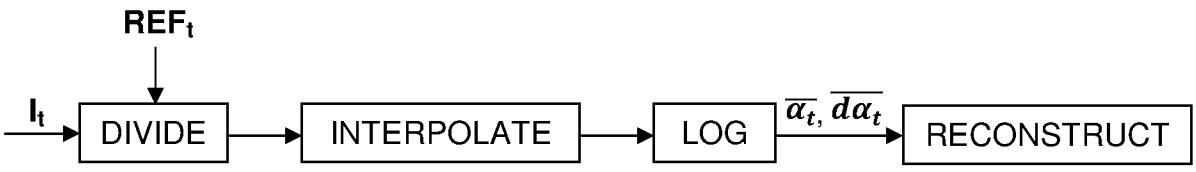


Fig. 12C

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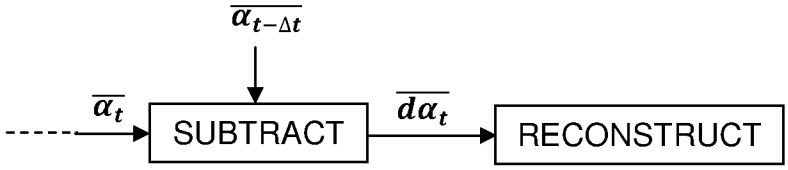


Fig. 12D

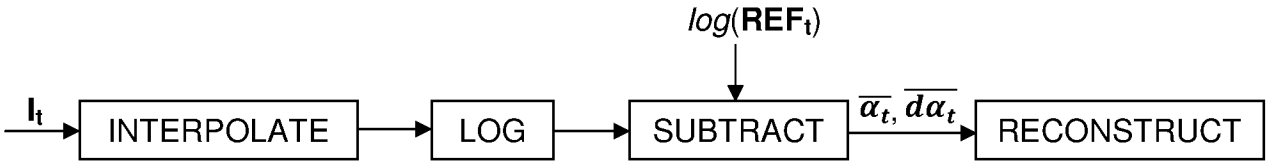


Fig. 13A

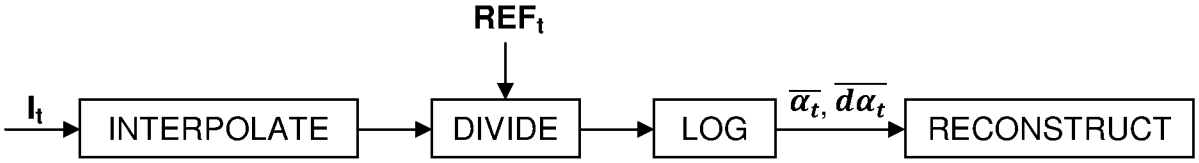


Fig. 13B

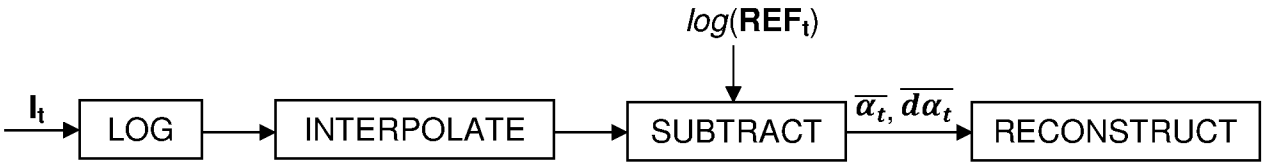


Fig. 13C

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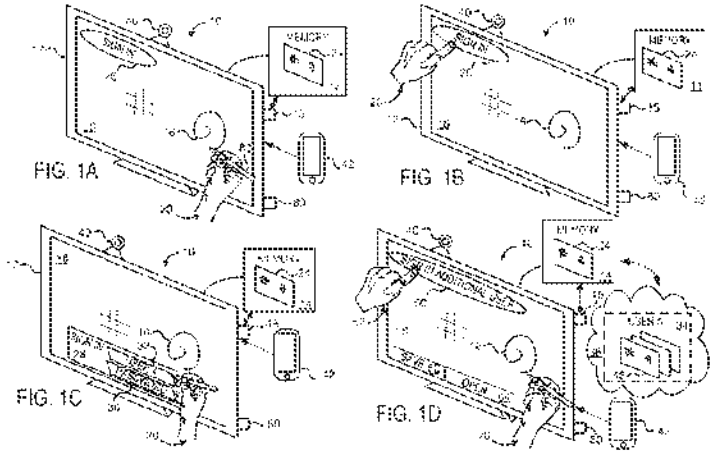
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[Continued on next page]

(54) **Title:** CLAIMING DATA FROM A VIRTUAL WHITEBOARD



(57) **Abstract:** A method of storing data from a whiteboard application executed on a computing system including an interactive display device is provided. The method comprises storing, in a memory of the computing system, whiteboard data input to the whiteboard application in response to user interaction with the interactive display device, displaying a login selector on the interactive display device, upon detecting actuation of the login selector, identifying the user based on credentials of the user; and in response to identifying the user (i) retrieving previews of stored whiteboard files from a user account in a cloud-based storage system corresponding to the identity of the user, (ii) displaying the previews on the interactive display device, and (iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

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CLAIMING DATA FROM A VIRTUAL WHITEBOARD

BACKGROUND

[0001] Prior whiteboard applications have been used via computer systems, enabling displayed content to be drawn upon or otherwise manipulated via input devices such as mice, trackpads, touchscreens, etc. In this way, the whiteboard application can provide the functionality of a physical dry-erase or chalkboard in a computing context. Whiteboard applications are commonly used in collaborative settings such as meetings, brainstorming sessions, classrooms, etc. Therefore, in some instances a plurality of users may manipulate content presented via the whiteboard application in one or more sessions. The data associated with the manipulation of the content may be saved locally by the computing system. However, the computing system using the whiteboard application may be used by a number of users. Therefore, storing the data locally may create security concerns. Furthermore, storing the data locally may increase the amount of storage needed in the computing system. Therefore, offloading the content may be desirable to alleviate the security concerns and decrease local storage needs. However, offloading the content to a portable storage device (e.g., thumbdrive), for example, can be cumbersome and require many awkward steps involving numerous input commands. Consequently, it may be inefficient for one or more users to offload the content quickly during a collaborative session. As a result, users may find interaction with the whiteboard application slow and awkward. Moreover, it may be difficult to upload the offloaded content for use in a subsequent whiteboard session, leading to additional interactive inefficiency.

SUMMARY

[0002] A method of storing data from a whiteboard application executed on a computing system including an interactive display device is provided. The method comprises storing, in a memory of the computing system, whiteboard data input to the whiteboard application in response to user interaction with the interactive display device, displaying a login selector on the interactive display device, upon detecting actuation of the login selector, identifying the user based on credentials of the user; and in response to identifying the user, (i) retrieving previews of stored whiteboard files from a user account in a cloud-based storage system corresponding to the identity of the user, (ii) displaying the previews on the interactive display device, and (iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

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[0003] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1A depicts a computing system configured to store data from a whiteboard application executed on the computing system.

[0005] FIG. 1B depicts the computing system of FIG. 1A further configured to display a login selector on an interactive display device

[0006] FIG. 1C depicts the computing system of FIG. 1A further configured to identify the user via a sign in prompt requesting the user enter a user ID and a password.

[0007] FIG. 1D depicts the computing system if FIG. 1A further configured to access a user account on a cloud-based storage system.

[0008] FIG. 2A depicts the computing system of FIGS. 1A-1D further configured to display a logout selector on the interactive display device.

[0009] FIG. 2B depicts the operation of the logout selector of FIG. 2A.

[0010] FIG. 3A depicts the computing system of FIGS. 1A-1D further configured to retrieve previews of stored whiteboard files from the user account on the cloud-based storage system.

[0011] FIG. 3B depicts the computing system of FIG. 3A configured to display a stored whiteboard file corresponding to a selected preview.

[0012] FIG. 4 depicts the computing system of FIGS. 1A-1D further configured to create virtual sticky-notes and recognize privacy keywords via handwriting recognition.

[0013] FIGS. 5A and 5B depict a flowchart for a method for storing data from a whiteboard application executed on the computing system in accordance with an embodiment of the present disclosure.

[0014] FIG. 6 schematically depicts a non-limiting embodiment of a computing system in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0015] A whiteboard application executed by a computing system including an interactive display device is described herein. The whiteboard application is configured to quickly and efficiently upload and download data to and from a cloud-based storage

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device during a whiteboard application user session. Specifically, data may be generated via the whiteboard application and subsequently sent to a cloud-based storage system when a user provides credentials to a user account in the cloud-based storage system. Additionally, previews of files stored in the cloud-based storage device can also be presented via the interactive display device in response to the user entering user credentials. As a result, a user can not only easily offload desired content to a cloud-based storage system but also quickly preview content stored in the cloud-based storage system, thereby enhancing the current whiteboard session. In this way, a user can quickly capture content and send the captured content to a cloud-based system for later use as well as preview previously captured content stored in the cloud-based system.

[0016] FIG. 1A depicts a computing system 10 configured to store data from a whiteboard application 18 executed on the computing system 10. The computing system 10 may be configured to include an interactive display device 12 (e.g., interactive touch sensitive display device) and a memory 14 including instructions executable by a processor 15. The whiteboard application 18 may be stored in memory 14 as instructions executable by the processor 15. The computing system 10 may be further configured to record, in the memory 14, a whiteboard file 24. The whiteboard file 24 may include whiteboard data 16 input into the whiteboard application 18 by a user 20 via the interactive display device 12.

[0017] The interactive display device 12 may include a sensing device 80. The sensing device may include one or more of a capacitive touch sensor, an optical touch sensor, etc. The interactive display device 12 may include a liquid crystal display (LCD), an organic light-emitting diode (OLED), active-matrix organic light-emitting diode (AMOLED), projection display, etc., for presenting graphics. The interactive display device 12 is configured to receive and process ink inputs and touch inputs. It will be appreciated that an ink input includes an interactive input with a stylus 82. The interactive display device 12 may further be configured to receive and process multi-touch inputs. Additionally, it will be appreciated that the aforementioned inputs may be sent to the memory 14 and processor 15 for processing via the whiteboard application 18.

[0018] FIG. 1B depicts the computing system 10 further configured to display a login selector 26 on the interactive display device 12. The login selector 26 may be a soft button generated graphically by the interactive display device 12 or a hard button physically present on the interactive display device 12 itself. Upon detecting actuation of the login selector 26, the computing system 10 may then be further configured to identify

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the user 20 based on credentials of the user 20. In one example, the login selector 26 may be a soft button persistently displayed on the interactive display device 12 via the whiteboard application 18. In this way, a user can quickly select the login selector while the whiteboard application is executed. However, other whiteboard application user interface configurations have been contemplated, such as using biometric indicators including facial image recognition to log a user in, or using a device identifier received from a user device (e.g., mobile phone, watch, stylus, etc.) to log a user in, as described below.

[0019] FIG. 1C depicts the computing system 10 further configured to identify the user 20 via a sign in prompt 28 requesting the user 20 enter a user ID 30 and a password 32. The user 20 is identified by the computing system 10 as "USER A". The computing system 10 may also be further configured to identify the credentials of the user 20 via facial recognition. For example, the computing system 10 may be configured to compare a captured image of the user 20 captured with camera 40 to a stored profile image associated with a cloud-based account (e.g., online account) of the user 20. The camera 40 linked to the computing system 10. In addition, the computing system 10 may be configured to identify the user 20 by wirelessly detecting the credentials of the user stored in a linked portable device. In FIG. 1C, the linked portable device is depicted as cell phone 42 which may be configured to communicate wirelessly with the computing system 10. It should be noted, however, that the computing system 10 may be configured to wirelessly detect the credentials of a user 20 via another suitable device, such as a security token (e.g., fob), stylus, or watch.

[0020] FIG. 1D depicts the computing system 10 further configured to access a user account 34 on a cloud-based storage system 36. The user account 34 corresponds to the identity of the user 20 established by the computing system 10, as described above with respect to FIG. 1C. Upon accessing the user account 34, the computing system 10 may be configured to upload the whiteboard file 24 from the memory 14 of the computing system 10 to the user account 34. For example, the computing system may be configured to display on the interactive display device 12 a save selector 62 and, upon detecting actuation of the save selector 62 by the user 20, to upload the whiteboard file 24 to the user account 34.

[0021] Turning briefly to FIG. 2A, the computing system 10 may be further configured to display a logout selector 38 on the interactive display device. As shown in FIG. 2B, the computing system 10 may be then configured to revoke access to the user

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account 34 upon detecting actuation of the logout selector 38 by the user 20. Additionally, previews of the files stored in the cloud-based storage system may be removed from the interactive display device upon detecting actuation of the logout selector. The previews are discussed in greater detail herein.

[0022] Turning next to FIG. 3A, the computing system 10 may be further configured to retrieve previews 44 of stored whiteboard files 46 from the user account 34 on the cloud-based storage system 36. For example, the computing system 10 may be configured to display an open selector 64 on the interactive display device 12 and, upon detecting actuation of the open selector 64 by the user 20, to retrieve previews 44 of the stored whiteboard files 46 from the user account 34. The computing system may then be configured to display the previews 44 on the interactive display device 12. The previews 44 may be displayed by the computing device as a horizontal strip of preview images, with the preview images grouped chronologically. The previews 44 may be further grouped into folders. Additionally or alternatively, the previews may be presented as tiles (e.g., tiles aligned in a grid pattern) or stacked with each preview having a different z-order. The computing system 10 may be further configured to allow the user 20 to select one of the previews 44 via the interactive display device 12. Upon detecting a selection by the user 20, the computing system 10 may be configured to retrieve the stored whiteboard file 46 corresponding to the selected preview 44. As shown in FIG. 3B, the computing system 10 may then be configured to display the stored whiteboard file 46 on the interactive display device 12. The whiteboard application may be configured to enable the user manipulate the whiteboard file, such as adding additional content, erasing content, modifying content, etc. For instance, a user may implement an ink input and/or touch input to generate additional graphics (e.g., alphanumeric symbols) in the whiteboard file.

[0023] Turning back to FIG. 1D, the computing system 10 may be further configured to display a second login selector 50 on the interactive display device 12. The computing system 10 may be configured to identify a second user 52 based on credentials of the second user 52 after detecting actuation of the second login selector 50 by the second user 52. The computing system 10 may then be configured to access a second user account on a cloud-based storage system corresponding to the identity of the second user 52 and upload the whiteboard file 24 from the memory 14 of the computing system 10 to the second user account. Although only the user account 34 is depicted in FIG. 1D, it should be noted that the computing system 10 may be configured to upload the whiteboard file 24 from the memory 14 to the second user account, as well. For example, it should be

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further noted that the computing system 10 may be configured to allow multiple user to operate in a split-screen mode wherein the whiteboard data from one predetermined half of the interactive display device is uploaded to the user account of the first user, and the whiteboard data from the other half may be uploaded to the user account of the second user. In another example, multiple users may be able to select portions of the whiteboard data and upload only the selected portion to their user account.

[0024] Turning next to FIG. 4, the computing system 10 may be configured to create virtual sticky-notes 54 via the interactive display device 12. The virtual sticky-notes 54 may contain content such as text input by the user and may be associated with a location or an element in the whiteboard data. For example, if a virtual sticky-note 54 is placed on a location within the whiteboard data of the whiteboard application 18, the virtual sticky-note 54 will remain in that location even if the whiteboard data is scrolled or resized on the interactive display device 12. The virtual sticky-notes 54 may also be configured such that multiple virtual sticky-notes may be stacked, resized, or arranged on the screen by the user 20. The computing system 10 may be further configured to record the virtual sticky-notes 54 in the memory 14 and to upload the virtual sticky-notes 54 to the user account 34 as a part of a whiteboard file 56. As such, the virtual sticky-notes can be stored on the computing system 10 and in user account 34 of the user 20.

[0025] FIG. 4 further depicts the computing system 10 configured to detect a privacy keyword 58 via handwriting recognition on the interactive display device 12. In the example shown in FIG. 4, the computing system 10 is configured to detect the word "Secret" or another suitable privacy keyword, such as confidential, private, etc., via handwriting recognition. The computing system 10 may then be configured to assign a privacy level 60 to the whiteboard file 56 based on the privacy keyword 58. The computing system may then be configured to restrict access to the whiteboard file 56 based on the privacy level 60. For example, the computing system 10 may be configured to restrict access to the whiteboard file 56 by locking the file and not allowing any unauthorized users to upload the whiteboard file 56. Alternately, the computing system 10 may be configured to restrict access to a whiteboard file 56 by not displaying a preview of the file among the previews of stored files retrieved from the user account 34 if unauthorized users are currently logged into the computing system 10. In another example, the computing system 10 may restrict access to a whiteboard file 56 by displaying a warning message when an additional user logs into the computing system 10, if the additional user is not authorized to upload the whiteboard file 56.

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[0026] FIG. 5 is a flowchart depicting a method 500 of storing data from a whiteboard application executed on a computing system including an interactive display device. At 502, the method 500 includes receiving ink inputs and/or touch inputs at the interactive display device. It will be appreciated that the ink inputs may be implemented via a stylus and the touch inputs may be implemented via digits of a user, for instance.

[0027] Next at 504 the method includes generating whiteboard data based on the received inputs in response to receiving the inputs. In one example, the whiteboard data is in a data format specific to the whiteboard application. However, other whiteboard data formats have been contemplated. Further in one example, the whiteboard data includes at least one of modifiable ink input data, touch input data, and sticky-note data associated with a location or another element in the whiteboard data. It will be appreciated that the sticky-note data may mimic the functionality of physical sticky notes on a physical whiteboard.

[0028] At 506 the method includes storing, in a memory of the computing system, the whiteboard data in response to receiving the inputs at the interactive display. In one example, the whiteboard data may be stored in the memory in direct response to receiving the inputs at the interactive display. In the context of the invention direct response means that there are not intervening input commands implemented between the corresponding actions. Next at 508 the method includes detecting a privacy keyword via handwriting recognition on the interactive display device and at 510 the method includes assigning a privacy level to the whiteboard data based on the privacy keyword. The privacy keyword may be "secret", "classified", "confidential", etc. At 512 the method includes restricting access to the whiteboard data based on the privacy level. In this way, a user may provide increased security to data quickly and intuitively through interaction with the interactive display device.

[0029] At 514 the method includes displaying a login selector on the interactive display and at 516 the method includes detecting actuation of the login selector. Detecting actuation of the login selector may include detecting actuation of a button via user input (e.g., ink input, touch input, mouse input, etc.), for instance. At 518 the method includes upon detecting actuation of the login selector, identifying a user based on credentials of the user. Identifying the user based on the credential of the user may include at 520 prompting user to input a username and password associated with a user account on a cloud-based storage system. Additionally or alternatively, identifying the user based on the credentials of the user may include at 522 determining the identity of the user based on

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a facial recognition. Additionally or alternatively, identifying the user based on the credential of the user may include at 524 wirelessly detecting the credentials of the user stored in a linked portable device and at 526 determining the identity of the user based on the credentials. In one example, the linked portable device is one of a stylus, mobile computing device, and security token device. Thus, the credentials may be supplied by at least one of a stylus, mobile computing device, and security token device via wireless communication. In this way, a device associated with the user may be used to quickly identify the identity of the user.

[0030] Now turning to FIG. 5B, the method includes at 528-534 in response to identifying the user (i) retrieving preview of stored whiteboard files from a user account in a cloud-based storage system corresponding to the identity of the user, (ii) displaying the previews on the interactive display device, and (iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account. In this way, whiteboard data may be quickly pushed and pulled from the user account in the cloud-based storage system. In one example, the uploaded whiteboard data only includes a selected portion of data presented on the interactive touch sensitive display associated with the whiteboard application. For instance, a user may select a portion of the data via an ink input, touch gesture, etc., indicating the portion of data they would like to be uploaded. Still further in other examples, a stylus may be associated with a user and only the portion of whiteboard data generated by the specific stylus may be uploaded to the cloud-based storage system. However, in other examples all of the whiteboard data presented on the interactive display may be uploaded to the cloud-based storage system.

[0031] At 536 the method includes receiving a selection input of one of the previews via the interactive display device. Next at 538 the method includes retrieving the stored whiteboard file corresponding to the selected preview from the cloud-based storage system. At 540 the method includes displaying the stored whiteboard file on the interactive display and at 542 the method includes displaying a second login selector on the interactive display. At 544 the method includes detecting actuation of the second login selector. At 546 the method includes upon detection of actuation of the second login selector, identifying a second user based on credentials of the second user. Next at 548 the method includes in response to identifying the second user, uploading the whiteboard data from the memory of the computing system to a second user account in the cloud-based storage system, the second user account distinct from the first user account. At 550 the method includes displaying a logout selector on the interactive display device. Next at

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552 the method includes upon detecting actuation of the logout selector, revoking access to the user account and removing the previews of the stored whiteboard files from the interactive display device.

[0032] The above described systems and methods provide the potential advantage that a user can quickly pull and push data to and from a cloud-based storage system. As a result, the users can quickly and intuitively acquire relevant data during a collaborative session for use at a later time. Furthermore, previously stored files are presented during the current whiteboard session for use during the current whiteboard session, if desired, further expanding the content that can be used is a single session. In this way, data from multiple whiteboard sessions can be provided in a single interface further enhancing the current whiteboard session by providing greater amount of collaborative content. As a result, the functionality of the whiteboard is expanded to provide a user with quick and efficient access to cloud-based content. In this way, content from more than one whiteboard session may be linked via a cloud-based storage system enabling the user to link content from multiple whiteboard sessions, if desired.

[0033] In some embodiments, the methods and processes described herein may be tied to a computing system of one or more computing devices. In particular, such methods and processes may be implemented as a computer-application program or service, an application-programming interface (API), a library, and/or other computer-program product. Specifically, the methods and processing herein may be tied to the computing system discussed above with regard to FIGS. 1-4.

[0034] FIG. 6 schematically shows a non-limiting embodiment of a computing system 600 that can enact one or more of the methods and processes described above. Computing system 600 is shown in simplified form. Computing system 600 may take the form of a touch-screen display device, as well as any other suitable computing system, including but not limited to game consoles, one or more personal computers, server computers, tablet computers, home-entertainment computers, network computing devices, gaming devices, mobile computing devices, mobile communication devices (e.g., smart phone), and/or other computing devices.

[0035] Computing system 600 includes a logic machine 602 and a storage machine 604. Computing system 600 may also include a display subsystem 606, input subsystem 608, communication subsystem 610, and/or other components not shown in FIG. 6.

[0036] Logic machine 602 includes one or more physical devices configured to execute instructions. For example, the logic machine may be configured to execute

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instructions that are part of one or more applications, services, programs, routines, libraries, objects, components, data structures, or other logical constructs. Such instructions may be implemented to perform a task, implement a data type, transform the state of one or more components, achieve a technical effect, or otherwise arrive at a desired result.

[0037] The logic machine may include one or more processors configured to execute software instructions. Additionally or alternatively, the logic machine may include one or more hardware or firmware logic machines configured to execute hardware or firmware instructions. Processors of the logic machine may be single-core or multi-core, and the instructions executed thereon may be configured for sequential, parallel, and/or distributed processing. Individual components of the logic machine optionally may be distributed among two or more separate devices, which may be remotely located and/or configured for coordinated processing. Aspects of the logic machine may be virtualized and executed by remotely accessible, networked computing devices configured in a cloud-computing configuration.

[0038] Storage machine 604 includes one or more physical devices configured to hold instructions executable by the logic machine to implement the methods and processes described herein. When such methods and processes are implemented, the state of storage machine 604 may be transformed—e.g., to hold different data.

[0039] Storage machine 604 may include removable and/or built-in devices. Storage machine 604 may include optical memory (e.g., CD, DVD, HD-DVD, Blu-Ray Disc, etc.), semiconductor memory (e.g., RAM, EPROM, EEPROM, etc.), and/or magnetic memory (e.g., hard-disk drive, floppy-disk drive, tape drive, MRAM, etc.), among others. Storage machine 604 may include volatile, nonvolatile, dynamic, static, read/write, read-only, random-access, sequential-access, location-addressable, file-addressable, and/or content-addressable devices.

[0040] It will be appreciated that storage machine 604 includes one or more physical devices. However, aspects of the instructions described herein alternatively may be propagated by a communication medium (e.g., an electromagnetic signal, an optical signal, etc.) that is not held by a physical device for a finite duration.

[0041] Aspects of logic machine 602 and storage machine 604 may be integrated together into one or more hardware-logic components. Such hardware-logic components may include field-programmable gate arrays (FPGAs), program- and application-specific integrated circuits (PASIC / ASICs), program- and application-specific standard products

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(PSSP / ASSPs), system-on-a-chip (SOC), and complex programmable logic devices (CPLDs), for example.

[0042] The terms "module," "program," and "engine" may be used to describe an aspect of computing system 600 implemented to perform a particular function. In some cases, a module, program, or engine may be instantiated via logic machine 602 executing instructions held by storage machine 604. It will be understood that different modules, programs, and/or engines may be instantiated from the same application, service, code block, object, library, routine, API, function, etc. Likewise, the same module, program, and/or engine may be instantiated by different applications, services, code blocks, objects, routines, APIs, functions, etc. The terms "module," "program," and "engine" may encompass individual or groups of executable files, data files, libraries, drivers, scripts, database records, etc.

[0043] When included, display subsystem 606 may be used to present a visual representation of data held by storage machine 604. This visual representation may take the form of a graphical user interface (GUI). As the herein described methods and processes change the data held by the storage machine, and thus transform the state of the storage machine, the state of display subsystem 606 may likewise be transformed to visually represent changes in the underlying data. Display subsystem 606 may include one or more display devices utilizing virtually any type of technology. Such display devices may be combined with logic machine 602 and/or storage machine 604 in a shared enclosure, or such display devices may be peripheral display devices.

[0044] When included, input subsystem 608 may comprise or interface with one or more user-input devices such as a keyboard, mouse, touch screen, or game controller. In some embodiments, the input subsystem may comprise or interface with selected natural user input (NUI) componentry. Such componentry may be integrated or peripheral, and the transduction and/or processing of input actions may be handled on- or off-board. Example NUI componentry may include a microphone for speech and/or voice recognition; an infrared, color, stereoscopic, and/or depth camera for machine vision and/or gesture recognition; a head tracker, eye tracker, accelerometer, and/or gyroscope for motion detection and/or intent recognition; as well as electric-field sensing componentry for assessing brain activity.

[0045] When included, communication subsystem 610 may be configured to communicatively couple computing system 600 with one or more other computing devices. Communication subsystem 610 may include wired and/or wireless

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communication devices compatible with one or more different communication protocols. As non-limiting examples, the communication subsystem may be configured for communication via a wireless telephone network, or a wired or wireless local- or wide-area network. In some embodiments, the communication subsystem may allow computing system 600 to send and/or receive messages to and/or from other devices via a network such as the Internet.

[0046] It will be understood that the configurations and/or approaches described herein are exemplary in nature, and that these specific embodiments or examples are not to be considered in a limiting sense, because numerous variations are possible. The specific routines or methods described herein may represent one or more of any number of processing strategies. As such, various acts illustrated and/or described may be performed in the sequence illustrated and/or described, in other sequences, in parallel, or omitted. Likewise, the order of the above-described processes may be changed.

[0047] The subject matter of the present disclosure includes all novel and nonobvious combinations and subcombinations of the various processes, systems and configurations, and other features, functions, acts, and/or properties disclosed herein, as well as any and all equivalents thereof.

[0048] The subject matter of the present disclosure is further described in the following paragraphs. According to one aspect, a method of storing data from a whiteboard application executed on a computing system including an interactive display device is provided. The method includes, storing, in a memory of the computing system, whiteboard data input to the whiteboard application in response to user interaction with the interactive display device, displaying a login selector on the interactive display device, and upon detecting actuation of the login selector: identifying the user based on credentials of the user; in response to identifying the user, (i) retrieving previews of stored whiteboard files from a user account in a cloud-based storage system corresponding to the identity of the user, (ii) displaying the previews on the interactive display device, and (iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

[0049] In this aspect, the method may further include displaying a logout selector on the interactive display device; and upon detecting actuation of the logout selector, revoking access to the user account and removing the previews of the stored whiteboard files from the interactive display device.

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[0050] In this aspect, identifying the user based on credentials of the user may further comprise: prompting the user to input a username and a password associated with a user account on a cloud-based storage system.

[0051] In this aspect, identifying the user based on credentials of the user may further comprise: determining the identity of the user based on a facial recognition.

[0052] In this aspect, identifying the user based on credentials of the user may further comprise: wirelessly detecting the credentials of the user stored in a linked portable device; and determining the identity of the user based on the credentials.

[0053] In this aspect, the linked portable device may be one of a stylus, mobile computing device, and security token device.

[0054] In this aspect, the method may further include receiving a selection input of one of the previews via the interactive display device; retrieving the stored whiteboard file corresponding to the selected preview from the cloud-based storage system; and displaying the stored whiteboard file on the interactive display device.

[0055] In this aspect, the method may further include displaying a second login selector on the interactive display device; upon detecting actuation of the second login selector, identifying a second user based on credentials of the second user; and in response to identifying the second user, uploading the whiteboard data from the memory of the computing system to a second user account in the cloud-based storage system, the second user account distinct from the first user account.

[0056] In this aspect, the method may further include detecting a privacy keyword via handwriting recognition on the interactive display device; assigning a privacy level to the whiteboard data based on the privacy keyword; and restricting access to the whiteboard data based on the privacy level.

[0057] In this aspect, the whiteboard data may be in a data format specific to the whiteboard application.

[0058] In this aspect, the uploaded whiteboard data may only include a selected portion of data presented on the interactive touch sensitive display associated with the whiteboard application.

[0059] According to another aspect, a computing system is provided which includes an interactive touch sensitive display device; code stored in memory executable by a processor to: store, in a memory of the computing system, whiteboard data input to the whiteboard application in direct response to user interaction with the interactive touch sensitive display device; display a login selector on the interactive touch sensitive display

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device: upon detecting actuation of the login selector, identifying the user based on credentials of the user; and in response to identifying the user, (i) retrieve previews of stored whiteboard files from the user account on the cloud-based storage system, (ii) display the previews on the interactive touch sensitive display device, and (iii) upload the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

[0060] In this aspect, the whiteboard data may be in a data format specific to the whiteboard application.

[0061] In this aspect, the whiteboard data may include at least one of modifiable ink input data, touch input data, and sticky-note data associated with a location or another element in the whiteboard data

[0062] In this aspect, the computing system may further include code stored in memory executable by a processor to: detect a privacy keyword via handwriting recognition on the interactive touch sensitive display device; assign a privacy level to the whiteboard data based on the privacy keyword; and restrict access to the whiteboard data based on the privacy level.

[0063] In this aspect, the credentials may be supplied by at least one of a stylus, mobile computing device, and security token device via wireless communication.

[0064] In this aspect, the whiteboard data may be uploaded in direct response to identifying the user.

[0065] According to another aspect, a method of storing data from a whiteboard application executed on a computing system including an interactive touch sensitive display device is provided. The method includes storing, in a memory of the computing system, whiteboard data input to the whiteboard application in direct response to user interaction with the interactive touch sensitive display device, the whiteboard data includes at least one of modifiable ink input data, touch input data, and sticky-note data associated with a location or another element in the whiteboard data; displaying a login selector on the interactive touch sensitive display device; upon detecting actuation of the login selector, identifying the user based on credentials of the user; and in response to identifying the user, (i) retrieving previews of stored whiteboard files from the user account on the cloud-based storage system, (ii) displaying the previews on the interactive touch sensitive display device, and (iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

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[0066] In this aspect, the whiteboard data may be uploaded in direct response to identifying the user.

[0067] In this aspect, the uploaded whiteboard data may only include a selected portion of data presented on the interactive touch sensitive display associated with the whiteboard application.

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CLAIMS:

1. A method of storing data from a whiteboard application executed on a computing system including an interactive display device, the method comprising:

storing, in a memory of the computing system, whiteboard data input to the whiteboard application in response to user interaction with the interactive display device;

displaying a login selector on the interactive display device; and

upon detecting actuation of the login selector, identifying the user based on credentials of the user;

in response to identifying the user,

(i) retrieving previews of stored whiteboard files from a user account in a cloud-based storage system corresponding to the identity of the user,

(ii) displaying the previews on the interactive display device, and

(iii) uploading the whiteboard data as a whiteboard file from the memory of the computing system to the user account

2. The method of claim 1, further comprising:

displaying a logout selector on the interactive display device; and

upon detecting actuation of the logout selector, revoking access to the user account and removing the previews of the stored whiteboard files from the interactive display device.

3. The method of claim 1, wherein identifying the user based on credentials of the user further comprises:

prompting the user to input a username and a password associated with a user account on a cloud-based storage system.

4. The method of claim 1, wherein identifying the user based on credentials of the user further comprises:

determining the identity of the user based on a facial recognition.

5. The method of claim 1, wherein identifying the user based on credentials of the user further comprises:

wirelessly detecting the credentials of the user stored in a linked portable device; and

determining the identity of the user based on the credentials.

6. The method of claim 5, wherein the linked portable device is one of a stylus, mobile computing device, and security token device.

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7. The method of claim 1, further comprising:

receiving a selection input of one of the previews via the interactive display device;

retrieving the stored whiteboard file corresponding to the selected preview from the cloud-based storage system; and

displaying the stored whiteboard file on the interactive display device.

8. The method of claim 1, further comprising:

displaying a second login selector on the interactive display device;

upon detecting actuation of the second login selector, identifying a second user based on credentials of the second user; and

in response to identifying the second user, uploading the whiteboard data from the memory of the computing system to a second user account in the cloud-based storage system, the second user account distinct from the first user account.

9. The method of claim 1, further comprising:

detecting a privacy keyword via handwriting recognition on the interactive display device;

assigning a privacy level to the whiteboard data based on the privacy keyword; and

restricting access to the whiteboard data based on the privacy level.

10. The method of claim 1, wherein the whiteboard data is in a data format specific to the whiteboard application and wherein the uploaded whiteboard data only includes a selected portion of data presented on the interactive touch sensitive display associated with the whiteboard application.

11. A computing system comprising:

an interactive touch sensitive display device;

code stored in memory executable by a processor to:

store, in a memory of the computing system, whiteboard data input to the whiteboard application in direct response to user interaction with the interactive touch sensitive display device;

display a login selector on the interactive touch sensitive display device;

upon detecting actuation of the login selector, identifying the user based on credentials of the user; and

in response to identifying the user,

(i) retrieve previews of stored whiteboard files from the user account on the cloud-based storage system,

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(ii) display the previews on the interactive touch sensitive display device, and

(iii) upload the whiteboard data as a whiteboard file from the memory of the computing system to the user account.

12. The computing system of claim 11, wherein the whiteboard data is in a data format specific to the whiteboard application.

13. The computing system of claim 11, wherein the whiteboard data includes at least one of modifiable ink input data, touch input data, and sticky-note data associated with a location or another element in the whiteboard data.

14. The computing system of claim 11, further comprising code stored in memory executable by a processor to:

detect a privacy keyword via handwriting recognition on the interactive touch sensitive display device;

assign a privacy level to the whiteboard data based on the privacy keyword; and

restrict access to the whiteboard data based on the privacy level.

15. The computing system of claim 11, wherein the credentials are supplied by at least one of a stylus, mobile computing device, and security token device via wireless communication and the whiteboard data is uploaded in direct response to identifying the user.

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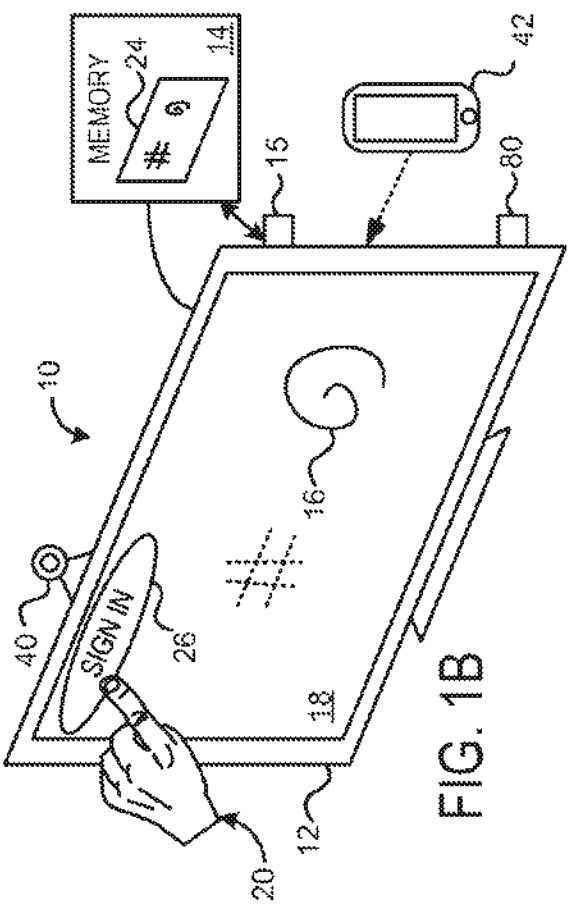


FIG. 1B

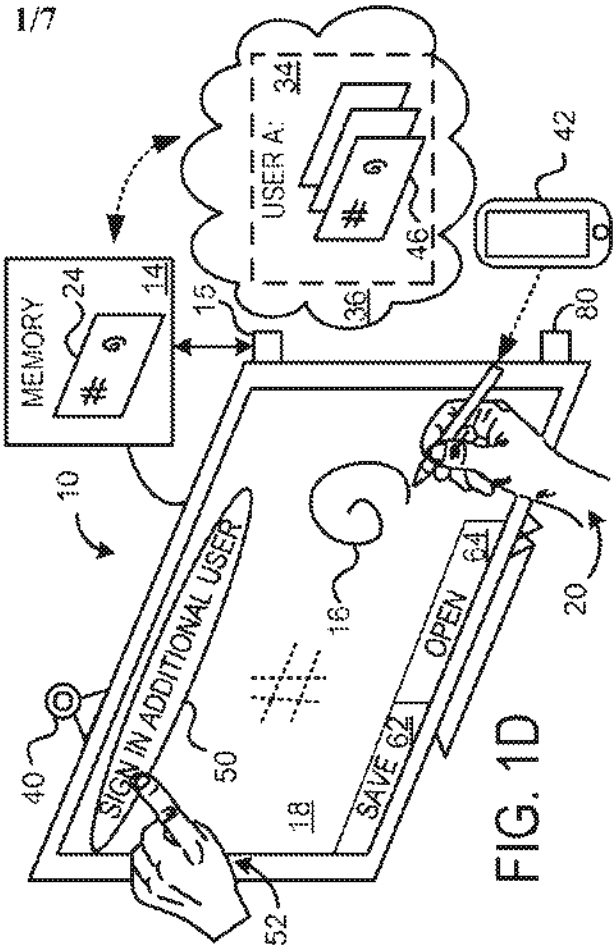


FIG. 1D

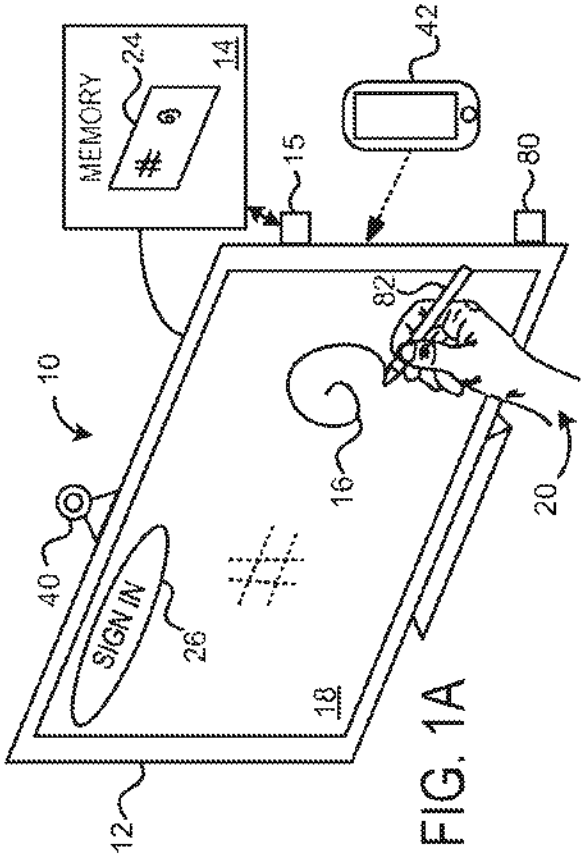


FIG. 1A

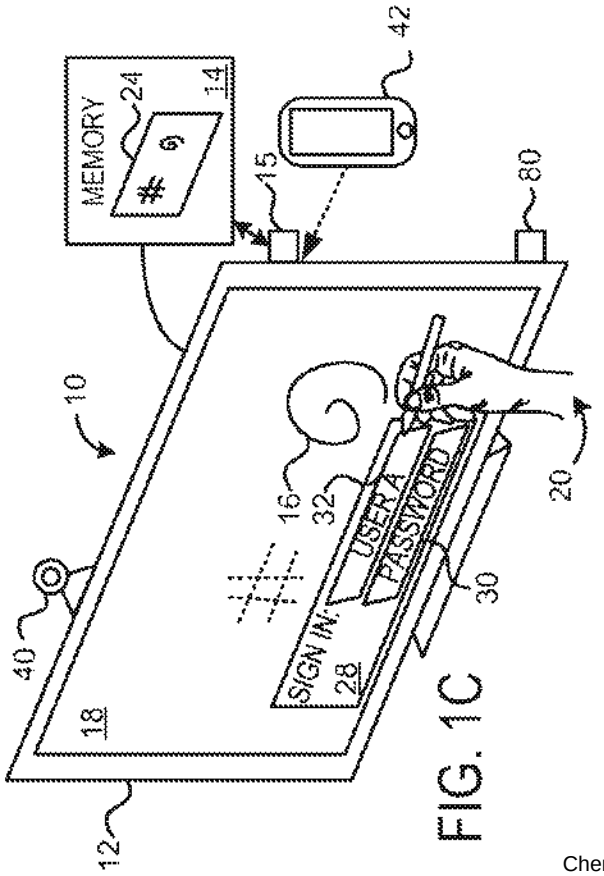


FIG. 1C

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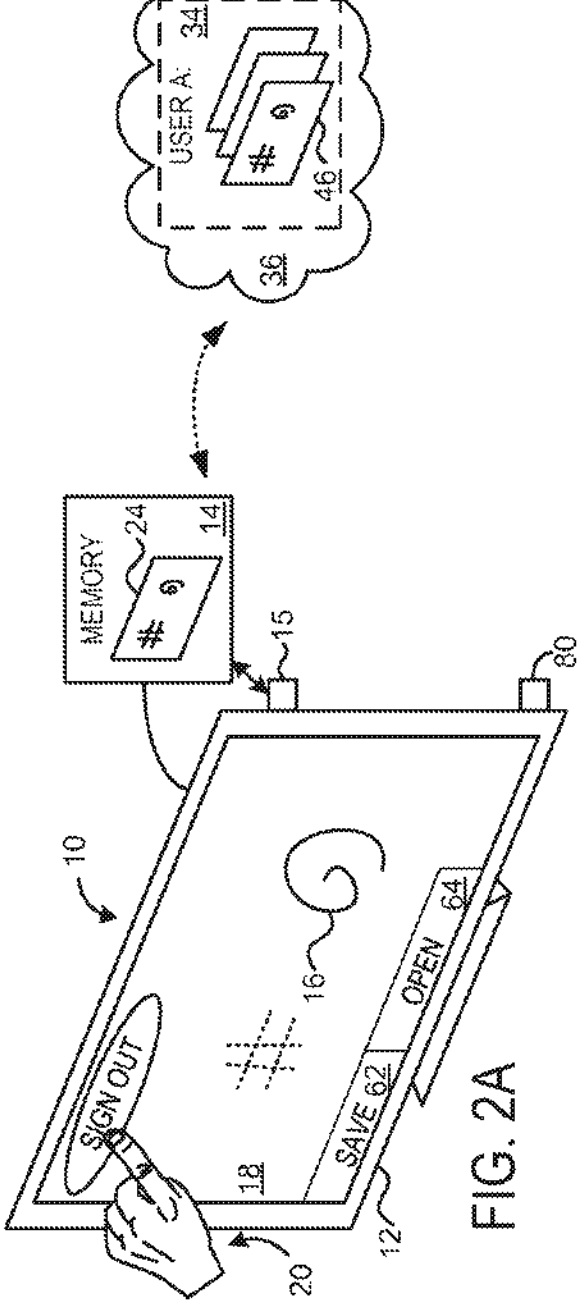


FIG. 2A

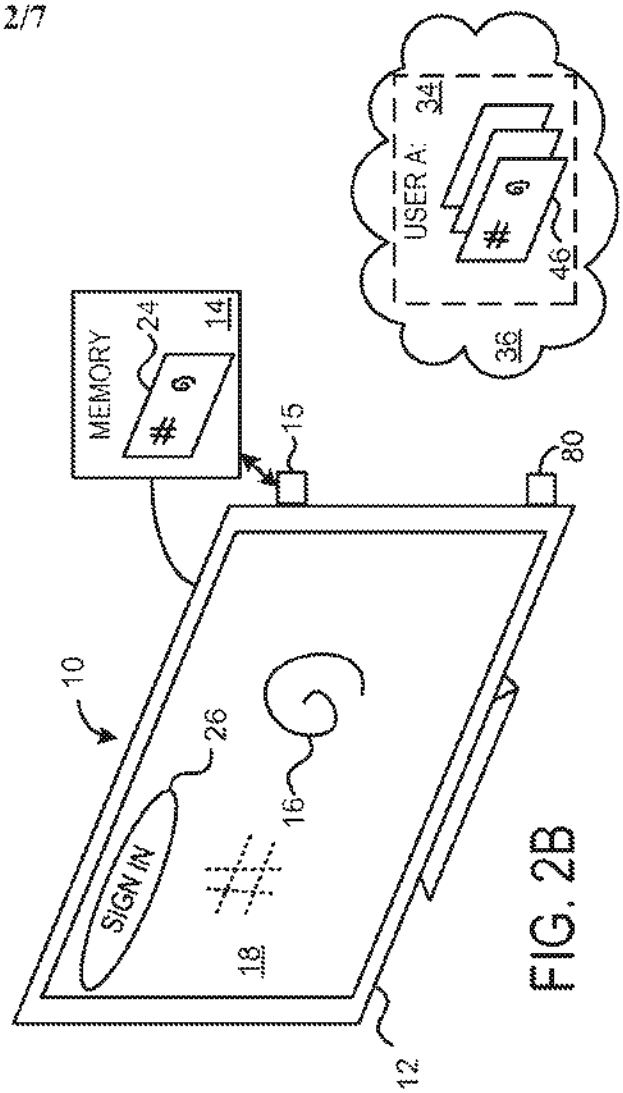


FIG. 2B

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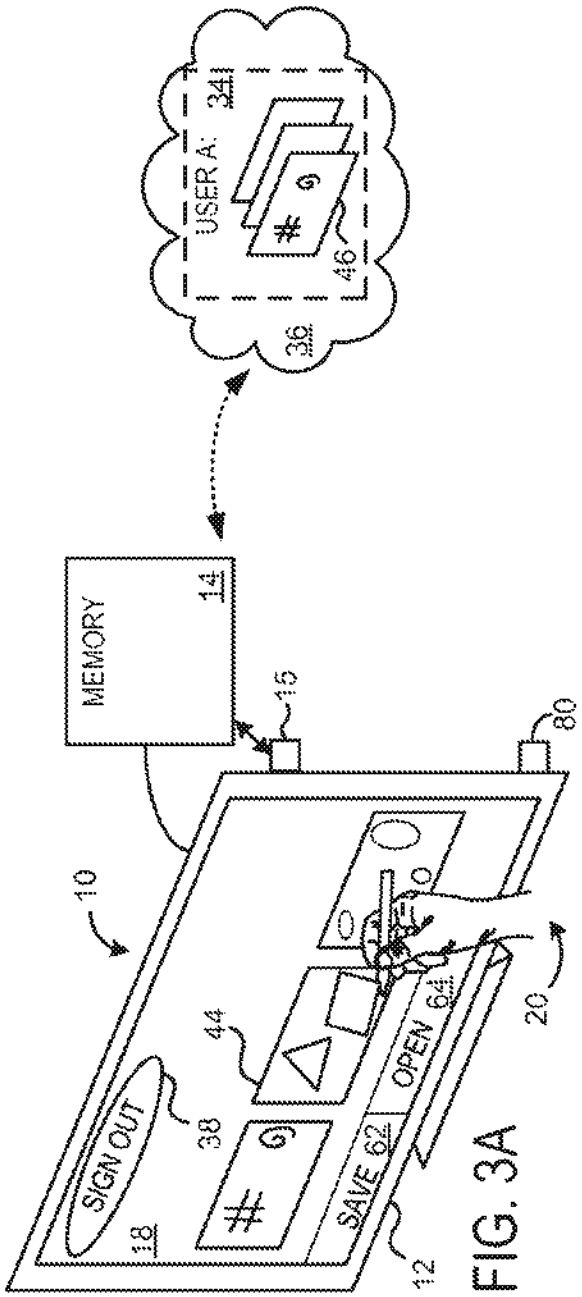


FIG. 3A

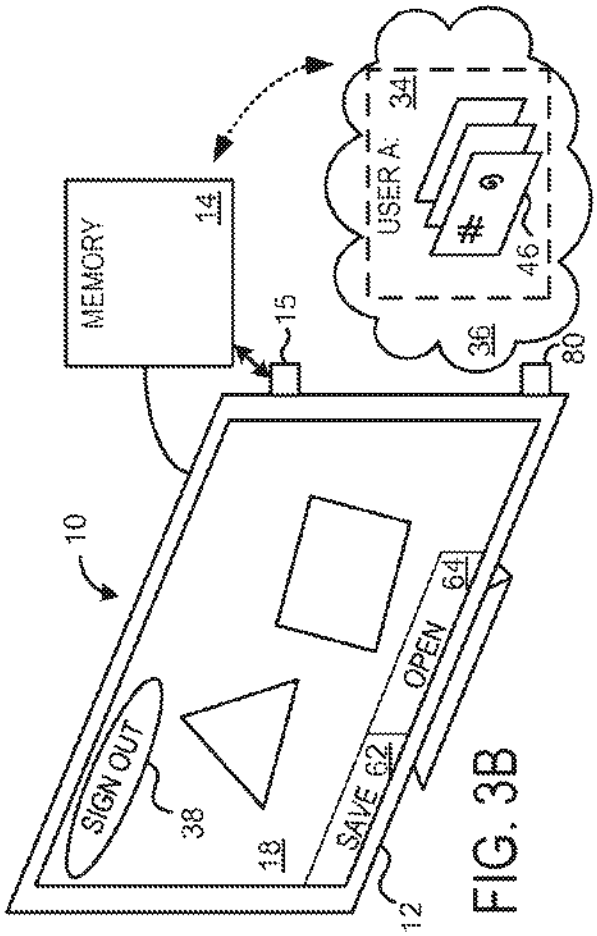


FIG. 3B

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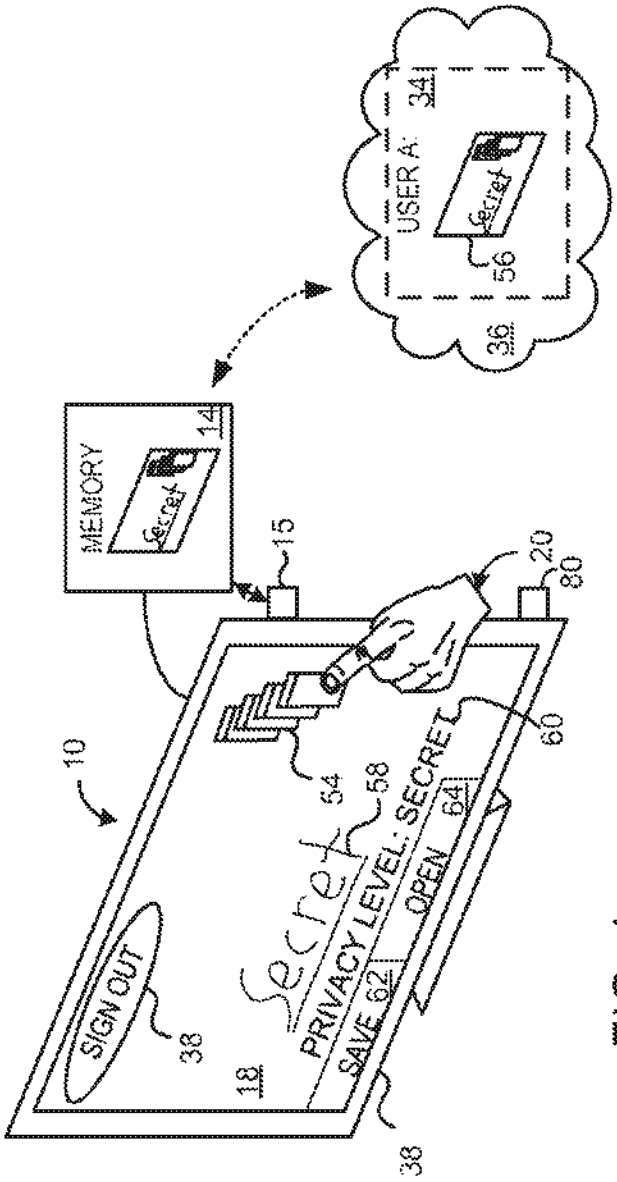


FIG. 4

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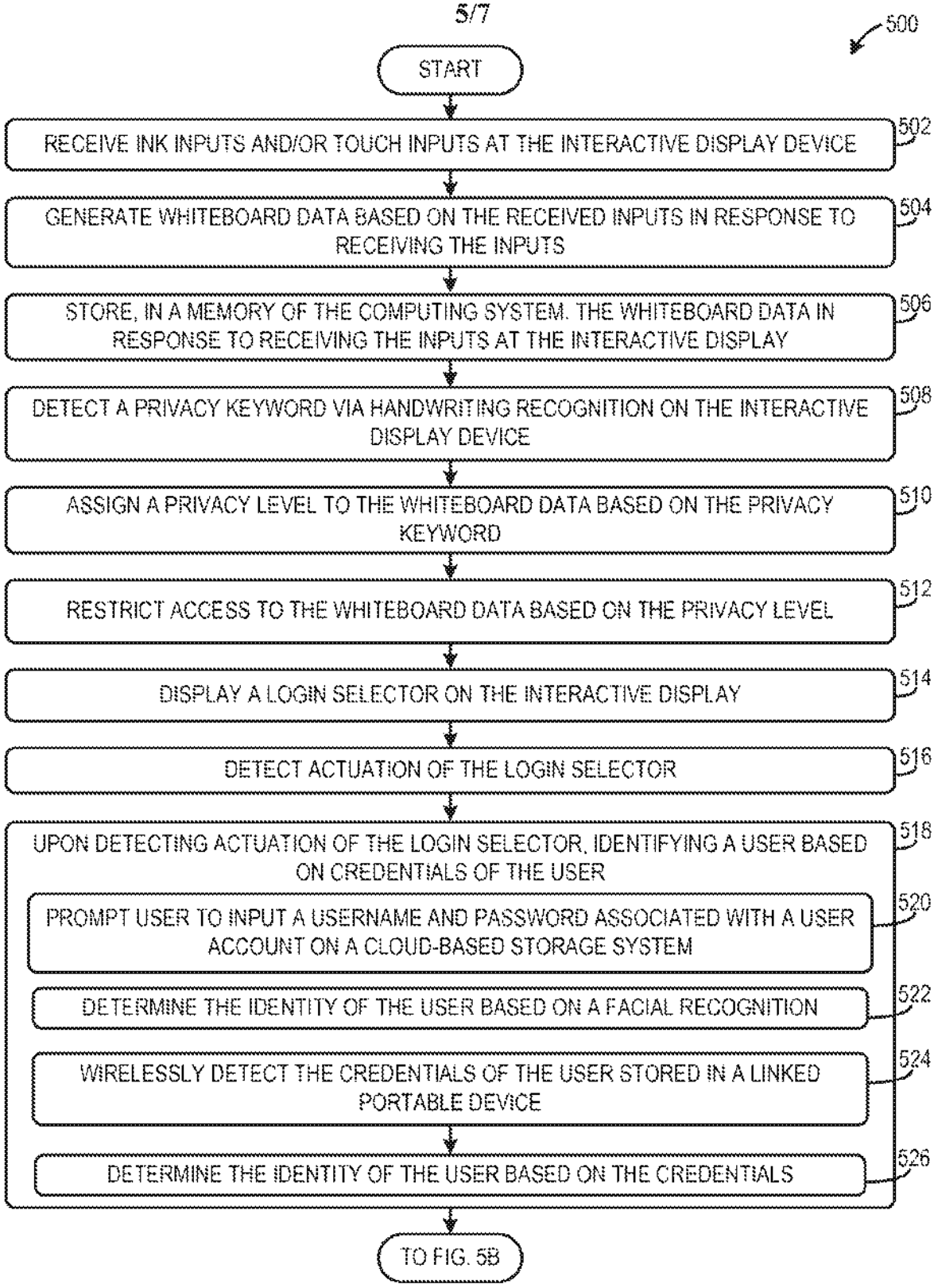


FIG. 5A

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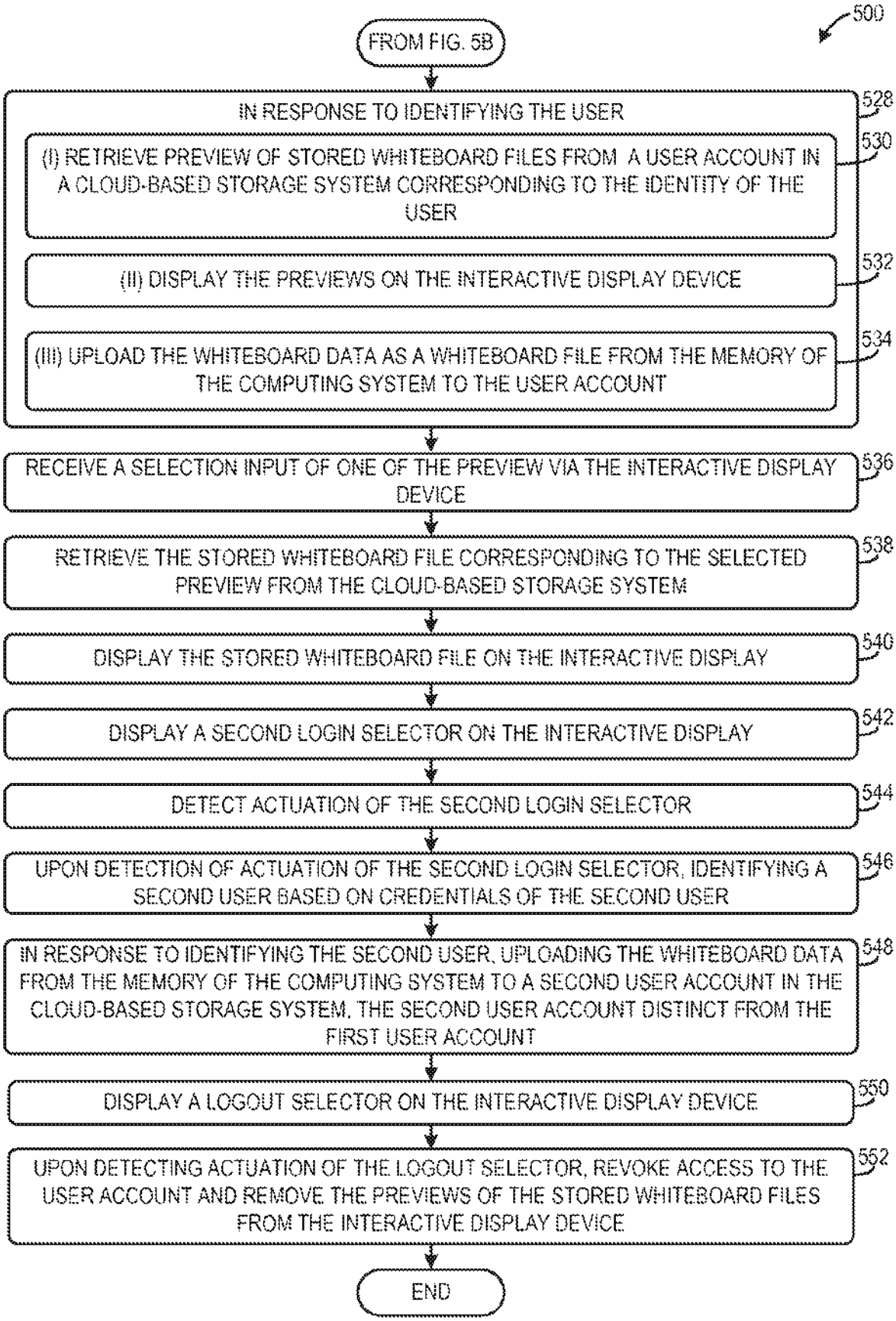


FIG. 5B

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Chemtronics Exhibit 1002 Page 799

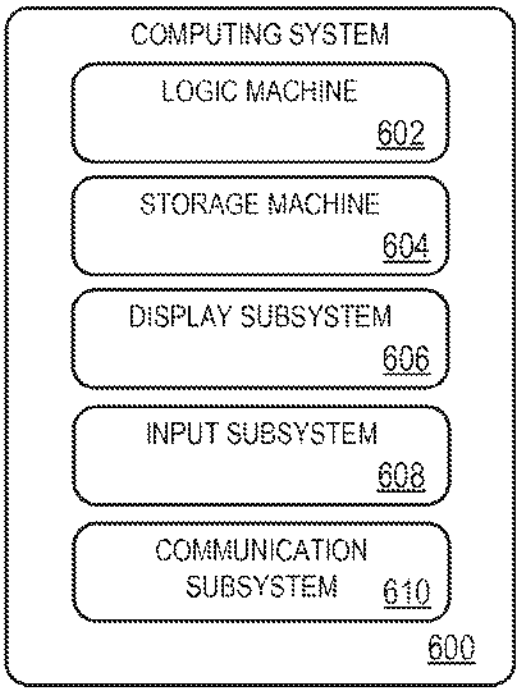


FIG. 6

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/030452

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F21/31 G06F21/32 G06F21/35
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2007/216660 A1 (SPOSATO STEVE [US] ET AL) 20 September 2007 (2007-09-20) paragraphs [0012], [0019] - [0024], [0026], [0029], [0043] - [0051], [0054] - [0056] figures 1, 2, 3, 6 -----	1-7,11, 13,15 8-10,12, 14
X Y	US 2004/139354 A1 (HORIKIRI KAZUNORI [JP] ET AL) 1 July 2004 (2004-07-01) paragraphs [0002], [0007], [0091] - [0093], [0100] - [0116], [0121], [0122], [0126] - [0146], [0224] - [0264] figures 3, 5 -----	1-7,11, 13,15 8

-/--

X Further documents are listed in the continuation of Box C.

X See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 October 2015	05/11/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	Volpato, Gian Luca

Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/030452

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/083109 A1 (HILDEBRANDT PETER W [US] ET AL) 7 April 2011 (2011-04-07) paragraphs [0003], [0008], [0013] - [0015], [0022], [0029] - [0032], [0054] - [0058], [0158] - [0161], [0197], [0229] - [0237] figures 26, 27, 30	1-8, 11, 13, 15
Y	US 2011/179352 A1 (TREADWELL WILLIAM S [US] ET AL) 21 July 2011 (2011-07-21) paragraphs [0002] - [0007], [0020] - [0022], [0026] - [0027], [0031], [0034], [0037], [0039] - [0044], [0060] figure 2	9, 14
Y	"IMS GLC IWB/CFF Specification Version 1.0 Final Specification", , 1 February 2012 (2012-02-01), XP055224018, Retrieved from the Internet: URL:https://www.imsglobal.org/specificationdownload.cfm [retrieved on 2015-10-28] the whole document	10, 12
A	"Blackboard collaborate web conferencing Version 12.6", , 1 November 2013 (2013-11-01), XP055224027, Retrieved from the Internet: URL:www.blackboard.com/docs/documentation.htm?DocID=611004PDF [retrieved on 2015-10-28] page 71 - page 94	10, 12

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/030452

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by the Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1 ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2 ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3 ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8, 11, 13, 15

   Method and system for claiming data from a virtual whiteboard

   ---

2. claims: 9, 14

   Method and system for classifying user input

   ---

3. claims: 10, 12

   Definition of data format for whiteboard applications

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/030452

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 2007216660 A1	20-09-2007	NONE		
US 2004126354 A1	01-07-2004	CN 1499841	A	26-05-2004
		JP 4321203	B2	26-08-2009
		JP 2004171526	A	17-06-2004
		US 2004126354	A1	01-07-2004
US 2011083109 A1	07-04-2011	AU 2004246630	A1	16-12-2004
		CA 2526306	A1	16-12-2004
		EP 1636688	A2	22-03-2006
		JP 2006526958	A	24-11-2006
		US 2004070616	A1	15-04-2004
		US 2011083109	A1	07-04-2011
		WO 2004109496	A2	16-12-2004
US 2011179352 A1	21-07-2011	US 2011179352	A1	21-07-2011
		WO 2011090671	A1	28-07-2011

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 7/051 224

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 201 301 06709 A 1 (SIMMONS MARTIN JOHN), 2 May 2013 (201 3-05-02), abstract; paragraphs [0020], [0028], [0030], [0032], [0036]-[0038], [0040]-[0041], [0045]; figure 4A; claim 15	1-2, 5, 8-1 1, 17-18, 24
Y	--	3-4, 6-7, 12-1 6, 19-23, 25
Y	US 201 60004898 A 1 (HOLZ CHRISTIAN), 7 January 201 6 (201 6-01 -07); abstract; paragraphs [0031], [0033]-[0035], [0037], [0046]-[0047], [0050]; figure 4; claims 15-1 6	3-4, 6-7, 15-1 6, 25
A	--	1-2, 5, 8-14, 17-24

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23-02-201 8	23-02-201 8

Name and mailing address of the ISA/SE	Authorized officer
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Form PCT/ISA/210 (second sheet) (January 2015)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 20120313865 A1 (PEARCE NIGEL), 13 December 2012 (2012-12-13); abstract; paragraphs [0132], [0134]-[0139]; figures 3,6	12-14
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Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/0354 (201 3.01)
G06F 3/041 (2006.01)
G06F 21/32 (201 3.01)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB201 7/057201

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, COMPENDEX, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category' *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 201 3 1 1571 0 A2 (FLATFROG LAB AB), 8 August 201 3 (201 3-08-08); abstract; page 26, line 9 - page 29, line 14 --	1-23
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06-03-201 8	06-03-201 8

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No.
PCT/IB201 7/057201

Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/042 (2006.01)

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Espacenet

Bibliographic data: WO2014086084 (A1) — 2014-06-12

INFRARED TOUCH SCREEN

Inventor(s): TANG HAIWEI [CN]; ZHONG DECHAO [CN]; AO YONG [CN] ± (TANG, HAIWEI, ; ZHONG, DECHAO, ; AO, YONG)

Applicant(s): GENERALTOUCH TECHNOLOGY CO LTD [CN]; TANG HAIWEI [CN]; ZHONG DECHAO [CN]; AO YONG [CN] ± (GENERALTOUCH TECHNOLOGY CO., LTD, ; TANG, HAIWEI, ; ZHONG, DECHAO, ; AO, YONG)

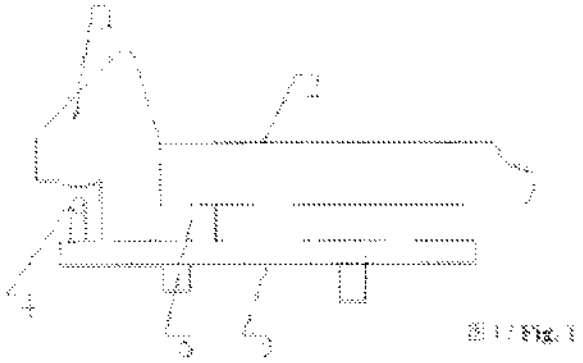
Classification: **- international:** ***G06F3/00***
- cooperative: **G06F3/0428**

Application number: WO2013CN00321 20130319 Global Dossier

Priority number(s): CN20121515263 20121205 ; CN20122662306U 20121205 ; CN20122662044U 20121205

Abstract of WO2014086084 (A1)

Disclosed is an infrared touch screen, including a light guiding pillar, a touch screen body, a circuit board and an infrared tube. A bearing platform is provided on the light guiding pillar and integrally formed with the light guiding pillar; the bearing platform is located between the touch screen body and the circuit board; and the touch screen body is fixedly connected to the bearing platform, and the circuit board is fixedly connected to the bearing platform. The invention enables infrared light emitted by an infrared ray emission tube to be transmitted to an infrared receiving tube with minimal attenuation, and can also avoid the occurrence of the edge effect, so that a touch screen body and a circuit board can be located and mounted, and the touch screen body maintains a relatively high degree of parallelism, further reducing the suspension height.



(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国 际 局

(43) 国际公布日
2014 年 6 月 12 日 (12.06.2014)

WIPO | PCT

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WO 2014/086084 A1

(51) 国转 利分类号：
G06F 3/00 (2006.01)

(21) 国际申请号： PCT/CN20 13/000321

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(25) 申飾 言： 中文

(26) 公布语言： 中文

(30) 优先权：
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201220662306.X 2012 年 12 ¼ 5 日 (05.12.2012) CN
201220662044.7 2012 年 12 月 5 日 (05. 12.2012) CN

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(74) 代理人：成都天嘉专利事务所 (普通合伙) (CHENGDU TIANJIA PATENT OFFICE (GENERAL PARTNERSHIP))；中国四川省成都市武侯区洗面桥街 13 号 2 楼毛¾军 ,Chengdu 610041 (CN)。

(81) 指定国 (除另有指明，要求每一种可提供的国家保护)：AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, ML, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国 (除另有指明，要求每一种可提供的地区保护)：ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

本国际公布：

- 包括国际检索报告(条约第 21 条(3))。

(54) Title: INFRARED TOUCH SCREEN

(54) 发明名称 :红外触摸屏

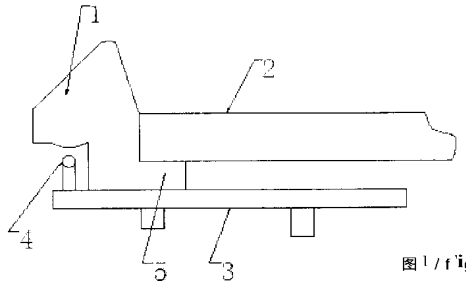


图 1 / f Fig. 1

(57) Abstract: Disclosed is an infrared touch screen, including a light guiding pillar, a touch screen body, a circuit board and an infrared tube. A bearing platform is provided on the light guiding pillar and integrally formed with the light guiding pillar; the bearing platform is located between the touch screen body and the circuit board; and the touch screen body is fixedly connected to the bearing platform, and the circuit board is fixedly connected to the bearing platform. The invention enables infrared light emitted by an infrared ray emission tube to be transmitted to an infrared receiving tube with minimal attenuation, and can also avoid the occurrence of the edge effect, so that a touch screen body and a circuit board can be located and mounted, and the touch screen body maintains a relatively high degree of parallelism, further reducing the suspension height.

(57) 摘要：本发明公开了一种红外触摸屏，包括导光柱、触摸屏体、电路板和红外管，所述导光柱上设置有与导光柱成一体的承台，所述承台位于触摸屏体和电路板之间，且触摸屏体与承台固定连接，电路板与承台固定连接。本发明能使红外线发射管发出的红外光以最少的衰减传输到红外接收管，又可以避免产生边沿效应，使触摸屏体与电路板能够进行定位安装，使触摸屏体保持较高的平行度，进一步减小悬浮高度。

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说 明 书

红外触摸屏

技术领域

[0001] 本发明涉及一种触摸屏，尤其涉及一种红外触摸屏。

背景技术

[0002] 现有红外触摸产品，其采用方式都是通过由沿着触摸区域四周安装在X、Y方向排布均匀的红外发射管和红外接收管，控制和驱动电路在MCU执行代码的控制下驱动红外发射管和红外接收管，对应扫描形成X方向和Y方向横竖交叉的红外线矩阵。当有触摸时，手指或其它物体就会挡住经过该点的横竖红外线，由控制系统判断出触摸点在触摸屏上的位置。

[0003] 目前在红外触摸屏领域，如专利号为200820109789.4的"一种应用于触摸屏上的反射镜"，此发明主要目的是：利用反射原理将，减少红外触摸屏上的发射和接收单元数量减半；如专利号为201020271758.6的"一种纯平结构的多点触摸屏"此发明的主要原理是：在普通红外触摸屏的基础上增加厂-个导光板，用于填充普通触摸屏触摸面上的凹腔，从而达到表面看似纯平的效果；如20071 0028616.X的"一种红外触摸屏及其多点触摸定位方法"等。现有红外触摸屏专利技术或产品屮无论是单点还是多点红外触摸屏，其红外触摸屏的基本组装方式，都是将红外管放于触摸屏的触摸面之上，在该结构中，都存在以下问题：1、抗光干扰的能力差。现有红外触摸屏，由于红外管是放在触摸面之上，外部的光线很容易射到红外接收单元，从而影响触摸屏的正常工作，因此一般的屏体都不能在强光(如阳光或较强的白炽灯)下正常工作。

[0004] 2、红外触摸屏触摸面的四边都存在较宽和较高的边沿凸起。在现有红外触摸屏领域，红外管一般都安装在屏体触摸面的上方，加上红外管保护结构的厚度，从而在屏体的四边形成较高和较宽的边沿凸起，对触摸屏的安装和触摸设备外观设计产生很大的限制，不容易用于制造真正的一体化红外触摸产品。

[0005] 针对上述问题，美国专利US2007/0165008 A1"一种小型红外屏触摸屏装置"，降低触摸屏边框宽度和产品成本。此装置"包括一个安装在框架里的触摸屏，一个安装在显示屏后部后面的电路板，一个安装在电路板上的红外发射装置和一个安装在电路板上的红外接收装置。一个第一反射装置和红外发射装置进行光通信，所述的第一反射装置可以改变显示屏后部红外发射装置产生的红外光束的方向，使其经过所述显示屏的前部区域。第二个反射装置与第一个反射装置进行光通信，第二个反射装置可以将改变所述显示屏前端的红外光束的

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方向，使其到达显示屏后部红外检测装置。" 但该技术在应用中还存在如下不足：

1. 由于红外发射装置和红外接收装置安装在电路板上，而电路板又安装在显示屏的背面，反射装置与显示屏又是相互独立的，在红外光通路上发射装与反射装置的相对位置不易确认和可靠的固定。大家都熟知红外发射装置和红外接收装置需要一一对应，这样势必会给安装调试带来很大的麻烦，同时显示屏背面不平整及显示屏与反光结构相对位置变化都会影响到安装精度，安装精度又会直接影响到触摸产品的性能。

[0006] 2. 由于安装红外发射装置的电路板和红外接收装置的电路板，均设置在显示屏的背面，而反射装置又超出显示屏的正面，显示屏存在一定的厚度，这将导致红外发射装置的发射的红外光传到红外接收装置接收需在反射装置中走过路径长，而导致红外接收装置接收的光强度很弱。使该红外屏装置成本高，可靠性差，抗干扰能力弱。

[0007] 3. 触摸面即为显示屏外表面，长时间使用会对显示屏造成很大影响，同时悬浮高度也没办法解决，即使用过程中还未 "点中" 触摸屏就已经响应，这样极易造成各种误操作。

[0008] 另有专利号为 2004201 17952.3 "一种使用反光镜的红外触摸屏的光路系统"，"由直立安装在与显示表面相平行的电路板上的红外发射和接收管阵列及其前方的，与显示表面成 45 度角的反光镜构成。红外发射管所发射的红外线被反光镜反射后，通过显示表面前方到达接收管前方的反光镜被反射到接收管。该结构特别适合触摸显示器.反光镜安装在显示表面和前面板之间构成光通路，发射和接收管安装在显示元件电路板上，在幅降低了触摸屏的厚度或高度。" 但是该技术在应用中存在如下不足：

1. 当安装红外发射管和接收管的电路板置于显屏的背面时，而反光镜又的超出显示屏的正面，显示屏都存在一定的厚度，这将导致红外发射管的红外光到红外接收管需走过的路径长，而导致红外接收管接收的光强度很弱。使该红外屏装置成本高，可靠性差，抗干扰能力弱。

[0009] 2. 红外光反射面与显示表面成 45 度角，若采用反光镜结构将会导致干扰光扰的进入和灰尘进入反射面造成反射性能的下降导致信号质量的下降，使工作的可靠性下降。若采用直角二棱镜的 45 度斜面作为反光面时，红外触摸屏的边沿效应会比较明显，这将严重影响触摸性能。

[0010] 3. 若该系统安装于显示屏正面时，不能达到降低触摸屏厚度或高度的效果。若电路板安装在显示屏的背面.而红外发射管和红外接收管安装的电路板上面，反光镜装置与显示屏又是相互独立的，在红外光通路上发射管与反射装置的相对位置不易确认和可靠的固定，而红外发射管和红外接收管需要一一对应，这样势必会给安装调试带来很大的麻烦，同时显

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示屏背面不平整及显示屏与反光结构相对位置变化都会影响到安装精度，安装精度又会直接影响到触摸产品的性能。电路板安装在显示屏的背面，反光装置与显示屏又是相互独立的，两者的想对位置极不稳定。

[0011] 4. 触摸面即为显示屏外表面，长时间使用会对显示屏造成很大影响，同时悬浮高度也没办法解决，即使用过程中还未"点中"触摸屏就已经响应，这样极易造成各种误操作。

发明内容

[0012] 本发明的目的在于克服现有红外触摸屏存在的上述问题，提供一种新型的红外触摸屏。本发明能使红外线发射管发出的红外光以最少的衰减传输到红外接收管，又可以避免产生边沿效应，使触摸屏体与电路板能够进行定位安装，使触摸屏体保持较高的平行度，进一步减小悬浮高度。

[0013] 为实现上述目的，本发明采用的技术方案如下：

一种新型的红外触摸屏，包括导光柱、触摸屏体、电路板和红外管，其特征在于：所述导光柱上设置有与导光柱成一体的承台，触摸屏体四周固定设置在所述承台上。

[0014] 所述承台位于触摸屏体和电路板之间，且触摸屏体与承台固定连接，电路板与承台固定连接。

[0015] 所述导光柱内侧横向延伸形成所述承台，外侧竖向延伸形成裙边，电路板分别与承台和裙边密封固定连接，裙边、导光柱、承台和电路板围合形成一密闭腔，红外管位于密闭腔内。

[0016] 所述导光柱的横截而成倾斜的凸字形，凸字形中部的下部内凹，一侧延伸形成承台，另一侧延伸形成竖向裙边。

[0017] 所述凸字形导光柱的内凹面、外侧面、内侧面为弧形面和平面的组合。

[0018] 所述内凹面为弧形面，外侧面和内侧面为平面，外侧面与承台所在面的夹角为大于39.5°小于45°或大于45°小于55°，内侧面与承台所在面的夹角为大于64°小于90°或大于90。小于140。。

[0019] 所述内凹面为弧形面，外侧面为弧形面，内侧面为平面，内侧面与承台所在面的夹角为大于64。小于90°或大于90°小于140°。

[0020] 所述内凹面为平面，与触摸屏体平行或在同一平面上，外侧面和内侧面均为弧形面。

[0021] 所述内凹面、外侧面和内侧面均为弧形面。

[0022] 所述内凹面、外侧面和内侧面均为平面，外侧面与承台所在面的夹角为大于39.5°

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小于 45° 或大于 45° 小于 55° ，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90。小于 140° 。

[0023] 所述触摸屏体与承台的上表面平行，所述电路板与承台的下表面平行。

[00241 所述承台、电路板和触摸屏体密封连接形成一个 U 形腔体，该 U 形腔体的开口通过连接件密封连接形成密闭腔，红外管位于该密闭腔内。所述的连接件可以是防尘泡棉和密封胶的结合。

[0025] 所述触摸屏体与承台的密封连接方式为粘接，电路板与承台的密封连接方式为粘接或设置密封件并通过螺栓连接。

[0026] 所述导光柱上设置有连接槽，触摸屏体四周嵌入式设置在连接槽中。

[0027] 所述的触摸屏体截面呈倒置的 "凸" 字形，倒 "凸" 形触摸屏体上部形成屏体触摸表面，下部中间部分凸出形成凸台，触摸屏体四周固定连接在承台上，所述电路板设置于承台内侧与触摸屏体卜部凸台侧壁形成的空腔中。

[0028] 所述电路板粘接在倒 "凸" 形触摸屏体两侧的台阶处。

[0029] 所述红外线触摸屏还包括一护板，所述护板位于触摸屏体中部凸台和承台的下部，并与触摸屏体中部凸台和承台的下部粘接，电路板设置在由触摸屏体、承台、护板所围成的相对密闭腔内。

[0030] 所述护板为金属板，金属护板设置有固定金属护板的螺纹孔。

[0031] 所述护板为聚脂薄膜片。

[0032] 所述触摸屏体由双层玻璃或透明塑胶粘合形成整体。

[00331 所述触摸屏体由一张玻璃或透明塑胶切割形成。

[0034] 所述触摸屏体密封固定连接在承台上，电路扳的非元件面与触摸屏体背面粘接，且电路板上的红外管均位于承台内侧。

[0035] 所述触摸屏体与承台的上表面粘接连接。

[0036] 所述触摸屏体与导光柱的内表面嵌合连接。

[0037] 所述触摸屏体的正面或背面设置有至少一层遮挡层，所述遮挡层位于触摸屏体非显示区域内。

[0038] 所述触摸屏体的四周设置有遮挡层。

[0039] 所述遮挡层是由胶带、遮光纸、半透明材料、塑料膜或金属片制成的薄片，所述薄片与触摸屏体粘接连接。

[0040] 所述遮挡层是涂覆在触摸屏体上的油漆涂层或油墨涂层。

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[0041] 所述遮挡层的厚度为 0.003 — 2mm 。

[0042] 采用本发明的优点在于：

一、本发明中，所述导光柱上设置有与导光柱成一体的承台，所述承台位于触摸屏体和电路板之间，且触摸屏体与承台固定连接，电路板与承台固定连接，固定在电路板上的红外管位于承台外侧的导光柱下方，与现有技术中导光柱通过触摸屏体来定位的结构相比，本发明采用承台结构，触摸屏体通过承台来安装定位，在安装时，触摸屏体能够快速定位在由导光柱形成的一体式框架结构内，整体性更好，相应地使电路板、红外发射管和红外接收管也能够快速定位安装，使得红外触摸产品安装调试简便，有利于整个触摸屏结构的稳定，使触摸屏体的平行度和精确度更高，能够提升触摸屏的触摸精度和响应速度，由于承台的支撑作用，可以使用比传统红外触摸屏更薄的触摸屏体，使用更薄的触摸屏体，不仅能够节约生产材料，降低生产成本，还使红外光在触摸屏上的传输路径变短，传输路径变短能够减少红外光的发散度，提高触摸精度，更薄的触摸屏体也使整个触摸屏更富有美感，有利于增强市场竞争力；同时根据实际需要，生产不同厚度的承台，与不同厚度的触摸屏体配合，能够提高触摸屏体的平行度，无限减小触摸悬浮高度问题；解决了现有技术中触摸悬浮高度较高、触摸屏体不易定位、平行度低、设备使用寿命低及触摸屏四边有较高和较宽边沿凸起的问题。

[0043] 二、本发明中，所述导光柱内侧横向延伸形成所述承台，外侧竖向延伸形成裙边，电路板分别与承台和裙边密封固定连接，裙边、导光柱、承台和电路板围合形成一密闭腔，红外管位于密闭腔内，采用此结构，由于红外管是设置在密封腔内，能够减小外界强光对红外发射管和红外接收管的干扰，提高信号发射和接收的精确度，并且裙边具有防止灰尘进入触摸屏内的作用，可以延长触摸屏的使用寿命。

[0044] 三、本发明中，所述导光柱的横截面成倾斜的凸字形，凸字形中部的下部内凹，一侧延伸形成承台，另一侧延伸形成竖向裙边，承台和裙边均为延伸形成，与导光柱为一体式结构，导光柱对红外光* 进行会聚和/或反射和/或折射，使红外光束尽可能汇聚成平行光通过触摸屏的触摸区域，减小红外光信号的衰减，增强红外光束的信号强度，提高触摸屏的抗干扰能力。

[0045] 四、本发明中，所述凸字形导光柱的内凹面、外侧面、内侧面为弧形面和平面的组合，可适用于不同厚度、不同材质的触摸屏，并且通过弧形面和平面的组合，便于调整红外光的汇聚和反射，适当调整红外管与弧形面的距离，在发射端能将红外管发出的发射角度分散的红外光汇聚成近似平行光向前传输，在接收端又能将较大角度范围内的近似平行的红外光汇聚，即能增加检测范围又能增强接收红外光信号强度，从而有利于减少红外光信号的损

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失，提高红外触摸产品的抗干扰能力，提高红外触摸产品的触摸精度。

[0046] 五、本发明中，所述内凹面为弧形面，外侧面和内侧面为平面，外侧面与承台所在面的夹角为大于 39.5° 小于 45° 或大于 45° 小于 55° ，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° ，红外光通过内凹面汇聚和反射，便于红外光的汇聚，再通过外侧面和内侧面反射，此范围内的角度即能保证发射管发出的红外光在红外反光界面上发生全发射，防止红外信号的损失，适当调整折射界面与垂直方向的角度，又能使得反射后的红外光经折射界面折射后以平行于水平面的方向传输，同时又可以避免边沿效应。

[0047] 六、本发明中，所述内凹面为弧形面，外侧面为弧形面，内侧面为平面，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° ，红外光通过内凹面和外侧面的两次汇聚和发射，进一步保证红外光的汇聚，减少红外光的损失，再通过内侧面反射到触摸屏体上，且内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° ，可以避免边沿效应。

[0048] 七、本发明中，所述内凹面为平面，与触摸屏体平行或在同一平面上，外侧面为弧形面，内侧面为弧形面，红外光通过内凹面反射，再通过外侧面和内侧面汇聚和反射到触摸屏体上，减少了导光柱内的红外光损失，提高了触摸精度。

[0049] 八、本发明中，所述内凹面、外侧面和内侧面均为平面，外侧面与承台所在面的夹角为大于 39.5° 小于 45。或大于 45° 小于 55° ，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° ，红外光通过内凹面、外侧面和内侧面直接反射到触摸屏体上，便于控制红外光与触摸屏体之间的距离，从而有利于减小悬浮高度。

[0050] 九、本发明中，所述内凹面、外侧面和内侧面均为弧形面红外光通过三个面的汇聚和反射，进一步减小了红外光的损失。

[0051] 十、本发明中，所述触摸屏体与承台的上表面平行，所述电路板与承台的下表面平行，此结构不仅能够增强屏体的平行度，还使红外发射管与导光柱之间、红外接收管与导光柱之间的对应精度更高，有利于增强红外光的聚集度，进一步克服因触摸悬浮高度引起的触摸提前响应问题。

[0052] 十一、本发明中，所述导光柱上设置有连接槽，触摸屏体四周嵌入式设置在连接槽中，使导光柱与触摸屏体结合得更紧密，整个触摸屏中各部件的稳定性更好。

[0053] 十二、本发明中，所述承台、电路板和触摸屏体密封连接形成一个 U 形腔体，该 U 形腔体的开口通过连接件密封连接形成密闭腔，红外管位于该密闭腔内，该密闭腔对电路板及电路板上的红外发射管构成二次保护，能够防止外部强光、灰尘或水从触摸屏各部件间的

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细小缝隙进入触摸屏内部，影响红外收发管的发射接精度，此结构有利于提高触摸屏的使用寿命。

[0054] 十三、本发明中，所述触摸屏体与承台的密封连接方式为粘接，电路板与承台的密封连接方式为粘接或设置密封件并通过螺栓连接，与现有技术直接将电路板粘接在触摸屏体下方相比，首先此结构使电路板及电路板上的红外管更稳定，即使长久使用，也不会降低发射和接收精度，触摸屏的使用效果更好，其次，当电路板或触摸屏体损坏时，由于不便拆卸，现有技术需要同时更换电路板和触摸屏体，而采用此方式只需要单独更换损坏部件即可。

[0055] 十四、本发明中，所述的触摸屏体截面呈倒置的"凸"字形，倒"凸"形触摸屏体上部形成屏体触摸农面，下部中间部分凸出形成凸台，触摸屏体四周固定连接在承台上，所述电路板设置于承台内侧与触摸屏体下部凸台侧壁形成的空腔中，通过电路板位置，也就改变红外管的位置，减少了传统红外屏的边框厚度，可以做到超低超窄边框；另一方面，又可以根据光源设计成特定的光束控制透镜，满足触摸扫描检测对光源的要求。

[0056] 十五、本发明中，所述电路板粘接在倒"凸"形触摸屏体两侧的台阶处，采用该结构红外管在触摸屏体第一层背部，能有效降低触摸屏整体厚度，同时由于采用导光柱达成超薄边框，超低边框，及超低悬浮高度。

[0057] 十六、本发明中，所述红外线触摸屏还包括一护板，所述护板位于触摸屏体中部凸台和承台的下部，并与触摸屏体中部凸台和承台的下部粘接，电路板设置在由触摸屏体、承台、护板所围成的相对密闭腔内，能有效的避免灰尘，水等其它物质对红外光传输的影响，保证恶劣条件下触屏的正常使用，同时提高了产品的防护性。

[0058] 十七、本发明中，所述触摸屏体密封固定连接在承台上，电路板的非元件面与触摸屏体背面粘接连接，且电路板上的红外管均位于承台内侧，此结构使电路板及电路板上的红外管在触摸屏内更稳定，红外接收管都能精确地接收到对应红外发射管发射的经导光柱反射后的红外光。

[0059] 十八、本发明中，由于在触摸屏体非显示区域的正面或背面设置有遮挡层，因此外界强光难以穿透遮挡层并照射到红外管，减小了外界强光对红外管的干扰，提高了信号发射和接收的精确度，同时对设置在触摸屏体背面的电路板、红外管起遮挡作用，使产品外观更富有美感，有利于扩人市场竞争力；克服了现有技术中触摸屏抗光干扰能力差、产品缺乏美感的缺点。

[0060] 十九、本发明中，在所述触摸屏体的四周还问样设置冇遮挡层，此结构能够阻止外

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界强光穿过导光柱后从触摸屏体四周进入触摸屏体的显示区域，与触摸屏体非显示区域的正面或背面设置的遮挡层配合，能够对红外管全面保护，抗光干扰能力更强。

[0061] 二十、本发明中，所述遮挡层是由胶带、遮光纸、半透明材料、塑料膜或金属片制成的薄片，所述薄片与触摸屏体粘接连接，使用常见的材料和简单的粘接方式就能克服现有技术中触摸屏抗光干扰能力差、产品缺乏美感的缺点，结构简单，成本低廉；相应地使用金属片作为遮挡层，还具有减少外界电磁对电路板干扰的优点。

[0062] 二十一、本发明中，使用油漆涂层或油墨涂层作为遮挡层，不仅克服了现有技术中触摸屏抗光干扰能力差、产品缺乏美感的缺点，还具有工艺简单，成本低廉的优点。

[0063] 二十二、本发明中，所述遮挡层的厚度为 0.003—2mm，如果遮挡层厚度大于 2mm，会挡住经导光柱反射出的红外光，造成触摸悬浮高度较高，如果遮挡层厚度小于 0.003mm，外界强光将穿过触摸屏体对红外管造成干扰，而将遮挡层的厚度设置为 0.003—2mm，既能对电路板、红外管起很好的保护作用，又不会引起触摸悬浮高度较高的问题。

[0064] 二十三、本发明的技术方案将边框由传统的 20MM 降为 3MM 左右，边框高度由 5MM 降为 1..5MM 左右，悬浮高度由 3-5MM 降为 0.3MM 以内。

[0065] 二十四、本发明中，由导光柱、触摸屏体、电路板、红外管形成的触摸屏系统，与显示屏是分开设置的，既可以单独出售触摸屏，也可以与显示屏组装后一起出售，满足不同用户需要。

附图说明

[0066] 图 1 为本发明实施例 1 结构示意图

图 2 为本发明实施例 2 结构示意图

图 3 为本发明实施例 3 结构示意图

图 4 为本发明实施例 4 结构示意图

图 5 为本发明实施例 7 结构示意图

图 6 为本发明实施例 8 结构示意图

图 7 为本发明实施例 11 结构示意图

图 8 为本发明实施例 12 结构示意图

图 9 为本发明实施例 13 结构示意图

图 10 为本发明实施例 14 结构示意图

图 11 为本发明实施例 15 结构示意图

图 12 为本发明实施例 16 结构示意图

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图 13 为图 12 中的触摸屏俯视结构示意图

图中标记为：1、导光柱，2、触摸屏体，3、电路板，4、红外管，5、承台，6、裙边，7、密闭腔，8、内凹面，9、外侧面，10、内侧面，11、连接件，12、凸台，13、护板，14、螺纹孔，15、密封件，16、遮挡层，17、显示屏。

具体实施方式

[0067] 实施例 1

如图 1 所示，一种新型的红外触摸屏，包括导光柱 1、触摸屏体 2、电路板 3 和红外管 4，所述导光柱 1 上设置有与导光柱 1 成一体的承台 5，所述承台 5 位于触摸屏体 2 和电路板 3 之间，且触摸屏体 2 与承台 5 固定连接，电路板 3 与承台 5 固定连接，固定在电路板 3 上的红外管 4 位于承台 5 外侧的导光柱 1 下方。

[0068] 进一步地，所述触摸屏体 2 与承台 5 的上表面平行，所述电路板 3 与承台 5 的下表面平行。

[0069] 本发明中的红外管，包括红外接收管和红外发射管。触摸屏体 2 与承台 5 固定连接的方式可以为粘接，电路板 3 与承台 5 固定连接的方式可以为粘接或螺栓连接或螺栓与粘接配合连接。

[0070] 实施例 2

本实施例与上述实施例基本相同，主要区别在于：

如图 2 所示，本实施例中，所述导光柱 1 内侧横向延伸形成所述承台 5，外侧竖向延伸形成裙边 6，电路板 3 分别与承台 5 和裙边 6 密封固定连接，裙边 6、导光柱 1、承台 5 和电路板 3 围合形成一密闭腔 7，红外管 4 位于密闭 7 腔内。密封固定连接的方式可以采用粘接但并不局限于粘接。

[0071] 实施例 3

本实施例与上述实施例基本相同，主要区别在于：

如图 3 所示，所述导光柱的横截面成倾斜的凸字形，凸字形中部的下部内凹，一侧延伸形成承台，另一侧延伸形成竖向裙边。进一步地，裙边所在平面与电路板所在平面垂直。

[0072] 并且，所述凸字形导光柱的内凹面 8、外侧面 9、内侧面 10 为弧形面和平面的组合。

[0073] 例如，所述内凹面为弧形面，外侧面和内侧面为平面，外侧面与承台所在面的夹角为大于 39.5° 小于 45° 或大于 45° 小于 55°，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140°。

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[0074] 实施例 4

本实施例与上述实施例基本相同，主要区别在于：

如图 4 所示，所述凸字形导光柱的内凹面 8、外侧面 9、内侧面 10 为弧形面和平面的组合。

[0075] 例如，所述内凹面 8 为弧形面，外侧面 9 为弧形面，内侧面 10 为平面，内侧面 10 与承台 5 所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° 。

[0076] 实施例 5

本实施例与上述实施例基本相同，主要区别在于：

所述凸字形导光柱的内凹面 8、外侧面 9、内侧面 10 为弧形面和平面的组合。

[0077] 例如，所述内凹面 8 为平面，与触摸屏体平行或在同一平面上，外侧面 9 为弧形面，内侧面 10 为弧形面。

[0078] 实施例 6

本实施例与上述实施例基本相同，主要区别在于：

所述凸字形导光柱的内凹面 8、外侧面 9、内侧面 10 为弧形面和平面的组合。

[0079] 例如，所述内凹面为弧形面，外侧面为弧形面，内侧面为弧形面。

[0080] 实施例 7

本实施例与上述实施例基本相同，主要区别在于：

如图 5 所示，所述凸字形导光柱的内凹面 8、外侧面 9、内侧面 10 为弧形面和平面的组合。

[0081] 例如，所述内凹面 8、外侧面 9 和内侧面 10 均为平面，外侧面 9 与承台 5 所在面的夹角为大于 39.5° 小于 45° 或大于 45° 小于 55° ，内侧面 10 与承台 5 所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140° 。

[0082] 实施例 8

本实施例与上述实施例基本相同，主要区别在于：

如图 6 所示，所述导光柱 1 上设置有连接槽，触摸屏体 2 四周嵌入式设置在连接槽中。触摸屏体 2 四周嵌入连接槽中并粘接，底面四周边沿与承台 5 粘接。

[0083] 实施例 9

本实施例是对上述实施例 3 的进一步说明：

导光柱 1 的截面大致呈倾斜的 "凸" 字形，"凸" 字形导光柱一侧延伸为横向的承台 5，另一侧延伸为竖向的裙边 6，中部下端成外凸弧形面聚光界面；"凸" 字形导光柱的外侧端成倾斜平面反光界面，内侧端成倾斜的平面的折射界面。

[0084] 其工作原理是：红外线导光柱为折射率 1.488(以红外波长 0.94nm) 的 PMMA 材料，

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聚光界面设计为弧面，弧面焦点在红外发射单元(或接收单元)，反光界面与承台所在面的夹角大于 39.5° 小于 45° 或大于 45° 小于 55° (实质，反光界面与触摸面夹角大于 39.5° 小于 45° 或大于 45° 小于 55°)，当反光界面与触摸屏夹角为 48 度时，折射界面与触摸屏体夹角为 17 度，且发射端导光柱和接收端导光柱完全对称。在发射端红外发射管发出的红外光经聚光界面聚光后，大部分红外光转换为垂直向上的平行光，并且垂直向上的红外光以 48 度入射角入射红外反光界面，由于导光柱的折射率为 1.488，根据公式 (1.488 = sin90/sina) 可以计算出本材料的全反射角为 a=41.5 度，当红外光以 48 度入射角入射时，在反光界面上将发生全发射，反射后红外光与触摸屏夹角约等于 6 度，反射后的红外光以约为 11 度角入射折射界面，由折射率 1.488 计算出折射后的光以与触摸屏平行光出射；在接收端，从发射端导光柱传输过来的平行光入射到接受端红外导光柱折射界面，折射后约为 11 度入射到反光界面，发生全发射，反射后红外光经聚光界面汇聚后被红外接收管接收。利用凸透镜的聚光原理，适当调整红外管与曲面的距离，在发射端能将红外管发出的发射角度分散的红外光 (类似点光源)汇聚成近似平行光向前传输。在接收端又能将较大角度范围内的近似平行的红外光汇聚，即能增加检测范围又能增强接收红外光信号强度。从而有利于减少红外光信号的损失，提高红外触摸产品的抗干扰能力，提高红外触摸产品的触摸精度，同时又可以降低红外管发射功率，提高红外触摸产品的使用寿命。

[0085] 实施例 10

本实施例是对上述实施例 4 的进一步说明：

导光柱的截面大致呈倾斜的 "凸" 字形，"凸" 字形导光柱一侧延伸为横向的承台，另一侧延伸为竖向的裙边．屮部下端成外凸弧形面的聚光界面；"凸" 字形导光柱的外侧端成倾斜弧形面的反光界面，内侧端成倾斜的平面的折射界面。

[0086] 其工作原理是：导光柱为折射率 1.488(以红外波长 0.94nm) 的 PMMA 材料，聚光界面 8 设计为平面或弧形面，，反光界面为弧形面，折射界面与触摸屏体平面夹角为 17 度。发射端导光柱和接收端导光柱完全对称。在发射端红外发射管发出的红外光经聚光界面后，折射向上入射红外反光界面，在反光界面上将发生全发射，并且由于反光界面曲面产生聚焦成平行光 平行光以反射后红外光与触摸屏夹角约等于 6 度，反射后的红外光以约为 11 度角入射折射界面，由折射率 1.488 计算出折射后的光以与触摸面平行光出射；在接收端，从发射端导光柱传输过来的平行光入射折射界面，以约为 11 度折射角透射至反射界面，接着红外光发生全发射并由十反射界面为曲面产生聚焦而转为焦点在红外接收管的向下红外光透过聚光界面被红外接收管接收。所述红外反光界面为曲面时，类似凹面镜。具有如下优点：红外

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发射管发出的红外光经聚光界面聚光后并不能保证所有光线均为平行光，还是存在一部分有一定发散角度的红外光，利用凹面镜的聚光作用 (例如汽车灯，手电筒等) 可以将较大发散角度的红外光汇聚成平行光，从而有利于减少红外光信号的损失，提高红外触摸产品的抗干扰能力，提高红外触摸产品的触摸精度，同时又能降低红外管发射功率。

[0087] 上述所有实施例，能防止红外信号的损失，适当调整折射界面与垂直方向的角度，又能使得反射后的红外光经折射界面折射后以平行于水平面的方向传输，同时又可以避免边沿效应；有利于减少红外光信号的损失，提高红外触摸产品的抗干扰能力，提高红外触摸产品的触摸精度，同时又能降低红外管发射功率，提高红外触摸产品的实用寿命；实际产品中触摸屏固定于承台的上表面，电路板固定于承台的下表面。触摸屏固定在承台的上面,有利于整个导光柱结构的稳定，减少悬浮高度,同时也可以加强触摸手感，电路板固定(粘结或螺钉锁护)在承台的下表面，有利于红外发射和红外接收管的对位，使得红外触摸产品安装调试简便，适合大批量生产。

[0088] 实施例 11

一种新型的红外触摸屏，包括导光柱 1、触摸屏体 2、电路板 3 和红外管 4，所述导光柱 1 上设置有与导光柱 1 成一体的承台 5，所述承台 5 位于触摸屏体 2 和电路板 3 之间，且触摸屏体 2 与承台 5 固定连接，电路板 3 与承台 5 固定连接。

[0089] 进一步地，如图 7 所示，所述承台 5、电路板 3 和触摸屏体 2 密封连接形成一个 U 形腔体，该 U 形腔体的开口通过连接件 11 密封连接形成密闭腔，红外管 4 位于该密闭腔 7 内。所述的连接件 11 可以是防尘泡棉和密封胶的结合。

[0090] 本实施例的优选实施方式为，所述触摸屏体 2 与承台 5 的密封连接方式为粘接，电路板 3 与承台 5 的密封连接方式为粘接或设置密封件并通过螺栓连接。

[0091] 实施例 12

本实施例是对实施例 11 的进一步说明。如图 8 所示，所述导光柱 1 上设置有连接槽，触摸屏体 2 四周嵌入式设置在连接槽中，触摸屏体 2 底面四周与承台 5 通过密封胶密封。

[0092] 实施例 13

如图 9 所示，红外线触摸屏包括导光柱 1、触摸屏体 2、电路板 3，触摸屏体 2 截面呈倒置的 "凸" 字形，倒 "凸" 形触摸屏体 1 上部形成触摸表面，下部中间部分凸出形成凸台 12，触摸屏体 2 两侧的下部放置在导光柱 1 的承台 5 上，所述电路板 3 置于承台 5 内侧与触摸屏体下部凸台 12 侧壁形成的空腔中。电路板 3 粘接在倒 "凸" 形触摸屏体 2 两侧的下部台阶处。

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[0093] 所述红外线触摸屏还包括一护板 13，护板 13 位于触摸屏体 2 中部凸台 12 和承台 5 的下部，并与触摸屏体 2 中部凸台 12 和承台 5 的下部粘接。所述护板 13 选用金属板，金属护板上设置有固定金属护板的螺纹孔 14。可以通过螺纹孔 14 与显示屏连接。

[0094] 上述触摸屏体 2、导光柱 1、护板 13 围成一相对密闭腔 7，电路板 3 位于所述密闭腔 7 内。上述触摸屏体 2 由双层玻璃或透明塑胶粘合形成整体。

[0095] 该结构红外管 4 在触摸屏体第一层背部，能有效降低触摸屏整体厚度，同时由于采用导光元件达成超薄边框，超低边框，及超低悬浮高度，同时导光元件及触摸屏体背面，设置一安装护板以方便，触摸屏与显示设备 (显示器，一体机，平板电脑等) 的安装。

[0096] 实施例 14

本实施例与实施例 13 基本相同，主要区别如下：

如图 10 所示，所述护板 13 为聚脂薄膜片，能有效降低触摸屏整体厚度，同时由于采用导光元件达成超薄边框，超低边框，及超低悬浮高度。上述触摸屏体由一张玻璃或透明塑胶切割形成。

[0097] 该结构防水，防尘等功效更好，同时易与更换方便电路板等器件维修及更换。

[0098] 实施例 15

如图 11 所示，一种红外触摸屏，包括触摸屏体 2、导光柱 1、电路板 3，电路板 3 上固定安装有红外管 4，所述触摸屏体 2 与承台 5 的上表面粘接连接，所述电路板 3 的非元件面与触摸屏体 2 背面粘接连接，且电路板 3 上的红外管 4 均位于承台 5 内侧。

[0099] 或者所述承台 5 的下表面连接有密封件 15，所述密封件 15、触摸屏体 2 和承台 5 三者通过密封胶形成密闭腔结构，电路板 3 及电路板 3 上的红外管 4 均位于该密闭腔 7 内；密封件 15 与承台 5 优选粘接连接，但也可以通过螺栓连接或螺栓与粘接配合连接；所述密封胶包括防尘胶、防水胶、橡胶制品、硅胶制品，优选在密封的时候使用 EVI 泡绵、防尘条、EPE 等柔性实体配合密封。

[0100] 进一步的，所述密封件优选为 L 形塑料板或钣金面板，L 形一端与承台的下表面固定连接，另一端与触摸屏体背面粘接连接，但并不局限于上述设置方式，例如密封件也可以为圆弧形的金属片等。

[0101] 实施例 16

红外触摸屏，包括触摸屏体 2、导光柱 1、含红外管 4 的电路板 3，触摸屏体 2 的背面与导光柱 1 的承台 5 固定连接，所述触摸屏体 2 的正面或背面设置有至少一层遮挡层 16，所述遮挡层 16 位于触摸屏体 2 非显示区域内。

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[0102] 本实施例的优选实施方式为，所述设置在触摸屏体 2 正面或背面的遮挡层 16 与设置在触摸屏体 2 下方的显示屏 17 的边框齐平。

[0103] 进一步的，优选在所述触摸屏体 2 的四周还同样设置遮挡层 16，与触摸屏体 2 正面或背面的遮挡层 16 配合，对触摸屏体 2 全面保护，提高触摸屏的抗光干扰能力。

[0104] 本实施例的又一优选实施方式为，所述遮挡层 16 是由胶带、遮光纸、半透明材料、塑料膜或金属片制成的薄片，所述薄片与触摸屏体粘接连接，但并不局限于上述方式，也可采用现有技术中公知的其它遮光材料。

[0105] 本实施例的又一优选实施方式为，所述遮挡层 16 是涂覆在触摸屏体上的油漆涂层或油墨涂层。

[0106] 进一步的，所述遮挡层 16 可以通过印刷丝印工艺形成，即在需要遮挡的区域印刷黑色或具有花纹的图案等，还可以通过腐蚀或咬花工艺形成，即在需要遮挡的区域腐蚀或咬花，达到雾面效果，以遮挡红外管以及显示屏的金属边框，起到遮光与美化效果。

[0107] 本实施例的又一优选实施方式为，所述遮挡层 16 的厚度为 0.003 — 2mm 。

[0108] 所述触摸屏体 2 非显示区域是指除与显示屏 17 显示区域对应的屏体之外的区域。

[0109] 如图 12 和 13 所示，所述触摸屏体 2 的正面、背面和四周均设置有至少一层遮挡层 16，其中，触摸屏体 2 正面和背面的遮挡层 16 优选由相同材料制成，但并不局限于上述设置方式，例如触摸屏体正面的遮挡层由金属片制成，其背面的遮挡层由遮光纸制成，正面和背面遮挡层可以由上述任意一种材料制成。

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权 利 要 求 书

1. 一种红外触摸屏，包括导光柱（1）、触摸屏体（2）、电路板（3）和红外管（4），其特征在于：所述导光柱（1）上设置有与导光柱（1）成一体的承台（5），触摸屏体（2）四周固定设置在所述承台（5）上。

2. 根据权利要求 1 所述的红外触摸屏，其特征在于：所述承台（5）位于触摸屏体（2）和电路板（3）之间，且触摸屏体（2）与承台（5）固定连接，电路板（3）与承台（5）固定连接。

3. 根据权利要求 1 所述的红外触摸屏，其特征在于：所述导光柱（1）内侧横向延伸形成所述承台（5），外侧竖向延伸形成裙边（6），电路板（3）分别与承台（5）和裙边（6）密封固定连接，裙边（6）、导光柱（1）、承台（5）和电路板（3）围合形成一密闭腔，红外管（4）位于密闭腔内，

4. 根据权利要求 3 所述的红外触摸屏，其特征在于：所述导光柱（1）的横截面成倾斜的凸字形，凸字形中部的下部内凹，一侧延伸形成承台（5），另一侧延伸形成竖向裙边（6）。

5. 根据权利要求 4 所述的红外触摸屏，其特征在于：所述凸字形导光柱（1）的内凹面（8）、外侧面（9）、内侧面（10）为弧形面和平面的组合。

6. 根据权利要求 5 所述的红外触摸屏，其特征在于：所述内凹面（8）为弧形面，外侧面（9）和内侧面（10）为平面，外侧面（9）与承台（5）所在面的夹角为大于 39.5° 小于 45° 或大于 45° 小于 55°，内侧面（10）与承台（5）所在面的夹角为大于 64° 小于 90° 或大十 90° 小于 140°。

7. 根据权利要求 5 所述的红外触摸屏，其特征在于：所述内凹面为弧形面，外侧面为弧形面，内侧面为平面，内侧面与承台所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140°。。

8. 根据权利要求 5 所述的红外触摸屏，其特征在于：所述内凹面为平面，与触摸屏体平行或在同一平面上，外侧面和内侧面均为弧形面。

9. 根据权利要求 5 所述的红外触摸屏，其特征在于：所述内凹面（8）、外侧面（9）和内侧面（10）均为平面，外侧面（9）与承台（5）所在面的夹角为大于 39.5° 小于 45° 或大于 45° 小于 55°，内侧面（10）与承台（5）所在面的夹角为大于 64° 小于 90° 或大于 90° 小于 140°。

10. 根据权利要求 1—9 中任一项所述的红外触摸屏，其特征在于：所述触摸屏体（2）与承台（5）的上表面平行，所述电路板（3）与承台（5）的下表面平行。

11. 根据权利要求 1 所述的红外触摸屏，其特征在于：所述承台（5）、电路板（3）和触摸

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屏体 (2) 密封连接形成一个 U 形腔体，该 U 形腔体的开口通过连接件 (11) 密封连接形成密闭腔 (7)，红外管 (4) 位于该密闭腔 (7) 内。

12. 根据权利要求 10 所述的红外触摸屏，其特征在于：所述触摸屏体 (2) 与承台 (5) 的密封连接方式为粘接，电路板 (3) 与承台 (5) 的密封连接方式为粘接或设置密封件并通过螺栓连接。

13. 根据权利要求 10 所述的红外触摸屏，其特征在于：所述导光柱 (1) 上设置有连接槽，触摸屏体 (2) 四周嵌入式设置在连接槽中。

14. 根据权利要求 1 所述的红外触摸屏，其特征在于：所述的触摸屏体 (2) 截面呈倒置的 "凸" 字形，倒 "凸" 形触摸屏体 (2) 上部形成屏体触摸表面，下部中间部分凸出形成凸台 (12)，触摸屏体 (2) 四周固定连接在承台 (5) 上，所述电路板 (3) 设置于承台 (5) 内侧与触摸屏体 (2) 下部凸台 (12) 侧壁形成的空腔中。

15. 根据权利要求 14 所述的红外触摸屏，其特征在于：所述电路板 (3) 粘接在倒 "凸" 形触摸屏体 (2) 两侧的台阶处。

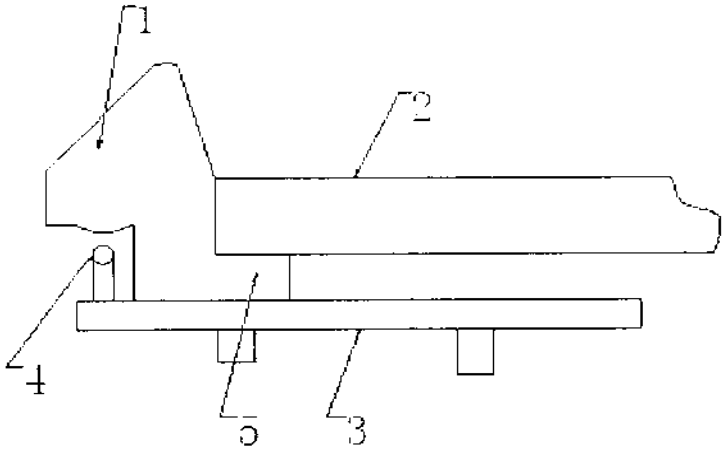
16. 根据权利要求 14 或 15 所述的红外触摸屏，其特征在于：还包括一护板 (13)，所述护板 (13) 位于触摸屏体 (2) 中部凸台 (12) 和承台 (5) 的下部，并与触摸屏体 (2) 中部凸台 (12) 和承台 (5) 的下部粘接，电路板 (3) 设置在由触摸屏体 (2)、承台 (5)、护板 (13) 所围成的相对密闭腔 (7) 内。

17. 根据权利要求 1 所述的红外触摸屏，其特征在于：所述触摸屏体 (2) 密封固定连接在承台 (5) 上，电路板 (3) 的非元件面与触摸屏体 (2) 背面粘接，且电路板 (3) 上的红外管 (4) 均位于承台 (5) 内侧。

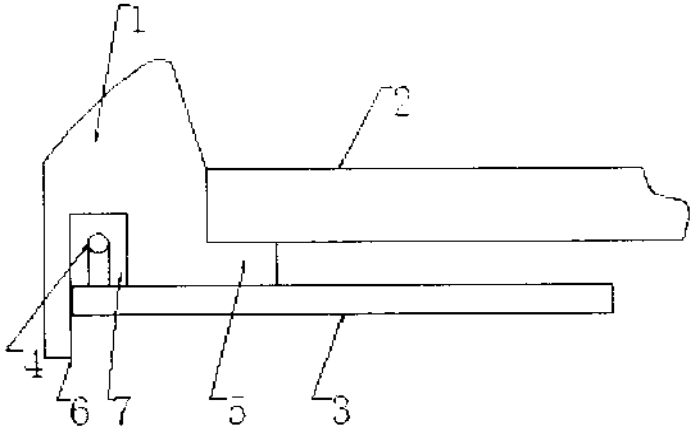
18. 根据权利要求 1—9、11、12、13、14、15 或 17 所述的红外触摸屏，其特征在于：所述触摸屏体 (2) 的正面或背面设置有至少一层遮挡层 (16)，所述遮挡层 (16) 位于触摸屏体 (2) 非显示区域内。

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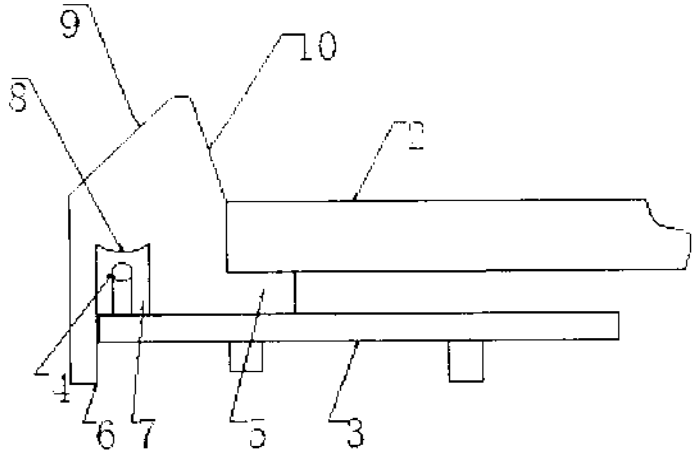
说 明 书 附 图



【图号】 图 1

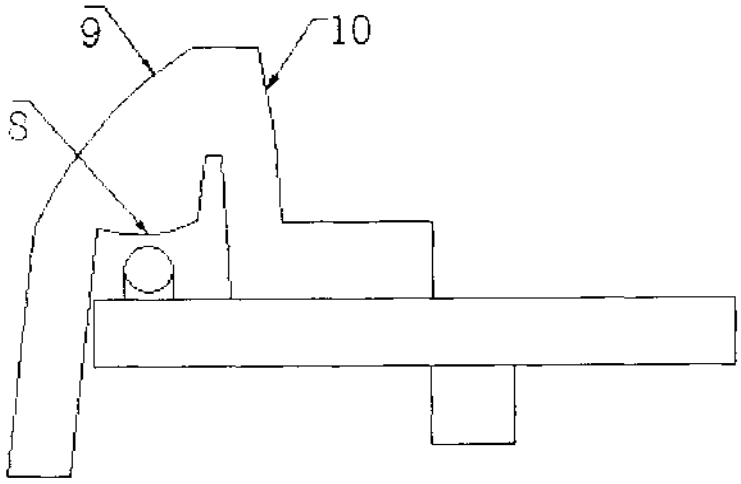


【图号】 图 2

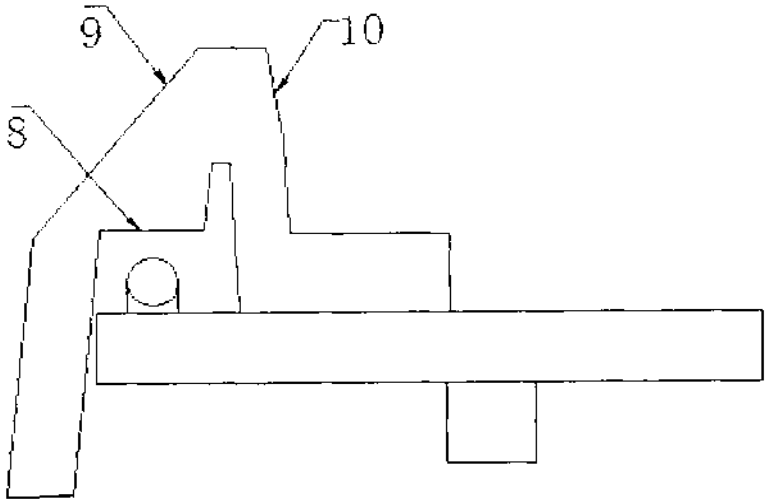


【图号】 图 3

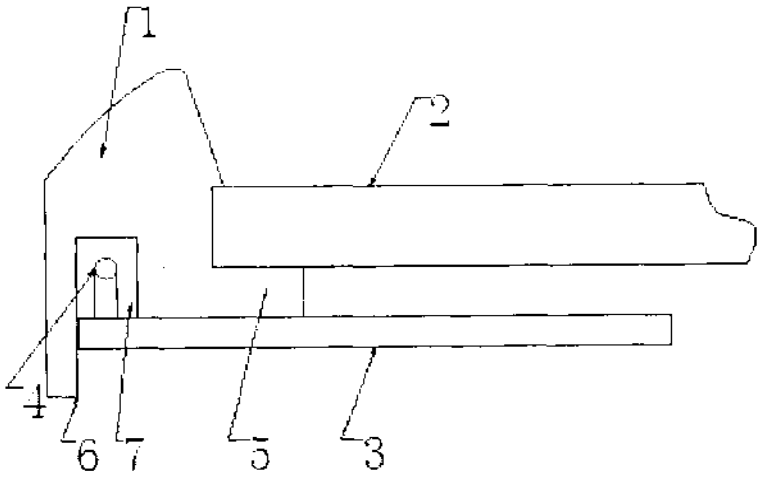
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【图号】 图 4

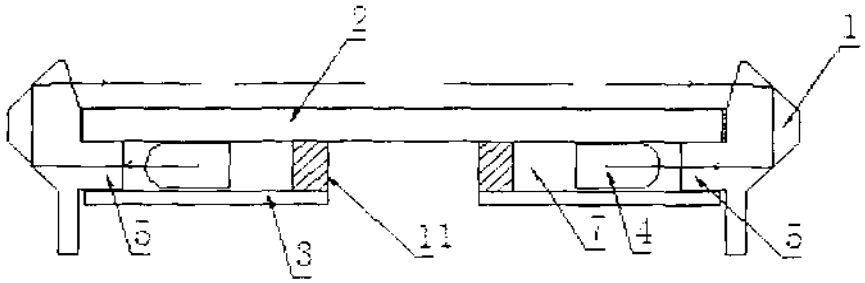


【图号】 图 5

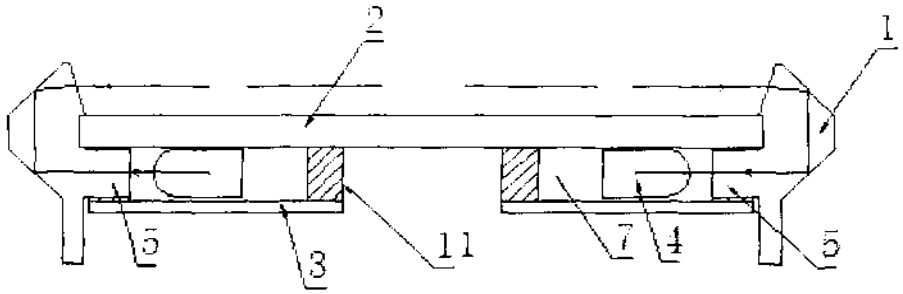


【图号】 图 6

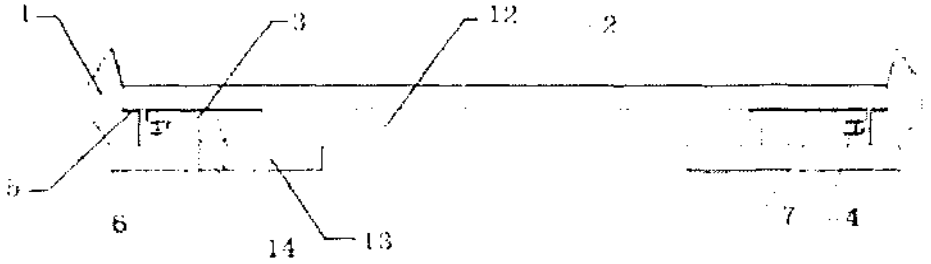
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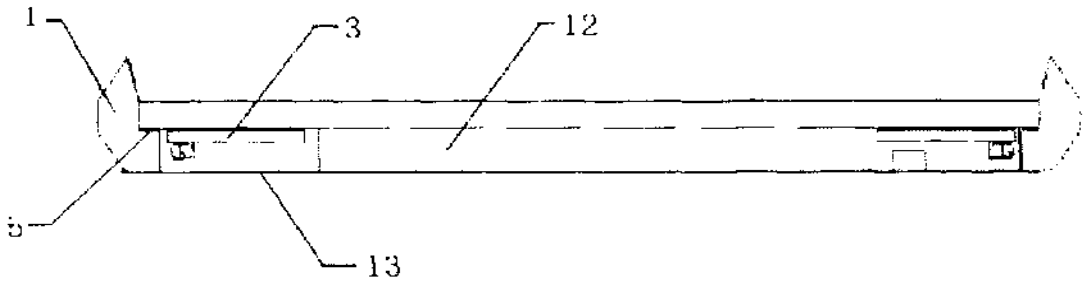
【图号】 图 7



【图号】 图 8

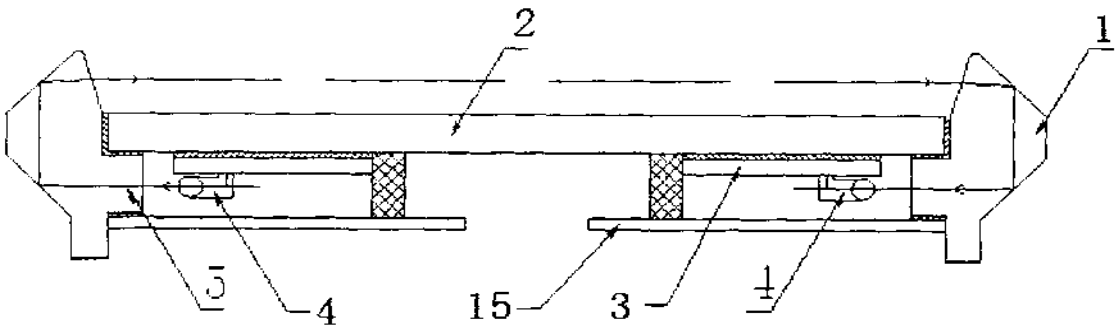


【图号】 图 9

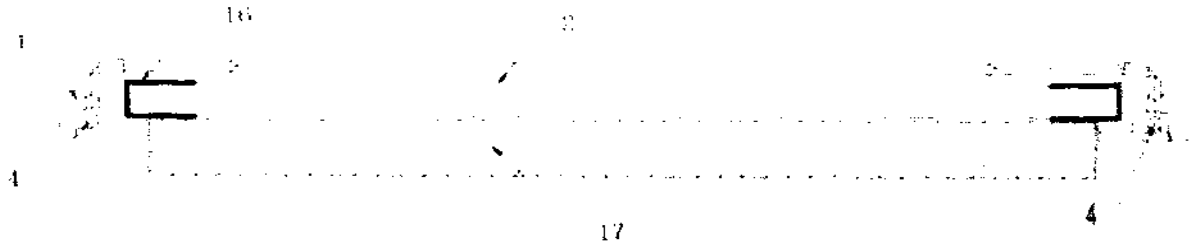


【图号】 图 10

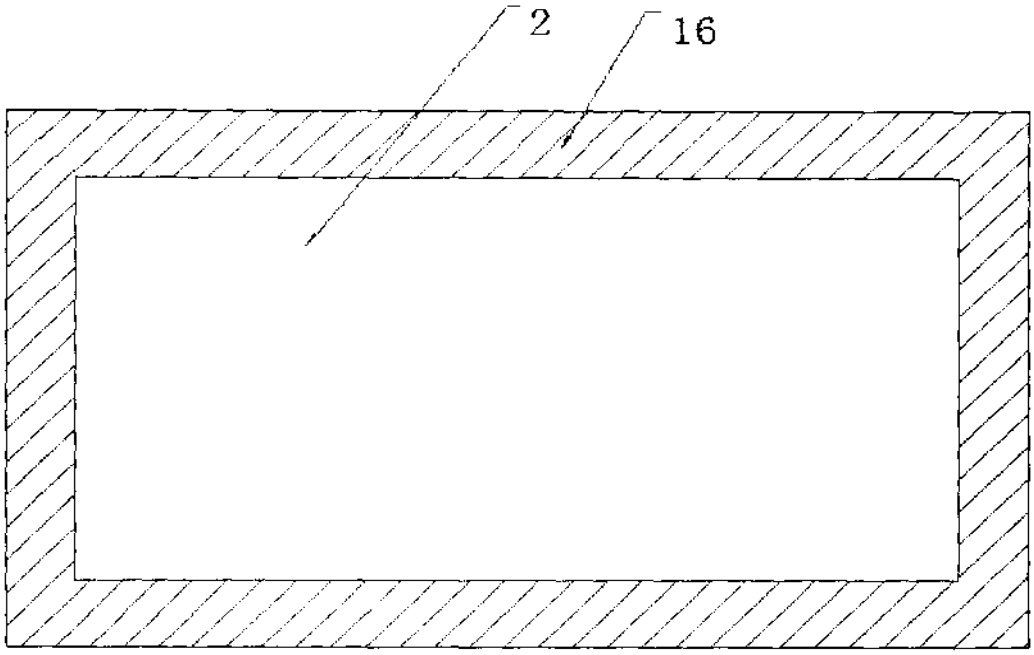
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【图号】 图 11



【图号】 图 12



【图号】 图 13

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INTERNATIONAL SEARCH REPORT

Intemational application No.
PCT/CN2013/000321

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/00 (2006.01) i

According to Intemational Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F 3/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: infrared, touch screen, light, guide, integrative, bearing platform, install, fix, embed, slot, adhibit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102622133 A (CHENGDU GENERAL TOUCH TECHNOLOGY CO., LTD.) 01 August 2012 (01.08.2012), description, paragraphs [0036] and [0037] and figure 2	1, 2, 10, 12, 13, 17., 18
A		3-9, 11, 14-16
A	CN 102722295 A (BEIJING IRTOUCH SYSTEMS CO., LTD.) 10 October 2012 (10.10.2012). , the whole document	1-18
P, X	CN 102968223 A (CHENGDU GENERAL TOUCH TECHNOLOGY CO., LTD.), 13 March 2013 (13.03.2013), claims 1-18	1-18

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 September 2013 (05.09.2013)	19 September 2013 (19.09.2013)

[Name and mailing address of the ISA
State Intellectual Property Office of the P. R. China
No. 6, Xitucheng Road, Jimenqiao
Haidian District, Beijing 100088, China
[Facsimile No. (86-10) 62019451

Authorized officer

WU, Min

Telephone No. (86-10) 62411697

Form PCT/ISA/210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN20 13/000321

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102622133 A	0 1.08.2012	None	
CN 102722295 A	10.10.2012	None	
CN 102968223 A	13.03.2013	None	

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国 际 检 索 报 告

国际申请号
PCT/CN2013/000321

A．主题的分类

G06F 3/00 (2006.01) ;

按照国际专利分类(IPC) 或者同时按照国家分类和 IPC 两种分类

B．检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: G06F 3/-

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词 (如使用))

CNPAT,CNKI: 红外，触摸屏，导光，传导，一体，承台，安装，固定，嵌入，槽，粘

WPI, EPODOC: infrared, touch screen, light, guide, integrative, bearing platform, install, fix, embed, slot, adhibit

C．相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN 102622 133 A，(成都吉锐触摸技术股份有限公司)，01. 8 月 2012 (01. 08. 2012)，说明书第 [0036] 、[0037] 段，附图 2	1-2 ,10 ,12-13 ,17-18
A		3—9, 11, 14—16
A	CN 102722295 A，(北京汇冠新技术股份有限公司)，10. 10 月 2012 (10. 10. 2012)，全文	1—18
P, X	CN 102968223 A，(成都吉锐触摸技术股份有限公司)，13. 3 月 2013 (13. 03. 2013)，权利要求 1-18	1—18

□ 其余文件在 C 栏的续页中列出。 ☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的¾ ¾ ¾言公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件 (如具体说明的)

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
05. 9 月 2013 (05. 09. 2013)	19.9 月 2013 (19.09.2013)
ISA/CN 的名称和邮寄地址： 中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号： (86-10)62019451	受权官员 吴敏 电话号码：(86-10) 62411697

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国际检索报告

关于同族专利的信息

国际申请号
PCT/CN2013/000321

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN 102622133 A	01.08.2012	无	
CN 102722295 A	10.10.2012	无	
CN 102968223 A	13.03.2013	无	

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 565 770 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.03.2013 Bulletin 2013/10

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(22) Date of filing: **29.08.2012**

(51) Int Cl.:
G06F 3/0488 *(2013.01)* ***G06F 3/044*** *(2006.01)*
G06F 3/046 *(2006.01)* ***G06F 3/0354*** *(2013.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **31.08.2011 KR 20110087527**

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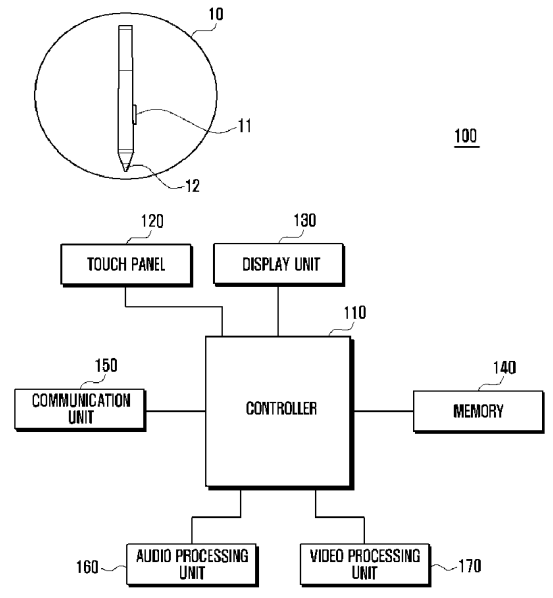
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(54) A portable apparatus and an input method of a portable apparatus

(57) A portable apparatus comprising a portable terminal and a pen. The pen includes a button arranged to set the pen to a first input state in which the pen generates a first level of electricity or to a second input state in which the pen generates a second level of electricity. A touch sensor changes electricity according to the level of electricity generated by the pen when touched by the pen, to generate a first input signal or a second input signal accordingly. A controller analyses the first or second input signal, to determine a first input or second input, and performs a corresponding pre-set function for the first input in an executed application and calls a pre-set application or performs a pre-set command for the second input. A display unit displays a screen processed according to at least one of the first input and the second input.

FIG. 1



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Description

Field of the Invention

[0001] The present invention relates to a portable apparatus and an input method of a portable apparatus. In particular, the portable apparatus comprises a portable terminal and a pen. More particularly, although not exclusively, the present invention relates to a pen input device and a method of a combination of a portable terminal and a pen, the portable terminal having a touch panel.

Description of the Related Art

[0002] A portable terminal may often include a touch device, and the touch device may sense touched points within a touch panel and to control the operation of the portable terminal. Such a touch device often uses an electrostatic capacitive sensing method in which the touch panel comprises an array of electrostatic capacitive sensors. Such a portable terminal provides for finger touch interaction. However, a finger touch method is not appropriate for performing precise work due to the large size of the touch contact area of a finger on a touch panel.

[0003] Therefore, there is an increasing need for another input method in addition to or instead of using fingers in a portable terminal including a touch device. In particular, in case a precise and detailed input is needed, such as when taking a memo or drawing a picture, using a pen in accordance with embodiments of the present invention may be advantageous.

Summary of the Invention

[0004] Embodiments of the present invention aim to address at least some of the above problems, and provide a portable apparatus comprising a portable terminal and a pen and an input method of a portable terminal including a touch panel. In an exemplary embodiment of the present invention, the experience of actually using a pen is applied in a touch mobile device, thereby providing a new experience allowing different input options such as pen gesture and pen handwriting, etc. which are not possible with only a finger touch.

[0005] To this end according to certain embodiments of the invention, the pen and the touch panel are arranged such that when the pen is set to a first input state an operation of an application can be performed using the a pen, and when set to a second input state an application can be called or a certain command can be performed. The portable terminal can be arranged to perform a function or command which is respectively set according to the first pen input state and the second pen input state.

[0006] Embodiments of the present invention provide an input device in the form of a portable apparatus comprising a portable terminal and a pen, and an input method of such a portable apparatus capable of controlling operations of an application executed according to user input with the pen. Such user input may relate to inputting letters by handwriting and drawing an image in various applications. Further, embodiments of the present invention provide a device and method for generating various inputs to a portable terminal capable of calling a certain application of a portable terminal independently of the operational control of an application executed in the portable terminal and generating a certain command by adding a button to a pen.

[0007] In accordance with a first aspect of the present invention there is provided a portable apparatus comprising a portable terminal and a pen, the portable terminal comprising a controller, a touch panel, and a display unit: wherein the pen includes a button and the pen is arranged to be set to a first input state in which the pen generates a first level of electricity or to a second input state in which the pen generates a second level of electricity depending on whether or not the button has been pressed; wherein the touch panel includes a touch sensor arranged to change electricity in response to being touched by the pen or the pen approaching the touch panel and according to the level of electricity generated by the pen, the touch panel being arranged to generate a first input signal or a second input signal depending upon the change in electricity; wherein the controller is arranged to analyse the first or second input signal, to determine a first input or second input depending upon the first or second input signal, to perform a pre-set function corresponding to the first input in an executed application, and to call a pre-set application or perform a pre-set command corresponding to the second input; wherein the display unit is arranged to display a screen processed according to at least one of the first input and the second input under the control of the controller; and wherein the first input includes at least one of a general input that controls operation of the executed application, a handwritten letter and a drawing, and the second input is a command that calls a predetermined application and/or a command for execution of a predetermined operation.

[0008] In accordance with a second aspect of the present invention there is provided an input method of a portable apparatus comprising a portable terminal and a pen, the portable terminal comprising a touch panel, the input method comprising: generating by the pen a first level electricity in a first input state and a second level of electricity in a second input state depending on whether or not a button of the pen has been pressed; generating by the touch panel a first input signal or a second input signal according to a sensed change in capacitance of a touch sensor in response to the touch panel being touched by the pen or the pen approaching the touch panel and according to the level of electricity generated at the pen; analysing the first or second input signal to determine a first input or a second input depending upon the first or second input signal; performing a pre-set function corresponding to the first input in an application being executed; calling a pre-set application or performing a pre-set command corresponding to the second input; and

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displaying, on a display unit, a screen processed according to at least one of the first input and the second input under the control of the controller; wherein the first input includes at least one of a general input that controls operation of the executed application, a handwritten letter and a drawing, and the second input is a command that calls a predetermined application and/or a command for execution of a predetermined operation.

[0009] According to embodiments of the present invention, by performing a touch function of a touch device using a pen in a portable terminal, a specialized experience can be provided, and precise operational control is possible. Further, because letters can be inputted by handwriting, user convenience can be improved, and because drawing images can be included in various applications, various effects of a portable terminal can be implemented. In addition, by adding a button in a pen, various inputs of a portable terminal are capable of calling a certain application and generating a certain command of the portable terminal independently of operational control of an application executed in the portable terminal. Therefore, by performing an input function using a pen in a portable terminal, a pen-specialized handwriting experience is extended to general mobile use, through which a specialized experience using a pen can be provided, which has not been possible before.

[0010] Another aspect of the invention provides a computer program comprising instructions arranged, when executed, to implement a method and/or apparatus in accordance with any one of the above-described aspects. A further aspect provides machine-readable storage storing such a program.

Brief Description of the Drawings

[0011] The objects, features and advantages of the present invention will be more apparent from the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates an implementation of a portable terminal according to an exemplary embodiment of the present invention;

FIG. 2 illustrates a pen setting procedure according to the exemplary embodiment of the present invention;

FIGS. 3A and 3B illustrate screens displayed in a display unit in the process of performing a pen setting procedure as in FIG. 2;

FIG. 4 is a flowchart illustrating a procedure for controlling an operation of an application executed in a portable terminal using a pen according to the exemplary embodiment of the present invention;

FIG. 5A illustrates an example of a form for a general input of a first input according to the exemplary embodiment of the present invention, and FIG. 5B illustrates an example of a form of a second input according to the exemplary embodiment of the present invention;

FIG. 6 is a flowchart illustrating a procedure for processing a first input performed in FIG. 4;

FIG. 7 illustrates a procedure for processing a general input of a first input processed in FIG. 6;

FIG. 8 illustrates a procedure for writing a document using a pen according to the exemplary embodiment of the present invention;

FIG. 9A illustrates a handwriting pad as a handwriting input method editor (IME) displayed in a letter writing application, and FIG. 9B illustrates a method for correcting handwritten letters and documents in a document writing application;

FIG. 10 illustrates a procedure for processing a drawing input in the exemplary embodiment of the present invention;

FIGS. 11A to 11G illustrate an example of performing a drawing mode as in FIG. 10;

FIG. 12 is a flowchart illustrating a procedure for processing a second input according to the exemplary embodiment of the present invention;

FIGS. 13A and 13B illustrate an example processed while performing a procedure as in FIG. 12;

FIGS. 14A to 14C illustrate a rich memo list of a portable terminal and a procedure for controlling the list according to the exemplary embodiment of the present invention;

FIG. 15A illustrates an example of a rich memo according to the exemplary embodiment of the present invention, and FIG. 15B illustrates an example of a drawing pad used in a rich memo;

FIG. 16 illustrates a quick memo list included in a rich memo according to the exemplary embodiment of the present invention;

FIG. 17 illustrates an exemplary embodiment of a pad for generating a quick memo in a quick memo list of FIG. 16; and

FIG. 18 illustrates a method for selecting a quick memo application according to the exemplary embodiment of the present invention.

Detailed Description of the Invention

[0012] Preferred embodiments of the present invention are described with reference to the accompanying drawings in detail. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. The same reference numbers are used throughout the drawings to refer to the same or like parts. Detailed descriptions of well-known functions and structures incorporated herein may be omitted to avoid obscuring the subject matter of the present invention. Also, terms described herein, which are defined considering the functions of the present invention, may be implemented differently depending on user and operator's intention and practice. Therefore, the terms should be understood on the basis of the disclosure throughout the specification.

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The principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.

[0013] Furthermore, although the drawings represent exemplary embodiments of the invention, the drawings are not necessarily to scale and certain features may be exaggerated or omitted in order to more clearly illustrate and explain the present invention.

[0014] Among the terms set forth herein, a terminal or portable terminal refers to any kind of device capable of processing data which is transmitted to or received from any external entity. The terminal may display icons or menus on a screen to which stored data and various executable functions are assigned or mapped. The terminal may include a computer, a notebook, a tablet PC, a mobile device, and the like.

[0015] Among the terms set forth herein, a pen refers to a pointer device for interacting with a touch screen, touch panel or other form of touch input within a portable terminal. Preferably such a pen has provides for finer control of the touch panel than is possible with a finger, by ensuring that the pen has a smaller tip for touching the touch panel than a fingertip. As will be explained below, certain embodiments of the invention include a pen having a button arranged to set the pen into either a first input state or a second input state. The input states may relate to first and second levels of electricity within the pen, which may be provided proximal to the pen tip. In certain embodiments the portable terminal touch panel may include an array of sensors arranged firstly to detect the presence of a pen touching the touch panel and secondly to distinguish between the electricity levels of the first and second input states in order to generate first and second input signals to be supplied to a portable terminal controller.

[0016] Among the terms set forth herein, a portable apparatus refers to a combination of a portable terminal including a touch panel and a pen as described above. Alternatively, the pen may be viewed as part of the portable terminal itself, in which case reference may be made solely to a terminal or portable terminal including a pen and a touch panel.

[0017] Among the terms set forth herein, a screen refers to a display or other output device which visually displays information to the user, and which optionally is capable of receiving and electronically processing tactile inputs from a user using a pen, a stylus, a finger of the user, or other techniques for conveying a user selection from the user to the output devices.

[0018] Among the terms set forth herein, an icon refers to a graphical element such as a figure or a symbol displayed on the screen of the device such that a user can easily select a desired function or data. In particular, each icon has a mapping relation with any function being executable in the device or with any data stored in the device and is used for processing functions or selecting data in the device. When a user selects one of the displayed icons, the device identifies a particular function or data associated with the selected icon. Then the device executes the identified function or displays the identified data.

[0019] Among terms set forth herein, data refers to any kind of information processed by the device, including text and/or images received from any external entities, messages transmitted or received, and information created when a specific function is executed by the device.

[0020] Among the terms set forth herein, first and second input states refer to an input state selected at the pen according to whether the pen button is pressed (second input state) or not pressed (first input state). A touch input refers to physical contact being made between the pen and the touch panel (pen touch) or between a hand or finger and the touch panel (hand touch or finger touch). Alternatively, a touch input may refer to the pen, hand, finger etc. approaching the touch panel without physical contact being made. First and second input signals refer to signals generated by the touch panel and supplied to a portable terminal controller in response to a pen touch according to whether the first or second input state is selected through the pen button. First and second input refers to a final user input determined by the processor in response to first and second input signals supplied by the touch panel and taking into account properties of the first and second input signals relating to movement of the pen relative to the touch panel.

[0021] The present invention discloses a device and method for performing a certain function or command according to a pen touch in a portable apparatus comprising a pen and a portable terminal having a touch device (for instance, a touch screen which may also be described as a touch display or a touch panel). Here, the portable terminal can include a mobile phone, a multimedia device like an MP3 player, and a tablet PC, etc. As noted above, in certain embodiments of the invention there may be provided a portable terminal which includes a pen. The pen may be a separable or detachable component of the portable terminal. However, in the present specification reference will be made to a portable apparatus comprising a portable terminal and a pen. Further, in an exemplary embodiment of the present invention, a pen can generate different kinds of input signals by having a button or a means and/or any other known devices, components, and methods having a function similar to that of a button. In the explanation below, a first input is determined by a portable terminal controller in response to a first input signal generated by a touch panel when a pen is in a first input state, and a second input is determined by the portable terminal controller in response to a second input signal generated by the touch panel when the pen is in a second input state where a button is pushed. It will be understood that the pen button may be pressed and released to transition between the first and second input states or the second input state may relate to the pen button being pressed and held pressed. Further, in the explanation below, a document writing mode refers to a mode for converting a user's handwritten letter

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inputs into letter data, and a drawing mode refers to a mode for converting a user's handwritten drawing inputs into an image. At this time, letters handwritten in the drawing mode can be converted into letter data when a recognition command is generated.

[0022] FIG. 1 illustrates an implementation of a portable apparatus comprising a portable terminal 100 and a pen 10 according to the exemplary embodiment of the present invention.

[0023] Referring to FIG. 1, the portable apparatus includes a pen 10 according to the exemplary embodiment of the present invention which comprises a button 11, a head 12, and a body made of, for example, aluminium, etc. Here, the head 12 is made of insulating material (e.g., silicone rubber or any known conductive material), and can contain a component known in the art that can generate an electrical field of different magnitudes depending on whether the button 11 has been pushed. Specifically, the pen 10 has a first input state in which the button 11 is not pressed in which at least part of the pen has a first level of electricity and a second input state in which the button 11 is pressed in which at least part of the pen has a second level of electricity. By "level of electricity" it is meant that the component within the pen 10 carries different levels of electrical charge according to whether the button 11 is pressed. Consequently, at least part of the pen 10 can be charged to a different electrical potential in the first and second input states. This difference in electrical potential can be detected by a sensor within a touch panel 120 of the portable terminal, and used to generate a first or second input signal accordingly. As will be described below, the first and second input signals are characterised by further properties relating to movement of the pen 10 relative to the touch panel 120.

[0024] The portable terminal 100 includes a touch panel 120 which can be a touch device of a capacitive-sensor type and electromagnetic type known in the art, and can be implemented integrally with a display unit 130. In addition, the touch panel 120 can be comprised of an electromagnetic touch device and a capacitive touch device. In such case, the electromagnetic touch panel is to be operated as a touch panel for the pen and thus a current is applied on the touch panel causing resonance and thereby current induced by a touch (i.e. a contact) from the pen, can be measured. Then, the control unit 110 determines whether a touch has been detected and location of the touch, in case the touch is detected, according to a touch signal of the pen from the touch panel 120. Moreover, the control unit 110 can detect a contact (i.e. a touch) from a finger of the user via the capacitive touch panel. Thus, the control unit 200 detects the touch input from the finger and the pen via independently operating touch panels. As a result, the control unit 200 can simultaneously receive the two touch inputs. In the following descriptions, the touch panel 120 can either be the capacitive touch panel or the electromagnetic touch panel.

[0025] The touch panel 120 according to the exemplary embodiment of the present invention should be able to distinguish and sense touch inputs of the pen 10 and a user's finger, etc. The touch panel 120 is able to distinguish between a pen touch when the pen is in the first input state and a pen touch when the pen is in the second input state, and generate first and second input signals accordingly, by sensing the electrical potential of the component within the pen through its interaction with the sensors within the touch panel. In certain embodiments the touch panel may be able to distinguish between a pen touch and a finger touch through changes at the sensors. The display unit 130 displays operation screens of applications executed in the portable terminal 100.

[0026] A memory 140 stores an operation program of the portable terminal 100 and programs according to the exemplary embodiment of the present invention for implementing the present invention as described herein, and stores functions or commands that should be operated according to the input state of the pen 10 in the exemplary embodiment of the present invention. A controller 110 controls general operation of the portable terminal 100 and analyses different types of input signals received from the touch panel 120 according to the exemplary embodiment of the present invention and processes a corresponding function or command. Further, the controller 110 includes a letter recognition processing unit, recognizes handwritten letters written in the document writing mode, and recognizes handwritten letters when a handwritten letter recognition command is generated in the screen of the display unit 130 and/or touch panel 120. Further, the controller 110 includes an image processing unit, and generates a new image by combining a drawn or handwritten image with a screen image being displayed. Further, the controller 110 includes a crop processing unit, and if the user draws a closed curved line and generates a crop command, the image in the closed curved line is cropped and processed.

[0027] The communication unit 150 performs a communication function of the portable terminal 100. Here, the communication unit 150 can be a CDMA, WCDMA or LTE type communication unit which wirelessly communicates with a public switched telephone network (PSTN), can be a communication unit of WiFi, WiMax WiBro type connected to a wireless Internet network, and/or can be a Bluetooth compatible device which can perform wireless communications with a short range device, and a communication unit of a near field communication (NFC) or RFID type. The communication unit 150 can include at least one of the above example communication units, and can also include any other known types of communication units. The audio processing unit 160 processes audio signals of the portable terminal 100, and processes video signals of the portable terminal 100. Alternatively, a video processing unit 170 may be included and connected to the portable terminal 100 for processing any video signals.

[0028] The pen 10 includes a body which may be composed, for example, of aluminium, which allows an electric current flowing in a human's body to reach the surface

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of a device, a head 12 made of any known insulating material, such as silicone or silicone rubber, which spreads; that is, capable of being deformed, so that electricity can be detected in an area larger than a certain predetermined minimum area. Further, the pen 10 includes a button 11, and can have a configuration which can generate electricity of different magnitudes depending on whether the button 11 has been pushed. That is, in the state where a person is in contact with the pen; for example, the state where a person is holding the pen 10, the pen 10 can generate electricity, and at this time, the pen 10 can be implemented with known components to generate electricity of a first magnitude in the state where the button 11 has not been pushed, and the pen 11 can be implemented with known components to generate electricity of a second magnitude in the state where the button 11 has been pushed.

[0029] In the portable terminal 100 having the above configurations and implementations, the touch panel 120 includes a touch sensor, and if electricity is sensed in an area larger than a certain predetermined minimum area, the touch sensor recognizes the contact with the touch panel 120 as a touch. For example, the "GALAXY S series", "GALAXY note" and "GALAXY NEXUS" devices, which are electronic devices with touch screens, commercially available from "SAMSUNG", recognize a touch when the sensed area is larger than 2.5mm (length) X 2.5mm (breadth), the "IPHONE", an electronic device commercially available from "APPLE CORPORATION", recognizes a touch when the sensed area is larger than 3mm X 3mm, and the "VEGA X", an electronic device commercially available from "PANTECH", recognizes a touch when the sensed area is larger than 5mm X 5mm. Further, in the case of the touch panel 120, the pen's head-contacting area is different from the finger-contacting area. That is, the contacting area of the pen 10 is relatively smaller than a typical finger-contacting area of most users of the portable terminal 100, and thus the controller 110 can sense and distinguish the input signal received from the touch panel 120 as a pen touch input or a finger touch input depending on the size of the contact area. Further, the pen 10 can generate electricity of different magnitudes depending on whether the button 11 has been pushed. Hence, changes of electricity sensed through the touch panel 120 can be different, and the controller 110 can sense a pen input depending on whether the button 11 has been pushed according to the changes of electricity.

[0030] Further, when constituting the touch panel 120, a touch sensor for sensing a finger touch and a touch sensor for sensing a touch of a pen 10 can be independently implemented. The contact area and/or magnitude of the electricity according to a touch by a finger and a pen can be different, and thus the controller 110 can sense a change of electricity generated from each touch sensor, and sense and distinguish a touch of the finger or the pen 10.

[0031] In the explanation below, a signal generated by the touch panel 120 in the state where the button 11 of a pen 10 has not been pushed (button off state) is called a first input signal, and a signal generated in the state where the button 11 has been pushed (button on state) is called a second input signal. In the exemplary embodiment of the present invention, the first input signal can be processed by the controller based upon properties of how the pen 10 moves relative to the touch panel 120 into a general first input such as a tap, a long press and a flick, handwriting, drawing and a crop, and there can be an input which performs a function that is set for the corresponding application. Further, the second input signal can be processed by the controller to determine a second input of a command which performs a certain function in the portable terminal 100, and can be generated by a hand gesture in the state where the button 11 of the pen 10 has been pushed. That is, the second input can be a long press in the state where the button 11 of the pen 10 has been pushed, a double tap (click), a flick (horizontal, vertical), and a certain form of a gesture (e.g., a movement which approximates the shape of a circle and a quadrangle, etc.). The second input may overlap a general input of the first input. The memory 140 can include a mapping table for functions and commands according to the first input and the second input, and the controller 110 can perform a function or command according to the first or second input in an application currently in operation with reference to the memory 140 when generating the first or second inputs.

[0032] In order to efficiently process an input signal resulting from use of the above pen 10, the controller 110 can perform a pen input setting operation. FIG. 2 illustrates a pen setting procedure according to the exemplary embodiment of the present invention. Further, FIGS. 3A and 3B illustrate screens displayed in the display unit 130 in the process of performing a pen setting procedure as in FIG. 2.

[0033] Referring to FIGS. 2, 3A and 3B, in the state where a screen 311 as shown in FIG. 3A is displayed, if a pen setting mode is selected, the controller 110 senses the pen setting mode in step 211. If no pen setting mode is detected in step 211, the method proceeds to step 250 to perform a corresponding function. However, if a pen setting mode is detected in step 211, the method displays a screen 313 as shown in FIG. 3A in step 213. The function, which can be set for the pen setting mode, can set a shortcut, a user touch area and a handwriting pad. First, the shortcut is defined as a function for quickly executing a certain application, the preferred hand side is defined as an area of the touch panel 120 where pen touches mainly occur, and the pen detection is for setting whether to turn on the handwriting when executing an application for performing a letter input.

[0034] At this time, if the user selects shortcut settings, the controller 110 senses the selection in step 215, and displays a menu of application items which can perform a shortcut function 315 as shown in FIG. 3A in step 217. FIG. 3A displays examples of memo items; for example,

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an "S memo" function is a rich memo function capable of writing various memos using the pen 10 in the portable terminal 100, with a rich memo being an electronic memo which can combine a handwriting, a drawing, an audio file, and an image, etc., and a "quick memo" function is a handwriting memo function. Hence, a user of the portable terminal 100 of the present invention can select one of the items or functions displayed in the menu 315, and if an item is selected, the controller 110 senses the selection in step 219, and registers the selected item as a shortcut in step 221; otherwise, in step 219, if no item is selected, the method loops back to continue to display items or functions to be selected in step 217. The shortcut function can be mapped with one of the second inputs determined by the controller 110 when the pen 10 is in the second input state as described above. The actions 317 shown in FIG. 3A may include the double click second input, and an example of the case of being set to a quick memo has been used as the default value of the shortcut. After step 221, the method checks in step 235 if a terminate command is entered. If so, the method ends; otherwise, the method loops back to continue displaying a setting item in step 213.

[0035] Further, if no shortcut is detected in step 215 to have been set, the method checks for the selection of a touch area setting, and if a user selects a touch area setting to be a preferred hand side instead of a touch area mode, the controller 110 senses the selection in step 223, and displays a touch area item in step 225. This is a function that is applied to the entire portable terminal 100, and is for separately recognizing touch areas for right-hand users and left-hand users according to the gradient of a pen 10 when the user uses the pen 10. At this time, if the user selects a touch area item to be right-handed or left-handed, the controller 110 senses the selection in step 227, and determines the touch area of the touch panel 120 according to the selected item in step 229. That is, the controller 110 checks whether the user is right-handed or left-handed, and then sets the touch area in the touch panel 120 according to the result of the selection, and the recognition ability for the set touch area is enhanced than that for other areas. After step 229, the method proceeds to step 235. However, if no touch area item is selected in step 227, the method loops back and continues to display the touch area item in step 225.

[0036] Further, if the user has set the touch area mode in step 223, the method checks if a pen detection mode has been set in step 231. If so, the method proceeds to step 235. Otherwise, if a user is to select a pen detection mode, the controller 110 senses the selection in step 231, and displays a message to set the on or off state of the pen detection mode and to determine whether or not to display a handwriting pad based on the on or off state, in step 233. Further, if the user selects the pen-off state at step 233, the portable terminal 100 is set to display an IME, such as a last IME screen which has been used before in the text input mode of the portable terminal 100, and if the user selects the pen-on state at step 233, the portable terminal 100 is set to display the handwriting pad at the text input mode of the portable terminal 100. Here, the text input mode of the portable terminal 100 can be a mode for executing an SMS or other text message application, an e-mail application, or a messenger application, etc. At this time, in case the text input mode is performed in the state where the pen detection mode is off, the controller 110 displays the previous IME in the display unit 130. If a hand touch is sensed as shown in the screen 331 in FIG. 3B, in the state where the pen detection mode is on, the controller 110 analyses the previous IME, and if the mode is a QWERTY mode, the screen 333 is displayed by the display unit 130, but if the mode is a 3*4 keypad mode, the screen 335 is displayed by the display unit 130, as shown in FIG. 3B. If the touch of the pen 10 is sensed on the screen 341 shown in FIG. 3B, the controller 110 displays a handwriting pad 343. In the handwriting pad, the user writes letters using the pen 10 in the area 355, and the written letters are recognized and are displayed in the area 351. Further, the user can write sentences using items such as soft keys, displayed in the area 353 while performing a handwriting operation.

[0037] After performing the pen setting mode as in FIG. 2, if the user terminates the pen setting mode, the controller 110 senses the action and terminates the pen setting mode in step 235 of FIG. 2.

[0038] After performing the pen setting mode, the user can perform or control operation of the portable terminal 100 using the pen 10. FIG. 4 is a flowchart illustrating a procedure for performing or controlling an operation of the portable terminal 100 using the pen 10 according to the exemplary embodiment of the present invention.

[0039] Referring to FIG. 4, an input signal can be generated by the touch panel 120 of the portable terminal 100 in response to a touch input by touching the touch panel with the pen 10 or using a finger. At this time, if the touch input is by the pen 10 (a pen touch), the touch panel 120 generates an input signal, which is supplied to the controller 110 to determine the input in step 411. If no touch input is sensed by the touch panel 120, the method loops back to step 411 to continue checking for touch inputs. Once a touch input is sensed, the controller 110 checks in step 413 whether the input is a pen input. If not, the method determines that the touch input is not a pen input, and processes the inputs as hand or finger touches. Otherwise, the controller determines in step 413 that the input is a pen input, and checks whether the input is the first input of the pen 10 or the second input of the pen 10, as defined herein, in step 415. Here, the first input is determined by the controller 110 when the touch panel 120 generates a first input signal in response to a touch input in the state where the button 11 of the pen 10 has not been pushed. The second input is determined by the controller 110 when the touch panel 120 generates a second input signal in response to a touch input in the state where the button 11 of the pen 10 has been pushed. At this time, if the input is the first input, the controller 110

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analyses a first input signal from the touch panel in step 417 and performs a corresponding operation according to the analysed result in step 419. The method then loops back to step 411. If the input is the second input in step 415, the controller 110 analyses the second input signal from the touch panel in step 421, and performs a corresponding command according to the analysed result in step 423. The method then loops back to step 411.

[0040] FIG. 5A illustrates an example of a form for a general input of a first input according to the exemplary embodiment of the present invention, and FIG. 5B illustrates an example of a form of a second input according to the exemplary embodiment of the present invention.

[0041] As shown in FIG. 5A, the first input can be a general input as in FIG. 5A, and a handwriting, a drawing and a crop, etc. A tap in the general input of the first input is a function for selecting an item in the application in operation, a long press is a function for displaying a contextual pop-up, and a flick is a function for moving to a next page or a previous page or scrolling up or down according to a right or a left direction, or an upward or a downward direction.

[0042] As shown in FIG. 5B, the second input is a hand gesture according to a touch of the pen 10 in the state where the button 11 has been pushed, and can be set to a command for performing a certain function of the portable terminal 100. That is, as illustrated in FIG. 5B, in the second input, a double click is moved to a memo mode. In the pen setting mode of FIG. 2, in the case where a quick memo is set as a shortcut function, the double click of the second input is set as a command for performing the shortcut. The double click is used as a command for performing the memo function. Further, in the above second input, the long press can be used as a screen capture command in the image processing mode, e.g., a mode for displaying moving pictures, such as a camera mode and an image display mode, etc. A flick can be used as a back or menu call command according to the horizontal or vertical direction of the movement of the user's hand performing the flick, and a round form input approximating a circle can be used as a command for moving to a home screen. That is, the second input can be used as an input for a command to perform a certain function in the state where an arbitrary application is performed in the portable terminal 100, and can be used as a command for directing the portable terminal 100 to perform a pre-set operation e.g., a screen capture, while a certain application is performed.

[0043] Here, the general input of the first input and the second input can use the same format. For example, the format can be a long press and a flick, etc.

[0044] FIG. 6 is a flowchart illustrating a procedure for processing a first input performed at step 417 of FIG. 4.

[0045] Referring to FIG. 6, if the first input of the pen 10 is sensed by the touch panel 120, the controller 110 analyses the first input signal generated by the touch panel 120 in step 611 to determine the first input. The first input according to the exemplary embodiment of the present invention can be a general input as in FIG. 5A, a handwriting letter in the document writing mode, a drawing in the drawing mode, and a crop in the image-displaying mode, etc. However, the first input of the pen 10 can be further extended in addition to the above input. In the explanation below, a general input, a first input in the document writing mode, a drawing input and a crop input, etc. will be considered in order.

[0046] First, if the first input is a general input as in FIG. 5A, the controller 110 senses the general input in step 613, and processes the general input in step 615. The method then returns to complete step 419 in FIG. 4. FIG. 7 illustrates a procedure in greater detail for processing a general input of a first input processed in FIG. 6.

[0047] Referring to FIG. 7, if a tap input is generated, the controller 110 selects an item touched in the currently executed application by checking if the item is touched with a tap input in step 711, and if so, processing the function of the selected item in step 713, and the method returns to step 615 in FIG. 6. Further, if a tap is not input in step 711, if a long press is sensed as determined in step 715, the controller 110 calls a pre-set menu to be displayed as a contextual pop-up for a related function in the corresponding application in step 717, and the method returns to step 615 in FIG. 6. Further, if no long press is detected in step 715, if a flick is generated, the controller 110 senses the flick generation in step 719, and performs a function which is set according to the flick direction in step 721, and the method returns to step 615 in FIG. 6. Otherwise, in step 719, if no flick is detected, the method returns to step 615, in FIG. 6. At this time, if the flick is sensed as a horizontal direction, the controller 110 moves from the current page to the previous or next page, and if the flick is sensed as vertical direction, the controller 110 scrolls up or down the screen. FIG. 7 assumes the case where a general input of the first input is set as in FIG. 5A, but a different function can be performed according to the result of the mapping between the general input and the input type. Further, the case where the form of a general input is a tap, a long press and a flick has been described as an example, but a different form of a general input can be further added.

[0048] Secondly, referring back to FIG. 6, if no general input is detected in step 613, if the first input is a handwriting and the current application is in the document writing mode, the controller 110 senses the mode in step 617, and recognizes and processes handwritten letters in step 619. FIG. 8 illustrates a procedure for writing a document using the pen 10 according to the exemplary embodiment of the present invention. FIG. 8 illustrates an operation performed at step 619 of FIG. 6.

[0049] Referring to FIG. 8, the document writing mode can be performed in an application such as an SMS, an e-mail and a messenger application, etc. as explained above. In such a case, if the controller 110 senses that the pen 10 is touched or approaches the touch panel 120 within a certain distance, the controller 110 displays, in step 811, the handwriting pad as in FIG. 9A in the display

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unit 130. As shown in FIG. 9A, the handwriting pad comprises a second display area 355 that displays letters written by the pen 10, a first display area 351 that recognizes written letters and displays the letters, and an area that displays soft keys which are necessary for handwriting.

[0050] Here, the area 911 labelled "Symbol" is a functional key for calling special letters, and displays a combination of letters such as Roman characters, mathematical symbols, and special symbols, etc. The area 913 labelled "Voice" performs a function for inserting a voice or other audible sounds in the document writing mode, and the area 915 which displays, for example, a compass or gear symbol, is an area where a setting function is performed to specify and save user-customized settings of the portable terminal 100. Further, the area 917 labelled, for example, "English", is an area for selecting a language, and if the user long-presses or clicks on the area 917, available languages are displayed in a contextual pop-up. At this time, the pop-up screen displays items of available languages such as English, French and Korean, etc. Further, the IME area 919 labelled "IME" is an area that changes the document writing pad, and in the state where the handwriting pad as in FIG. 9A is displayed, if the IME is selected, a QWERTY keypad or 3*4 keypad is displayed as shown in the area 335 of FIG. 3B. Further, the area 921 with the backspace or delete symbol is an area for performing a back space function, and if the area is selected, the controller 110 moves the current position of the cursor, for example, in a horizontal backward direction. The area 923 with the Enter or Return symbol is an enter key area, and performs an enter key function of a document being written. At this time, in case the enter key area is touched, the controller 110 performs an inserting operation if there is a text in the second display area 355, and in case there is no text in the second display area 355 and the area is multi-lined, an enter key operation is performed, while in case there is no text and the area is not multi-lined, a "done" function is performed, and in the case of an e-mail, if there is no text in the URL input window, a "go" function is performed.

[0051] In the state where the handwriting pad is displayed as in FIG. 9A, the method in FIG. 8 performs step 813 after step 811, in which the controller 110 displays handwriting letters in the second display area 815, when the user can generate handwritten letters in the second display area 355. Then the controller 110 senses the handwritten letters generated according to the movement track of the pen 10 through the touch panel 120, displays the letters in the second display area 355, recognizes handwritten letters displayed in the second display area 353 and displays the letters in the first display area 351 in step 815. At this time, the recognition method can use a completed recognition method known in the art, in which entered symbols are recognized in word units, or a stroke recognition method known in the art. Further, in case a wrong recognition occurs in the process of writing and recognizing a document as explained above, the controller 110 can display a recommended letter on the bottom of the first display area 315, or alternatively in an area which is set in a certain position of the handwriting pad, and if the user selects the displayed letter, the controller can insert the selected letter in the position of the corresponding letter of the first display area 351.

[0052] However, in case a wrong input of the user occurs or a wrong recognition occurs in the process of recognizing a letter, a user's correction is necessary. At this time, referring again to FIG. 8, after step 815, if there is a user's request for correction, the controller 110 senses the request in step 817, re-recognizes and corrects the handwritten letters inputted according to the user's document correction request in step 819, and loops back to step 813. At this time, it is desirable for the above amendment of the letters to be directly corrected by the user's handwriting in the second display area 355. FIG. 9B illustrates a method for correcting letters according to the exemplary embodiment of the present invention. Further, the document correction is performed by the user handwriting general document correction letters.

[0053] Referring to FIG. 9B, letters incorrectly inputted by the user are corrected by overwriting the incorrectly inputted letters displayed in the second display area 355. For example, in case "US" is intended to be corrected to "UK" as shown in the area 931 of FIG. 9B, which is displayed in the second display area 355, the letter "K" is handwritten over the letter "S" as displayed in the second display area 355. In such a case, the controller 110 recognizes the overwritten letter in the second display area 355 as a letter correction, and thus changes the previously written letter to the later written letter and displays the corrected letters in the first display area 351. Further, when writing a document, in case a line or a word is intended to be deleted, as shown in the area 933 of FIG. 9B, the user can draw a line, for example, from right to left on the corresponding letters displayed in the second display area 355. In such a case, if the controller 110 recognizes a line drawn from right to left, the controller 110 deletes the letters positioned in the line and displays the result in the first display area 351. In the method as described above, if line drawing from right to left on the written letters is sensed in the area 935 of FIG. 9B, the controller 110 makes a space between the previous letter and the corresponding letter, and if the written letter is connected to the letter as shown in the area 937 of FIG. 9B, the controller 110 removes the space between the letters. If line drawing of an entered shape is sensed as shown in the area 939 of FIG. 9B, the controller 110 performs a line changing function in the corresponding position, and if a gull-type touch occurs as shown in the area 941 of FIG. 9B, the controller 110 deletes letters written in the position of the gull-type touch. Further, if a long press occurs on the written letters as shown in the area 943 of FIG. 9B, the controller 110 displays words for correcting the letters on the pressed position, and if the user selects a displayed word, the word is selected.

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For example, if the letters displayed in the second display area 355 are "cook" and a long press of a pen 10 is sensed on the letters, the controller 110 displays words that can be substituted (e.g., "cook", "book" and "cool", etc.) in the pre-set position of the handwriting pad (e.g., the lower area of the first display area 351). Further, if a user-desired word is clicked on (tapped), the controller 110 substitutes the user-selected word with the long-pressed word.

[0054] As described above, letters handwritten in the second display area 355 of FIG. 9A are recognized and are displayed in the first display area 351. At this time, referring back to FIG. 8, if a correction as in FIG. 9B occurs, the controller 110 senses the correction in step 817, and corrects written letters or documents according to the correction request (letter correction, sentence or word deletion, space addition, space deletion, line change, letter deletion, and letter change selection, etc.). At this time, the above amendment can be directly done on the letters displayed in the second display area 355, and the controller 110 can sense the input of the pen 10 according to the user's correction request and perform a document correction procedure. Hence, it is seen that the document correction procedure can be conveniently performed by a user using the portable terminal 100 with the touch panel 120 and the components and methods of the present invention.

[0055] If the above handwriting letter input and correction are performed, the controller 110 recognizes the input and correction, and displays the result in the first display area 351. Further, in the state where the above document writing mode is performed, if a termination command occurs, the controller 110 senses the generation of the termination command in step 821, and processes the written letters in step 823. At this time, the method of processing the above written letters varies depending on the document writing mode. That is, in the case of an SMS, the written document is transmitted to a pre-set phone number subscriber and at the same time, is stored in the memory 140. In the case of a memo, a corresponding memo (an alarm and schedule, etc.) can be stored in the memory 140 according to the user's designation. After step 823, the method returns to complete step 619 in FIG. 6, to return to complete step 419 in FIG. 4.

[0056] FIG. 8 illustrates a method of processing written letters of the first input in the state where a handwriting pad is displayed in the document writing mode, but even in the state where the handwriting pad is not displayed, it is possible to recognize handwritten letters as a document. In such a case, the controller 110 displays the handwritten letters in the display unit 130, and if the user generates a recognition command, handwritten letters being displayed can be recognized and be converted into a document.

[0057] Third, referring back to FIG. 6, in step 617, if a document writing mode is not detected, if a drawing of a first input through the pen 10 is sensed, the controller 110 senses the drawing at step 621 of FIG. 6, and senses and processes the drawing inputted through the pen 10 at step 623. FIG. 10 illustrates a procedure for processing a drawing input in the exemplary embodiment of the present invention, and illustrates the operation procedure of step 623 of FIG. 6. FIGS. 11A to 11G illustrate an example of performing a drawing mode as in FIG. 10.

[0058] Referring to FIG. 10, in the case of drawing, the user can select the drawing mode and perform a drawing operation, and can perform handwriting or drawing in a currently operated application. That is, as illustrated in FIG. 11A, in case the user intends to insert or add a drawing in a document written in the document writing mode, and then transmit the document, the user can enter the drawing mode in the application and can perform the drawing operation, and then insert or add the drawing in the document. Further, by performing a drawing operation in the image in the currently operated application, the drawing can be overwritten.

[0059] If the user selects an indication of a drawing pad to be used in the drawing mode, the controller 110 senses the selection in step 1011, the controller 110 temporarily stops the current application and displays the drawing pad in step 1013. For example, as shown in the screen 1111 of FIG. 11A, if a tap function is performed while writing an e-mail document, selectable items are displayed as shown in the screen 1113, and here, if the drawing is tapped (clicked) as a first input using the pen 10, the controller 110 displays the drawing pad as shown in the screen 1115. Thereafter, if the user draws on the drawing pad using the pen 10, the controller 110 senses the drawing through the touch panel 120 and displays the drawing in the display unit 130 as shown in the screen 1117 in step 1015. Thereafter, if the user terminates drawing (i.e., touches "done" on the screen 1117), the controller 110 senses the touch in step 1017, generates a drawing image as shown in the screen 1119 in step 1019, and process the image in step 1021. After step 1021, the method returns to complete step 623 in FIG. 6, to return to complete step 419 in FIG. 4.

[0060] That is, in case a drawing mode is selected while writing an e-mail as in FIG. 11A, the controller 110 displays the drawing pad as shown in the example screen 1115, and displays the user's drawing on the drawing pad. Thereafter, if the drawing is terminated, the controller 110 inserts the generated drawing in the e-mail message, and if the user selects a function such as a transmission function, a message including the drawing image is transmitted to the other person; that is, the e-mail recipient, and at the same time, is stored in the memory 140 of the sending user's portable terminal 100. As explained above, among applications that perform a drawing function using a drawing pad, as shown in FIG. 11C, a document writing application (a message application such as a message and an e-mail, etc.) provides a drawing pad which allows for drawing a picture while writing a message, and thus it is possible to transmit a picture along with a message. Further, as shown in FIG. 11D, an application which provides a handwriting pad (i.e., ap-

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plications where a text input is possible) can perform a drawing function where the user can directly handwrite on the touch panel 120 and display unit 130 displaying the screen in FIG. 11D.

[0061] Further, referring back to FIG. 10, in the case of applications which can perform drawing without using the drawing pad, in case that the user generates a drawing of a first input using the pen 10, the controller 110 senses generation of such a drawing without a drawing pad in step 1011, and proceeds to step 1023 to display the drawing generated from the user on the current screen. Thereafter, if the user terminates drawing, the controller 110 senses the termination in step 1025, generates a drawing image in step 1019, and processes the generated image according to the user's command in step 1021, and then the method returns to complete step 623 in FIG. 6, to return to complete step 419 in FIG. 4. However, in step 1021, if the drawing operation is not terminated, the method loops back to step 1023 to continue processing an input drawing.

[0062] There are some applications where drawing can be performed without using a drawing pad as explained above. For example, in the case of a currently executed multimedia application (e.g., a photo editor, a video maker and a gallery application, etc.), as shown in the example screens in FIG. 11B, the user can directly draw on a multimedia image displayed by the display unit 130, and generate an image to which the user's drawing has been added. Further, in the case of a memo application that provides a handwriting function (e.g., a quick memo and a rich memo application, etc.), as shown in the example screens in FIG. 11E, the user can generate a handwritten memo as an image and process the image. That is, handwritten letters written in the memo application can be generated as an image as in the drawing. Further, in an application displayed as an image (e.g., an e-book application), the user can directly perform handwriting and drawing such as writing notes and highlighting, etc. on the displayed image, as shown in the circled image and crossed-out text in the example screen shown in FIG. 11F, to generate a drawing image. Further, in an editable application (e.g., an editable screen capture application, etc.), as shown in the example screens in FIG. 11G, the user can generate a drawing image by directly writing on the screen, such as the annotation "Cool-!" and other markings shown in FIG. 11G. In such a case, a handwriting-editing-possible screen capture function can be provided, and the corresponding drawing function can be performed in all screens displayed in the portable terminal 100. For example, in applications which display an Internet-based surfing magazine screen and document screen, etc., the drawing can be performed in the screen, and the screen can be edited.

[0063] Fourth, referring back to FIG. 6, after no drawing mode is detected in step 621, in the state where an image is displayed in the screen, if the user draws on a certain location of a displayed image using a pen (drawing a circular or polygonal closed curved line) and selects a crop function, the controller 110 senses the selection in step 625, and crops the screen and processes the cropped screen in step 627. For example, in the state where an image such as a photograph is displayed in the display unit 130, if the user draws a closed curved line, selects a crop item and touches (tap or click) the item, the controller 110 recognizes an image crop, and captures and processes the image inside the closed curve. Further, the cropped screen can be stored in the memory 140, and can also be generated as a new image by inserting the image into or adding to another screen. After step 627, the method returns to complete step 419 in FIG. 4. However, referring back to step 625, if crop mode is not selected, the method performs a corresponding function in step 629 and returns to complete step 419 in FIG. 4.

[0064] As described above, in case a touch input is sensed by the touch panel 120 in the first input state where the button 11 of the pen 10 is not pushed, the touch panel 120 generates a first input signal which is received by the controller 110. The controller 110 determines that the input is the first input at step 415 of FIG. 4, and if the first input is determined, the controller 110 recognizes a general input, handwriting, drawing or crop operation according to the inputted form, and processes the corresponding application at steps 417 and 419. However, in case a touch input is sensed by the touch panel 120 in the second input state where the button 11 of the pen 10 is pushed, the touch panel 120 generates a second input signal which is received by the controller 110. The controller 110 determines that the input is the second input at step 415 of FIG. 4, and if the second input is sensed, the controller 110 processes the command according to the hand gesture of the second input in steps 421 and 423. Here, the other second inputs except a certain input (e.g., a long press) perform applications corresponding to the command regardless of the currently executed application.

[0065] As described above, the first input of the present invention is inputted without pushing the button 11 of the pen 10. The first input can provide all interactions done by fingers in the same manner with the pen 10. At this time, the first input can perform a pen-specialized function in the application.

[0066] FIG. 12 is a flowchart illustrating a procedure for processing a second input according to the exemplary embodiment of the present invention, and FIGS. 13A and 13B illustrate an example processed while performing a procedure as in FIG. 12.

[0067] Referring to FIGS. 4 and 12, if the second input is determined by the controller 110 in step 415, the controller 110 checks the second input and then analyses the form of the second input in step 421, and proceeds to step 1211. At this time, if the second input is a double click, the click is sensed in step 1213, and a pre-set application is called and processed in step 1215. At this time, the setting of the application can be a shortcut application which is set in the pen setting procedure as in

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FIG. 2. For example, in case the shortcut application is set to the quick memo, if a double click occurs in the state where the button 11 of the pen 10 is clicked as shown in the representation 1311 of the pen 10 followed by the double click operation 1321 of FIG. 13A, the controller 110 displays a quick memo, which is set as a shortcut 1323, shown in the display unit 130. The method then returns to complete step 421 and process the input command in step 423 in FIG. 4.

[0068] Further, referring to FIG. 12, if no double click is detected in step 1213, if the second input is a long press, the controller 110 senses the input in step 1217, and captures a screen displayed in the application currently in operation in step 1219. At this time, the application can perform additional applications for displaying the screen image. For example, as shown in the representation 1311 of the pen 10 followed by the long press operation 1321 of FIG. 13A, if a long press occurs in the state where the button 11 of the pen 10 is clicked on, the controller 110 captures the displayed image and displays the captured image 1323 in the display unit 130. The method then returns to complete step 421 and process the input command in step 423 in FIG. 4.

[0069] Further, referring to FIG. 12, if no long press is detected in step 1271, if the second input is a horizontal flick, the controller 110 senses the input in step 1221, and performs a command which has been set for the horizontal flick in step 1223. Here, in an exemplary embodiment of step 1223, the horizontal flick is performed from right to left, and the pre-set command has been set to perform a back function. In such a case, as shown in the representation 1311 of the pen 10 followed by the horizontal flick operation 1331 of FIG. 13B, if a flick is sensed from right to left in the state where the button 11 of the pen 10 has been clicked on, the controller 110 performs a "back" function represented by the operation 1333. The method then returns to complete step 421 and process the input command in step 423 in FIG. 4.

[0070] Further, referring to FIG. 12, if no horizontal flick is detected in step 1221, if the second input is a vertical flick, the controller 110 senses the input in step 1225, and performs a command which has been set for the vertical flick in step 1227. Here, in an exemplary embodiment, the vertical flick is performed from bottom to top, and the pre-set command is set to perform a menu call function. In such a case, as shown in the representation 1311 of the pen 10 followed by the vertical flick operation 1341 of FIG. 13B, if a flick is sensed from bottom to top in the state where the button 11 of the pen 10 has been clicked on, the controller 110 performs a "menu" call function represented by the operation 1343. The method then returns to complete step 421 and process the input command in step 423 in FIG. 4.

[0071] Further, referring to FIG. 12, if no vertical flick is detected in step 1225, if the second input is circle-shaped, the controller 110 senses the input in step 1229, and performs a command which is indicated within the circle on the touch panel 120 in step 1231. In an exemplary embodiment, the command, which is indicated within the circle-shaped second input, is a home screen call. The method then returns to complete step 421 and process the input command in step 423 in FIG. 4. However, in step 1229, of no circle shape is detected, the method proceeds to step 1234 to perform a corresponding command, and the method then returns to complete step 421 and process the input command in step 423 in FIG. 4.

[0072] As described above, the second input can be a hand gesture which is inputted in the state where the button 11 of the pen 10 has been clicked on, and the controller 110 analyses the sensed second input and performs each corresponding command. At this time, the second input can comprise an application call gesture such as a double tap and a long press, and a certain command execution gesture such as a right-to-left flick and a bottom-to-top flick, etc. The second input is a gesture input which is pre-set in the state where the button 11 of the pen 10 is pushed, and can improve the general usability of the pen 10, call applications such as a screen capture and a memo, etc. and perform a certain command such as "Back" and "Menu" by mapping the function of the hard key with the gesture of the pen 10 so that the use experience of the pen 10 can be continued.

[0073] Further, in the exemplary embodiment of the present invention, as described above, the first input and the second input are determined by the controller 110 in response to first and second input signals generated by the touch panel 120 in response to sensed pen touch inputs according to whether the button 11 has been pressed (and therefore whether the pen is in the first or second input state). The input state of the pen 10 is sensed by the touched panel through different magnitudes of changes of electricity of the touch panel 120 when the pen 10 touches the touch panel 120. That is, in the pen 10, the magnitude of generated electricity can be different depending on whether the button 11 is clicked or not, and such different magnitudes of electricity cause correspondingly different changes in electricity. In such a case, when the pen 10 is touched on the touch panel 120, different electricity changes are caused. Here, in the exemplary embodiment, the first input signal is generated by the touch panel 120 in the state where the button 11 of the pen 10 is not clicked on, and the second input signal is generated by the touch panel 120 in the state where the button 11 of the pen 10 is clicked on. However, even if the input signal generated by the touch panel 120 in the state where the button 11 of the pen is not clicked on is set to the second input, and the input signal generated by the touch panel 120 in the state where the button 11 of the pen is clicked on is set to the first input, the same operation can be performed.

[0074] In addition, in a portable terminal having a touch device, if a pen input function is used, various specialized services can be efficiently performed. One of such services is a memo function. The memo function of the portable terminal 100 of the present invention provides an

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integrated memo (a rich memo also called an s-memo) function which combines a letter, an image, a video and audio file, etc. Further, a portable terminal can used as a scheduler, and thus it is preferable that a quick memo function, capable of quickly performing a memo function, is added. Accordingly, the portable terminal 100 of the present invention, using the components and methods described herein, includes such a quick memo function.

[0075] FIGS. 14A to 14C illustrate a rich memo list of the portable terminal 100 and a procedure for controlling the list according to the exemplary embodiment of the present invention.

[0076] Referring to FIGS. 14A to 14C, FIG. 14A illustrates the rich memo as a list arranged by thumbnails, and FIG. 14B illustrates the rich memo as a list arranged by lists. Referring to FIG. 14A, the rich memo list 1411 illustrates the thumbnail items of the quick memo and rich memo as a list, and the feature of each item of the list can be defined by the settings as shown in the table 1413. Here, the quick memo button displays quick memos as one thumbnail, and rich memos are constituted respectively as corresponding thumbnails to constitute a list. In the state where thumbnail lists of the rich memo are displayed as a list 1411 of FIG. 14A, if a user menu is called, a menu 1421 of FIG. 14A is called, which may be a second input processed by steps 421-423 of FIG. 4. Here, the menu calling can be performed in response to a second input as described above, and as shown in FIG. 5B which shows different types of second input, in the state where the thumbnail list is displayed as the list 1411 of FIG. 14A, if the button 11 of the pen 10 is clicked on and is flicked from bottom to top, the controller 110 senses the flick as a menu call. Further, in the displayed menu 1421, if a corresponding item is clicked on (tap of the first input), the lists 1423, 1425, 1427 of the selected items is displayed.

[0077] The rich memo list of FIG. 14B has a form which is different from the form of the thumbnail list of FIG. 14A, and so the items 1451, 1453, 1461, 1463, 1465, 1467 of the rich memo list respectively correspond to the items 1411, 1413, 1421, 1423, 1425, 1427 of the thumbnail list shown in FIG. 14A.

[0078] FIG. 14C illustrates a procedure for selecting the rich memo and the quick memo according to the exemplary embodiment of the present invention. As shown in the thumbnail list 1481, if a quick memo button is clicked on (tap) in the thumbnail list screen 1481, a quick memo list 1491 is displayed. Further, as shown in the quick memo list 1491, in the state where such a quick memo list 1491 is displayed, if a second input of the horizontal flick (right to left) is generated using the pen 10, the controller 110 displays the thumbnail list 1481 of the rich memo. Further, in the state where the thumbnail list 1481 of the rich memo is displayed, if a second input of the vertical flick (bottom to top) is generated using the pen 10, the controller 110 calls a menu, and can display the list 1483 of the rich memo by the user's selection.

[0079] Further, in the state where either of a rich memo list 1481, 1483 is displayed, if the user clicks on the generation button using the pen 10, an example of a drawing pad 1485 is generated, and the user can write a rich memo through the drawing pad 1485. Further, for the quick memo list 1491, in the state where the quick memo list 1491 is displayed, if the user clicks on the quick memo (tap of the first input), the drawing pad 1493 or the text pad 1495 is generated, and the user can generate the quick memo as the drawing or text using the drawing pad 1493 or the text pad 1495.

[0080] FIG. 15A illustrates an example of a rich memo according to the exemplary embodiment of the present invention, and FIG. 15B illustrates an example of a drawing pad used in a rich memo.

[0081] Referring to FIGS. 15A and 15B, in the state where the list of the rich memo is displayed, if the user selects a certain rich memo thumbnail (or an item on the list), corresponding rich memos 1511 are displayed as shown in FIG. 15A. At this time, the rich memo has a structure 1513. Further, in the state of the rich memo 1511, if a menu is called by the second input as described above, a menu 1521 is called, and sub-menus 1523-1527 can be selected from the called menu 1521.

[0082] Further, in the state where a certain rich memo is displayed, if the user pushes a generation button, a drawing pad 1551 of FIG. 15B is displayed. Here, the drawing pad 1551 can have menu 1553 and various settings 1555. Using the menu 1553 and settings 1555, the user can add a title to the drawing which is drawn or to be drawn in the drawing pad 1551, such that the added title appears, for example, near the top of an updated drawing pad 1557 on the touch panel 120. Further, using the menu 1553 and settings 1555, the user can add a tag identifying the drawing which is drawn or to be drawn, such that the tag appears, for example, near the bottom of an update drawing pad 1559. In addition, the rich memo can perform an image generation in response to the drawing operation by the user, as well as performing an image insertion and an audio sound, etc. as well as a text memo. At this time, the method of writing the rich memo can be performed using the pen 10. Here, methods such as text writing, drawing and cropping of the first input can be used, and an operation of the rich memo application by the generation input can be controlled. Here, the handwriting of the rich memo can be performed in the drawing pad 1551, the handwritten letters can be processed as an image, and a recognition command can be generated and recognized through the menu. That is, the rich memo can be written through drawing and handwriting, etc. using the pen 10, and a video and/or audio file can be inserted into the written rich memo. Further, the handwritten letters can be converted into data by a recognition command and can be stored when necessary. Further, the written rich memo can be stored in the memory 140, and can be transmitted to an external device or an external subscriber through the communication unit 150.

[0083] FIG. 16 illustrates a quick memo list included in

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a rich memo according to the exemplary embodiment of the present invention. Quick memos are displayed as a thumbnail list, such as the example thumbnail list 1611, and when a second input of the menu call is generated, a menu 1613 is displayed and sub-menus 1615-1621 can be selected for performing functions on the thumbnail list 1611.

[0084] FIG. 17 illustrates an exemplary embodiment of a pad for generating a quick memo in a quick memo list of FIG. 16. Referring to FIG. 17, in a quick memo application, the user can write a quick memo using a drawing pad 1711 or a text pad 1723. Further, the user can call a menu through use of the pen 10, and the menu can be any of the menus 1725, 1727, 1729, 1731 providing various menu selections, functions, and settings.

[0085] Further, the quick memo application can be selected when performing a rich memo application, and a quick memo can be selected through the second input. That is, as described herein with reference to FIGS. 2 and 3A, the user can set an application which can perform as a shortcut function in the setting process. At this time, in case the quick memo is set by the shortcut application, the quick memo application can be selected as shown in FIG. 18. FIG. 18 illustrates a method for selecting a quick memo application according to the exemplary embodiment of the present invention. Referring to FIG. 18, in case the quick memo is set by a shortcut application, if a second input for selecting a quick memo, which set as a shortcut function, is determined in the state in which an arbitrary application is being executed using the screen 1811 (a double click in the state where the button 11 of the pen 10 is clicked on), the controller 110 displays a drawing pad 1813 for executing the quick memo application. Further, if the user writes a quick memo (drawing and/or handwriting) on the drawing pad 1813, the controller 110 displays the written quick memo in the drawing pad 1813. Further, the written quick memo is registered in the quick memo thumbnail list 1611 of FIG. 16.

[0086] The above-described apparatus and methods according to the present invention can be implemented in hardware, firmware or as software or computer code that can be stored in a recording medium such as a CD ROM, a RAM, a ROM, a floppy disk, DVDs, a hard disk, a magnetic storage media, an optical recording media, or a magnetooptical disk or computer code downloaded over a network originally stored on a remote recording medium, a computer readable recording medium, or a non-transitory machine readable medium and to be stored on a local recording medium, so that the methods described herein can be rendered in such software that is stored on the recording medium using a general purpose computer, a digital computer, or a special processor or in programmable or dedicated hardware, such as an ASIC or FPGA. As would be understood in the art, the computer, the processor, microprocessor controller or the programmable hardware include memory components, e.g., RAM, ROM, Flash, etc. that may store or receive software or computer code that when accessed and executed by the computer, processor or hardware implement the processing methods described herein. In addition, it would be recognized that when a general purpose computer accesses code for implementing the processing shown herein, the execution of the code transforms the general purpose computer into a special purpose computer for executing the processing shown herein.

[0087] Accordingly, embodiments provide a program comprising code for implementing apparatus or a method as claimed in any one of the claims of this specification and a machine-readable storage storing such a program. Still further, such programs may be conveyed electronically via any medium such as a communication signal carried over a wired or wireless connection and embodiments suitably encompass the same.

[0088] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", means "including but not limited to", and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

[0089] Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0090] Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.

[0091] It will be also be appreciated that, throughout the description and claims of this specification, language in the general form of "X for Y" (where Y is some action, activity or step and X is some means for carrying out that action, activity or step) encompasses means X adapted or arranged specifically, but not exclusively, to do Y.

[0092] Although exemplary embodiments of the present invention have been described in detail hereinabove, it should be clearly understood that many variations and modifications of the basic inventive concepts herein taught which may appear to those skilled in the present art will still fall within the scope of the present invention, as defined in the appended claims.

Claims

1. A portable apparatus comprising a portable terminal and a pen, the portable terminal comprising a controller, a touch panel, and a display unit:

   wherein the pen includes a button and the pen is arranged to be set to a first input state in which the pen generates a first level of electricity or to

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a second input state in which the pen generates a second level of electricity depending on whether or not the button has been pressed;
wherein the touch panel includes a touch sensor arranged to change electricity in response to being touched by the pen or the pen approaching the touch panel and according to the level of electricity generated by the pen, the touch panel being arranged to generate a first input signal or a second input signal depending upon the change in electricity;
wherein the controller is arranged to analyse the first or second input signal, to determine a first input or second input depending upon the first or second input signal, to perform a pre-set function corresponding to the first input in an executed application, and to call a pre-set application or perform a pre-set command corresponding to the second input;
wherein the display unit is arranged to display a screen processed according to at least one of the first input and the second input under the control of the controller; and
wherein the first input includes at least one of a general input that controls operation of the executed application, a handwritten letter and a drawing, and the second input is a command that calls a predetermined application and/or a command for execution of a predetermined operation.

2. The portable apparatus of claim 1, wherein in response to determining a first input the controller is further arranged to operate a drawing function to cause the display unit to display a handwriting pad when executing a document writing application, and to display a handwritten letter inputted in the handwriting pad, and recognizes and processes the handwritten letter.

3. The portable apparatus of claim 1 or claim 2, wherein in response to determining a first input the controller is further arranged to operate a drawing function to cause the display unit to display a drawing pad when selecting a drawing application, and to display the drawing of the first input in the drawing pad, to include the drawing image in the currently executed application, and process the drawing image when the drawing function is terminated.

4. The portable apparatus of claim 3, wherein in response to determining a first input the controller is further arranged to display a drawing in the current screen in response to the first input when the drawing occurs in an application which displays an image on the display unit, and when the drawing function is terminated the controller is further arranged to display an image including the drawing in the screen image.

5. The portable apparatus of any one of the preceding claims, wherein the controller is further arranged to analyse an input type in response to determining a second input, if the input type is an application call, to call and display an application corresponding to the application call, which is set for the corresponding second input, is called and displayed, and if the input type is a command, to perform the command, which is set for the corresponding second input.

6. An input method of a portable apparatus comprising a portable terminal and a pen, the portable terminal comprising a touch panel, the input method comprising:

generating by the pen a first level electricity in a first input state and a second level of electricity in a second input state depending on whether or not a button of the pen has been pressed;
generating by the touch panel a first input signal or a second input signal according to a sensed change in electricity of a touch sensor in response to the touch panel being touched by the pen or the pen approaching the touch panel and according to the level of electricity generated at the pen;
analysing the first or second input signal to determine a first input or a second input depending upon the first or second input signal;
performing a pre-set function corresponding to the first input in an application being executed;
calling a pre-set application or performing a pre-set command corresponding to the second input; and
displaying, on a display unit, a screen processed according to at least one of the first input and the second input under the control of the controller;
wherein the first input includes at least one of a general input that controls operation of the executed application, a handwritten letter and a drawing, and the second input is a command that calls a predetermined application and/or a command for execution of a predetermined operation.

7. The input method of claim 6, wherein performing a pre-set function corresponding to the first input comprises:

displaying, on a display unit, a handwriting pad when executing a document writing application;
displaying, on the display unit, a handwritten letter inputted in the handwriting pad; and
recognizing and processing the handwritten letter.

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8. The input method of claim 7, wherein recognizing the handwritten letter further comprises:

correcting the letter using a corresponding function if a first input for correcting a handwritten letter is generated.

9. The input method of claim 7 or claim 8, wherein the document writing mode is at least one of a text message, e-mail or messenger application.

10. The input method of any one of claims 6 to 9, wherein performing of a pre-set function corresponding to the first input further comprises:

performing a drawing function using the controller;
displaying, on the display unit, a drawing pad when selecting a drawing mode application;
displaying, on the display unit, the drawing of the first input in the drawing pad; and
including the drawing image in the currently executed application and processing the drawing image when the drawing function is terminated.

11. The input method of claim 10, wherein the application being executed is a letter writing application, and the generated drawing image is included in the written text message.

12. The input method of claim 10 or claim 11, wherein performing the pre-set function corresponding to the first input further comprises:

displaying the drawing of the first input inputted in the current screen image when the drawing occurs in the application which displays an image; and
generating an image including the drawing in the screen image when the drawing function is terminated.

13. The input method of any one of claims 6 to 12, wherein a general input of the first input includes at least one of a tap, a long press, a horizontal flick and a vertical flick, and when the general input occurs, the application being executed performs a function corresponding to the general input.

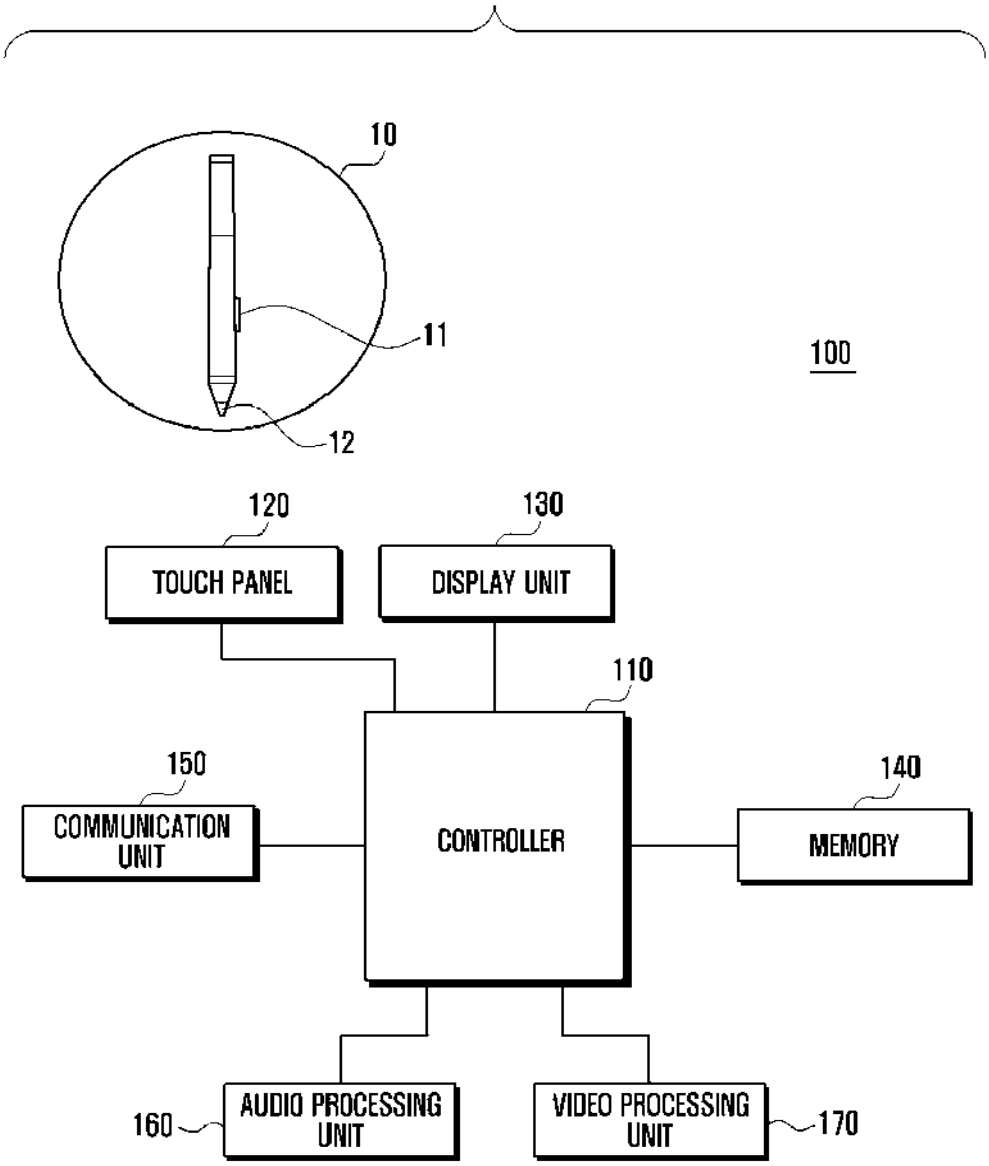
14. The input method of any one of claims 6 to 13, calling the pre-set application or performing a pre-set command corresponding to the second input comprises:

analysing an input type of the second input;
calling and displaying the pre-set application which is set for the second input if the input is an application call for the pre-set application; and
performing the pre-set command which is set for the corresponding second input if the input is the pre-set command.

15. The input method of claim 14, wherein a second input for the application call includes at least one of a double click and a long press, and a second input for command execution is a flick.

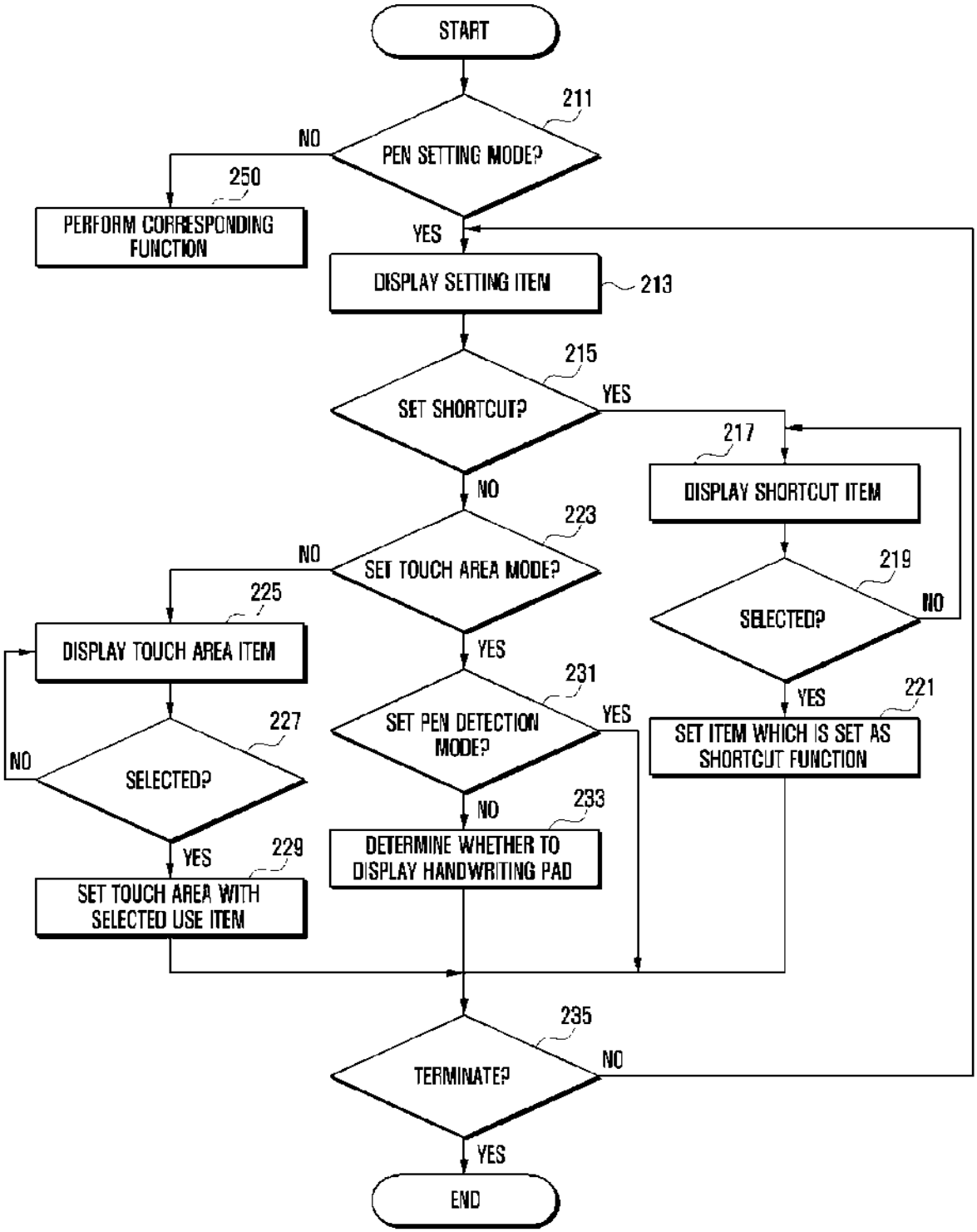
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FIG. 1



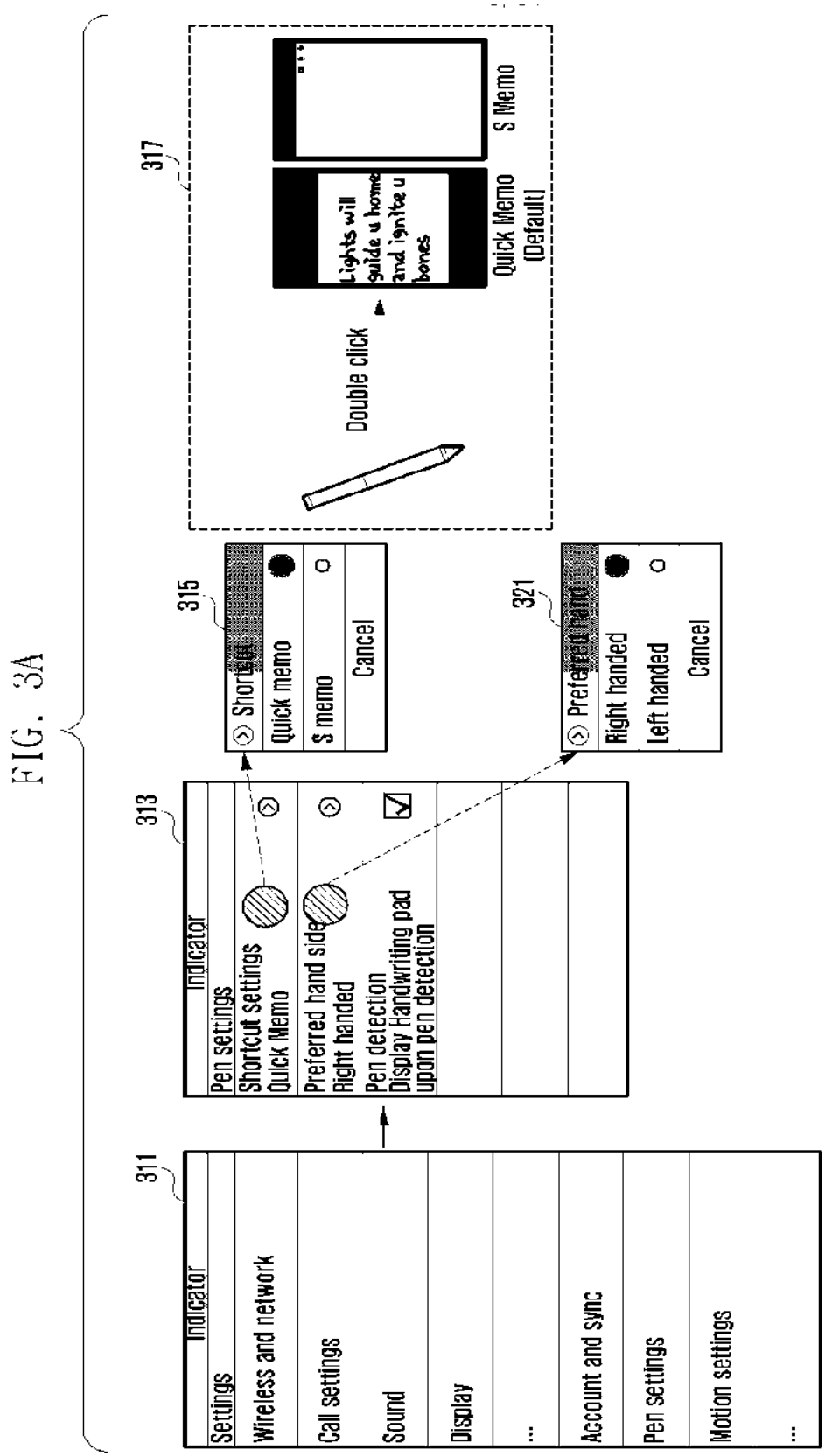
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FIG. 2



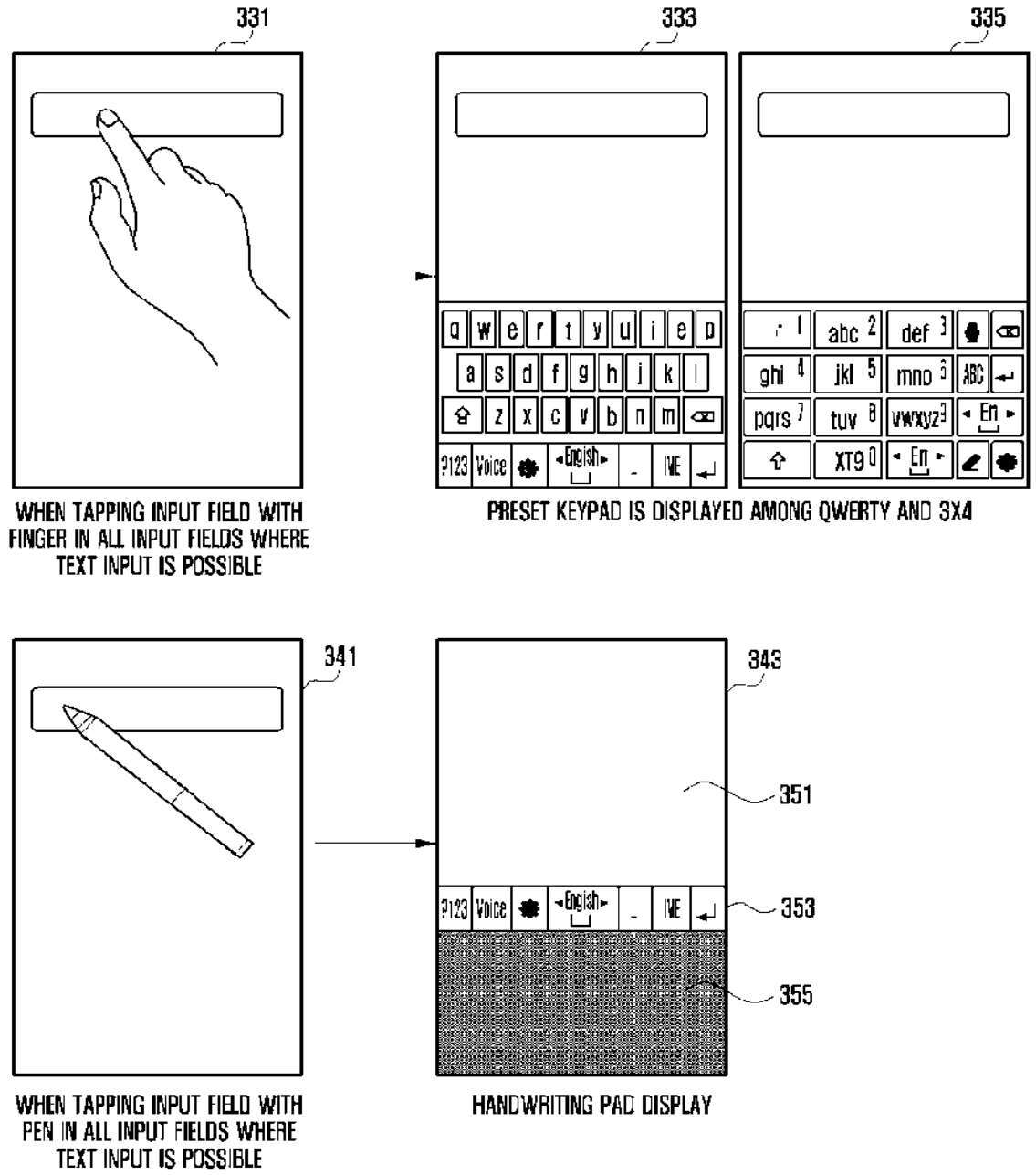
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FIG. 3A



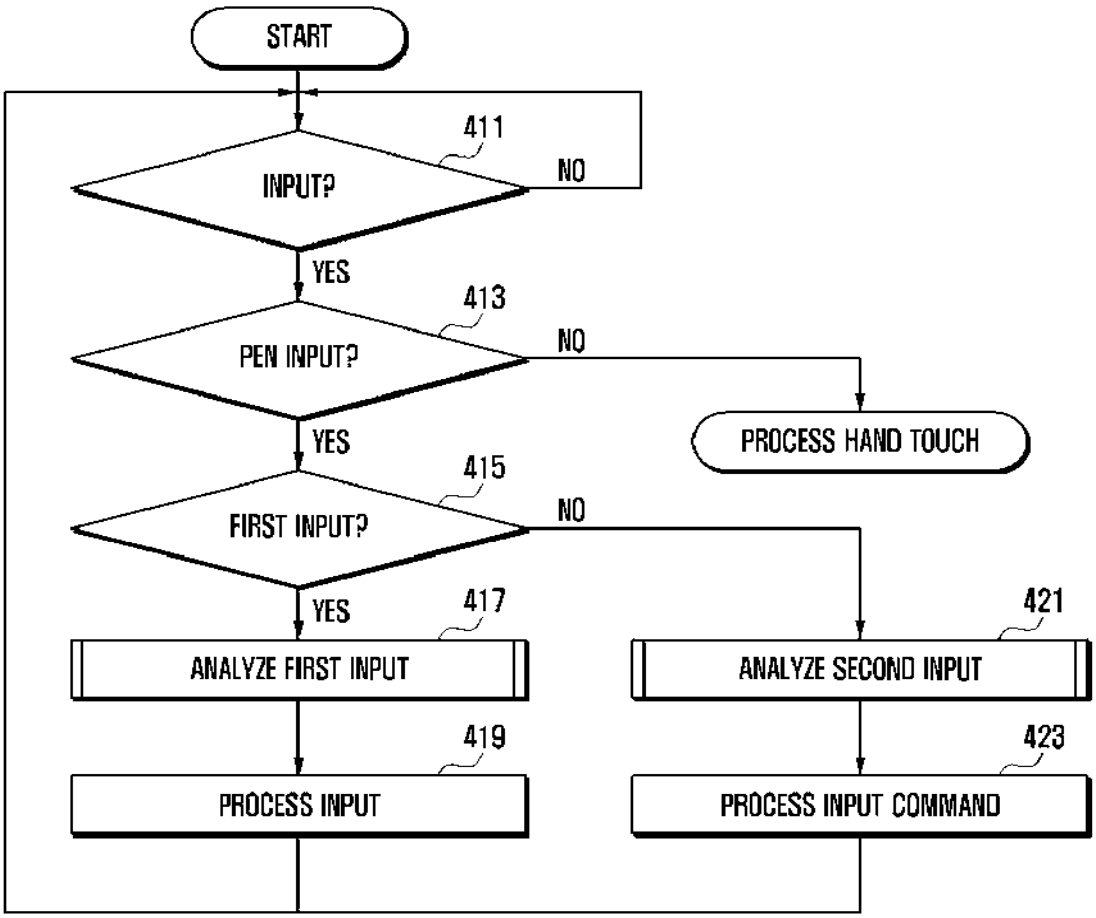
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FIG. 3B



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FIG. 4



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FIG. 5A

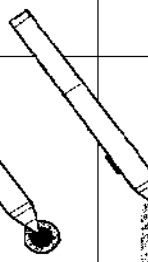
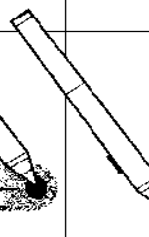
WHEN PERFORMING OPERATION WITHOUT CLICKING ON PEN SIDE BUTTON

	Type	Operation	Visual effect
	Tap	• Select Item	○
	Long press	• Display contextual pop-up	○
	Flick	• Move to next page • Scroll up, down	○ (NATURAL FEEDBACK IS PROVIDED WHEN FLICKS CONSECUTIVELY OCCUR)

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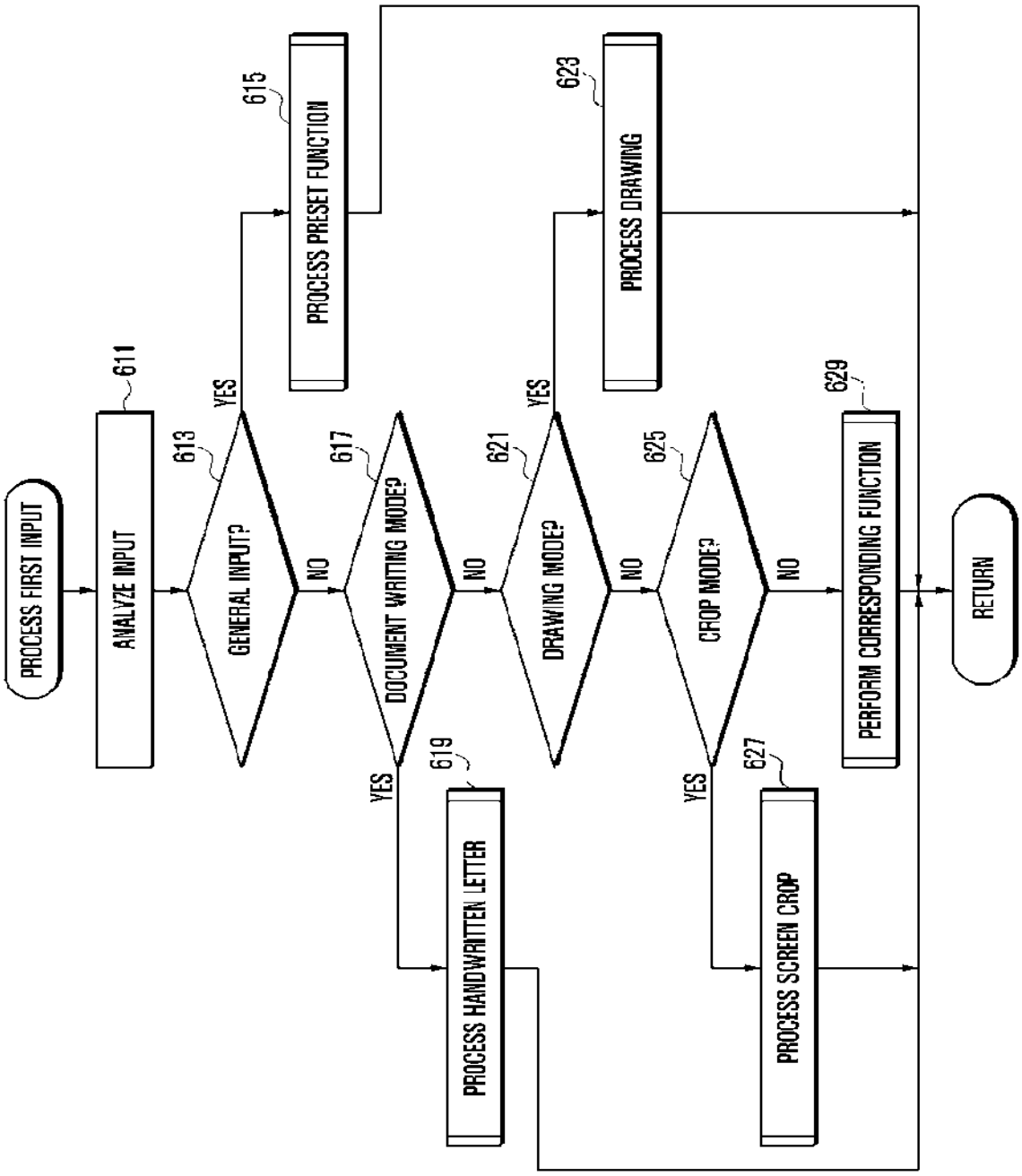
FIG. 5B

WHEN PERFORMING OPERATION BELOW AFTER CLICKING ON PEN SIDE BUTTON

	Type	Operation	Visual effect
	Double click	• Memo Application CALL	×
	Long press	• Screen capture	×
	Flick (RIGHT→LEFT)	" Back" OPERATION	×
	Flick (BOTTOM →TOP)	" Menu" CALL	×
	Circle	"Home" OPERATION	×

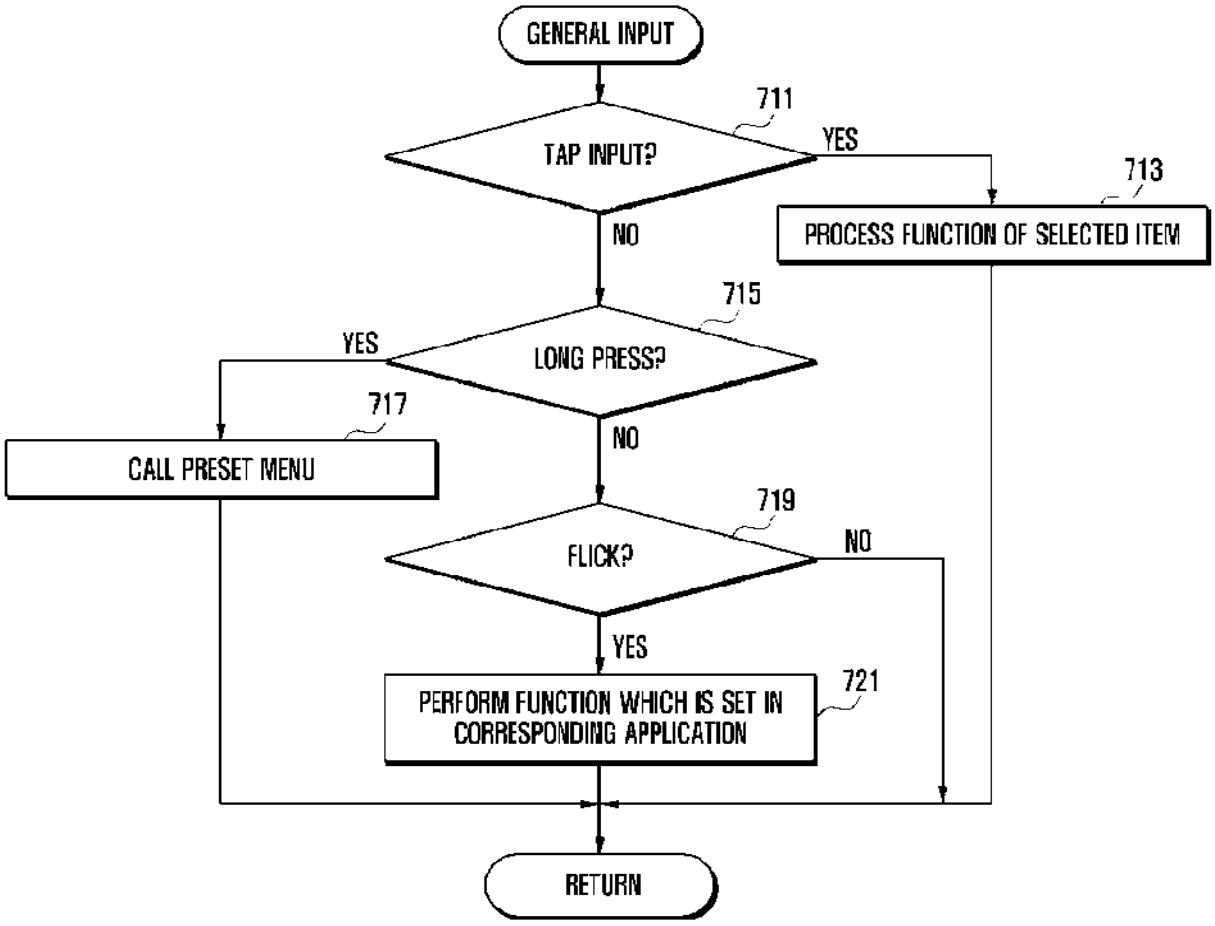
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FIG. 6



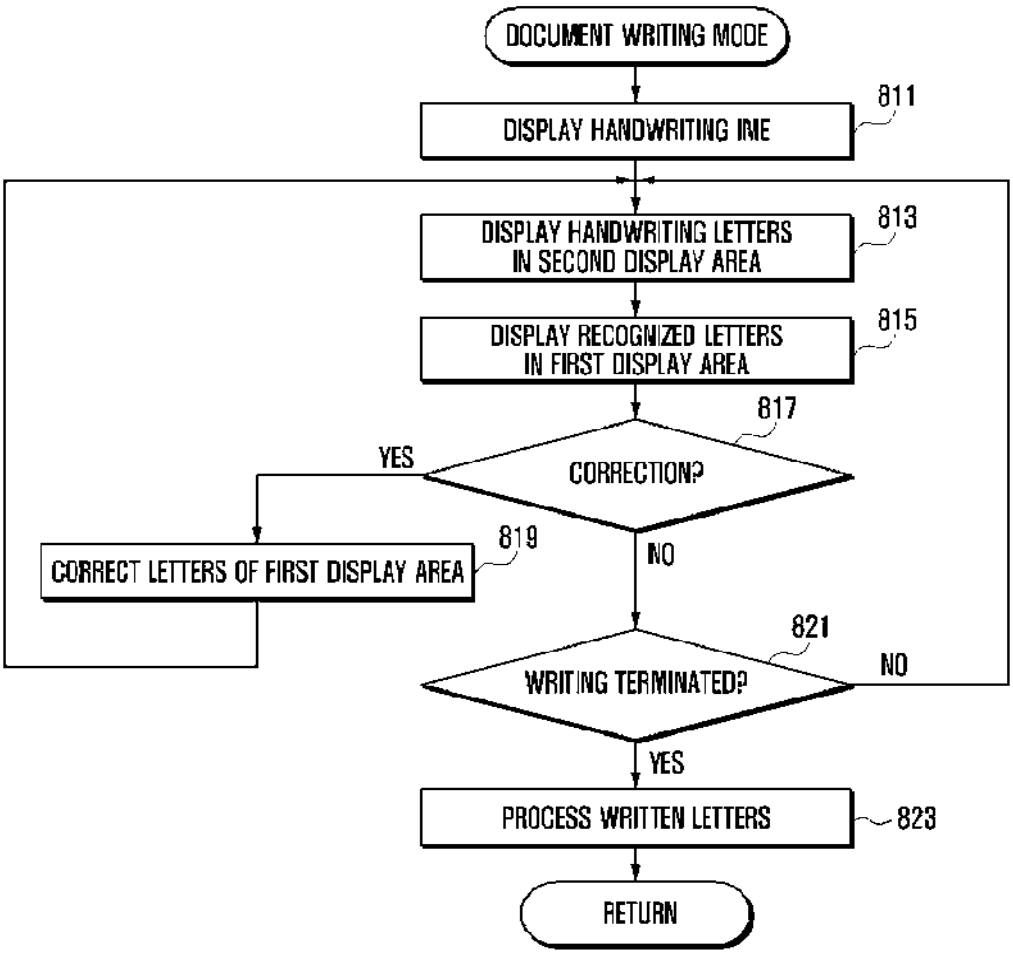
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FIG. 7



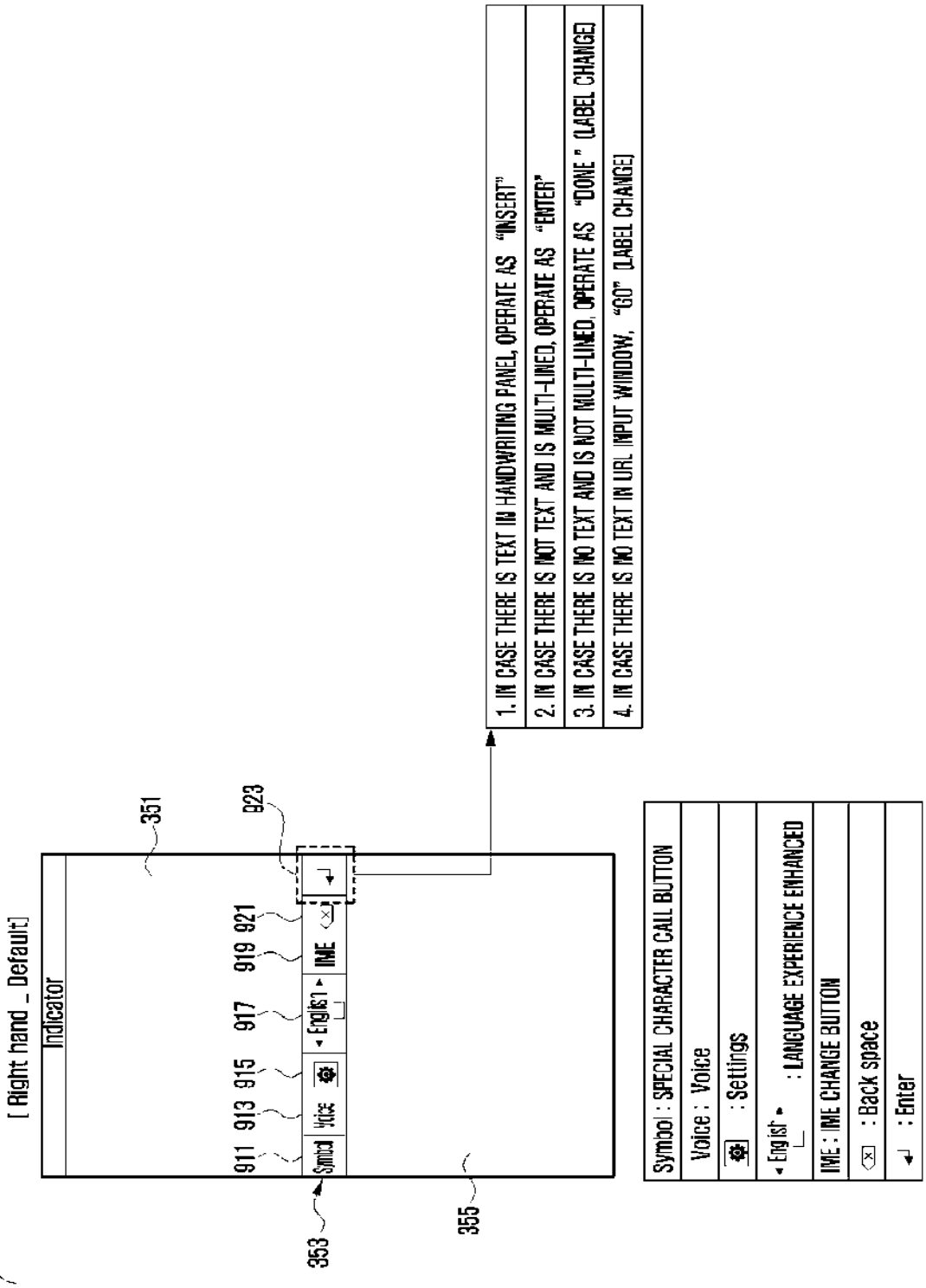
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FIG. 8



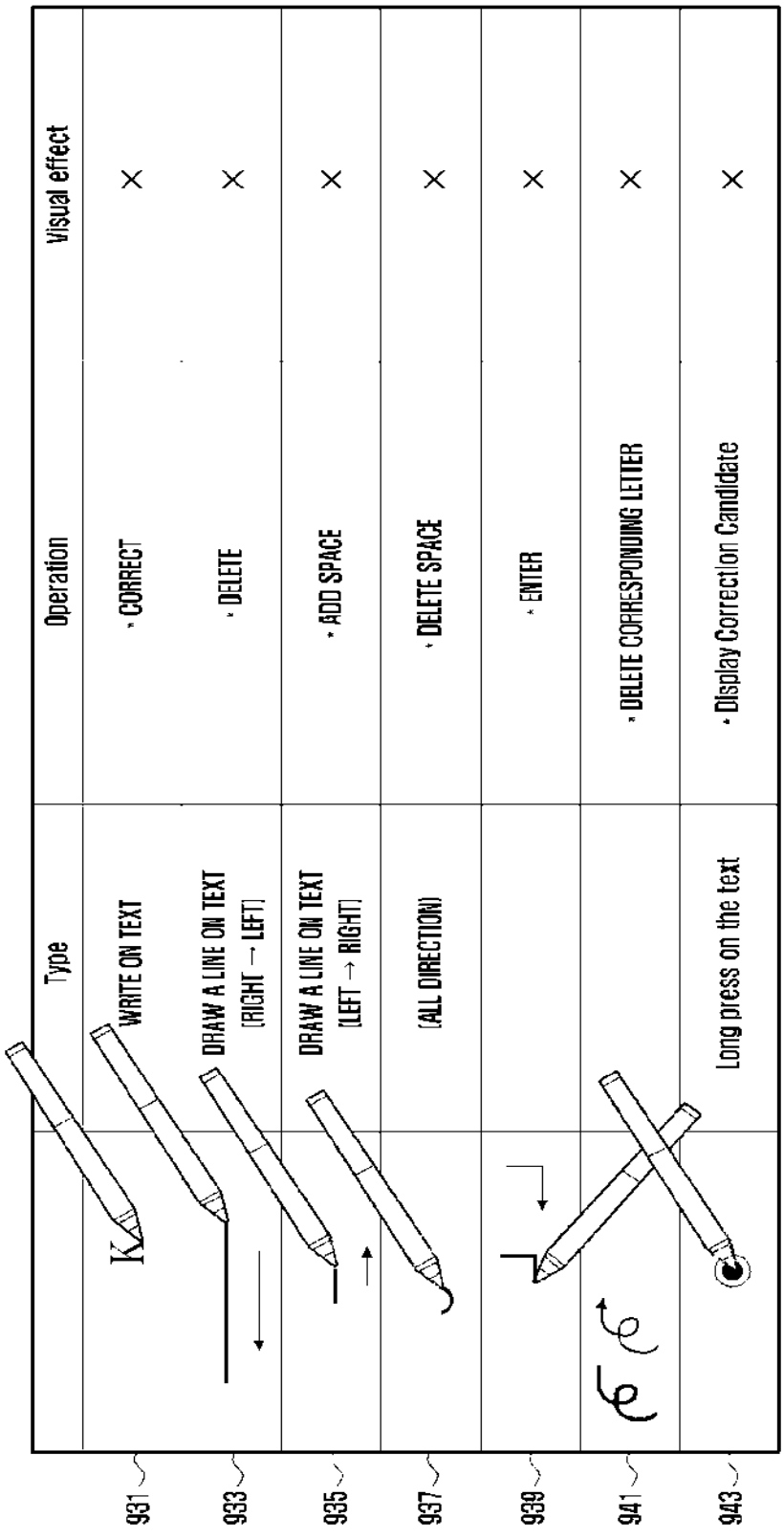
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FIG. 9A



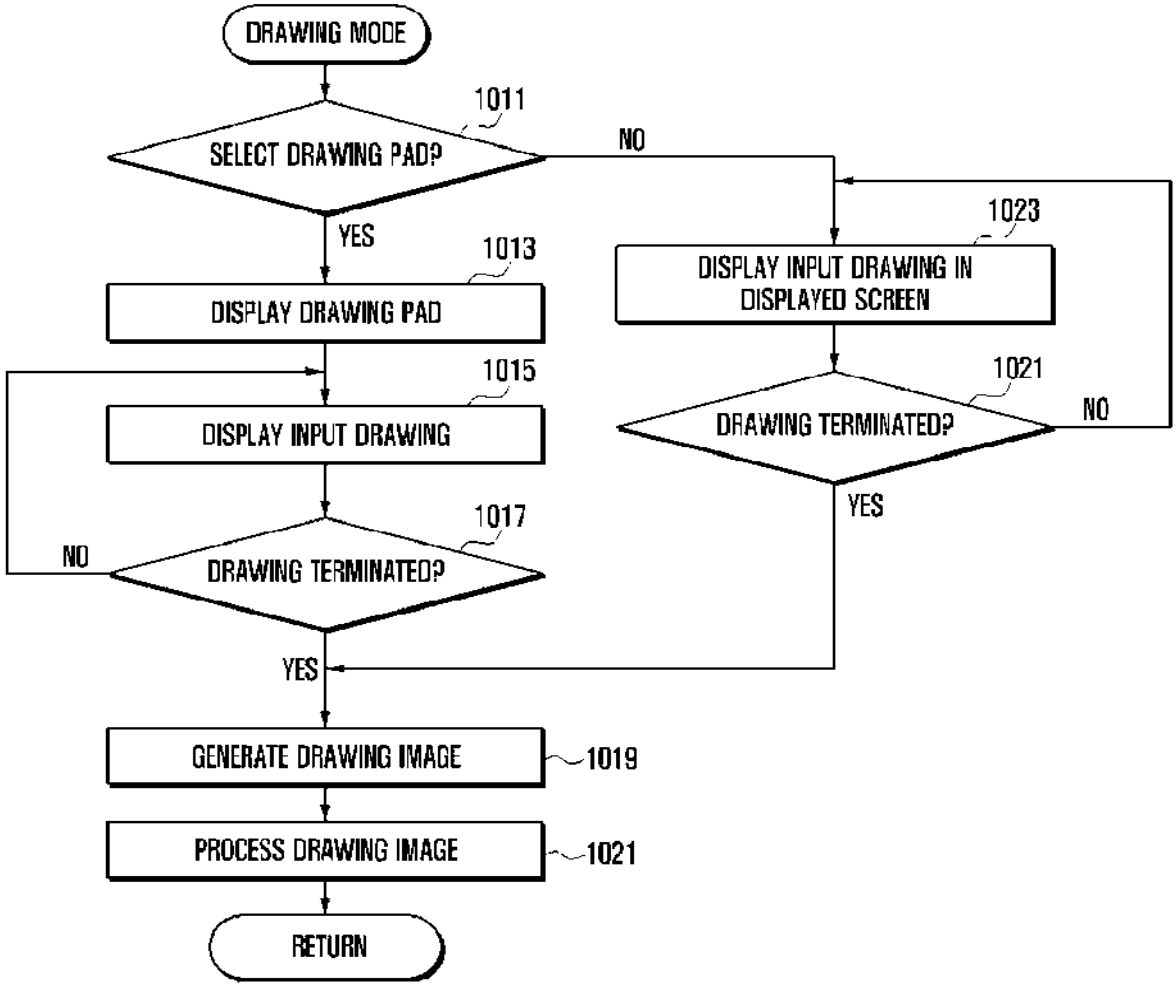
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FIG. 9B



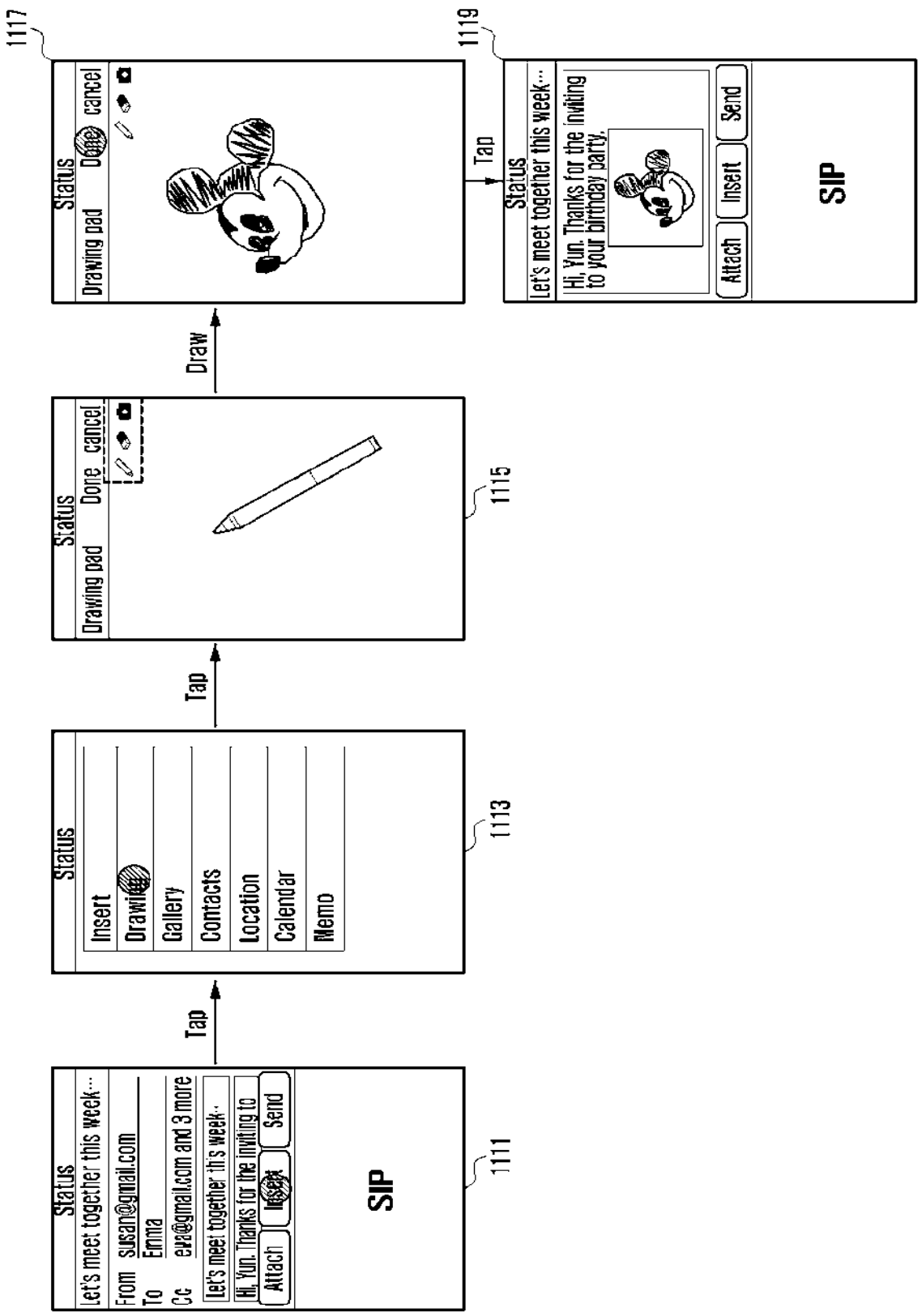
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FIG. 10



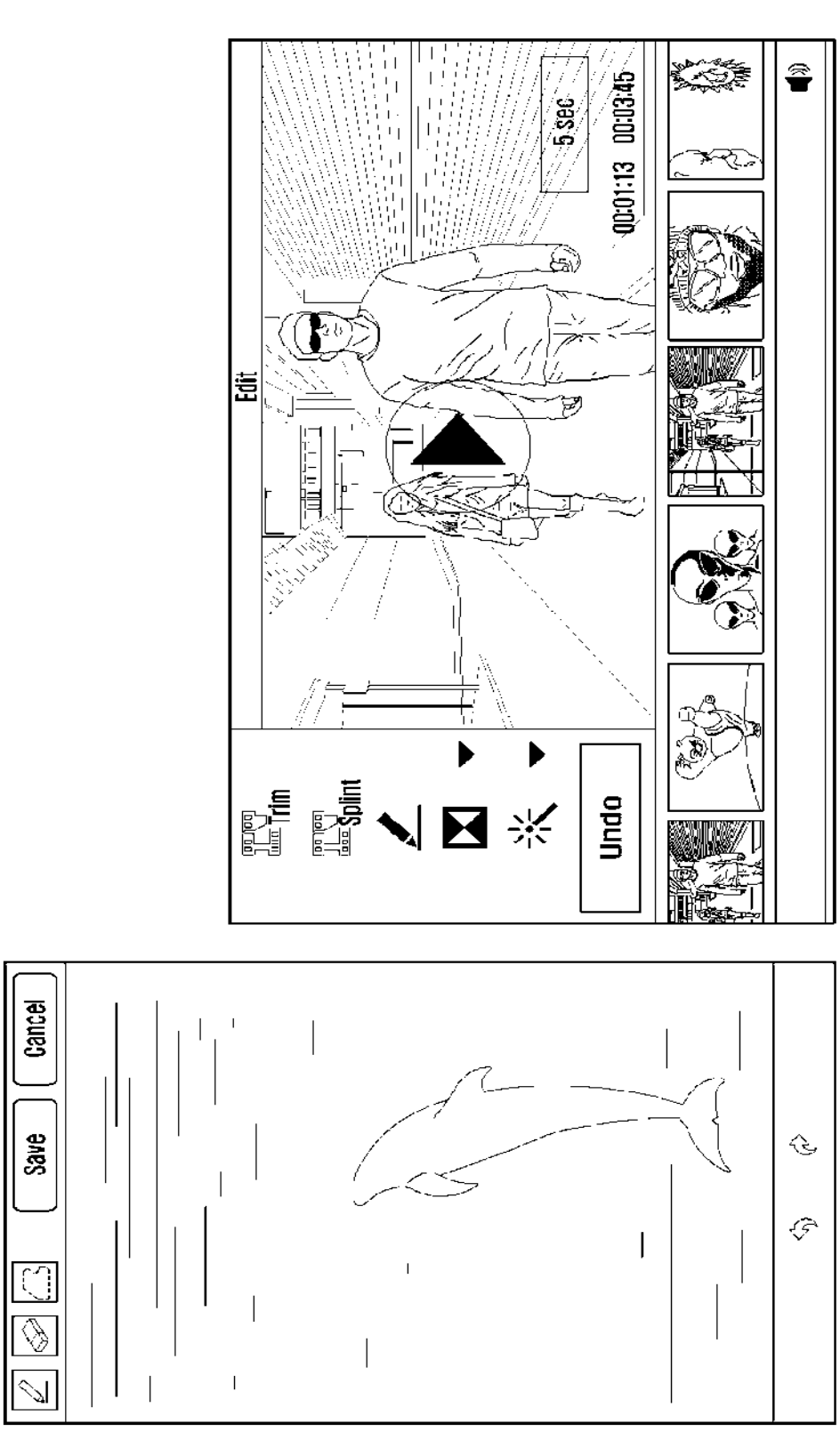
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FIG. 11A



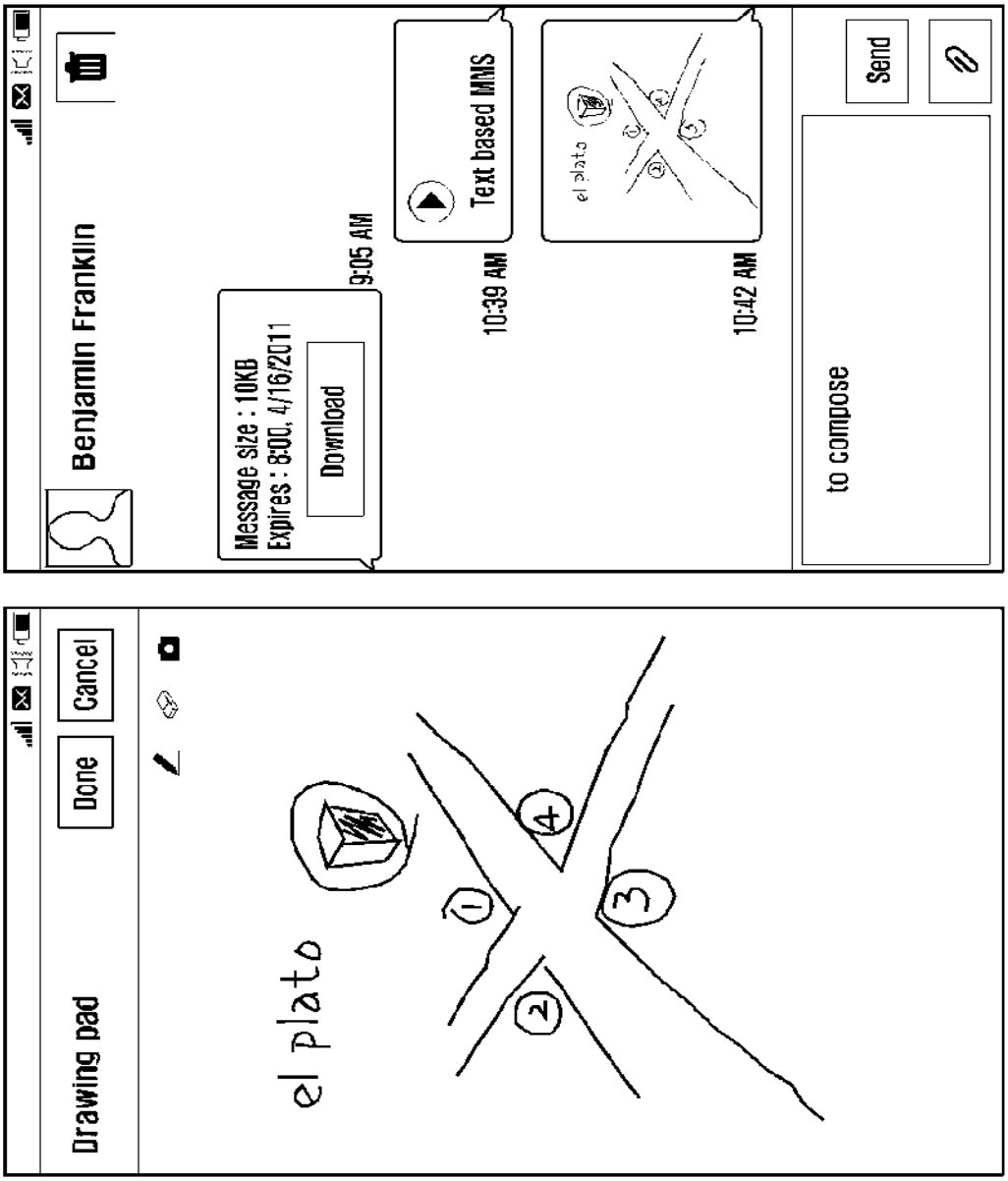
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FIG. 11B



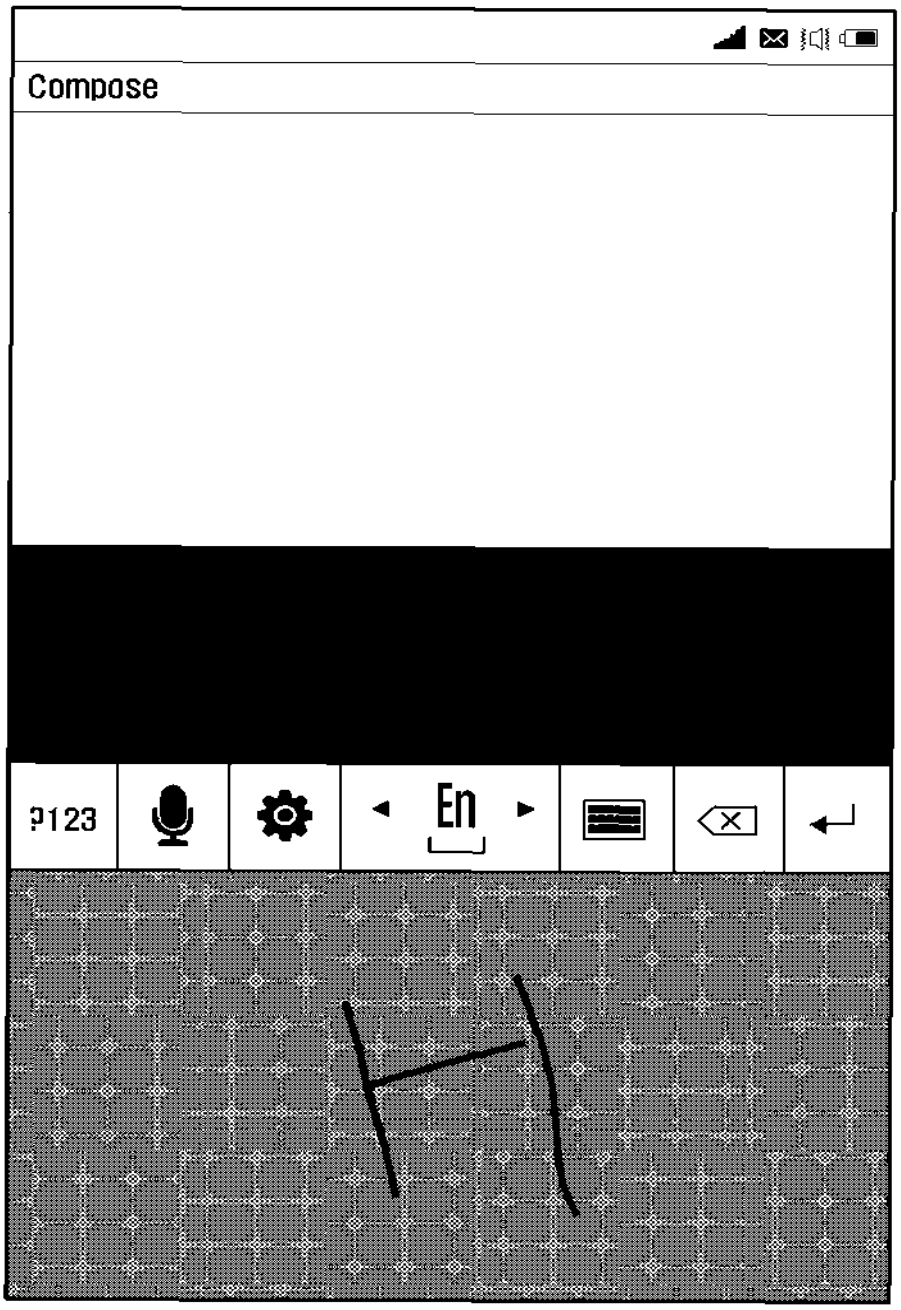
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FIG. 11C



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FIG. 11D



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FIG. 11E

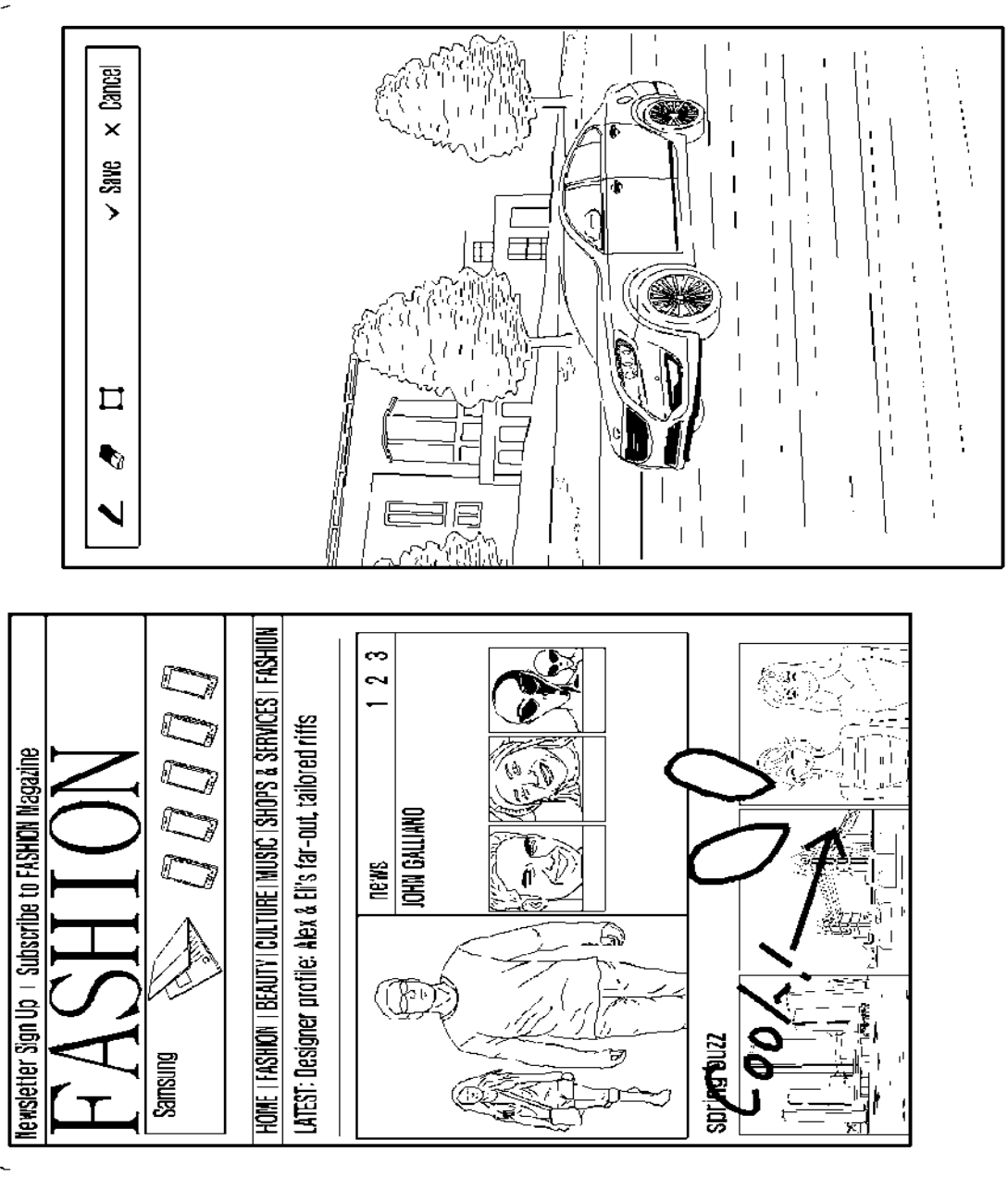
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FIG. 11F



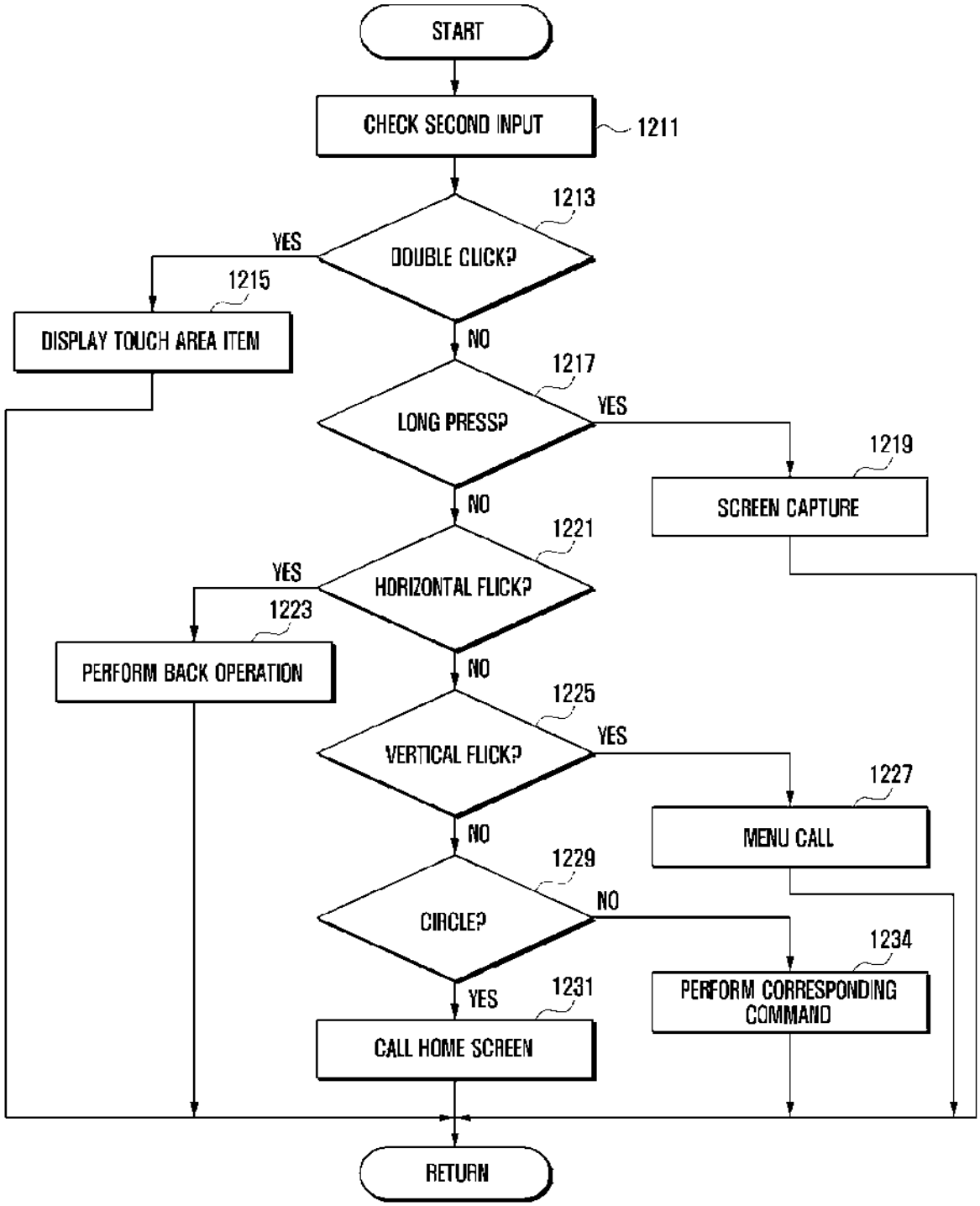
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FIG. 11G



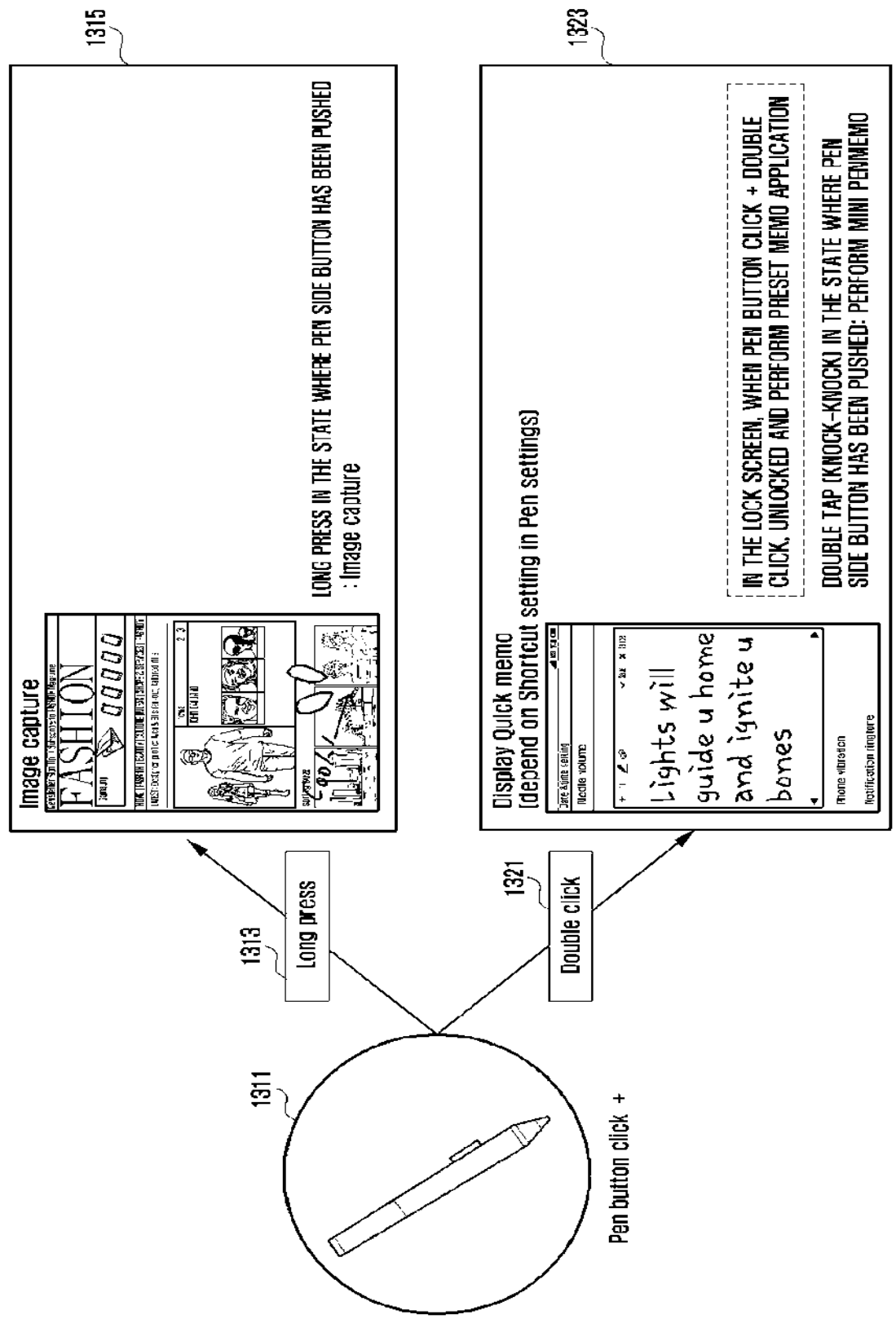
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FIG. 12



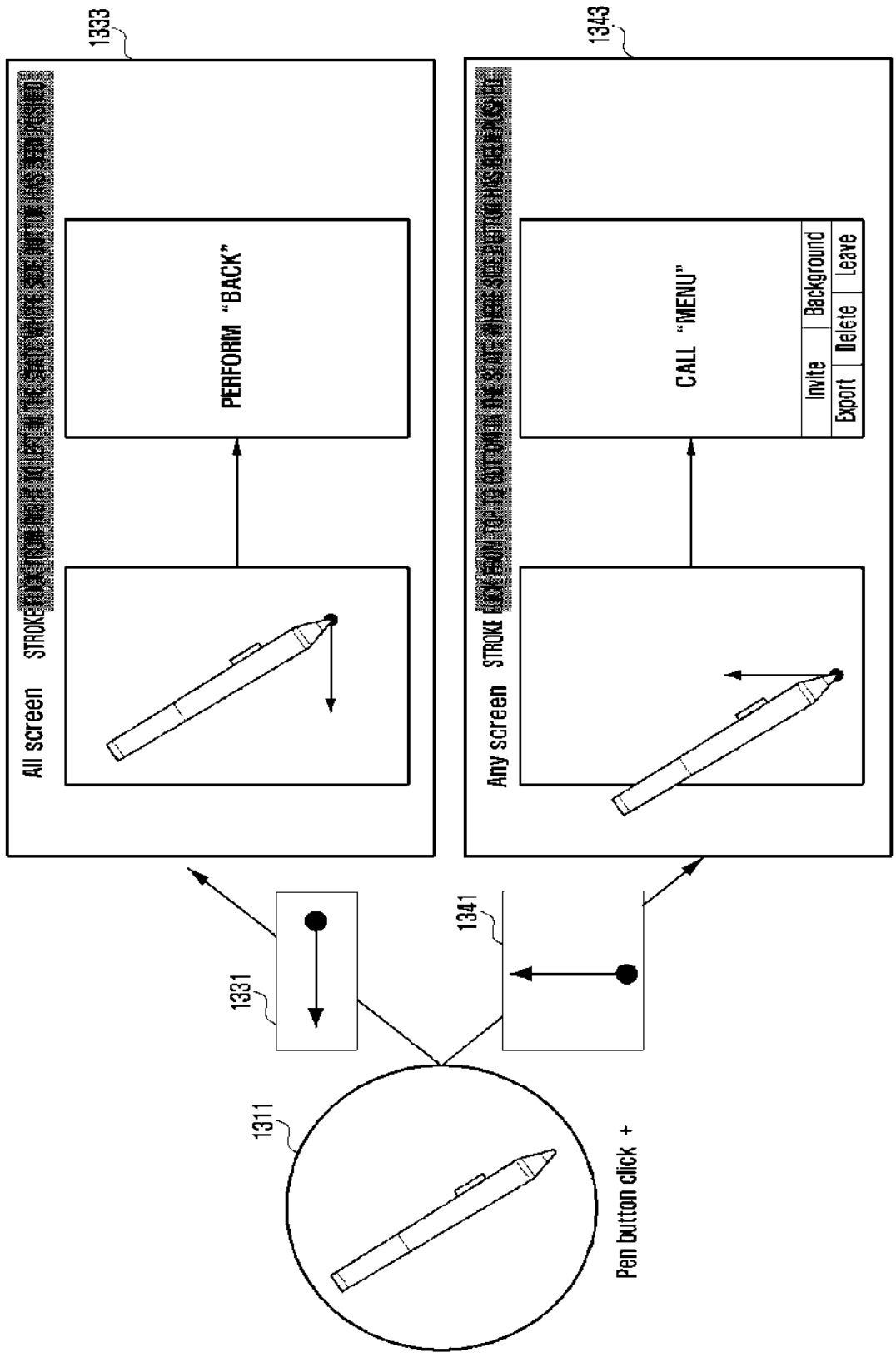
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FIG. 13A



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FIG. 13B



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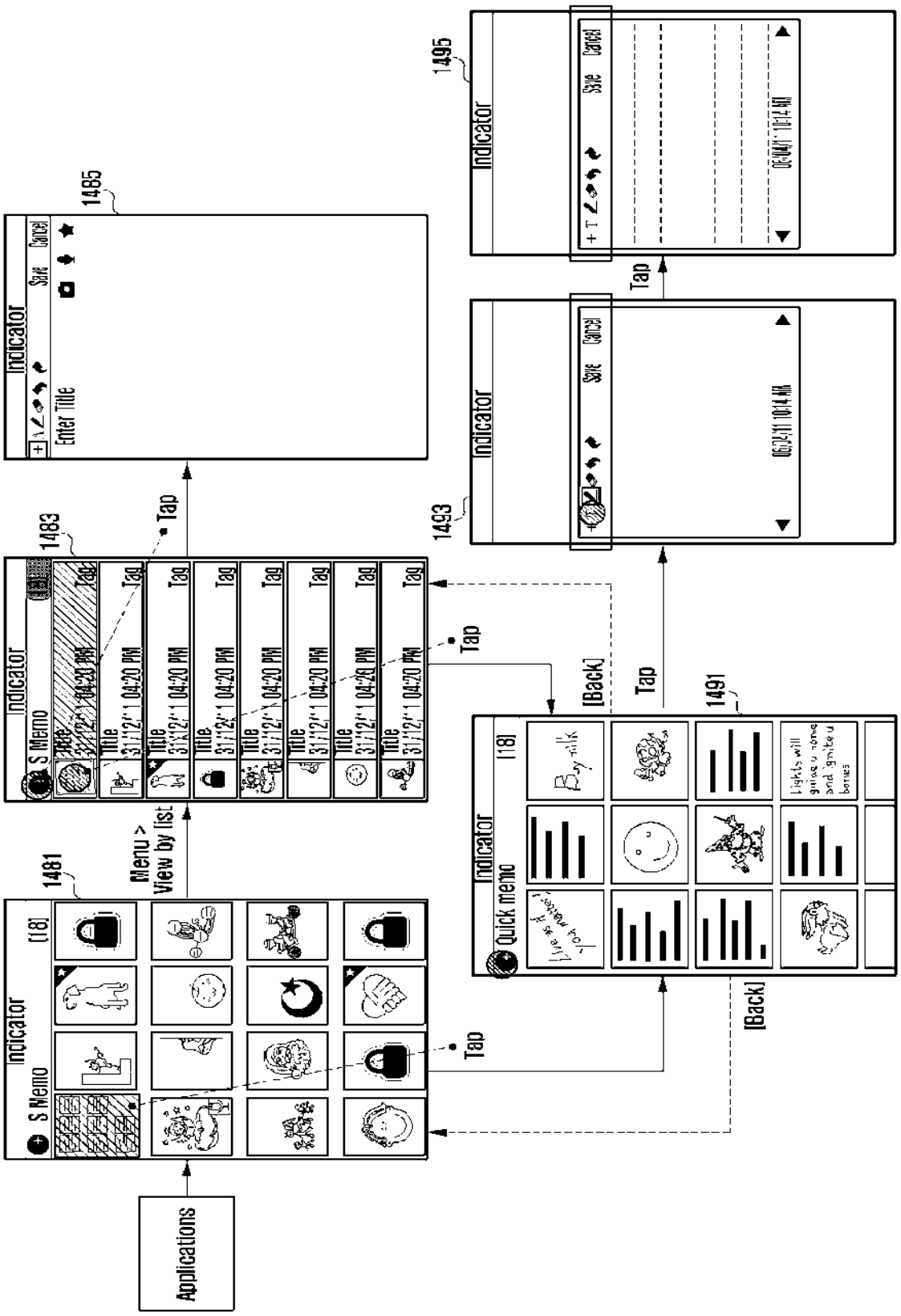
FIG. 14A

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FIG. 14B

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FIG. 14C

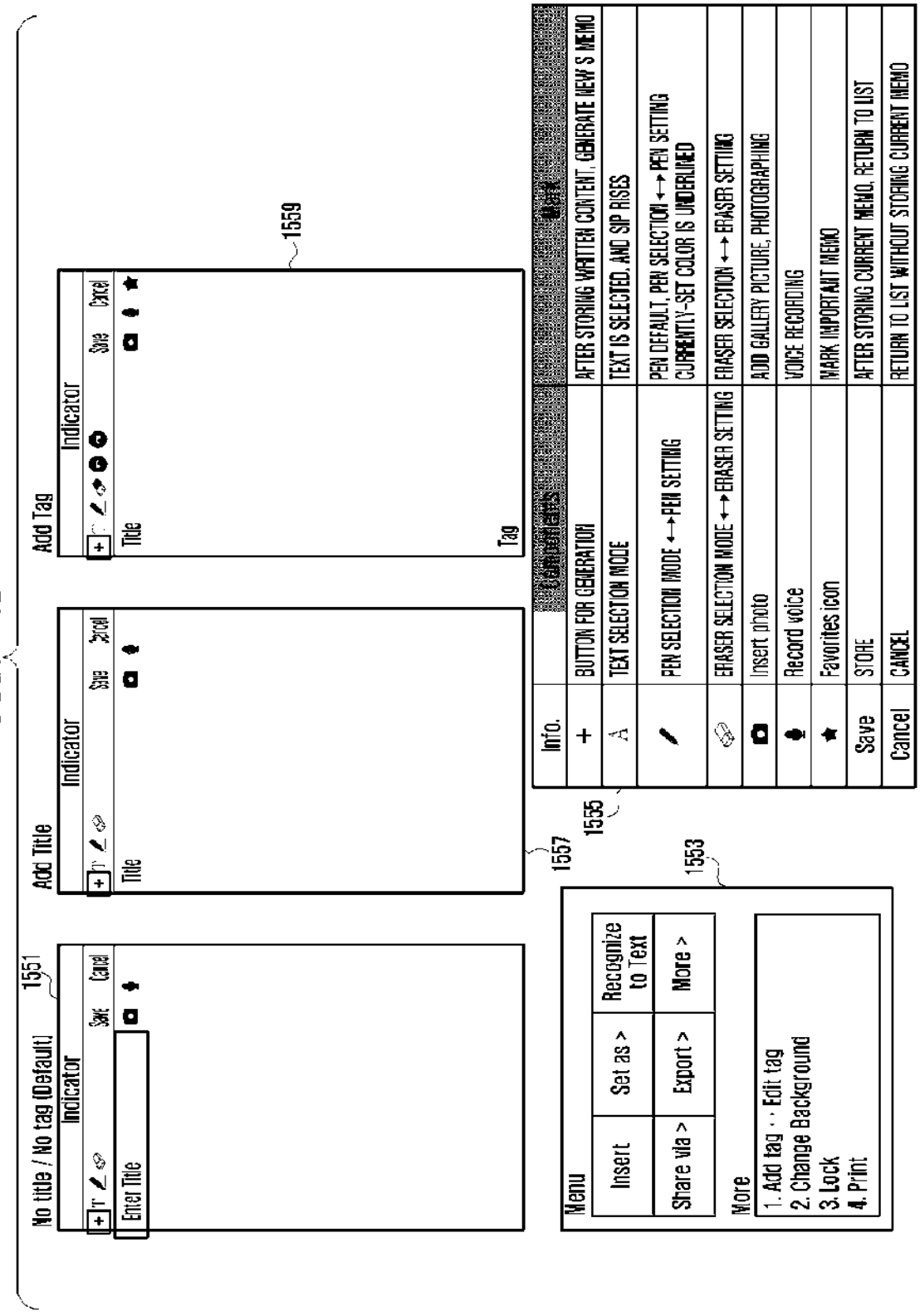


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FIG. 15A

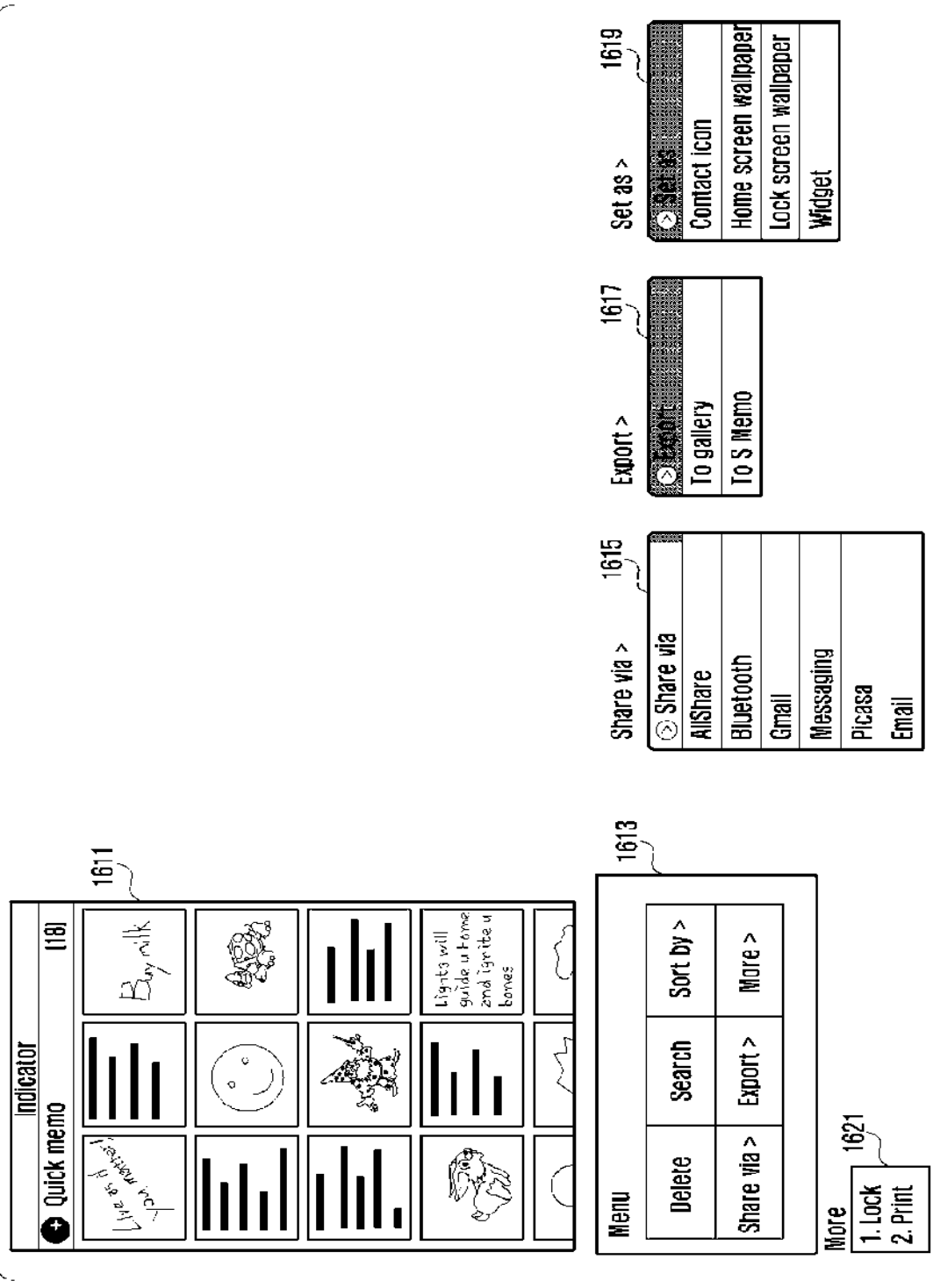
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FIG. 15B



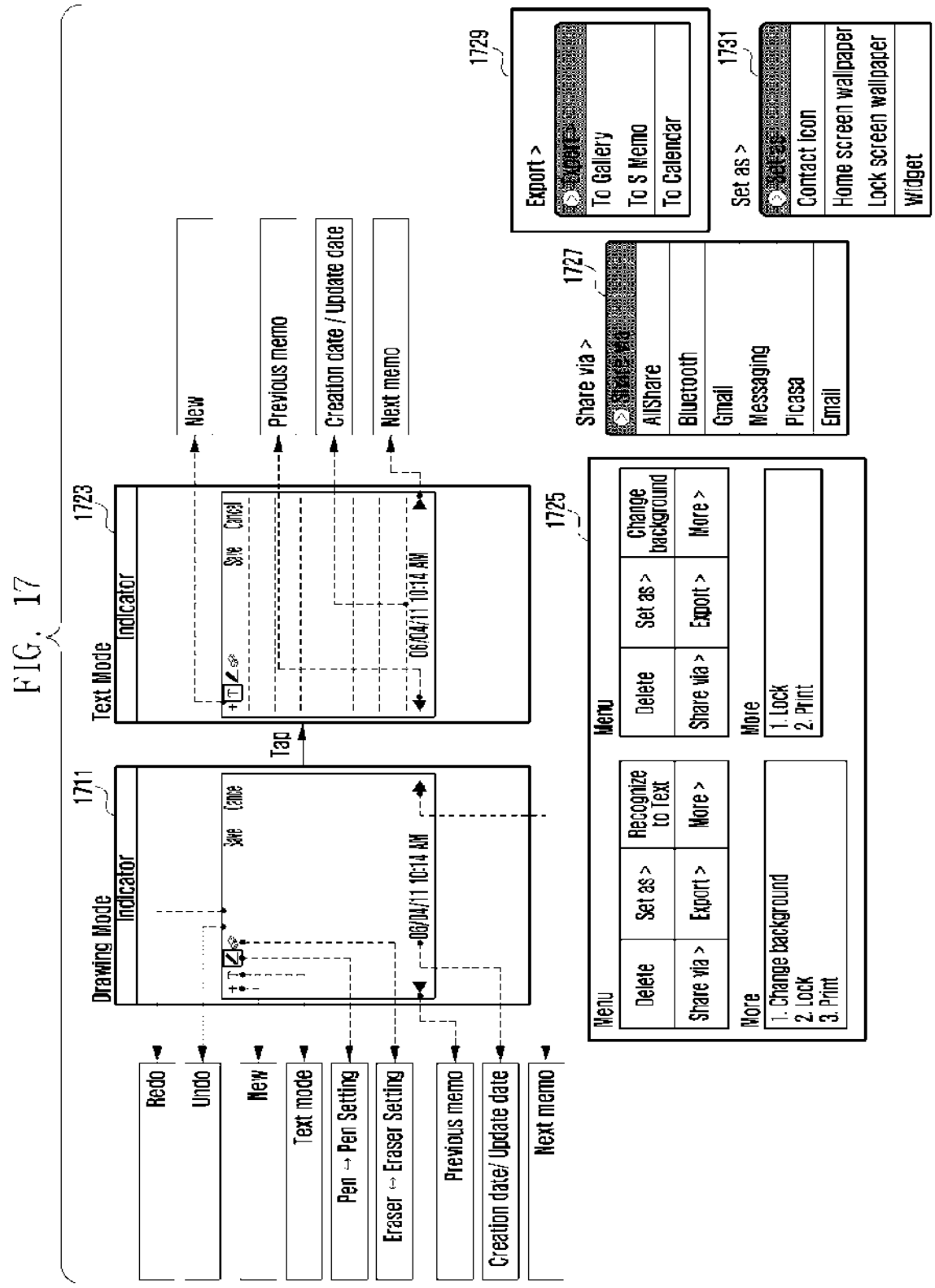
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FIG. 16



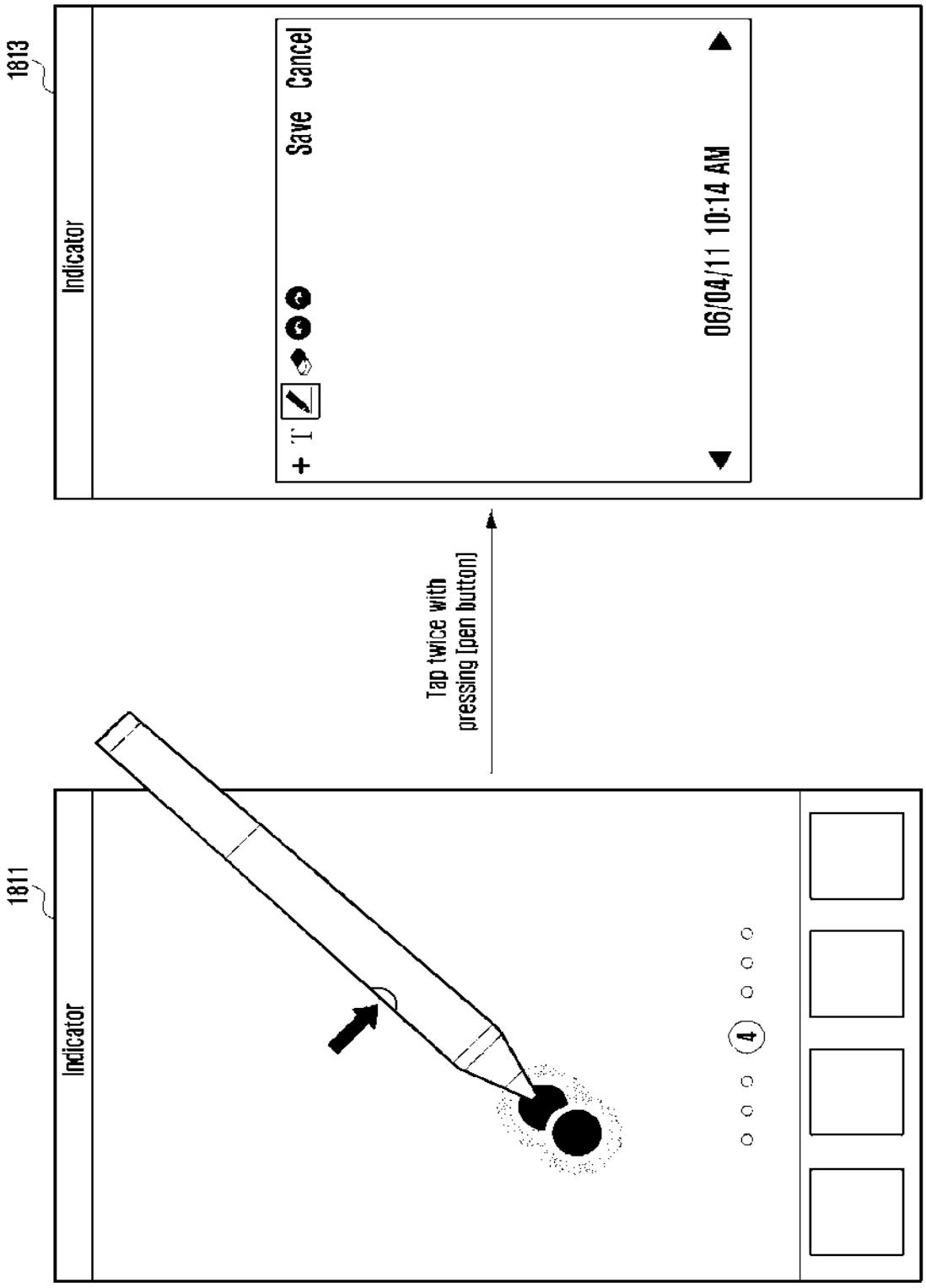
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FIG. 17



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FIG. 18



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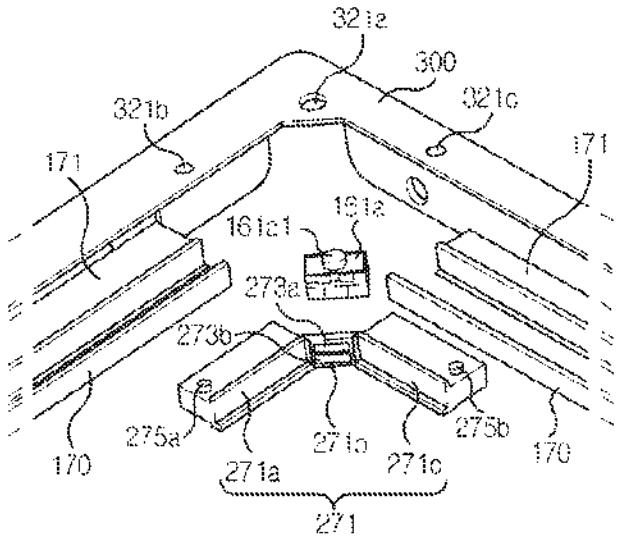
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(54) Title: OPTICAL TOUCH SCREEN AND METHOD FOR ASSEMBLING THE SAME

[Fig. 7]



(57) Abstract: The present invention relates to an optical touch screen and a method for assembling the same, the screen including a flat plate display panel; a case mounted and assembled with the flat plate display panel; brackets assembled at each corner of the case; a camera module mounted at each bracket, and a retro reflector arranged along an inner lateral surface of the case.

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Description

Title of Invention: OPTICAL TOUCH SCREEN AND METHOD FOR ASSEMBLING THE SAME

Technical Field

[1] The teachings in accordance with the exemplary embodiments of this invention relate generally to an optical touch screen and a method for assembling the same.

Background Art

[2] A touch screen or touch panel is a display which can detect a location of touch within a display area, usually performed either with the human hand or a stylus. This allows the display to be used as an input device, removing a keyboard and/or a mouse as a primary input device for interacting with the display's content.

[3]

[4] Technically speaking, the commonly used touch screens employ resistive, capacitive, ultrasonic wave, electromagnetic, vector force and optical (Infrared) touch modes. Among these types of touch screens, resistive type is the most common one, which has approximately 60% of market share (the second is capacitive type with around 24% of market share). Each of these types of touch screens has its own features, advantages and disadvantages. Now, these touch screens are briefly explained.

[5]

[6] The resistive is a common type of touch screen technology. It is a low-cost solution found in many touch screen applications, including hand-held computers, PDA's, consumer electronics, and point-of-sale-applications. The resistive touch screens are such that a pair of resistive layers facing with each other is provided on a touch screen element. The pressed position is detected by contact between the resistive layers so that one of the resistive layers is formed on a flexible film for deformation during pressing. As mentioned above, the resistive film type is widely used, but disadvantageous due to degraded mechanical and environmental reliability. At the same time, although the resistive touch screen today are widely used on consuming electronic products, it is unable to identify multiple contact points simultaneously on its display area.

[7]

[8] The ultrasonic wave touch screen first converts an electric signal into an ultrasonic wave through a transducer, and then directly transmits the ultrasonic wave through a surface of the touch panel. When the touch panel is used, the ultrasonic wave may be absorbed by contacting a pointer to cause attenuation, and an accurate position of the contact is obtained through comparison and calculation between attenuation amounts before and after use. The surface acoustic wave touch screen is disadvantageous due to

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generation of noise and/or susceptibility to noise.

[9]

[10] The electromagnetic type touch screen is such that, in the field of magnetism, a magnetic field is normally generated by a coil due to electromagnetism and said magnetic field induces a voltage in another coil, also called receiver coil, under the premise that the magnetic field strength changes in the receiver coil. It is clear that a non-moving receiver coil is not capable to measure a non-altering magnetic field since no voltage is induced by said magnetic field. There are already means, which can measure a position and/or orientation of a receiver means in relation to a specific magnetic field generating means. To measure the orientation in a 3-dimensional space normally three orthogonal arranged probes are used to calculate the coordinates. These arrangements are most of the time very bulky, space taking and need a special stylus.

[11]

[12] The capacitance type touch screen adopts capacity changes generated from the combination of static electricity between arranged transparent electrodes and a human body, so as to detect coordinates of the contact position through a generated induced current. That is, the capacitance type touch screen includes one substrate having an electrode formed thereon. In the capacitance type touch panel, when, for example, a finger contacts and approaches the touch panel, a variation in capacitance between the electrode and the finger is detected, thereby detecting input coordinates. Since the capacitance type touch panel is a non-contact type, it has high durability, excellent environmental and mechanical reliability due to changeable upper barrier layer unlike the resistive film type touch panel. However, the capacitance type touch panel has disadvantages in that it is difficult to input information with fingers or a pen.

[13]

[14] The optical type touch screens principally use no films for touch recognition such that transmittance is 100%. Furthermore, no reflexibility, degradation of brightness and blurring of displays are generated from these optical touch screens. Maintenance of transmittance and brightness in displays is an important factor for image clarity, such that an optical type is adequate for implementation of high quality screens. Furthermore, the optical type touch screens utilize the principle of light source reception and blocking, such that no load is applied to a sensor as detection is not performed by physical or electrical contacts, which increases reliability for use in factory monitoring, various automation equipment and ATM's. The optical type touch screens are advantageously free from such materials as films or ITO (Indium Tin Oxide) protective films to have less susceptibility to scratches or external shocks and a lower error probability including erroneous operation.

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Disclosure of Invention

Technical Problem

[15] The present invention is directed to solving an object of performing an easy assembly of an optical touch screen.

[16]

[17] Technical problems to be solved by the present invention are not restricted to the above-mentioned, and any other technical problems not mentioned so far will be clearly appreciated from the following description by skilled in the art.

Solution to Problem

[18] An object of the invention is to solve at least one or more of the above problems and/or disadvantages in a whole or in part and to provide at least the advantages described hereinafter. In order to achieve at least the above objects, in whole or in part, and in accordance with the purposes of the invention, as embodied and broadly described, and in one general aspect of the present invention, there is provided an optical touch screen, the optical touch screen comprising: a flat plate display panel; a case mounted and assembled with the flat plate display panel; brackets assembled at each corner of the case; a camera module mounted at each bracket; and a retro reflector arranged along an inner lateral surface of the case.

[19]

[20] Preferably, the optical touch screen further includes a frame mounted at an inner lateral surface between the brackets, wherein the retro reflector is mounted at the frame.

[21]

[22] Preferably, the case takes the shape of a square ring.

[23]

[24] Preferably, the brackets include first and second fixtures fixed on the case, and a connection connected to the first and second fixtures, wherein the camera module is mounted at the connection.

[25]

[26] Preferably, the connection of the bracket includes a first passage through which infrared (IR) emitted from the camera module can pass, and a second passage through which infrared (IR) incident on the camera module can pass.

[27]

[28] Preferably, the retro reflector is mounted on the first and second fixtures.

[29]

[30] Preferably, the frame is formed with a groove, and the retro reflector is formed with a lug insertable to the groove, wherein the lug formed at the retro reflector is inserted

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into the groove formed at the frame, whereby the retro reflector is mounted at the frame.

[31]

[32] Preferably, the camera module includes an IR emitting diode emitting IR; an IR pass filter passing only the IR reflected from the retro reflector; and a linear sensor detecting an area touched by incidence of IR that has passed the IR pass filter.

[33]

[34] Preferably, the camera module includes a holder formed with a stair unit and an opening; an IR emitting diode mounted at the stair unit for emitting IR; and an image sensor detecting the IR through the opening.

[35]

[36] Preferably, the stair unit is formed at an upper surface of the holder, and the opening is formed at a bottom surface of the holder.

[37]

[38] Preferably, the holder is formed at one side with a first groove and is formed at the other side with a second groove, and the opening connects the first groove and the second groove, and the stair unit is formed at an upper surface of the one side.

[39]

[40] Preferably, the first groove is formed with an objective lens, the second groove is formed with an infrared pass filter that passes an infrared of a particular wave band, and a printed circuit board mounted with the image sensor is attached to the holder for blocking the second groove.

[41]

[42] Preferably, the IR pass filter is implemented by coating an IR pass filter material on a glass.

[43]

[44] In another general aspect of the present invention, there is provided a method for assembling an optical touch screen, the method comprising: preparing a bracket mounted with a camera module and a square ring-shaped case; fixing the bracket at each corner of the case; fixing a retro reflector on the case; and mounting a flat plate display panel on the case.

[45]

[46] Preferably, the brackets include first and second fixtures fixed on the case, and a connection connected to the first and second fixtures, wherein the camera module is mounted at the connection.

[47]

[48] Preferably, the camera module is formed with a first fastening lug, the first and second fixtures of the bracket are formed with second and third fastening lugs, and the

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case is formed with first, second and third fastening holes corresponding to the first, second and third fastening lugs, wherein the first, second and third fastening lugs are inserted into the first, second and third fastening holes to allow the camera module and the bracket to be mounted at the case.

[49]

[50] Preferably, the step of fixing the bracket at each corner of the case is performed in such a manner that three inner corners of the square ring-shaped case are fixed by brackets on which the camera module is mounted, and one inner corner of the square ring-shaped case is mounted with a dummy bracket on which the camera module is not mounted.

[51]

[52] Preferably, the camera module includes a holder formed with a stair unit and an opening; an IR emitting diode mounted at the stair unit for emitting IR; and an image sensor detecting the IR through the opening.

[53]

[54] Preferably, the stair unit is formed at an upper surface of the holder, and the opening is formed at a bottom surface of the holder.

[55]

[56] Preferably, the holder is formed at one side with a first groove and is formed at the other side with a second groove, and the opening connects the first groove and the second groove, and the stair unit is formed at an upper surface of the one side.

Advantageous Effects of Invention

[57] The present invention has an advantageous effect in that a camera module can be easily mounted on a case through a bracket, a retro reflector can be easily assembled on a frame mounted on the case, and each constituent element can simply perform a mechanical arrangement for normally realizing an operational mechanism of an optical touch screen.

[58]

[59] The present invention has another advantageous effect in that the camera module and the retro reflector need no mount on a high-priced reinforced glass to reduce the manufacturing cost.

[60]

[61] The present invention has still another advantageous effect in that a frame and the bracket are formed with grooves, and the retro reflector is formed with a lug to allow the retro reflector to be easily fastened on the frame and the bracket by way of shield bar (rail) coupling method.

Brief Description of Drawings

[62] The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings, in which:

[63] FIG. 1 is a conceptual cross-sectional view illustrating an optical touch screen according to the present invention;

[64] FIG. 2 is a conceptual view illustrating a method for detecting a coordinate of a particular area touched on an optical touch screen according to the present invention;

[65] FIGS. 3a and 3b are schematic conceptual views illustrating a linear sensor of an optical touch screen according to the present invention;

[66] FIG. 4 is a schematic perspective view illustrating a state in which an optical touch screen is fastened according to the present invention;

[67] FIG. 5 is a schematic plan illustrating a case of an optical touch screen according to the present invention;

[68] FIGS. 6a through 6d are schematic plans illustrating a method of assembling an optical touch screen according to the present invention;

[69] FIG. 7 is a schematic partial perspective view illustrating a method for assembling an optical touch screen according to the present invention;

[70] FIGS. 8a and 8b are schematic partial perspective view illustrating in detail a process of attaching a retro reflector in a method for assembling an optical touch screen according to the present invention;

[71] FIG. 9 is a schematic cross-sectional view illustrating a camera module according to the present invention;

[72] FIG. 10 is schematic cross-sectional view illustrating a camera module according to an exemplary embodiment of the present invention;

[73] FIG. 11 is a schematic partially cut-out perspective view illustrating a state where an IR pass filter is mounted to a bracket according to the present invention; and

[74] FIG. 12 is a schematic cross-sectional view illustrating a connected relationship between a camera module and a bracket according to the present invention.

Best Mode for Carrying out the Invention

[75] The following description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the following teachings, and skill and knowledge of the relevant art are within the scope of the present invention. The embodiments described herein are further intended to explain modes known of practicing the invention and to enable others skilled in the art to utilize the invention in such, or other embodiments and with various modifications required by the particular application(s) or use(s) of the present invention.

[76]

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[77] The disclosed embodiments and advantages thereof are best understood by referring to FIGS. 1-12 of the drawings, like numerals being used for like and corresponding parts of the various drawings. Other features and advantages of the disclosed embodiments will be or will become apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such additional features and advantages be included within the scope of the disclosed embodiments, and protected by the accompanying drawings. Further, the illustrated figures are only exemplary and not intended to assert or imply any limitation with regard to the environment, architecture, or process in which different embodiments may be implemented. Accordingly, the described aspect is intended to embrace all such alterations, modifications, and variations that fall within the scope and novel idea of the present invention.

[78]

[79] It will be understood that the terms "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof. That is, the terms "including", "includes", "having", "has", "with", or variants thereof may be used in the detailed description and/or the claims to denote non-exhaustive inclusion in a manner similar to the term "characterized by".

[80]

[81] Furthermore, "exemplary" is merely meant to mean an example, rather than the best. It is also to be appreciated that features, layers and/or elements depicted herein are illustrated with particular dimensions and/or orientations relative to one another for purposes of simplicity and ease of understanding, and that the actual dimensions and/or orientations may differ substantially from that illustrated. That is, in the drawings, the size and relative sizes of layers, regions and/or other elements may be exaggerated or reduced for clarity. Like numbers refer to like elements throughout and explanations that duplicate one another will be omitted. Now, the present invention will be described in detail with reference to the accompanying drawings.

[82]

[83] FIG. 1 is a conceptual cross-sectional view illustrating an optical touch screen according to the present invention.

[84]

[85] An optical touch screen according to the present invention includes a camera module (160) and a retro reflector (170), all of which are mounted to a front surface of a flat plate display panel (200). The camera module (160) may include an infrared light emitting diode (100) emitting infrared light, an IR (Infrared) pass filter (130) that

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passes only the infrared reflected from the retro reflector (170), and a linear sensor (150) detecting an area touched by the incident infrared that has passed the IR pass filter (130).

[86]

[87] At this time, the optical touch screen may further include an object lens (140) collecting the infrared that has passed the IR pass filter (130). Alternatively, the optical touch screen may be so configured as to allow the light emitted from the infrared light emitting diode (100) to be emitted through a lens (110).

[88]

[89] Furthermore, the retro reflector (170) reflects the infrared emitted from the infrared light emitting diode (100), where an incident angle and reflection angle of the infrared are same. Therefore, the infrared light emitting diode (100) of the camera module (160) emits an infrared, where the emitted infrared advances along the flat plate display panel (200) to be reflected from the retro reflector (170) and incident on the IR pass filter (130) of the camera module (160).

[90]

[91] At this time, the IR pass filter (130) passes only the infrared that has been reflected from the retro reflector (170), and the infrared that has passed the IR pass filter (130) is incident on the linear sensor (150). In a case a particular area of the flat plate display panel (200) is touched by a finger of a hand (250) while a user views an image displayed on the flat plate display panel (200), the infrared is blocked from the touched area to form a black spot on the linear sensor (150), whereby a coordinate of the touched particular area can be detected.

[92]

[93] Furthermore, the flat plate display panel (200) is situated under an area between the infrared light emitting diode (100) and the retro reflector (170), and in a case a user touches a particular area of an image displayed on the flat plate display panel, a driving signal is generated that corresponds to a coordinate detected by the linear sensor (150), whereby various functions including screen change, sound adjustment, screen movement, screen enlargement and screen reduction can be performed. At this time, the flat plate display panel may be one of an LCD (Liquid Crystal Display), an FED (Field Emission Display), a PDP (Plasma Display Panel), an EL (Electroluminescence), an OLED (Organic Light Emitting Diode), and an electronic paper display panel.

[94]

[95] FIG. 2 is a conceptual view illustrating a method for detecting a coordinate of a particular area touched on an optical touch screen according to the present invention, and FIGS. 3a and 3b are schematic conceptual views illustrating a linear sensor of an

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optical touch screen according to the present invention.

[96]

[97] The camera module of the optical touch screen may be installed at two or three corner areas of the flat plate display panel (200). For example, as illustrated in FIG. 2, in a case first and second camera modules (161a, 161b) are mounted on two corner areas (211, 212) of the flat plate display panel (200), and a predetermined area (250) of the flat plate display panel (200) is touched, the touched predetermined area (250) is blocked of infrared, and each linear sensor of the first and second camera module (161a, 161b) is formed with a black spot. Therefore, the linear sensor can detect a co-ordinate of the touched particular area using a position of the black spot.

[98]

[99] Each of the linear sensors (150a, 150b) of the first and second camera module (161a, 161b) is mounted with 1st to nth sensing pixel (151, 152, 153, 154, 155) as illustrated in FIGS. 3a and 3b. At this time, in a case the particular predetermined area of the flat plate display panel (200) is touched, one of the 1st to nth sensing pixel (151, 152, 153, 154, 155) is formed with the black spot. Furthermore, because each of the linear sensors (150a, 150b) of the first and second camera module (161a, 161b) is installed at a different position from that of the touched area, there is a high probability that the sensing pixel of the linear sensor (150a) of the first camera module (161a) is differently positioned from the linear sensor (150b) of the second camera module (161b).

[100]

[101] For example, as depicted in FIG. 3a, a black spot (251) is formed at the second sensing pixel (152) on the linear sensor (150a) of the first camera module (161a), and as illustrated in FIG. 3b, a black spot (251) is formed at the fourth sensing pixel (154) on the linear sensor (150b) of the second camera module (161b).

[102]

[103] Meanwhile, as shown in FIG. 2, if a crosswise direction of the flat plate display panel (200) is defined as x axis, and a lengthwise direction of the flat plate display panel (200) is defined as y axis, a coordinate of the touched area (250) can be extracted, if a connection line (S1) from the touched area (250) to the linear sensor (150a) of the first camera module (161a), a first angle (01) formed by a crosswise direction of the flat plate display panel (200), a connection line (S2) from the touched area (250) to the linear sensor (150b) of the second camera module (161b), a second angle (02) formed by a crosswise direction of the flat plate display panel (200) and a crosswise length of the flat plate display panel (200) are known.

[104]

[105] Furthermore, the first angle (01) and the second angle (02) are changed according to the position of the touched area (250), and in response thereto, the 1st to the nth

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sensing pixel (151, 152, 153, 154, 155) of the linear sensors (150a, 150b) are subdivided. That is, each of the 1st to the nth sensing pixel (151, 152, 153, 154, 155) of the linear sensors (150a, 150b) corresponds to the first angle (01) and the second angle (02).

[106]

[107] Therefore, in a case a black spot is formed on one of the sensing pixel of the 1st to the nth sensing pixel (151, 152, 153, 154, 155) of the linear sensors (150a, 150b) on the first and second camera modules (161a, 161b), the first angle (01) and the second angle (02) can be known, whereby a coordinate (x, y) of the touched area (250) can be extracted.

[108]

[109] Furthermore, the optical touch screen may include a coordinate extraction calculator capable of extracting real time a coordinate (x, y) of the touched area (250) touched by the aforementioned method or other methods, in a case a predetermined area (250) of the flat plate display panel (200) is touched.

[110]

[111] FIG. 4 is a schematic perspective view illustrating a state in which an optical touch screen is fastened according to the present invention, and FIG. 5 is a schematic plan illustrating a case of an optical touch screen according to the present invention.

[112]

[113] The optical touch screen according to the present invention may include a case (300) on which the flat plate display panel (200) is mounted, where the case (300) may be called a case top. The case (300) takes the shape of a square ring, and as shown in FIG. 5, an inner lateral surface of the square ring is mounted with the retro reflector (170), and two or three corner areas of the square ring is mounted and assembled with camera modules (161a, 161b, 161c).

[114]

[115] At this time, the camera modules (161a, 161b, 161c) are mounted on brackets (271, 272, 273), and each of the brackets (271, 272, 273) is mounted at three square ring corners. Furthermore, a balance one square ring corner is mounted with a dummy bracket (280) that is not mounted with a camera module. That is, the optical touch screen includes the flat plate display panel (200), the square ring-shaped case (300) on which the flat plate display panel (200) is assembled and attached, the brackets assembled on corners of the case (300), and the camera modules (161a, 161b, 161c). At least one of the brackets is a bracket that is not mounted with the camera modules (161a, 161b, 161c). An inner lateral surface of the case (300) in the brackets is mounted with the retro reflector (170). The retro reflector (170) is also mounted on the dummy bracket (280).

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[116]

[117] FIGS. 6a through 6d are schematic plans illustrating a method of assembling an optical touch screen according to the present invention.

[118]

[119] The method of assembling an optical touch screen according to the present invention is to first prepare the square ring shaped case (300), as illustrated in FIG. 6a.

[120]

[121] Next, the brackets (271, 272, 273) mounted at three square ring corners of the square ring shaped case (300) are fixed, and the dummy bracket (280) that is not mounted with the camera modules (161a, 161b, 161c) is fixed at one inner lateral corner of the square ring shaped case (300) (FIG. 6b).

[122]

[123] In the brackets (271, 272, 273) mounted with the camera modules (161a, 161b, 161c), infrared is emitted from the camera modules (161a, 161b, 161c) and the brackets (271, 272, 273) are formed with openings (not shown) through which the infrared can be incident reflected from the retro reflector (170). The dummy bracket (280) is not formed with an opening which is not needed.

[124]

[125] Successively, an inner lateral surface of the case in the brackets (271, 272, 273, 280) is mounted with a frame (171) for fixing the retro reflector (170) (FIG. 6c). Referring to FIG. 6c, the brackets (271, 272, 273, 280) means the brackets (271, 272, 273) that are mounted with camera modules (161a, 161b, 161c) and the dummy bracket (280) that is not mounted with camera module.

[126]

[127] Thereafter, the retro reflector (170) is fixed at the frame (171) and the dummy bracket (280) (FIG. 6d), where the retro reflector (170) can be fixed without blocking each opening of the brackets (271, 272, 273) mounted with camera modules (161a, 161b, 161c). Following the assembly process of FIG. 6d, the flat plate display panel (200) is mounted on the case (300).

[128]

[129] Therefore, the optical touch screen according to the present invention includes a flat plate display panel; a square ring-shaped case (300) mounted and assembled with the flat plate display panel; brackets (271, 272, 273, 280) assembled at each corner of the case (300); a frame (171) mounted at an inner lateral surface of case among the brackets (271, 272, 273, 280), camera modules (161a, 161b, 161c) mounted at each bracket; and a retro reflector mounted on the frame (171).

[130]

[131] FIG. 7 is a schematic partial perspective view illustrating a method for assembling an

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optical touch screen according to the present invention.

[132]

[133] The bracket (271) mounted with the camera module (161a) includes first and second fixtures (271a, 271c) fixed on the case, and a connection (271b) connected to the first and second fixtures (271a, 271c).

[134]

[135] The method for assembling the optical touch screen first includes mounting the camera module (161a) to the connection (271b) of the bracket (271), where the connection (271b) of the bracket (271) may include a first passage (273a) through which infrared (IR) emitted from the camera module (161a) can pass, and a second passage (273b) through which infrared (IR) incident on the camera module (161a) can pass.

[136]

[137] The first and second passages (273a, 273b) may be also implemented by openings formed at the connection (271b) of the bracket (271), as illustrated in FIG.7, but configuration of which is not limited thereto.

[138]

[139] Thereafter, the bracket (271) mounted with the camera module (161a) is mounted at each corner of the case (300).

[140]

[141] To be more specific, as shown in FIG.7, the camera module (161a) is formed with a first fastening lug (161a1), the first and second fixtures (271a, 271c) of the bracket (271) are formed with second and third fastening lugs (275a, 275b), and the case (300) is formed with first, second and third fastening holes (321a, 321b, 321c) corresponding to the first, second and third fastening lugs (161a1, 275a, 275b), wherein the first, second and third fastening lugs (161a1, 275a, 275b) are inserted into the first, second and third fastening holes (321a, 321b, 321c) to allow the camera module (161a) and the bracket (271) to be mounted at the case (300).

[142]

[143] Successively, the frame (171) is mounted on the case (300), and the retro reflector (170) is mounted on the frame (171). At this time, the retro reflector (170) may be mounted on the first and second fixtures (271a, 271c) of the bracket (271).

[144]

[145] Therefore, the present invention has an advantage in that a camera module can be easily mounted on a case through a bracket, a retro reflector can be easily assembled on a frame mounted on the case, and each constitsent element can simply perform a mechanical arrangement for normally realizing an operational mechanism of an optical touch screen. Furthermore, the present invention has another advantage in that the

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camera module and the retro reflector need no mount on a high-priced reinforced glass to reduce the manufacturing cost.

[146]

[147] FIGS. 8a and 8b are schematic partial perspective view illustrating in detail a process of attaching a retro reflector in a method for assembling an optical touch screen according to the present invention.

[148]

[149] Referring to FIG.8a, the bracket (271) mounted with the camera module (161a) and the frame (171) are mounted on the case (300), and then, as shown in FIG.8b, the retro reflector (170) is mounted on the frame (171) and a partial area of the bracket (271).

[150]

[151] At this time, only the connection (271b) of the bracket (271) is exposed, and the retro reflector (170) is encompassed by the inner lateral surface of the case (300) to reflect the IR, where the IR emitted from the camera module (161a) is emitted through the first passage (273a) of the connection (271b) at the bracket (271), and the emitted IR is reflected from the retro reflector (170) to enter the second passage (273b). Therefore, the IR emitted from the camera module (161a) does not interfere with the incident IR.

[152]

[153] Meanwhile, the frame (171) and the partial area of the bracket (271) may be formed with a groove and the retro reflector (170) may be formed with a lug insertable to the groove (171a).

[154]

[155] Thus, the present invention has an advantage in that the retro reflector (170) can be easily fastened to the frame (171) and the bracket (271), by way of shield bar (rail) coupling method, by grooves formed at the frame (171) and the bracket (271), and the lug formed on the retro reflector (170).

[156]

[157] Alternatively, in a case guides are respectively formed on an upper surface and a bottom surface of the frame (171) and the bracket (271), an area between the guides is concavely formed to allow the retro reflector (170) to be inserted into the concave area between the guides. That is, the retro reflector (170) can be fastened to the frame (171) and the bracket (271) by way of shield bar (rail) coupling method.

[158]

[159] FIG.9 is a schematic cross-sectional view illustrating a camera module according to the present invention.

[160]

[161] Referring to FIG.9, the camera module includes a holder (380) formed with a stair unit (381) and an opening (383); an IR emitting diode (100) mounted at the stair unit

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(381) for emitting IR (G1); and an image sensor (150) for detecting the IR (G2) through the opening (383).

[162]

[163] The stair unit (381) may be formed at an upper surface of the holder (380), and the opening (383) may be formed at a bottom surface of the holder (380).

[164] Thus, the stair unit (381) and the opening (383) are formed at a different area of the holder (380) to prevent the IR (G1) emitted from the IR emitting diode (100) from being interfered by the IR (G2) through the opening (383), such that the IR incident on the image sensor (150) is free from the IR (G1) components emitted from the IR emitting diode (100).

[165]

[166] Therefore, the camera module according to the present invention has an advantage in that the image sensor (150) is so positioned as to allow the stair unit (381) of the holder (380) to be mounted with the IR emitting diode (100), and the IR (G2) to be detected through the opening (383), thereby preventing the IR emitted from the IR emitting diode (100) from entering the image sensor (150). That is, the camera module according to the present invention is assembled in a two-tier structure where a light emitting unit and a light receiving unit are separately disposed as shown in FIG.8.

[167]

[168] FIG. 10 is schematic cross-sectional view illustrating a camera module according to an exemplary embodiment of the present invention.

[169]

[170] Now, an exemplary embodiment of the camera module will be illustrated with reference to FIG.10.

[171]

[172] The camera module includes a holder (380) formed at one side with a first groove (381) and formed at the other side with a second groove (384), where an opening (383) connects the first groove (381) and the second groove (384), a stair unit (381) is formed at an upper surface of the one side of the holder (380), the first groove (381) is formed with an objective lens (140), the second groove (384) is formed with an infrared pass filter (131) that passes an infrared of a particular wave band, and a printed circuit board (151) mounted with the image sensor (150) is attached to the holder (380) for blocking the second groove (384), and the stair unit (381) is mounted with the IR emitting diode (100).

[173]

[174] At this time, the IR pass filter (131) may be implemented by coating on a glass an IR pass filter material that passes an infrared of a particular wave band, where the glass functions as a cover plate protecting the image sensor. Furthermore, the stair unit (381)

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is mounted with the IR emitting diode (100).

[175]

[176] Therefore, the IR emitted from the IR emitting diode (100) advances to an upper surface of the flat plate display panel, and the IR reflected from the retro reflector passes the objective lens (140) and the IR pass filter (131) that passes an infrared of a particular wave band to be incident on the image sensor (150), whereby touch can be detected.

Mode for the Invention

[177] FIG. 11 is a schematic partially cut-out perspective view illustrating a state where an IR pass filter is mounted to a bracket according to the present invention, and FIG. 12 is a schematic cross-sectional view illustrating a connected relationship between a camera module and a bracket according to the present invention.

[178]

[179] The camera module is mounted at a rear surface of the connection (271b) of the bracket (271), and first and second infrared pass filters (410, 420) are mounted at a front surface of the connection (271b) of the bracket (271). At this time, the first infrared pass filter (410) is aligned on the first passage (273a) of the connection (271b) at the bracket (271), and the second infrared pass filter (420) is aligned on the second passage (273b), as illustrated in FIG. 12.

[180]

[181] Furthermore, a light leakage prevention lug (273d) may be formed between the first and second passages (273a, 273b) of the connection (271b) at the bracket (271)

[182]

[183] At this time, in a case the camera module is mounted at the connection (271b) of the bracket (271), the light leakage prevention lug (273d) is accommodated at the stair unit (381) mounted with the infrared light emitting diode (100), such that the infrared emitted from the infrared light emitting diode (100) advances only to the first passage (273a), instead of entering the image sensor (150).

[184]

[185] Therefore, the present invention is such that the camera module can be optically aligned by a simple assembly process of mounting the first and second infrared pass filters (410, 420) with the connection (271b) of the bracket (271) to advantageously simplify the processes.

[186]

[187] Furthermore, the connection (271b) of the bracket (271) is formed with the light leakage prevention lug (273d), and the camera module and the bracket are so coupled as to allow the stair unit (381) mounted with the infrared light emitting diode (100) to

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be accommodated with the light leakage prevention lug (273d), whereby the infrared emitted from the infrared light emitting diode (100) is advantageously prevented from entering the image sensor (150).

[188]

[189] The previous description of the present invention is provided to enable any person skilled in the art to make or use the invention. Various modifications to the invention will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the spirit or scope of the invention. Thus, the invention is not intended to limit the examples described herein, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

Industrial Applicability

[190] The present invention has an industrial applicability in that a frame and a bracket are formed with grooves, and a retro reflector is formed with a lug to allow the retro reflector to be easily fastened on the frame and the bracket by way of shield bar (rail) coupling method.

Claims

[Claim 1] An optical touch screen, the optical touch screen comprising: a flat plate display panel; a case mounted and assembled with the flat plate display panel; brackets assembled at each corner of the case; a camera module mounted at each bracket; and a retro reflector arranged along an inner lateral surface of the case.

[Claim 2] The optical touch screen of claim 1, wherein the optical touch screen further includes a frame mounted at an inner lateral surface between the brackets, wherein the retro reflector is mounted at the frame.

[Claim 3] The optical touch screen of claim 1, wherein the case takes the shape of a square ring.

[Claim 4] The optical touch screen of claim 1, wherein the brackets include first and second fixtures fixed on the case, and a connection connected to the first and second fixtures, wherein the camera module is mounted at the connection.

[Claim 5] The optical touch screen of claim 4, wherein the connection of the bracket includes a first passage through which infrared (IR) emitted from the camera module can pass, and a second passage through which infrared (IR) incident on the camera module can pass.

[Claim 6] The optical touch screen of claim 4, wherein the retro reflector is mounted on the first and second fixtures.

[Claim 7] The optical touch screen of claim 2, wherein the frame is formed with a groove, and the retro reflector is formed with a lug insertable to the groove, wherein the lug formed at the retro reflector is inserted into the groove formed at the frame, whereby the retro reflector is mounted at the frame.

[Claim 8] The optical touch screen of claim 1, wherein the camera module includes an IR emitting diode emitting IR; an IR pass filter passing only the IR reflected from the retro reflector; and a linear sensor detecting an area touched by incidence of IR that has passed the IR pass filter.

[Claim 9] The optical touch screen of claim 1, wherein the camera module includes a holder formed with a stair unit and an opening; an IR emitting diode mounted at the stair unit for emitting IR; and an image sensor detecting the IR through the opening.

[Claim 10] The optical touch screen of claim 9, wherein the stair unit is formed at an upper surface of the holder, and the opening is formed at a bottom

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surface of the holder.

[Claim 11] The optical touch screen of claim 9, wherein the holder is formed at one side with a first groove and is formed at the other side with a second groove, and the opening connects the first groove and the second groove, and the stair unit is formed at an upper surface of the one side.

[Claim 12] The optical touch screen of claim 11, wherein the first groove is formed with an objective lens, the second groove is formed with an infrared pass filter that passes an infrared of a particular wave band, and a printed circuit board mounted with the image sensor is attached to the holder for blocking the second groove.

[Claim 13] The optical touch screen of claim 12, wherein the IR pass filter is implemented by coating an IR pass filter material on a glass.

[Claim 14] A method for assembling an optical touch screen, the method comprising: preparing a bracket mounted with a camera module and a case; fixing the bracket at each corner of the case; fixing a retro reflector on the case; and mounting a flat plate display panel on the case.

[Claim 15] The method of claim 14, wherein the brackets include first and second fixtures fixed on the case, and a connection connected to the first and second fixtures, wherein the camera module is mounted at the connection.

[Claim 16] The method of claim 15, wherein the camera module is formed with a first fastening lug, the first and second fixtures of the bracket are formed with second and third fastening lugs, and the case is formed with first, second and third fastening holes corresponding to the first, second and third fastening lugs, wherein the first, second and third fastening lugs are inserted into the first, second and third fastening holes to allow the camera module and the bracket to be mounted at the case.

[Claim 17] The method of claim 14, wherein the step of fixing the bracket at each corner of the case is performed in such a manner that three inner corners of the square ring-shaped case are fixed by brackets on which the camera module is mounted, and one inner corner of the square-ring shaped case is mounted with a dummy bracket on which the camera module is not mounted.

[Claim 18] The method of claim 14, wherein the camera module includes a holder formed with a stair unit and an opening; an IR emitting diode mounted

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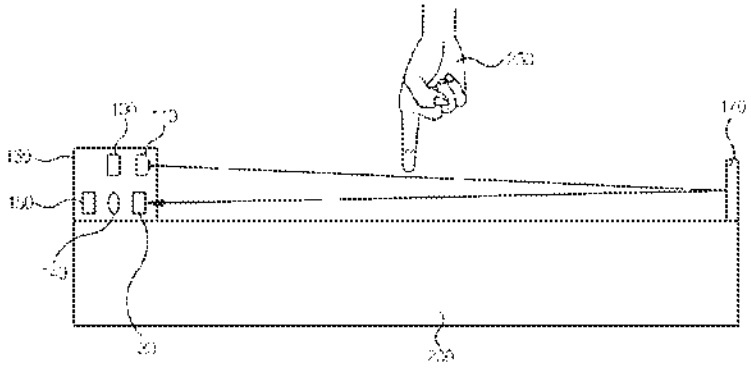
at the stair unit for emitting IR; and an image sensor detecting the IR through the opening.

[Claim 19] The method of claim 18, wherein the stair unit is formed at an upper surface of the holder, and the opening is formed at a bottom surface of the holder.

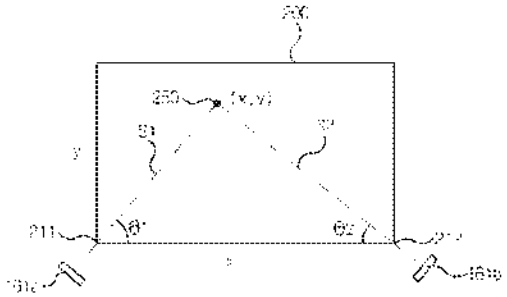
[Claim 20] The method of claim 18, wherein the holder is formed at one side with a first groove and is formed at the other side with a second groove, and the opening connects the first groove and the second groove, and the stair unit is formed at an upper surface of the one side.

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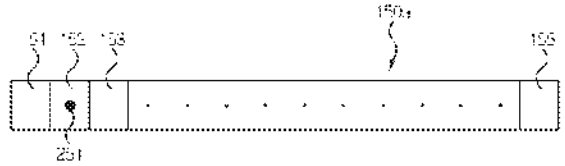
[Fig. 1]



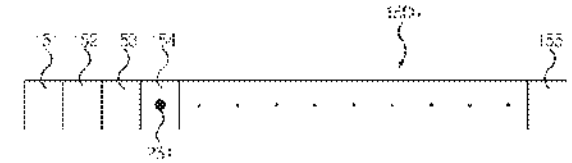
[Fig. 2]



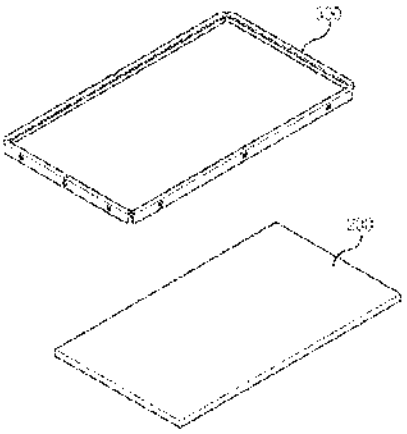
[Fig. 3a]



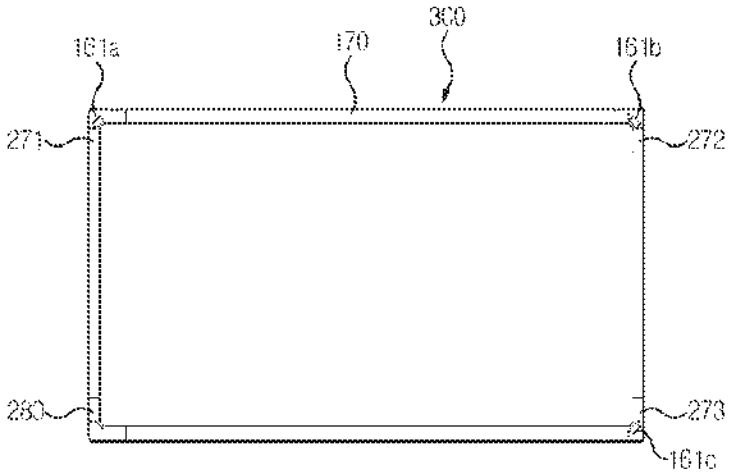
[Fig. 3b]



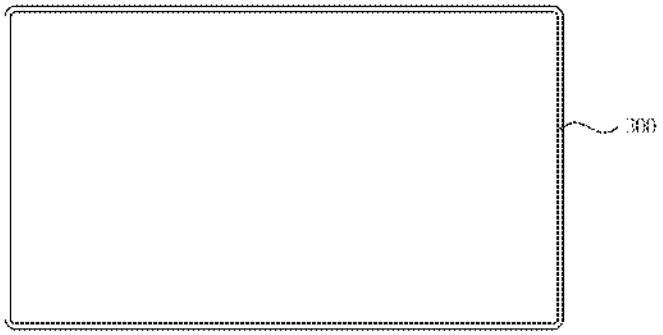
[Fig. 4]



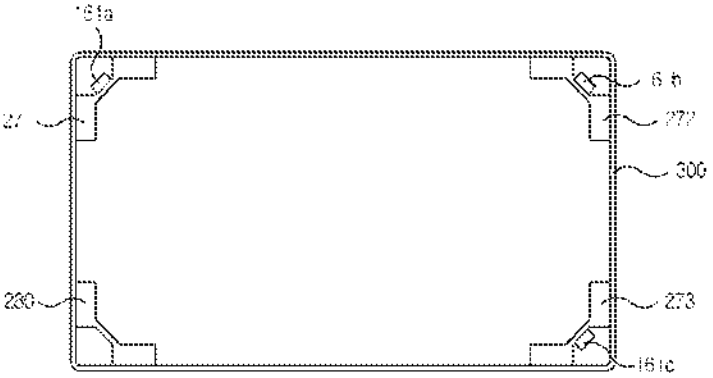
[Fig. 5]



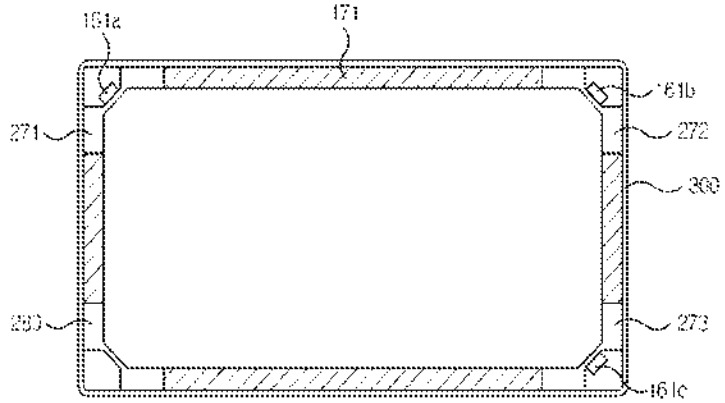
[Fig. 6a]



[Fig. 6b]

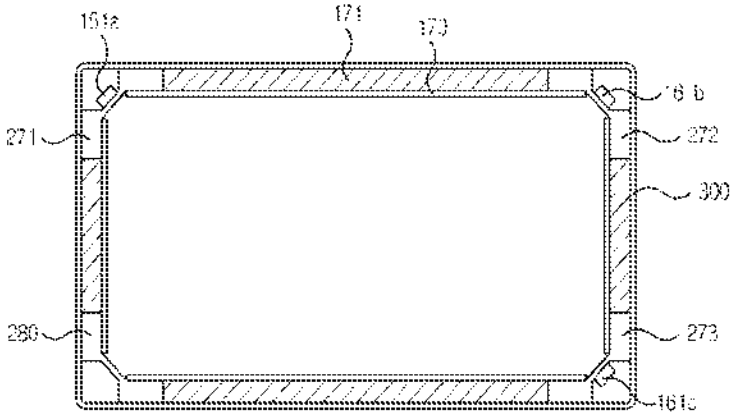


[Fig. 6c]

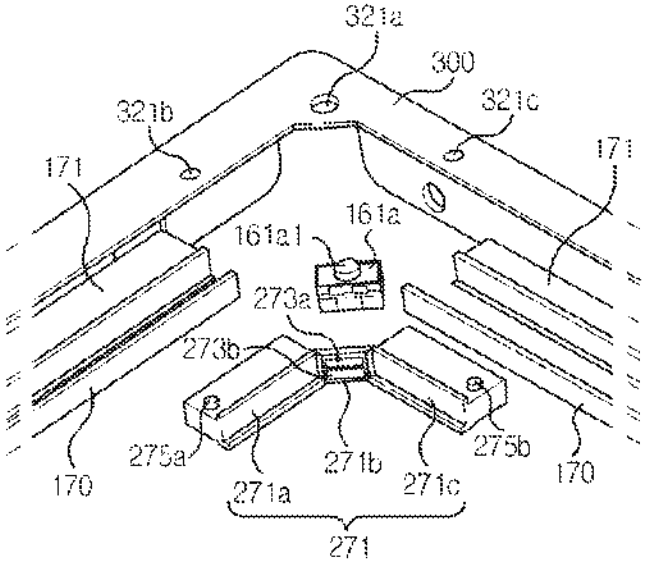


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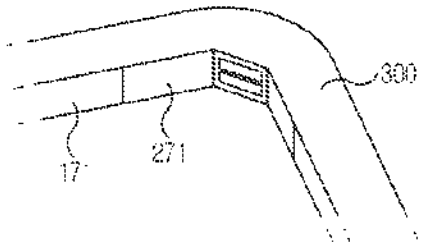
[Fig. 6d]



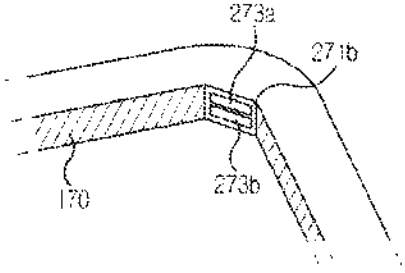
[Fig. 7]



[Fig. 8a]

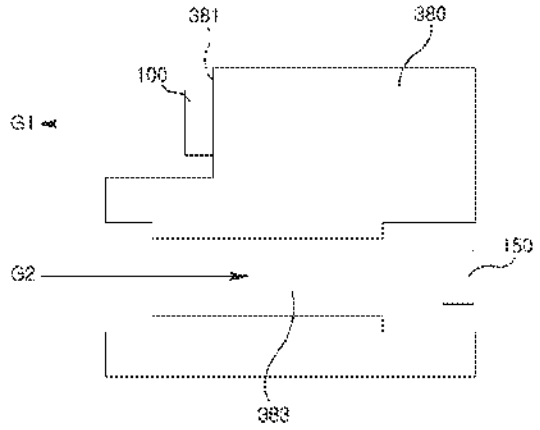


[Fig. 8b]

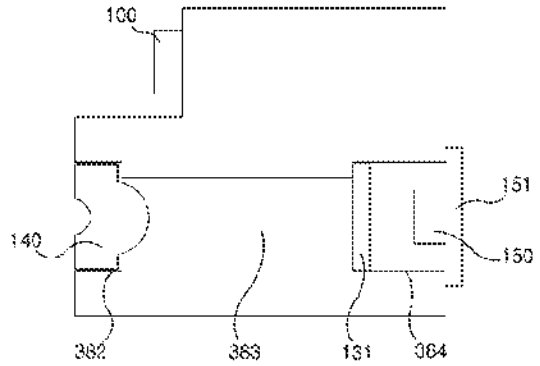


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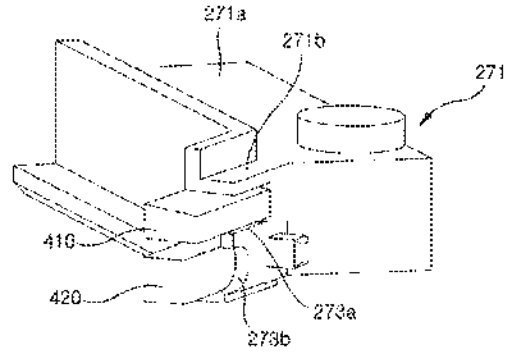
[Fig. 9]



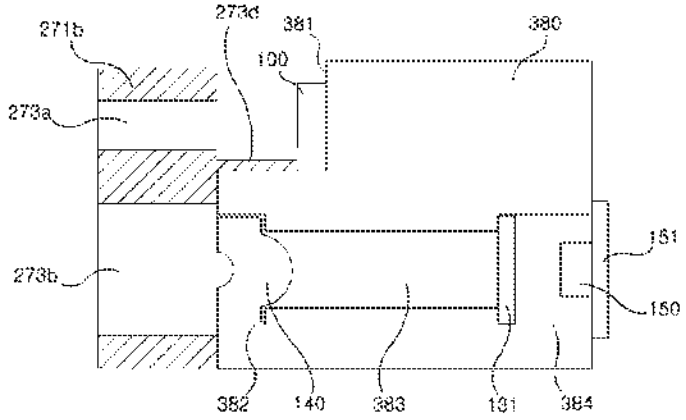
[Fig. 10]



[Fig. 11]



[Fig. 12]



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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
16/989,292	**04/02/2021 09:06:44 PM ET**	**FFOG.054C6**

Title of Invention

TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	8380	FILED BY	Jenny Kim
PATENT CENTER #	60170186	FILING DATE	08/10/2020
CUSTOMER #	20995	FIRST NAMED INVENTOR	Daniel Skagmo
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	HARNIK SHUKLA

Documents

TOTAL DOCUMENTS: 30

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
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ABSTRACT

A low profile touch display can be provided, namely one including an optical detection system with the bulk of the electronics and optics positioned partially or completely below the detecting plane surface. The light source and optical detection system components can be configured so that the exit and entry apertures for light being directed to and/or received from the detection plane are the only members above the touch surface. For instance, a reflective or refractive member at the edge of the touch surface can direct light to detection optics and/or from illumination sources via a pinhole aperture, with the light moving between the detection optics and illumination sources in one or more detection planes above the touch surface. Consequently, the touch screen can have a thin cross section that is more suitable for devices such as mobile phones, PDAs, and other portable computing devices for which minimal device thickness is a priority.

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LOW PROFILE TOUCH PANEL SYSTEMS

PRIORITY CLAIM

[0001] This application claims priority to New Zealand Provisional Patent Application No. 561,038, filed on August 30, 2007 and entitled OPTICAL TOUCHSCREEN ENABLING THIN CROSS SECTION, which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present subject matter generally pertains to touch display systems that allow a user to interact with one or more processing devices by touching on or near a surface.

BACKGROUND

[0003] Digitizers and tablets can be incorporated as a coordinate input apparatus in processing units. For instance, the digitizer or tablet can be used alongside one or more display devices (e.g. CRT, LCD, or other display technology) in a touch enabled display assembly. Generally speaking, various systems for detecting an angle (direction) or a position of an object relative to the display area can be used, such as pressure sensitive resistance membrane systems, capacitance systems, electromagnetic induction systems, and the like. As another example, optical systems capable of detecting the angle or the position of the object can be used.

[0004] More particularly, touch screen input devices include resistive, surface capacitive, surface acoustic wave (SAW), infrared (IR), Frustrated Total Internal Reflection (FTIR), Projected capacitive, optical and bending wave. Often, the foregoing touch screen devices (aside from some optical and infrared technologies) require use of a touch enabled transparent cover layer that adds height to the display assembly.

[0005] Certain optical and infrared systems rely on detection of light traveling in optical paths that lie in one or more detection planes in an area ("touch area" herein) above the touched surface. For example, optical imaging for touch screens can use a combination of line-scan or area image cameras, digital signal processing, front or back illumination, and algorithms to determine a point or area of touch. Components used to emit and detect light in the detection plane(s) can be positioned along one or more edges of the touch screen area as part of a bezel surrounding the touch screen area. Optical touch technology often uses

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line-scanning or area cameras orientated along one or more edges of the touch surface to image the bezel and track the movement of any object close to the surface of the touch screen by detecting the interruption of an infrared light source.

[0006] In some systems, the light can be emitted across the surface of the touch screen by IR-LED emitters aligned along the optical axis of the camera to detect the existence or non existence of light reflected by a retro-reflective border. If an object is interrupting light in the detection plane, the object will cast a shadow in the retroreflected light. Based on the direction of the shadow as cast toward multiple detectors and the spatial arrangement of the detectors, the object's location in the detection area can be triangulated. As another example, light can be emitted across the touch area in a grid pattern, with the object's location determined based on where the grid is interrupted.

[0007] For instance, Figure 1 is a cross-sectional view of an exemplary touch detection system 10 in which an optical detection and illumination system 12 and illuminated bezel 14 both extend above a touch surface 18. In this particular example, the optical detection system and illumination system are combined into a single unit as is known in the art. The plane of touch surface 18 in this example corresponds to the top of display screen 16 or a protective layer positioned above the display screen. Light is emitted from illumination source 20 and is directed along an outgoing optical path 20. The light is then retroreflected along return optical path 24, passing into optics 28 (a lens in this example) and detector 26. In this example, the profile of the touch detection system is 3.2mm.

[0008] As is known to those of skill in the art, the triangulation principle can be used to calculate the position at which an object impinges on a detection plane via measurements from two or more detection systems. Figure 2 provides a top view of an exemplary touch detection system 29 which can identify coordinates within a detection plane 31. In this example, two optical detection and illumination systems 30 are provided, with respective exemplary paths 34 and 36 showing the route of light emitted from and returned to the illumination/detection systems 30 via reflective components positioned along edges 32. For example, retroreflective components can be positioned along edges 32 covered by or included in a bezel.

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[0009] When an object interrupts the beams as represented at 33, the location of the interruption can be triangulated based on the change in optical paths across detection plane 31. For example, an object may cast shadows which are detected by illumination/detection systems 30, with location 33 triangulated from the direction of the shadows and the known spatial relationship between illumination/detection systems 30.

[0010] Figure 3 shows a side view of another exemplary touch detection system 40. In this example, illuminated stylus 42 is used to intersect detection plane 44. Light traveling in detection plane 44 may be collected via optics 46 and directed via reflector 48 to detector 50. In this example, detector 50 is interfaced with detector electronics 52 mounted above the touch surface. For example, detector 50, electronics 52, lenses 46, and reflector 58 may all be built into a bezel surrounding screen 58.

[0011] The relative complexity of the optical components used to emit and detect light can lead to a profile height of the bezel that is not suitable for all applications. For example, the bezel height may be too large for use in a handheld computing device, such as a mobile phone, or personal digital assistant (PDA).

[0012] RPO Pty Ltd of Australia, attempts to provide a low profile by having the IR emitters and receivers optically connected by wave guides. In the example of Figure 4, touch-enabled display 60 comprises an LCD display 62 surrounded by a plurality of transmit side waveguides 64 and receive side waveguides 66. Transmit side waveguides provide an optical path from light source 68, while receive side waveguides provide an optical path to detection electronics (ASIC) 70. Light from transmit side waveguides 64 forms a grid pattern across display 62 which can be detected by electronics 70. An object's location on the detection plane can be determined based on interruptions or other disruptions in the expected grid pattern. For example, source 68 may emit infrared or other light, and interruption of the grid may result in a shadow that diminishes the light received at one or more receive side waveguides 66.

[0013] Although waveguides 64 and 66 allow for source 68 and electronics 70 to be positioned below the screen surface, the waveguides add cost and complexity to the touch-enabled display. For example, the waveguides may be fragile and require careful handling. As another example, each of several waveguides must be connected to the touchscreen at one

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end and to electronics 70 at the other end. In short, use of the waveguides can complicate assembly and repair and may lead to a less durable product

SUMMARY

[0014] Objects and advantages of the present subject matter will be apparent to one of ordinary skill in the art upon careful review of the present disclosure and/or practice of one or more embodiments of the claimed subject matter.

[0015] In accordance with one or more aspects of the present subject matter, a low profile touch display can feature a touch surface corresponding to the outer surface of the display or a protective layer over the display. A reflective or refractive member at one or more edges of the touch surface can direct light traveling in one or more detection planes above the touch surface to the detection optics of the touch display via one or more pinhole apertures. The bulk of the electronics and optics of the optical detection system are positioned partially or completely below the plane of the touch surface, with only the refractive or reflective members and the exit and entry apertures for light extending above the touch surface. Consequently, the touch display system can have a thin cross section that is well suited for devices such as mobile phones, PDAs, and other portable computing devices for which minimal device thickness is a priority.

[0016] For example, a touch detection system can include an illuminated bezel positioned at an edge of a touch surface and configured to direct light along one or more optical paths laying in a detection plane (or planes) above the plane of the touch surface. The illuminated bezel may reflect, refract, or otherwise scatter light from one or more sources so that light is directed towards an optical detection system. As mentioned above, the touch surface may, for example, correspond to the surface of a display device or a protective surface (e.g. transparent or semi-transparent glass, plastic, or other material) positioned over the display device.

[0017] The touch detection system can further comprise an optical detection system positioned at an edge of the touch surface and partially or completely below the plane of the touch surface. The term "below" is meant to refer to the vertical positioning of the optical detection system relative to the plane of the touch surface and not necessarily its lateral position relative to the edges of the touch surface.

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[0018] At one or more edges of the touch surface, the system can include an optical assembly extending above the plane of the touch surface so as to intersect with the detection plane(s), with the optical assembly configured to direct light from an optical path (or paths) laying in the detection plane into the detection system via a pinhole aperture.

[0019] In some embodiments, the illuminated bezel is illuminated by an illumination source positioned at least partially below the plane of the touch surface. The illumination source can be configured to direct light toward an optical assembly through a pinhole aperture and into an optical path lying in the detection plane.

[0020] The illumination source may be positioned alongside the detection components of the optical detection system in some implementations and provide illumination via the same optical assembly that receives light returned from the touch area, with the same optical assembly relaying light up to the detection plane from the source. In such embodiments, the illuminated bezel can reflect, refract, or otherwise scatter light towards the detection components.

[0021] However, in other embodiments, the illumination source may be located at a different location on an edge of the touch surface and direct light through a pinhole aperture having the same size as the first pinhole aperture. The pinhole aperture can lead to a second optical assembly positioned at an edge of the touch surface and extending above the plane of the touch surface so as to intersect with the detection plane. Light can be directed up into the second optical assembly, across the touch area, into the first optical assembly, and then into the optical detection system.

[0022] In certain embodiments, the optical assembly or assemblies extend above the plane of the touch surface by a height approximately equal to the diameter of the pinhole aperture(s). For example, if the pinhole aperture is circular, the diameter can refer to the diameter of the circle, or if the aperture is square, the diameter can refer to the diagonal of the square. More generally, the diameter can refer to the maximum distance across the opening measured along a line that passes through the opening. In some embodiments, the pinhole aperture diameter(s) can be equal to or approximately 0.5 mm, although other diameters could be used, as appropriate. As used herein, "approximately" is meant to convey

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that the value is within ±20% of the stated value, thus "approximately" 0.5 mm includes 0.5 mm ±0.1mm. Pinhole apertures can have other shapes in other embodiments.

[0023] The "plane of the touch surface" is used to refer generally to a plane extending through space that, within the touch area, corresponds to the top of the touch surface. For example, the top of the touch surface can correspond to the top of display screen or a protective layer positioned above the display screen in some embodiments.

[0024] Multiple detection systems can be used in some embodiments. For example, a second detection system can be positioned at an edge of the touch surface and configured to receive light directed toward the second detection system via a second pinhole aperture. Depending on the configuration of the touch detection system, a single optical assembly with appropriate characteristics can be used to route light to the respective detection systems, or each detection system can feature a separate corresponding optical assembly extending above the touch surface.

[0025] Some embodiments can include at least one computing device interfaced with the detection system or systems and configured to determine a location at which an object has intersected the detection plane based on data collected from the detection system(s). For example, location may be determined based on the object's disturbance of the propagation of light in the detection plane(s), such as by detecting variances in illumination intensity (e.g. illumination intensity increases and/or shadows). As one particular example, the "triangulation principle" may be used to determine an object's location relative to the touch surface area.

[0026] One or more display systems can be included, the display system(s) having a surface positioned parallel to or corresponding the touch surface. For example, an LCD or other type of display can comprise the touch surface. The display systems can, in some embodiments, be interfaced with the at least one computing device. Accordingly, the computing device(s), in conjunction with the touch detection system and displays, can provide a touch-enabled display for use in operating the computing device(s).

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] A full and enabling disclosure including the best mode of practicing the appended claims and directed to one of ordinary skill in the art is set forth more particularly

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in the remainder of the specification. The specification makes reference to the following appended figures, in which use of like reference numerals in different features is intended to illustrate like or analogous components:

[0028] Figure 1 is a diagram illustrating an exemplary prior art illumination and detection system which is positioned above a touch surface;

[0029] Figure 2 is a diagram generally illustrating the triangulation principle employed in various prior art systems;

[0030] Figure 3 is a diagram illustrating an optical touch system including detection components above the detection plane in another exemplary prior art system;

[0031] Figure 4 generally illustrates one prior art solution in which illumination and detection components are positioned behind a touch surface through use of waveguide structures;

[0032] Figure 5 is a diagram illustrating an exemplary low profile touch detection system according to some aspects of the present subject matter;

[0033] Figure 6 shows a portion of the exemplary low profile touch detection system shown in Figure 5 in closer detail;

[0034] Figure 7 shows a portion of another exemplary low profile touch detection system according to some aspects of the present subject matter; and

[0035] Figure 8 is a block diagram illustrating an exemplary touch panel display system as interfaced with an exemplary computing device according to some aspects of the present subject matter.

DETAILED DESCRIPTION

[0036] Reference will now be made in detail to various and alternative exemplary embodiments and to the accompanying drawings, with like numerals representing substantially identical structural elements. Each example is provided by way of explanation, and not as a limitation. It will be apparent to those skilled in the art that modifications and variations can be made without departing from the scope or spirit of the disclosure and claims. For instance, features illustrated or described as part of one embodiment may be used

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on another embodiment to yield a still further embodiment. Thus, it is intended that the instant disclosure includes modifications and variations as come within the scope of the appended claims and their equivalents.

[0037] Turning now to Figure 5, an exemplary touch detection system 80 configured in accordance with one or more aspects of the present subject matter is shown. In this example, an illuminated bezel 82 directs light from source 86 along optical paths 88 and 90 which lie in detection planes above touch surface 84. Bezel 82 can be illuminated in any suitable way as will be noted below. As illustrated, touch surface 84 intersects with the surface of display 85, which is a liquid crystal display (LD) panel. It will be understood that in some embodiments, touch surface 84 may be above the actual surface of a display, such as when a covering is included on the surface of the display.

[0038] Optical detection system 92 is operative to detect light traveling in optical paths such as 88 and 90. Optical detection system 92 in this example comprises lens 98, detector 99, and related electronics. For instance, detector 99 may comprise a CMOS or other suitable light detector interfaced with an ASIC or other suitable circuitry to filter or otherwise process the output of detector 99. Of course, any suitable detection technology appropriate for detecting light from source 86 can be used. Further, although lens 98 is shown in this example for purposes of clarity, more complex optics may be used, including additional lenses, filters, and/or other suitable components.

[0039] Light traveling along optical paths 88 and 90 is directed into detection system 92 via a pinhole aperture 96 having a diameter d, which may be viewed in closer detail in Figure 6. Although in this example pinhole aperture 96 is round and its size is expressed as a diameter in the traditional sense, it will be understood that pinhole apertures can have other shapes; in such cases, its diameter or size would refer to the length from one side to the other of the aperture, passing through the center.

[0040] Optical assembly 94 is positioned at an edge of touch surface 84 and acts to direct light from one or more detection planes towards pinhole aperture 96. Optical assembly 94 extends above touch surface 84 to a profile height P equal or approximately equal to the diameter d of pinhole aperture 96. For instance, diameter d (and thus the profile height of optical assembly 94) may be approximately 0.5 mm in some embodiments.

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[0041] In example of Figures 5 and 6, optical assembly 94 is configured to direct light using refraction. Namely, a first facet F1 of the assembly 94 faces on the outside toward the touch detection area, while a second facet, F2, does not. Light entering facet F2 enters the assembly and is directed out of facet F1. Due to refraction the direction of light traveling from facet F2 to F1, and vice versa, is altered. Thus, optical detection system 92 can be positioned at least partially below the plane of touch surface 84.

[0042] In Figure 5, optical detection system 92 is positioned outside the edges of touch surface 84 and partially below the plane of touch surface 84, while in Figure 6 detection system 92 is depicted as entirely below the plane of touch surface 84. The relative distance between pinhole aperture 96 and optical assembly 94 can vary; in some embodiments, the aperture is minimally spaced from optical assembly 94.

[0043] Figure 7 is an illustration of another exemplary touch detection system 180 as viewed in cross section. In this example, optical detection system 192 is positioned completely below touch surface 184. Similarly to system 92 in the examples of Figures 5-6, optical detection system 192 comprises a lens (198) and detector (199). In this example, optical assembly 194 comprises a first facet F1 facing toward the detection area and a second facet F2 partially facing away from the detection area. In this example, facet F2 is configured to reflect rays traveling in optical paths 88 and 90 downward through pinhole aperture 196. This facilitates placement of optical detector assembly 192 completely below touch surface 184. Optical assembly 194 extends above touch surface 184 to a profile height P equal or approximately equal to the diameter d of pinhole aperture 196. As noted above, in some embodiments, d is equal or approximately equal to 0.5 mm.

[0044] In any event, an optical assembly 82, 94, 194 can comprise any suitable material or materials. For instance, in some embodiments, polycarbonate or acrylic plastics can have suitable cost, durability, and clarity characteristics.

[0045] Figure 8 is a block diagram illustrating an exemplary touch detection system 280 as interfaced to an exemplary display 250 and a computing device 201 in accordance with certain aspects of the present subject matter. Computing device 201 may be functionally coupled to touch screen system 200, by hardwire and/or wireless connections. Computing device 201 may be any suitable computing device, including, but not limited to a

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processor-driven device such as a personal computer, a laptop computer, a handheld computer, a personal digital assistant (PDA), a digital and/or cellular telephone, a pager, a video game device, etc. These and other types of processor-driven devices will be apparent to those of skill in the art. As used in this discussion, the term "processor" can refer to any type of programmable logic device, including a microprocessor or any other type of similar device.

[0046] Computing device 201 may include, for example, a processor 202, a system memory 204, and various system interface components 206. The processor 202, system memory 204, a digital signal processing (DSP) unit 205 and system interface components 206 may be functionally connected via a system bus 208. The system interface components 206 may enable the processor 202 to communicate with peripheral devices. For example, a storage device interface 210 can provide an interface between the processor 202 and a storage device 211 (removable and/or non-removable), such as a disk drive. A network interface 212 may also be provided as an interface between the processor 202 and a network communications device (not shown), so that the computing device 201 can be connected to a network.

[0047] A display screen interface 214 can provide an interface between the processor 202 and display device 250. For instance, interface 214 may provide data in a suitable format for rendering by display device 250. Although not illustrated, computing device 201 may include additional components dictated by its intended function. For example, if computing device 201 comprises a cellular telephone, appropriate transmission and reception components may be included. As another example, computing device 201 may include networking components as noted above, such as a radio transmitter/receiver for communication using one or more wireless standards such as those governed by IEEE 802.11.

[0048] In this example, touch screen 250 is bounded by edges 251, 252, 253, and 254. For instance, a bezel may be used to protect the edges of screen 250. Further, the edges of touch surface 284 correspond to edges 251, 252, 253, and 254. As was noted above, touch surface 284 may correspond to the outer surface of display 250 or may correspond to the outer surface of a protective material positioned on display 250. Although in this example

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the touch screen is enabled to detect an object's position relative to the entire display area, in other embodiments, the system may be operative to detect an object's position relative to only a part of the display area.

[0049] In any event, Figure 8 further illustrates a plurality of light sources 282A and 282B positioned at edge 252 and optical detection assemblies 292A and 292B positioned along edge 254. Since sources 282 and assemblies 292 are at least partially below touch surface 284, sources 282 and assemblies 292 are illustrated in phantom. In this example, optical assemblies 286A and 286B are shown along edge 252 for relaying light from sources 282 to optical paths in one or more detection planes above touch surface 284, while optical assemblies 294A and 294B are shown along edge 254 for relaying light from the detection plane(s) to detection assemblies 292.

[0050] One or more input/output ("I/O") port interfaces 216 may be provided as an interface between the processor 202 and various input and/or output devices. For example, the detection assemblies 292 or other suitable components of the touch screen system may be connected to the computing device 201 via an input port and may provide input signals to the processor 202 via an input port interface 216. Similarly, the light sources 282 of the touch screen system may be connected to the computing device 201 by way of an output port and may receive output signals (e.g. illumination timing and level controls) from the processor 202 via an output port interface 216.

[0051] A number of program modules may be stored in the system memory 204 and/or any other computer-readable media associated with the storage device 211 (e.g., a hard disk drive) or otherwise accessible by computing device 201. The program modules may include an operating system 217. The program modules may also include an information display program module 219 comprising computer-executable instructions for displaying images or other information on a display screen 250. Other aspects of the exemplary embodiments of the invention may be embodied in a touch screen control program module 221 for controlling the energy sources 282 and/or detector assemblies 292 and/or for calculating touch locations and discerning interaction states relative to the touch screen 250 based on signals received from the detector assemblies.

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[0052] In some embodiments, a DSP unit is included for performing some or all of the functionality ascribed to the Touch Panel Control program module 221. As is known in the art, a DSP unit 205 may be configured to perform many types of calculations including filtering, data sampling, and triangulation and other calculations and to control the modulation and/or other characteristics of light sources 282. The DSP unit 205 may include a series of scanning imagers, digital filters, and comparators implemented in software. The DSP unit 205 may therefore be programmed for calculating touch locations and discerning other interaction characteristics as known in the art.

[0053] The processor 202, which may be controlled by the operating system 217, can be configured to execute the computer-executable instructions of the various program modules. Methods in accordance with one or more aspects of the present subject matter may be carried out due to execution of such instructions. Furthermore, the images or other information displayed by the information display program module 219 may be stored in one or more information data files 223, which may be stored on any computer readable medium associated with the computing device 201.

[0054] As discussed above, when a user touches on or near the touch screen 250, a variation will occur in the intensity of the energy beams that are directed across the surface of the touch screen in one or more detection planes. The detector assemblies 292 are configured to detect the intensity of the energy beams reflected or otherwise scattered across the surface of the touch screen 250 and should be sensitive enough to detect variations in such intensity. Information signals produced by the detector assemblies 292 and/or other components of the touch screen display system may be used by the computing device 201 to determine the location of the touch relative to the touch screen 250. Computing device 201 may also determine the appropriate response to a touch on or near touch screen 250.

[0055] In accordance with some implementations, data from the detector assemblies may be periodically processed by the computing device 201 to monitor the typical intensity level of the energy beams directed along the detection plane(s) when no touch is present. This allows the system to account for, and thereby reduce the effects of, changes in ambient light levels and other ambient conditions. Computing device 201 may optionally increase or decrease the intensity of the energy beams emitted by the light sources 282, as needed.

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Subsequently, if a variation in the intensity of the energy beams is detected by the detector assemblies, the computing device 201 can process this information to determine that a touch has occurred on or near the touch screen 250.

[0056] The location of a touch relative to the area of touch screen 250 may be determined, for example, by processing information received from each detector assembly 292 and performing one or more well-known triangulation calculations. By way of illustration, the computing device 201 may receive information from each detector assembly 292 that can be used to identify the position of an area of increased or decreased energy beam intensity relative to each detector assembly. The location of the area of decreased energy beam intensity relative to each detector assembly may be determined in relation to the coordinates of one or more pixels, or virtual pixels, of screen 250. The location of the area of increased or decreased energy beam intensity relative to each detector may then be triangulated, based on the geometry between the detector assemblies 292 to determine the actual location of the touch relative to the touch screen 250.

[0057] Any such calculations to determine touch location and/or interaction state can include algorithms to compensate for discrepancies (e.g., lens distortions, ambient conditions, damage to or impediments on the touch screen 100 or other touched surface, etc.), as applicable.

[0058] The locations and number of illumination sources 282, optical assemblies 286 and 294, and detector assemblies 292 in Figure 8 are for purposes of example only. For instance, more or fewer illumination sources 282 and corresponding optical assemblies 286 could be used. Similarly more or fewer detector assemblies 292 and corresponding optical assemblies 294 could be used.

[0059] For example, rather than using triangulation, the system may establish a grid across the display surface using a plurality of illumination pinhole apertures and corresponding receiving pinhole apertures configured to direct light down to optical detection assemblies. For good resolution, several illumination sources and corresponding detection assemblies could be used.

[0060] In some embodiments, rather than discrete optical assemblies 294A and 294B, a continuous optical assembly can be provided along an edge, with the detector assemblies

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292 and corresponding pinhole apertures located along the edge at different locations. Similarly, a continuous optical assembly 286 could be used in conjunction with multiple sources 282.

[0061] In certain embodiments, optical units comprising both detector assemblies and illumination sources are used. For instance, a detector assembly can include illumination sources that illuminate a retroreflector that returns the light to its point of origin. See, for instance, U.S. Patent No. 6,362,468. In such embodiments, the same optical assembly and pinhole aperture could be used to route light from the illumination sources and across the detection plane and also return retroreflected light.

[0062] The above examples referred to various illumination sources and it should be understood that any suitable radiation source can be used. For instance, light emitting diodes (LEDs) may be used to generate infrared (IR) radiation that is directed over one or more optical paths in the detection plane. However, other portions of the EM spectrum or even other types of energy may be used as applicable with appropriate sources, detection systems, and optical (or other) units that redirect the energy to and from the detection plane.

[0063] Several of the above examples were presented in the context of a touch-enabled display. However, it will be understood that the principles disclosed herein could be applied even in the absence of a display screen when the position of an object relative to an area is to be tracked.

[0064] The various systems discussed herein are not limited to any particular hardware architecture or configuration. As was noted above, a computing device can include any suitable arrangement of components that provide a result conditioned on one or more inputs. Suitable computing devices include multipurpose microprocessor-based computer systems accessing stored software, but also application-specific integrated circuits and other programmable logic, and combinations thereof. Any suitable programming, scripting, or other type of language or combinations of languages may be used to implement the teachings contained herein in software.

[0065] Embodiments of the methods disclosed herein may be executed by one or more suitable computing devices. Such system(s) may comprise one or more computing devices adapted to perform one or more embodiments of the methods disclosed herein. As

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noted above, such devices may access one or more computer-readable media that embody computer-readable instructions which, when executed by at least one computer, cause the at least one computer to implement one or more embodiments of the methods of the present subject matter. When software is utilized, the software may comprise one or more components, processes, and/or applications. Additionally or alternatively to software, the computing device(s) may comprise circuitry that renders the device(s) operative to implement one or more of the methods of the present subject matter.

[0066] Any suitable computer-readable medium or media may be used to implement or practice the presently-disclosed subject matter, including, but not limited to, diskettes, drives, magnetic-based storage media, optical storage media, including disks (including CD-ROMS, DVD-ROMS, and variants thereof), flash, RAM, ROM, and other memory devices, and the like.

[0067] While the present subject matter has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, it should be understood that the present disclosure has been presented for purposes of example rather than limitation, and does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art

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WHAT IS CLAIMED:

1. A touch detection system comprising:

an optical detection system positioned at an edge of a touch surface and positioned at least partially below a plane of the touch surface, the plane of the touch surface corresponding to the top of the touch surface; and

an optical assembly positioned at an edge of the touch surface and extending above the plane of the touch surface so as to intersect with a detection plane above the plane of the touch surface, the optical assembly configured to refract light from an optical path in the detection plane into the optical detection system via a pinhole aperture;

wherein the optical assembly defines a profile height above the plane of the touch surface, the profile height approximately equal to the diameter of the pinhole aperture.

2. The touch detection system set forth in claim 1, wherein the profile height is equal to the diameter of the pinhole aperture.

3. The touch detection system set forth in claim 1, wherein the profile height is less than 1 mm.

4. The touch detection system set forth in claim 3, wherein the pinhole aperture diameter is less than or equal to 0.5 mm.

5. The touch detection system set forth in claim 1, further comprising:

an illumination source positioned at least partially below the plane of the touch surface and configured to direct light toward the optical assembly through the pinhole aperture; and

an illuminated bezel at an edge of the touch surface, the illuminated bezel comprising a surface that reflects light traveling towards the bezel in the detection plane back into the detection plane.

6. The touch detection system set forth in claim 1, further comprising:

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an illumination source positioned at least partially below the plane of the touch surface; and

an illuminated bezel at an edge of the touch surface, the illuminated bezel comprising a second optical assembly positioned at an edge of the touch surface and extending above the plane of the touch surface so as to intersect with the detection plane;

wherein the illumination source is configured to direct light toward the second optical assembly and the second optical assembly is configured to refract light received from the illumination source into the optical path lying in the detection plane.

7. The touch detection system set forth in claim 6, wherein the second optical assembly defines a profile height approximately equal to the size of the pinhole aperture.

8. The touch detection system set forth in claim 1, further comprising:

at least a second optical detection system, the second optical detection system positioned an edge of the touch surface and configured to receive light directed toward the second detection system via a pinhole aperture; and

at least one computing device interfaced with the first and second optical detection systems and configured to determine a location at which an object has intersected the detection plane based on data collected from the optical detection systems.

9. The touch detection system set forth in claim 1, further comprising a display system having a top surface positioned parallel to or corresponding to the touch surface.

10. The touch detection system set forth in claim 1, wherein the detection system is positioned completely below the plane of the touch surface.

11. A touch detection system comprising:

an illuminated bezel positioned at an edge of a touch surface and configured to direct light along an optical path laying in a detection plane above a plane of the touch surface, the plane of the touch surface corresponding to the top of the touch surface;

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a plurality of detection systems positioned along an edge of the touch surface and positioned at least partially below the plane of the touch surface; and

at least one optical assembly positioned at an edge of the touch surface and extending above the plane of the touch surface so as to intersect with the detection plane, the optical assembly configured to direct light from an optical path laying in the detection plane into the respective detection systems via a pinhole aperture corresponding to each detection system;

wherein the optical assembly extends above the touch surface by a height approximately equal to the diameter of the pinhole apertures.

12. The touch detection system set forth in claim 11,

further comprising an illumination source positioned at least partially below the touch surface and configured to direct light toward the optical assembly through the pinhole aperture; and

wherein the illuminated bezel comprises a surface that reflects light traveling towards the bezel in the detection plane back into the detection plane.

13. The touch detection system set forth in claim 11,

further comprising an illumination source positioned at least partially below the plane of the touch surface;

wherein the illuminated bezel comprises a second optical assembly positioned at an edge of the touch surface and extending above the plane of the touch surface so as to intersect with the detection plane; and

wherein the illumination source is configured to direct light toward the second optical assembly and the second optical assembly is configured to direct light received from the illumination source into the optical path lying in the detection plane.

14. The touch detection system set forth in claim 11, wherein the diameter of each pinhole aperture is less than or equal to 0.5 mm.

15. The touch detection system set forth in claim 11, further comprising:

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at least one computing device interfaced with the detection systems and configured to determine a location at which an object has intersected the detection plane based on data collected from the detection systems.

16. The touch detection system set forth in claim 15, further comprising a display system having a surface positioned parallel to or corresponding to the touch surface, the display system interfaced with the at least one computing device.

17. A touch-enabled display device, comprising:

a display screen having a surface and an area;

a detection system, with at least a portion of the detection system positioned vertically below the screen surface;

an illumination system, with at least a portion of the illumination system positioned vertically below the screen surface;

a computing device configured to determine the location at which an object has changed the transmission of light across a touch area, the touch area being coextensive with at least a part of the area of the display screen; and

at least one optical assembly positioned along at least one edge of the screen, the optical assembly comprising a first facet that faces toward the interior of the touch area and a second facet that does not face toward the interior of the touch area;

wherein the at least one optical assembly is configured so that light entering the assembly at the first facet is directed to exit the optical assembly at the second facet and light entering the optical assembly at the second facet is directed to exit the optical assembly at the first facet; and

wherein the display device is configured so that light is emitted from the illumination system and is directed into the second facet of the optical assembly before crossing the touch area.

18. The touch-enabled display device set forth in claim 17, wherein the display device is configured so that:

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the illumination system and detection system are separate from one another; and

light is emitted from the illumination system into a first optical assembly, crosses the touch area, and enters a second optical assembly which directs the light into the detection system via a pinhole aperture.

19. The touch-enabled display device set forth in claim 17, wherein the optical assembly is configured to direct light by reflection.

20. The touch-enabled display device set forth in claim 17, wherein the optical assembly is configured to direct light by refracting light at the first facet.

21. The touch-enabled display device set forth in claim 17, wherein the optical assembly at is configured so that:

light traveling in an optical path in a plane parallel to the plane of the touch surface and intersecting with the first facet is directed by the optical assembly to travel in an optical path in a plane that is not parallel to the plane of the touch surface and intersecting with the second facet.

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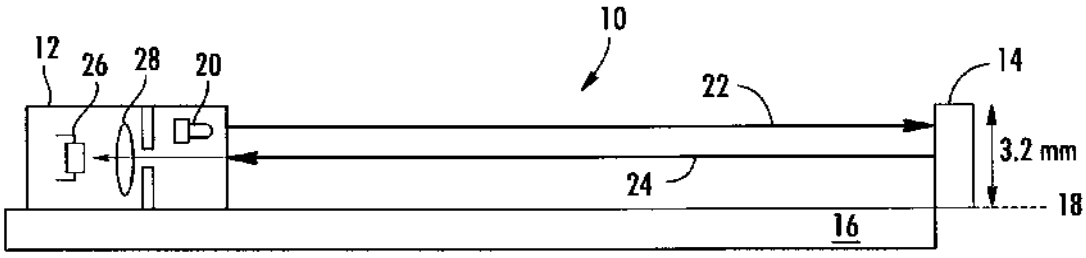


FIG. 1
PRIOR ART

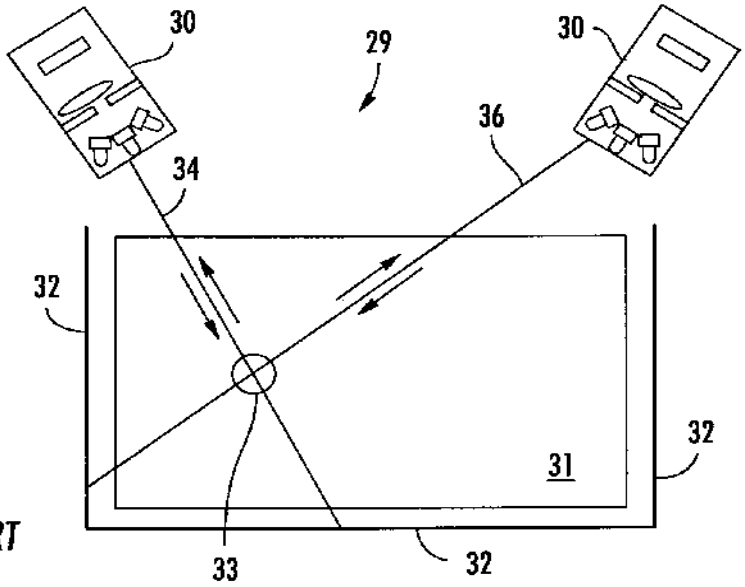


FIG. 2
PRIOR ART

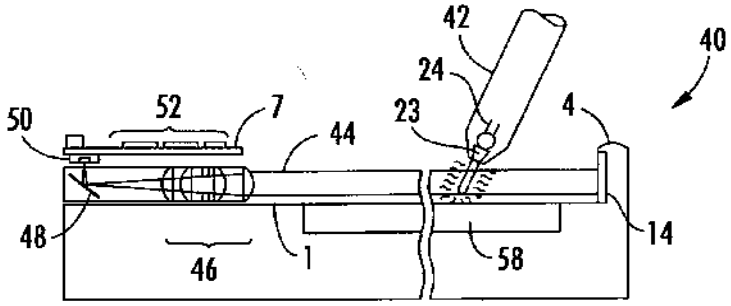


FIG. 3
PRIOR ART

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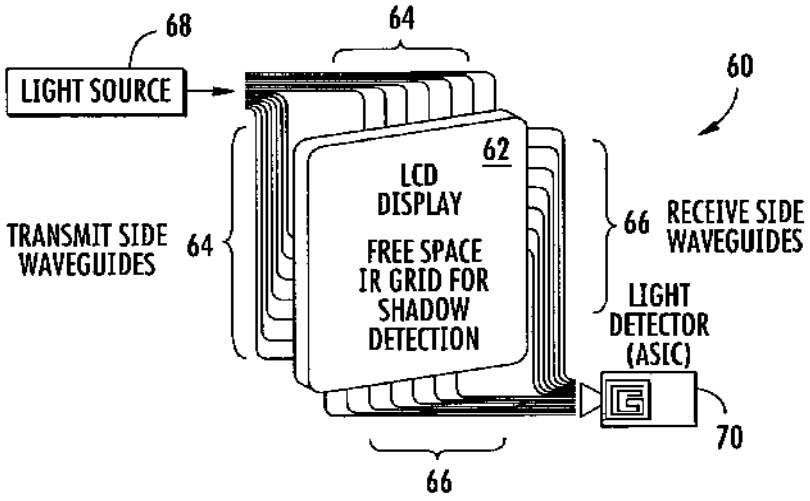


FIG. 4
PRIOR ART

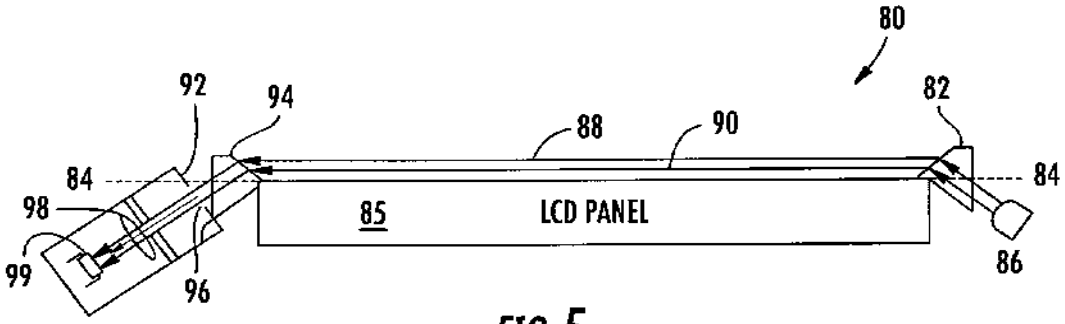


FIG. 5

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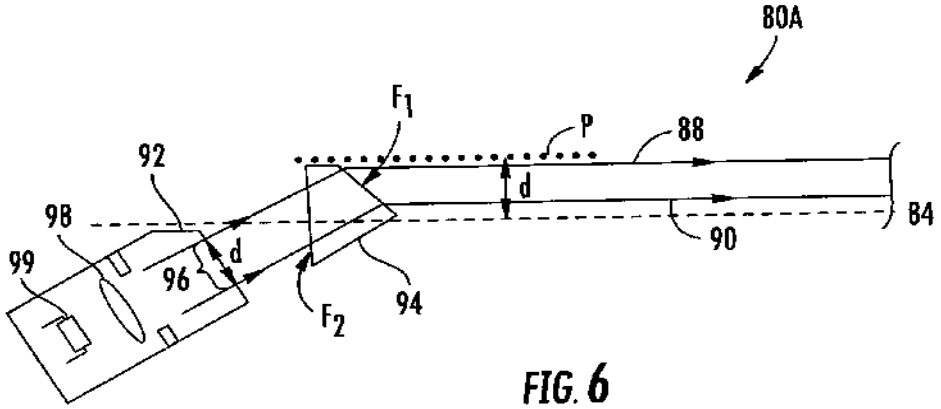


FIG. 6

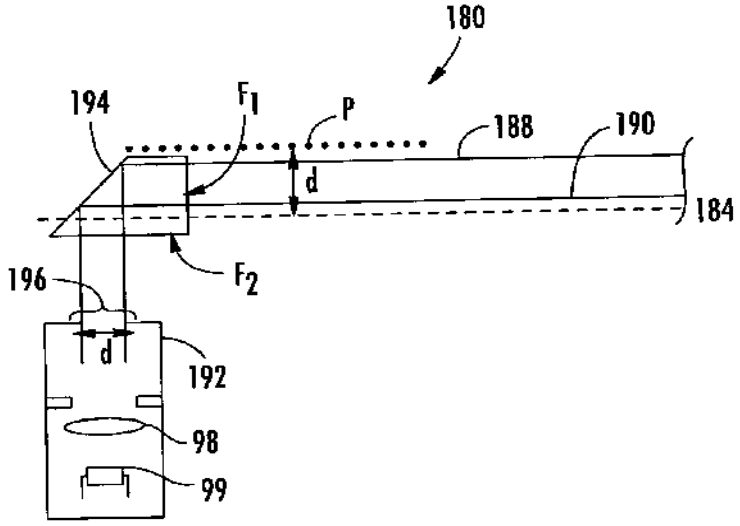


FIG. 7

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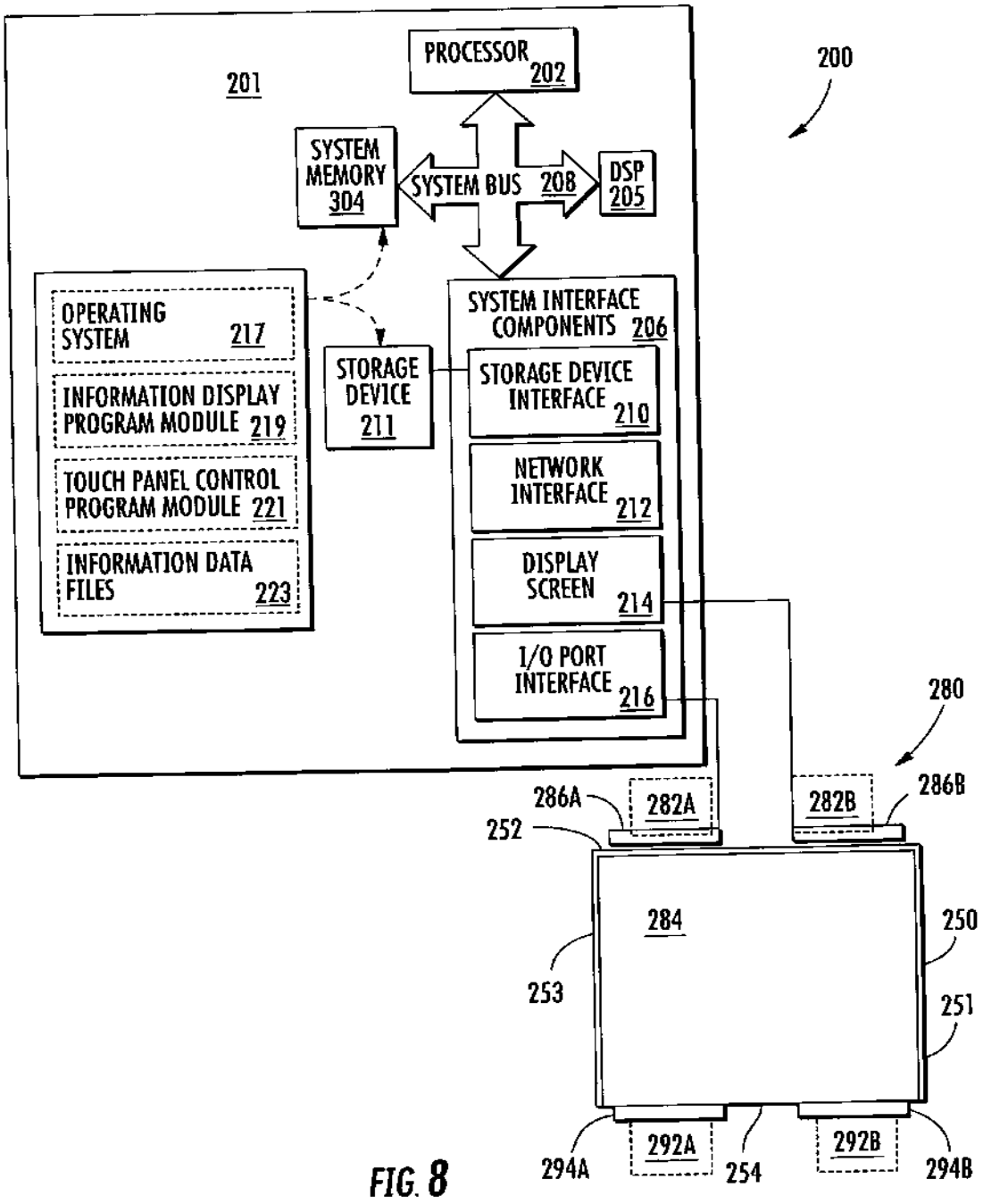


FIG. 8

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Espacenet

Bibliographic data: CN201465071 (U) — 2010-05-12

Infrared touch screen frame structure

Inventor(s):	WEI HE ± (HE WEI)
Applicant(s):	WEI HE ± (HE WEI)
Classification:	**- international:** *G06F3/042* **- cooperative:**
Application number:	CN20092060781U 20090720
Priority number(s):	CN20092060781U 20090720

Abstract of CN201465071 (U)

The utility model discloses an infrared touch screen frame structure, which comprises four frames which are arranged at the periphery of a touch screen and are provided with circuit boards inside thereof, a right angle connecting component is arranged between two adjacent frames; positive guide rail shafts are respectively arranged at two ends of the right angle connecting component; and sliding guide rail grooves matched with the positive guide rail shafts are formed in the frames and are perpendicular to the circuit boards. The infrared touch screen frame structure has the advantages of firm structure, easy instaliation, good stability of connected integral structure and good appearance and visual effects.

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DESCRIPTION CN201465071

The utility model discloses a frame structure of an infrared touch screen, which comprises four bezels provided with a circuit board disposed around the periphery of the touch screen, and a right angle connection component is respectively arranged between two adjacent frames, the right angle connection The two ends of the assembly are respectively provided with a positive rail shaft, and a sliding rail groove matched with the positive rail shaft is disposed in the frame, and the sliding rail slot is perpendicular to the circuit board. The utility model has the advantages that the structure is firm, the installation is easy, the overall structure stability after connection is good, and the visual effect of the appearance is good.

Infrared touch screen frame structure

Technical field

The utility model relates to a frame structure of an infrared touch screen.

Background technique

a frame structure for a touch screen frame for fixing an infrared ray emitting and receiving circuit board used in an existing infrared touch screen, which is composed of a frame disposed along four sides of the touch screen, and a circuit board is respectively disposed in each of the frames, and correspondingly disposed thereon Infrared transceiver unit. The splicing between adjacent two frames at the four corners of the touch screen is usually in a misaligned manner, that is, one of the frames is pressed against the end of the adjacent frame. The frame structure is not compact enough, and is not aesthetically pleasing. The frame needs to be cut multiple times during

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installation, and the steps are complicated.

Summary of the invention

The purpose of the utility model is to provide a frame structure of an infrared touch screen which is simple in structure, convenient in installation and beautiful in appearance.

The technical solution of the utility model is: a frame structure of an infrared touch screen, comprising a frame with a circuit board inside, and a right angle connection component is respectively arranged between two adjacent frames, and two of the right angle connection components The ends are respectively provided with a positive rail shaft, and a sliding rail groove matched with the positive rail shaft is disposed in the frame, and the sliding rail slot is perpendicular to the circuit board.

The front rail shafts at both ends of the right angle connecting component are respectively inserted into the sliding rail slots in the adjacent frame, so that the adjacent two frames are plugged and integrated into one by a right angle connecting component, which is convenient to install, and does not need to be cut by using a tool, and the right angle connecting component can be used. The material is made in the same shape as the shape of the frame, and the overall structure of the touch screen frame structure is high and the visual effect is good.

a side rail shaft perpendicular to the positive rail axis is disposed on the right angle connecting component, and a side sliding slot matched with the side rail shaft is disposed in the frame, and the side rail shaft and the side sliding slot are matched with each other. It can increase the stability of the connection between the right-angle connecting component and the frame, and at the same time set two mutually perpendicular axes, which is also conducive to accurate positioning during installation.

Electrically connected connector pins are respectively disposed at two ends of the right angle connecting component, and a connector terminal mated with the connector pin is respectively disposed on the circuit board in the frame, and the pin header is connected through the connector The circuit boards in the adjacent two frames are connected for easy installation, and are also convenient to be made into standard parts, thereby reducing the number of processes in the field.

A screw hole is arranged on the front rail shaft for fixing the right angle connecting component to the frame, which can improve the firmness of the connection.

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The utility model has the advantages that the structure is firm, the installation is easy, the overall structure stability after connection is good, and the visual effect of the appearance is good.

DRAWINGS

Figure 1 is a cross-sectional structural view of a bezel according to an embodiment of the present invention;

Figure 2 is a schematic structural view of an embodiment of the present invention;

Figure 3 is an enlarged view of a portion A of Figure 2;

Figure 4 is a structural view of a right angle connecting assembly in the embodiment of the present invention;

Figure 5 is another perspective view of the right angle connecting assembly in the embodiment of the present invention;

1、
Sliding rail groove, 2, filter, 3, infrared transceiver unit, 4, frame, 5, circuit board, 6, side rail shaft, 7, positive rail shaft, 8, screw hole, 9, connector pin, 10 , side chute, 11, right angle connection assembly, 12, connector terminal.

Detailed ways

Example:

Referring to FIG. 1-5, a frame structure of an infrared touch screen includes an integrally formed hollow frame 4, and a circuit board 5 with an infrared transceiver unit 3 is disposed therein, and a filter 2 is disposed on the frame 4 for protection. Infrared transceiver unit 3.

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During installation, the circuit board 5 is on and the infrared transceiver unit 3 is below, which can reduce the gap between the infrared transceiver unit and the touch screen surface, and can improve the accuracy of touch recognition. A right angle connecting assembly 11 is disposed between two adjacent frames 4, and two ends of the right angle connecting assembly 11 are respectively provided with a positive rail shaft 7 and a side rail shaft 6 perpendicular to the positive rail shaft 7. The sliding rail slot 1 is matched with the front rail shaft 7 in the frame 4, and the sliding rail slot 1 is perpendicular to the circuit board 5. The side rail 4 is also provided with a side sliding slot 10 matched with the side rail shaft 6. The slide rail groove 1 and the side slide grooves 10 are also perpendicular to each other.

Electrically connected connector pins 9 are respectively disposed at two ends of the right angle connecting component 11, and the connector terminals 12 mated with the connector pins 9 are respectively disposed on the circuit board 5 in the frame 4, and the pins are arranged through the connectors. 9 electrically connects the circuit boards 5 in the adjacent two frames 4.

The positive rail shaft 7 of the right angle connecting assembly 11 is provided with a screw hole 8 which can be fixed to the bezel 4 using a screw.

The detailed description above is a detailed description of one of the possible embodiments of the present invention, and is not intended to limit the scope of the invention. In the scope of the patent in this case.

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CLAIMS CN201465071

1.

A frame structure of an infrared touch screen includes four bezels disposed on a periphery of the touch screen and having a circuit board, wherein a right angle connection component is respectively disposed between two adjacent frames, and the right angle connection component The two ends are respectively provided with a positive rail shaft, and a sliding rail groove is formed in the frame with the positive rail shaft, and the sliding rail slot is perpendicular to the circuit board.

2.

The frame structure of an infrared touch screen according to claim 1, wherein a side rail shaft perpendicular to the positive rail axis is disposed on the right angle connecting component, and the side is provided in the frame Side chute with rail shaft fit.

3.

The frame structure of an infrared touch screen according to claim 1 or 2, wherein an electrical connection connector pin is disposed at each end of the right angle connection component, and a circuit board in the frame is provided There are respectively connector terminals that cooperate with the connector pins.

4.

The frame structure of an infrared touch screen according to claim 3, wherein a screw hole is provided on the front rail shaft.

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(12)实用新型专利

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(51)Int.Cl.
G06F 3/042(2006.01)

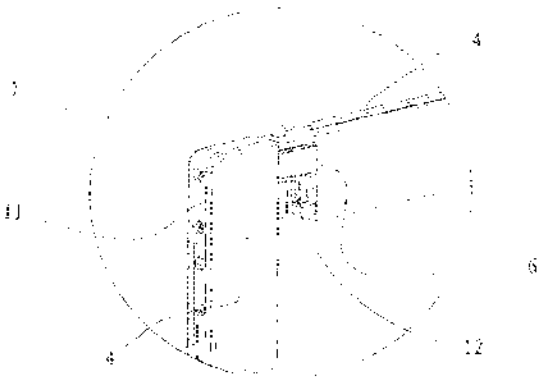
权利要求书 1 页 说明书 2 页 附图 2 页

(54)实用新型名称

红外线触摸屏框架结构

(57)摘要

本实用新型公开了一种红外线触摸屏的框架结构，包括设置在触摸屏周边的四个内部设有电路板的边框，在相邻的两个所述边框之间分别设有直角连接组件，该直角连接组件的两端分别设有主导轨轴，在所述边框两设有与主导轨轴配合的滑动导轨槽，且该滑动导轨槽与所述电路板垂直。本实用新型的优点是：结构牢固，安装容易，连接后整体结构稳定性好，外观视觉效果佳。



CN 201465071 U

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1. 一种红外线触摸屏的框架结构，包括设置在触摸屏周边的四个内部设有电路板的边框，其特征在于：在相邻的两个所述边框之间分别设有直角连接组件，该直角连接组件的两端分别设有正导轨轴，在所述边框内设有与正导轨轴配合的滑动导轨槽，且该滑动导轨槽与所述电路板垂直。

2. 根据权利要求 1 所述的一种红外线触摸屏的框架结构，其特征在于：在所述直角连接组件上设有与所述正导轨轴垂直的侧导轨轴，在所述边框内设有与该侧导轨轴配合的侧滑槽。

3. 根据权利要求 1 或 2 所述的一种红外线触摸屏的框架结构，其特征在于：在所述的直角连接组件的两端分别设有电连接的连接器排针，在所述边框内的电路板上分别设有与连接器排针配合的连接器端子。

4. 根据权利要求 3 所述的一种红外线触摸屏的框架结构，其特征在于：在所述正导轨轴上设有螺孔。

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红外线触摸屏框架结构

技术领域

[0001] 本实用新型涉及一种红外线触摸屏的框架结构。

背景技术

[0002] 在现有的红外线触摸屏中所使用的用于固定红外线发射、接收电路板的触摸屏框架的框架结构，其主要触摸屏四边设置的边框组成，每个边框内分别设置电路板，其上设置相应的红外线收发单元。在触摸屏四角处的相邻两个边框之间的拼接，通常采用错位方式，即其中一个边框压在相邻边框的端头上。这样框架结构不够紧凑，不美观，安装时需要多次切割边框，步骤复杂。

发明内容

[0003] 本实用新型的目的是提供一种结构简单、安装方便且外形美观的红外线触摸屏的框架结构。

[0004] 本实用新型的技术解决方案是：一种红外线触摸屏的框架结构，包括内部设有电路板的边框，在相邻的两个所述边框之间分别设有直角连接组件，该直角连接组件的两端分别设有主导轨轴，在所述边框内设有与主导轨轴配合的滑动导轨槽，且该滑动导轨槽与所述电路板垂直。

[0005] 直角连接组件两端的主导轨轴分别插入相邻边框内的滑动导轨槽内，这样相邻两个边框通过直角连接组件拆接拼接成一体，安装方便，无需使用工具进行切割，直角连接组件可以使用与边框外形一致的材料制作，触摸屏框架结构整体美观度高，视觉效果好。

[0006] 在所述直角连接组件上设有与所述主导轨轴垂直的侧导轨轴，在所述边框内设有与该侧导轨轴配合的侧滑槽，设置相互配合的侧导轨轴和侧滑槽，可以增加直角连接组件与边框连接的稳固程度，同时设置的两种互相垂直的轴，也利于安装时的准确定位。

[0007] 在所述的直角连接组件的两端分别设有电连接的连接器排针，在所述边框内的电路板上分别设有与连接器排针配合的连接器端子，通过连接器排针将相邻两个边框内的电路板连接起来，方便安装，同时也方便制作成标准件，减少现场制作的工序。

[0008] 在所述主导轨轴上设有螺孔，用于将直角连接组件固定在边框上，可以提高连接的牢固度。

[0009] 本实用新型的优点是：结构牢固，安装容易，连接后整体结构稳定性好，外观视觉效果佳。

附图说明

[0010] 附图 1 为本实用新型实施例中边框的剖视结构图；

[0011] 附图 2 为本实用新型实施例的结构示意图；

[0012] 附图 3 为图 2 中 A 部的放大图；

[0013] 附图 4 为本实用新型实施例中直角连接组件的结构视图；

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[0014] 附图 5 为本实用新型实施例中直角连接组件的另一方向视图；

[0015] 1、滑动导轨槽，2、滤光片，3、红外线收发单元，4、边框，5、电路板，6、侧导轨轴，7、正导轨轴，8、螺孔，9、连接器排针，10、侧滑槽，11、直角连接组件，12、连接器端子。

具体实施方式

[0016] 实施例：

[0017] 参阅图 1-5，一种红外线触摸屏的框架结构，包括一体成型中空的边框 4，其内部设有带有红外线收发单元 3 的电路板 5，边框 4 上设有滤光片 2，用来保护红外线收发单元 3。安装时，电路板 5 在上，红外线收发单元 3 在下，这样可以减少红外线收发单元与触摸屏表面的间隙，可以提高触摸识别的精度。在相邻的两个所述边框 4 之间设有直角连接组件 11，该直角连接组件 11 的两端分别设有正导轨轴 7、以及与所述正导轨轴 7 垂直的侧导轨轴 6，边框 4 内分别设有与正导轨轴 7 配合的滑动导轨槽 1，且该滑动导轨槽 1 与所述电路板 5 垂直，边框 4 内还设有与侧导轨轴 6 配合的侧滑槽 10，滑动导轨槽 1 和侧滑槽 10 也相互垂直。

[0018] 在直角连接组件 11 的两端分别设有电连接的连接器排针 9，在边框 4 内的电路板 5 上分别设有与连接器排针 9 配合的连接器端子 12，通过连接器排针 9 将相邻两个边框 4 内的电路板 5 电连接起来。

[0019] 直角连接组件 11 的正导轨轴 7 上设有螺孔 8，可以使用螺钉将其固定在边框 4 上。

[0020] 上列详细说明是针对本实用新型之一可行实施例的具体说明，该实施例并非用以限制本实用新型的专利范围，凡未脱离本实用新型所为的等效实施或变更，均应包含于本案的专利范围中。

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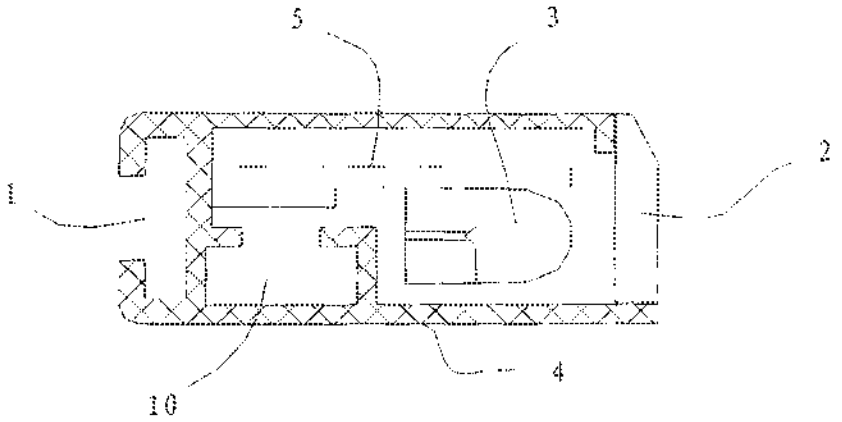


图 1

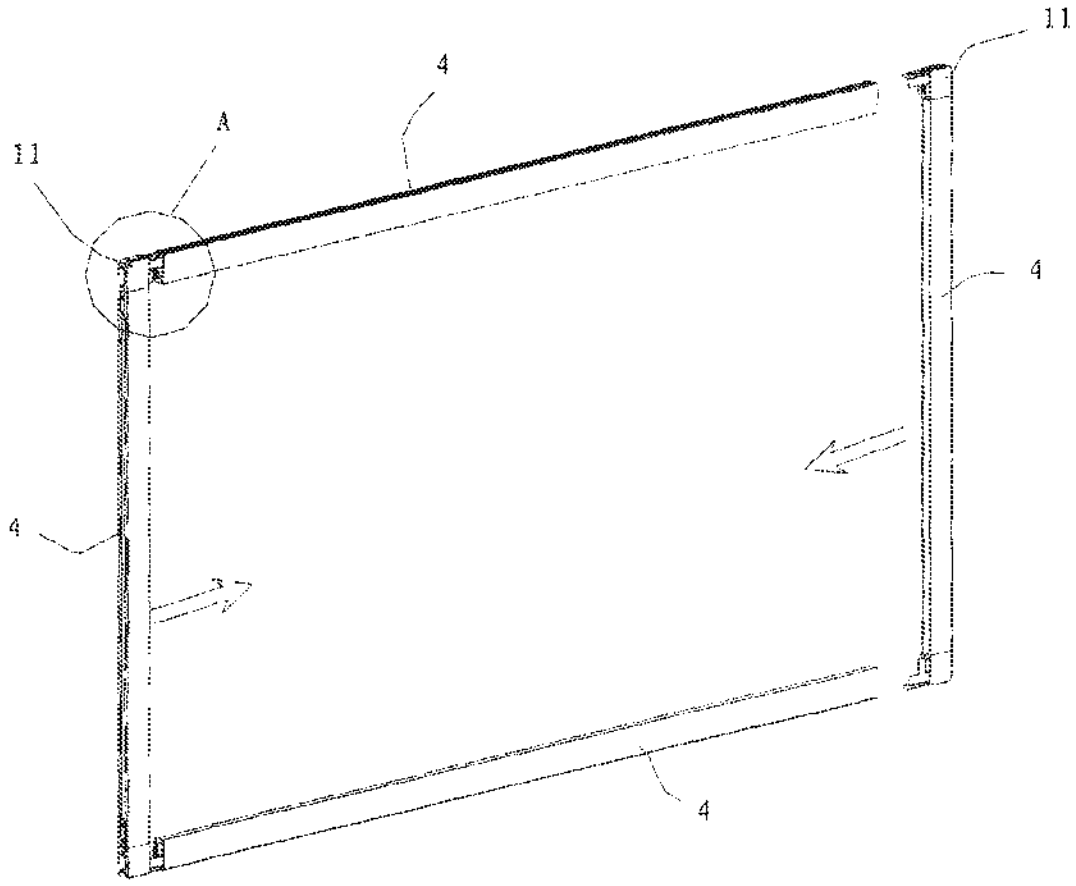


图 2

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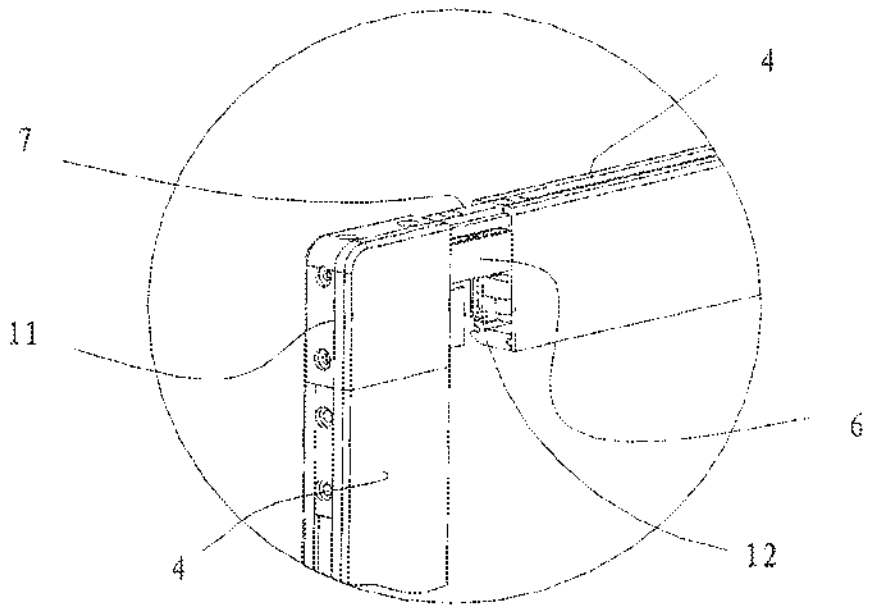


图 3

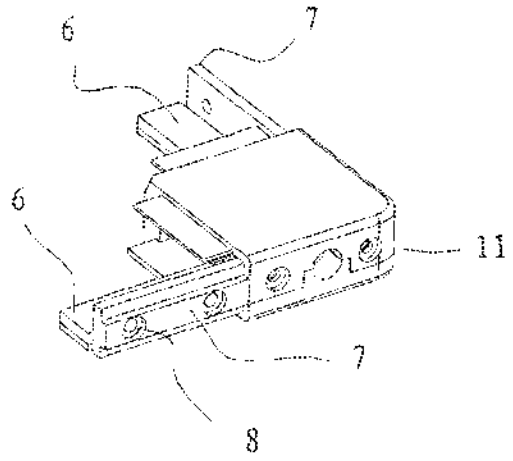


图 4

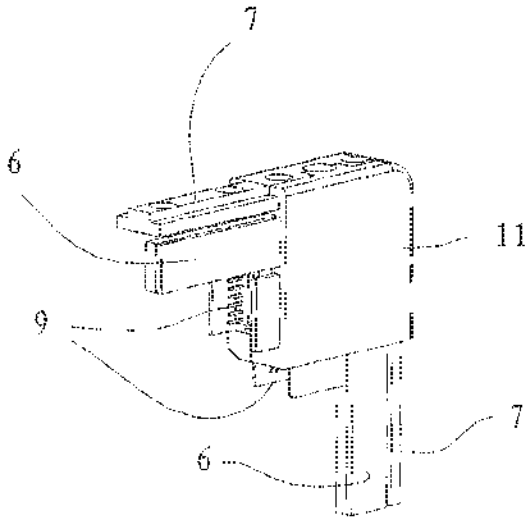


图 5

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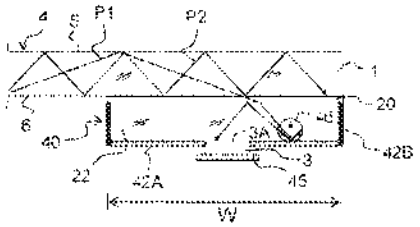


Fig. 10B

(57) Abstract: A touch-sensitive apparatus operates by light frustration (FTIR) and comprises a light transmissive panel (1) that defines a front surface (5) and a rear surface (6). light emitters optically connected to the panel (1) so as to generate light that propagates by total internal reflection inside the panel, and light detectors (3) optically connected to the panel (1) so as to define a grid of propagation paths inside the panel (1) between pairs of light emitters and light detectors (3). Each light detector (3) is optically connected to the panel (1) via an angular filter (20). The filter (20) is applied to an outcoupling region on at least one of the front and rear surfaces (5, 6) and is configured to transmit light only within a confined range of angles with respect to the normal of the outcoupling region. The confined range extends from a lower angle limit θ_{limit} to an upper angle limit θ_{limit}. The lower angle limit θ_{limit} is equal to or larger than a critical angle θ_c, which is given by $\theta_c = \arcsin(1/n_{panel})$, with n_{panel} being the refractive index of the light transmissive panel (1) at the outcoupling region.

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IMPROVEMENTS IN TIR-BASED OPTICAL TOUCH SYSTEMS OF PROJECTION-TYPE

Cross-reference to Related Applications

The present application claims the benefit of Swedish patent application No. 1251474-1, filed 20 December 2012, and US provisional application No. 61/740093, filed 20 December 2012, both of which are incorporated herein by reference.

Technical Field

The present invention generally relates to optical touch-sensing systems, and in particular to such systems that operate by projection measurements of light that propagates by total internal reflection (TIR) inside a light transmissive panel.

Background Art

Touch-sensing systems ("touch systems") are in widespread use in a variety of applications. Typically, the touch systems are actuated by a touching object such as a finger or stylus, either in direct contact, or through proximity (i.e. without contact), with a touch surface. Touch systems are for example used as touch pads of laptop computers, in control panels, and as overlays to displays on e.g. hand held devices, such as mobile telephones. A touch panel that is overlaid on or integrated in a display is also denoted a "touch screen". Many other applications are known in the art.

There are numerous known techniques for providing touch sensitivity, e.g. by incorporating resistive wire grids, capacitive sensors, strain gauges, etc into a touch panel. There are also various types of optical touch systems, which e.g. detect shadows cast by touching objects onto a touch surface, or detect light scattered off the point(s) of touching objects on a touch panel.

One specific type of optical touch system uses projection measurements of light that propagates on a plurality of propagation paths inside a light transmissive panel that defines a touch surface. The projection measurements thus quantify a property, e.g. power, of the light on the individual propagation paths, when the light has passed the panel. The light propagates inside the panel by total internal reflection (TIR) against the touch surface, such that objects on the touch surface causes the propagating light on one or more propagation paths to be attenuated, commonly denoted FTIR (Frustrated Total Internal Reflection). For touch determination, the projection measurements may be processed by simple triangulation, or by more advanced image reconstruction techniques that generate a two-dimensional distribution of disturbances on the touch surface,

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i.e. an "image" of everything on the touch surface that affects the measured property. Examples of such touch systems are found in US3673327, US4254333, US6972753, US7432893, US2006/0114237, US2007/0075648, WO2009/048365, US2009/0153519, WO2010/006882, WO2010/064983, WO2010/134865 and WO2012/105893.

The prior art suggests several different approaches for introducing the light into the panel and for detecting the light downstream of the touch surface. For example, US7432893 proposes coupling light into the panel via revolved prisms that are attached to the rear surface of the panel, and detecting the light at photodetectors that are directly attached to the front surface of panel. In WO2010/064983, light is coupled into and out of the panel via the edge surface that connects the front and rear surfaces of the panel, or via wedges that are attached to the front or rear surface of the panel. In WO2012/105893, a sheet-like microstructured element, e.g. a tape of light transmissive material, is provided on the front or rear surface of the panel for coupling light into and out of the panel.

One challenge when designing an optical touch system of this type is to enable consistent touch determination despite the fact that the detectors need to detect small changes in weak optical signals in presence of potentially significant interferences that affect the reliability of the optical signals. One such interference is caused by ambient light, e.g. from sunlight or residential lighting, that may impinge on the detectors and influence the optical signals. Another interference is caused by accumulation of contamination on the touch surface, such a fingerprints, drops of saliva, sweat, smear, liquid spills, etc. The contamination will interact with the propagating light and cause changes to the optical signals that may be difficult to distinguish from changes caused by "true objects", e.g. objects that are actively manipulated in contact with the touch surface.

In touch-sensitive devices, there is also a general trend to avoid attaching components to the front surface. These components may form a frame around the touch-sensitive region and thereby reduce the ratio of the active area (the surface area that is available for touch interaction) to the total surface area of the touch-sensitive device. Furthermore, if the components protrude from the front surface of the panel, it may be necessary to provide a bezel at the perimeter of the panel to protect and hide the components and possibly any wiring connected to the components. Given the nature of user interaction with touch-sensitive devices, such a bezel may disrupt the user experience and even prevent certain types of interaction. The bezel may also cause dirt and other contaminants to accumulate in the area where the bezel joins the panel. To overcome this problem, it is desirable to design touch systems for flush mount of the panel in the supporting frame of the touch-sensitive device, i.e. such that the front surface of the panel is essentially level with the surrounding frame material. This is also

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known as "edge-to-edge".

In aforesaid US7432893, the impact of ambient light is reduced by attaching the photodetectors to the front surface, such that the photodetectors face away from the ambient light that enters the panel through the front surface. This solution requires a significant bezel to hide and protect the photodetectors and the associated wiring. US7432893 also proposes to intermittently measure ambient levels at the photodetectors and compensate the respective projection measurement for the measured ambient level.

The influence of contamination may be handled by dedicated signal processing that actively estimates the influence of contamination over time and compensates for this influence, e.g. as disclosed in WO2011/028169, WO2011/049512 and WO2012/121652.

However, in view of the weak optical signals and small attenuation caused by touching objects, there is room for further improvement when it comes to increasing the robustness of the touch system to ambient light and contamination on the touch surface.

In the field of LCD display technology, which is outside the field of touch-sensitive systems, it is known to couple light from LEDs into thin light guide panels as part of so-called backlights (BLUs, Backlight units) for LCD displays. The light guide panel is located behind the LCD and is configured to emit light from its top surface to uniformly illuminate the rear side of the LCD. One approach for coupling the LEDs to the light guide panel is proposed in the article "Injecting Light of High-Power LEDs into Thin Light Guides", by Cornelissen et al. published in Proc. SPIE 7652, International Optical Design Conference 2010, pp 7652121-7652126, 2010. According to this approach, the top surface of the LED is modified to have a rough surface behaving like a Lambertian reflector. A dielectric multilayer filter is deposited on the bottom of the light guide panel, and the top surface of the LED is optically coupled to the filter by a silicone adhesive. The filter is optimized to only transmit light emitted from the LED at angles larger than the critical angle at the light guide-air interface. The purpose of the multilayer is thus to only transmit light that can propagate in the light guide. The light emitted at smaller angles is reflected back toward the rough LED surface where it is subsequently recycled by reflection and redistribution. Further elaboration on this incoupling approach is given in the article "Dielectric multilayer angular filters for coupling LEDs to thin light guides", by Mu et al. published in Proc. SPIE 8170, pp 817001 1-817001 10, 2011.

Summary

It is an objective of the invention to at least partly overcome one or more of the above-identified limitations of the prior art.

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Another objective is to provide a touch-sensitive apparatus that has a reduced sensitivity to ambient light.

A further objective to provide a touch-sensitive apparatus that has a reduced sensitivity to contamination on the touch surface.

A still further objective is to provide a touch-sensitive apparatus that has a flat front surface, without bezel or other projecting structures.

Yet another objective is to provide a compact touch-sensitive apparatus.

Another objective is to provide a touch-sensitive apparatus suitable for mass-production.

One or more of these objectives, as well as further objectives that may appear from the description below, are at least partly achieved by touch-sensitive apparatuses according to the independent claims, embodiments thereof being defined by the dependent claims.

A first aspect of the invention is a touch-sensitive apparatus, comprising: a light transmissive panel that defines a front surface and an opposite, rear surface; a plurality of light emitters optically connected to the light transmissive panel so as to generate propagating light that propagates by total internal reflection inside the light transmissive panel across a touch-sensitive region on the light transmissive panel; a plurality of light detectors optically connected to the light transmissive panel so as to define a grid of propagation paths across the touch-sensitive region between pairs of light emitters and light detectors; wherein each light detector is optically connected to the light transmissive panel via an angular filter which is applied to an outcoupling region on at least one of the front and rear surfaces and is configured to transmit the propagating light only within a confined range of angles with respect to the normal of the outcoupling region, and wherein the confined range extends from a lower angle limit θ_{min} to an upper angle limit θ_{max}, wherein the lower angle limit θ_{min} is equal to or larger than a critical angle θ_C which is given by $\theta_C = \arcsin(1/n_{panel})$, with n_{panel} being the refractive index of the light transmissive panel at the outcoupling region.

In one embodiment, the lower angle limit θ_{min} exceeds the critical angle by an angle $\Delta\theta$, which is at least 5°, 10° or 15°.

In another embodiment, the lower angle limit θ_{min} is equal to or larger than a first cut-off angle $\theta_w = \arcsin(n_w / n_{panel})$, with n_w being the refractive index of water, $n_{panel} > n_w$.

In one embodiment, the lower angle limit θ_{min} is equal to or larger than a second cut-off angle $\theta_f = \arcsin(n_f / n_{panel})$, with n_f being the refractive index of finger fat, $n_{panel} > n_f$.

In one embodiment, the upper angle limit θ_{max} is equal to or smaller than a third

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cut-off angle θ_{cc} = arcsin (1.55/n $_{panel}$), $n_{panel} > 1.55$.

In one embodiment, the light transmissive panel is mounted onto a front surface of a display device by a lamination layer of light transmissive material which is arranged in contact with the rear surface of the light transmissive panel and the front surface of the display device, wherein the lower angle limit θ_{min} is approximately equal to or larger than a laminate cut-off angle θ_{cl} = arcsin (n_{lam}/n_{panel}), with n_{lam} being the refractive index of lamination layer, $n_{lam} < n_{panel}$.

In an alternative embodiment, the touch-sensitive apparatus further comprises a layered light absorber comprising a coupling layer of light transmissive material on the rear surface of the light transmissive panel, and an absorbing layer of light-absorbing material on the coupling layer, said coupling layer having an index of refraction $n_{coupl} < n_{panel}$. The lower angle limit θ_{min} of the angular filter may be approximately equal to or larger than an absorber cut-off angle θ_{CC} = arcsin (n_{coupl}/n_{panel}), and the layered light absorber may extend from the respective outcoupling port and may have a width which, along the detection lines that extend to the respective light detector, is at least equal to a distance between consecutive reflections in the rear surface for propagating light that impinges on the rear surface with an angle of incidence of θ_{CC} to a normal of the rear surface. It may be preferable that the layered light absorber is arranged to overlap a major part, or essentially all, of the touch-sensitive region.

In one embodiment, the angular filter is configured to define essentially the same confined range of angles for all detection lines that extend to the respective light detector.

In one embodiment, the angular filter is configured as a dielectric multilayer structure. The touch-sensitive apparatus may further comprise a light recycler which is arranged beneath the angular filter to define a light reflective enclosure with respect to the angular filter and a light-sensitive surface of the respective light detector.

In one recycler embodiment, the light reflective enclosure is at least partly diffusively reflecting to angularly re-distribute the light that enters the light reflective enclosure via the angular filter.

In one recycler embodiment, the light reflective enclosure comprises a light reflective bottom surface that is spaced from and extends parallel to the angular filter and a reflective side wall structure that extends between the light reflective bottom surface and the angular filter. In one implementation, the side wall structure may be specularly reflective, and at least a portion of the bottom surface may be diffusively reflective

In one recycler embodiment, the light reflective enclosure may be filled by a light transmissive material.

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In an alternative recycler embodiment, the light reflective enclosure is hollow, and a disruptive structure is provided on the angular filter so as to face the light reflective enclosure, wherein the disruptive structure is configured to transmit and redirect at least part of the light transmitted by the angular filter into the light reflective enclosure. The disruptive structure may be one of a non-imaging, diffusively transmitting structure, and an imaging structure configured to refract the light transmitted by the angular filter.

In one recycler embodiment, the light detector is arranged with the light-sensitive surface facing the angular filter. In an alternative recycler embodiment, the light detector is arranged to project into the light enclosure such that the light-sensitive surface is facing the side wall structure.

In one recycler embodiment, the light reflective enclosure comprises a microstructure that defines a mirror with an optical power so as to re-direct the transmitted propagating light onto the light-sensing surface.

In one recycler embodiment, the light recycler is configured as a funnel which is configured to specularly reflect the transmitted propagating light from the angular filter towards the light-sensitive surface of the light detector.

In an embodiment without a light recycler, a body of light-transmissive material is attached to the angular filter, and the light detector is attached to the body such that a light-sensitive surface of the light detector directly receives the transmitted propagating light from the angular filter.

In one embodiment, the angular filter is arranged to transmit the propagating light to the respective light detector within a respective outcoupling port on the rear surface, wherein the extent of the respective outcoupling port, along the detection lines that extend to the respective light detector, is at least equal to a distance between consecutive reflections in the rear surface for the propagating light that impinges on the angular filter with an angle of incidence of θ_{min} to a normal of the angular filter.

In one embodiment, the touch-sensitive apparatus comprises a specularly reflective edge element which is arranged, adjacent to the outcoupling region, on an edge portion that connects the front surface and the rear surface of the light transmissive panel, so as to specularly reflect the propagating light that impinges on the specularly reflective edge element.

In one embodiment, the propagating light comprises light in an infrared wavelength region, and wherein the touch-sensitive apparatus further comprises a visibility shield which is arranged intermediate the rear surface and the angular filter, the visibility shield being configured to block light that is visible to the human eye and to transmit at least part of said light in the infrared wavelength region.

In one embodiment, each light emitter is optically connected to the light

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transmissive panel via an angular filter which is applied to an incoupling region on at least one of the front and rear surfaces and is configured to transmit light from the respective light emitter only within a confined range of angles inside the light transmissive panel. The confined range of angles of the angular filter on the incoupling region may be matched to the confined range of angles of the angular filter on the outcoupling region, e.g. by the angular filter on the incoupling region being identical to the angular filter on the outcoupling region. In one embodiment, the touch-sensitive apparatus, further comprises a light recycler which is arranged beneath the angular filter on the incoupling region, so as to define a light reflective enclosure with respect to the angular filter and a light-emitting surface of the respective light emitter

A second aspect of the invention is a touch-sensitive apparatus comprising: a light transmissive panel that defines a front surface and an opposite, rear surface; a plurality of light emitters optically connected to the light transmissive panel so as to generate propagating light that propagates by total internal reflection inside the light transmissive panel across a touch-sensitive region on the light transmissive panel; and a plurality of light detectors optically connected to the light transmissive panel so as to define a grid of propagation paths across the touch-sensitive region between pairs of light emitters and light detectors; wherein the light transmissive panel is mounted onto a front surface of a display device by a lamination layer of light transmissive material which is arranged in contact with the rear surface of the light transmissive panel and the front surface of the display device; and wherein the lamination layer has a refractive index n_{lam} which is smaller than a refractive index n_{panel} of the light transmissive panel at the rear surface and which is chosen such that a laminate cut-off angle $\theta_{cl} = \arcsin(n_{lam}/n_{panel})$ exceeds a critical angle θ_c which is given by $\theta_c = \arcsin(1/n_{panel})$ by an angle $\Delta\theta$, which is at least 5°, 10° or 15°.

In one embodiment, the laminate cut-off angle θ_{cl} is equal to or larger than a first cut-off angle $\theta_w = \arcsin(n_w/n_{panel})$, with n_w being the refractive index of water, $n_{panel} > n_w$.

In another embodiment, the laminate cut-off angle θ_{cl} is equal to or larger than a second cut-off angle $\theta_f = \arcsin(nf/n_{vane}i)$, with n_f being the refractive index of finger fat, $n_{panel} > n_f$.

In one embodiment, the light emitters are optically coupled to the light transmissive panel such that the propagating light is generated to impinge on the lamination layer at an angle that is equal to or larger than the laminate cut-off angle θ_{cl}.

A third aspect of the invention is a touch-sensitive apparatus comprising: a light transmissive panel that defines a front surface and an opposite, rear surface; a plurality of light emitters optically connected to the light transmissive panel so as to generate

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propagating light that propagates by total internal reflection inside the light transmissive panel across a touch-sensitive region on the light transmissive panel; and a plurality of light detectors optically connected to the light transmissive panel so as to define a grid of propagation paths across the touch-sensitive region between pairs of light emitters and light detectors; wherein a layered light absorber is provided on the rear surface of the light transmissive panel, said layered light absorber comprising a coupling layer of light transmissive material on the rear surface of the light transmissive panel, and an absorbing layer of light-absorbing material on the coupling layer, and wherein the coupling layer has a refractive index n_{coupl} which is smaller than a refractive index n_{panel} of the light transmissive panel at the rear surface and which is chosen such that an absorber cut-off angle $\theta_{CC} = \arcsin(n_{coupl}/n_{panel})$ exceeds a critical angle θ_C which is given by $\theta_C = \arcsin(1/n_{panel})$ by an angle $\Delta\Theta$, which is at least 5°, 10° or 15°.

In one embodiment, the absorber cut-off angle θ_{CC} is equal to or larger than a first cut-off angle $\theta_w = \arcsin(n_w/n_{panel})$, with n_w being the refractive index of water, $n_{panel} > n_w$.

In another embodiment, the absorber cut-off angle θ_{CC} is equal to or larger than a second cut-off angle $\theta f = \arcsin(nf/n_{panel})$, with n_f being the refractive index of finger fat, $n_{panel} > n_f$.

In one embodiment, the light emitters are optically coupled to the light transmissive panel such that the propagating light is generated to impinge on the coupling layer at an angle that is equal to or larger than the absorber cut-off angle θ_{CC}.

In one embodiment, the layered light absorber is arranged to overlap a major part, or essentially all, of the touch-sensitive region.

It is realized that any one of the embodiments of the first aspect may be adapted and implemented as an embodiment of the second and third aspects. For example, each light detector may be optically connected to the light transmissive panel via an angular filter which is applied to an outcoupling region on at least one of the front and rear surfaces and is configured to transmit the propagating light only within a confined range of angles with respect to the normal of the outcoupling region, wherein the confined range may extend from a lower angle limit θ_{min} to an upper angle limit θ_{max}, and wherein the lower angle limit θ_{min} may be equal to or larger than a critical angle θ_C which is given by $\theta_C = \arcsin(1/n_{panel})$, with n_{panel} being the refractive index of the light transmissive panel at the outcoupling region.

Still other objectives, features, aspects and advantages of the present invention will appear from the following detailed description, from the attached claims as well as from the drawings.

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Brief Description of Drawings

Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.

Fig. 1 is a section view of a light transmissive panel to illustrate the principle of using TIR for touch detection.

Fig. 2 is a top plan view of an exemplifying touch-sensitive apparatus.

Fig. 3 is a 3D plot of an attenuation pattern generated based on energy signals from a TIR-based projection-type touch-sensitive apparatus.

Fig. 4 is a section view of a light outcoupling structure according to a first embodiment.

Fig. 5A is a plot of transmission as a function of incidence angle for an angular filter included in the first embodiment, and Fig. 5B is a perspective view of the range of angles that are transmitted by the angular filter.

Fig. 6 is a section view to illustrate characteristic angles of the angular filter and characteristic angles of the panel.

Fig. 7 is a section view to illustrate incoupling of ambient light via contamination on the touch surface.

Fig. 8 is a section view to illustrate a relation between bounce angles in a two-layer panel.

Fig. 9A is a section view to illustrate bounce angles in a panel which is laminated to a display device, and Fig. 9B illustrates a panel with a layered light absorber between light incoupling and outcoupling structures to control bounce angles for propagating light in the panel.

Fig. 10A is a section view of a light outcoupling structure according to a second embodiment.

Figs 10B-10C are section and plan views of a light outcoupling structure according to a third embodiment.

Figs 10D-10H are section views of variations of the first to third embodiments.

Figs 11A-11B are section and plan views of a first alternative outcoupling structure.

Figs 12A-12B are section and plan views of a second alternative outcoupling structure.

Figs 13A-13B are section views of outcoupling structures combined with a layered light absorber.

Figs 14A-14B are section and plan views of a light incoupling structure according to a first embodiment. Figs 14C-14D are section views of variations of the first

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embodiment.

Figs 15A-15B are bottom plan views of a sequence of structures arranged on a panel to couple light into and/or out of the panel.

Fig 16 is a graph of light reflectivity at a panel-water interface as a function of angle of incidence inside the panel.

Figs 17A-17B are graphs of signal attenuation measured before, during and after a finger tap without and with the layered light absorber on the panel in Fig. 9B.

Detailed Description of Example Embodiments

In the following, various inventive light coupling structures will be presented as installed in an exemplifying TIR-based projection-type touch-sensitive apparatus. Throughout the description, the same reference numerals are used to identify corresponding elements.

1. Touch-sensitive apparatus

Fig. 1 illustrates the concept of touch detection based on attenuation of propagating light, commonly denoted FTIR (Frustrated Total Internal Reflection). According to this concept, light is transmitted inside a panel 1 along a plurality of well-defined propagation paths. The panel 1 is made of solid material in one or more layers and may have any shape. The panel 1 defines an internal radiation propagation channel, in which light propagates by internal reflections, also denoted "bounces" in the following. In the example of Fig. 1, the propagation channel is defined between the boundary surfaces 5, 6 of the panel 1, and the front surface 5 allows the propagating light to interact with touching objects 7 and thereby defines the touch surface 4. The interaction is enabled by injecting the light into the panel 1 such that the light is reflected by total internal reflection (TIR) in the front surface 5 as it propagates through the panel 1. The light may be reflected by TIR in the rear surface 6 or against a reflective coating thereon. It is also conceivable that the propagation channel is spaced from the rear surface 6, e.g. if the panel comprises multiple layers of different materials. The panel 1 may thus be made of any solid material (or combination of materials) that transmits a sufficient amount of light in the relevant wavelength range to permit a sensible measurement of transmitted energy. Such material includes glass, poly(methyl methacrylate) (PMMA) and polycarbonates (PC). The panel 1 typically has a refractive index in the range of 1.3-1.7. For example, PMMA has a refractive index of about 1.5 and PC has a refractive index of about 1.6 in the near infrared (NIR). The panel 1 may be designed to be overlaid on or integrated into a display device or monitor (not shown).

As shown in Fig. 1, an object 7 that is brought into close vicinity of, or in contact

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with the touch surface 4 may interact with the propagating light at the point of touch. In this interaction, part of the light may be scattered by the object 7, part of the light may be absorbed by the object 7, and part of the light may continue to propagate in its original direction across the panel 1. Thus, the touching object 7 causes a local attenuation or "frustration" of the total internal reflection, which leads to a decrease in the energy (or equivalently, the power or intensity) of the transmitted light, as indicated by the thinned lines to the right of the touching objects 7 in Fig. 1.

Fig. 2 illustrates an example embodiment of a touch-sensitive apparatus 100 that is based on the concept of FTIR. Emitters 2 are distributed along the perimeter of the touch surface 4, beneath the panel 1, to project light onto an incoupling structure on the panel 1 such that at least part of the light is captured inside the panel 1 for propagation by internal reflections in the propagation channel. Detectors 3 are distributed along the perimeter of the touch surface 4, beneath the panel 1, and are optically coupled to the panel 1 so as to receive part of the propagating light from a respective outcoupling structure. The light from each emitter 2 will thereby propagate inside the panel 1 to a number of different detectors 3 on a plurality of light propagation paths D. Even if the light propagation paths D correspond to light that propagates by internal reflections inside the panel 1, the light propagation paths D may conceptually be represented as "detection lines" that extend across the touch surface 4 between pairs of emitters 2 and detectors 3, as indicated by dashed lines in Fig. 2. Thus, the detection lines correspond to a projection of the propagation paths onto the touch surface 4. Thereby, the emitters 2 and detectors 3 collectively define a grid of detection lines ("detection grid") on the touch surface 4, as seen in a top plan view. It is appreciated that Fig. 2 is an example, and that a (significantly) larger number of emitters 2 and/or detectors 3 may be included in the apparatus 100. Also, the distribution of emitters 2 and detectors 3 may differ.

As used herein, the emitter 2 may be any type of device capable of emitting radiation in a desired wavelength range, for example a diode laser, a VCSEL (vertical-cavity surface-emitting laser), an LED (light-emitting diode), an incandescent lamp, a halogen lamp, etc. The emitter 2 may also be formed by the end of an optical fiber. The emitters 2 may generate light in any wavelength range. The following examples presume that the light is generated in the near infrared (NIR), i.e. at wavelengths of about 750 nm-1400 nm. Analogously, the detector 3 may be any device capable of converting light (in the same wavelength range) into an electrical signal, such as a photo-detector, a CCD device, a CMOS device, etc.

The detectors 3 collectively provide an output signal, which is received and sampled by a signal processor 10. The output signal contains a number of sub-signals, also denoted "projection signals", each representing the energy of light received by a certain

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light detector 3 from a certain light emitter 2. Depending on implementation, the signal processor 10 may need to process the output signal for separation of the individual projection signals. The projection signals represent the energy, intensity or power of light received by the detectors 3 on the individual detection lines D. Whenever an object touches a detection line, the received energy on this detection line is decreased ("attenuated").

The signal processor 10 may be configured to process the projection signals so as to determine a property of the touching objects, such as a position (e.g. in the x,y coordinate system shown in Fig. 2), a shape, or an area. This determination may involve a straight-forward triangulation based on the attenuated detection lines, e.g. as disclosed in US7432893 and WO2010/015408, or a more advanced processing to recreate a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 1, where each attenuation value represents a local degree of light attenuation. An example of such an attenuation pattern is given in the 3D plot of Fig. 3, where the peaks of increased attenuation represent touching objects. The attenuation pattern may be further processed by the signal processor 10 or by a separate device (not shown) for determination of the position, shape or area of touching objects. The attenuation pattern may be generated e.g. by any available algorithm for image reconstruction based on projection signal values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the attenuation pattern may be generated by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of such and other reconstruction functions designed for use in touch determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, WO2013/062471, WO2013/133757, WO2013/165305 and WO2013/165306, all of which are incorporated herein by reference.

In the illustrated example, the apparatus 100 also includes a controller 12 which is connected to selectively control the activation of the emitters 2 and, possibly, the readout of data from the detectors 3. Depending on implementation, the emitters 2 and/or detectors 3 may be activated in sequence or concurrently, e.g. as disclosed in WO2010/064983. The signal processor 10 and the controller 12 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 10 and the controller 12 may be at least partially implemented by software executed by a processing unit 14, such as a CPU.

Embodiments of structures for outcoupling and detection of light will now be explained in detail with reference to Figs 4-12. Generally, these embodiments are

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presented in the context of the touch-sensitive apparatus shown in Fig. 2.

2. Outcoupling structure

Fig. 4 illustrates a section that may be taken along any one of the detection lines D of the touch-sensitive apparatus in Fig. 2. For simplicity, only a portion of the apparatus at and around the outcoupling structure is shown. The outcoupling structure is made up of a sheet-like angular filter 20 which is applied with its front face to the panel 1 at the periphery of the touch surface 4 to define an outcoupling port for the light propagating in the panel 1. A detector 3 is applied with its light-sensing surface 3A onto the rear face of the angular filter 20. In an alternative (not shown), a spacer of light transmissive material is disposed between the surface 3A and the filter 20. The angular filter 20 is designed to only be transmissive to light within a given angular range, i.e. for light that impinges on the filter 20 at certain angles of incidence to the normal N (Fig. 5B) of the filter 20. Fig. 5A is a plot of the transmission of the filter 20 as a function of angle of incidence. As seen, the filter 20 transmits light within a given angular range between a lower limit θ_{min} and an upper limit θ_{max}, while reflecting light that impinges on the filter at other angles of incidence. Any criterion may be used for defining the limits θ_{min}, θ_{max}, e.g. a percentage (e.g. 25, 50 or 75) of absolute or maximum transmission. Fig. 5B illustrates the angular range in relation to a single position on the front surface of the filter 20. As seen, the angular range is equal in all directions in the plane of the filter 20. Preferably, the angular range is essentially the same at all positions on the filter 20.

It should be understood that the filter 20 need not be designed to define the given angular range for all wavelengths, but only for a limited wavelength range that includes the wavelength(s) of the propagating light. In a preferred embodiment, the angular filter 20 is reflective to all angles outside the limited wavelength range. In one example, the propagating light has a wavelength 850 nm with a bandwidth of 20 nm, and the filter 20 is designed to have an angular range $[\theta_{min} - \theta_{max}]$ in the wavelength range of 800-900 nm, and to be reflective to light at wavelengths from 400 nm to 800 nm, and possibly also at wavelengths above 900 nm, irrespective of angle of incidence. Alternatively, a dedicated wavelength filter may be installed in front of or behind the angular filter 20 to be absorbing or reflective to incoming light outside the limited wavelength range, for all angles of incidence.

It should also be understood that the filter 20 is designed to provide the angular range $[\theta_{min} - \theta_{max}]$ for a specific installation, i.e. when mounted with its front face to the panel 1 and with its rear side to the surface 3A (or a spacer). For example, the design may be adapted to the refractive index of the panel 1 and the refractive index of

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the light-sensing surface 3A (or the spacer).

The filter 20 may be designed as a dielectric multilayer structure of at least two different materials, similar to an interference filter. It lies within the reach of the person skilled in optical design to select appropriate materials and number of layers to achieve the desired angular range for light at a wavelength generated by the emitters 2.

In embodiments of the invention, the filter 20 is tailored to suppress the amount of ambient light received at the light-sensing surface 3A in relation to the amount of useful light, i.e. light that has propagated on one or more detection lines from a respective incoupling structure. This effect may be achieved by adapting the angular range of the filter 20 to the angles of incidence (AOI) of the propagating light on the filter 20. Ambient light typically contains daylight and/or light from artificial light sources. Such ambient light includes NIR light which, if it falls on the surface 3A, will interfere with the detection of the propagating NIR light inside the panel 1. As exemplified by ray A1 shown in Fig. 4, ambient light that falls on the front surface 5 is refracted into the panel 1 and would have impinged on the surface 3A were it not for the angular filter 20. The angular filter 20 is designed to reflect the ambient light A1 back towards the front surface 5. As exemplified by ray P1, light that propagates in the panel 1 by TIR and strikes the filter at an AOI within the angular range of the filter 20, is transmitted to the light-sensing surface 3A. Fig. 4 also indicates a ray P2 that propagates in the panel 1 by TIR and strikes the filter 20 at a smaller AOI, which is outside the angular range of the filter 20. This ray P2 is reflected by the filter 20. Any ambient light that falls onto the touch surface 4 will, irrespective of its angle to the touch surface 4, be transmitted through the panel 1, as exemplified by ray A2. The ambient light will not be captured by TIR in the panel 1 since it cannot be refracted into the panel 1 at an angle larger the critical angle (see below).

The use of an angular filter 20 provides a simple technique for selecting the light that is passed to the detector 3 to be represented in the projection signals. The angular filter 20 allows the apparatus 100 to be manufactured with relative ease at low cost and high reliability.

The present Applicant has realized that advantageous technical effects may be achieved by careful selection of the lower limit θ_{min} of the filter 20. Fig. 6 illustrates, in section view, a portion of the panel 1, where different characteristic angles of the panel 1, as well as the limits θ_{min}, θ_{max} of the filter 20, are mapped to a position on the front surface 5. In this example, it is assumed that the panel 1 is made of a single material and has the same refractive index n_{panel} at the front and rear surfaces 5, 6. All angles are defined with respect to the normal N of the front surface 5.

Fig. 6 indicates the critical angle θ_C which is given by $\theta_C = \arcsin(1/n_{panel})$

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and is the minimum AOI of the light that propagates by TIR between the surfaces 5, 6. Fig. 6 also indicates a cut-off angle θ_W for interaction between the propagating light and water deposited on the front surface 5. Propagating light that strikes the surface 5 at AOIs below θ_W will be partly coupled out of the panel 1 and into water on the surface 5, whereas propagating light at AOIs above θ_W will be totally reflected at the interface between the surface 5 and water. According to Snell's law: $n_{panel} \cdot \sin(\theta_W) = n_W \cdot \sin(90°)$, which yields $\theta_W = \arcsin(n_W / n_{panel})$, where the refractive index of water, n_W, is in the range 1.31-1.34, depending on temperature, wavelength, salt content, etc. Fig. 6 also indicates a cut-off angle θf for interaction between the propagating light and finger fat deposited on the front surface 5. Propagating light that strikes the surface 5 at AOIs below θf will be partly coupled out of the panel 1 and into finger fat on the surface 5, whereas propagating light at AOIs above θf will be totally reflected at the interface between the surface 5 and finger fat. According to Snell's law: $n_{panel} \cdot \sin(\theta_f) = n_f \cdot \sin(90°)$, which yields $\theta_f = \arcsin(n_f / n_{panel})$, where the refractive index of finger fat, n_f, typically is in the range of 1.36-1.48, depending on temperature, wavelength, composition, etc. Measurement results presented in "Some observations on fingerprint deposits", by G L Thomas and T E Reynoldson, published in J. Phys. D: Appl. Phys., Vol. 8, pp 724-729 (1975), indicate that n_f may be distributed over the range of 1.40-1.54, with a histogram peak at 1.48-1.50.

Even if the cutoff angles θ_W and θf may not have universally applicable values, given that the refractive indices of water and finger fat fall within a respective range, it is possible to conduct experiments to determine an average or an otherwise representative value of n_W and n_f, respectively, for a particular use case. The examples herein assume $n_W = 1.33$ and $n_f = 1.45$ —1.46. For a panel made of soda-lime glass with *Npanel* = 1-51, assuming $n_W = 1.33$ and $n_f = 1.46$, the cutoff angles are $\theta_C = 41.5°$, $\theta_W = 62°$, and $\theta f = 75°$. For a panel made of PMMA with $n_{panel} = 1.49$, assuming $n_W = 1.33$ and $n_f = 1.45$, the cutoff angles are $\theta_C = 42°$, $\theta_W = 63°$, and $\theta_f = 77°$.

In one embodiment, the angular range of the filter 20 is set to $\theta_{min} \approx \theta_C < \theta_{max} < 90°$. This will ensure that all propagating light reaches the light-sensing surface 3A while preventing a major part of the ambient light from striking the light-sensing surface 3A.

Further suppression of interferences, i.e. unwanted signal components at the light-sensing surface 3A, may be achieved by setting θ_{min} to exceed θ_C.

In one such embodiment, the angular range is set to $\theta_{min} = \theta_C + \Delta\Theta < \theta_{max} < 90°$, with $\Delta\Theta$ equal to, or larger than, e.g. 5°, 10° or 15°. This embodiment has been found to reduce the influence of ambient light that is coupled into the panel 1 through deposits on the touch surface 4, such as water, saliva, fingerprints, smear, etc

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(collectively denoted "contamination" or "surface contamination" herein). With reference to ray A2 in Fig. 4, it was mentioned that all ambient light that falls onto the touch surface 4 will pass through the panel 1. However, the present Applicant has found that this is only true for a perfectly clean touch surface 4. As indicated in Fig. 7, contamination 30 on the touch surface 4 may allow ambient light at an angle of incidence near or larger than θ_c to leak into the panel 1 and be trapped by TIR therein. The present Applicant has realized that this ambient light may have a sizeable influence on the measured signal levels at the detector 3. The Applicant has also found, surprisingly, that the trapped ambient light is largely concentrated to a limited range of AOIs at the filter 20, close to and above the critical angle θ_c. Thus, a portion of the trapped ambient light may be prevented from reaching the detector 3 by choosing $\theta_{min} = \theta_c + \Delta\Theta$ with an angular span $\Delta\Theta$ equal to or larger than the limited range of AOIs. It is currently believed that the concentration of the ambient light to the limited range of AOIs is caused by Mie scattering in the contamination 30, as well as refraction by contamination droplets, causing the ambient light to enter the panel with a slightly widened distribution, as indicated by 32 in Fig. 7. The widening due to Mie scattering and refraction in contamination droplets may be in the range of ±5° to ±10°. The ambient light typically falls onto the contamination 30 at many different angles. Since all ambient light that enters the panel 1 at an angle below θ_c will pass through the panel 1 and since the intensity of the ambient light typically decreases with increasing angle to the normal N of the panel, the trapped ambient light will be concentrated at and slightly above θ_c. It should also be noted that if the refractive index of the panel 1 is larger than the refractive index of the contamination 30: $n_{panel} > n_{cont}$, the AOIs for the ambient light refracted into the panel 1 via the contamination 30 cannot exceed $arcsin(n_{cont} / n_{panel})$.

The present Applicant has found that further advantageous and unexpected effects are achieved by designing the filter 20 with a given relation between the lower limit θ_{min} and the cut-off angle θ_w or θ_i.

In one such embodiment, the angular range is set to $\theta_{min} \leq \Theta \leq \theta_{max}$, where $\theta_{min} \geq \theta_w$ and $\theta_{max} < 90°$. Thus, the filter 20 is designed to only transmit light with AOIs that are equal to or larger than the cut-off angle θ_w for water. This embodiment has the ability of significantly reducing the influence on the resulting projection signals from water-containing deposits on the touch surface 4. As noted above, the portion of the propagating light that strikes water at AOIs below θ_w will be at least partially coupled out of the panel 1 and interact with the water. Thus, the portion of the propagating light that reaches the filter 20 at AOIs below θ_w has been significantly more attenuated by water than the remainder of the propagating light. This embodiment

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also has the ability of reducing the impact of differences in finger interaction between users and even between fingers of a single user. These differences may make it difficult to properly detect all touching objects on the touch surface, and it may require the signal processor 10 to be configured with a large dynamic range for retrieving and processing the projection signals. A significant part of the differences in finger interaction has been found to emanate from different moisture levels on the fingers. The filter design of this embodiment will suppress the influence of moisture in the projection signals and thus reduce the impact of differences in finger interaction.

In this embodiment, the propagating light that is transmitted by the filter 20 has impinged on the touch surface 4 with AOIs at or above θ_w. At these AOIs, the propagating light will still be coupled into the outermost layer of the finger that form part of the epidermis, since this layer *(stratum corneum)* is known to have a refractive index of about 1.55 in the infrared, e.g. according to measurement results presented in *"A survey of some fundamental aspects of the absorption and reflection of light by tissue"*, by R.J. Scheuplein, published in J. SOC. COS. CHEM. 15, 111-122 (1964), and *"The optics of human skin"*, by Anderson and Parrish, published in Journal of Investigative Dermatology 77, 1, 13-19 (1981). This means that propagating light is coupled into the finger for AOIs at least up to a cutoff angle $\theta_{sc} = \arcsin(1.55/n_{panel})$. If $n_{panel} \leq 1.55$, the cutoff angle θ_{sc} is not relevant, and all AOIs below 90° will interact with the stratum corneum (and other outer layers of the finger). If $n_{panel} > 1.55$, it is conceivable to set $\theta_{max} \leq \theta_{sc}$ for the filter 20, should there be a need to suppress propagating light at AOIs above θ_{sc}.

It should also be noted that this embodiment may eliminate, or at least significantly suppress, ambient light that has been coupled into the panel via water on the touch surface 4 and has propagated by TIR to the filter 20. As explained above, this ambient light has a maximum AOI of $\arcsin(n_{cont}/n_{panel})$, which is equal to θ_w with $n_{cont} = n_w$.

In another embodiment, the angular range is set to $\theta_{min} \leq \Theta \leq \theta_{max}$, where $\theta_{min} \geq \theta_w$ and $\theta_{max} < 90°$. This embodiment has the ability of significantly reducing the influence on the resulting projection signals from deposits containing finger fat, e.g. fingerprints, on the touch surface 4. Fingerprints are typically a substantial part of the contamination on the touch surface, and a major concern when processing the projection signals for detecting the touching objects. It is thus a significant technical achievement to be able to suppress the influence of fingerprints, and it will reduce the requirements on the signal processor 10 to track and compensate for surface contamination. This embodiment also has the ability of further reducing the impact of differences in finger interaction, since it suppresses the interaction caused by fat on the fingers. Furthermore,

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this embodiment may essentially eliminate, or at least significantly suppress, ambient light that has been coupled into the panel via finger fat on the touch surface 4 and has propagated by TIR to the filter 20. This ambient light has a maximum AOI of $arcsin(n_{com} / n_{panel})$, which is equal to θ_f with $n_{com} = n_f$.

Reverting to Fig. 4, the width W of the filter 20 (in the direction of the respective detection line) may be optimized with respect to the range of AOIs of the propagating light that should be transmitted onto the light-sensing surface 3A. To ensure that all of this propagating light (i.e. the light with appropriate AOIs) strikes the filter at least once, the width W may be set to exceed the relevant minimum distance between bounces in the rear surface ("minimum bounce distance"). If the panel is made of a single material, the minimum bounce distance is given by $2 \cdot t \cdot \tan(\theta_{min})$, where t is the thickness of the panel 1. To achieve a consistent detection of the propagating light within the limits θ_{min}, θ_{max}, it may be desirable to set the width to exceed the relevant maximum distance between bounces in the rear surface ("maximum bounce distance"). If the panel is made of a single material, the maximum bounce distance is given by $2 \cdot t \cdot \tan(\theta_{max})$. In practice, the width W may be given by other design considerations, which may (but need not) set the limit θ_{max} of the filter 20. Further, the skilled person is able to calculate the minimum bounce distance and the maximum bounce distance for a panel consisting of more than one layer.

The foregoing design rules for the angular filter were given for a panel 1 with a single index of refraction. However, corresponding design rules are applicable for the angular filter 20 when applied to a panel 1 made up of two or more layers with different index of refraction. Fig. 8 illustrates a panel 1 formed by a top layer with index of refraction n_1 and a bottom layer with index of refraction n_2. Light having an angle of incidence θ_1 at the front surface 5 will impinge on the rear surface 6 with an angle of incidence $\theta_2 = \arcsin(n_1 / n_2 \cdot \sin(\theta_1))$. This means that the limits θ_{min}, θ_{max} of the filter 20, if mounted on the rear surface 6, should be set with respect to the critical angle θ_c at the front surface 5 as represented at the rear surface 6, or with respect to the cut-off angles θ_w, θ_f at the front surface 5 as represented at the rear surface 6. The skilled person realizes that n_{panel} in the above expressions for θ_c, θ_w, and θf is the refractive index of the panel 1 at the outcoupling region where the filter is mounted. In the example of Fig. 8, $n_{panel} = n_2$.

A different situation may arise if the panel 1 is laminated to a display 34 by means of a lamination layer 36 of light transmissive material, as shown in Fig. 9A. If the display 34 does not reflect light back to the panel 1, the lamination layer 36 may be designed with a smaller refractive index n_{lam} than the panel. This will cause light that impinges on the interface between the panel and the lamination layer 36 at angles equal

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to $\theta_{c,l}$ = arcsin(n_{lam}/n_{panel}), or larger, to be totally reflected at this interface. Light that impinges on the interface at smaller angles, e.g. as indicated by a dotted arrow in Fig. 9A, will be transmitted via the lamination layer 36 to the display 34. This means that the minimum AOI of the light that propagates by TIR between the surfaces 5, 6 and strikes the filter 20, is $\theta_{c,l}$ rather than θ_c. In such an embodiment the angular range of the filter 20 may be set according to $\theta_{min} \leq \Theta \leq \theta_{max}$, where $\theta_{min} \geq \theta_{c,l}$ and $\theta_{max} < 90°$. Of course, the angular range may instead be designed with respect to θ_H or θ_f, according to the embodiments described above.

It should be noted that a lamination layer 36 may generally be introduced between the rear surface 6 of the panel 1 and any external device when it is desirable to "optically isolate" the propagating light in panel from the external device, whereby the propagating light is shifted to larger angles of incidence by virtue of $\theta_{c,l} > \theta_c$. Based on the foregoing discussion, it is understood that it may be desirable to select the material of the lamination layer 36 such that $\theta_{c,l} \geq \theta_H$ or $\theta_{c,l} \geq \theta_f$, so as to reduce the attenuation caused by contamination on the touch surface 4. In another variant, it may be desirable to select the material of the lamination layer 36 such that $\theta_{c,l} \geq \theta_c + \Delta\Theta$, where $\Delta\Theta$ is selected to reduce the influence of ambient light that enters the panel via contamination on the touch surface 4, as discussed above with reference to Fig. 7.

A similar concept may be implemented even if the panel 1 is not laminated to a display 34. This concept is illustrated in Fig. 9B, in which an assembly of layers 37, 38 is applied to the rear surface 6 to extend between an incoupling structure, which couples an emitter 2 to the panel 1, to an outcoupling structure, which couples a detector 3 to the panel 1, in this example via an angular filter 20. A coupling layer 37 of light transmissive material is applied to the rear surface 6 and a light absorbing layer 38 is applied to the coupling layer 37. The layers 37, 38 may be provided as thin, sheet-like elements. The light absorbing layer 38 absorbs at least in the wavelength range of the light injected by the emitter 2 and is preferably transmissive in the visible wavelength range so that e.g. an underlying display may be seen through the front surface 5. Such a display may be either spaced from or attached (laminated) to the absorbing layer 38. The refractive index n_{coupl} of the coupling layer 37 may be tailored in relation to the refractive index n_{panel} of the panel 1, so as to selectively define the minimum AOI of the light that propagates in the panel 1. Thus, if the coupling layer 37 is designed with a smaller refractive index n_{coupl} than the panel, the minimum AOI of the light that propagates by TIR between the surfaces 5, 6 and reaches the outcoupling site is θ_{CC} = arcsin(n_{coupl}/n_{panel}) rather than θ_c. It is understood that the material of the coupling layer 37 may be selected such that $\theta_{CC} \geq \theta_H$ or $\theta_{CC} \geq \theta_f$, so as to reduce the attenuation caused by contamination on the touch surface 4. In another variant, the

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material of the coupling layer 37 may be selected such that $\theta_{CC} \geq \theta_C + \Delta\Theta$, where $\Delta\Theta$ is selected to reduce the influence of ambient light that enters the panel via contamination on the touch surface 4, as discussed above with reference to Fig. 7.

Advantageous effects are obtained even if the assembly of layers 37, 38 do not extend across the entire rear surface 6 between the incoupling and outcoupling structures. For example, the assembly of layers 37, 38 may be spaced from both the incoupling structure and the outcoupling structure. Further alternatives are discussed further below with reference to Figs 13A-13B and Fig. 14D.

It should be noted that the concepts of using a lamination layer 36 or a coupling layer 37 to control the minimum AOI of the propagating light need not be combined with an angular filter in the outcoupling structure and/or an angular filter in the incoupling structure (see below), in order to reduce the impact of ambient light or contamination. However, such a combination may be desirable in certain implementations. For example, the angular filter 20 may be installed in the outcoupling structure to block ambient light that falls onto the front surface 5 and is refracted towards the outcoupling structure (cf. ray A1 in Fig. 4). However, it is to be understood that the impact of such ambient light may be reduced by other techniques, e.g. by modulation of the propagating light or by installing a dedicated shielding layer on the front surface 5 above the outcoupling structure. It may also be advantageous to combine a lamination layer 36 or coupling layer 37, for controlling the minimum AOI of the propagating light, with an angular filter in the outcoupling structure, so as to relax the requirements on the layer 36, 37 and the filter 20, respectively. Thus, a less than optimal selection of the layer 36, 37 may be compensated by the angular filter 20, and vice versa. The lower limit of the filter 20 may be set as: $\theta_{min} \geq \theta_{CC}$. Of course, the angular range may instead be designed with respect to θ_w or θ_f, as described hereinabove.

It should also be noted that, for efficient utilization of light, the light emitter 2 may be coupled to the panel 1 such that the injected light impinges on the lamination layer 36 (or the coupling layer 37) at an AOI that is essentially equal to or exceeds $\theta_{c,i}$ (or θ_{CC}) to avoid that useful light is leaked into the layer 36 (or 37). Such an implementation may also serve to further reduce the impact of contamination on the front surface 5. In Fig. 9B, the incoupling structure injects a ray P1 which, in the absence of surface contamination, would be specularly reflected at the front surface 5 and then coupled into layer 37 and absorbed by layer 38. However, as illustrated, the ray P1 strikes the contamination 30 on the front surface 5, and some of the resulting scattered light, represented by ray S1, may propagate to the outcoupling site. If sensed by the detector 3, the scattered light S1 might disrupt the detection of touches. It is understood that the impact of contamination is reduced if the incoupling structure is designed such that a

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major portion, or ideally all, of the injected light is injected at angles that sustain propagation in the panel 1, represented by ray P2 in Fig. 9B.

In the foregoing, it has been assumed that the cutoff angles θ_w and θ_f are given by the TIR angle at the interface between the panel and water and finger fat, respectively. However, it shall be appreciated that the TIR angles correspond to 100% reflection at the interface, and that the reflectivity at the interface does not exhibit a step change at the TIR angle but is a continuous, but steep, function within increasing AOI until the TIR angle. This is illustrated in Fig. 16, which is a graph of the reflectivity R at a panel-to-water interface as a function of AOI, Θ given by the equations:

$$R_p = \left| \frac{n_{panel} * \cos\theta - n_w * \sqrt{1 - \left(\frac{n_{panel}}{n_w} \sin\theta\right)^2}}{n_{panel} * \cos\Theta - n_w * \sqrt{1 - \left(\frac{n_{panel}}{n_w} \sin\theta\right)^2}} \right|^2$$

$$R_s = \left| \frac{n_{panel} * \sqrt{1 - \left(\frac{n_{panel}}{n_w} \sin\theta\right)^2} - n_w * \cos\Theta}{n_{panel} * \sqrt{1 - \left(\frac{n_{panel}}{n_w} \sin\theta\right)^2} + n_w * \cos\Theta} \right|^2$$

$$R = \frac{R_s + R_p}{2}$$

with $n_{panel} = 1.51$ and $n_w = 1.33$.

As understood from Fig. 16, it is possible to define the cutoff angles θ_w and θ_f at a given fraction of 100% reflection, e.g. 0.25 or 0.50, while still achieving an essentially complete suppression of the influence of water and finger fat, respectively. In practice, this means that it is possible to adjust the cutoff angles slightly from the TIR angles towards smaller AOIs: $\theta_w = \arcsin(n_w / n_{panel}) - \delta\theta$ and $\theta_f = \arcsin(n_f / n_{panel}) - \delta\theta$, where $\delta\theta$ is typically less than 2°. As used herein, any reference to θ_w and θ_f is intended to inherently include this minor shift $\delta\theta$.

Generally, it may be desirable to limit the size of the individual detectors 3, and specifically the extent of the light-sensing surface 3A. For example, the cost of light detectors may increase with size. Also, a larger detector typically has a larger capacitance, which may lead to slower response (longer rise and fall times) of the detector. It is realized that it may be difficult to reduce the extent W of the detector 3 in the embodiment of Fig. 4, without sacrificing the ability to consistently detect the propagating light.

Fig. 10A illustrates an alternative embodiment that at least partly overcomes this problem. Like in Fig. 4, the angular filter 20 is applied to the rear surface 6, but the detector 3 is arranged with its light-sensing surface 3A essentially perpendicular to the

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main extent of the panel 1. As used herein, "essentially perpendicular" is intended to include deviations of about ±20° or less from perpendicular. A spacer 22 is disposed between the angular filter 20 and the light-sensing surface 3A. The spacer 22 may be made of any suitable light transmissive material, such a plastic material or glass, or a silicone compound, a glue, a gel, etc. In the example of Fig. 10A, the spacer 22 is made of the same material as the panel 1, i.e. $n_{spacer} \approx n_{panel}$. By arranging the surface 3A vertically, the extent of the surface 3A may be reduced significantly compared to the embodiment in Fig. 4. When the extent of the angular filter is W, the minimum vertical extent of the surface 3A may be given by $W / \tan(\theta_{min})$ to ensure that all of the transmitted light from the filter 20 is received at the surface 3A. The extent of the surface 3A may be reduced further by selecting the material of the spacer 22 such that $n_{spacer} > n_{panel}$ causing the transmitted light to be refracted away from the normal and resulting in a smaller projected height at the location of the surface 3A.

Even if the outcoupling structure in Fig. 10A allows for a smaller light-sensing surface 3A, the extent of the surface 3A is still dependent on the angular range of the filter 20. Further, the vertical extent of the surface 3A has a direct impact on the thickness of the apparatus 100. At present, the embodiment in Fig. 10A is believed to be useful only when θ_{min} is larger than about 45°, to avoid that the height of the outcoupling structure becomes excessive.

This problem is at least partly overcome by the embodiment illustrated in Figs 10B-10C. As shown in section in Fig. 10B, the angular filter 20 is applied to the rear surface 6, and a light recycler 40 is arranged beneath the filter 20 in surrounding relationship to the light-sensing surface 3A. The recycler 40 is designed to internally reflect the light that is transmitted by the filter 20 and to modify the angular distribution of the transmitted light. The recycler 40 defines a reflective enclosure around the light-sensing surface 3A. The enclosure is filled by a spacer material 22, e.g. any of the spacer materials discussed in relation to Fig. 10A. The recycler 40 comprises a reflective bottom surface 42A with an opening for the detector 3 (illustrated as mounted on a PCB 45) and reflective sidewalls 42B that extend from the bottom surface 42A to the filter 20. In the illustrated embodiment, the bottom surface 42A is diffusively reflective to impinging light, whereas the sidewalls 42B are specularly reflective to impinging light. As used herein, "specular reflection" is given its ordinary meaning, which refers to the mirror-like reflection of light from a surface, in which light from a single incoming direction (a ray) is reflected into a single outgoing direction. Specular reflection is described by the law of reflection, which states that the direction of incoming light (the incident ray) and the direction of outgoing light reflected (the reflected ray) make the same angle with respect to the surface normal, and that the incident, normal, and

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reflected directions are coplanar. As used herein, "diffuse reflection" is given its ordinary meaning, which refers to reflection of light from a surface such that an incident ray is reflected at many angles rather than at just one angle as in specular reflection. The diffuse reflection is also known as "scattering". The skilled person appreciates that many surfaces/elements/materials exhibit a combination of specular and diffuse reflection. As used herein, a surface is considered "diffusively reflective" when at least 20% of the reflected light is diffuse. The relation between diffuse and specular reflection is a measurable property of all surfaces/elements/materials.

To exemplify the function of the outcoupling structure, Fig. 10B illustrates a single ray P1 that is transmitted and refracted into the recycler 40 by the filter 20. The ray strikes the bottom wall 42A and is diffusively reflected, as indicated by the encircled rays 46. The diffusively reflected light spreads over a large solid angle in the recycler 40, and some of this light is specularly reflected by the filter 20 onto the light-sensing surface 3A. Although not shown, other parts of the diffusively reflected light is likely to undergo further reflections in the recycler 40, against the sidewalls 42B, the angular filter 20 and the bottom wall 42A, and eventually impinge on the surface 3A. It should be noted that the angular filter 20 will also transmit light from the recycler 40 back into the panel 1, specifically light that has an angle of incidence within a given angular range which may, but need not, be identical to the angular range $|\theta_{min} - \theta_{max}|$. If these angular ranges are identical, or at least substantially overlapping, it is necessary to redistribute the light by diffuse reflection inside the recycler 40 to prevent that the light that enters the recycler 40 from the panel 1 escapes back into the panel 1 via the filter 20. If the filter 20 is designed such that the angular ranges are sufficiently different (cf. Fig. 10E, below), the recycler 40 may be configured with only specularly reflective walls 42A, 42B.

In the embodiment of Fig. 10B, the use of specular side walls 42B ensures that all of the light that enters the recycler 40 via the filter 20 is re-directed by specular reflection(s) towards the bottom of the recycler 40, where it is either redistributed by diffuse reflection in the bottom wall 42A or directly received by the light-sensing surface 3A. The diffusively reflected light is typically, but not necessarily, emitted with a main direction that is perpendicular to the bottom wall 42A, as shown in Fig. 10B. The bottom wall 42A may e.g. be a near-Lambertian diffuser. The use of a planar bottom wall 42A, as in Fig. 10B, ensures that most of the diffusively reflected light hits the filter 20 at AOIs outside the angular range, such that a main portion of the diffusively reflected light is reflected by the filter 20 back into the recycler 40.

In an alternative, both the bottom wall 42A and the side walls 42B are diffusively reflective. In another alternative, the side walls 42B are diffusively reflective, while the

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bottom surface 42A is specularly reflective. In all embodiments, it is possible that only a part of the bottom wall 42A and/or the side walls 42B is diffusively reflective. Generally, it may be advantageous to provide diffusive scattering on surfaces that are arranged such that a significant portion of the light impinging on these surfaces would otherwise be specularly reflected onto the filter 20 within the angular range

In yet another alternative, the bottom wall 42A is not specularly or diffusively reflective, but provided with a micro-structure, which is configured to reflect and re-direct impinging light onto the light sensing-surface 3A, by specular reflection against the filter 20 and possibly by reflection against the specular side walls 42B. The micro-structure thus forms a mirror with an optical power that is tailored to the incoming light, i.e. the light that is transmitted by the filter 20 and hits the micro-structure on the bottom wall 42A, either directly or by reflection(s) in the side walls 42B. The use of specularly reflective side walls 42B may facilitate the design of the micro-structure, but it is possible to use diffusively reflective side walls 42B, or a combination thereof. The micro-structure may be implemented as a sheet-like Fresnel mirror.

Compared to the embodiments in Fig. 4 and Fig. 10A, there is no direct relation between the extent of the angular filter 20 and the required size of the light-sensing surface 3A, since the recycler 40 is designed to retain a portion of the transmitted light by internal reflections until it impinges on the surface 3A. Furthermore, there is large freedom of placing the detector 3 in relation to the recycler 40, and it can even be accommodated in a side wall 42B instead of the bottom wall 42A. It is realized that the outcoupling structure may be optimized with respect to manufacturing requirements, without any major loss in outcoupling efficiency. Also, assembly tolerances may be relaxed.

As shown in the plan view of Fig. 10C, the combination of angular filter 20 and recycler 40 will collect light from all directions in the plane of the panel 1, provided that the incoming light impinges on the angular filter 20 with AOIs within the angular range $[\theta_{min} - \theta_{max}]$. Thus, the outcoupling structure in Fig. 10C can accept light from many different directions in the plane of the panel 1 and define the end point of detection lines from different emitters (cf. Fig. 2). In the example of Fig. 10C, the recycler 40 is circular in plan view, but other shapes are possible, e.g. elliptical or polygonal. As described in relation to Fig. 4, it may be desirable that the extent W of the recycler along each of the detection lines is equal to at least the minimum bounce distance or at least the maximum bounce distance.

In all embodiments, the specularly reflective wall(s) of the recycler 40, if present, may be implemented by an external coating, layer or film which is applied to the spacer material 22, e.g. a metal such as aluminum, copper or silver, or a multilayer structure, as

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is well-known to the skilled person.

In all embodiments, the diffusively reflective wall(s) of the recycler 40, if present, may be implemented by an external coating, layer or film of diffusively reflective material which is applied to the spacer material 22. In one implementation, the diffusively reflective material is a matte white paint or ink. In order to achieve a high diffuse reflectivity, it may be preferable for the paint/ink to contain pigments with high refractive index. One such pigment is TiO_2, which has a refractive index n=2.5-2.7. It may also be desirable, e.g. to reduce Fresnel losses, for the refractive index of the paint binder (vehicle) to match the refractive index of the spacer 22. For example, depending on refractive index, a range of vehicles are available such as oxidizing soya alkyds, tung oil, acrylic resin, vinyl resin and polyvinyl acetate resin. The properties of the paint may be further improved by use of e.g. EVOQUE™ Pre-Composite Polymer Technology provided by the Dow Chemical Company. There are many other diffusively reflective coating materials that are commercially available, e.g. the fluoropolymer Spectralon, polyurethane enamel, barium-sulphate-based paints or solutions, granular PTFE, micro-porous polyester, Makrofol® polycarbonate films, GORE® Diffuse Reflector Product, etc. Also, white paper may be used. Alternatively, the diffusively reflective material may be a so-called engineered diffuser. Examples of engineered diffusers include holographic diffusers, such as so-called LSD films provided by the company Luminit LLC.

According to other alternatives, the diffusively reflective wall(s) of the recycler 40 may be implemented as a micro-structure in the spacer material 22 with an overlying coating of specularly reflective material. The micro-structure may e.g. be provided in the spacer material 22 by etching, embossing, molding, abrasive blasting, etc. Alternatively, the micro-structure may be attached as a film or sheet onto the spacer material 22. The above-described mirror with an optical power tailored to incoming light may also be provided as a micro-structure in or on the spacer material 22.

Below follows a description of variants of the outcoupling structure in Fig. 4. Unless explicitly excluded, the bottom wall 42A and the side walls 42B may be configured according to any of the embodiments, alternatives and variants described in relation to Figs 10B-10C.

Fig. 10D illustrates an outcoupling structure that may improve the ability of the outcoupling structure to achieve a consistent detection of the propagating light within the limits θ_{min}, θ_{max}, when the width W of the angular filter 20 and the light-sensing surface 3A is smaller than the maximum bounce distance or even smaller than the minimum bounce distance. This is achieved by providing the edge surface, which connects the front and rear surfaces 5, 6, with a specularly reflective coating 48 at the location of angular filter 20. As shown, the coating 48 will operate to reflect, back into

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the panel 1, the propagating light that passes above the angular filter 20, including propagating light that strikes the filter 20 at AOIs outside the angular range $[\theta_{min} - \theta_{max}]$ and propagating light that does not strike the angular filter 20. It is realized that the coating 48 will reflect the incoming light without changing its AOIs. Thus, a portion of the reflected light will have AOIs that fall within the angular range of the filter 20. Such reflected light will be transmitted by the filter 20 to the extent that it strikes the filter 20 on its way back towards the touch surface 4. Thereby, the reflective coating 48 operates to increase the outcoupling efficiency.

It is not strictly necessary to arrange the angular filter 20 directly adjacent to the edge surface for the coating 48 to perform its function of increasing outcoupling efficiency. However, such a placement may be preferred to ensure that light on different detection lines can be reflected by the coating 48 onto the angular filter 20.

The reflective coating 48 may be generally implemented to increase outcoupling efficiency in all embodiments disclosed herein.

Fig. 10E illustrates a variant of the outcoupling structure in Fig. 10B. The recycler 40 is configured as a hollow case, i.e. without spacer material. This is achieved by providing the angular filter 20 with a disruptive optical element 52 on its exit surface to enable the light transmitted by the angular filter 20 to enter the hollow recycler 40. In the absence of the disruptive optical element 52, the light passing the filter 20 would have been reflected back into the filter 20 by TIR in the exit surface. In one embodiment, the element 52 is a transmissive imaging component that refracts the incoming light. The imaging component 52 thus defines an optical power that is tailored to the light passing the filter 20, e.g. to refract the light onto the light sensitive surface 3A and/or dedicated portions of the bottom and sidewalls 42A, 42B. Thereby, the walls 42A, 42B may, but need not, be specularly reflective. Such an imaging component 52 may achieve highly efficient coupling of light into the recycler 40, but may require careful positioning with respect to the filter 20 and the recycler 40. The optical power may be defined by a micro-structure that spans the surface of the imaging component 52. In one example, the micro-structure defines a sheet-like Fresnel lens.

In another embodiment, the disruptive optical element 52 is a non-imaging, diffusively transmitting component ("transmissive diffuser"). In this embodiment, the light that enters the recycler 40 is diffusive. Since light is angularly redistributed on entry, the walls 42A, 42B may, but need not, be specularly reflective. Preferably, the transmissive diffuser 52 is shift invariant to the incoming light, so that it does not have to have a specific position to the incoming light. In one example, the transmissive diffuser 52 is configured without refracting structures. Such a transmissive diffuser 52 may be implemented as a film of diffusing particles in a simple, robust and cost

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effective manner. The film may be applied to the filter 20 by painting, spraying, lamination, gluing, etc. Any inherently translucent material may be used for forming the film, e.g. a matte white paint or ink. However, the paint may be optimized to obtain a desired diffusive transmission ratio, e.g. by including pigments with low refractive index or spherical objects of different materials. In another example, the transmissive diffuser 52 comprises refracting structures on the side facing the away from the filter 20. In such a transmissive diffuser, also known as an engineered diffuser, the refracting structures may be implemented as an arrangement (e.g. random, pseudo-random, hexagonal, etc) of microstructures (e.g. micro-lenses, micro-cones or micro-prisms) tailored to generate a desired diffuse transmission. The engineered diffuser may be a separate flat or sheet-like device which is attached to the filter 20, or may be a surface structure on the filter 20 provided by etching, embossing, molding, abrasive blasting, etc.It is to be understood that the disruptive optical element 52 may also be implemented in the embodiment in Fig. 10A, to obviate the need for spacer material 22 between the angular filter 20 and the detector 3.

Fig. 10F illustrates a further variant of the outcoupling structure in Fig. 10B. Here, the detector 3 is side-looking when mounted on a PCB 45. The detector 3 is inserted into the spacer material 22 such that the light-sensing surface 3A projects beyond the bottom surface 42A of the recycler 40 and is perpendicular to the extent of the panel 1 and the angular filter 20. By arranging a side-looking detector 3 inside the recycler 40, it is possible to provide an increased light-sensing surface 3A for a given opening in bottom surface 42A, especially if the light-sensing surface 3A extends around the perimeter of the detector 3. The increased light-sensing surface 3A may result in an increased outcoupling efficiency. In a variant, the top surface of the detector 3 may be provided with a diffusively reflective structure to enhance the angular redistribution of light inside the recycler 40.

Fig. 10G illustrates a further variant of the outcoupling structure in Fig. 10B, in which the recycler 40 is configured as a funnel tailored to direct the light transmitted by the filter 20 onto the light-sensing surface 3A. The funnel is defined by the walls 42A, 42B, which are specularly reflective. It should be noted that the recycler 40 may have other shapes than shown in Fig. 10G. For example, the bottom wall 42A may be parabolic. Other suitable shapes may be obtained by optical system optimization, such as by ray tracing. Furthermore, the walls 42A, 42B may be merged into a common funnel structure, which may be parabolic or have any optimized shape. The recycler 40, and optionally the filter 20, may be integrated with the detector 3 into a package, which is attached to the rear surface 6 during manufacture of the apparatus.

Fig. 10H illustrates a variant of the outcoupling structure in Fig. 4. In Fig. 10H,

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the apparatus 100 further comprises a visibility filter 50, which is arranged to hide (shield) the angular filter 20, the detector 3 and the internal structure of the apparatus 100 from view through the front surface 5. The visibility filter 50 is non-transmissive (reflecting and/or absorbing) to visible light and transmissive to NIR light, and preferably only transmissive to NIR light in the wavelength region of the propagating light. The visibility filter 50 may be implemented as a coating or film, in one or more layers. In Fig. 10H, the visibility filter 50 extends from the inner edge of the angular filter 20 to the edge of the panel 1, although the visibility filter 50 may extend further beyond the angular filter 20 towards the center of the panel. In Fig. 10H, the visibility filter 50 is arranged beneath the panel 1, intermediate the rear surface 6 and the angular filter 20. This enables the front surface 5 to be perfectly flat and free of projecting elements. In a variation, not shown, the visibility filter 50 is arranged intermediate the angular filter 20 and the detector 3. In a further variation, not shown, the visibility filter 50 is applied to the front surface 5. It is to be understood that the visibility filter 50 may be implemented in conjunction with any outcoupling structure described herein.

There are other ways of integrating the angular filter in the outcoupling structure than by arranging the above-described multilayer structure in front of the detector 3. For example, the angular filter may be formed by a structure that geometrically and mechanically limits the light rays that can reach the detector, as exemplified below with reference to Figs 11-12.

Fig. 11A is a side view of a first alternative outcoupling structure as attached to the panel 1, and Fig. 11B is a top plan view of the outcoupling structure. The outcoupling structure forms an angular filter 20 by defining an angularly limited propagation path from an outcoupling port 60 to the light-sensitive surface 3A. The angular filter 20 is defined by non-transmissive layers 61-63 on a body of light transmissive material 22, e.g. any of the spacer materials discussed in relation to Fig. 10A. Layers 61 and 62 are arranged on top of the body, to define the outcoupling port 60 at the interface between the body and the panel 1. Layer 61 is light-absorbing and formed as an annulus segment. Layer 61 only needs to be absorbing to light inside the body. Layer 62 is specularly reflective and formed as a semi-circle, which may extend to the inner radius of the annulus segment, as shown, or to the outer radius of the annulus segment (i.e. between layer 61 and the panel 1). The top of the body is attached to the rear surface 6 of the panel 1, and the light detector 3 is attached to a short-side of the body such that the surface 3A is shielded beneath the layers 61, 62. Layer 63 is specularly reflective and attached to bottom side of the body.

Fig. 11A illustrates one propagating ray P1 that passes the outcoupling port 60 at an AOI within the angular range of the filter 20 and is reflected by layer 63 onto surface

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3A. Fig. 11A also illustrates a propagating ray P2 that propagates in the panel 1 by TIR and passes the outcoupling port 60 and is reflected by layer 63 onto layer 61 which absorbs the ray. As seen, the structure of layers 61-63 define the angular range of the filter 20. The width of the layer 61 along the respective detection line defines θ_{min}, for a given vertical height of the body. To achieve similar θ_{min} for all detection lines in the plane of the panel, layer 61 is shaped as an annulus segment, although more complicated shapes are conceivable to achieve a corresponding effect.

Fig. 12A is a side view of a second alternative outcoupling structure as attached to the panel 1, and Fig. 12B is a top plan view of the outcoupling structure. Like the first variant in Fig. 11, the outcoupling structure forms an angular filter 20 by layers 71-73 attached to a body of light transmissive material which is attached to the rear surface 6 of the panel 1. Layer 71 is arranged on top of the body, to define an outcoupling port 70 at the interface between the body and the panel 1. Layer 71 is specularly reflective and, in this example, formed as a semi-circle. Layer 72 is light-transmissive and attached to the bottom surface of the body, and has a refractive index that causes light that impinges on the outcoupling port 70 at AOIs above θ_{min} to be reflected by TIR at the interface between the body and layer 72, whereas light at smaller AOIs is transmitted into layer 72 and is absorbed by layer 73 of light-absorbing material. It is realized that the refractive index of layer 72 is given by $n_{72} = n_{panel} \cdot \sin(\theta_{min})$. The function of the outcoupling structure exemplified by one ray P1 that passes the filter 20 and one ray P2 that is coupled into layer 72.

In both of the first and second variants, it is conceivable that the refractive index *nspacer* of the body is selected to yield a desired θ_{max} by TIR in the interface between the body and the panel. $n_{spacer} = n_{panel} \cdot \sin(\theta_{max})$.

Fig. 13A illustrates a variant of the embodiment in Fig. 4, in which an assembly of layers 87, 88 (denoted "layered absorber" in the following) is attached to the rear surface 6 adjacent to the outcoupling structure. Layer 87 is light-transmissive and attached to the rear surface 6, and layer 88 is light-absorbing and attached to layer 87. Layers 87, 88 may be configured in correspondence with the coupling layer 37 and the light-absorbing layer 38, respectively, as described above with reference to Fig. 9B. Thereby, the layered absorber will absorb all light that impinges thereon with an AOI below $\theta_{CC} = \arcsin(n_{coupl}/n_{panel})$, where n_{coupl} is the index of refraction of the coupling layer 87. It is realized that the layered absorber may combine with the angular filter 20 to limit the angles of the light that reaches the detector 3. The layered absorber may be configured with a width $W \geq 2 \cdot t \cdot \tan(\theta_{CC})$, in the direction of the respective detection line, to ensure that the propagating light with AOIs below θ_{CC} strikes the coupling layer 87 at least once. The provision of the layered absorber may relax the

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requirements of the angular filter 20, and it may even be possible to omit the angular filter 20, in this and all other outcoupling structures described herein, since the layered absorber effectively forms an angular filter to the light that propagates in the panel 1 towards the outcoupling structure. The limit angle θ_{GC} may be selected to reduce the impact of ambient light and contamination as described above for the assembly of layers 37, 38 (Fig. 9B). The layered absorber may be combined with all outcoupling structures described herein. As a further example, Fig. 13B illustrates such a combination with the outcoupling structure in Fig. 10B which includes a recycler 40.

The sensitivity to contamination may be reduced by increasing the width W1 of the layered absorber. In one extreme, the assembly of layers 87, 88 spans the entire rear surface 6 from the outcoupling structure to the incoupling structure. At this extreme, the layered absorber is identical to the assembly of layers 37, 38 in Fig. 9B. The reason for the improvement with increasing width W1 is believed to be that the propagating light that reaches the detector 3 is less affected by light scattering in surface contamination. As mentioned in relation to Fig. 9B, light that propagates in the panel 1 is scattered when it hits surface contamination, and part of the scattered light will propagate in the panel 1 and possibly be further scattered against surface contamination, and so on. This means that the intensity distribution as a function of AOI for the light that reaches the filter 20, and the amount of light received by the detector 3, will depend on the current distribution of contamination on the touch surface 4. This may, e.g., make it difficult to detect a finger tap on the touch surface 4, since the finger tap leaves a fingerprint which may cause a signal change at the detector 3 that at least partly masks the signal change caused by the finger being lifted from the touch surface. A larger width W1 of the layered absorber will reduce the intensity redistribution caused by light scattering in surface contamination. This effect is seen in Figs 17A-17B, which illustrate time-resolved signal attenuation measured for a detection line on a touch surface heavily contaminated by sebum, while a short finger tap (touch-down followed by touch-up) occurs within the time window. At. Fig. 17A shows the result for a panel without a layered absorber, and Fig. 17B shows the result with a layered absorber (θ_{GC} = 70°) that spans the entire rear surface between the incoupling and outcoupling structures (cf. Fig. 9B). Signal attenuation is defined as I/I0, where I is the measured intensity at the detector 3, and I0 is the measured intensity without a finger on the detection line. As seen, the measured attenuation rises to a peak at touch-down and then returns to an elevated level at touch-up. The elevated level is caused by the fingerprint left by the finger tap on the touch surface. However, the difference in attenuation between touch-down and touch-up is increased by a factor of 2 in Fig. 17B compared to Fig. 17A. It is understood that the layered absorber may improve the ability to detect a touch-up event

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during a finger tap.

3. Incoupling structure

Generally, any type of incoupling structure may be used for coupling light into the panel 1 of the touch-sensitive apparatus. In certain implementations, it may be advantageous for the incoupling structure to include an angular filter similar to the one in the above-described outcoupling structures. A few embodiments of such light incoupling structures will be explained in detail with reference to Fig. 14. Generally, these embodiments are presented in the context of the touch-sensitive apparatus shown in Fig. 2.

Fig. 14A illustrates a section that may be taken along any one of the detection lines **D** of the touch-sensitive apparatus in Fig. 2. For simplicity, only a portion of the apparatus at and around the incoupling structure is shown. The incoupling structure includes a sheet-like angular filter 120 which is applied with its front face to the rear surface 6 of the panel 1 to define an incoupling port at the periphery of the touch surface 4. In the illustrated example, the angular filter 120 is implemented as a multilayer structure, which may be similar to, or even identical to, the angular filter 20 described above in relation to Figs 4-5. A recycler 140 is arranged beneath the angular filter 120 in surrounding relationship to a light-emitting surface 2A of an emitter 2. The recycler 140 defines a reflective enclosure around the light-emitting surface 2A. The enclosure is filled by a spacer material 122, e.g. any of the spacer materials discussed in relation to Fig. 10A. The recycler 140 comprises a reflective bottom surface 142A with an opening for the emitter 2 (illustrated as mounted on a PCB 45) and reflective sidewalls 142B that extend from the bottom surface 142A to the filter 120.

The angular filter 120 is configured to only be transmissive to light from within the recycler 140 within a given angular range $[\theta'_{min} - \theta'_{max}]$ with respect to the normal of the filter 120. Light at other angles of incidence is reflected, specularly or diffusively, back into the recycler 140.

In the embodiment of Fig. 14A, the bottom surface 142A is diffusively reflective to impinging light, whereas the sidewalls 142B are specularly reflective to impinging light. The function of the incoupling structure is exemplified for a few rays originating from the light-emitting surface 2A. As shown, light is emitted from the surface 2A in a divergent beam of light. Some light is emitted onto the filter 120 at angles that are directly transmitted into the panel 1 (one ray shown), whereas other light is reflected against the filter 120 back towards the bottom surface 142A (one ray shown), where it is diffusively reflected, as indicated by the encircled rays 46. Some of this diffusively emitted light is transmitted into the panel 1 by the filter 120, either directly or after reflection in the side wall 142B. The rest of the diffusively reflected light will be

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recirculated by further reflections inside the recycler 140. Thus, the recycler 140 operates to gradually concentrate the light from the emitter 2 into the angular range $[\theta'_{min} - \theta'_{max}]$ by multiple reflections inside the recycler 140. Due to the speed of light, this process is instant compared to the time scale used by the signal processor 10 for sampling data from the detectors 3. In a variation, both the bottom wall 142A and the side walls 142B are diffusively reflective. In another alternative, the side walls 142B are diffusively reflective, while the bottom surface 142A is specularly reflective. In all embodiments, it is possible that only a part of the bottom wall 142A and/or the side walls 142B is diffusively reflective.

The use of an angular filter 120 provides a simple, efficient and robust technique for providing light within a well-defined angular range $[\theta'_{min} - \theta'_{max}]$ inside the panel 1.

It should be noted, that the width W of the incoupling structure may be set to be less than the minimum bounce distance for the in-coupled light, which is given by $2 \cdot t \cdot \tan(\theta'_{min})$ if the panel 1 consists of a single material. This ensures that light transmitted by the angular filter 120 and impinging on the front surface 5 at θ'_{min}, or there above, will not be reflected back onto the angular filter 120.

The incoupling structure of Fig. 14A is configured to introduce light into the panel 1 within an angular range $[\theta'_{min} - \theta'_{max}]$ that at least approximately matches the angular range $[\theta_{min} - \theta_{max}]$ of the angular filter 20 in the outcoupling structure. The (approximate) matching of the angular ranges between the incoupling and outcoupling structures will ensure efficient utilization of the available light energy, and it may also reduce the impact of surface contamination, by analogy with the discussion above with reference to Fig. 9B. The matching may be inherently achieved by installing identical angular filters 20, 120 in the incoupling and outcoupling structures.

As shown in the plan view of Fig. 14B, the combination of angular filter 120 and recycler 140 will couple light into the panel for propagation in all directions in the plane of the panel 1, provided that the incoming light impinges on the angular filter 120 with AOIs within the angular range $[\theta'_{min} - \theta'_{max}]$. Thus, the incoupling structure in Fig. 14B can define the starting point of detection lines to different detectors 3 (cf. Fig. 2). In the example of Fig. 14B, the recycler 140 is circular in plan view, but other shapes are possible, e.g. elliptical or polygonal.

Fig. 14C illustrates a variant of the incoupling structure in Fig. 14A. Here, the emitter 2 is side-emitting when mounted on a PCB 45. The emitter 2 is inserted into the spacing material 122 such that the light-emitting surface 2A projects beyond the bottom surface 142A of the recycler 140 and is perpendicular to the extent of the panel 1 and the angular filter 120. By arranging a side-emitting emitter 2 inside the recycler 40, it is

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possible to increase the light-emitting surface 2A for a given opening in bottom surface 142A. Furthermore, the top surface of the emitter 2 may be provided with a diffusively reflective surface, to enhance the angular redistribution in the recycler 140. Also, the angular redistribution may be improved since the light from the emitter 2 is at least partly directed towards the bottom wall 142A and the side walls 142B, instead of directly against the angular filter 120 as in Fig. 14A.

Fig. 14D illustrates a variant of the embodiment in Fig. 14A, in which the above-mentioned layered absorber, consisting of layers 87, 88, is attached to the rear surface 6 adjacent to the incoupling structure. For the same reason as in Figs 13A-13B, the layered absorber preferably has a width $W1 \geq 2 \cdot t \cdot \tan(\theta_{c2})$, and as explained above the effects of the layered absorber may increase with increasing width W1. The layered absorber may be combined with all conceivable incoupling structures. The use of the layered absorber may enable the angular filter 20 to be omitted altogether, in this and all other incoupling structures described herein.

It should also be noted that the above-described visibility filter (cf. 50 in Fig. 10H) may be implemented in conjunction with any incoupling structure described herein, e.g. intermediate the rear surface 6 and the angular filter 120.

Fig. 15A is a bottom plan view of a part of a touch-sensitive apparatus, to illustrate a sequence of emitters 2 and/or detectors 3 that are optically coupled to a panel 1 near one of the panel edges, via a visibility filter 50 which is applied to the rear surface 6 to extend as a coherent, elongate strip along the panel edge. Each emitter 2 and detector 3 is coupled to the panel 1 by a coupling structure, which is formed by an angular filter 20/120 and a recycler 40, 140. The combination of angular filters 20/120 and recyclers 40/140 are arranged as discrete units along the panel edge. Fig. 15B illustrates an alternative implementation, where the angular filter 20/120 is applied onto the visibility filter 50 to extend as a coherent, elongate strip along the panel edge. Thus, the same angular filter 20/120 is used for coupling all emitters 2 and/or detectors 3 to the panel 1 along the panel edge. The recyclers 40/140 may be arranged side-by-side onto the angular filter 120, as shown, or they may be arranged with a mutual spacing, similar to Fig. 15A.

The coupling structures in Figs 15A-15B may be applied to the panel 1 in a sequence of operations, which include applying the visibility layer 50 on the panel 1, applying the angular filters 20/120 onto the visibility layer 50, and applying prefabricated recyclers 40/140 onto the angular filters 20/120. Alternatively, the angular filters 20/120 and the recyclers 40/140 may be provided as a single prefabricated strip which is attached onto the visibility layer 50 on the panel 1 (if present). In another alternative, the recyclers 40/140 are produced by a sequence of processing steps *in situ* on the panel,

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including e.g. attaching the spacer material 22/122 to the angular filter 20/120, applying a dedicated coating to the side walls 42B/142B while masking the bottom wall 42A/142A, applying a dedicated coating to the bottom walls 42A/142A while masking the openings for the detectors/emitters 2, 3, and attaching the detector/emitters 2, 3 to the openings.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and the scope of the appended claims.

For example, while technical advantages may be obtained by utilizing angular filters, in particular multilayer structures, for both outcoupling and incoupling, it is conceivable to combine the inventive outcoupling structures that utilize angular filters with conventional incoupling structures, e.g. large prisms or sheet-like microstructures as discussed in the Background section, by direct attachment to the front or rear surface, or by optical coupling via the edge surface.

In certain installations, one or both of the incoupling and outcoupling structures may be arranged on the front surface 5 instead of the rear surface 6.

The foregoing description indicates that certain selections of the lower limit θ_{min} (e.g. with respect to the cutoff angles $\theta_{c,t}$, $\theta_{c,c}$, θ_w, θ_f) results in significant performance improvement. However, it is possible that performance improves gradually as the lower limit θ_{min} is increased from the critical angle θ_c, e.g. in steps 1°, at least in certain installations. Testing of a certain installation may thus indicate that an acceptable performance improvement is attained at another selected θ_{min}, e.g. any angle between θ_c and θ_w, between θ_w and θ_f, and between θ_f and θ_{sc}. The same applies to the selection of refractive index of the lamination layer/coupling layer for suppressing the influence of contamination via the cutoff angle $\theta_{c,t}/\theta_{c,c}$.

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CLAIMS

1. A touch-sensitive apparatus, comprising:

a light transmissive panel (1) that defines a front surface (5) and an opposite, rear surface (6);

a plurality of light emitters (2) optically connected to the light transmissive panel (1) so as to generate propagating light that propagates by total internal reflection inside the light transmissive panel (1) across a touch-sensitive region (4) on the light transmissive panel (1);

a plurality of light detectors (3) optically connected to the light transmissive panel (1) so as to define a grid of propagation paths (D) across the touch-sensitive region (4) between pairs of light emitters (2) and light detectors (3);

wherein each light detector (3) is optically connected to the light transmissive panel (1) via an angular filter (20) which is applied to an outcoupling region on at least one of the front and rear surfaces (5, 6) and is configured to transmit the propagating light only within a confined range of angles with respect to the normal of the outcoupling region; and

wherein the confined range extends from a lower angle limit θ_{min} to an upper angle limit θ_{max}, wherein the lower angle limit θ_{min} is equal to or larger than a critical angle θ_C which is given by θ_C = arcsin (1/n $_{panel}$), with n_{panel} being the refractive index of the light transmissive panel (1) at the outcoupling region.

2. The touch-sensitive apparatus of claim 1, wherein the lower angle limit θ_{min} exceeds the critical angle by an angle $\Delta\theta$, which is at least 5°, 10° or 15°.

3. The touch-sensitive apparatus of claim 1, wherein the lower angle limit θ_{min} is equal to or larger than a first cut-off angle θ_W = arcsin (n_w n_{panel}), with n_w being the refractive index of water, $n_{panel} > n_w$.

4. The touch-sensitive apparatus of claim 1, wherein the lower angle limit θ_{min} is equal to or larger than a second cut-off angle θ_f = arcsin (n_f/n_{panel}), with n_f being the refractive index of finger fat, n_{panel} $n^{\wedge}$.

5. The touch-sensitive apparatus of any preceding claim, wherein the upper angle limit θ_{max} is equal to or smaller than a third cut-off angle θ_{55} = arcsin (1-55/n $_{panel}$), $n_{panel} > 1\text{-}55$.

6. The touch-sensitive apparatus of any preceding claim, wherein the light transmissive panel (1) is mounted onto a front surface of a display device (34) by a lamination layer (36) of light transmissive material which is arranged in contact with the rear surface (6) of the light transmissive panel (1) and the front surface of the display device (34), and wherein the lower angle limit θ_{min} is approximately equal to or larger

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than a laminate cut-off angle θ_{cl} = arcsin (n_{lam}/n_{panel}), with n_{lam} being the refractive index of lamination layer (36). $n_{lam} < n_{panel}$.

7. The touch-sensitive apparatus of any one of claims 1-5, further comprising a layered light absorber comprising a coupling layer (37, 87) of light transmissive material on the rear surface (6) of the light transmissive panel (1), and an absorbing layer (38, 88) of light-absorbing material on the coupling layer (37, 87), said coupling layer (37, 87) having an index of refraction n_{coupl} n_{panel}.

8. The touch-sensitive apparatus of claim 7, wherein said lower angle limit θ_{min} of the angular filter (20) is approximately equal to or larger than an absorber cut-off angle θ_{c-c} = arcsin $(n_{coupl}$ $n_{panel})$.

9. The touch-sensitive apparatus of claim 8, wherein the layered light absorber extends from the respective outcoupling port and has a width (WI) which, along the detection lines (D) that extend to the respective light detector (3), is at least equal to a distance between consecutive reflections in the rear surface (6) for propagating light that impinges on the rear surface (6) with an angle of incidence of θ_{ci} to a normal of the rear surface (6).

10. The touch-sensitive apparatus of claim 8 or 9, wherein the layered light absorber is arranged to overlap a major part, or essentially all of the touch-sensitive region (4).

11. The touch-sensitive apparatus of any preceding claim, wherein the angular filter (20) is configured to define essentially the same confined range of angles for all detection lines (D) that extend to the respective light detector (3).

12. The touch-sensitive apparatus of any preceding claim, wherein the angular filter (20) is configured as a dielectric multilayer structure.

13. The touch-sensitive apparatus of claim 12, further comprising a light recycler (40) which is arranged beneath the angular filter (20) to define a light reflective enclosure with respect to the angular filter (20) and a light-sensitive surface (3A) of the respective light detector (3).

14. The touch-sensitive apparatus of claim 13, wherein the light reflective enclosure comprises a light reflective bottom surface (42A) that is spaced from and extends parallel to the angular filter (20) and a reflective side wall structure (42B) that extends between the light reflective bottom surface (42A) and the angular filter (20). 15. The touch-sensitive apparatus of claim 14, wherein the side wall structure (42B) is specularly reflective, and at least a portion of the bottom surface (42A) is diffusively reflective.

16. The touch-sensitive apparatus of claim 13, 14 or 15, wherein the light reflective enclosure is at least partly diffusively reflecting.

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17. The touch-sensitive apparatus of any one of claims 13-16, wherein the light reflective enclosure is filled by a light transmissive material (22).

18. The touch-sensitive apparatus of any one of claims 13-16, wherein the light reflective enclosure is hollow, and wherein a disruptive structure (52) is provided on the angular filter (20) so as to face the light reflective enclosure, wherein the disruptive structure (52) is configured to transmit and redirect at least part of the light transmitted by the angular filter (20) into the light reflective enclosure.

19. The touch-sensitive apparatus of claim 18, wherein the disruptive structure (52) is a non-imaging, diffusively transmitting structure.

20. The touch-sensitive apparatus of claim 18, wherein the disruptive structure (52) is an imaging structure configured to refract the light transmitted by the angular filter (20).

21. The touch-sensitive apparatus of any one of claims 13-20, wherein the light detector (3) is arranged with the light-sensitive surface (3A) facing the angular filter (20)

22. The touch-sensitive apparatus of any one of claims 13-20, wherein the light detector (3) is arranged to project into the light enclosure such that the light-sensitive surface (3A) is facing the side wall structure (42B).

23. The touch-sensitive apparatus of claim 13 or 14, wherein the light reflective enclosure comprises a microstructure (42A) that defines a mirror with an optical power so as to re-direct the transmitted propagating light onto the light-sensing surface (3A).

24. The touch-sensitive apparatus of claim 13 or 14, wherein the light recycler (40) is configured as a funnel which is configured to specularly reflect the transmitted propagating light from the angular filter (20) towards the light-sensitive surface (3A) of the light detector (3).

25. The touch-sensitive apparatus of claim 12, wherein a body (22) of light-transmissive material is attached to the angular filter (20), and wherein the light detector (3) is attached to the body (22) such that a light-sensitive surface (3A) of the light detector (3) directly receives the transmitted propagating light from the angular filter (20).

26. The touch-sensitive apparatus of any preceding claim, wherein the angular filter (20) is arranged to transmit the propagating light to the respective light detector (3) within a respective outcoupling port on the rear surface (6), wherein the extent (W) of the respective outcoupling port, along the detection lines (D) that extend to the respective light detector (3), is at least equal to a distance between consecutive reflections in the rear surface (6) for the propagating light that impinges on the angular filter (20) with an angle of incidence of θ_{min} to a normal of the angular filter (20).

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27. The touch-sensitive apparatus of any preceding claim, further comprising a specularly reflective edge element (48) which is arranged, adjacent to the outcoupling region, on an edge portion that connects the front surface (5) and the rear surface (6) of the light transmissive panel (1), so as to specularly reflect the propagating light that impinges on the specularly reflective edge element (48).

28. The touch-sensitive apparatus of any preceding claim, wherein the propagating light comprises light in an infrared wavelength region, and wherein the touch-sensitive apparatus further comprises a visibility shield (50) which is arranged intermediate the rear surface (6) and the angular filter (20), the visibility shield (50) being configured to block light that is visible to the human eye and to transmit at least part of said light in the infrared wavelength region.

29. The touch-sensitive apparatus of any preceding claim, wherein each light emitter (2) is optically connected to the light transmissive panel (1) via an angular filter (120) which is applied to an incoupling region on at least one of the front and rear surfaces (5, 6) and is configured to transmit light from the respective light emitter (2) only within a confined range of angles inside the light transmissive panel (1).

30. The touch-sensitive apparatus of claim 29, wherein the confined range of angles of the angular filter (120) on the incoupling region is matched to the confined range of angles of the angular filter (20) on the outcoupling region.

31. The touch-sensitive apparatus of claim 30, wherein the angular filter (120) on the incoupling region is identical to the angular filter (20) on the outcoupling region.

32. The touch-sensitive apparatus of any one of claims 29-31, further comprising a light recycler (140) which is arranged beneath the angular filter (120) on the incoupling region, so as to define a light reflective enclosure with respect to the angular filter (120) and a light-emitting surface (2A) of the respective light emitter (2).

33. A touch-sensitive apparatus, comprising:

a light transmissive panel (1) that defines a front surface (5) and an opposite, rear surface (6);

a plurality of light emitters (2) optically connected to the light transmissive panel (1) so as to generate propagating light that propagates by total internal reflection inside the light transmissive panel (1) across a touch-sensitive region (4) on the light transmissive panel (1); and

a plurality of light detectors (3) optically connected to the light transmissive panel (1) so as to define a grid of propagation paths (D) across the touch-sensitive region (4) between pairs of light emitters (2) and light detectors (3);

wherein the light transmissive panel (1) is mounted onto a front surface of a display device (34) by a lamination layer (36) of light transmissive material which is

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arranged in contact with the rear surface (6) of the light transmissive panel (1) and the front surface of the display device (34); and

wherein the lamination layer (36) has a refractive index n_{lam} which is smaller than a refractive index n_{panel} of the light transmissive panel (1) at the rear surface (6) and which is chosen such that a laminate cut-off angle $\theta_{c,l} = \arcsin(n_{lam}/n_{panel})$ exceeds a critical angle θ_c, which is given by $\theta_c = \arcsin(1/n_{panel})$ by an angle $\Delta\Theta$, which is at least 5°, 10° or 15°.

34. The touch-sensitive apparatus of claim 33, wherein the laminate cut-off angle $\theta_{c,l}$ is equal to or larger than a first cut-off angle $\theta_w = \arcsin(n_w/n_{panel})$, with n_w being the refractive index of water, $n_{panel} > n_w$.

35. The touch-sensitive apparatus of claim 33, wherein the laminate cut-off angle $\theta_{c,l}$ is equal to or larger than a second cut-off angle $\theta_f = \arcsin(n_f/n_{panel})$, with n_f being the refractive index of finger fat, $n_{panel} > n_f$.

36. The touch-sensitive apparatus of any one of claims 33-35, wherein the light emitters (2) are optically coupled to the light transmissive panel (1) such that the propagating light is generated to impinge on the lamination layer (36) at an angle that is equal to or larger than the laminate cut-off angle $\theta_{c,l}$.

37. A touch-sensitive apparatus, comprising:

a light transmissive panel (1) that defines a front surface (5) and an opposite, rear surface (6);

a plurality of light emitters (2) optically connected to the light transmissive panel (1) so as to generate propagating light that propagates by total internal reflection inside the light transmissive panel (1) across a touch-sensitive region (4) on the light transmissive panel (1); and

a plurality of light detectors (3) optically connected to the light transmissive panel (1) so as to define a grid of propagation paths (D) across the touch-sensitive region (4) between pairs of light emitters (2) and light detectors (3);

wherein a layered light absorber is provided on the rear surface of the light transmissive panel (1), said layered light absorber comprising a coupling layer (37, 87) of light transmissive material on the rear surface (6) of the light transmissive panel (1), and an absorbing layer (38, 88) of light-absorbing material on the coupling layer (37, 87); and

wherein the coupling layer (37, 87) has a refractive index n_{coupl} which is smaller than a refractive index n_{panel} of the light transmissive panel (1) at the rear surface (6) and which is chosen such that an absorber cut-off angle $\theta_{c,a} = \arcsin(n_{coup}/n_{panel})$ exceeds a critical angle θ_c, which is given by $\theta_c = \arcsin(1/n_{panel})$ by an angle $\Delta\Theta$, which is at least 5°, 10° or 15°.

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38. The touch-sensitive apparatus of claim 37, wherein the absorber cut-off angle θ_{CC} is equal to or larger than a first cut-off angle θ_W = arcsin (n_w/n_{panel}), with n_w being the refractive index of water, $n_{panel} > n_w$

39. The touch-sensitive apparatus of claim 37, wherein the absorber cut-off angle θ_{CC} is equal to or larger than a second cut-off angle θ_f = arcsin (n_f/n_{panel}), with n_f being the refractive index of finger fat, $n_{panel} > n_f$.

40. The touch-sensitive apparatus of any one of claims 37-39, wherein the light emitters (2) are optically coupled to the light transmissive panel (1) such that the propagating light is generated to impinge on the coupling layer (37, 38) at an angle that is equal to or larger than the absorber cut-off angle θ_{CC}.

41. The touch-sensitive apparatus of any one of claims 37-40, wherein the layered light absorber is arranged to overlap a major part, or essentially all, of the touch-sensitive region (4).

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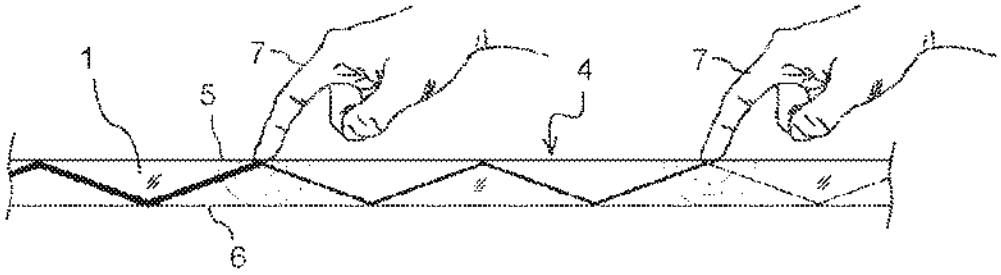


Fig. 1 (Prior Art)

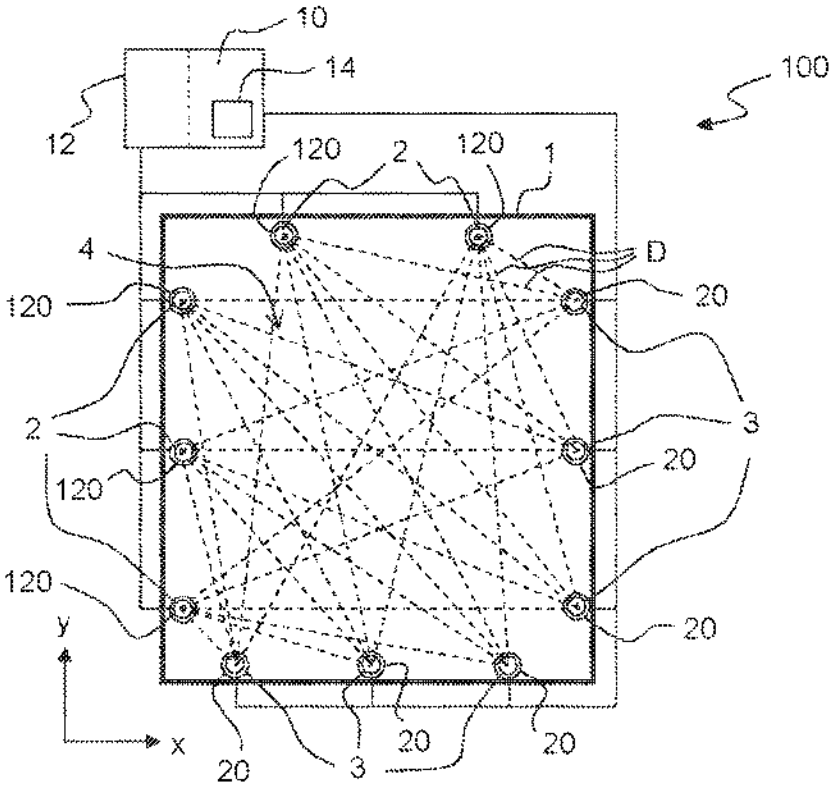


Fig. 2

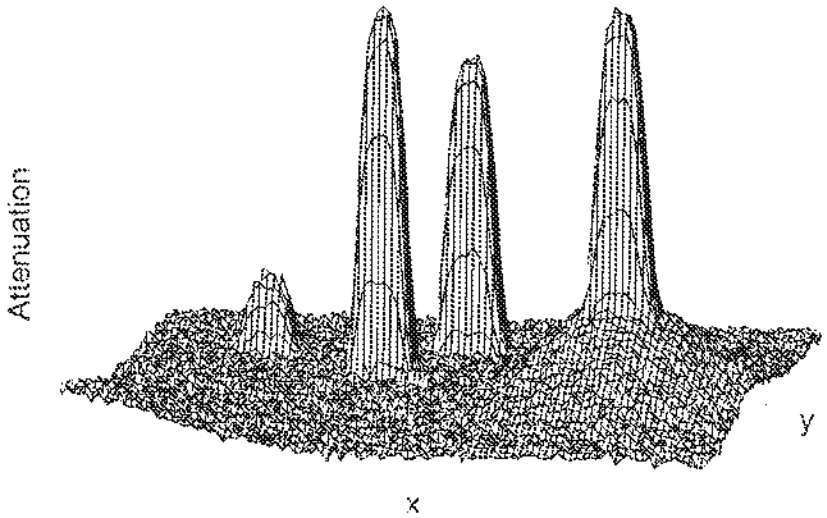


Fig. 3

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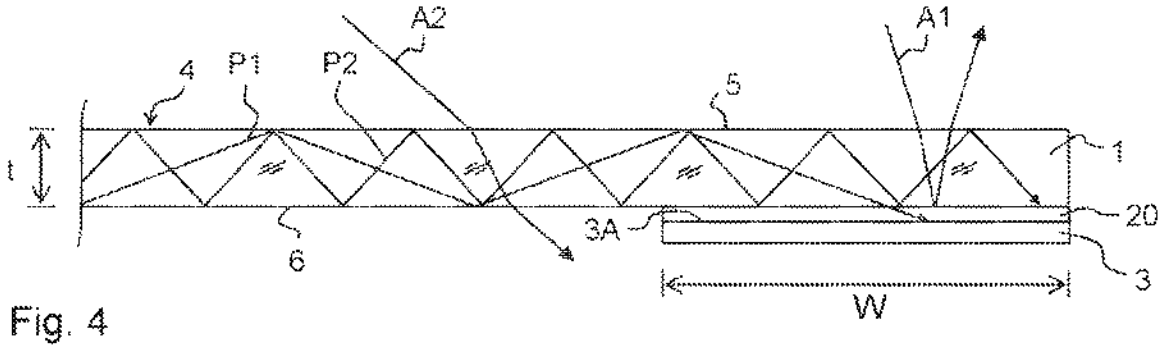


Fig. 4

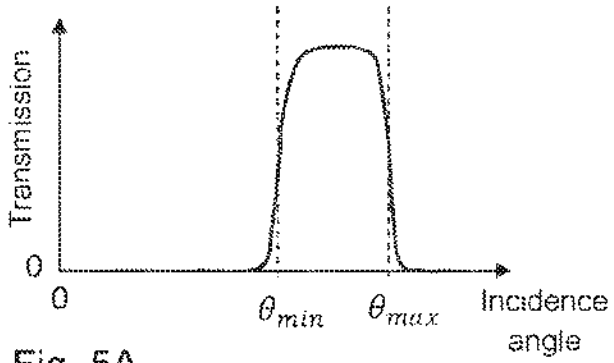


Fig. 5A

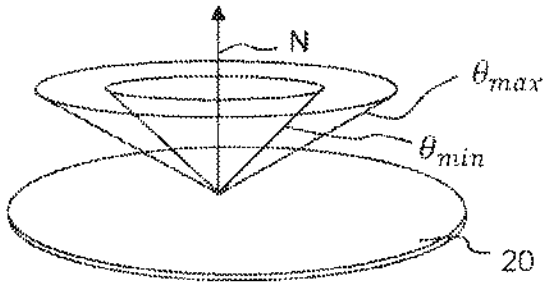


Fig. 5B

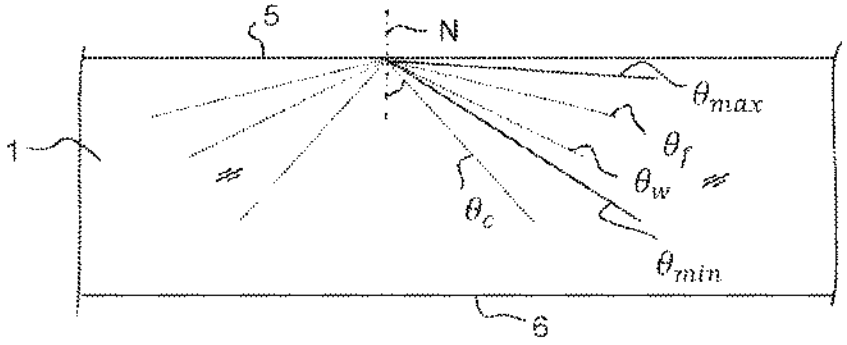


Fig. 6

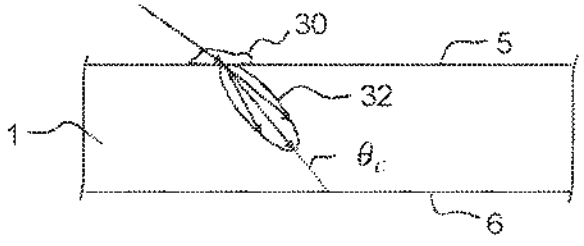


Fig. 7

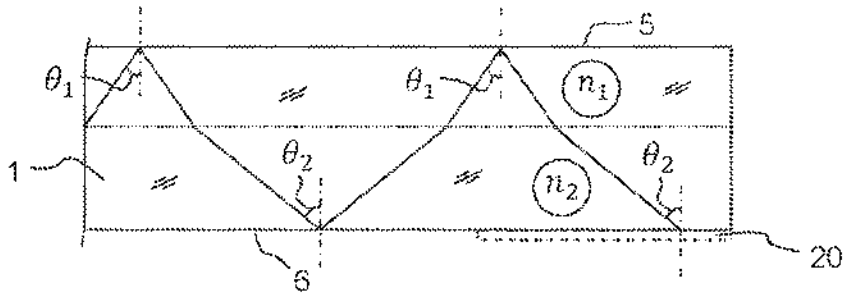


Fig. 8

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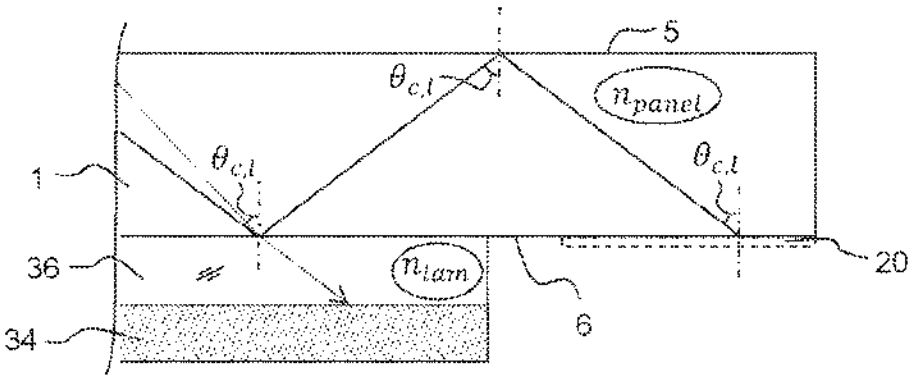


Fig. 9A

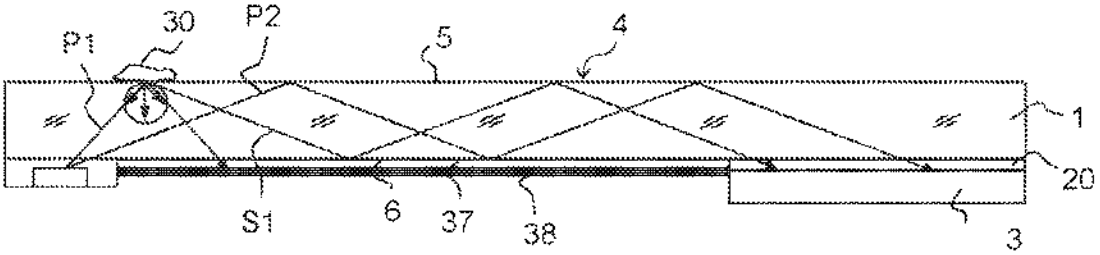


Fig. 9B

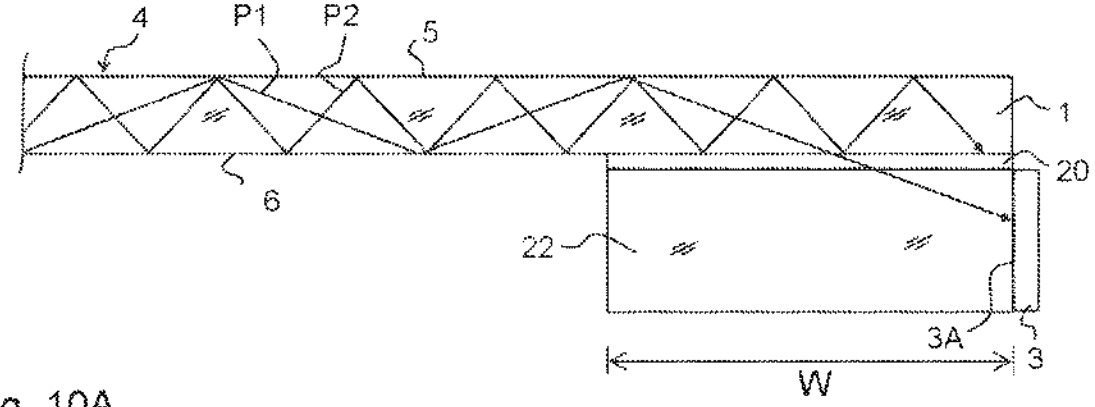


Fig. 10A

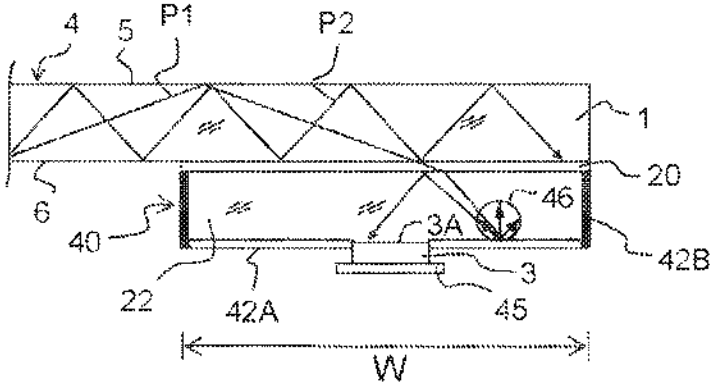


Fig. 10B

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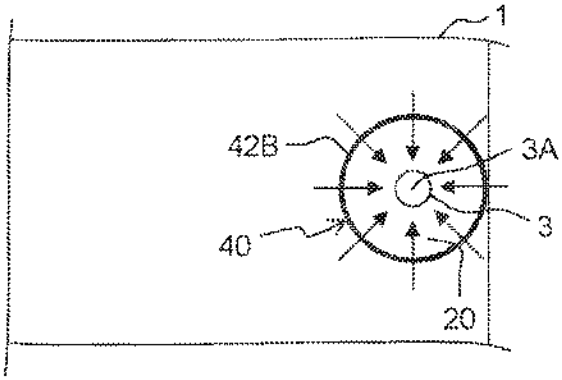


Fig. 10C

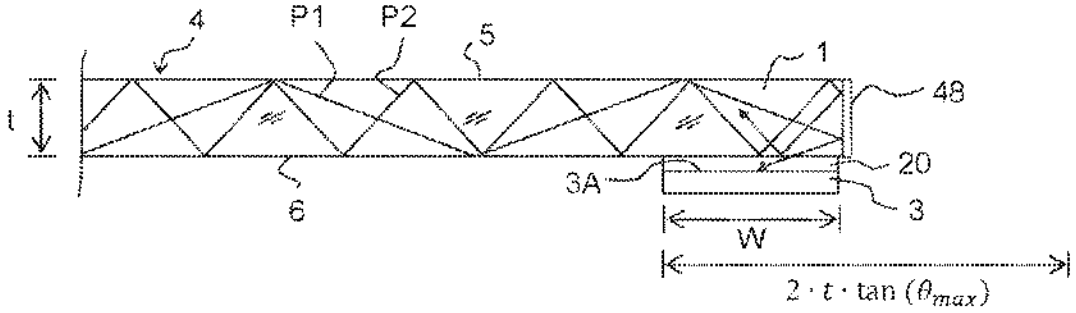


FIG. 10D

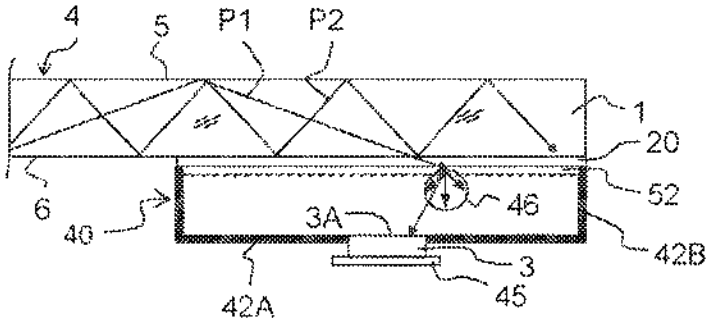


Fig. 10E

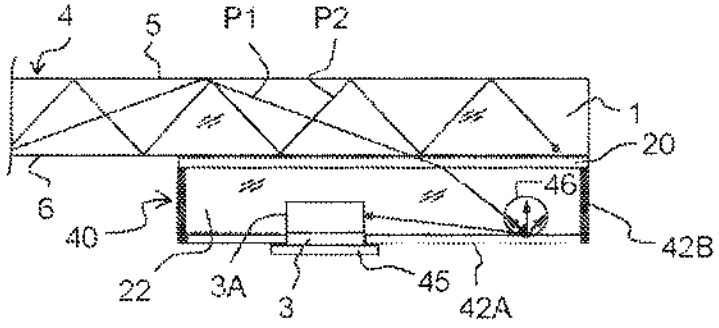


Fig. 10F

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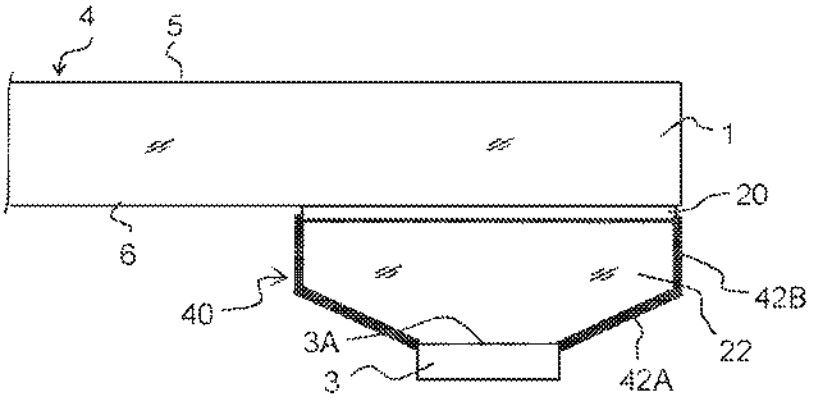


Fig. 10G

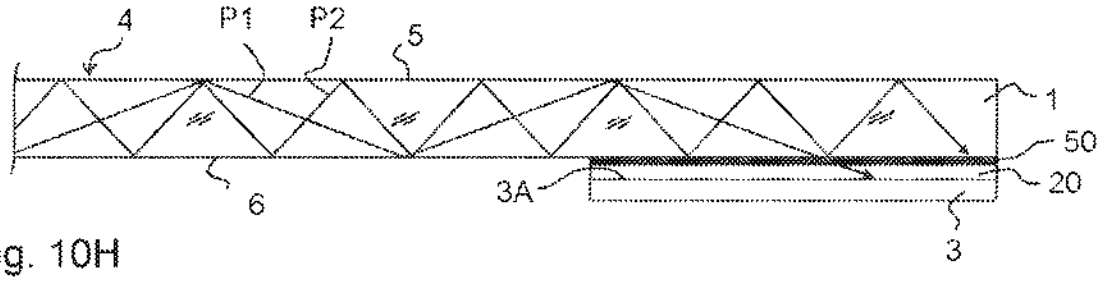


Fig. 10H

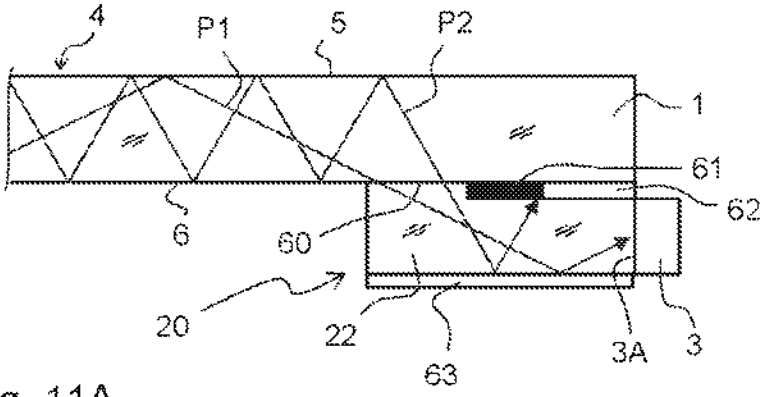


Fig. 11A

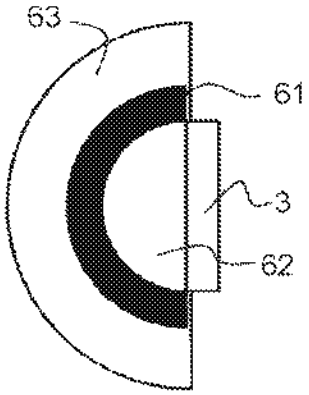


Fig. 11B

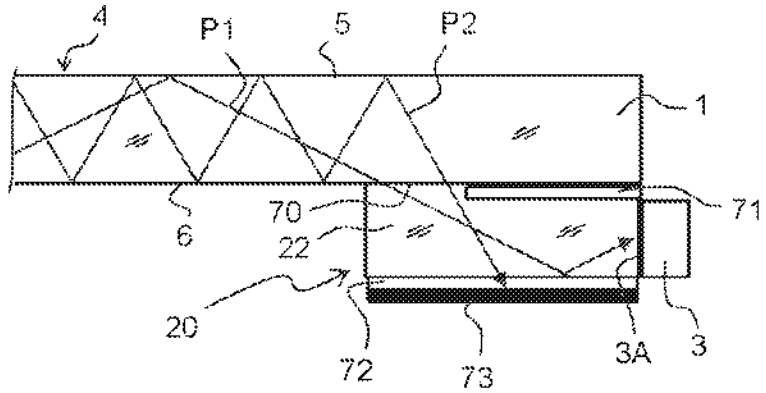


Fig. 12A

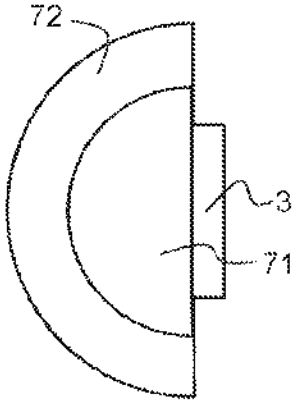


Fig. 12B

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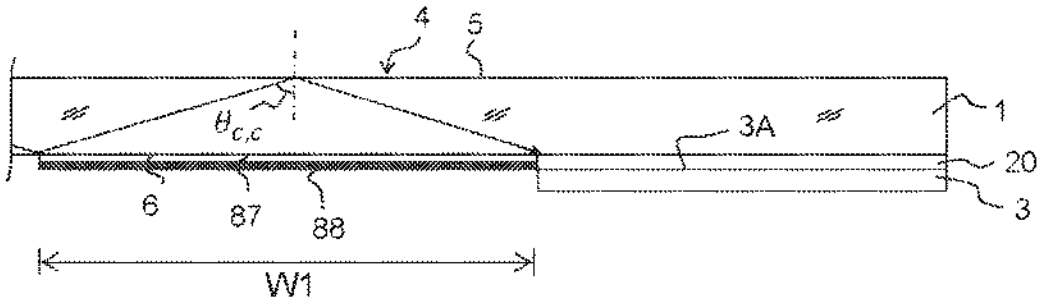


Fig. 13A

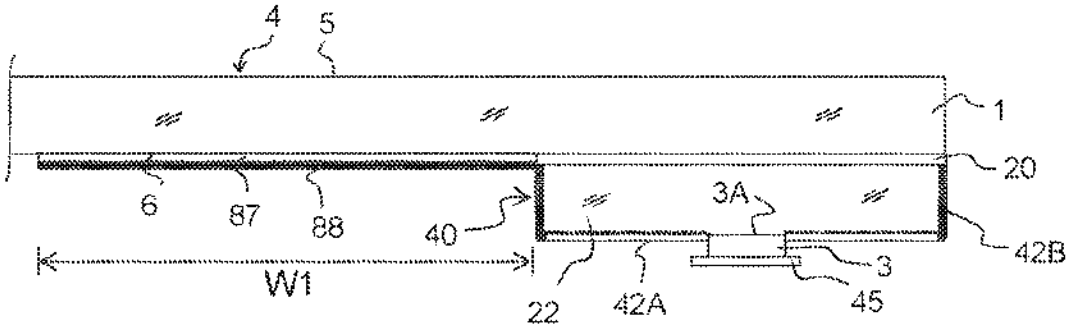


Fig. 13B

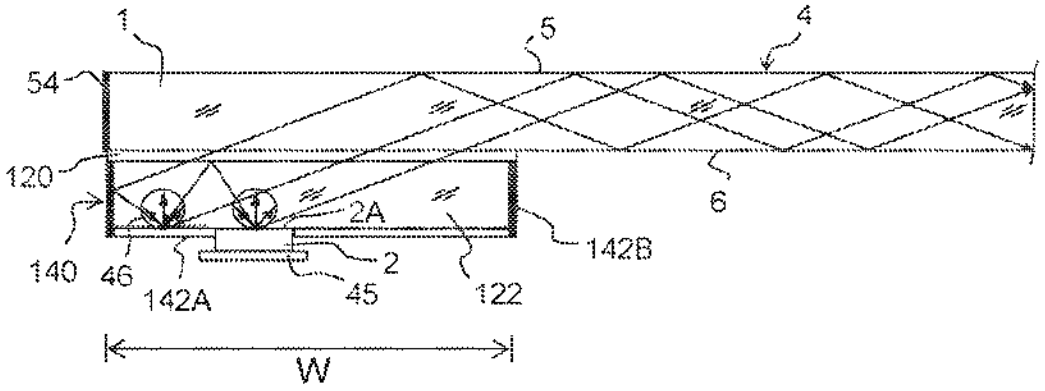


Fig. 14A

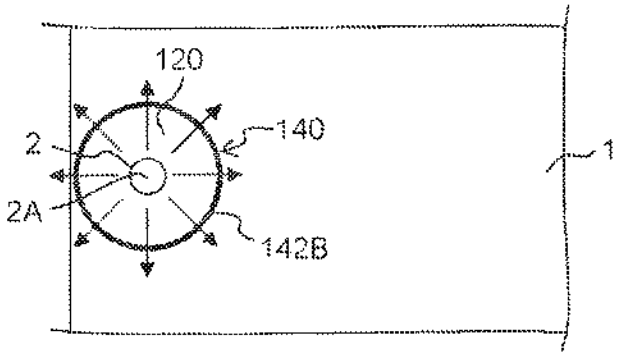


Fig. 14B

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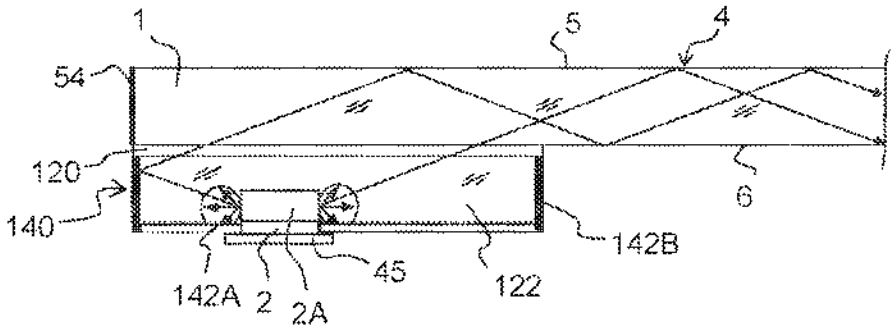


Fig. 14C

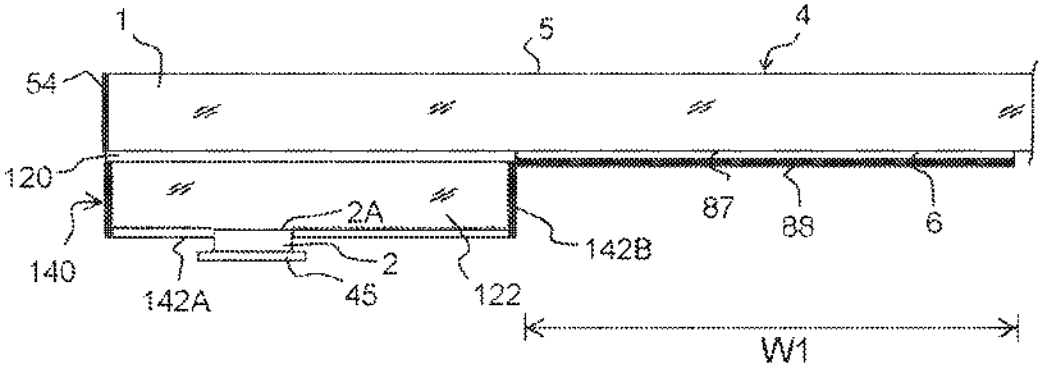


Fig. 14D

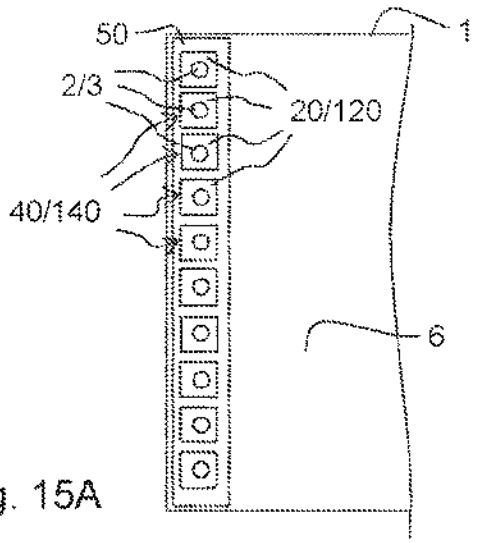


Fig. 15A

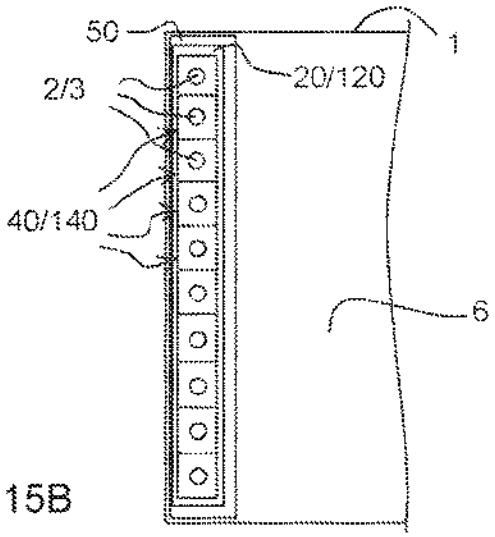


Fig. 15B

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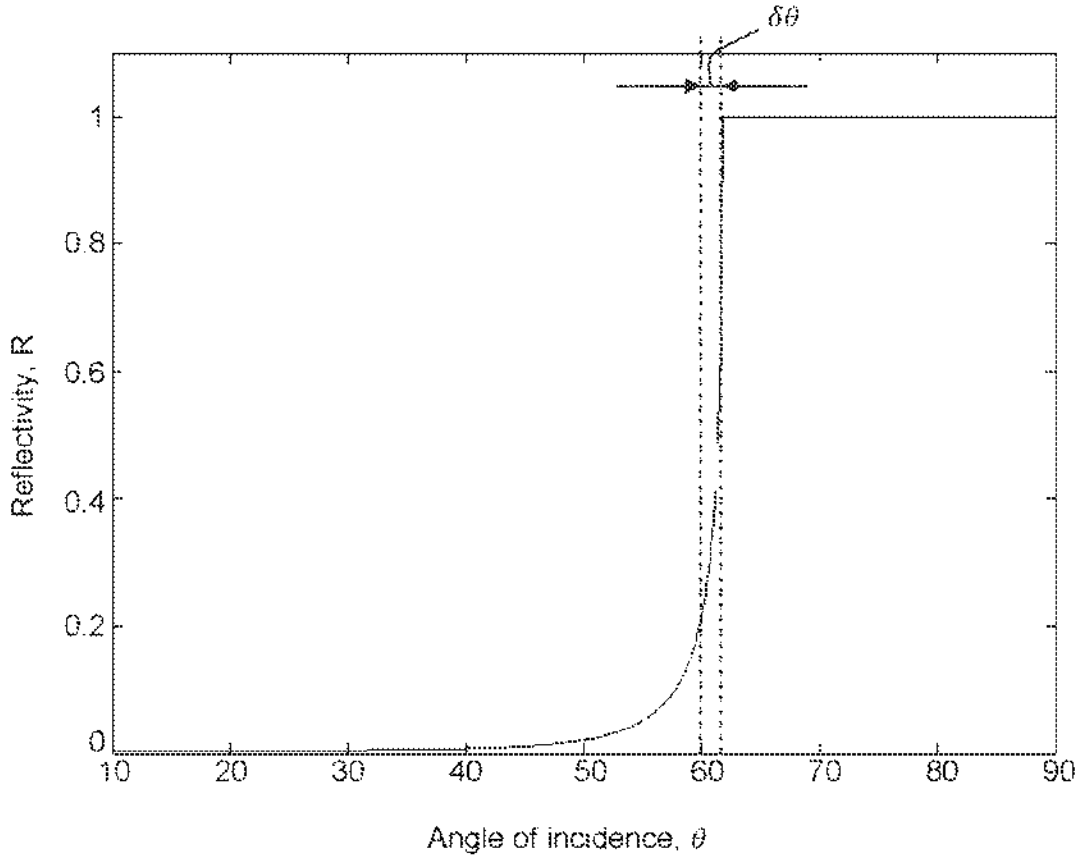


Fig. 16

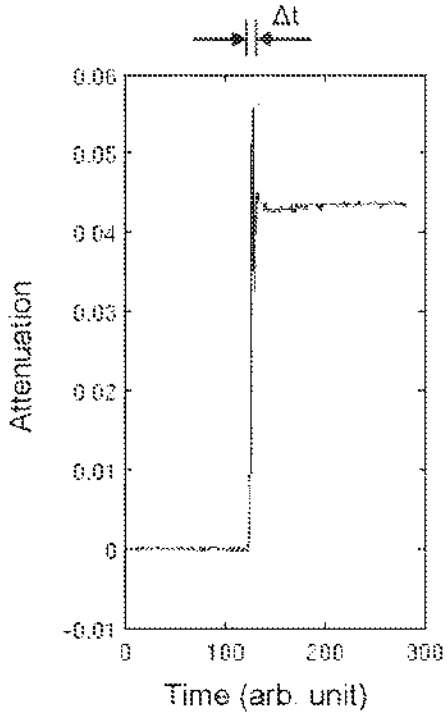


Fig. 17A

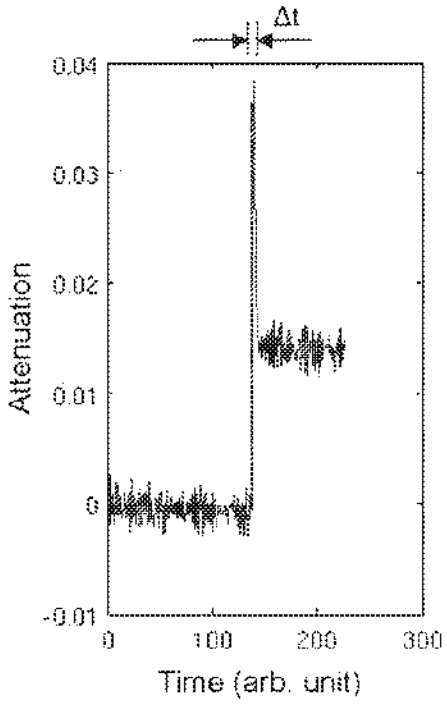


FIG. 17B

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 3/051 537

A. CLASSIFICATION OF SUBJECT MATTER

IPC. see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G02B, G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 20070031 96 A2 (O PEN APS ET AL), 11 January 2007 (2007-01 - 1 1); abstract; page 7, line 15 - line 29; page 8, line 12 - line 15; page 8, line 29 - page 9, line 21; page 15, line 21 - line 24; page 16, line 17 - line 23	1-12, 25-31, 33-41
A	---	13-24, 32
Y	WO 201 0006884 A2 (FLATFROG LAB AB ET AL), 21 January 201 0 (201 0-01 -21); abstract; page 11, line 22 - page 12, line 2	1-12, 25-31, 33-41
A		13-24, 32

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25-04-201 4	25-04-201 4

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-1 02 42 STOCKHOLM Facsimile No. 1 46 8 666 02 86	Sebastian Diskay Telephone No. 1 46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 2009)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2472444 A (LIGHT BLUE OPTICS LTD), 9 February 201 1 (201 1-02-09); abstract; page 4, line 10 - line 19; claims 1-5	1-41

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Continuation of: second sheet

International Patent Classification (IPC)

G02B 6/00 (2006.01)
G02B 5/00 (2006.01)
G06F 3/03 (2006.01)

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WO	20070031 96	A2	11/01/2007	EP	190791 8	A2	09/04/2008
				US	200901 22020	A 1	14/05/2009
				US	7995039	B2	09/08/201 1
WO	201 0006884	A2	21/01/201 0	AU	2009272923	A 1	21/01/201 0
				CA	2728034	A 1	21/01/201 0
				CN	102067074	A	18/05/201 1
				EP	231 8906	A2	11/05/201 1
				TW	201 007530	A	16/02/201 0
				US	201 10074734	A 1	31/03/201 1
GB	2472444	A	09/02/201 1	NONE			

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61/746 278 27 December 2012 (27.12.2012) US

(71) **Applicant:** **FLATFROG LABORATORIES AB** [SE/SE]; Traktorvagen 11, S-226 60 Lund (SE).

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(74) **Agent:** **FLATFROG LABORATORIES AB;** Patent Department, Traktorvagen 11, S-226 60 Lund (SE).

(81) **Designated States** *unless otherwise indicated, for every kind of national protection available:* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW

[Continued on next page]

(54) **Title:** METHOD AND APPARATUS FOR DETECTING VISIBLE AMBIENT LIGHT

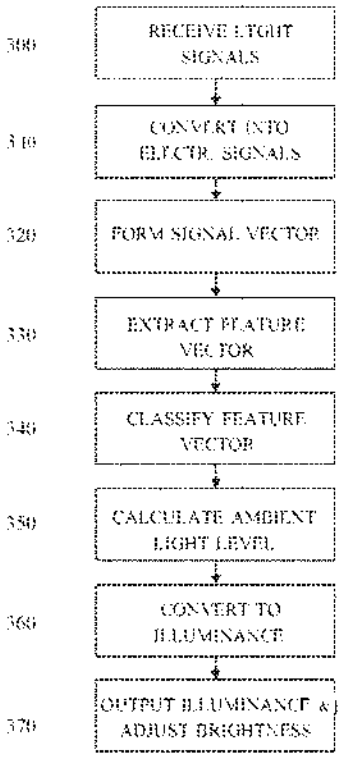


Fig. 7

(57) **Abstract:** Method and touch-sensitive apparatus for determining the amount of visible ambient light incident on the touch-sensitive apparatus comprising a first array of light-sensing elements, the method comprising receiving light signals at a plurality of light-sensing elements in the first array; converting the light signals into electrical signals; identifying at least one type of ambient light source from the signal by comparing features in the signal with characteristic features of one or more known light sources and obtaining information related to the amount of visible ambient light incident on the panel generated by the at least one type of ambient light source in relation to the amount of ambient light registered at the plurality of light-sensing elements.

WO 2014/104967 A1

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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

of inventorship (Rule 4.17(iv))

Published:

with international search report (Art. 21(3))

before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

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Method and apparatus for detecting visible ambient light

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of Swedish patent application No. 1251512-8, filed 27-Dec-2012, and US provisional application No. 61/746278, filed 27-Dec-2012.

TECHNICAL FIELD

The present invention relates to a method and apparatus for determining the amount of visible ambient light on a touch-sensitive apparatus. In particular, the apparatus for determining the visible ambient light comprises a first array of light-sensing elements.

BACKGROUND

Light sensors can be found in a large variety of applications today, most notably in consumer electronics. Their function is to detect the amount of light falling onto a display. Using the backlight function of the display, the brightness of the display can then be adjusted in relation to the amount of light detected.

Ambient light sensors are sensitive to visible light and the backlight power of a display is often made proportional to the amount of visible light falling onto the display.

Present day example solutions in detecting ambient light sources are described in documents US2011248170A1, US2011002566 1A1 and KR20030033832.

US2011248170 deals with a system for detecting the amount of visible light from one or more ambient lights sources analyzing the light signal received by a photodiode comprising an IR-sensitive light-sensing element stacked on top of a detector sensitive to visible light. The IR-sensitive element is constructed to be transparent to visible light. By calculating the ratio of the light intensities incident on the stacked light-sensing element the type of ambient light source can be characterized. One disadvantage of the solution is that it requires a specially constructed light-sensing element to work properly. Also, it is dependent on detection of both infrared and visible light for determining the type of ambient light source.

A different solution is disclosed in US2011002566 1A1, where it is attempted to characterize the ambient light source by focusing on the source voltage driving the ambient light source. Light from one or more ambient light sources is gathered from a number of light-sensing elements during several overlapping intervals, which are

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chosen to match one or more periods for known power sources driving ambient lighting. Integrating a signal over several of these periods reduces the influence of the power source signal when compensating for ambient light falling on the detectors. One disadvantage of this solution is that it cannot distinguish ambient light sources driven by the same power supply.

Finally, in the Korean patent application KR20030033832, a color content of the registered visible light from an ambient light source is analyzed and used to compensate the white balance of an image produced by a digital camera. It is to be noted that the solution requires ambient sensors sensitive to visible light and does not use the information obtained to compensate for the brightness of a display, but rather color fidelity of a captured image.

There is thus a need for a simple, cost-effective way of characterizing one or more ambient light sources in order to be able to provide accurate information for e.g. controlling the brightness of a display unit.

SUMMARY

A solution to at least some of the problems encountered in known technology is provided by the invention according to independent claims.

Preferable embodiments of the solution according to the present invention are presented in the dependent claims.

According to one aspect of the present invention the solution is provided by a method for determining the amount of visible ambient light on a touch-sensitive apparatus comprising a first array of light-sensing elements. The method according to one aspect of the invention comprises receiving light signals at a plurality of light-sensing elements in the first array, converting the light signals into electrical signals, identifying at least one type of ambient light source from the signal by comparing features in the signal with characteristic features of one or more known light sources and obtaining information related to the amount of visible ambient light incident on the panel generated by the at least one type of ambient light source in relation to the amount of ambient light registered at the plurality of light-sensing elements.

According to another aspect of the present invention, the solution to at least some of the problems mentioned earlier is given by a method for determining the visible ambient light level incident on a touch-sensing apparatus comprising a light transmissive panel defining a touch surface and an opposite surface, where light generated by an illumination arrangement comprising emitters propagates in the panel by total internal reflection. The method comprising receiving light signals at a plurality of light-sensing elements in a first array belonging to the touch-sensing apparatus, converting the light signals into electrical signals, identifying at least one type of ambient light source from

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the signal by comparing features in the signal with characteristic features of one or more known light sources and obtaining information related to the amount of visible ambient light generated by the at least one type of ambient light source identified which is incident on the panel.

The method according to the present invention has the advantage that it can use existing light detectors to identify one or more ambient light sources accurately. These existing light detectors may also be used in a touch-sensitive apparatus for detecting touches onto a surface of a transparent panel in which light transmitted by light-emitting elements propagates through total internal reflection and where a touch onto the surface introduces disturbances to the reflection of the light which after detection by the light detectors can be detected as touches. Hence, dedicated ambient light sensors which would add to the cost of a touch-sensitive apparatus are not needed. Once the one or more ambient light sources are identified, this information may be used to calculate a corresponding brightness value for a transmissive panel onto which the ambient light is incident and to adjust the brightness to make the information displayed on the panel readable by a user.

According to another aspect of the present invention, the solution is given by a touch-sensitive apparatus for determining the amount of visible ambient light incident onto a touch-sensitive panel. The apparatus comprises a first array of light-sensing elements configured to convert incident ambient light signals into electrical signals, a memory unit configured to store characteristic signal features for a plurality of known ambient light sources and a processor configured to identify at least one type of ambient light source from the signal by comparing features in the signal with the stored characteristic signal features of the one or more known light sources and wherein the processor is further configured to relate the amount of visible ambient light incident on a touch-sensitive panel of the apparatus generated by the ambient light source identified by the processor.

According to yet another aspect of the present invention, the solution is given by a touch-sensitive apparatus for determining the amount of visible ambient light incident onto the apparatus. The apparatus comprises a light transmissive panel defining a touch surface and an opposite surface, an illumination arrangement comprising emitters configured to generate light into the panel, such that light is propagated in the panel by total internal reflection, a first array of light-sensing elements configured to receive the light generated by the emitters and ambient light incident onto the touch surface of the panel and to convert the incident ambient signals light into electrical signals, a memory unit configured to store characteristic signal features for a plurality of known ambient light sources. The touch-sensitive apparatus further comprises a processor configured to identify at least one type of ambient light source from the signal by comparing features in the signal with the stored characteristic signal features of the one or more known light sources and wherein the processor is further configured to relate the amount of ambient light received by the plurality of light-sensing elements to the amount of visible ambient

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light incident on the transmissive panel and generated by the ambient light source identified

Having the advantages listed for the method according to the present invention earlier in the description, these same advantages also apply to the touch-sensitive apparatus according to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 displays a known touch-sensitive apparatus according to known technology in a top view.

Fig. 2 displays the touch-sensitive apparatus in a sectional view.

Fig. 3 displays the touch-sensitive apparatus from Fig. 2 where ambient light is incident onto the apparatus.

Fig. 4 displays a spectral distribution of some known light sources in the visible and infrared spectrum.

Figs. 5 and 6 display a time-domain representation of two common light source classes.

Fig. 7 displays a flow chart of one embodiment of a method according to the present invention.

DETAILED DESCRIPTION

In the following detailed description a number of example embodiment of the present invention are given. These embodiments serve only to clarify the principles on which the present invention rests and should therefore not be construed as limiting the present invention to these embodiments exclusively. Ultimately, the present invention is only limited by the scope of the accompanying claims.

It should also be added that certain details not relevant to the explanation of the present invention have been omitted in the embodiments presented in the description below.

Fig. 1 displays a known touch-sensitive apparatus belonging to the applicant in a top view and described in detail in the published patent application WO 2011/139213 A1. The touch-sensitive apparatus comprises a panel 1, an illumination arrangement 3 comprising emitters 2 and an illumination control unit 3A, and a light detection arrangement 5 comprising detectors 4 and a detection control unit 5A. The touch-sensitive apparatus is according to one embodiment a multi-touch system, thus enabling detection of a multiplicity of touches. The emitters 2 introduce light L into the panel at in-coupling points, an in-coupling point defining a point on the panel 1 where light L

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from an emitter 2 enters the panel 1. The detectors 4 detect the energy of the light at out-coupling points, an out-coupling point defining a point on the panel where the light propagating in the panel 1 leaves the panel 1 for subsequent detection by a detector 4. It is only the in-coupling and out-coupling points of the detectors 4 and emitters 2, respectively, that have to be arranged along the periphery of the panel. the detectors 4 and emitters 2 may be arranged at a distance from the panel 1. Light may enter and leave the panel 1 through the edges of the panel 1, or through the top or bottom surface of the panel, e.g. by the use of an appropriate light coupling element. Moreover, the touch-sensitive apparatus comprises a control unit 6 configured to control the emission of light L propagating in the panel 1 and the collection of data from the detectors 4 via the detection control unit 5A. The control unit 6 may also be directly connected to the emitters 2 and the detectors 4. Also, the touch-sensitive apparatus comprises a mode selector 7 for selecting the emission pattern in dependence of occurrence of touches on the touch service. The mode selector 7 is not essential to the description of the invention and will not be elaborated further. The control unit also comprises a processor 8 which may include a memory (not shown) performing calculations used by the control unit 6 to control the function of the touch-sensitive apparatus.

In Fig. 2 the touch-sensitive apparatus from Fig. 1 is displayed in a sectional view. Light L from the emitter 2 is injected into the light transmissive panel 1 and propagates inside the panel 1 while being reflected in the top and bottom surfaces 1a, 1b. Light may be reflected by total internal reflection (TIR) at least in the top surface 1a which forms a touch surface. The bottom surface 1b may reflect the light by TIR, or by a reflective coating (not shown) applied to the bottom surface 1b. At some other end of the panel 1, the energy of the transmitted light is detected by the detector 4. In the event of an object touching the touch surface of the panel 1, the object interacts with the light beam inside the panel 1 and frustrates the TIR. Frustrated total internal reflection (FTIR), in which energy is dissipated into the object from an evanescent wave formed by the propagating light, provided that the object has a higher refractive index than the material surrounding the panel surface material and is placed within less than several wavelengths distance from the surface, may be used in the present invention. During the frustration of TIR, part of the light beam will be absorbed by the object, and another part will be reflected and/or scattered by the object. The remaining light beam will continue with total internal reflection as before but now attenuated due to the absorption, reflection and scattering, as illustrated in FIG. 2 with a slightly thinner line.

The apparatus detects touches p1, p2 on the top surface 1a by analyzing an ensemble of energy values determined for different detection lines s_i. A detection line s_i (illustrated by dotted lines in Fig. 1) is defined as the light path between one in-coupling and one out-coupling point, and an emitter 2 and a detector 4 at ends of a detection line are referred to as an emitter-detector pair.

The occurrence of one or more touches pi, p2 may be determined by identifying changes in the ensemble of energy values. To determine the position of a plurality of

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touches p1, p2 on the top surface 1a, the energy values for the detection lines are compared against a reference value for the respective detection line. The reference value may be an energy value measured at an earlier time. Alternatively, the energy values may be converted into transmission values. Each detector 4 measures the energy d_i of the transmitted light for a particular detection line S_i, and the reference value that the energy value d_i is compared with is a background energy value d_{i0} for the detection line. The transmission value for detection line S_i may be computed as $T_i = d_i / d_{i0}$. The transmission may alternatively also be computed as a difference value, $T_i = d_{i0} - d_i$. Such a difference value may e.g. be used to quickly derive approximate touch data from the measured energy values.

The background energy value can be obtained by calibrating the touch sensitive apparatus at start up, i.e. by setting the background energy value d_{i0} equal to the energy measured for detection line S_i when no objects are touching the touch surface.

As illustrated in Figure 2, the transmitted light may carry information about a plurality of touches. In an FTIR system, each touch point p_n (corresponding to a touching object) has a transmission τ_n, which generally is in the range 0-1, but normally in the range 0.7-0.99. The total transmission T_i along a detection line S_i is at least approximately given by the product of the individual transmissions t_n of the touch points p_n on that detection line. $T = \Pi\tau_n$ (1)

For example, two touch points p_1 and p_2 with transmissions 0.9 and 0.8, respectively, on a detection line S_j yield a total transmission $T_j = 0.72$. The second touch point p_2 will attenuate a part of the light L that reaches the second touch point, hence the multiplication. With an FTIR setup it is thus possible to "see through" touches on the panel 1.

The entire touch-sensitive apparatus and the method of detecting touches on the surface of the apparatus are described in detail in the published patent application WO 2011/139213 A1 filed by the applicant which is hereby incorporated by reference.

Fig. 3 displays the touch-sensitive apparatus from Fig. 2 where the emitters (not shown) have been switched off and only ambient light L_A is registered by the detector 4. We assume for the sake of simplicity that we have one ambient light source 9 such as a halogen lamp and that the light source 9 is located far away from the touch-sensitive panel 1. We thus assume that the ambient light rays L_A are incident parallel onto the upper panel surface 1a and that they are evenly distributed over the panel surface 1a. Ambient light L_A from the remote light source L_A will upon entry into the transmissive panel 1 be scattered, where a part of the scattered ambient light L_S will propagate in the transmissive panel 1 by total internal reflection. Totally internally reflect light is illustrated by the light rays L_{TIR} in Fig. 3. It is this part of the incident ambient light L_A that will be registered by the one or more detectors 4.

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Fig. 4 displays a diagram over the spectral distribution of different ambient light sources as a function of the relative power produced by each ambient light source.

Looking at the dotted curve 110 which represents the spectral distribution of a flash tube, it is apparent that there are three distinct wavelength areas where the majority of the relative power is located - namely in the ultraviolet between about 300-400 nm, in the visible domain and moreover in the far-infrared region between about 1000-1900 nm. Hence, depending on the type of light-sensing element used and having in mind that most ambient light-sensing elements today are either sensitive to infrared or visible light, measuring only in the infrared domain will not give an accurate picture of the ambient light source in the visible domain.

This problem becomes even more pronounced when using infrared light-sensing elements having their peak sensitivity somewhere in the near-infrared region of the light spectrum. In that scenario, when receiving light from a quartz-halogen lamp 120 or a tungsten lamp 130, the light-sensing element will sense a large incident light-intensity (where it should be remembered that received power is proportional to the square of light intensity), while in reality, the intensity of the incident visible light for these ambient light sources is rather low.

A resultant controlling of the backlight or brightness of a display will most probably overcompensate for the incident ambient light if the brightness controlling mechanism is only relying upon the intensity of the received infrared light.

As evident from the figure, the majority of the light intensity or power produced by a quartz-halogen lamp 420 and a tungsten lamp 130 is in the infrared domain - i.e. the majority of the power is simply produced as heat radiation.

In contrast, a fluorescent lamp 140 as commonly used in office and factory buildings has essentially all of its power concentrated in the visible light spectrum with spectrum peaks around 600 and 700 nm.

A neon lamp 150 also has a similar spectral distribution as the fluorescent lamp.

As a side remark, a sodium lamp 160 has a majority of its spectral distribution in the visible domain with a power peak around 700 nm.

In contrast, light from a natural source (i.e., sun light) is more evenly distributed across the entire spectrum.

Thus, when using infrared light-sensing elements for detecting incident light it is important to bear in mind the different spectral distributions of different light sources and how they differ in the infrared and visible domain as illustrated in Fig. 1.

Fig. 5 displays a time- and frequency signature of a common halogen lamp. In the upper part of the figure the time domain output of the halogen lamp expressed in seconds is displayed as a function of amplitude expressed in Watts. The lower part of the figure

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displays the light output from the halogen lamp expressed as frequency in Hz in terms of amplitude expressed in W.

Fig. 6 displays the time- and frequency signature of an energy saving lamp (ESL) in the same fashion as in Fig. 5.

When comparing the two ambient light sources it is apparent that the time-domain behaviors differ significantly and that the halogen lamp oscillates with a lower frequency than the energy saving lamp. Furthermore, looking at the temporal frequency content of the two light sources it becomes apparent that the energy-saving lamp has a number of characteristic frequencies in the high frequency range, while the frequency spectrum of the halogen lamp is located at lower frequencies, corresponding to a rectified 50 Hz oscillation.

These different behaviors will be used further down in the description to identify the type or types of ambient light sources whose light has been detected by the detector 4.

Using Figs. 1-3 as examples the present invention will be explained.

In Fig. 1 the plurality of detectors 4 are used to detect light L propagating inside the transmissive panel 1. In order for the detectors 4 to only measure ambient light L_A incident onto the upper surface 1a of the panel 1, the control unit 6 is configured to switch the emitters 2 off. As already explained earlier in Fig. 3, ambient light L_A incident onto the upper surface 1a of the panel 1 will be scattered into the panel, while part of the scattered ambient light will be detected by the plurality of detectors 4. In the embodiment in Fig. 1 it is assumed that the detectors are sensitive to infrared light, which is preferred, or to visible light. In case the detectors 4 are sensitive to visible light it is assumed that their sensitivity curves differ from those of the human eye. Moreover, while the detectors 4 are displayed as being arranged around the edge of the transmissive panel 1, they may also be arranged around the periphery of the upper surface 1a or the lower surface 1b of the transmissive panel 1.

Now, output electrical signals corresponding to the light signals from one or more ambient sources are produced by each of the plurality of light-sensing elements 4 and received by the detector control unit 5A and from there sent further to the control unit 6. Moreover, the control unit 6 is configured to read out output values from the detectors 4 using the processor 8 form a signal vector representing ambient light signal received at each of the plurality of detectors 4. The processing unit 8, in turn, may comprise or is connected to a memory unit (not shown) configured to store a number of template vectors corresponding to different ambient light sources. Also, the processor 8 is configured to perform a correlation (or alternatively, a convolution) operation between the signal vector formed and the template vectors stored in the memory unit and thereby identify the type or types of ambient light source(s) detected by the plurality of detectors 4. The processor 8 may perform the identification by firstly extracting a feature vector from the correlation, convolution or other comparison operation between

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the signal and the template vectors and secondly by classifying the resultant feature vector according to a pattern recognition method which will be described more in detail in Fig. 7. Moreover, the control unit 6 is configured to instruct the processor 8 to calculate the level of ambient light incident on the upper surface 1a of the transmissive panel 1. The reason for this is that the plurality of detectors 4 only register a certain portion of the scattered ambient light Lg. One way to calculate the amount of ambient light incident onto the upper surface 1a of the panel is to assume that in the absence of contaminations on the upper panel surface 1a the amount of scattered incident ambient light LA is known and can be modeled by a known relation stored in the memory unit connected or present in the processor 8. Using this relation (which may or may not be linear) the control unit 6 may finally determine the amount of ambient light incident onto the panel. However, if the detectors 4 are only sensitive to infrared light it will be necessary for the control unit 6 to instruct the processor 8 to calculate the amount of visible ambient light from the calculated amount of incident ambient light. This will be necessary even in the case the plurality of detectors 4 are sensitive to visible light, since frequently the sensitivity curve for a detector 4 differs from the illuminance curve of the human eye.

The control unit 6 may also be configured to instruct the processor 8 to calculate a brightness value which may be used to adjust the brightness of the transmissive panel dependent on the amount of ambient light incident on the panel. This may be useful in cases where the transmissive panel is located above a backlight-powered display or where such a display is integrated with the transmissive panel. In this way power may be saved.

It shall be mentioned that in a normal case when measuring the ambient light level, the control unit 6 is configured to instruct the emitting control unit 3A to switch off all emitters and to instruct the detector control unit 5A to read out output values from the detectors. It is not necessary for the control unit 6 to instruct the reading out of all detector values. It may be sufficient to read out a few detector values which are sufficient to establish the level of ambient light incident on the transmissive panel 1.

Depending on implementation, the control unit 6 may instruct the detector control unit 5A to read out detector output values with a certain sampling rate which is chosen such that a sufficient number of sampling values are available from which an essentially accurate identification of the light signal and thus of the one or more ambient light sources may be performed. According to one variant, the control unit 6 may perform a sampling of the light-sensing element output values with sampling frequencies ranging from a couple of kHz to several hundred kHz, where electric signal values after every reading are composed into a signal vector. The sampling frequency and the length of the signal vector chosen will determine which frequencies can be used to classify the one or more ambient light sources.

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In the discussion above, it was assumed that no surface contamination is present on the upper surface 1a of the transmissive panel 1. Usually however, there will be always some form of finger prints, smears, dust or other types of surface contaminations present on the upper surface 1a. These can be either modeled as being evenly distributed over the entire upper surface 1a of the transmissive panel or to be evenly distributed in certain sub-areas of the panels. In both cases the ambient light incident onto the contaminated surface will be scattered differently from the surface and into the transmissive panel which will affect the amount of light detected by the plurality of detectors 4. If the surface contamination is distributed evenly over the entire first surface 1a, then the control unit 6 may instruct the processor 8 to add a correction factor to each value in the signal vector. In case the contamination distribution is not even over the entire surface of the transmissive panel, i.e. there is a significant difference in the amount of ambient light registered between a first group of detectors 4 and a second group of detectors 4, then the control unit 6 may divide the transmissive panel into sub-areas each with associated detectors. The control unit 6 may then instruct the processor to add a sub-area dependent correction factor to detector output values belonging to detectors of the specific sub-area in question. The correction factor may be a simple constant or a known linear or non-linear relation.

Fig. 7 illustrates a flowchart of an embodiment of a method according to the present invention. In this embodiment we use light-sensitive elements with main sensitivity in the infrared spectrum. However, it should be emphasized that the embodiment in Fig. 7 would equally hold true for light-sensitive elements having their main sensitivity in the visible domain.

At step 300, a touch-sensitive apparatus, such as the touch-sensitive apparatus from Fig. *1* receives light signals at its array of light-sensitive elements. As mentioned earlier, the array of light-sensitive elements may be sensitive to infrared light or light in the visible spectrum.

Thereafter, at step 310, the light signals are converted into electrical signals by the detectors, amplified and converted into their digital counterparts by the detector control unit 5A.

Besides the known conversion from optical to electrical signal in the light-sensing elements, the amplified and **A/D-converted** output electrical signals from the light-sensing elements are at step 320 sampled into a signal vector representative of the ambient light signals incident on the touch-sensing apparatus. The sampling may involve reading output signal values from all light-sensing elements in the array or only a plurality of the light-sensing elements. It may be added that these output values may be read out during a time interval during which light-emitting elements in the touch-sensitive apparatus are switched off.

Although not illustrated by the flow chart in Fig. 7, the reading out and sampling of the output values from all or a part of the light-sensitive elements in the detector array may

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occur during a set of time intervals, i.e. continuously. Also possible is to read and sample the output values during time intervals which may be predefined or user-defined.

At step 330, the signal vector from step 320 is combined with a template signal vector or characteristic signal matrix in order to extract a feature vector which may have one or more features representative of one or more known ambient light sources. These features may be characteristic frequencies present in an ambient light source, characteristic time-related behavior of light from an ambient light source or some other signal characteristic which uniquely defines an ambient light source. One way to extract a feature vector at step 330 may be to perform a correlation operation between the signal vector and the one or more characteristic signal vectors or with a characteristic signal matrix in which the columns are represented by the characteristic signal vectors for each known ambient light source. Another possibility is to perform a convolution operation between the signal vector and the one or more characteristic signal vectors for each known ambient light source and thereby extract the feature vector representative of the signal characteristics of the light incident from the one or more ambient light source onto the touch-sensitive apparatus.

It should be mentioned that while the conversion of the light signals received in step 310 is performed in the time domain, the signal vector at step 320 may be formed in the time or frequency domain. One possible way to form the signal vector at step 320 may be to perform an FFT-operation on the time domain signal vector. The principles of the FFT-algorithm are known and will not be elaborated further in this description.

In case the signal vector is formed in the frequency domain, the operations described for step 330 will then be performed in the frequency domain as well.

It should also be mentioned that there are more possible feature extraction methods than correlation or convolution which are mentioned in the earlier paragraph and the above two simply serve as examples to illustrate the underlying principles of the present invention.

At step 340 the feature vector extracted at the previous step is classified in order to obtain information on which type or types of ambient light sources are illuminating the touch-sensitive apparatus. Without going into too much detail any known pattern recognition algorithm may be used to perform this operation. For example, a branch metric algorithm may be used which compares the extracted feature vector with a plurality of candidate signal vectors each corresponding to a specific class of ambient light sources, such as incandescent lamps, halogen lamps, LED-lamps and similar.

At step 350 the amount of infrared ambient light incident onto surface of the touch-sensitive panel is determined. In order to perform this operation, the ambient light incident on the one or more light-sensitive elements (which in this example are sensitive to IR light), such as the light-sensitive elements in Fig. 1, is determined first. This may be necessary, since there will most probably be a difference between the amount of

ambient light incident onto the touch-sensitive apparatus and the amount of ambient light registered by the one or more light-sensitive elements in the touch-sensitive apparatus. One source of the discrepancy may be contaminations on the surface of the touch-sensitive plate stemming from fingerprints, smears, dust and other contamination sources. These contaminations lead to a different scattering of the ambient light through the light transmissive panel 4 and to the light-sensing elements. Also, the touch-sensitive apparatus as presented in Figs. 1 and 2 relies upon the principle that some part of the ambient light will be scattered by the light transmissive panel and it is this part that may be registered by the one or more light-sensitive elements. One simple way of modeling the contamination of the touch-sensitive panel may be to assume that the contaminations are on average evenly distributed over the entire surface of the touch-sensitive panel. In this case the influence of the contaminations on the ambient light incident on the touch-sensitive panel may be taken account by using a correction factor C_{corr}. Multiplying the signal vector formed at step 320 by the correction factor will yield a corrected signal vector more realistically representing the real amount of ambient light incident on the touch-sensitive panel. Taking the absolute value of the thus corrected signal vector may then yield the average intensity value of the ambient light incident onto the surface of the touch-sensitive panel. In case of a more uneven distribution of the surface contamination over the upper surface of the light transmissive panel the model described earlier with the partition of the light transmissive panel into sub-areas may be applied. Please note that this corrected intensity value still represents the amount of infrared ambient light incident onto the touch-sensitive panel from one or more ambient light source.

Thus, it is necessary to transform the corrected average intensity value from step 350 into an intensity value of visible light seen by the human eye which takes into account the type or types of ambient light source which is generating the ambient light. Therefore, at step 360, the processor of the touch-sensitive apparatus, such as the processor 8 will calculate a conversion factor corresponding to the type of ambient light source identified at step 340. If several ambient light sources have been identified at step 340, then the processing unit may for example calculate a conversion factor for each ambient light source classified at step 340 and thereafter a general conversion factor which may be an average value

It should be noted here that steps 350 and 360 are interchangeable, i.e. the calculation of a conversion factor or conversion factors for the ambient light source(s) detected may be performed on the signal vector from step 320 first and then the correction factor may be applied thereafter.

At step 370, the processor calculates from the corrected and converted intensity value of ambient light incident on obtained at steps 350 and 360 a brightness value for a display connected to the touch-sensitive apparatus of Figs. 1 and 2. This value may then be used to adjust the brightness of the display to correspond to the ambient light level.

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It should be noted that in the description of the steps in the flowchart in Fig. 7 it has been assumed that the light-sensing elements are mainly sensitive to infrared ambient light. However, the method may equally work with light-sensitive elements which are sensitive to visible light. In that case the conversion factor for the ambient light source or sources detected would again be calculated at step 360 to reflect the amount of light visible to the human eye.

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CLAIMS

1. Method for determining the amount of visible ambient light incident on a touch-sensitive apparatus comprising a first array of light-sensing elements, the method comprising the steps:
- receiving light signals at a plurality of light-sensing elements in the first array;
- converting the light signals into electrical signals;
- identifying at least one type of ambient light source from the signal by comparing features in the signal with characteristic features of one or more known light sources and;
- obtaining information related to the amount of visible ambient light incident on the panel generated by the at least one type of ambient light source in relation to the amount of ambient light registered at the plurality of light-sensing elements.

2. Method according to claim 1, further comprising the step of forming a signal vector from the electrical signals by sampling the converted electrical signals from the plurality of light-sensing elements.

3. Method according to claim 1 or 2, wherein the step of identifying at least one type of ambient light source by comparing features in the signal comprises extracting a feature vector by comparing the signal vector with at least one template vector representative of a known ambient light source.

4. Method according to claim 3, further comprising classifying the feature vector obtained according to a closest match obtained during the comparison with a known ambient light source.

5. Method according to one of the claims 1-4, wherein obtaining information related to the amount of visible ambient light incident on the panel comprises determining a correction factor indicative of the amount of scattering of the incident ambient light into the panel.

6. Method according to one of the claims 1-5, where obtaining information related to the amount of visible light incident on the panel comprises determining a conversion factor indicative of the amount of visible light incident on the panel in relation to the amount of ambient light detected by the one or more light-sensing elements.

7. Method according to one of the claims 1-6, further comprising the step calculating a brightness value from the information related to the amount of visible light incident on the panel.

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8. Method according to claim 7, further comprising compensating the brightness of the panel using the brightness value.

9. Method according to one of the claims 1-8, further comprising the step of generating light signals in a plurality of light-emitting elements belonging to a first array of light-emitting elements in the touch-sensitive apparatus during a first time period and receiving ambient light signals at the plurality of light-sensing elements during a second time period where the light-emitting elements are switched off.

10. Method according to one of the claims 1-8, further comprising:
- generating light signals in a plurality of light-emitting elements belonging to a first array of light-emitting elements in the touch-sensitive apparatus during a first time period;
- receiving the light signals during the first time period at a plurality of light-sensitive elements;
- receiving ambient light signals at the plurality of light-sensitive elements during a second time period where the plurality of light-emitting elements are switched off.

11. Method according to one of the claims 1-10, further comprising:
- generating light signals in a plurality of light-emitting elements belonging to a first array of light-emitting elements in the touch-sensitive apparatus;
- receiving the light signals at a plurality of light-sensitive elements and;
- measuring energy of the light signal for a particular detection line received at each of the plurality of light-sensitive elements;
- computing a relative change between the energy of the light signal for each particular detection line received at each of the plurality of light-sensitive elements and a reference energy value for the light signal for the particular detection line and;
- determining touch data for the transmissive panel based on the relative change.

12. Method for determining the visible ambient light level incident on a touch-sensing apparatus comprising a light transmissive panel defining a touch surface and an opposite surface, where light generated by an illumination arrangement comprising emitters propagates in the panel by total internal reflection, the method comprising the steps:
- receiving light signals at a plurality of light-sensing elements in a first array belonging to the touch-sensing apparatus;
- converting the light signals into electrical signals;
- identifying at least one type of ambient light source from the signal by comparing features in the signal with characteristic features of one or more known light sources and;

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- obtaining information related to the amount of visible ambient light generated by the at least one type of ambient light source identified which is incident on the panel.

13. Touch-sensitive apparatus for determining the amount of visible ambient light incident onto a touch-sensitive panel of the apparatus, comprising:
- a first array of light-sensing elements configured to convert incident ambient light signals into electrical signals;
- a memory unit configured to store characteristic signal features for a plurality of known ambient light sources;
characterized in that
the touch-sensitive apparatus further comprises a processor configured to identify at least one type of ambient light source from the signal by comparing features in the signal with the stored characteristic signal features of the one or more known light sources and wherein the processor is further configured to relate the amount of visible ambient light incident on a touch-sensitive panel of the apparatus generated by the ambient light source identified by the processor.

14. Touch-sensitive apparatus according to claim 13, wherein the first array of light-sensing elements is sensitive to infrared light.

15. Touch-sensitive apparatus according to claim 13 or 14, wherein the first array of light-sensing elements is sensitive to visible light.

16. Touch-sensitive apparatus according to one of the claims 13-15, wherein the first array of light-sensing elements is arranged along the periphery of the light-sensitive apparatus.

17. Touch-sensitive apparatus for determining the amount of visible ambient light incident onto the apparatus, comprising:
- a light transmissive panel defining a touch surface and an opposite surface,
- an illumination arrangement comprising emitters configured to generate light into the panel, such that light is propagated in the panel by total internal reflection;
- a first array of light-sensing elements configured to receive the light generated by the emitters and ambient light incident onto the touch surface of the panel and to convert the incident ambient signals light into electrical signals;
- a memory unit configured to store characteristic signal features for a plurality of known ambient light sources,
characterized in that
the touch-sensitive apparatus further comprises a processor configured to identify at least one type of ambient light source from the signal by comparing features in the signal with the stored characteristic signal features of the one or

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more known light sources and wherein the processor is further configured to relate the amount of visible ambient light received by the plurality of light-sensing elements to the amount of visible ambient light incident on the transmissive panel and generated by the ambient light source identified.

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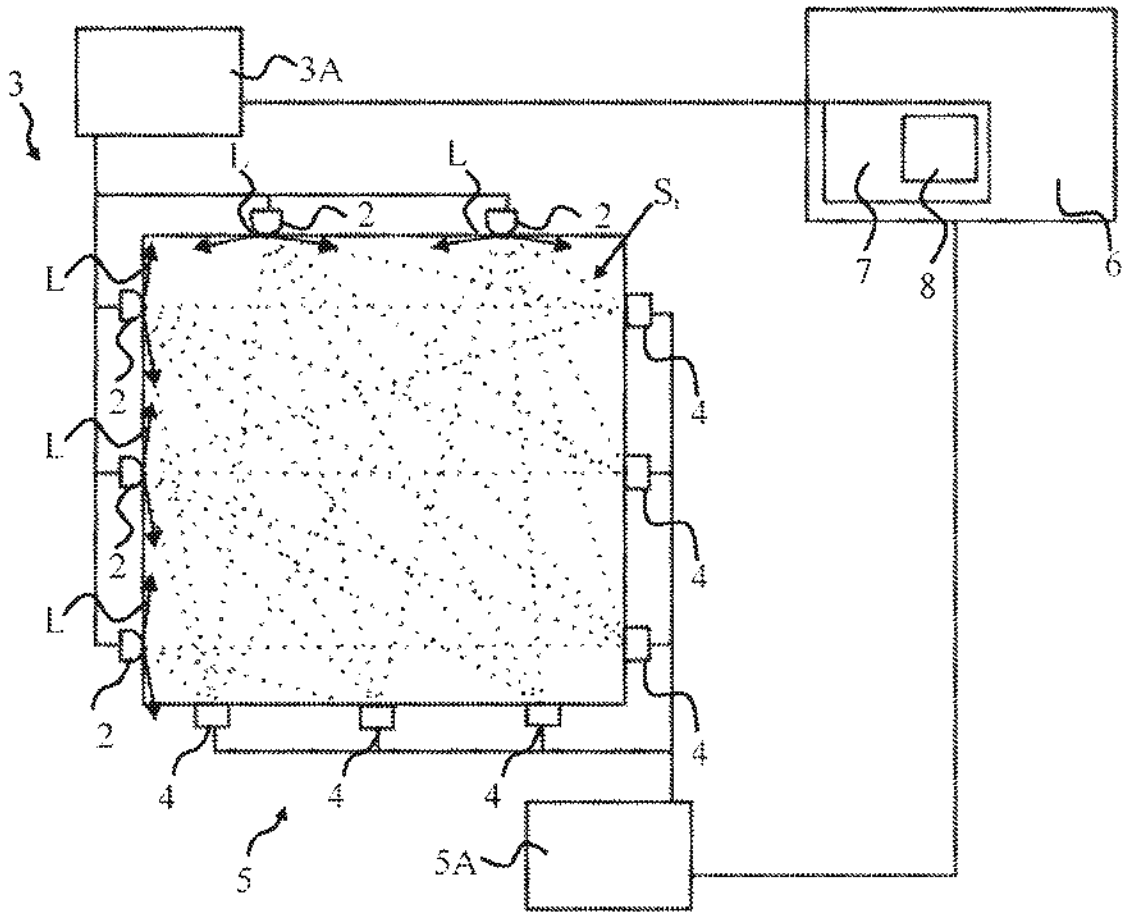


Fig. 1 (Prior art)

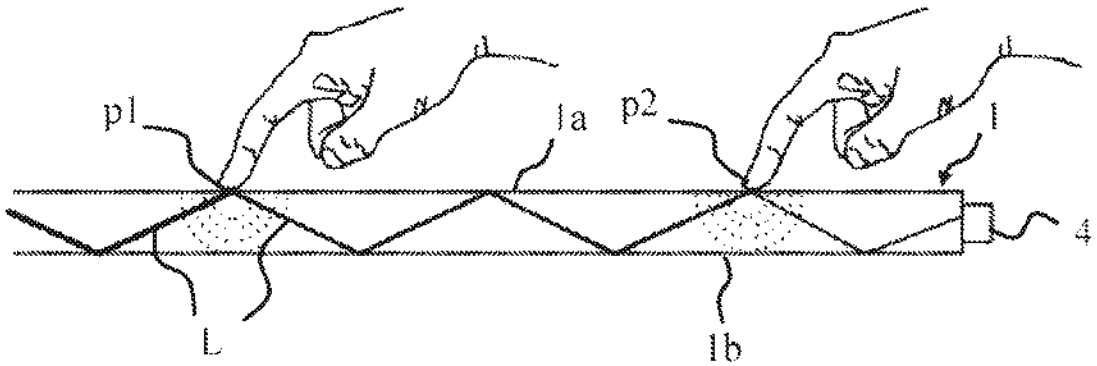


Fig. 2 (Prior art)

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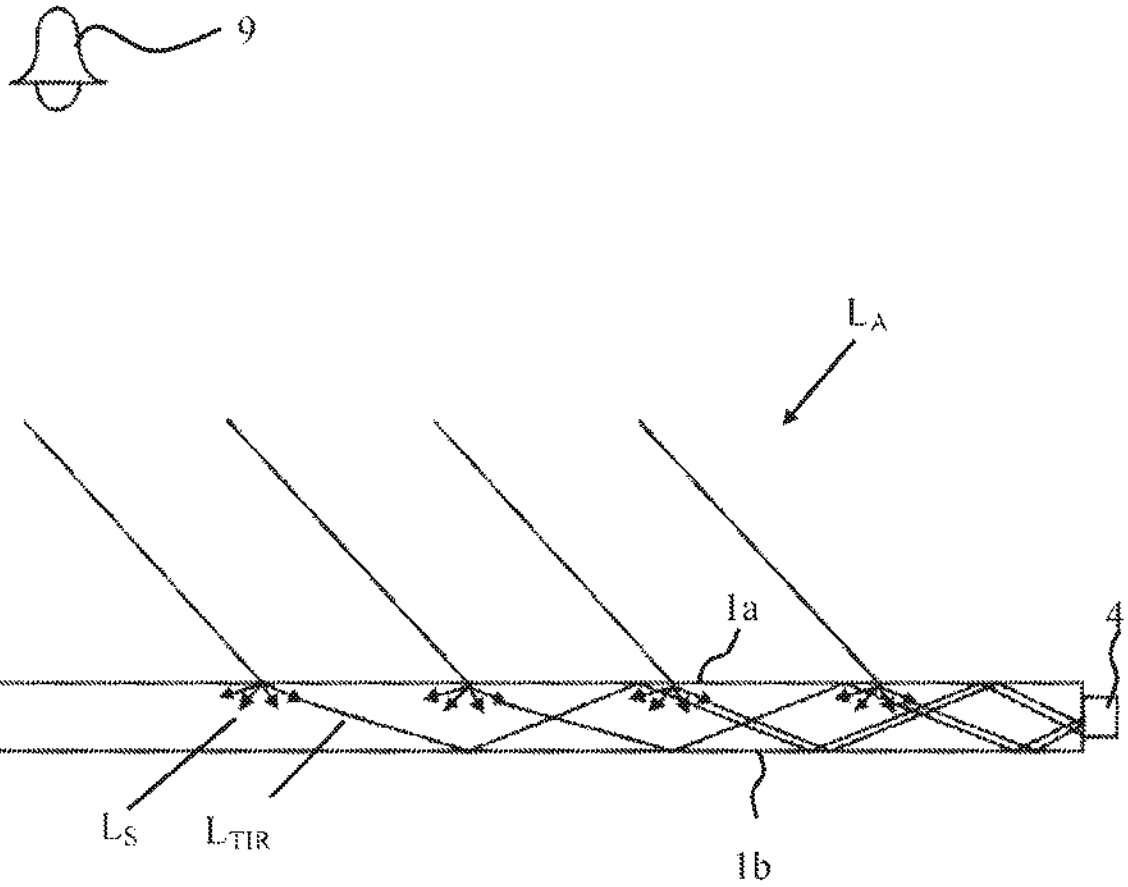


Fig. 3

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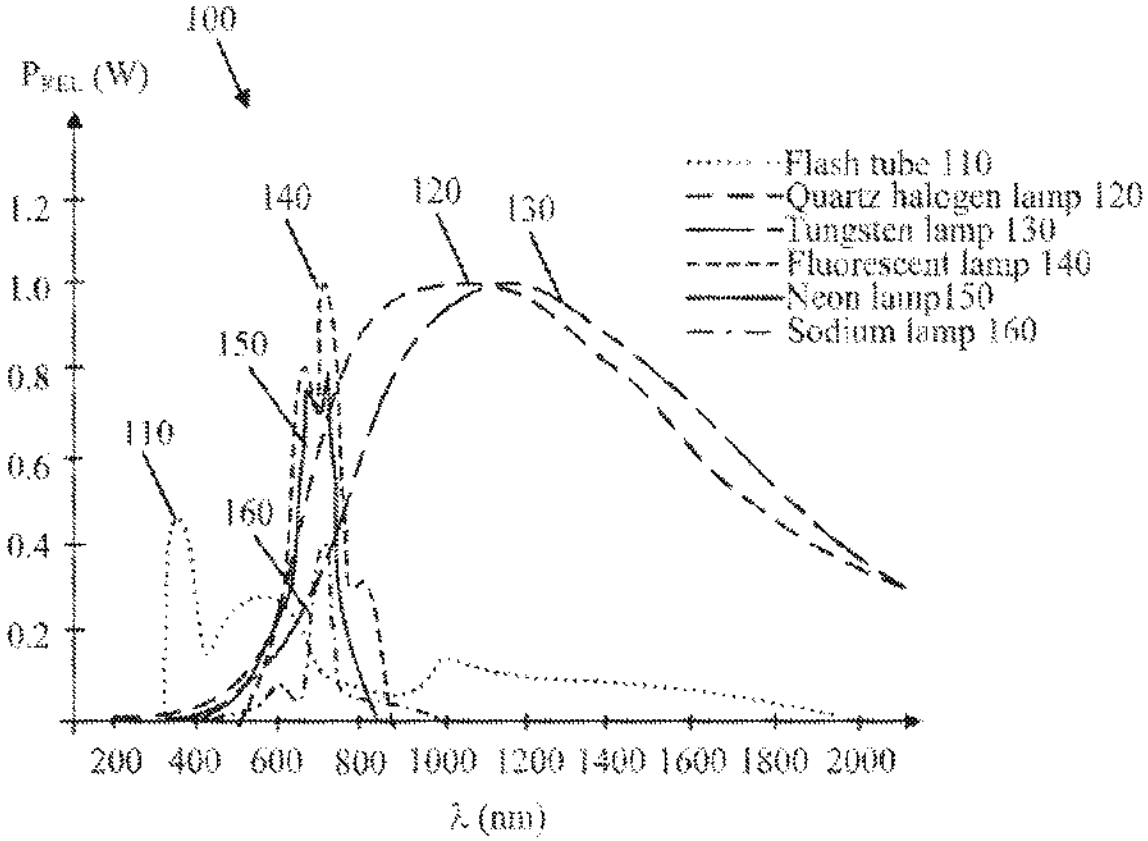


Fig. 4 (Prior art)

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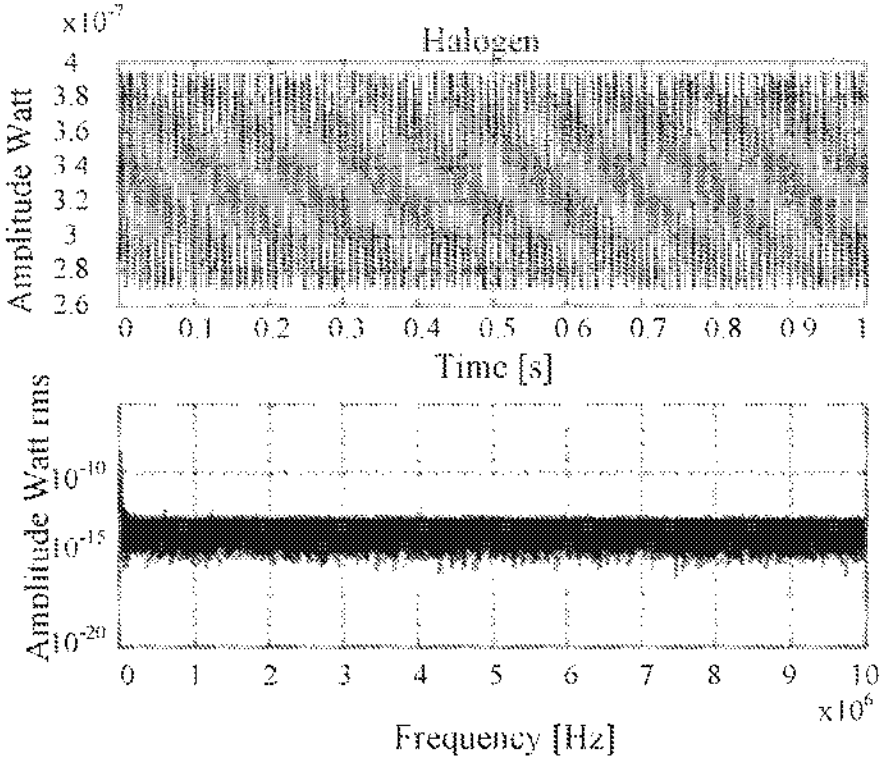


Fig. 5

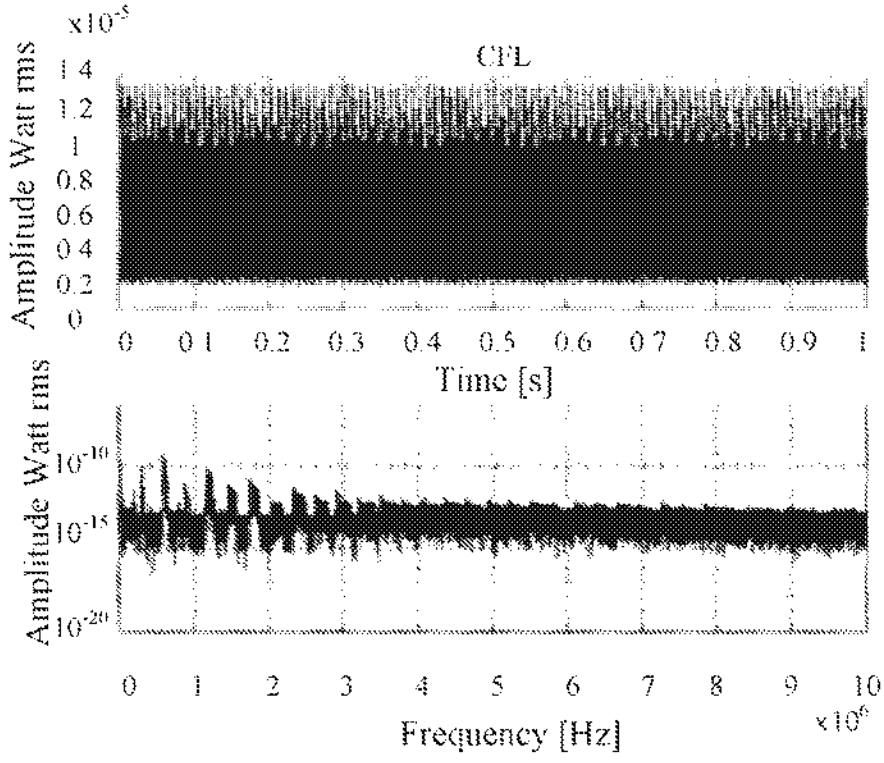


Fig. 6

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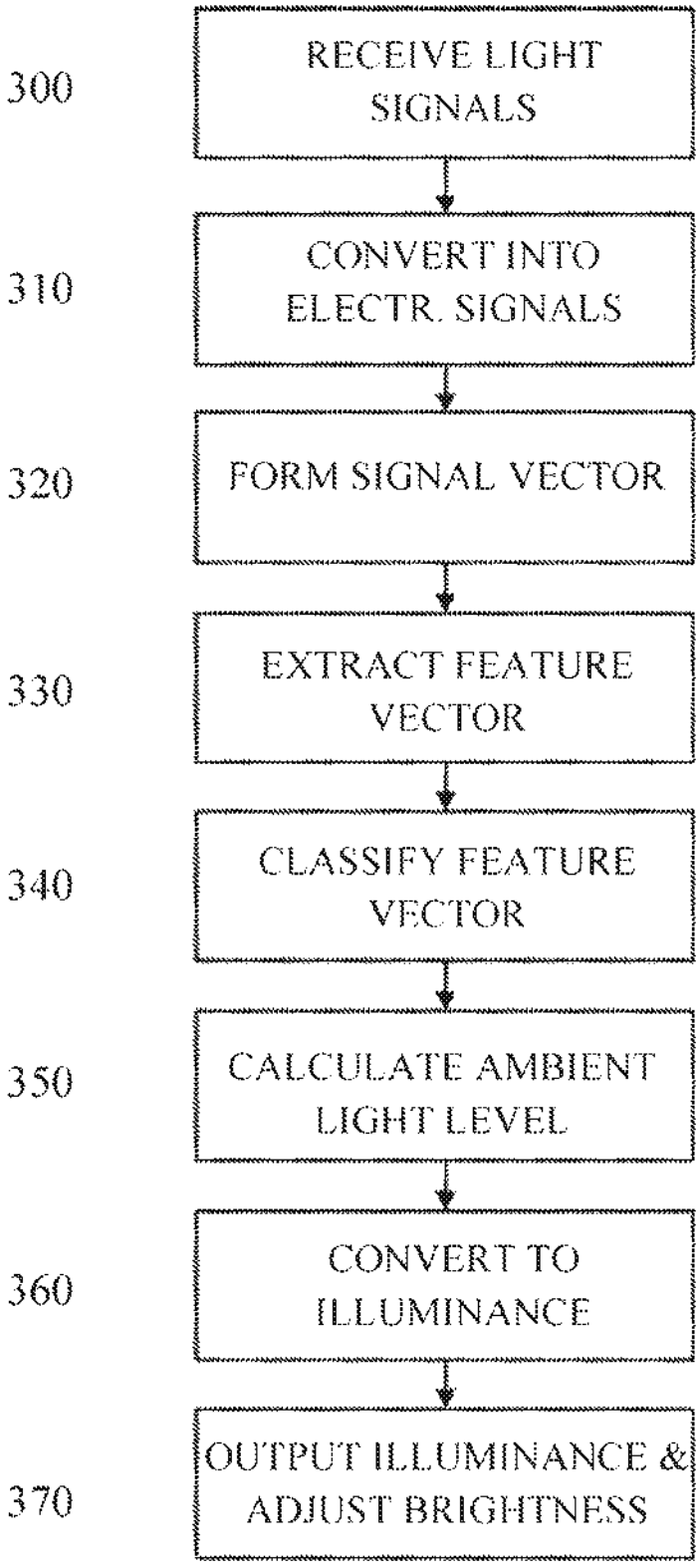


Fig. 7

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 3/051 6 14

A. CLASSIFICATION OF SUBJECT MATTER

IPC. see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	--	3, 4, 17
Y	US 20040095402 A 1 (NAKANO TAKAO), 20 May 2004 (2004-05-20); abstract; paragraphs [01 32]-[01 33], [01 55]; figure 20; claim 16	1-2, 5-1 6
A		3, 4, 17

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Continuation of: second sheet
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 3/051 6 14

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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P, Y	US 201 301 35258 A 1 (KING JEFFREY STAPLETON ET AL), 30 May 201 3 (201 3-05-30); abstract; paragraphs [01 02]-[01 03], [01 06]; figures 6A,6B,7,1 1,1 4A,1 4B,1 5A,1 5B; claims 1, 6	1-17

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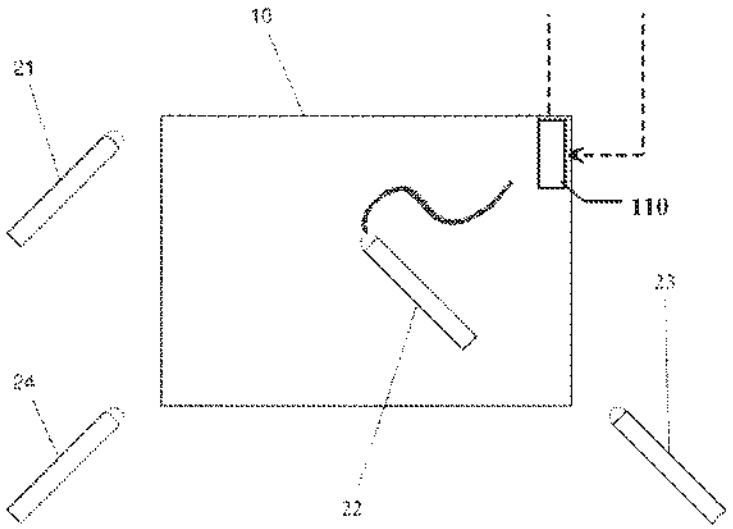


Fig. 1b

(57) Abstract: A method of controlling an interaction between a stylus and a touch sensitive device is disclosed. The stylus comprises a unique identifier and a wireless transmitter for wireless transmission of the unique identifier. The touch sensitive device comprises a wireless receiver for wirelessly receiving the unique identifier of one or more styluses. The method comprises transmitting the unique identifier from a first stylus to the touch sensitive device, determining from a database, a set of controls associated with the unique identifier, and controlling the interaction between the touch sensitive device and the user of the first stylus according to the set of controls. A touch interaction system is also disclosed.

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GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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Technical Field

The present invention relates to techniques for detecting and uniquely identifying styluses and other objects to be used with a touch sensitive device.

Background

Various user identification techniques are employed in touch applications in order to distinguish different users, such as biometric techniques, or techniques based on distinguishing different gestures. By being able to distinguish different users, it is also possible to control the interaction with the touch application depending on the identified user. This allows for customizing the touch interaction to the specific user. This also opens up for user authentication procedures. A problem with previous techniques such as those using a fingerprint scanner, is increased complexity and costs. Also, gesture control can be cumbersome and slow down the user experience. In many situations, the user may also refrain from using such identification procedures due to the added complexity. This will hinder the development with respect to user customization or user security in touch applications.

Hence, an improved method of identifying unique styluses and users would be advantageous and in particular allowing for avoiding more of the above-mentioned problems and compromises.

Summary

Accordingly, examples of the present invention preferably seek to mitigate, alleviate or eliminate one or more deficiencies, disadvantages or issues in the art, such as the above-identified, singly or in any combination by providing a device according to the appended patent claims.

According to a first aspect a method of controlling an interaction between a stylus and a touch sensitive device is provided. The stylus comprises a unique identifier and a wireless transmitter for wireless transmission of the unique identifier. The touch sensitive device comprises a wireless receiver for wirelessly receiving the unique identifier of one or more styluses, and an interactive display controllable with touch interactions. The method comprises transmitting the unique identifier from a

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first stylus to the touch sensitive device; determining from a database, a set of controls associated with the unique identifier; and controlling the interaction between the touch sensitive device and the user of the first stylus according to the set of controls.

According to a second aspect a touch interaction system is provided, comprising a first stylus comprising a wireless transmitter adapted to transmit a unique identifier. The touch interaction system further comprises a touch sensitive device comprising a receiver adapted to receive the unique identifier from the first stylus, and an interactive display controllable with touch interactions. The touch interaction system further comprises a control unit adapted to transmit the unique identifier from the first stylus to the touch sensitive device; determine from a database, a set of controls associated with the unique identifier, and control the interaction between the touch sensitive device and the user of the first stylus according to the set of controls.

Further examples of the invention are defined in the dependent claims, wherein features for the second and subsequent aspects of the invention are as for the first aspect mutatis mutandis.

Some examples of the disclosure provide for a simpler stylus- or user identification system.

Some examples of the disclosure provide for stylus- or user identification which is more intuitive.

Some examples of the disclosure provide for a less costly stylus- or user identification system.

Some examples of the disclosure provide for a more reliable and robust stylus- or user identification system.

Some examples of the disclosure provide for a more flexible and adaptable stylus- or user identification system.

Some examples of the disclosure provide for a stylus- or user identification system which is quicker to use.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

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Brief Description of the Drawings

These and other aspects, features and advantages of which embodiments of the invention are capable of will be apparent and elucidated from the following description of embodiments of the present invention, reference being made to the accompanying drawings:

Fig. 1 is a schematic illustration of a touch interaction system according to one example, in which;

Fig. 1a is a schematic illustration of a stylus according to one example; and

Fig. 1b is a schematic illustration of a touch device and styluses according to one example.

Fig. 2 is a schematic illustration of a touch interaction system according to one example.

Fig. 3 is a schematic illustration of different users of a touch interaction system according to one example.

Detailed Description

Specific examples of the invention will now be described with reference to the accompanying drawings. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. The terminology used in the detailed description of the embodiments illustrated in the accompanying drawings is not intended to be limiting of the invention. In the drawings, like numbers refer to like elements.

Figs. 1a-b show a touch interaction system 100 comprising a first stylus 22 and a touch sensitive device 10. The stylus 22 comprises a wireless transmitter 70 adapted to transmit a unique identifier 90, and the touch sensitive device 10 comprises a receiver 110 adapted to receive the unique identifier 90 from the first stylus 22. The stylus 22 may be a first stylus among a plurality of styluses 21, 22, 23, 24, in the touch interaction system 100. The receiver 110 may be adapted to receive a unique identifier 90 from each of the plurality of styluses 21, 22, 23, 24. The touch interaction system 100 comprises a control unit 120 adapted to transmit the unique identifier 90 from the first stylus 22 to the touch sensitive device 10. The control unit 120 communicates with the first stylus 22 and the touch sensitive device 10, and is

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further adapted to determine, from a database 130, a set of controls associated with the unique identifier 90. The communication between the control unit 120 and the mentioned components in the touch interaction system 100 may be wireless communication. It is conceivable that the stylus 22 or the touch sensitive device 10 may comprise the control device 120. In case the touch sensitive device 10 comprise the control device 120, the stylus may have a stylus control device 60 adapted to communicate with the control device 120, via the transmitter 70 and receiver 110. Upon receiving a first unique identifier 90 the control unit 120 is adapted to identify a first set of controls stored in the database 130 that are associated with the first unique identifier 90. The control unit 120 is further adapted to control the interaction between the touch sensitive device 10 and the user of the first stylus 22 according to the set of controls that has been identified for the received unique identifier 90. Thus, this provides for a simple and effective procedure to associate a set of rules, i.e. a set of controls, to a particular stylus and user thereof. Several users may accordingly have their personal styluses 21, 22, 23, 24, each having a unique identifier 90, that will have an associated set of controls stored in the database 130, allowing for the control unit 120 to distinguish and associate each of the users to the particular set of controls to customize and regulate the particular user's interaction with the touch sensitive device 10. This allows, for example, setting different authorization levels for a plurality of styluses and users. E.g. an administrator 301 (Fig. 3) may have a stylus 21 that transmits a first unique identifier 90 associated with a set of controls that allows administrator interaction with the touch sensitive device 10, whereas a sub-user 302 has a stylus 22 that transmits a second unique identifier 90' which is associated with another set of controls that allows restricted or different interaction with the touch sensitive device 10.

Thus, a method of controlling an interaction between a stylus 22 and a touch sensitive device 10 is provided. The method comprises transmitting the unique identifier 90 from a first stylus 22 to the touch sensitive device 10, determining from a database 130, a set of controls associated with the unique identifier 90, and controlling the interaction between the touch sensitive device 10 and the user of the first stylus 22 according to the set of controls.

The unique identifier 90 may be transmitted upon contact between the first stylus 22 and the touch sensitive device 10. It is thus possible to synchronize the user's interaction with the touch sensitive device 10 and the unique set of controls that

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should apply to that particular event of interaction. I.e. once a user engages a first stylus 22 in contact with the touch sensitive device 10, the first unique identifier 90 is transmitted, received and associated with the corresponding set of first controls that dictates the rules that should apply to the interaction detected at the time of sensing the user's contact with the touch sensitive device 10. This allows for a simple and effective distinguishing between several users that may, for example, have different authorization levels. E.g., any control setting associated with an administrator- or higher authorization level applies only to the interactions, i.e. events of contact in time, carried out by a user having a stylus identified as authorized to interact at such level.

A time stamp may be transmitted from the first stylus 22 to the touch sensitive device upon contact between the first stylus 22 and the touch sensitive device 10. The method may comprise comparing this time stamp with the time of a registered touch event of the first stylus 22 at the touch sensitive display. It is thus possible to distinguish touch events occurring in fast sequences in time and synchronise these events with the set of controls that should apply for each event, depending on which of the styluses, among the plurality of styluses 22, 23, 24, 25, that contacts the touch sensitive device 10, and send the unique identifier 90 at that particular event.

Thus, the control unit 120 may be adapted to transmit the unique identifier 90 upon contact between the first stylus 22 and the touch sensitive device 10, and adapted to generate a time stamp that is transmitted from the first stylus 22 to the touch sensitive display 10 upon said contact. The control unit 120 may be further adapted to compare the time stamp with the time of a registered touch event of the first stylus 22 at the touch sensitive display 10.

The touch event may be registered based on a passive touch interaction between the first stylus 22 and the touch sensitive display 10. Thus, is not needed to have active detection of the stylus 22 touch event to register the input on the touch sensitive display 10. It is sufficient to detect the point in time the stylus contacts, or possibly come in to close contact, with the touch sensitive display 10. This reduces the complexity of the stylus 22, while still being able to distinguish input as described above. The time of contact may be registered by a distal detection unit 80 at the stylus 22, such as a mechanical, electrical or optical sensor. The distal detection unit 80 may for example comprise a pressure sensor or any electro-mechanical actuator

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being adapted to register a pushing action of the stylus against the touch sensitive device 10.

Controlling the interaction between the touch sensitive device 10 and the first stylus 22 may comprise providing access to the user of the first stylus 22 to an operating system account or application account identified by the set of controls. It is thus possible for a user to get access to designated accounts that are approved for the user's particular stylus 22.

Access for the user of the first stylus 22 to the operating system account or application account may be disabled a set period of time after the last interaction between the first stylus and the touch sensitive device. This may be advantageous in certain authorization environments, where a time limited access to the accounts is desirable, which may be the case when styluses are re-used after a certain period of time.

Access for the user of the first stylus to the operating system account or application account may be disabled a set period of time after the last received wireless transmission between the first stylus and the touch sensitive device. This further improves security since proximity to the touch sensitive device 10 may be required to maintain the set authorization level and access.

Controlling the interaction between the touch sensitive device and the first stylus may comprise controlling characteristics of the interaction input provided by the first stylus. Thus, characteristics of the input can be tailored to the different needs of the user. This may be advantageous when several users interact with a shared touch sensitive device 10, such as schematically illustrated in Fig. 2.

Controlling characteristics of the interaction input provided by the first stylus may for example comprise one or more of the following; i) controlling the colour of a digital ink applied using the first stylus 22 on the touch sensitive device 10; ii) controlling a brush configuration of a digital ink applied using the first stylus 22 on the touch sensitive device 10; iii) controlling a latency of interaction input provided by the first stylus 22 on the touch sensitive device 10; iv) controlling post processing of interaction input provided by the first stylus 22 on the touch sensitive device 10; or v) controlling a function of a secondary stylus tip 23 with respect to the touch sensitive device 10.

Controlling characteristics of the interaction input provided by the first stylus 22 may comprise visibly and distinctly associating input from each stylus 22, 23, 24, 25,

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to the respective stylus. It is thus possible to easily distinguish the input provided by the different styluses 22, 23, 24, 25.

Controlling the interaction between the touch sensitive device 10 and the first stylus 22 may comprise limiting editing of digital objects, created by or associated with the first stylus, to the first stylus. Limiting the editing of objects may be desirable in, for example, digital authentication procedures where a signature is required, e.g. when digitally signing a contract. I.e. once the authorization is given, by providing a signature, there is no possibility to cancel the authorization or signing. This provides for a more secure and reliable digital signing procedure to the users involved.

Controlling the interaction between the touch sensitive device 10 and the first stylus 22 may comprise limiting interaction input from the first stylus 22 to a first portion of the interactive display, wherein the first portion is defined by the set of controls. This advantageously provides for the possibility to restrict or grant access to interact with certain portions of the touch display device 10 for a particular stylus user. Each user may then have the ability to interact with different portions of the display depending on the set of controls associated with each of the styluses and users. It may for example be desirable to limit the interaction in a transactional application, used by a seller and buyer, so that the buyer may interact with a signing portion or field of the display only, and not with the remaining interaction fields such as the amounts payable.

Controlling the interaction between the touch sensitive device 10 and the first stylus 22 may comprise providing a first portion of the interactive display with one or more applications or UI elements customised in dependence on the set of controls. This further provides for the ability to customize the user experience or authorization level to the particular stylus and user.

The location and/or size of the first portion of the interactive display may be dependent on an interaction position of the first stylus 22 on the touch sensitive device 10. Thus, it is possible to adapt the first portion depending on the interaction with the first stylus.

The transmission of the unique identifier from the first stylus 22 to the touch sensitive device 10 may occur only in response to an indication from a biometric sensor 50 located on the pen identifying an authorised user. This provides for further increasing the security level, since the set of controls defining the rules for interaction with the touch sensitive device is linked to the particular user's biometric data.

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The method may further comprise transmitting a biometric value from a biometric sensor located on the pen to the touch sensitive device in combination with the unique identifier, and wherein the set of controls is determined in dependence on the unique identifier and the biometric value. As mentioned, this provides for uniquely associating the interaction with the touch sensitive device 10 with a user' biometrical input, such as a fingerprint.

The method may further comprise transmitting the unique identifier 90 from a second stylus 23 to the touch sensitive device, and determining from the database, a set of controls associated with the unique identifier of the first stylus 22 in combination with the unique identifier of the second stylus 23. It is thus possible to have a different set of controls and rules for the interaction when more than one user interacts with the touch sensitive device 10. This provides for adapting the above-mentioned interaction to a plurality of users, such as the style or features of the UI or applications, or authorisation requirements, e.g. signing or access to an application is only possible when two users are present.

Controlling the interaction between the touch sensitive device and the first stylus may comprise, in dependence on the set of controls, identifying a user ID and providing an authentication interface to allow the user of the first stylus to authenticate against the identified user ID. Thus, a user may have a personal stylus 22, which transmit a user ID with the unique identifier 90. But in order for the set of controls associated with the unique identifier to be activated, the user is required to sign or otherwise authenticate that he or she is in fact owner of the user ID.

The step of providing an authentication interface may comprise enabling the user of the first stylus 22 to provide a signature using the first stylus to authenticate themselves. As elucidated above, this provides increased security and reliability, without having to incorporate biometric sensing etc.

The step of providing an authentication interface may comprise enabling the user of the first stylus to provide a passcode using the first stylus to authenticate themselves. This is one possibility for user ID confirmation. Alternatively, or in addition, the step of providing an authentication interface may comprise enabling the user of the first stylus to provide a geometric pattern using the first stylus to authenticate themselves. Alternatively, or in addition, the step of providing an authentication interface may comprise enabling the user of the first stylus to provide a tap sequence using the first stylus to authenticate themselves.

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The authentication interface may be configured to not display the input interaction from the first stylus. The provides for increased security and privacy, since it will be more difficult for other nearby users to identify the input.

In any of the above embodiments, public-key cryptography or equivalent system may be used to ensure secure communication between a stylus and the touch sensitive device. The use of a cryptography system such as public-key cryptography also ensures that the unique identifier of a stylus cannot be replayed at a later date to allow authorisation to an attacker.

In any of the above embodiments, database 130 may be stored locally to control unit 120, i.e. as part of the same device. Alternatively, database 130 may be stored remotely, e.g. on a remote server. In such an embodiment, touch interaction system 100 comprises a network connection to allow control unit 120 to contact and retrieve data from remote database 130. The network connection may comprise a wireless or wired network connection, provided either directly to component 120 or to a device hosting component 120. This embodiment allows remote database 130 to be shared between more than one touch interaction system e.g. via the internet. This allows the portability of styluses, their unique identifiers, and the corresponding interaction controls and/or authentications between different touch interaction systems. In one example, a single administrator stylus may be provided with a same set of controls across a plurality of touch systems that allow administrator interaction.

The present invention has been described above with reference to specific embodiments. However, other embodiments than the above described are equally possible within the scope of the invention. The different features and steps of the invention may be combined in other combinations than those described. The scope of the invention is only limited by the appended patent claims.

More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the teachings of the present invention is/are used.

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CLAIMS:

1. A method of controlling an interaction between a stylus and a touch sensitive device,

the stylus comprising a unique identifier and a wireless transmitter for wireless transmission of the unique identifier,

the touch sensitive device comprising a wireless receiver for wirelessly receiving the unique identifier of one or more styluses, and an interactive display controllable with touch interactions,

wherein the method comprises:

transmitting the unique identifier from a first stylus to the touch sensitive device,

determining from a database, a set of controls associated with the unique identifier,

controlling the interaction between the touch sensitive device and the user of the first stylus according to the set of controls.

2. The method of claim 1, wherein the unique identifier is transmitted upon contact between the first stylus and the touch sensitive device.

3. The method of claim 2, wherein a time stamp is transmitted from the first stylus to the touch sensitive device upon said contact, the method further comprising comparing the time stamp with the time of a registered touch event of the first stylus at the touch sensitive display.

4. The method of claim 3, wherein the touch event is registered based on a passive touch interaction between the first stylus and the touch sensitive display.

5. The method of claim 1, wherein controlling the interaction between the touch sensitive device and the first stylus comprises providing access to the user of the first stylus to an operating system account or application account identified by the set of controls.

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6.The method of claim 5, wherein access for the user of the first stylus to the operating system account or application account is disabled a set period of time after the last interaction between the first stylus and the touch sensitive device.

7.The method of claim 5, wherein access for the user of the first stylus to the operating system account or application account is disabled a set period of time after the last received wireless transmission between the first stylus and the touch sensitive device.

8.The method of any preceding claim, wherein controlling the interaction between the touch sensitive device and the first stylus comprises controlling characteristics of the interaction input provided by the first stylus.

9.The method of claim 8, wherein controlling characteristics of the interaction input provided by the first stylus comprises one or more of the following:

controlling the colour of a digital ink applied using the first stylus on the touch sensitive device,

controlling a brush configuration of a digital ink applied using the first stylus on the touch sensitive device,

controlling a latency of interaction input provided by the first stylus on the touch sensitive device,

controlling post processing of interaction input provided by the first stylus on the touch sensitive device,

controlling a function of a secondary stylus tip with respect to the touch sensitive device.

10. The method of claim 8, wherein controlling characteristics of the interaction input provided by the first stylus comprises visibly and distinctly associating input from each stylus to the respective stylus.

11.The method of any preceding claim, wherein controlling the interaction between the touch sensitive device and the first stylus comprises limiting editing of digital objects created by or associated with the first stylus to the first stylus.

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12. The method of any preceding claim, wherein controlling the interaction between the touch sensitive device and the first stylus comprises limiting interaction input from the first stylus to a first portion of the interactive display, wherein the first portion is defined by the set of controls.

13. The method of any preceding claim, wherein controlling the interaction between the touch sensitive device and the first stylus comprises providing a first portion of the interactive display with one or more applications or UI elements customised in dependence on the set of controls.

14. The method of claim 13, wherein the location and/or size of the first portion of the interactive display is dependent on an interaction position of the first stylus on the touch sensitive device.

15. The method of any preceding claim, wherein transmission of the unique identifier from the first stylus to the touch sensitive device occurs only in response to an indication from a biometric sensor located on the pen identifying an authorised user.

16. The method of any preceding claim, wherein the method further comprises transmitting a biometric value from a biometric sensor located on the pen to the touch sensitive device in combination with the unique identifier, and wherein the set of controls is determined in dependence on the unique identifier and the biometric value.

17. The method of any preceding claim, wherein the method further comprises:

transmitting the unique identifier from a second stylus to the touch sensitive device,

determining from the database, a set of controls associated with the unique identifier of the first stylus in combination with the unique identifier of the second stylus.

18. The method of any preceding claim, wherein controlling the interaction between the touch sensitive device and the first stylus comprises, in dependence on

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the set of controls, identifying a user ID and providing an authentication interface to allow the user of the first stylus to authenticate against the identified user ID.

19. The method of claim 18, wherein the step of providing an authentication interface comprises enabling the user of the first stylus to provide a signature using the first stylus to authenticate themselves.

20. The method of claim 18, wherein the step of providing an authentication interface comprises enabling the user of the first stylus to provide a passcode using the first stylus to authenticate themselves.

21. The method of claim 18, wherein the step of providing an authentication interface comprises enabling the user of the first stylus to provide a geometric pattern using the first stylus to authenticate themselves.

22. The method of claim 18, wherein the step of providing an authentication interface comprises enabling the user of the first stylus to provide a tap sequence using the first stylus to authenticate themselves.

23. The method of claim 18, wherein the authentication interface is configured to not display the input interaction from the first stylus.

24. A touch interaction system (100), comprising

a first stylus (22) comprising a wireless transmitter (70) adapted to transmit a unique identifier (90),

a touch sensitive device (10) comprising a receiver (110) adapted to receive the unique identifier from the first stylus, and an interactive display controllable with touch interactions, the touch interaction system further comprising

a control unit (120) adapted to

transmit the unique identifier from the first stylus to the touch sensitive device,

determine from a database (130), a set of controls associated with the unique identifier, and

control the interaction between the touch sensitive device and the user of the first stylus according to the set of controls.

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25. The touch interaction system according to claim 24, wherein the control unit is adapted to

transmit the unique identifier upon contact between the first stylus and the touch sensitive device,

generate a time stamp that is transmitted from the first stylus to the touch sensitive display upon said contact, and

compare the time stamp with the time of a registered touch event of the first stylus at the touch sensitive display.

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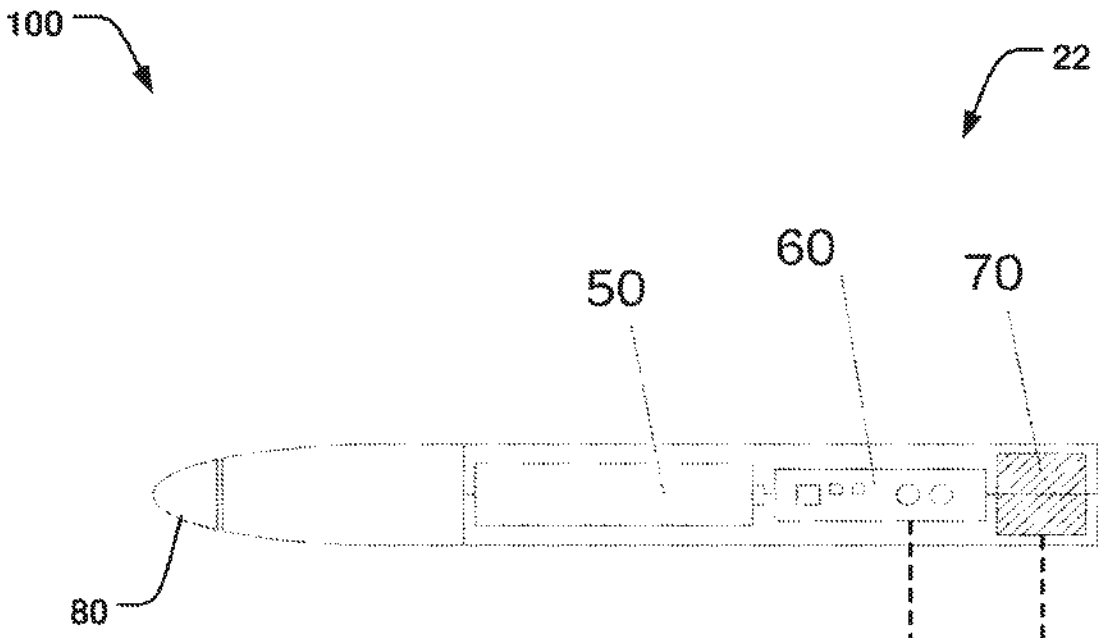


Fig. 1a

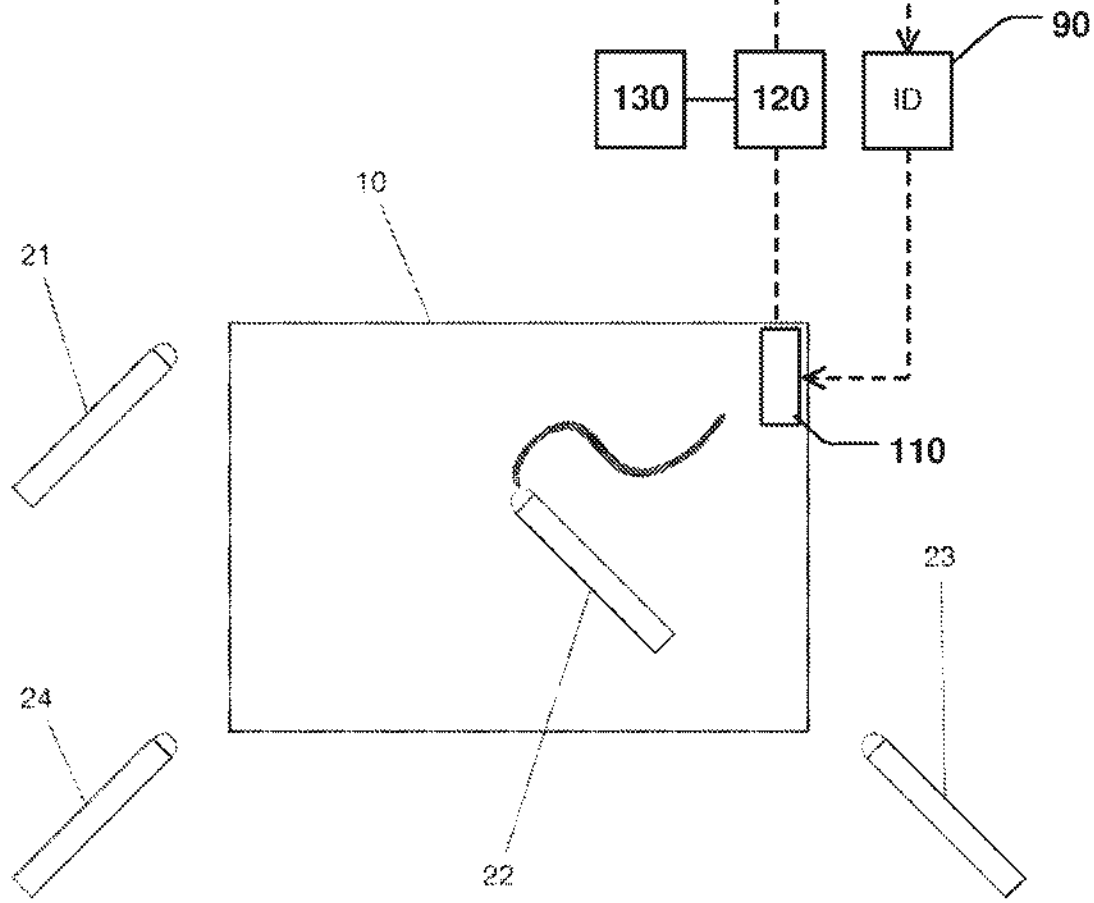


Fig. 1b

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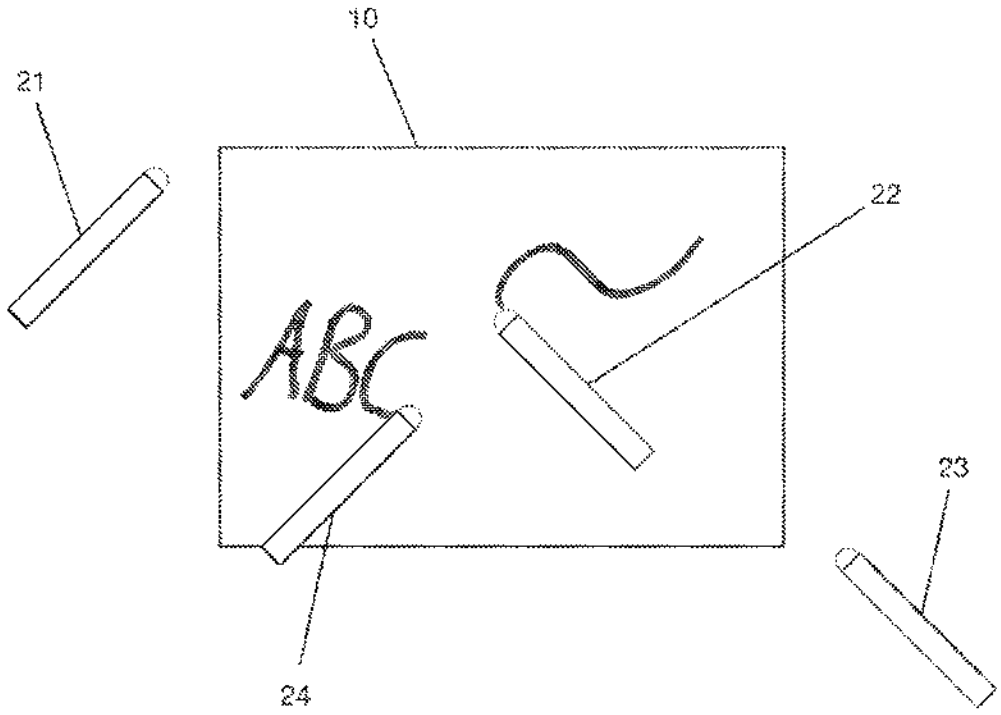


Fig. 2

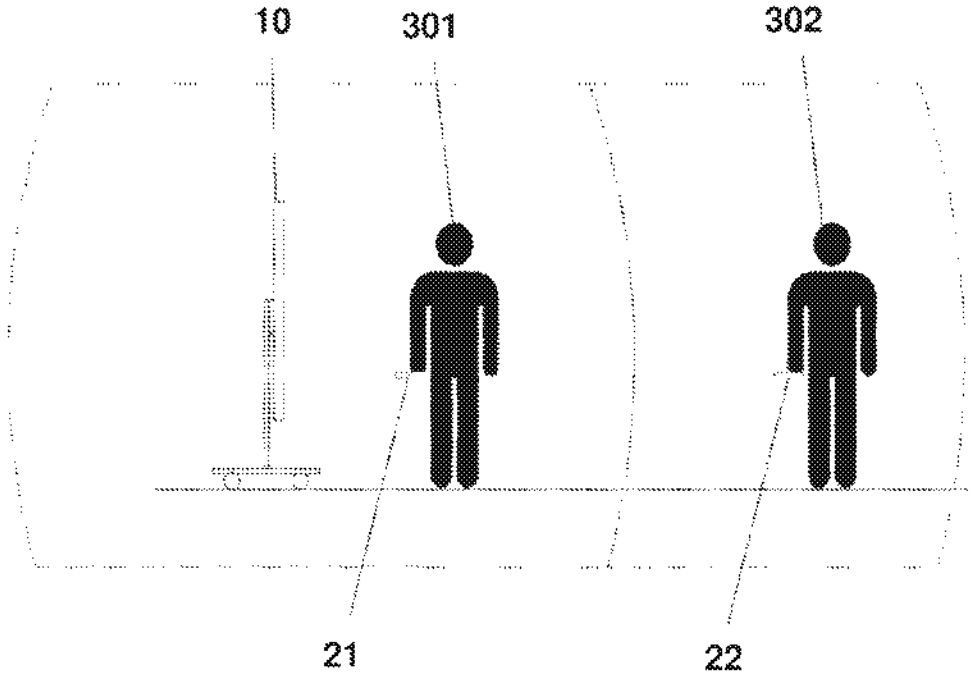


Fig. 3

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1055

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 7/051 224

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 201 301 06709 A 1 (SIMMONS MARTIN JOHN), 2 May 2013 (201 3-05-02), abstract; paragraphs [0020], [0028], [0030], [0032], [0036]-[0038], [0040]-[0041], [0045]; figure 4A; claim 15	1-2, 5, 8-1 1, 17-18, 24
Y	--	3-4, 6-7, 12-1 6, 19-23, 25
Y	US 201 60004898 A 1 (HOLZ CHRISTIAN), 7 January 201 6 (201 6-01 -07); abstract; paragraphs [0031], [0033]-[0035], [0037], [0046]-[0047], [0050]; figure 4; claims 15-1 6	3-4, 6-7, 15-1 6, 25
A	--	1-2, 5, 8-14, 17-24

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23-02-201 8	23-02-201 8

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Jimmie Femzen Telephone No. +46 8 782 28 00

Form PCT/ISA/210 (second sheet) (January 2015)

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1056

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013018953 A1 (HINCKLEY KENNETH P ET AL), 18 July 2013 (2013-07-18); abstract; paragraphs [0032], [0050]-[0061]; figure 3	19-23
A	--	1-18, 24-25
Y	US 20120313865 A1 (PEARCE NIGEL), 13 December 2012 (2012-12-13); abstract; paragraphs [0132], [0134]-[0139]; figures 3,6	12-14
A	--	1-11, 15-25
A	US 20160299583 A1 (WATANABE NAOKI), 13 October 2016 (2016-10-13); abstract	1-25
	--	
A	US 9201520 B2 (BENKO HRVOJE ET AL), 3 October 2013 (2013-10-03); abstract	1-25
	--	
A	US 20160077616 A1 (DUROJAIYE OLUMUYIWA M ET AL), 17 March 2016 (2016-03-17); abstract	1-25
	--	
A	US 20140259029 A1 (CHOI BOKUN ET AL), 11 September 2014 (2014-09-11); abstract	1-25
	--	
A	WO 2015175586 A1 (MICROSOFT TECHNOLOGY LICENSING LLC), 19 November 2015 (2015-11-19); abstract	1-25
	--	

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International application No.
PCT/SE201 7/051 224

Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/0354 (201 3.01)
G06F 3/041 (2006.01)
G06F 21/32 (201 3.01)

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US	201301 06709	A 1	02/05/201 3	DE	20201 2101399	U 1	29/05/201 2
US	20160004898	A 1	07/01/201 6	NONE			
US	201301 81953	A 1	18/07/201 3	CN	104067204	A	24/09/2014
				EP	2802971	A 1	19/1 1/2014
				TW	201346654	A	16/1 1/201 3
				WO	201 3106235	A 1	18/07/201 3
US	2012031 3865	A 1	13/1 2/201 2	CN	102576268	A	11/07/201 2
				EP	2467771	A 1	27/06/201 2
				GB	2486843	B	18/06/2014
				WO	201 1023225	A 1	03/03/201 1
US	20160299583	A 1	13/1 0/201 6	CN	107077226	A	18/08/201 7
				EP	3267293	A4	24/01/201 8
				JP	6046321	B1	14/12/201 6
				JP	WO201 6139861	A 1	27/04/201 7
				JP	201 7073149	A	13/04/201 7
				KR	201 701221 73	A	03/1 1/201 7
				TW	201643623	A	16/12/201 6
				US	201 70060274	A 1	02/03/201 7
				US	9495024	B2	15/1 1/201 6
				US	9652058	B2	16/05/201 7
				US	201 70249029	A 1	31/08/201 7
				WO	201 6139861	A 1	09/09/201 6
US	9201 520	B2	03/1 0/201 3	US	201 30257777	A 1	03/10/201 3
US	2016007761 6	A 1	17/03/201 6	AU	201 5314950	A 1	09/03/201 7
				CA	2959771	A 1	17/03/201 6
				CN	106605202	A	26/04/201 7
				EP	3191930	A 1	19/07/201 7
				JP	201 7531 246	A	19/10/201 7
				KR	201 7005551 8	A	19/05/201 7
				MX	201 70031 50	A	23/05/201 7
				US	9626020	B2	18/04/201 7
				WO	201 604071 9	A 1	17/03/201 6
US	20140259029	A 1	11/09/2014	AU	2014201 293	A 1	25/09/2014
				CN	104049732	A	17/09/2014
				EP	2778881	A3	17/12/2014
				JP	20141 7501 5	A	22/09/2014
				KR	201401 11526	A	19/09/2014
				RU	201 5138736	A	20/03/201 7
				US	9256483	B2	09/02/201 6
				WO	2014142471	A 1	18/09/2014

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Chemtronics Exhibit 1002 Page 1059

WO	20151 75586	A 1	19/1 1/201 5	CN	106462679	A	22/02/201 7
				EP	3143544	A 1	22/03/201 7
				KR	201 70008780	A	24/01/201 7
				US	9552473	B2	24/01/201 7
				US	201 7001 1227	A 1	12/01/201 7
				US	201 50332037	A 1	19/1 1/201 5

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference P3135PC00	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/SE2017/051233	International filing date *(day/month/year)* 07 December 2017 (07.12.2017)	Priority date *(day/month/year)* 07 December 2016 (07.12.2016)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant FLATFROG LABORATORIES AB		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44*bis*.1(a).

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis*.2).

	Date of issuance of this report 11 June 2019 (11.06.2019)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pct.team9@wipo.int

Form PCT/IB/373 (January 2004)

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1061

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
EVENT HORIZON IP
Barometergatan 16B
211 17 Malmö

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

	Date of mailing (*day/month/year*) 12-03-2018
Applicant's or agent's file reference P3135PC00	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/SE2017/051233	07-12-2017	07-12-2016

International Patent Classification (IPC) or both national classification and IPC
See Supplemental Box

Applicant
FLATFROG LABORATORIES AB

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [x] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/SE	Date of completion of this opinion	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	12-03-2018	Emil Bäcklund Telephone No. +46 8 782 28 00

Form PCT/ISA/237 (cover sheet) (January 2015)

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1062

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: cover sheet

International Patent Classification (IPC)

G06F 1/16 (2006.01)
G06F 3/01 (2006.01)
G06F 3/03 (2006.01)
G06F 3/041 (2006.01)

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Chemtronics Exhibit 1002 Page 1063

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/SE2017/051233

Box No. I Basis of this opinion

1 With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4 ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1064

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/SE2017/051233

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-24	YES
	Claims		NO
Inventive step (IS)	Claims	1-24	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-24	YES
	Claims		NO

2. Citations and explanations

Documents cited in the International Search Report:

D1: US20162957 11 A1
D2: EP3043242 A1
D3: WO2016177592 A1
D4: US2012062492 A1
D5: US20120451 70 A1
D6: US6031524 A1

The cited documents represents the general state of the art.

The invention defined in claims 1-24 is not disclosed by these documents.

The cited prior art does not give any indication that would lead a person skilled in the art to the claimed assembly and touch sensing apparatus in order to obtain a improved assembly for holding and controlling the touch screen. Therefore, the claimed invention is not obvious to a person skilled in the art.

Accordingly, the invention defined in claims 1-24 is novel and is considered to involve an inventive step. The invention is industrially applicable

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Chemtronics Exhibit 1002 Page 1065

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

The features of the claims 16-24 are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Claims 1, 3-4 and 15 are missing a reference to the drawing for the spacing element. However, it is clear from the description that said spacing element should have the reference 116. Furthermore, claim 4 incorrectly disclose spacing element (112, 112a and 112b).

According to the requirements of Rule 10.2 PCT, the terminology and the signs shall be consistent throughout the application. This requirement has not been met in view of the use of the expressions "an assembly" in claims 1-12, and the expression "a frame assembly" in claims 13-14 for the same feature. The same claim category must be used for those claims.

Claims 1-19 area missing a reference to an assembly and the frame assembly

Claim 15, what is performing the method ?

Claim 21 discloses the expression " the mathematical parabola" is unclear since it is in definite form. The first time an object is mention it should be in indefinite form.

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1066

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 8/050070

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, EMBASE, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category' *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2565770 A2 (SAMSUNG ELECTRONICS CO LTD), 6 March 201 3 (201 3-03-06); abstract; paragraphs [0023]-[0024], [0039], [0066]-[0071]; figures 1,4,5A-B,9A-B,1 1A-G,1 2,13A-B	1-3, 5-1 2
A	--	4
Y	US 201 601 1701 9 A 1 (TAKEDA MICHIAKI), 28 April 201 6 (201 6-04-28); abstract; paragraphs [0076]-[0084]; figure 4	1-3, 5-1 2
A	--	4

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 8/050070

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20140253520 A 1 (CUETO GERALD B ET AL), 11 September 2014 (2014-09-1 1); abstract; paragraphs [0023]-[0027]; figures 1A-C --	1-12
A	US 20090000831 A 1 (MILLER THURMAN ET AL), 1 January 2009 (2009-01 -01); abstract; paragraphs [001 9]-[0026] -- --------	1-12

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Continuation of: second sheet

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Touch control display module

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Abstract of CN203224848 (U)

Provided is a touch control display module, comprising a display and a first panel. The display comprises a display panel, a rubber frame encircling the display panel, and at least two first positioning parts disposed on the rubber frame. A first panel is disposed on the display, and is composed of a guard plate and at least two second positioning parts disposed on the guard plate. The first positioning part is combined with the second positioning part, enabling the first panel to be fixed to the display panel, with respect to the first panel. The touch control display module is advantageous in that during the assembling process of the touch control display module, with the assistance of the first positioning part and the second positioning part, abnormal problems between the first panel and the display are not easy to occur; the assembling yield rate of the touch control display module can be further improved.

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DESCRIPTION CN203224848

A touch display module includes a display and a first panel. The display comprises a display panel, a plastic frame surrounding the display panel, and at least two first positioning portions disposed on the plastic frame. The first panel is disposed on the display. The first panel includes at least two second positioning portions on the protection panel and the protection panel. The first positioning portion is combined with the second positioning portion to fix the relative position of the first panel and the display panel. In the assembly process of the touch display module of the present invention, with the assistance of the first positioning portion and the second positioning portion, an abnormal problem is less likely to occur between the first panel and the display, thereby improving the touch display of the present invention. Module assembly yield.

Touch display module

Technical field

The utility model relates to a display module, and in particular to a touch display module.

Background technique

With the rapid development and application of information technology, wireless mobile communication and information appliances, in order to achieve more convenient carrying, lighter weight and more user-friendly operation, many information products have been transformed by traditional keyboard or mouse input devices. To use a touch device as an input device. Touch panels have been widely used in various electronic products due to their user interface advantages, especially mobile electronic products such as mobile phones or tablet

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computers. According to the sensing principle, the touch panel can be divided into a resistive type, a capacitive type, and an optical type. Among them, the capacitive touch panel has a better sensing effect, and has become the mainstream of today's touch panels.

Generally, a touch display device mainly includes a display and a touch panel. In the assembly process of the touch display device, an assembly tool is often used to position the touch panel and the display, and then the touch panel is bonded to the display with double-sided tape. In the production of different sizes of touch display devices, assembly tools must be separately prepared, and the tolerances of the assembly tools and the labor hours assembled by the tools often result in an increase in production costs. In addition, when the tool tolerance is too large, the alignment between the display and the touch panel is prone to abnormality, and the display area is offset or the chip trace of the display is exposed.

Summary of the invention

The utility model provides a touch display module, which has high assembly yield.

The utility model provides a touch display module, which comprises a display and a first panel. The display comprises a display panel, a plastic frame surrounding the display panel, and at least two first positioning portions disposed on the plastic frame. The first panel is disposed on the display, and the first panel includes at least two second positioning portions on the protection panel and the protection panel. The first positioning portion is respectively coupled to the second positioning portion to fix the relative position of the first panel and the display.

In an embodiment of the present invention, the first positioning portion is a protrusion extending toward the first panel, and the second positioning portion is a recess corresponding to the protrusion.

In an embodiment of the present invention, the first panel further includes a touch sensing layer, and the touch sensing layer is located between the protection board and the display.

In an embodiment of the present invention, the display panel includes an active component substrate, an opposite substrate with respect to the active component substrate, and a display medium layer and touch sensing disposed between the active component substrate and the opposite substrate. The layer is disposed between the opposite substrate and the display medium layer.

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In an embodiment of the present invention, the display panel includes an active component substrate, an opposite substrate with respect to the active component substrate, and a display medium layer and touch sensing disposed between the active component substrate and the opposite substrate. The layer is disposed between the touch sensing layer and the display medium layer.

In an embodiment of the present invention, the display panel includes an active component substrate, an opposite substrate with respect to the active component substrate, and a display medium layer and touch sensing disposed between the active component substrate and the opposite substrate. The layer, the touch sensing layer is located between the active component substrate and the display medium layer.

In an embodiment of the invention, the protective plate has a first surface and a second surface opposite to the first surface, wherein the first surface is located between the display and the second surface. The recess extends through the first surface and toward the second surface, and the recess does not penetrate the second surface.

In an embodiment of the invention, the recesses penetrate through the protective plate.

In an embodiment of the invention, the touch display module further includes a plurality of masks. The shielding is disposed on the second surface of the protection panel and respectively covers the recess.

In an embodiment of the present invention, each of the first positioning portions includes a first positioning sub-portion and a second positioning sub-portion. The first positioning sub-port connects the second positioning sub-section with the plastic frame. The maximum diameter of the second positioning subsection is greater than the largest diameter of the first positioning subsection.

In an embodiment of the present invention, the first positioning sub-portion is a cylinder, and the second positioning sub-portion has a bottom surface directly connected to the column body, a top surface opposite to the bottom surface, and a surrounding bottom surface and a top surface And connect the bottom surface of the bottom surface and the top surface. The area of the bottom surface is larger than the area of the top surface. Moreover, the cross-sectional area of the cylinder that is cut by the reference plane is smaller than the area of the bottom surface, wherein the reference plane is parallel to the display surface of the display.

In an embodiment of the present invention, the cross-sectional area of the second positioning sub-portion that is cut by the reference plane gradually decreases as the reference plane moves away from the display.

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In an embodiment of the invention, the second positioning portion includes a third positioning sub-section and a fourth positioning sub-portion. The third positioning sub-portion is located between the fourth positioning sub-portion and the display, wherein the maximum diameter of the fourth positioning sub-portion is greater than the maximum caliber of the third positioning sub-portion.

In an embodiment of the present invention, the first positioning sub-portion is engaged in the third positioning sub-portion, and the second positioning sub-portion is engaged in the fourth positioning sub-portion.

In an embodiment of the invention, the first positioning portion includes a base and a plurality of claws connected to the base. There is at least one elastic space between the claws.

In an embodiment of the present invention, the base is engaged in the third positioning sub-portion, and the claw is engaged in the fourth positioning sub-portion.

In an embodiment of the present invention, the first positioning portion is a plurality of recesses extending toward the first panel, and the second positioning portion is a plurality of protrusions corresponding to the recesses.

In an embodiment of the invention, the touch display module further includes a colloid. The colloid is disposed between the display and the first panel. The gel is adapted to conform the first panel to the display.

In an embodiment of the invention, the colloid is a double-sided tape, a water glue or a combination thereof.

Based on the above, in the assembly process of the touch display module of the present invention, by the assistance of the first positioning portion and the second positioning portion, an abnormal problem is less likely to occur between the first panel and the display, thereby improving the utility model. The assembly yield of the touch display module.

DRAWINGS

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FIG. 1A is a perspective view of a touch display module according to an embodiment of the present invention.

FIG. 1B is an exploded view of a touch display module according to an embodiment of the present invention.

1C is a partial enlarged view of the first positioning portion of FIG. 1B.

FIG. 1D is a partial enlarged view of the second positioning portion of FIG. 1B.

2A to 2C are cross-sectional views showing other embodiments of the present invention.

FIG. 3A is a partial enlarged view of a first positioning portion of the touch display module according to an embodiment of the present invention.

FIG. 3B is a partial enlarged view of a second positioning portion of the touch display module according to an embodiment of the present invention.

Fig. 4A is a cross-sectional view of the first positioning portion of Fig. 1C taken along line A-A'.

Figure 4B is a cross-sectional view of the second positioning portion of Figure 1D taken along line B-B'.

5 is a cross-sectional view of the touch display module of FIG. 1A taken along line I-I'.

6A is a cross-sectional view of a touch display module according to another embodiment of the present invention.

Figure 6B is a cross-sectional view of the first panel of Figure 6A assembled with the display.

FIG. 7A is a perspective view of a touch display module according to still another embodiment of the present invention.

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7B is a cross-sectional view of the touch display module along line C-C' of still another embodiment of the present invention.

8A to 8C are cross-sectional views showing the assembly process of the display of Fig. 7A and the first panel.

[Main component symbol description]

100、100A: touch display module

110、110d, 110e, 110f, 210, 410: display

111: Display surface

112、212、412: First positioning part

112a: first positioning subsection

112b: second positioning subsection

112c: bottom

112d: top surface

112e: circumferential surface

114: Display panel

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115: Counter substrate

115a: upper surface

115b: lower surface

116: Plastic frame

117: Active component substrate

118: Display media layer

120、220、320、420: First panel

122、222、322、422: Second positioning part

122a: third positioning subsection

122b: fourth positioning subsection

122c: surface

124、324: Protection board

124a: the first surface

124b, 324b: second surface

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126D, 126e, 126f: touch sensing layer

D1, d2: diameter

D3, d4: caliber

340: Shield

412a: base

412b: claw

412c: elastic space

412d: bevel

412e: bulge

412f: elastic arm

422a: surface

422b: side wall

Detailed ways

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Referring to FIG. 1A to FIG. 1D , the touch display module 100 of the present invention includes a display 110 and a first panel 120 . The display 110 includes at least two first positioning portions 112. The first panel 120 is disposed on the display 110. The first panel 120 includes at least two second positioning portions 122. The first positioning portion 112 is coupled to the second positioning portion 122 to fix the relative position of the first panel 120 and the display 110. As a result, during the assembly process of the touch display module 100, the problem of alignment abnormality is less likely to occur between the first panel 120 and the display 110. Moreover, the man-hours of the display 110 and the first panel 120 can be effectively shortened by the assistance of the first positioning portion 112 and the second positioning portion 122.

The display 110 of this embodiment includes a display panel 114 and a plastic frame 116. The first panel 120 of the present embodiment includes a protection board 124 and a touch sensing layer 126 disposed on the protection board 124. The touch sensing layer 126 is located between the protection board 124 and the display 110. The touch sensing layer 126 can be directly connected to the protection board 124. Therefore, the first panel 120 in this embodiment can be regarded as a touch panel. In this embodiment, the protection plate 124 is, for example, a rigid substrate, but the present invention is not limited thereto.

The relative position of the touch sensing layer in the display module may be different in different forms depending on the design manner of the display module, which will be described below. 2A, 2B and 2C are cross-sectional views of other embodiments of the present invention, respectively. In FIG. 2A, the display 110d includes an active component substrate 117, an opposite substrate 115 with respect to the active component substrate 117, a display medium layer 118 disposed between the active component substrate 117 and the opposite substrate 115, and a touch sensing. Layer 126d. In this embodiment, the opposite substrate 115 is located between the touch sensing layer 126d and the display medium layer 118, and the touch sensing layer 126d is disposed on an upper surface 115a of the opposite substrate 115. In the embodiment shown in FIG. 2B , the touch sensing layer 126 e of the display 110 e is located between the opposite substrate 115 and the display medium layer 118 . In other words, the touch sensing layer 126e is disposed on the lower surface 115b of the opposite substrate 115 opposite to the upper surface 115a. In addition, in FIG. 2C, the touch sensing layer 126f of the display 110f is located between the active component substrate 117 and the display medium layer 118. In the embodiment of FIG. 2B and FIG. 2C, the touch sensing layers 126e, 126f are all disposed within the display. In the above-described embodiments, the touch sensing layers are all disposed in the display, so the first panel disposed outside the display only has a protective plate.

In detail, in the embodiment, the first positioning portion 112 can be disposed on the plastic frame 116 of the display 110. Further, the material of the first positioning portion 112 and the material of the plastic frame 116 can be the same. On the other hand, the second positioning portion 122 may be formed on the protective plate 124 of the first panel 120. In this embodiment, the first positioning portion 112 may be a protrusion extending toward the first panel 120, and the second positioning portion 122 may be a recess corresponding to the protrusion. However, the present invention does not limit the first positioning portion on the display as a protrusion, and the

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second positioning portion on the first panel is a recess. An embodiment will be described below. 3A and 3B are partially enlarged views of a first positioning portion and a second positioning portion of a touch display module according to another embodiment of the present invention. In this embodiment, the second positioning portion 222 can be a protrusion extending toward the display 210, and the first positioning portion 212 can be a recess corresponding to the protrusion. The relative position of the first panel 220 and the display 210 can also be fixed by the second positioning portion 222 and the first positioning portion 212 being coupled to each other.

Hereinafter, the design of the positioning unit will be described in detail. For convenience of the description herein, the following description will be made with the embodiment shown in FIGS. 1A to 1D, but the present invention does not limit this design. Fig. 4A is a cross-sectional view taken along line A-A' of Fig. 1C. Fig. 4B is a cross-sectional view taken along line B-B' of Fig. 1D. In FIG. 4A, the first positioning portion 112 is a protrusion, and each of the first positioning portions 112 includes a first positioning sub-portion 112a and a second positioning sub-portion 112b. The first positioning sub-portion 112a connects the second positioning sub-portion 112b with the bezel 116. The maximum diameter d1 of the second positioning sub-portion 112b may be greater than the maximum diameter d2 of the first positioning sub-portion 112a. Specifically, the first positioning sub-portion 112a may be a cylinder, and the second positioning sub-portion 112b is similar to a cone. Still further, the second positioning sub-portion 112b has a bottom surface 112c directly connected to the first positioning sub-portion 112a, a top surface 112d opposite to the bottom surface 112c, and a surrounding bottom surface 112c and a top surface 112d and connecting the bottom surface 112c and the top surface 112d The circumferential surface 112e. In this embodiment, the area of the bottom surface 112c may be larger than the area of the top surface 112d. Moreover, the cross-sectional area of the first positioning sub-portion 112a cut by a reference plane may be smaller than the area of the bottom surface 112c. The reference plane referred to herein in this embodiment is a plane parallel to the X-Y plane shown by the coordinate axis of Fig. 1C. The plane is parallel to the display surface 111 of the display 110, wherein the display surface 111 refers to the plane in which the display panel 114 is located. Overall, the appearance of the second positioning sub-portion 112b of the present embodiment is similar to the shape of the mushroom head. In other words, as the distance of the reference plane from the display 110 in the positive Z direction of the coordinate axis increases, the cross-sectional area of the second positioning sub-portion 112b cut by the reference plane gradually decreases.

In contrast, the form of the second positioning portion 122 corresponding to the first positioning portion 112 will be described in detail below. In FIG. 4B, the protective plate 124 of the first panel 120 has a first surface 124a and a second surface 124b relative to the first surface 124a. The first surface 124a is located between the display 110 and the second surface 124b. The second positioning portion 122 (ie, the recess) extends through the first surface 124a and toward the second surface 124b. In this embodiment, the second positioning portion 122 may not penetrate the second surface 124b. In detail, each of the second positioning portions 122 includes a third positioning sub-portion 122a and a fourth positioning sub-portion 122b. The third positioning sub-portion 122a is located between the fourth positioning sub-portion 122b and the display 110. The maximum aperture d3 of the fourth positioning sub-portion 122b is greater than the maximum aperture d4 of the third positioning sub-portion 122a. In this embodiment, the third positioning sub-portion 122a may be a cylindrical recess having a

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smaller diameter and a thicker thickness, and the fourth positioning sub-portion 122b may be a disc-shaped recess having a larger diameter and a thinner thickness.

Figure 5 is a cross-sectional view taken along line I-I' of Figure 1A. Referring to FIG. 5, after the first panel 120 is assembled with the display 110, the first positioning sub-portion 112a of the first positioning portion 112 can be engaged to the third positioning sub-portion 122a of the second positioning portion 122, and the second positioning is performed. The sub-portion 112b can be engaged in the fourth positioning sub-portion 122b. The bottom surface 112c of the second positioning sub-portion 112b may overlap on a surface 122c of the fourth positioning sub-portion 122b. In this way, the first positioning portion 112 and the second positioning portion 122 can be firmly coupled, thereby fixing the relative position of the first panel 120 and the display 110.

In addition, in order to enhance the fixing effect of the display 110 and the first panel 120 of the present embodiment, the touch display module 100 of the present invention may further include a colloid 130. As shown in FIG. 1B and FIG. 5, the colloid 130 can be disposed between the display 110 and the first panel 120, so that the first panel 120 is more firmly attached to the display 110. In the present embodiment, the colloid 130 is, for example, a double-sided tape, a water gel, a combination of the two, or other suitable adhesive.

It should be noted that the configurations of the first positioning portion and the second positioning portion of the present invention are not limited to the protrusions and recesses each having two sub-portions. All of the structures that can be formed on the first panel and the display, and thereby the structure can fix the relative positions of the first panel and the display, which can be used as the positioning portion of the present invention.

As shown in FIG. 4B, the second positioning portion 122 of the above embodiment does not penetrate the protection plate 124. Therefore, when the first panel 120 is assembled with the display 110, the surface of the protection plate 124 does not have an opening. However, in other embodiments of the present invention, the first panel can reduce the thickness in response to the demand for thinning. At this time, the positioning structure of the display and the first panel can be effectively molded and functioned, and the second positioning is performed. The portion 122 can also extend through the protective plate 124. 6A is a cross-sectional view of a touch display module according to another embodiment of the present invention. 6B is a cross-sectional view of the first panel of FIG. 6A assembled with the display. The difference between the touch display device 100A shown in FIG. 6B and the touch display device 100 shown in FIG. 5 is that the second positioning portion 322 of the first panel 320 can penetrate the protection plate as shown in FIG. 6A and FIG. 6B. 324. When the first panel 320 is assembled with the display 110, the second positioning portion 322 can still be engaged with the first positioning portion 112. It is to be noted that the touch display device 100A of the present embodiment may further include a plurality of masks 340 because the second positioning portion 322 can penetrate the protection board 324. The shield 340 is disposed on the second surface 324b of the protection plate 324 and covers the second positioning portion 322, respectively. As a result, the second positioning portion 322 does not easily

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affect the appearance of the touch display device 100A. The shield 340 is, for example, a plastic insulating sheet (mylar), but the invention is not limited thereto.

Hereinafter, another embodiment will be described to explain the design of the present invention when at least one of the positioning portions is a protrusion. FIG. 7A is a perspective view of a touch display module according to still another embodiment of the present invention. Figure 7B is a cross-sectional view of Figure 7A taken along line C-C'. For the sake of clarity, the first panel is omitted in Figures 7A and 7B. 8A to 8C illustrate an assembly process of the display of Fig. 7A and the first panel. Referring to FIG. 7A and FIG. 7B , in the embodiment, the first positioning portion 412 can be a protrusion, and the second positioning portion 422 is, for example, a recess, which is the same as the foregoing embodiment, and details are not described herein. . In the present embodiment, each of the first positioning portions 412 includes a base 412a and a plurality of claws 412b coupled to the base 412a. There is at least one elastic space 412c between the claws 412b.

The claw 412b can have a slope 412d, a protrusion 412e, and a resilient arm 412f. The projection 412e is adapted to overlap the surface 422a of the second positioning portion 422 when the first panel 420 is engaged with the display 410. The elastic arm 412f connects the projection 412e and the base 412a. The elastic arm 412f can store the elastic position energy to cause the buckle 412b to be reset without permanent deformation. As shown in FIG. 8A, when the first panel 420 and the display 410 begin assembly, the pawl 412b begins to enter the second positioning portion 422 on the first panel 420. As shown in FIG. 8B, in the process in which the claw 412b enters the second positioning portion 422, the slope 412d and the projection 412e can be pressed by the side wall 422b of the second positioning portion 422. At this time, the elastic arm 412f generates a deflection, and the elastic space 412c between the claws 412b becomes small. At this time, the elastic arm 412f can store the elastic potential energy. As shown in Figure 8C. When the claw 412b is no longer pressed by the recessed side wall 422b, the elastic arm 412f drives the buckle 412b to be reset, and the protruding portion 412e overlaps the plane 422a of the second positioning portion 422, thereby causing the first panel 420 and the display. The relative position of 410 is fixed.

In summary, in the assembly process of the touch display module according to an embodiment of the present invention, by the assistance of the first positioning portion and the second positioning portion, an abnormal problem is less likely to occur between the first panel and the display, and further Increase the assembly rate of the touch display module. In addition, with the aid of the first positioning portion and the second positioning portion, the manufacturer can save time to adjust the existing positioning tool, and the working time required for assembling the touch display module is effectively reduced.

Although the present invention has been disclosed in the above embodiments, it is not intended to limit the present invention, and any person skilled in the art can make some changes without departing from the spirit and scope of the present invention. And the scope of protection of the present invention is subject to the definition of

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the scope of the appended patent application.

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CLAIMS CN203224848

1.

A touch display module, comprising: a display panel, a display panel, a plastic frame surrounding the display panel, and at least two first positioning portions disposed on the plastic frame; and a first panel The first panel includes a protection panel and at least two second positioning portions disposed on the protection panel, wherein the first positioning portion is respectively coupled with the second positioning portion, and the first panel is The relative position to the display is fixed.

2.

The touch display module of claim 1 , wherein the first positioning portion is a plurality of protrusions extending toward the first panel, and the second positioning portion is opposite to the protrusion A plurality of depressions corresponding to the object.

3.

The touch display module of claim 2, wherein the first panel further comprises a touch sensing layer, and the touch sensing layer is located between the protection board and the display.

4.

The touch display module according to claim 2, wherein the display panel comprises an active component substrate, a pair of substrates opposite to the active component substrate, and the active component substrate and the opposite direction a display medium layer and a touch sensing layer between the substrates, wherein the touch sensing layer is located between the opposite substrate and the display medium layer.

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5.
The touch display module according to claim 2, wherein the display panel comprises an active component substrate, a pair of substrates opposite to the active component substrate, and the active component substrate and the a display medium layer and a touch sensing layer between the opposite substrates, the opposite substrate being located between the touch sensing layer and the display medium layer.

6.
The touch display module according to claim 2, wherein the display panel comprises an active component substrate, a pair of substrates opposite to the active component substrate, and the active component substrate and the a display medium layer and a touch sensing layer between the opposite substrates, the touch sensing layer being located between the active component substrate and the display medium layer.

7.
The touch display module according to claim 2, wherein the protection panel has a first surface and a second surface opposite to the first surface, the first surface being located at the display and the Between the second surfaces, wherein the recess extends through the first surface and toward the second surface, and the recess does not penetrate the second surface.

8.
The touch display module of claim 2, wherein the recess extends through the protection plate.

9.
The touch display module of claim 8 , wherein the touch display module further comprises a plurality of masks disposed on the second surface of the protection panel and covering the recesses respectively.

10.
The touch display module of claim 2, wherein the first positioning portion comprises a first positioning sub-portion and a second positioning sub-portion, the first positioning sub-portion connecting the second positioning The sub-portion and the plastic frame, wherein a maximum diameter of the second positioning sub-portion is greater than a maximum diameter of the first positioning sub-portion.

11.
The touch display module as claimed in claim 10, wherein the first positioning sub-portion is a cylinder, and the second positioning sub-portion has a bottom surface directly connected to the column body, relative to the a top

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surface of the bottom surface and a circumferential surface surrounding the bottom surface and the top surface and connecting the bottom surface and the top surface, wherein an area of the bottom surface is larger than an area of the top surface, and the pillar is A cross-sectional area cut by a reference plane is smaller than an area of the bottom surface, the reference plane being parallel to a display surface of the display.

12.

The touch display module of claim 11 , wherein a cross-sectional area of the second positioning sub-section that is cut by the reference plane is gradually reduced as the reference plane is away from the display.

13.

The touch display module of claim 10, wherein the second positioning portion comprises: a third positioning sub-portion and a fourth positioning sub-portion, wherein the third positioning sub-portion is located in the fourth positioning sub-portion And the display, wherein a maximum aperture of the fourth positioning sub-portion is greater than a maximum aperture of the third positioning sub-portion.

14.

The touch display module of claim 13 , wherein the first positioning sub-port is engaged in the third positioning sub-portion, and the second positioning sub-port is engaged in the fourth positioning sub-portion .

15.

The touch display module of claim 2, wherein the first positioning portion comprises a base and a plurality of claws connected to the base, and at least one elastic space exists between the claws.

16.

The touch display module of claim 15 , wherein the second positioning portion comprises: a third positioning sub-portion and a fourth positioning sub-portion, wherein the third positioning sub-portion is located in the fourth positioning sub-portion Between the displays, wherein the maximum aperture of the fourth positioning sub-portion is greater than the maximum aperture of the third positioning sub-portion.

17.

The touch display module of claim 16 , wherein the base is engaged in the third positioning sub-section, and the claw is engaged in the fourth positioning sub-section.

18.

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The touch display module of claim 3, wherein the first positioning portion is a plurality of recesses extending toward the first panel, and the second positioning portion is a plurality of protrusions corresponding to the recesses .

19.

The touch display module as claimed in claim 1 , further comprising a glue disposed between the display and the first panel, the glue being adapted to attach the first panel to the display.

20.

The touch display module according to claim 19, wherein the colloid is a double-sided tape, a water glue or a combination thereof.

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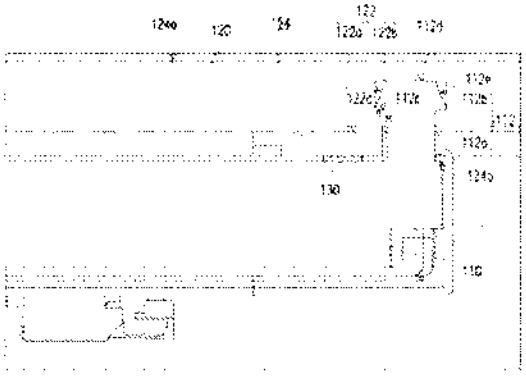
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(54)实用新型名称

一种触控显示模块

(57)摘要

一种触控显示模块，包括显示器及第一面板，显示器包括显示面板、环绕显示面板的胶框及设置在胶框上的至少一第一定位部，第一面板配置于显示器上，第一面板包括保护板及保护板上的至少一第二定位部，第一定位部与第二定位部结合，而使第一面板与显示面板的相对位置固定。在本实用新型的触控显示模块的组装过程中，由第一定位部与第二定位部的辅助，第一面板与显示器之间便不易产生异常的问题，进而提高本实用新型的触控显示模块的组装良率。



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1. 一种触控显示模块，其特征在于，包括：

一显示器，包括一显示面板、环绕该显示面板的一胶框及设置在该胶框上的至少二第一定位部；以及

一第一面板，配置于该显示器上，该第一面板包括一保护板及设置在该保护板上的至少二第二定位部，其中该第一定位部分别与该第二定位部结合，而使该第一面板与该显示器的相对位置固定。

2. 如权利要求 1 所述的触控显示模块，其特征在于，所述第一定位部为朝向所述第一面板延伸的多个凸起物，而所述第二定位部为与所述凸起物对应的多个凹陷。

3. 如权利要求 2 所述的触控显示模块，其特征在于，所述第一面板还包括一触控感测层，且所述触控感测层位于所述保护板与所述显示器之间。

4. 如权利要求 2 所述的触控显示模块，其特征在于，所述显示面板包括一主动组件基板、相对于该主动组件基板的一对向基板、配置于所述主动组件基板与所述对向基板之间的一显示介质层及一触控感测层，所述触控感测层位于所述对向基板与所述显示介质层之间。

5. 如权利要求 2 所述的触控显示模块，其特征在于，所述显示面板包括一主动组件基板、相对于所述主动组件基板的一对向基板、及配置于所述主动组件基板与所述对向基板之间的一显示介质层及一触控感测层，所述对向基板位于所述触控感测层与所述显示介质层之间。

6. 如权利要求 2 所述的触控显示模块，其特征在于，所述显示面板包括一主动组件基板、相对于所述主动组件基板的一对向基板、及配置于所述主动组件基板与所述对向基板之间的一显示介质层及一触控感测层，所述触控感测层位于所述主动组件基板与所述显示介质层之间。

7. 如权利要求 2 所述的触控显示模块，其特征在于，所述保护板具有一第一表面以及相对于所述第一表面的一第二表面，所述第一表面位于所述显示器与所述第二表面之间，其中所述凹陷贯穿所述第一表面并朝所述第二表面延伸，且所述凹陷未贯穿所述第二表面。

8. 如权利要求 2 所述的触控显示模块，其特征在于，所述凹陷贯穿该保护板。

9. 如权利要求 8 所述的触控显示模块，其特征在于，所述触控显示模块还包括多个遮蔽物，配置于所述保护板的所述第二表面上且分别覆盖所述凹陷。

10. 如权利要求 2 所述的触控显示模块，其特征在于，所述第一定位部包括一第一定位子部以及一第二定位子部，所述第一定位子部连接所述第二定位子部与所述胶框，其中所述第二定位子部的最大直径大于所述第一定位子部的最大直径。

11. 如权利要求 10 所述的触控显示模块，其特征在于，所述第一定位子部为一柱体，所述第二定位子部具有与所述柱体直接连接的一底面、相对于所述底面的一顶面以及环绕所述底面及所述顶面并连接所述底面与所述顶面的一周面，其中所述底面的面积大于所述顶面的面积，且所述柱体被一参考平面所截出的截面积小于所述底面的面积，所述参考平面与所述显示器的显示面平行。

12. 如权利要求 11 所述的触控显示模块，其特征在于，所述第二定位子部被该参考平面所截出的截面积随着该参考平面远离该显示器而逐渐缩小。

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13. 如权利要求 10 所述的触控显示模块，其特征在于，所述第二定位部包括：一第二定位子部以及一第四定位子部，第二定位子部位于该第四定位子部与该显示器之间，其中该第四定位子部的最大口径大于该第二定位子部的最大口径。

14. 如权利要求 13 所述的触控显示模块，其特征在于，该第一定位子部卡合于该第二定位子部中，而该第二定位子部卡合于该第四定位子部中。

15. 如权利要求 2 所述的触控显示模块，其特征在于，该第一定位部包括一基座以及与该基座连接的多个扣爪，该扣爪之间存在至少一弹性空间。

16. 如权利要求 15 所述的触控显示模块，其特征在于，该第二定位部包括：一第二定位子部以及一第四定位子部，第二定位子部位于该第四定位子部与该显示器之间，其中该第四定位子部的最大口径大于该第二定位子部的最大口径。

17. 如权利要求 16 所述的触控显示模块，其特征在于，该基座卡合于该第二定位子部中，而该扣爪扣合于该第四定位子部中。

18. 如权利要求 3 所述的触控显示模块，其特征在于，该第一定位部为朝向该第一面板延伸的多个凹陷，而该第二定位部为与该凹陷对应的多个凸起物。

19. 如权利要求 1 所述的触控显示模块，其特征在于，还包括一胶体，设置于该显示器与该第一面板之间，该胶体适于使该第一面板贴合于该显示器上。

20. 如权利要求 19 所述的触控显示模块，其特征在于，该胶体为双面胶、水胶或其组合。

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一种触控显示模块

技术领域

[0001] 本实用新型是有关于一种显示模块，且特别是有关于一种触控显示模块。

背景技术

[0002] 随着信息技术、无线移动通讯和信息家电的快速发展与应用，为了达到携带更便利、体积更轻巧化以及操作更人性化的目的，许多信息产品已由传统的键盘或鼠标等输入设备，转变为使用触控装置作为输入设备。触控面板因具有操作界面人性化的优点，目前已广泛地被应用在各式电子产品中，特别是移动电子产品，如手机或平板计算机等。以感测原理来区分，触控面板可分为电阻式、电容式以及光学式。其中，以电容式触控面板的感测效果较好，而成为现今触控面板的主流。

[0003] 一般来说，触控显示设备主要包括一显示器以及一触控面板。在触控显示设备的组装过程中，常使用一组装工具将触控面板与显示器定位后，再以双面胶将触控面板与显示器黏合在一起。在生产不同尺寸触控显示设备就须分别准备组装工具，且组装工具制作的公差以及利用工具组装的工时，往往造成生产成本的提高。此外，当工具公差过大时，显示器及触控面板之间对位易发生异常，而使得显示区偏移或显示器的芯片走线外露。

[0004] 发明内容

[0005] 本实用新型提供一种触控显示模块，其组装良率高。

[0006] 本实用新型提供一种触控显示模块，包括显示器及第一面板。显示器包括显示面板、环绕显示面板的胶框及设置在胶框上的至少一第一定位部。第一面板配置于显示器上，第一面板包括保护板及保护板上的至少一第二定位部，第一定位部分别与第二定位部结合，而使第一面板与显示器的相对位置固定。

[0007] 在本实用新型的一实施例中，上述的第一定位部为朝向第一面板延伸的凸起物，而第二定位部为与凸起物对应的凹陷。

[0008] 在本实用新型的一实施例中，上述的第一面板还包括触控感测层，且触控感测层位于保护板与显示器之间。

[0009] 在本实用新型的一实施例中，上述的显示面板包括主动组件基板、相对于主动组件基板的对向基板、及配置于主动组件基板与对向基板之间的显示介质层及触控感测层，该触控感测层位于该对向基板与该显示介质层之间。

[0010] 在本实用新型的一实施例中，上述的显示面板包括主动组件基板、相对于主动组件基板的对向基板、及配置于主动组件基板与对向基板之间的显示介质层及触控感测层，该对向基板位于该触控感测层与该显示介质层之间。

[0011] 在本实用新型的一实施例中，上述的显示面板包括主动组件基板、相对于主动组件基板的对向基板、及配置于主动组件基板与对向基板之间的显示介质层及触控感测层，触控感测层位于主动组件基板与显示介质层之间。

[0012] 在本实用新型的一实施例中，上述的保护板具有第一表面以及相对于第一表面的第二表面，其中第一表面位于显示器与第二表面之间。凹陷贯穿第一表面并朝第二表面延

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伸，且凹陷未贯穿第二表面。

[0013] 在本实用新型的一实施例中，上述的凹陷贯穿保护板。

[0014] 在本实用新型的一实施例中，触控显示模块还包括多个遮蔽物。所述的遮蔽物配置于保护板的第二表面上且分别覆盖凹陷。

[0015] 在本实用新型的一实施例中，上述的每一第一定位部包括第一定位子部以及第二定位子部。第一定位子部连接第二定位子部与胶框。第二定位子部的最大直径大于第一定位子部的最大直径。

[0016] 在本实用新型的一实施例中，上述的第一定位子部为柱体，而第二定位子部具有与柱体直接连接的一底面、相对于底面的一顶面以及环绕底面及顶面并连接底面与顶面的一周面。底面之面积大于顶面之面积。并且，柱体被参考平面所截出的截面积小于底面的面积，其中参考平面与显示器的显示面平行。

[0017] 在本实用新型的一实施例中，上述的第二定位子部被参考平面所截出的截面积随着参考平面远离显示器而逐渐缩小。

[0018] 在本实用新型的一实施例中，上述的第二定位部包括第三定位子部以及第四定位子部。第三定位子部位于第四定位子部与显示器之间，其中第四定位子部的最大口径大于第三定位子部的最大口径。

[0019] 在本实用新型的一实施例中，上述的第一定位子部卡合于第三定位子部中，而第二定位子部卡合于第四定位子部中。

[0020] 在本实用新型的一实施例中，上述的第一定位部包括基座以及与基座连接的多个扣爪。扣爪之间存在至少一弹性空间。

[0021] 在本实用新型的一实施例中，上述基座卡合于第三定位子部中，而扣爪扣合于第四定位子部中。

[0022] 在本实用新型的一实施例中，上述的第一定位部为朝向第一面板延伸的多个凹陷，而第二定位部为与凹陷对应的多个凸起物。

[0023] 在本实用新型的一实施例中，触控显示模块还包括胶体。所述的胶体设置于显示器与第一面板之间。胶体适于使第一面板贴合于显示器上。

[0024] 在本实用新型的一实施例中，上述的胶体为双面胶、水胶或其组合。

[0025] 基于上述，在本实用新型的触控显示模块的组装过程中，由第一定位部与第二定位部的辅助，第一面板与显示器之间便不易产生异常的问题，进而提高本实用新型的触控显示模块的组装良率。

附图说明

[0026] 图 1A 为本实用新型的一实施例的触控显示模块的立体图。

[0027] 图 1B 为本实用新型的一实施例的触控显示模块的爆炸图。

[0028] 图 1C 为图 1B 的第一定位部的局部放大图。

[0029] 图 1D 为图 1B 的第二定位部的局部放大图。

[0030] 图 2A 至图 2C 为本实用型的其他实施例的剖面图。

[0031] 图 3A 为本实用新型的一实施例的触控显示模块的第一定位部的局部放大图。

[0032] 图 3B 为本实用新型的一实施例的触控显示模块的第二定位部的局部放大图。

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[0033] 图 4A 为图 1C 的第一定位部沿 A-A' 线段的剖面图。

[0034] 图 4B 为图 1D 的第二定位部沿 B-B' 线段的剖面图。

[0035] 图 5 为图 1A 的触控显示模块沿 I-I' 线段的剖面图。

[0036] 图 6A 为本实用新型的另一实施例的触控显示模块的剖面图。

[0037] 图 6B 为图 6A 的第一面板与显示器组装的剖面图。

[0038] 图 7A 为本实用新型再一实施例的触控显示模块的立体图。

[0039] 图 7B 为本实用新型再一实施例的触控显示模块沿着 C-C' 线段的剖面图。

[0040] 图 8A 至图 8C 为图 7A 的显示器与第一面板组装过程的剖面图。

[0041] 【主要组件符号说明】

[0042] 100、100A：触控显示模块

[0043] 110、110d、110e、110f、210、410：显示器

[0044] 111：显示面

[0045] 112、212、412：第一定位部

[0046] 112a：第一定位子部

[0047] 112b：第二定位子部

[0048] 112c：底面

[0049] 112d：顶面

[0050] 112e：周面

[0051] 114：显示面板

[0052] 115：对向基板

[0053] 115a：上表面

[0054] 115b：下表面

[0055] 116：胶框

[0056] 117：主动组件基板

[0057] 118：显示介质层

[0058] 120、220、320、420：第一面板

[0059] 122、222、322、422：第二定位部

[0060] 122a：第三定位子部

[0061] 122b：第四定位子部

[0062] 122c：表面

[0063] 124、324：保护板

[0064] 124a：第一表面

[0065] 124b、324b：第二表面

[0066] 126d、126e、126f：触控感测层

[0067] d1、d2：直径

[0068] d3、d4：口径

[0069] 340：遮蔽物

[0070] 412a：基座

[0071] 412b：扣爪

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[0072] 412c：弹性空间

[0073] 412d：斜面

[0074] 412e：凸出部

[0075] 412f：弹性臂

[0076] 422a：表面

[0077] 422b：侧壁

具体实施方式

[0078] 请参考图 1A 至图 1D，本实用新型的触控显示模块 100 包括显示器 110 及第一面板 120。显示器 110 包括至少一第一定位部 112。第一面板 120 配置于显示器 110 上。第一面板 120 包括至少一第二定位部 122。第一定位部 112 与第二定位部 122 结合，而使第一面板 120 与显示器 110 的相对位置固定。如此一来，在触控显示模块 100 的组装过程中，第一面板 120 与显示器 110 之间便不易发生对位异常的问题。此外，由第一定位部 112 与第二定位部 122 的辅助，显示器 110 与第一面板 120 贴合的工时也可有效地缩短。

[0079] 本实施例的显示器 110 包括显示面板 114 及胶框 116。本实施例的第一面板 120 包括保护板 124 以及配置于保护板 124 上的触控感测层 126，触控感测层 126 位于保护板 124 与显示器 110 之间。触控感测层 126 可与保护板 124 直接连接，因此在本实施例的第一面板 120 即可视为一触控面板。在本实施例中，保护板 124 例如为一硬质基板，但本实用新型不以此为限。

[0080] 触控感测层在显示模块中的相对位置，随着显示模块的设计方式不同更可有不同的形式，以下再举实施例说明。图 2A、2B 及图 2C 分别为本实用新型的其他实施例的剖面图。在图 2A 中，显示器 110d 包括主动组件基板 117、相对于主动组件基板 117 的对向基板 115、配置于主动组件基板 117 与对向基板 115 之间的显示介质层 118、以及一触控感测层 126d。在本实施例中，对向基板 115 是位于触控感测层 126d 与显示介质层 118 之间，触控感测层 126d 即为设置在对向基板 115 的一上表面 115a 上。而在图 2B 所示的实施例中，显示器 110e 的触控感测层 126e 位于对向基板 115 与显示介质层 118 之间。换言之，触控感测层 126e 即为设置在对向基板 115 的相对于上表面 115a 的一下表面 115b 上。此外，在图 2C 中，显示器 110f 的触控感测层 126f 位于主动组件基板 117 与显示介质层 118 之间。在图 2B 与图 2C 的实施例中，触控感测层 126e、126f 皆为设置在显示器之内。在以上所述的实施例中，触控感测层皆设置在显示器中，因此设置在显示器之外的第一面板仅会具有一保护板。

[0081] 详言之，在本实施例中，第一定位部 112 可设置在显示器 110 的胶框 116 上。进一步而言，第一定位部 112 的材质与胶框 116 的材质可相同。另一方面，第二定位部 122 可形成于第一面板 120 的保护板 124 上。在本实施例中，第一定位部 112 可为朝向第一面板 120 延伸的凸起物，而第二定位部 122 可为与此凸起物对应的凹陷。然而，本实用新型并不限定显示器上的第一定位部为凸起物，而第一面板上的第二定位部为凹陷。以下举一实施例说明。图 3A 及图 3B 分别为本实用新型的另一实施例的触控显示模块的第一定位部及第二定位部的局部放大图。在本实施例中，第二定位部 222 可为朝向显示器 210 延伸的凸起物，而第一定位部 212 可为与凸起物对应的凹陷。当第二定位部 222 与第一定位部 212 互相结合

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也可使第一面板 220 与显示器 210 的相对位置固定。

[0082] 以下，将详细说明上述定位部的设计方式。为方便本文说明，以下将以图 1A 至图 1D 所示实施例说明，然而本实用新型并不限制此设计方案。图 4A 为根据图 1C 的线段 A-A' 所绘的剖面图、图 4B 为根据图 1D 的线段 B-B' 所绘的剖面图。在图 4A 中，第一定位部 112 为一凸起物，且每一第一定位部 112 包括一第一定位子部 112a 以及一第二定位子部 112b。第一定位子部 112a 连接第二定位子部 112b 与胶框 116。第二定位子部 112b 的最大直径 d1 可大于第一定位子部 112a 的最大直径 d2。具体而言，第一定位子部 112a 可为一柱体，而第二定位子部 112b 近似于圆锥体。还进一步地说，第二定位子部 112b 具有与第一定位子部 112a 直接连接的底面 112c、相对于底面 112c 的顶面 112d，以及环绕底面 112c 及顶面 112d 并连接底面 112c 与顶面 112d 的周面 112e。在本实施例中，底面 112c 的面积可大于顶面 112d 的面积。并且，第一定位子部 112a 被一参考平面所截出的截面积可小于底面 112c 的面积。本实施例在此所指的参考平面为与图 1C 的坐标轴所示的 X-Y 平面平行的平面。所述的平面与显示器 110 的显示面 111 平行，其中显示面 111 是指显示面板 114 所在的平面。整体而言，本实施例的第二定位子部 112b 的外观类似于香菇头的外形。换言之，随着参考平面沿着坐标轴的正 Z 方向远离显示器 110 的距离增加，第二定位子部 112b 被参考平面所截出的截面积会逐渐缩小。

[0083] 相对地，以下详述与第一定位部 112 相对应的第二定位部 122 的形式。在图 4B 中，第一面板 120 的保护板 124 具有第一表面 124a 以及相对于第一表面 124a 的第二表面 124b。第一表面 124a 位于显示器 110 与第二表面 124b 之间。第二定位部 122（即凹陷）贯穿第一表面 124a 并朝第二表面 124b 延伸。在本实施例中，第二定位部 122 可不贯穿第二表面 124b。详细地说，每一第二定位部 122 包括一第三定位子部 122a 以及一第四定位子部 122b。第三定位子部 122a 位于第四定位子部 122b 与显示器 110 之间。第四定位子部 122b 的最大口径 d3 大于第三定位子部 122a 的最大口径 d4。在本实施例中，第三定位子部 122a 可为口径较小且厚度较厚的圆柱形凹陷，而第四定位子部 122b 可为口径较大且厚度较薄的圆锥形凹陷。

[0084] 图 5 为沿着图 1A 的线段 I-I' 所绘的剖面图。请参考图 5，第一面板 120 与显示器 110 组装完成后，第一定位部 112 的第一定位子部 112a 可卡合至第二定位部 122 的第三定位子部 122a，而第二定位子部 112b 可卡合于第四定位子部 122b 中。第二定位子部 112b 的底面 112c 可搭接在第四定位子部 122b 的一表面 122c 上。如此一来，第一定位部 112 与第二定位部 122 便可稳固地结合，进而使第一面板 120 与显示器 110 的相对位置固定。

[0085] 此外，为加强本实施例的显示器 110 与第一面板 120 的固定效果，本实用新型的触控显示模块 100 可进一步地包括一胶体 130。如图 1B 及图 5 所示，胶体 130 可设置于显示器 110 与第一面板 120 之间，而使第一面板 120 更牢固地贴附在显示器 110 上。在本实施例中，胶体 130 例如是双面胶、水胶、上述两者的组合或其他适当的黏着物。

[0086] 需说明的是，本实用新型的第一定位部与第二定位部的结构形式并不限于皆具有两个子部的凸起物及凹陷。所有可形成在第一面板及显示器上的结构，且由此结构可固定第一面板及显示器的相对位置，其皆可作为本实用新型的定位部。

[0087] 如图 4B 所示，上述的实施例的第二定位部 122 并未贯穿保护板 124，所以当第一面板 120 与显示器 110 组装后，保护板 124 的表面不会有开孔。然而，在本实用新型的其他实

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施例中，第一面板可因应薄型化的需求降低厚度，此时，为保持显示器与第一面板的定位结构仍可有效地被成型并且发挥作用，第二定位部 122 也可贯穿保护板 124。图 6A 为本实用新型的另一实施例的触控显示模块的剖面图。图 6B 为图 6A 的第一面板与显示器组装后的剖面示意图。图 6B 所示的触控显示设备 100A 与图 5 所示的触控显示设备 100 的差异之处在于：如图 6A 及图 6B 所示，第一面板 320 的第二定位部 322 可贯穿保护板 324。当第一面板 320 与显示器 110 组装时，第二定位部 322 仍可与第一定位部 112 卡合定位。值得注意的是，由于第二定位部 322 可贯穿保护板 324，故本实施例的触控显示设备 100A 可进一步包括多个遮蔽物 340。遮蔽物 340 配置于保护板 324 的第二表面 324b 上且分别覆盖第二定位部 322。如此一来，第二定位部 322 便不易影响触控显示设备 100A 外观。遮蔽物 340 例如是塑料材质的绝缘贴片 (mylar)，但本实用新型不以此为限。

[0088] 以下，将再举一实施例说明当本实用新型的其中至少一个定位部为凸起物时的设计方式。图 7A 为本实用新型再一实施例的触控显示模块的立体图。图 7B 为图 7A 沿着 C-C' 线段的剖面图。为清楚起见，图 7A 及图 7B 省略第一面板。图 8A 至图 8C 示出图 7A 的显示器与第一面板的组装过程。请参考图 7A 及图 7B，在本实施例中，第一定位部 412 可为凸起物，而第二定位部 422 例如是凹陷，此凹陷且与前述实施例相同，于此便不再赘述。在本实施例中，每一第一定位部 412 包括基座 412a 以及与基座 412a 连接的多个扣爪 412b。扣爪 412b 之间存在至少一弹性空间 412c。

[0089] 扣爪 412b 可具有一斜面 412d、一凸出部 412e 以及一弹性臂 412f。凸出部 412e 适于在第一面板 420 与显示器 110 卡合时，搭接在第二定位部 422 的表面 422a 上。弹性臂 412f 连接凸出部 412e 与基座 412a。弹性臂 412f 可在不发生永久形变的情况下储存弹性位能以带动扣爪 412b 复位。如图 8A 所示，当第一面板 420 与显示器 410 开始组装时，扣爪 412b 开始进入位于第一面板 420 上的第二定位部 422。如图 8B 所示，在扣爪 412b 进入第二定位部 422 的过程中，斜面 112d 及凸出部 412e 可被第二定位部 422 的侧壁 422b 挤压。此时，弹性臂 412f 产生一挠曲，而使扣爪 412b 间的弹性空间 412c 变小。此时，弹性臂 412f 可储存弹性位能。如图 8C 所示。在扣爪 412b 不再被凹陷的侧壁 422b 挤压时，弹性臂 412f 带动扣爪 412b 复位，凸出部 412e 搭接在第二定位部 422 的平面 422a 上，进而使得第一面板 420 与显示器 410 的相对位置固定。

[0090] 综上所述，在本实用新型一实施例的触控显示模块的组装过程中，由第一定位部与第二定位部的辅助，第一面板与显示器之间便不易产生异常的问题，进而使触控显示模块的组装率上升。此外，由第一定位部与第二定位部的辅助，制造者可节省去调整现有定位工具的时间，而使组装触控显示模块所需的工时有效降低。

[0091] 虽然本实用新型已以实施例公开如上，然其并非用以限定本实用新型，任何所属技术领域中具有通常知识者，在不脱离本实用新型的精神和范围内，当可作些许的更动与润饰，故本实用新型的保护范围当视后附的申请专利范围所界定者为准。

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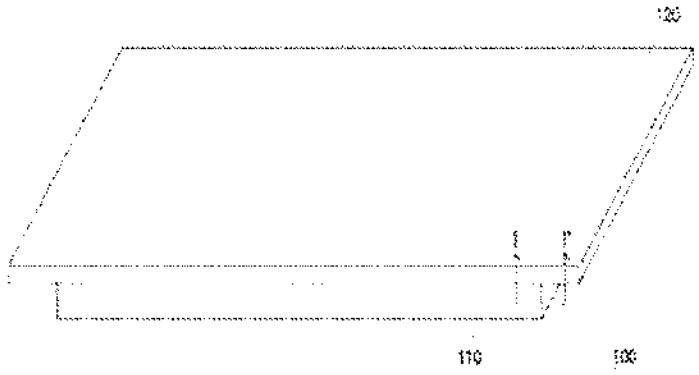


图 1A

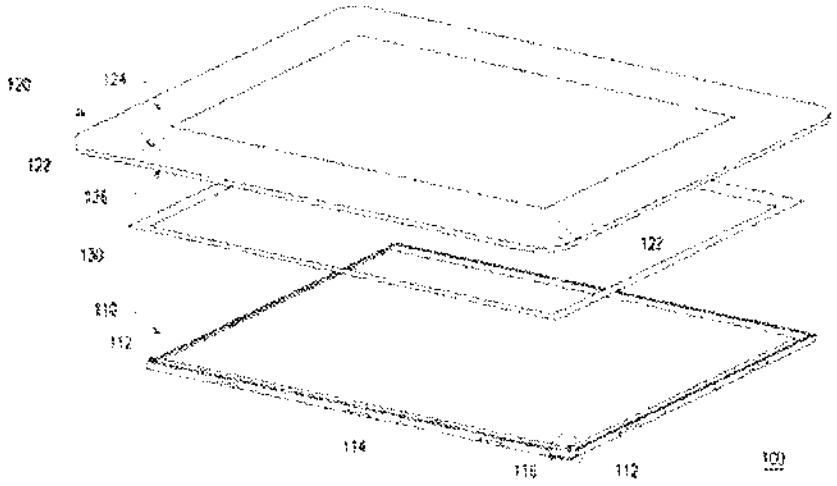


图 1B

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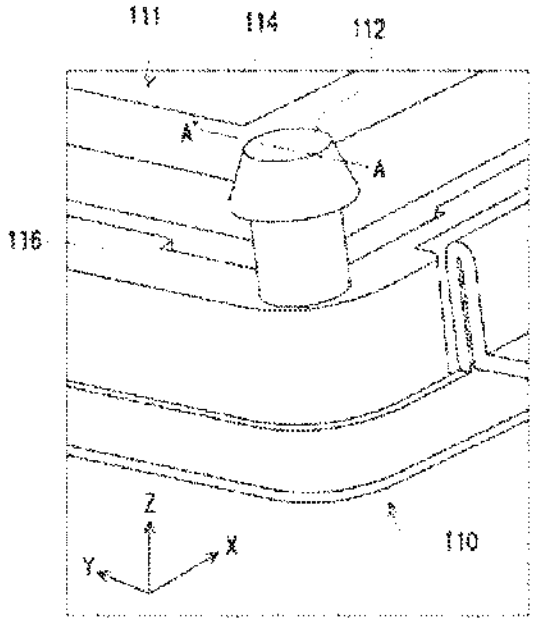


图 1C

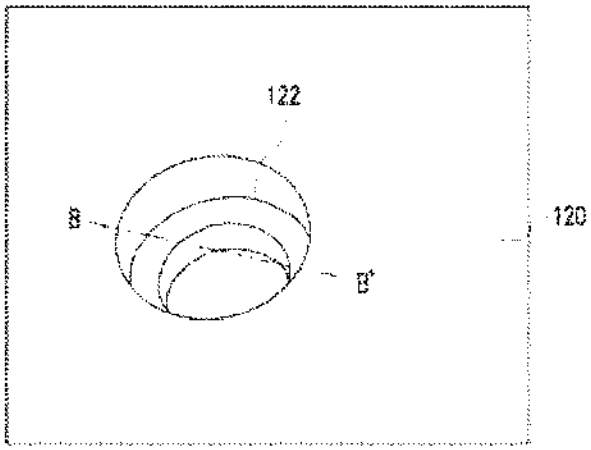


图 1D

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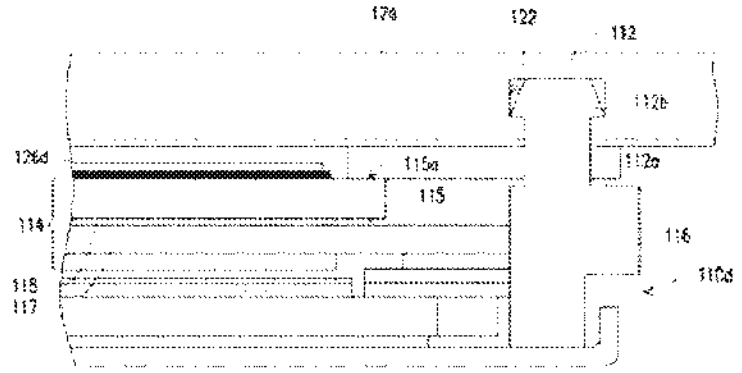


图 2A

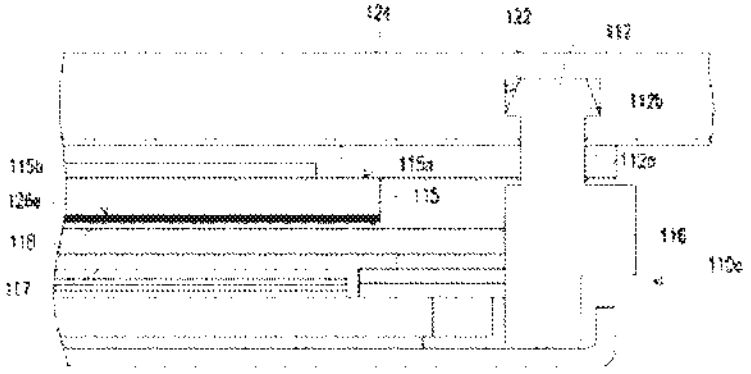


图 2B

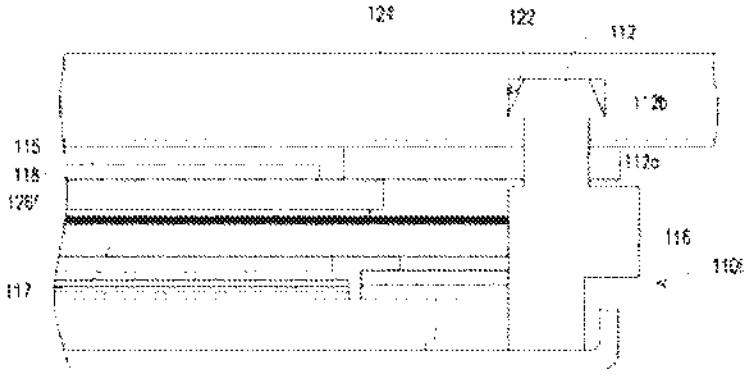


图 2C

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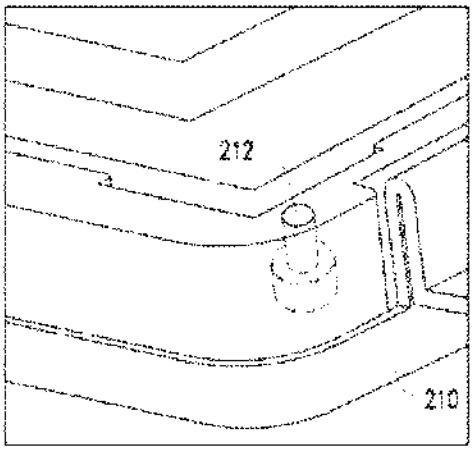


图 3A

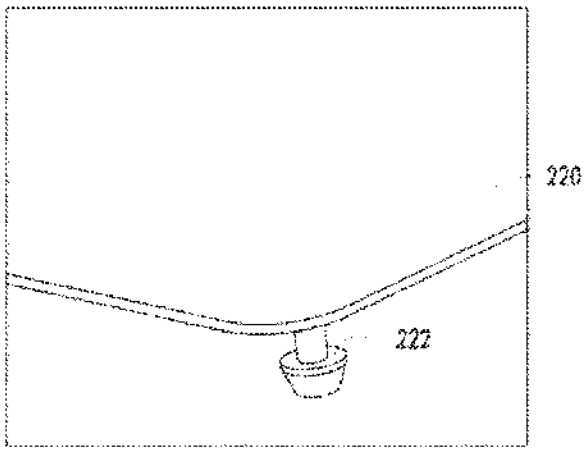


图 3B

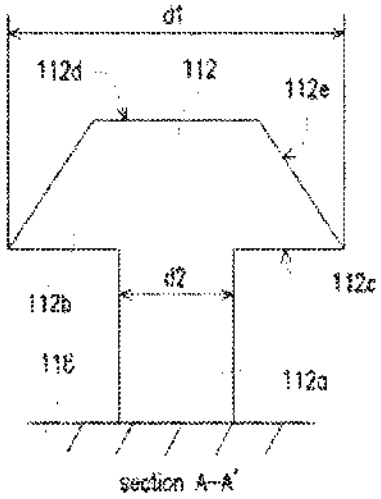


图 4A

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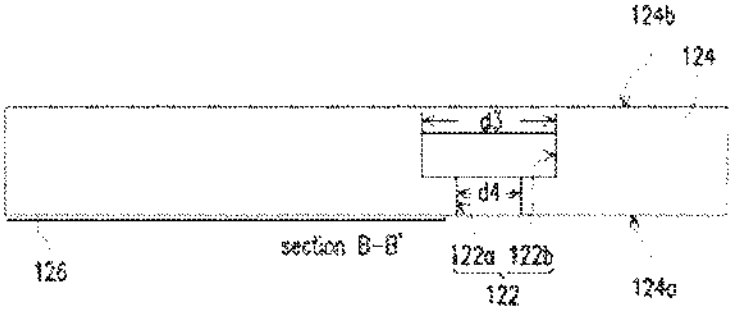


图 4B

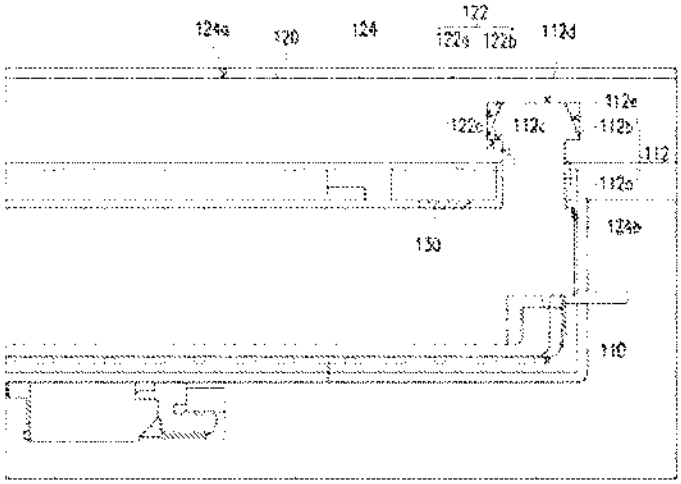


图 5

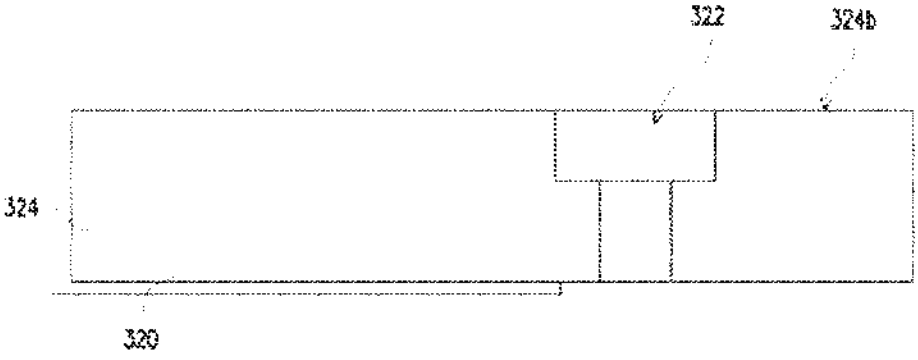


图 6A

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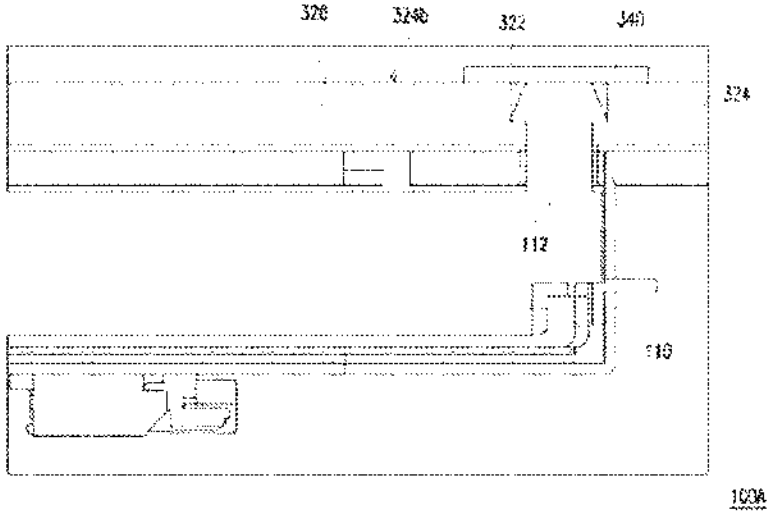


图 6B

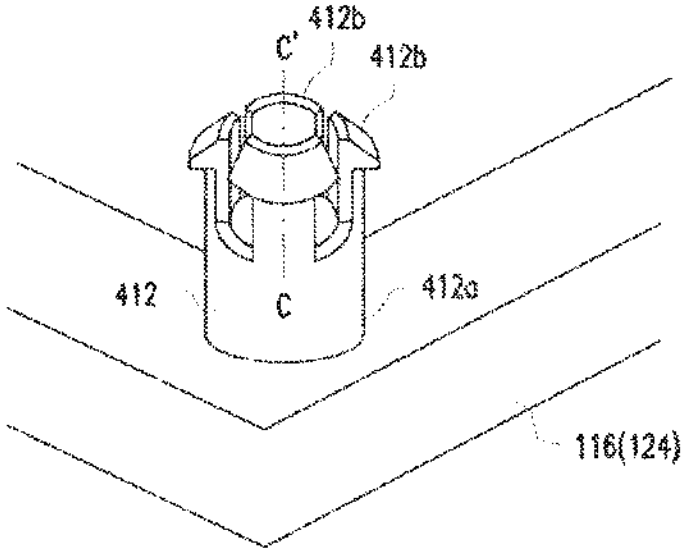


图 7A

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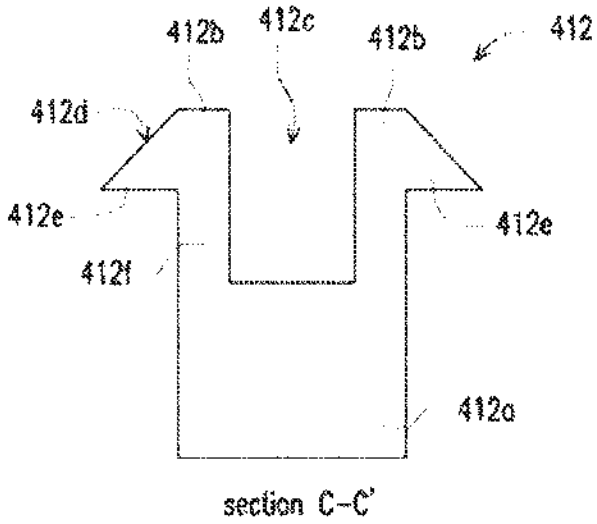


图 7B

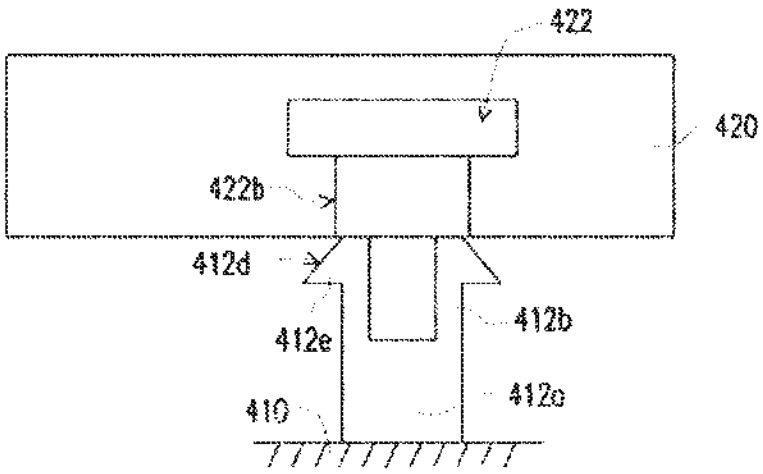


图 8A

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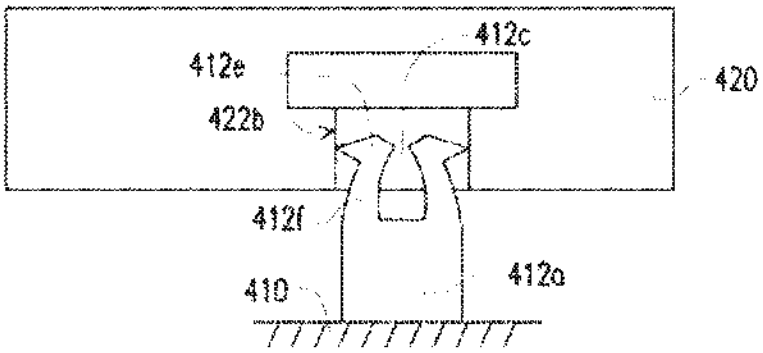


图 8B

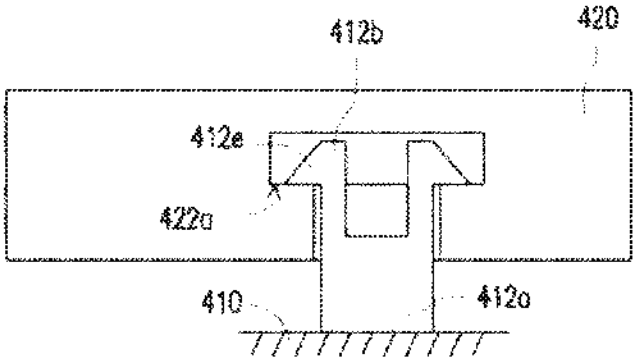


图 8C

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Bibliographic data: CN205015574 (U) — 2016-02-03

Touch -sensitive screen and LCD module laminating tool group

Inventor(s): XIAO LIWEI; CHEN LIN; SHI ZHONGLING ± (XIAO LIWEI, ; CHEN LIN, ; SHI ZHONGLING)

Applicant(s): SHENZHEN LIANHESHENG ELECTRONICS CO LTD ± (SHENZHEN LIANHESHENG ELECTRONICS CO., LTD)

Classification: **- international:** ***G02F1/13; G02F1/1333; G06F3/041***
- cooperative:

Application number: CN20152791177U 20151014

Priority number(s): CN20152791177U 20151014

Abstract of CN205015574 (U)

The utility model discloses a touch -sensitive screen and LCD module laminating tool group, include: a second tool for inciting somebody to action the first tool of liquid crystal display panel and touch -sensitive screen laminating and being used for whole and backlight unit laminating after liquid crystal display panel and the touch -sensitive screen laminating, first tool includes: first bottom plate and four first locating pieces being connected with first bottom plate four angles respectively, first locating piece is equipped with a liquid crystal display panel location portion and touch -sensitive screen location portion with first bottom plate junction, the second tool includes: second bottom plate and four second locating pieces being connected with second bottom plate four angles respectively, the second locating piece is equipped with the 2nd liquid crystal display panel location portion and backlight unit location portion with second bottom plate junction. The utility model discloses adopt earlier appearance frame counterpoint mode to be in the same place liquid crystal display panel with the touch pad laminating, guarantee the product display area uniformity of frame all around, adopt appearance frame counterpoint mode and backlight unit laminating to be in the same place again, guarantee backlight unit's overall dimension well.

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DESCRIPTION CN205015574

The utility model discloses a touch panel and a liquid crystal module bonding fixture group, comprising: a first fixture for bonding a liquid crystal panel and a touch screen, and an overall and a backlight module for bonding the liquid crystal panel and the touch screen; a first jig; the first jig includes: a first bottom plate and four first positioning blocks respectively connected to the four corners of the first bottom plate, and the first positioning block and the first bottom plate are provided with a first a liquid crystal panel positioning portion and a touch screen positioning portion; the second fixture includes: a second bottom plate and four second positioning blocks respectively connected to the four corners of the second bottom plate, and the second positioning block and the second bottom plate are provided with a second connection The liquid crystal panel positioning portion and the backlight module positioning portion. The utility model firstly adopts the outer frame alignment manner to fit the liquid crystal panel and the touch panel together to ensure the consistency of the border around the display area of the product, and then adopts the outer frame alignment manner and the backlight module to be closely attached. Ensure the size of the backlight module.

Touch screen and LCD module bonding fixture set

Technical field

The utility model relates to the technical field of liquid crystal touch screen production, in particular to a touch screen and a liquid crystal module bonding fixture.

Background technique

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At present, with the development of technology and the touch of electronic display products, more and more touch screen and LCD module products have appeared in the market; however, in the production process, the touch screen and the liquid crystal module are used together. The alignment method is two ways of capturing the alignment of the outline frame and the alignment of the capture display area:

1. When the matching frame is used to fit the position, the fixture is used to capture the shape of the touch screen and the LCD module, and the tolerance of the two sides of the fixture is adjusted to ensure the tolerance of the fitting, as shown in Figure 1.

2. When the position of the display area is used to fit the position, the CCD lens is used to project the border of the display area of the touch screen and the liquid crystal module onto the computer display, and the distance between the two frames of the display area is adjusted by the computer to ensure the fit. The tolerances are shown in Figure 2.

With the development of science and technology, the surface color of many touch screen covers has been diversified, not just black covers, which causes defects in the two methods of conformation alignment described above. The first one is to capture the alignment of the outline of the frame, although it can guarantee the fit of the shape, but can not guarantee that the display area of the two is centered (the surrounding frame size is symmetrical). The so-called frame asymmetry phenomenon is that when the touch screen is attached to the liquid crystal module, as shown in FIG. 3, a black border having a width of about 1 mm exists around the visible area of the liquid crystal module, that is, a display area and a visible area may appear. Black border, the size of the border around the display area is inconsistent after the fit. When the touch screen is a bright color cover, the size of the black border is asymmetrical. The second is to capture the alignment of the display area border. Although it can ensure that the size of the surrounding area of the visible area is symmetrical after the bonding, the outer dimensions of the backlight module on the LCD module cannot be controlled, as shown in Figure 4.

Therefore, the prior art has drawbacks and needs improvement.

Utility model content

The purpose of the utility model is to overcome the deficiencies of the prior art, and provide a touch panel and a liquid crystal module bonding fixture set, which can well solve the problem that the border sizes of the display areas of the liquid crystal module are inconsistent in the prior art, and cannot Ensure the size of the backlight module.

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The technical solution of the utility model is as follows: The utility model provides a touch panel and a liquid crystal module bonding fixture set, comprising: a first treatment for bonding a liquid crystal panel and a touch screen which have not been assembled with the backlight module together And a second jig for integrally bonding the liquid crystal panel and the touch screen to the backlight module; the first jig includes: a first bottom plate, and the first bottom plate respectively Four first positioning blocks connected to the four corners, the first positioning block and the first bottom plate are provided with a first liquid crystal panel positioning portion and a touch screen positioning portion; the second fixture includes: a second bottom plate And a second second positioning block respectively connected to the four corners of the second bottom plate, wherein the second positioning block and the second bottom plate are connected with a second liquid crystal panel positioning portion and a backlight module positioning portion.

In the first positioning block, the first liquid crystal panel positioning portion and the touch screen positioning portion are arranged in a step, and the first liquid crystal panel positioning portion is located below the touch screen positioning portion.

In the second positioning block, the second liquid crystal panel positioning portion and the backlight module positioning portion are arranged in a step, and the backlight module positioning portion is located below the second liquid crystal panel positioning portion.

The first positioning block is further provided with a first groove, the first groove is connected with the touch screen positioning portion; any of the second positioning blocks is further provided with a second groove, the second The groove is connected to the positioning portion of the second liquid crystal panel, and the second positioning block is further provided with a third groove, and the third groove is connected to the positioning portion of the second liquid crystal panel and the positioning portion of the backlight module.

The first positioning block is integrally formed with the first bottom plate, and the second positioning block is integrally formed with the second bottom plate.

According to the above solution, the touch screen and the liquid crystal module of the utility model are attached to the jig set, and the jig set is used to firstly align the liquid crystal panel and the touch panel by using the outer frame alignment manner, thereby ensuring the border of the product display area. Consistency, and then the shape border alignment mode and the backlight module are attached together, which can well ensure the outer dimensions of the backlight module, and the utility model can also reduce the backlight loss well.

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DRAWINGS

FIG. 1 is a schematic diagram of the prior art in which the capture frame is used to fit the position.

FIG. 2 is a schematic diagram of the prior art in which the frame of the capture display area is aligned.

FIG. 3 is a schematic diagram showing a black border appearing in a visible area of a liquid crystal module in the prior art.

FIG. 4 is a schematic diagram of the appearance of the backlight module being uncontrollable when the frame of the capture display area is aligned in the prior art.

FIG. 5 is a schematic structural view of the first fixture in the touch panel and the liquid crystal module bonding fixture set of the present invention.

Figure 6 is an enlarged view of a portion A in Figure 5.

FIG. 7 is a schematic structural view of a second jig in a touch panel and a liquid crystal module bonding jig set according to the present invention.

Figure 8 is an enlarged view of B in Figure 7.

Detailed ways

The present invention will be described in detail below in conjunction with the accompanying drawings and specific embodiments.

Referring to FIG. 5 to FIG. 8 , the present invention provides a touch panel and a liquid crystal module bonding jig set. The jig set can be used to solve the problem that the border size of the display area of the liquid crystal module is inconsistent and cannot be solved in the prior art. The problem of ensuring the size of the backlight

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module. The fixture set includes: a first jig 20 for bonding a liquid crystal panel that has not been assembled with a backlight module and a touch screen, and an integral and backlight module for bonding the liquid crystal panel and the touch screen together A second jig 40 that is attached together.

Specifically, the first jig 20 includes: a first bottom plate 22, and four first positioning blocks 24 respectively connected to four corners of the first bottom plate 22, the first positioning block 24 and the first A first liquid crystal panel positioning portion 26 and a touch screen positioning portion 28 are provided at a joint of the bottom plate 22. In the first positioning block 24 , the first liquid crystal panel positioning portion 26 and the touch screen positioning portion 28 are arranged in a step, and the first liquid crystal panel positioning portion 26 is located below the touch screen positioning portion 28 . The second jig 40 includes a second bottom plate 42 and four second positioning blocks 44 respectively connected to the four corners of the second bottom plate 42 . The second positioning block 44 and the second bottom plate 42 . The second liquid crystal panel positioning portion 46 and the backlight module positioning portion 48 are provided at the connection. In the second positioning block 44, the second liquid crystal panel positioning portion 46 and the backlight module positioning portion 48 are arranged in a stepped manner, and the backlight module positioning portion 48 is located in the second liquid crystal panel positioning portion 46. Below.

Further, the first positioning block 24 is further provided with a first recess 25, and the first recess 25 is connected to the touch screen positioning portion 28, and the first recess 25 can be used to assist the liquid crystal panel with After the touch screen is attached, the whole fixture is quickly disassembled from the first jig 20 to improve work efficiency. The second positioning block 44 is further provided with a second recess 45. The second recess 45 is connected to the second liquid crystal panel positioning portion 46, and the other second positioning block 44 is further provided with a second recess 44. The three recesses 47 are connected to the second liquid crystal panel positioning portion 46 and the backlight module positioning portion 48. The second and third recesses 45 and 47 can assist the liquid crystal panel and the touch screen. After the backlight module is attached, the whole fixture is quickly disassembled from the second fixture 40 to improve work efficiency.

The first positioning block 24 is integrally formed with the first bottom plate 22, and the second positioning block 44 is integrally formed with the second bottom plate 42, which has high production efficiency and is convenient for reducing the production cost of the fixture set.

The specific bonding principle is that the liquid crystal panel is placed in the receiving space formed by the first liquid crystal panel positioning portion 26 of the four first positioning blocks 24 and the first bottom plate 22, and the touch screen is placed on the touch screen of the four first positioning blocks 24. In the accommodating space formed by the positioning portion 28 and the first bottom plate 22, the first jig 20 is used to capture the outer border of the touch screen and the outer frame of the liquid crystal panel, and the alignment is completed, and the touch screen and the liquid crystal panel are attached together. The liquid crystal panel of the assembled

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backlight module is attached to the touch panel, and the alignment of the outer frame is used for alignment, which can ensure the consistency of the border around the display area. Then, the backlight module is placed in the accommodating space formed by the backlight module positioning portion 48 and the second bottom plate 42 of the four second positioning blocks 44, and the touch screen and the liquid crystal panel are bonded together to form the whole body. In the accommodating space formed by the second liquid crystal panel positioning portion 46 and the second bottom plate 22 of the second positioning block 44, the second jig 40 captures the overall outer frame formed by the touch panel and the liquid crystal panel. And the outer frame of the backlight module completes the alignment, and the liquid crystal panel and the backlight module are attached together to complete the bonding of the touch screen and the liquid crystal module, so as to ensure the outer dimensions after the bonding.

In summary, the utility model provides a touch panel and a liquid crystal module bonding fixture group, and the utility model adopts the outer frame alignment manner to firstly laminate the liquid crystal panel and the touch panel to ensure the product display area. The consistency of the surrounding frames, and then the alignment of the outline frame and the backlight module are attached together, which can well ensure the outer dimensions of the backlight module, and the utility model can also reduce the backlight loss well.

The above are only the preferred embodiments of the present invention, and are not intended to limit the present invention. Any modifications, equivalent substitutions and improvements made within the spirit and principles of the present invention should be included in the present invention. Within the scope of protection.

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CLAIMS CN205015574

1.

A touch panel and a liquid crystal module bonding fixture set, comprising: a first fixture for bonding a liquid crystal panel not assembled with a backlight module and a touch screen, and a liquid crystal panel a second jig attached to the touch screen and integrated with the backlight module; the first jig includes: a first bottom plate, and four first ends respectively connected to the four corners of the first bottom plate a positioning block, the first positioning block and the first bottom plate are provided with a first liquid crystal panel positioning portion and a touch screen positioning portion; the second jig includes: a second bottom plate, and the second and the second Four second positioning blocks connected to the four corners of the bottom plate, and a second liquid crystal panel positioning portion and a backlight module positioning portion are disposed at the connection between the second positioning block and the second bottom plate.

2.

The touch panel and the liquid crystal module bonding fixture set according to claim 1, wherein in the first positioning block, the first liquid crystal panel positioning portion and the touch screen positioning portion are arranged in a stepped manner, The first liquid crystal panel positioning portion is located below the touch screen positioning portion.

3.

The touch panel and the liquid crystal module bonding fixture set according to claim 1 , wherein in the second positioning block, the second liquid crystal panel positioning portion and the backlight module positioning portion are arranged in a step shape. The backlight module positioning portion is located below the second liquid crystal panel positioning portion.

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4.

The touch panel and the liquid crystal module bonding fixture set according to claim 1, wherein any one of the first positioning blocks is further provided with a first groove, and the first groove is connected with the touch screen positioning portion. The second positioning block is further provided with a second groove, the second groove is connected to the second liquid crystal panel positioning portion, and the other second positioning block is further provided with a third groove. Each of the third grooves is connected to the second liquid crystal panel positioning portion and the backlight module positioning portion.

5.

The touch panel and the liquid crystal module bonding jig set according to any one of claims 1 to 4, wherein the first positioning block is integrally formed with the first bottom plate, and the second positioning block and the second bottom plate are integrally formed. One piece.

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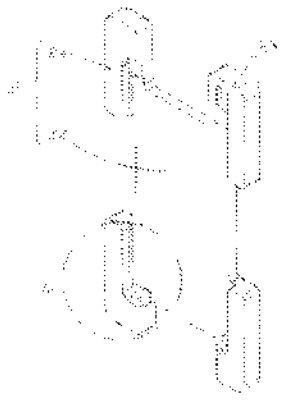
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(54)实用新型名称

触摸屏与液晶模组贴合治具组

(57)摘要

本实用新型公开一种触摸屏与液晶模组贴合治具组，包括：用于将液晶面板与触摸屏贴合的第一治具、及用于将液晶面板与触摸屏贴合后的整体与背光模组贴合的第二治具；第一治具包括：第一底板及分别与第一底板四个角连接的四个第一定位块，第一定位块与第一底板连接处设有第一液晶面板定位部及触摸屏定位部；第二治具包括：第二底板及分别与第二底板四个角连接的四个第二定位块，第二定位块与第二底板连接处设有第二液晶面板定位部及背光模组定位部。本实用新型先采用外形边框对位方式将液晶面板与触摸板贴合在一起，保证产品显示区域四周边框的一致性，再采用外形边框对位方式与背光模组贴合在一起，很好地保证背光模组的外形尺寸，



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1. 一种触摸屏与液晶模组贴合治具组，其特征在于，包括：用于将还没与背光模组组装的液晶面板与触摸屏贴合在一起的第一治具、以及用于将液晶面板与触摸屏贴合在一起的整体与背光模组贴合在一起的第二治具；所述第一治具包括：第一底板、以及分别与所述第一底板四个角连接的四个第一定位块，所述第一定位块与所述第一底板连接处设有第一液晶面板定位部以及触摸屏定位部；所述第二治具包括：第二底板、以及分别与所述第二底板四个角连接的四个第二定位块，所述第二定位块与所述第二底板连接处设有第二液晶面板定位部以及背光模组定位部。

2. 根据权利要求 1 所述的触摸屏与液晶模组贴合治具组，其特征在于，在所述第一定位块中，所述第一液晶面板定位部与触摸屏定位部呈阶梯状设置，所述第一液晶面板定位部位于所述触摸屏定位部的下方。

3. 根据权利要求 1 所述的触摸屏与液晶模组贴合治具组，其特征在于，在所述第二定位块中，所述第二液晶面板定位部与背光模组定位部呈阶梯状设置，所述背光模组定位部位于所述第二液晶面板定位部的下方。

4. 根据权利要求 1 所述的触摸屏与液晶模组贴合治具组，其特征在于，任一所述第一定位块上还设有第一凹槽，所述第一凹槽与触摸屏定位部连接；任一所述第二定位块上还设有第二凹槽，所述第二凹槽与第二液晶面板定位部连接，另一所述第二定位块上还设有第三凹槽，所述第三凹槽均与第二液晶面板定位部及背光模组定位部连接。

5. 根据权利要求 1 至 4 任一项所述的触摸屏与液晶模组贴合治具组，其特征在于，所述第一定位块与第一底板一体成型，所述第二定位块与第二底板一体成型。

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触摸屏与液晶模组贴合治具组

技术领域

[0001] 本实用新型涉及液晶触摸屏生产技术领域，尤其涉及一种触摸屏与液晶模组贴合治具。

背景技术

[0002] 目前，随着科技的发展，电子显示产品的触控化，市场出现了越来越多的触摸屏与液晶模组贴合产品；但，在生产过程中，触摸屏与液晶模组贴合时所用的对位方式分别为捕抓外形边框对位与捕抓显示区域边框对位两种方法：

[0003] 一、采用捕抓外形边框对位进行贴合时，通过治具捕抓触摸屏与液晶模组的外形边框，通过调整治具上两边的固定距离来保证贴合的公差，如图 1 所示；

[0004] 二、采用捕抓显示区域边框对位进行贴合时，使用 CCD 镜头将触摸屏与液晶模组的显示区域边框分别投影到电脑显示上，通过电脑显示调整显示区域两个边框的距离来保证贴合的公差，如图 2 所示。

[0005] 随着科学技术的发展，许多触摸屏盖板的表面颜色呈多元化发展，而不仅仅为黑色盖板，这会造成以上所描述的两种贴合对位方法都存在缺陷。第一种是捕抓外形边框的对位方式虽然可以保证外形的贴合尺寸，但无法保证到两者的显示区域居中对应（四周的边框大小对称）。所谓边框不对称现象就是触摸屏与液晶模组贴合时，如图 3 所示，液晶模组可视区域四周存在宽度约为 1mm 的黑色边框，也就是说显示区域与可视区域之间会出现黑色边框，贴合后显示区域四周边框大小不一致。当触摸屏为亮色盖板时，此黑色边框四周大小不对称会非常明显。第二种是捕抓显示区域边框对位，虽然能保证贴合后可视区域四周大小边对称，但是液晶模组上的背光模组外形尺寸将无法得到管控，如图 4 所示。

[0006] 因此，现有技术存在缺陷，需要改进。

实用新型内容

[0007] 本实用新型的目的是克服现有技术的不足，提供一种触摸屏与液晶模组贴合治具组，很好地解决了现有技术中液晶模组显示区域四周边框大小不一致的问题，以及无法保证背光模组外形尺寸。

[0008] 本实用新型的技术方案如下：本实用新型提供一种触摸屏与液晶模组贴合治具组，包括：用于将还没与背光模组组装的液晶面板与触摸屏贴合在一起的第一治具，以及用于将液晶面板与触摸屏贴合在一起的整体与背光模组贴合在一起的第二治具；所述第一治具包括：第一底板、以及分别与所述第一底板四个角连接的四个第一定位块，所述第一定位块与所述第一底板连接处设有第一液晶面板定位部以及触摸屏定位部；所述第二治具包括：第二底板、以及分别与所述第二底板四个角连接的四个第二定位块，所述第二定位块与所述第二底板连接处设有第二液晶面板定位部以及背光模组定位部。

[0009] 在所述第一定位块中，所述第一液晶面板定位部与触摸屏定位部呈阶梯状设置，所述第一液晶面板定位部位于所述触摸屏定位部的下方。

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[0010] 在所述第二定位块中，所述第二液晶面板定位部与背光模组定位部呈阶梯状设置，所述背光模组定位部位于所述第二液晶面板定位部的下方。

[0011] 任一所述第一定位块上还设有第一凹槽，所述第一凹槽与触摸屏定位部连接；任一所述第二定位块上还设有第二凹槽，所述第二凹槽与第二液晶面板定位部连接，另一所述第二定位块上还设有第三凹槽，所述第三凹槽均与第二液晶面板定位部及背光模组定位部连接。

[0012] 所述第一定位块与第一底板一体成型，所述第二定位块与第二底板一体成型。

[0013] 采用上述方案，本实用新型的触摸屏与液晶模组贴合治具组，应用该治具组先采用外形边框对位方式将液晶面板与触摸板贴合在一起，保证了产品显示区域四周边框的一致性，之后再采用外形边框对位方式与背光模组贴合在一起，可以很好地保证背光模组的外形尺寸，本实用新型还能够很好地降低背光损耗。

附图说明

[0014] 图 1 为现有技术中采用辅抓外形边框对位进行贴合的原理图。

[0015] 图 2 为现有技术中采用辅抓显示区域边框对位进行贴合的原理图。

[0016] 图 3 为现有技术中液晶模组可视区域出现黑色边框的示意图。

[0017] 图 4 为现有技术中采用辅抓显示区域边框对位时出现背光模组外形尺寸无法管控的示意图。

[0018] 图 5 为本实用新型触摸屏与液晶模组贴合治具组中第一治具的结构示意图。

[0019] 图 6 为图 5 中 A 处的放大图。

[0020] 图 7 为本实用新型触摸屏与液晶模组贴合治具组中第二治具的结构示意图。

[0021] 图 8 为图 7 中 B 处的放大图。

具体实施方式

[0022] 以下结合附图和具体实施例，对本实用新型进行详细说明。

[0023] 请参阅图 5 至图 8，本实用新型提供一种触摸屏与液晶模组贴合治具组，利用该治具组可以很好解决现有技术中存在液晶模组显示区域四周边框大小不一致以及无法保证背光模组外形尺寸的问题。该治具组包括：用于将还没与背光模组组装的液晶面板与触摸屏贴合在一起的第一治具 20、以及用于将液晶面板与触摸屏贴合在一起的整体与背光模组贴合在一起的第二治具 40。

[0024] 具体的，所述第一治具 20 包括：第一底板 22、以及分别与所述第一底板 22 四个角连接的四个第一定位块 24，所述第一定位块 24 与所述第一底板 22 连接处设有第一液晶面板定位部 26 以及触摸屏定位部 28。在所述第一定位块 24 中，所述第一液晶面板定位部 26 与触摸屏定位部 28 呈阶梯状设置，所述第一液晶面板定位部 26 位于所述触摸屏定位部 28 的下方。所述第二治具 40 包括：第二底板 42、以及分别与所述第二底板 42 四个角连接的四个第二定位块 44，所述第二定位块 44 与所述第二底板 42 连接处设有第二液晶面板定位部 46 以及背光模组定位部 48。在所述第二定位块 44 中，所述第二液晶面板定位部 46 与背光模组定位部 48 呈阶梯状设置，所述背光模组定位部 48 位于所述第二液晶面板定位部 46 的下方。

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[0025] 进一步地，任一所述第一定位块 21 上还设有第一凹槽 25，所述第一凹槽 25 与触摸屏定位部 28 连接，利用该第一凹槽 25，可以辅助将液晶面板与触摸屏贴合后的整体，从第一治具 20 上快速拆卸下来，提升工作效率。任一所述第二定位块 41 上还设有第二凹槽 45，所述第二凹槽 45 与第二液晶面板定位部 46 连接，另一所述第二定位块 41 上还设有第三凹槽 47，所述第三凹槽 47 均与第二液晶面板定位部 46 及背光模组定位部 48 连接，利用该第二与第三凹槽 45、47，可以辅助将液晶面板、触摸屏及背光模组贴合后的整体，从第二治具 40 上快速拆卸下来，提升工作效率。

[0026] 所述第一定位块 21 与第一底板 22 一体成型，所述第二定位块 41 与第二底板 42 一体成型，生产效率高，便于降低治具组的生产成本。

[0027] 具体贴合原理是：将液晶面板放置于四个第一定位块 24 的第一液晶面板定位部 26 与第一底板 22 形成的收容空间中，将触摸屏放置于四个第一定位块 24 的触摸屏定位部 28 与第一底板 22 形成的收容空间中，利用第一治具 20 分别抓取触摸屏外形边框与液晶面板外形边框，完成对位，并将触摸屏与液晶面板贴合在一起，采用还没组装背光模组的液晶面板与触摸板贴合在一起，并采用外形边框的对位方式进行对位，可以很好地保证显示区域四周边框的一致性。之后，再将背光模组放置于四个第二定位块 41 的背光模组定位部 48 与第二底板 42 形成的收容空间中，将触摸屏与液晶面板贴合在一起后形成的整体放置于四个第二定位块 41 的第二液晶面板定位部 46 与第二底板 22 形成的收容空间中，利用第二治具 40 分别抓取触摸屏与液晶面板贴合在一起后形成的整体的外形边框、以及背光模组的外形边框，完成对位，并将液晶面板与背光模组贴合在一起，以完成触摸屏与液晶模组的贴合，这样可以保证贴合后的外形尺寸。

[0028] 综上所述，本实用新型提供一种触摸屏与液晶模组贴合治具组，应用该治具组先采用外形边框对位方式将液晶面板与触摸板贴合在一起，保证了产品显示区域四周边框的一致性，之后再采用外形边框对位方式与背光模组贴合在一起，可以很好地保证背光模组的外形尺寸，本实用新型还能够很好地降低背光损耗。

[0029] 以上仅为本实用新型的较佳实施例而已，并不用于限制本实用新型，凡在本实用新型的精神和原则之内所作的任何修改、等同替换和改进等，均应包含在本实用新型的保护范围之内。

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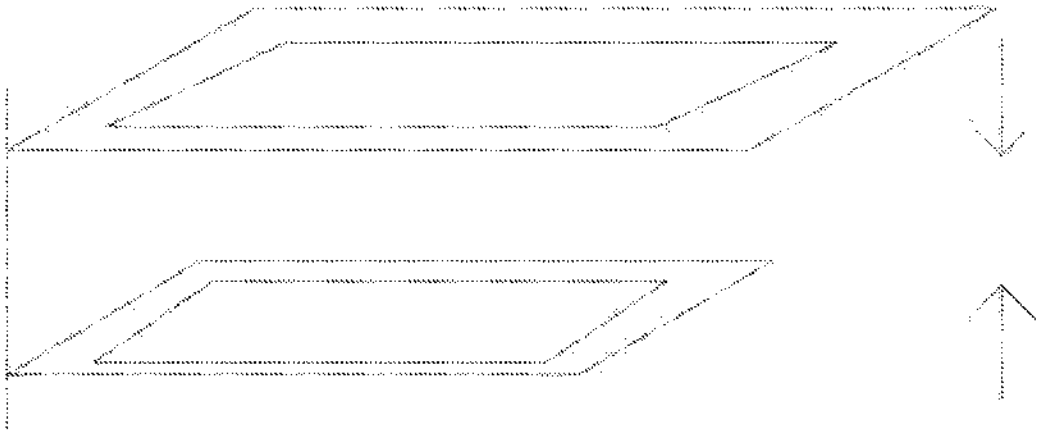


图 1



图 2

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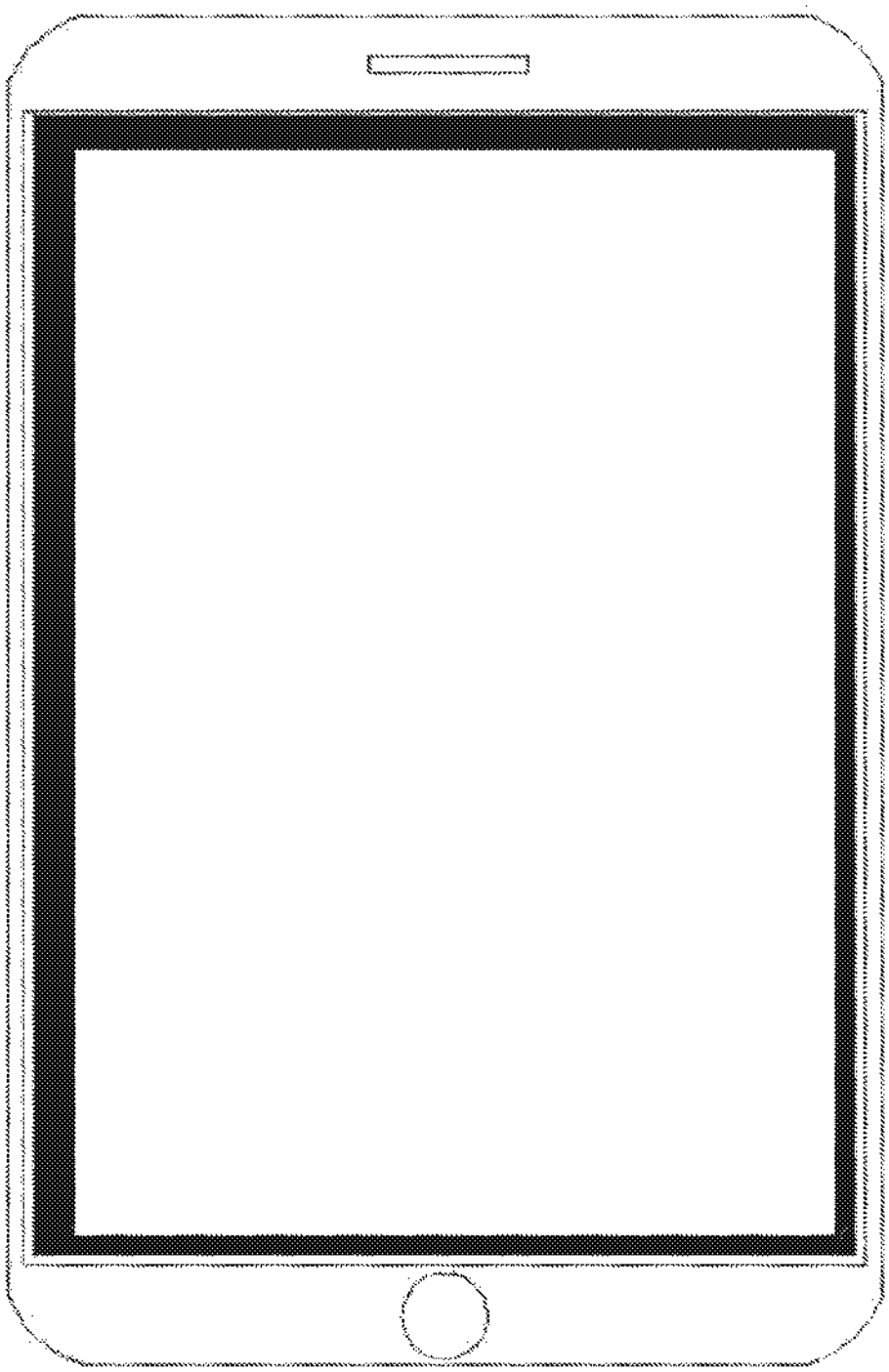


图 3

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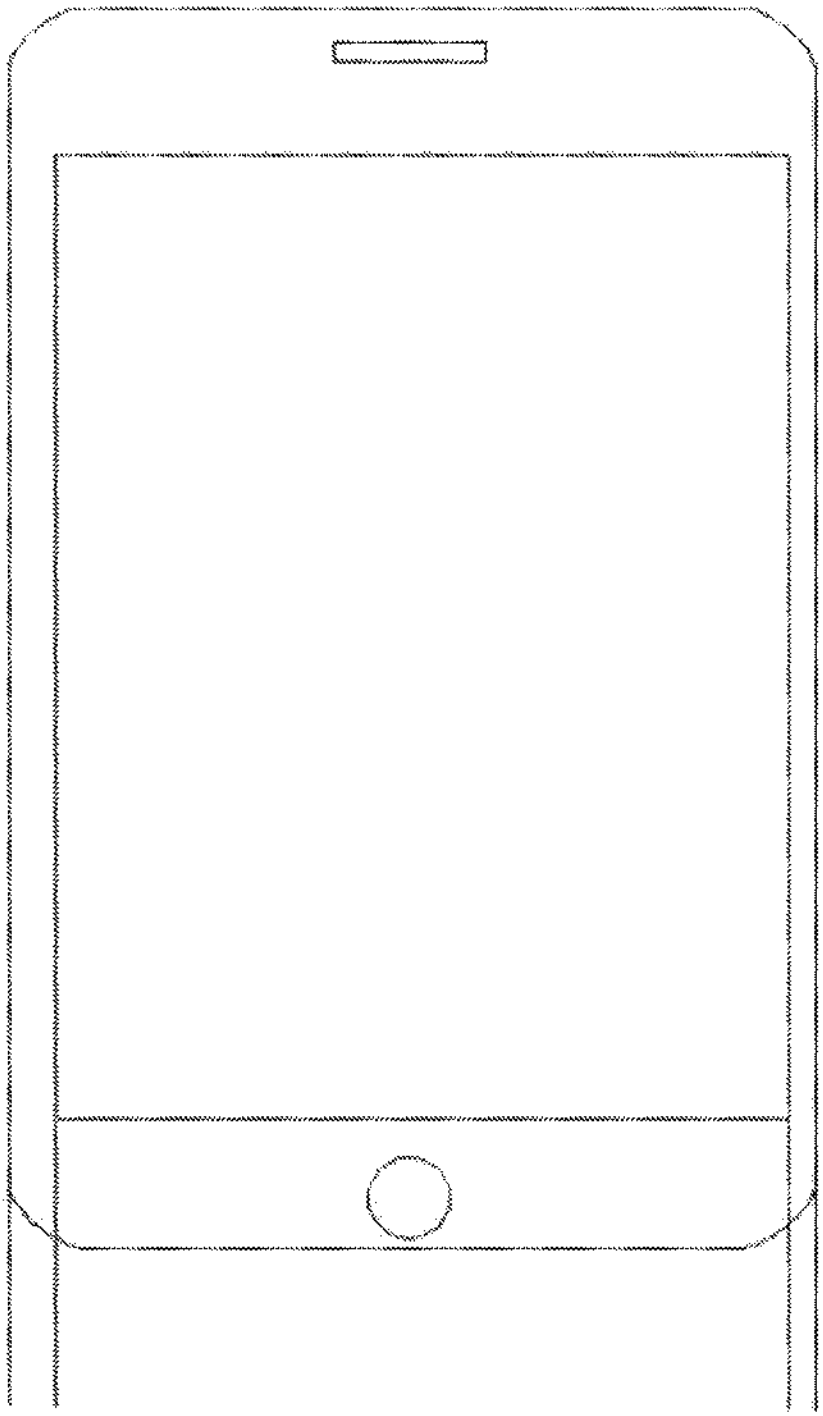


图 4

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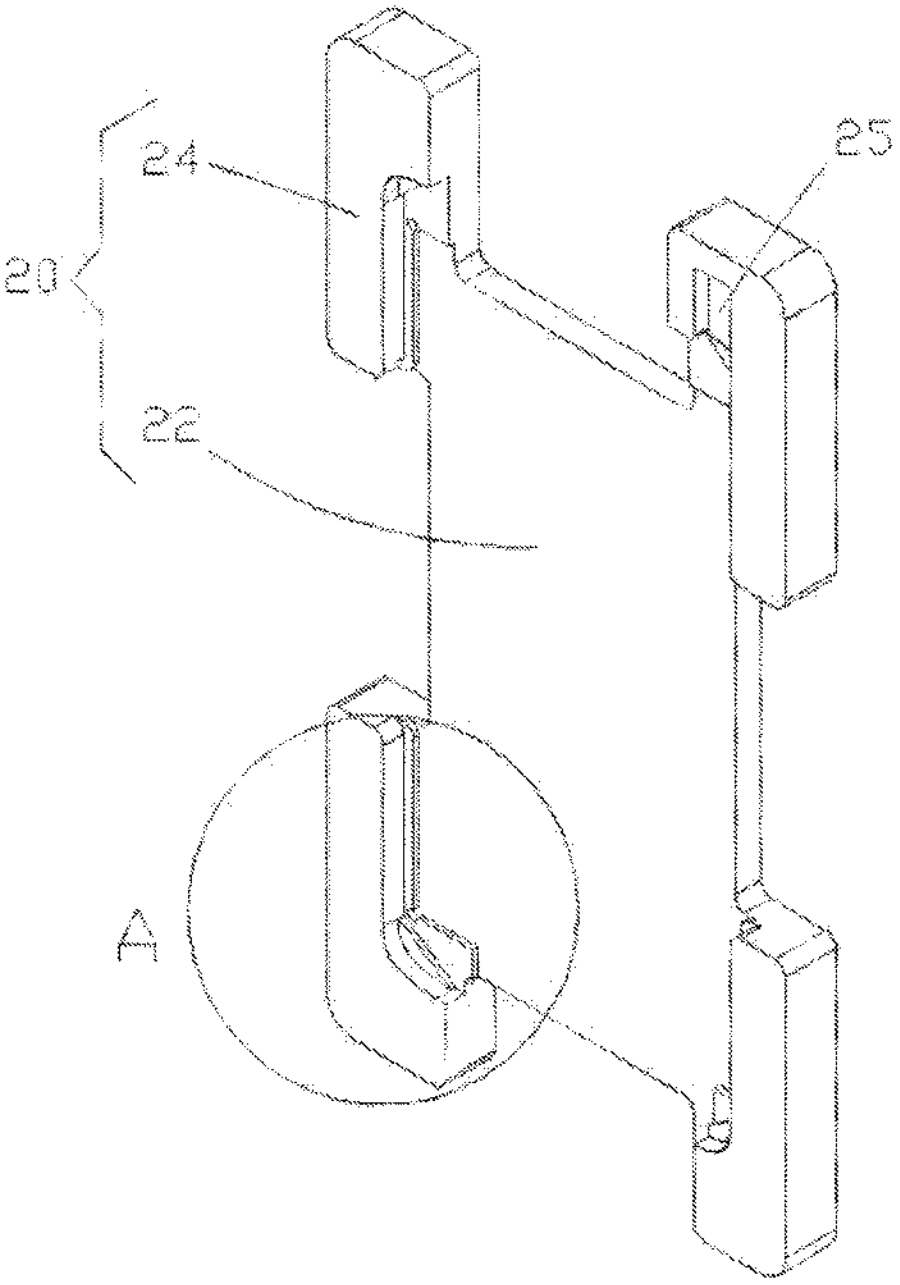


图 5

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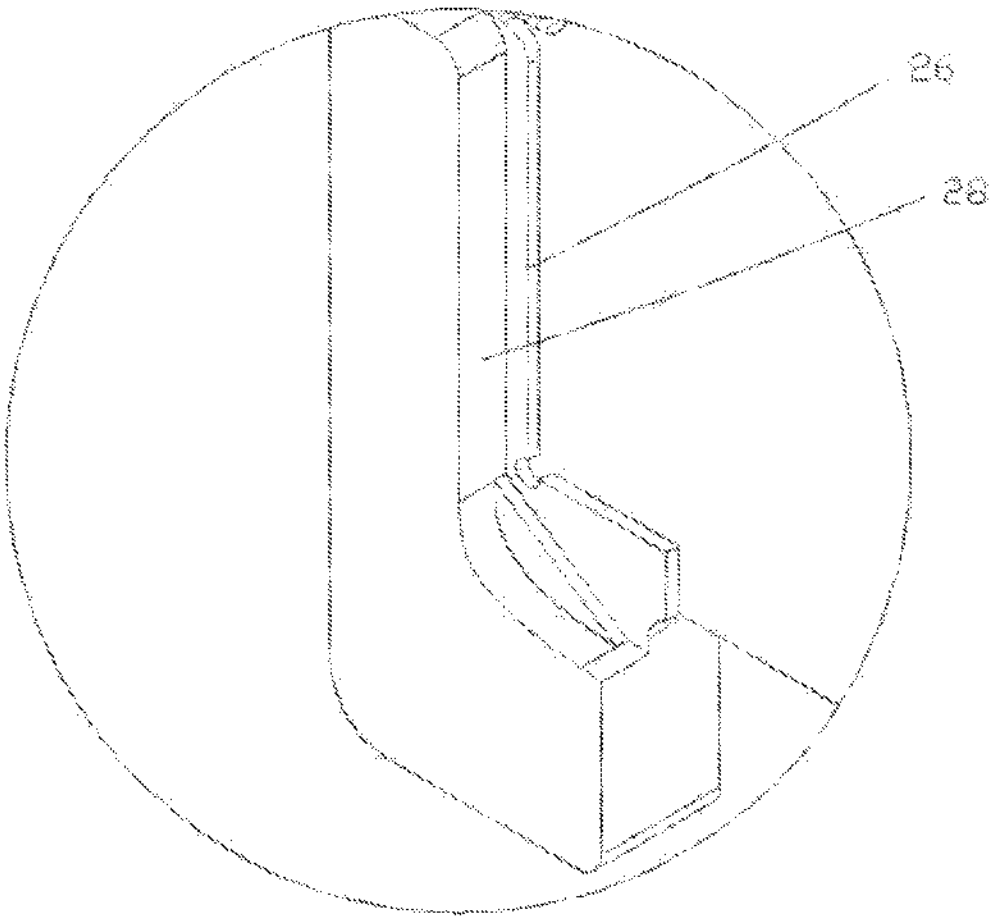


图 6

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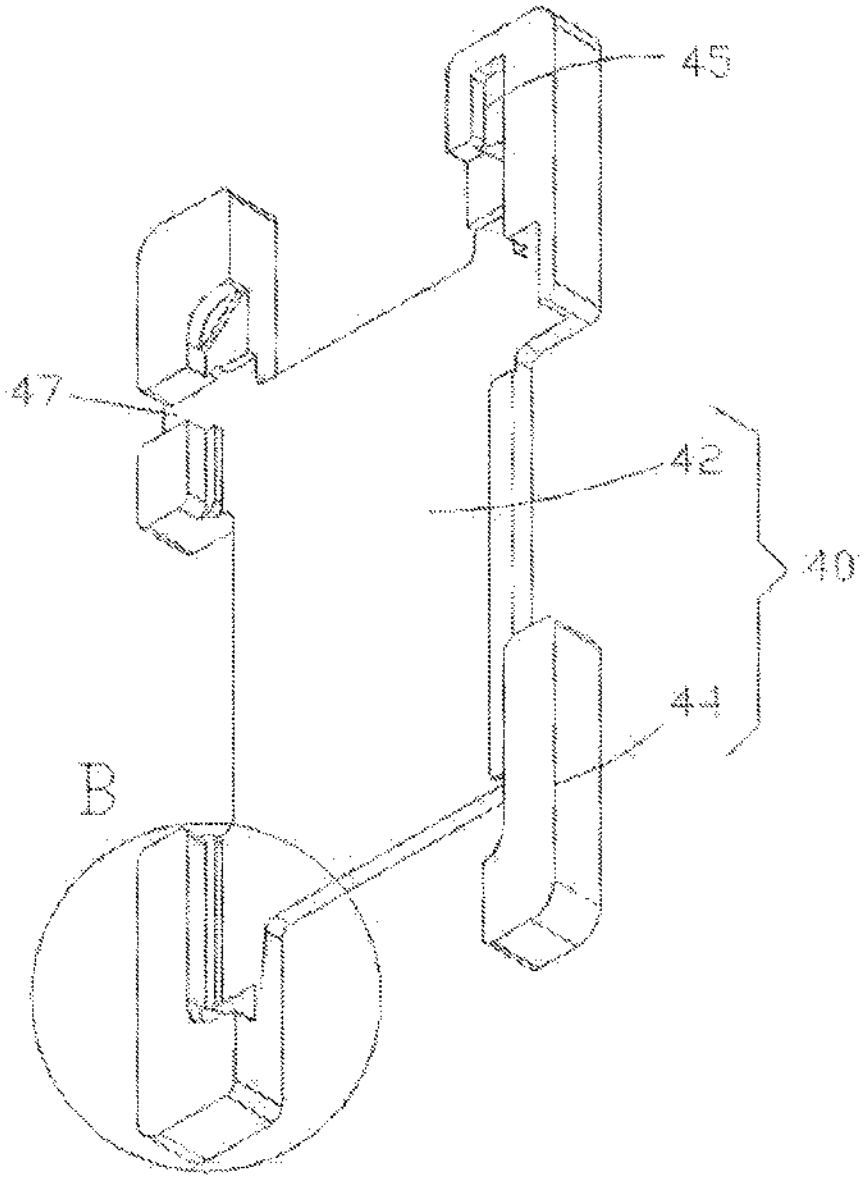


图 7

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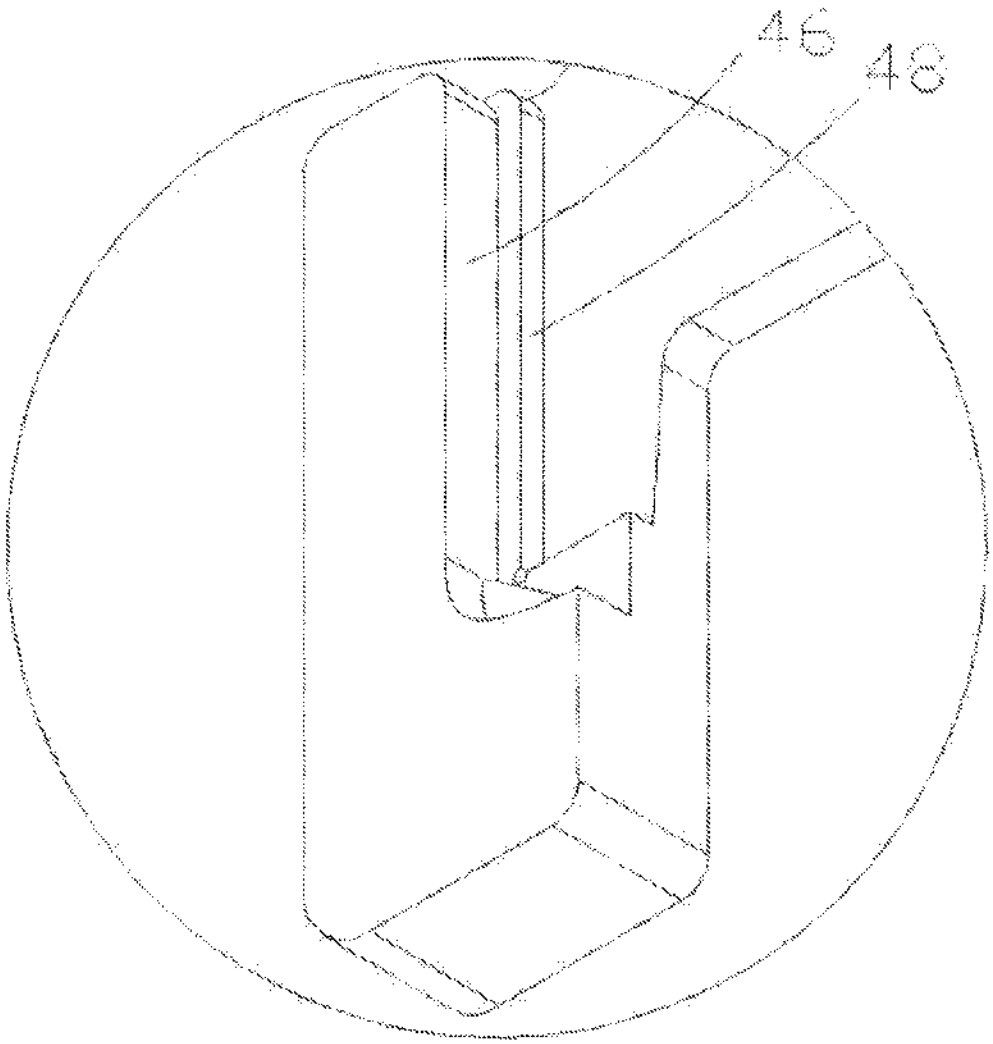


图 8

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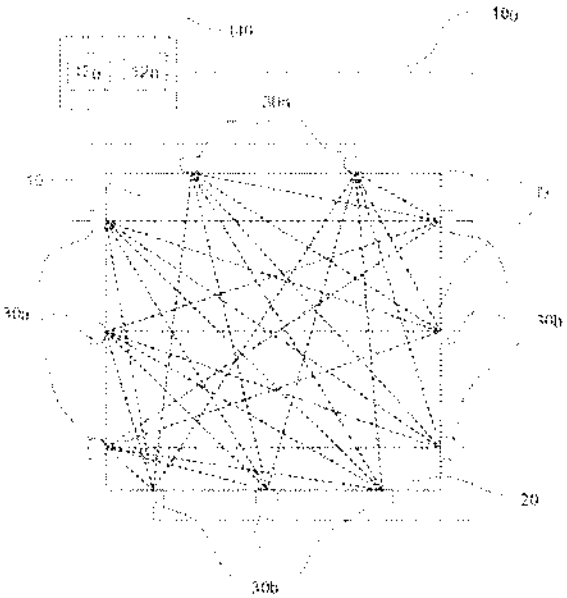


Figure 1

(57) Abstract: A method of operating an optical touch apparatus is described wherein, the optical touch apparatus comprising a panel, a plurality of emitters and a plurality of detectors arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples of light transmitted between pairs of emitters and detectors. The optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of: generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise, wherein the touch apparatus is configured to perform the following steps: operating according to the ambient light evaluation mode for a plurality of repetitions.

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AUTOMATIC OPTIMISATION OF TOUCH SIGNAL

Technical Field

The present invention relates to a method and apparatus for reducing the effects of ambient light noise resulting from incident ambient light on an optical touch system.

Background Art

Touch sensing systems ("touch systems") are in widespread use in a variety of applications. Typically, the touch sensing systems are actuated by a touch object such as a finger or stylus, either in direct contact, or through proximity (i.e. without contact), with a touch surface. Touch sensing systems are for example used as touch pads of laptop computers, in control panels, and as overlays to displays on e.g. hand held devices, such as mobile telephones and interactive whiteboards. A touch panel that is overlaid on or integrated in a display is also denoted a "touch screen". Many other applications are known in the art.

WO2010/064983 discloses a multi-touch system, which is based on frustrated total internal reflection (FTIR). Light sheets are coupled into a panel to propagate inside the panel by total internal reflection (TIR). When an object comes into contact with a touch surface of the panel, the propagating light will be attenuated at the point of touch. Arrays of light sensors are located around the perimeter of the touch surface to detect the received light for each light sheet and generate a signal value for each light path across the touch surface. The signal values of the light sensors are normalized by respective reference values and input into an image reconstruction algorithm that generates a two-dimensional distribution of attenuation values across the touch surface. This enables repeated determination of current position/size/shape of touches while one or more users interact with the touch surface. In FTIR systems, the touches need to be detected against a background of interferences, e.g. originating from fingerprints and other types of smear on the touch surface. The influence of interferences may vary not only over time but also across the touch surface, making it difficult to properly detect the touches on the touch surface at all times. WO2011/028169 proposes manipulating the reference values to compensate for the influence of contaminations in the attenuation pattern, and

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WO2011/049512 proposes tracking a two-dimensional background pattern of the contamination contribution and using the background pattern to generate an attenuation pattern that is compensated for contaminations.

Optical touch systems often need to be designed with a high sensitivity, since a touching object may result in only a small attenuation of the propagating light, e.g. less than 1%. Certain systems may therefore be designed to detect attenuations on the order of 0.1% - 0.01 %. To ensure proper touch detection, WO2011/078769 proposes monitoring the temporal variability of the signal values to identify potential causes for reduced performance of the touch system, e.g. due to component failure, and implementing corrective measures to account for unreliable signal values.

WO2013/115710 describes processing the output signal of an optical touch system to generate a set of data samples comprises ON energy values when the light signal is being transmitted and OFF energy value when no light signal is being transmitted. An estimated ambient value is determined from the OFF energy value. An ambient-compensated energy value is generated by subtracting an estimated ambient value from the ON energy value for each actual detection line. However, this technique only provides significant improvements for light noise sources that are unmodulated (e.g. Sunlight) or modulated with a low frequency (e.g. Incandescent lamps). This technique provides poor results with respect to modulated noise sources like fluorescent lighting.

Therefore, what is needed is a way of improving performance of an optical touch system in an environment that comprises various types of ambient light noise.

Summary

It is an objective of the invention to at least partly overcome one or more limitations of the prior art.

A first embodiment of the invention describes a method of operating an optical touch apparatus, the optical touch apparatus comprising: a panel (10), a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors, a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal, the optical touch apparatus being configured to operate in a data

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sampling mode operating in a sequence of repetitions, each repetition comprising the steps of: turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value, processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and processing the set of data samples to detect an interaction with the panel, the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of: generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise, wherein the method comprises the steps of: operating the optical touch apparatus according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions, selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and operating the optical touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time. The filter may be configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between the second set of samples and the first set of samples. The optimal residual ambient light value may correspond to the residual ambient light value having the lowest magnitude. The first integration time may be the same length as the second integration time. A first settling period may occur between the first integration time and the second integration time.

The ambient light evaluation mode may further comprising the steps of: generating a first set of samples over a first integration time, a second set of samples over a second integration time, and a third set of samples over a third integration time using at least one detector (30b'), and applying an ambient light filter to the first, second, and third set of samples to generate a residual ambient light value indicative of ambient light noise, wherein the touch apparatus is configured to operate in the data sampling mode with a timing configuration corresponding to the first, second, and third integration time of the determined the ambient light evaluation mode repetition. The first integration time may be the same length as the third integration

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time. A second settling period may occur between the second integration time and the third integration time. The second integration time may correspond to the integration time of the ON signal, the first integration time corresponds to integration time of the OFF signal preceding the ON signal, and the third integration time corresponds to integration time of the OFF signal following the ON signal. The ambient light filter may be configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and an average of the signal sampled over the first integration time and the signal sampled over the third integration time. The ambient light filter may be configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and a linear interpolation of the signal sampled over the first integration time and the signal sampled over the third integration time. The steps of the ambient light evaluation mode may be performed once per frame, more than once per frame, or less often than every frame. The ambient light evaluation mode steps may be performed at the beginning, middle or end of every frame. The residual ambient light value may be determined for a plurality of the detectors of the touch apparatus and wherein the optimal residual ambient light value is determined as a function of the plurality of residual ambient light values. The function may be an average or maximum of the residual ambient light values. A total of number of different configurations of the first, second, and third integration times may be greater than 2 and wherein the apparatus being configured to cycle through the total of number of configurations in subsequent ambient light evaluation mode repetitions. Preferably, between 1 and 10 configurations of the total number of configurations may be tested each frame. Preferably, the first second or third integration time may have a length of between 3ps to 30ps. Preferably, the first second or third integration times are changed in steps of between 0.1 μs and 20μs each ambient light evaluation mode repetition. The optimal residual ambient light value may also be selected as a function of the first and second integration times as well as the residual ambient light value. The residual ambient light value exceeding a performance threshold value and having the shortest first and second integration times may be selected as the optimal residual ambient light value. The system may be configured to not alter the first, second and third integration times used by the

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optical touch apparatus whilst operating in the data sampling mode whilst a touch interaction with the touch system is occurring.

A second embodiment of the invention describes An optical touch apparatus (100) comprising: a panel (10), a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors, a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal, the optical touch apparatus being configured to operate in a data sampling mode operating in a sequence of repetitions, each repetition comprising the steps of: turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value, processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and processing the set of data samples to detect an interaction with the panel, the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of: generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise,
wherein the touch apparatus is configured to perform the following steps: operating according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions, selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and operating the touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time.

Still other objectives, features, aspects and advantages of the present invention will appear from the following detailed description, from the attached claims as well as from the drawings.

Brief Description of Drawings

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Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.

Figure 1 is a top plan view of a touch sensing apparatus with light beams.

Figure 2 is a side view of the apparatus in figure 1 in which light propagates from emitters to detectors by total internal reflection through a glass panel.

Figure 3 is a side view of the apparatus in figure 1 in which light travels from emitters to detectors along a path largely above a glass panel.

Figures 4a to 4e show a portion of the scan scheme sequence.

Figure 5 shows a signal detected at a single detector. An uncompensated signal with ambient disturbances and an uncompensated signal without ambient disturbances is shown.

Figure 6 shows typical power spectrum received by a detector with no ambient electrical light source present.

Figure 7 shows a typical ambient filter kernel.

Figure 8 shows an ambient light filter response function where N=44.

Figure 9 shows an ambient light filter response function where N=32.

Figure 10 shows an ambient light filter response function where N=20.

Figure 11 shows a normalised ambient performance magnitude.

Figure 12 shows typical power spectrum received by a detector with a compact fluorescent lamp light source present.

Figure 13a shows an ambient light filter response function where N=20 with respect to the compact fluorescent lamp light source.

Figure 13b shows an ambient light filter response function where N=32 with respect to the compact fluorescent lamp light source.

Figure 14 shows an ambient light filter response function where N=44 with respect to the compact fluorescent lamp light source.

Figure 15 shows a normalised ambient performance magnitude with a compact fluorescent lamp light source present.

Figure 16 is a flow chart of an embodiment of the ambient light evaluation mode and data sampling mode.

Figure 17 is a flow chart of another embodiment of the ambient light evaluation mode and data sampling mode.

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Detailed Description of Example Embodiments

Below follows a description of example embodiments of a technique for enabling extraction of touch data for objects in contact with a touch surface of a touch-sensitive apparatus. Throughout the following description, the same reference numerals are used to identify corresponding elements.

Terms

Before describing embodiments of the invention, a few definitions will be given.

A "touch object" or "touching object" is a physical object that touches, or is brought in sufficient proximity to, a touch surface so as to be detected by one or more sensors in the touch system. The physical object may be animate or inanimate.

An "interaction" occurs when the touch object affects a parameter measured by the sensor.

An "interaction strength" is a relative or absolute measure of the degree of interaction. The "interaction strength" may be represented as an "attenuation".

An "interaction map" or "interaction pattern" is a two-dimensional (2D) distribution of interaction strength across the touch surface, or a portion thereof. If the interaction is presented as attenuation, the interaction map/pattern is also denoted an "attenuation map" or "attenuation pattern".

A "touch" denotes a point of interaction as seen in the interaction pattern.

A "frame" or "iteration" denotes a repeated event comprising an ambient light evaluation, data collection, and determination of touch data.

As used herein, a "trace" is information about the temporal history of an interaction. Touches from an interaction detected in a sequence of frames, i.e. at different points in time, are collected into a trace.

Embodiments of the inventions relate to signal processing in relation to a touch-sensitive apparatus which is based on the concept of transmitting energy of some form across a touch surface, such that an object that is brought into close vicinity of, or in contact with, the touch surface causes a local decrease in the transmitted energy. The apparatus may be configured to permit transmission of energy in one of many different forms. The emitted signals may be any radiation or wave energy that can travel in and/or across the touch surface including, without limitation, light waves in the visible or infrared or ultraviolet spectral regions. Example embodiments of the

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invention will be described in relation to a touch-sensitive apparatus 100, which is shown in Figures 1-3 and is based on the concept of transmitting the light through a glass panel via TIR (Total Internal Reflection) or transmission of the light above the touch surface. The apparatus 100 operates by transmitting light across a panel 10, from light emitters 30a, 31a, 32a to light sensors or detectors 30b, 31b, 32b. In the embodiment shown in figure 2, the transmitted light illuminates a touch surface 20 from within the panel 10. The panel 10 is made of solid material in one or more layers and may have any shape. The panel 10 defines an internal radiation propagation channel, in which light propagates by internal reflections. The propagation channel is defined between the boundary surfaces 5, 6 of the panel 10, where the top surface 5 allows the propagating light to interact with touching objects 7 and thereby defines the touch surface 20. This is achieved by injecting the light into the panel 10 such that the light is reflected by total internal reflection (TIR) in the touch surface 20 as it propagates through the panel 10. The light may be reflected by TIR in the bottom surface 6 or against a reflective coating thereon. It is also conceivable that the propagation channel is spaced from the bottom surface 6, e.g. if the panel comprises multiple layers of different materials. The apparatus 100 may be designed to be overlaid on or integrated into a display device or monitor.

The apparatus 100 allows an object 7 that is brought in contact with the touch surface 20 to interact with the propagating light at the point of touch. In this interaction, part of the light may be scattered by the object 7, part of the light may be absorbed by the object 7, and part of the light may continue to propagate in its original direction across the panel 10. Thus, the touching object 7 causes a local frustration of the total internal reflection, which leads to a decrease in the energy (or, equivalently, power or intensity) of the transmitted light.

In the embodiment shown in figure 3, light is passed above the surface of the panel instead of within the panel. Such a configuration of an optical touch system may be described as an 'above surface' optical touch system. In this configuration, the apparatus 100 allows an object 7 that is brought in contact with the touch surface 20 to interact with the light travelling above the surface of the panel at the point of touch on the panel. In this interaction, a portion of the light travelling above the surface of the panel will be interrupted by the object, which leads to a decrease in the energy (or, equivalently, power or intensity) of the transmitted light received at detectors downstream of the touching objects 7.

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The emitters 30a, 31a, 32a are distributed along the perimeter of the touch surface 20 to generate a corresponding number of light sheets inside or above the panel 10. In the example of figure 2, each emitter 31a generates a beam of light that expands in the plane of the panel 10 while propagating in the panel 10. Each beam propagates from one or more entry or incoupling points on the panel 10. The detectors 31b are distributed along the perimeter of the touch surface 20 to receive the light from the emitters 31a at a number of spaced-apart outcoupling points on the panel 10. It should be understood that the incoupling and outcoupling points merely refer to the position where the beam enters and leaves, respectively, the panel 10. Thus, although not shown in figure 2, one emitter/detector may be optically coupled to a number of incoupling/outcoupling points.

While various configurations for an above surface system exist, figure 3 describes an embodiment in which a portion of the light emitted by emitters 32a is transmitted through transmissive panel 100. The light exits transmissive panel 100 through touch surface 20 and is reflected by reflector surface 80 of edge reflector 70 to travel along paths 90a and 90b in a plane parallel with touch surface 20. The light will then continue until deflected by reflector surface 80 of the edge reflector 70 at an opposing edge of the transmissive panel 100, wherein the light will be deflected back down through transmissive panel 100 and onto detectors 32b. In another embodiment, the emitters and detectors may be positioned to emit and receive light directly above the surface of the panel. Alternatively, the light from emitters positioned below the panel may be directed around the edge of the panel by means of a light guide or other optical arrangement. A corresponding arrangement may convey the light from above the surface of the panel to the detectors positioned beneath the panel.

The detectors 30b, 31b, 32b collectively provide an output signal, which is received and sampled by a signal processor 130. The output signal contains a number of sub-signals, also denoted "projection signals", each representing the energy of light emitted by a certain light emitter and received by a certain detector. Depending on implementation, the signal processor 130 may need to process the output signal for separation of the individual projection signals. Conceptually, the touch apparatus 100 is considered to define a grid of detection lines D on the touch surface 20, where each detection line D corresponds to a light propagation path from an emitter to a detector, as projected onto the touch surface 20. Thus, the projection

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signals represent the received energy or power of light on the individual detection lines D. It is realised that the touching object 7 results in a decrease (attenuation) of the received energy on one or more detection lines D.

As will be explained below, the signal processor 130 may be configured to process the projection signals so as to determine a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 20, where each attenuation value represents a local attenuation of light. The attenuation pattern may be represented in many different ways, e.g. as attenuation values arranged in a regular x-y-grid, such as in an ordinary digital image, although other types of grids are conceivable, e.g. hexagonal patterns or triangular meshes. The attenuation pattern may be further processed by the signal processor 130 or by a separate device (not shown) for touch determination, which may involve extraction of touch data, such as a position (e.g. x,y coordinates), a shape or an area of each touching object. In the following, a "frame" denotes a repeated event starting with ambient light evaluation and data collection and ending with determination of touch data.

The signal processor 130 may be configured to process the projection signals so as to determine a property of the touching objects, such as a position (e.g. in an x,y coordinate system), a shape, or an area. This determination may involve a straight-forward triangulation based on the attenuated detection lines, e.g. as disclosed in US7432893 and WO2010/015408, or a more advanced processing to recreate a distribution of attenuation values (for simplicity, referred to as an "attenuation pattern") across the touch surface 20, where each attenuation value represents a local degree of light attenuation. The attenuation pattern may be further processed by the signal processor 130 or by a separate device (not shown) for determination of a position, shape or area of touching objects. The attenuation pattern may be generated e.g. by any available algorithm for image reconstruction based on projection signal values, including tomographic reconstruction methods such as Filtered Back Projection, FFT-based algorithms, ART (Algebraic Reconstruction Technique), SART (Simultaneous Algebraic Reconstruction Technique), etc. Alternatively, the attenuation pattern may be generated by adapting one or more basis functions and/or by statistical methods such as Bayesian inversion. Examples of such reconstruction functions designed for use in touch

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determination are found in WO2009/077962, WO201 1/04951 1, WO201 1/139213, WO201 2/050510, and WO201 3/062471 .

In the illustrated example, the apparatus 100 also includes a controller 120 (also called a which is connected to selectively control the activation of the emitters 30a, 31a, 32a and, possibly, the readout of data from the detectors 30b, 31b, 32b. The signal processor 130 and the controller 120 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 130 and the controller 120 may be at least partially implemented by software executed by a processing unit 140.

In one embodiment, the different emitters 30a, 31a, 32a are activated in sequence within a frame, such that each individual emitter is activated separately, whereby the transmitted light energy can be measured at each detector that receives light from the activated emitter. Thereby, an energy value is measured for each detection line during the frame.

In an alternative embodiment, groups of emitters 30a, 31a, 32a are activated concurrently, wherein each emitter is controlled to transmit a code by way of the emitted light such that the code identifies the respective emitter. Based on the transmitted codes, the energy measured by each detector in the light detection arrangement can be separated into energy values for each detection line. Such an emitter activation scheme is denoted "multiplexing" and is further described in PCT publication WO201 0/064983.

Embodiments of the invention utilise the energy values measured by the detectors 30b, 31b, 32b while the emitters 30a, 31a, 32a are OFF and ON. In the following, an "ON value" denotes detected energy when a signal is conducted from the emitter to the detector, and an "OFF value" denotes detected energy without a signal being conducted.

The OFF values are conventionally used for so-called ambient compensation, which aims at removing or at least suppressing signal components originating from ambient light and detector dark level, including any analog-to-digital conversion (ADC) offset. Ambient light refers to light that is received by a detector while not originating from the emitters. The ON/OFF activation scheme of the emitters may enable each detector to measure an OFF value one or several times during a frame. As described in WO20131 15710A2, an ambient-compensated energy value each for

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detection line may then be obtained. The ON value or an average of ON values is recorded for each detection line, i.e. the energy measured by the detector associated with detection line when the emitter associated with detection line is ON, and OFF value or an average of OFF values, i.e. the energy measured by the detector associated with detection line is recorded when all emitters are OFF. The OFF values, obtained during one or plural frames, are processed to generate a current estimate of the noise level for each individual detector, and hence for each detection line. The ambient-compensated energy value of each detection line is then determined to be the difference between the ON value and OFF value. By using the ambient measurements for validation, all influence from touching objects on the estimated noise level is avoided. Furthermore, the validation process may be designed to operate on the same data as the ambient compensation. In one embodiment, the noise estimate is continuously updated using the latest OFF values. In another embodiment, the noise estimate is given by an exponential forget estimation of the variance (standard deviation) of the OFF values.

It was realised that the above technique was insufficient to handle ambient noise having a variety of different power spectra. Although unmodulated or modulated light at low frequencies may be adequately addressed by the above technique, light modulated at a frequency higher than the frequency at which the emitters are turned ON and OFF is effectively unfiltered and may cause significant detrimental effects to performance of the touch system. Therefore, the following text describes a dynamic ambient light filter configured to respond to the characteristics of ambient light sources and filter to the ambient light source in an optimal way, taking into account restraints including touch accuracy, frame rate, and power usage.

Figures 4a-4e and figure 5 provide an example of the measurement of OFF and ON samples. Figures 4a-4e show a portion of a scan scheme sequence in which a sequence of emitters are used to transmit a signal with rest periods in between. Figure 5 shows an uncompensated signal 210 with ambient disturbances and uncompensated signal 200 without ambient disturbances. Figure 5 shows a received signal at detector 30b' over a portion of the scan scheme sequence. In figure 4a, no signal is being transmitted by any emitter for a first period of time. Figure 5 shows a corresponding received signal at detector 30b' over the first period of time marked AO. In figure 4b, emitter 30a' emits a signal for a second period of time. Figure 5 shows a corresponding received signal at detector 30b' over the second period of

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time marked S'. In figure 4c, no signal is being transmitted by any emitter for a third period of time. Figure 5 shows a corresponding received signal at detector 30b' over the third period of time marked A1. In figure 4d, emitter 30a" emits a signal for a fourth period of time. Figure 5 shows a corresponding received signal at detector 30b' over the fourth period of time marked S". In figure 4e, no signal is being transmitted by any emitter for a fifth period of time. Figure 5 shows a corresponding received signal at detector 30b' over the third period of time marked A2.

Figure 6 shows typical power spectrum received by a detector with no ambient electrical light source present and no emitter turned on.

Figure 16 shows a flow chart for a system according to an embodiment of the present invention. The flow chart shown in figure 16 may describe a sequence of steps performed by the optical touch System of the present invention in each frame. In one embodiment, the steps of the ambient light evaluation mode are performed once per frame. In alternative embodiments, the ambient light evaluation mode steps may be performed more than once per frame or once every number of frames. The ambient light evaluation mode steps may be performed at the beginning, middle or end of every frame. In the following embodiment, the ambient light evaluation mode steps are executed once per frame and at the start of every frame.

According to the embodiment shown in figure 16, the optical touch system begins the frame in an ambient light evaluation mode. Whilst in the ambient light evaluation mode, the system executes the following steps:

1 - A sample A0 is recorded over a first integration time from a single detector 30b'.

2 - A sample S' is recorded over a second integration time, subsequent to the first integration time, from detector 30b'.

3 - A sample A1 is recorded over a third integration time, subsequent to the second integration time, from detector 30b'.

4 - An ambient light filter function is applied to samples A0, A1 and S' to generate a residual ambient light value.

5 - Record the first, second, and third integration time and corresponding residual ambient light value in a memory as a 'filter configuration'.

6 - (Repeat at least once) Modify the length of the first, second, and/or third integration time and repeat steps 1-5.

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7 - Determine the filter configuration in the memory having the optimal residual ambient light value.

8 - Operating the optical touch system in a data sampling mode using the first, second, and third integration time of the filter configuration having the optimal residual ambient light value.

The above steps will now be described in detail.

1 - A sample A0 is recorded over a first integration time from a single detector 30b'.

The sample A0 may be a single data value recorded from a detector over the first integration time. In this case, the first integration time describes a period of time over which an analogue filtering and/or integration of the received signal is generated. Alternatively, A0 may be a series of data samples.

2 - A sample S' is recorded over a second integration time, subsequent to the first integration time, from detector 30b'.

The sample S' may be a single data value recorded from a detector over the second integration time. In this case, the second integration time describes a period of time over which an analogue filtering and/or integration of the received signal is generated. Alternatively, S' may be a series of data samples.

Preferably, a settling time is used between the first integration time and second integration time in order to minimise distortions resulting from the rise and/or fall times of the emitter and detector components between the first integration time and second integration time.

Preferably, the same settling time is used between the second integration time and third integration time as that used between the first integration time and second integration time.

3 - A sample A1 is recorded over a third integration time, subsequent to the second integration time, from detector 30b'.

The sample A1 may be a single data value recorded from a detector over the third integration time. In this case, the third integration time describes a period of time over which an analogue filtering and/or integration of the received signal is generated. Alternatively, A1 may be a series of data samples.

In one embodiment, instead of sampling values from a single detector 30b', a plurality or all of the detectors are sampled and an average of the sampled values is used for each of A0, A1, and S'.

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4 - An ambient light filter function is applied to samples A0, A1 and S' to generate a residual ambient light value.

In a preferred embodiment, the ambient light filter function calculates the residual ambient light value according to the following equation:

A = Average of A0 and A1

S = Average of S'

Residual ambient light value = Magnitude of difference between A and S.

In an embodiment, the ambient light filter function calculates the residual ambient light value according to a linear interpolation of A0 and A1 evaluated at the centre of S'. If S' is a collection of data samples, S' may be digitally integrated and normalised by the number of samples in S' to generate S.

The ambient light filter function may be executed on signal processor 12. Other digital filters as known in the art may be used.

Figure 7 shows a typical ambient filter kernel. The ambient filter kernel is applied to the samples recorded at a detector 30b'. Settling times are used in which samples are set to 0 in order to minimise distortions resulting from any signal changes between the first integration time and second integration time. Detector and emitter components typically have a rise and fall time in which output or detection stabilises to a correct value.

Figure 8 shows an ambient light filter response function where N=44 and P=15. Figure 8 is a Fourier transform of the ambient filter kernel shown in figure 7, wherein N is the number of digitally accumulated samples used for each of the first, second, and third integration times and P is the number of samples used during the settling times. The ADC in this example is running at 2.5 MHz, i.e. each data sample is 0.4 microseconds long. The left side lobe of figure 8 shows that low frequency components are somewhat filtered by filter. At the first singularity, frequencies are not filtered at all. The multiple lobes on the right of the graph at the higher frequencies are a result of the settling times used in between the integration times.

It is clear that from figure 8 that shorter integration times (i.e. first, second, and third integration times with fewer samples) can compensate low-frequencies better, i.e. moving the main lobe of figure 8 higher up in frequency.

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It should be noted that the ambient filter may actually worsen the residual for some frequencies. If the filter response magnitude is 1.0, the ambient filter does not reduce the ambient light impact at all. If it is above 1.0 it will make matters worse. A desired outcome is one with the lowest filter output values possible. It is important that the main and side lobes do not line up with peaks in the power spectral density of high-frequency noise from lamps.

Figure 9 shows an ambient light filter response function where N=32 and P=15.

Figure 10 shows an ambient light filter response function where N=20 and P=15.

5 - Record the first, second, and third integration time and corresponding residual ambient light value in a memory as a 'filter configuration'.

The data may be stored in a datastore on signal processor 120. Each filter configuration comprises a first integration time, a second integration time, a third integration time and a residual ambient light value.

In one embodiment, steps 1-3 are repeated a multiple number of times using the same first, second, and third integration times, with the recorded residual ambient light value being the average value of the residual ambient light values calculated each repetition.

6 - (Repeat at least once) Modify the length of the first, second, and/or third integration time and repeat steps 1-5.

Preferably, the first integration time, second integration time, and third integration time are all of the same length. Alternatively, both the first and third integration time may be the same length whilst varying in length in proportion to the second integration time. For example, if the first and third integration time are made longer by 5%, the second integration time is made longer by 5% also. However, in some embodiments, the length of the first, second, and third integration times may all be varied independently of each other.

The number of repeats of steps 1-4 may be chosen in dependence on the number of different residual ambient light values that are needed.

In one embodiment, a number of different configurations of the first integration time and second integration time are tested to determine an optimal residual ambient light value. Depending on the number of variables, the number of configurations may be between 5 and 5000. In a preferred embodiment, 3 configurations of 300 possible configurations are tested each frame. This way, all configurations of the first integration time and second integration time may be tested over 100 frames. For an

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optical touch system operating at 120 frames per second, this allows all 300 configurations to be tested in under a second. Once all 300 configurations have been tested, the system preferably restarts the cycle. This allows the optical touch system to rapidly react to changes in the ambient lighting conditions.

Figure 11 shows a normalised ambient performance magnitude with no significant ambient light noise. The normalisation is achieved by dividing the value by the integration time to compensate for the fact that the actual signal becomes higher when more samples are accumulated. In figure 11, where the number of accumulation samples (n) is 20, the residual ambient light value is 1.3. White noise causes the performance magnitude to curve downwards to the right of the graph.

In one embodiment, the residual ambient light value of each filter configuration may be formed from an averaging of residual ambient light values over a number of cycles. In one example, the residual ambient light values of a particular filter configuration may be calculated as the average of the residual ambient light values of the filter configuration of the previous three cycles. As this average is for samples taken at different times with respect to the ambient noise, the samples are more likely to be recorded at different phases of the modulated ambient noise, reducing the effect and likelihood of aliasing between the high-frequency component of the lamp and the ambient filter kernel. Doing an average over several values make sure that the difference in phase between lamp and filter gets averaged.

In a preferred embodiment where the first integration time and second integration time are the same length, the system is configured to test a second integration time over a range of 6µs to 30µs, and incremented in steps of between 0.4µs and 20µs.

In one embodiment of the invention, the length of the settling times can be varied in a similar manner to the first, second, and third integration times.

7 - Determine the filter configuration in the memory having the optimal residual ambient light value.

In an embodiment, the system is configured to review the filter configurations stored in the datastore to determine an optimal filter configuration. In one embodiment, the optimal filter configuration is determined to be the filter configuration having the residual ambient light value with the lowest magnitude. The lowest magnitude indicates that any modulated ambient light is modulated at a frequency which has less effect on the sampled signal when sampled according to the first and second integration times of the filter configuration.

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Figure 12 shows typical power spectrum received by a detector with a compact fluorescent lamp light source present. We can see that the lamp has a very strong modulation frequencies around 45 kHz, including overtones at 90, 135, 180, 225, 265 kHz.

Figure 13a shows an ambient light filter response function where N=20 with respect to the compact fluorescent lamp light source. We can see that the 45 kHz signal falls within the main lobe and that the first overtone at 90 kHz lines up with one of side lobes. This filter configuration provides a bad response with a substantial amount of the ambient noise remaining unfiltered.

Figure 13b shows an ambient light filter response function where N=32 with respect to the compact fluorescent lamp light source. This filter configuration provides a similarly bad response the N=20 filter configuration with a substantial amount of the ambient noise remaining unfiltered.

Figure 14 shows an ambient light filter response function where N=44 with respect to the compact fluorescent lamp light source. In this figure we see that the 45 kHz peak lies between the main lobe and the first side lobe. The 90 kHz peak also lies between two side lobes. This means that the ambient filter is very good at reducing the ambient residual error from this lamp.

Figure 15 shows a normalised ambient performance magnitude with a compact fluorescent lamp light source present. For short integration times ($N < 25$) we see that the 45 kHz peak become amplified by the filter since it falls within the region where the frequency response of the filter is greater than 1.0, see new figure. As the integration time increases we see that we have an optimal alignment between power spectral density of the current lamp and ambient filter response when N is around 44.

The optimal filter configuration may also be selected as a function of the first and second integration times as well as the residual ambient light value. In one embodiment shown in figure 15, a threshold value 300 exists wherein all filter configurations having a residual ambient light value below the threshold qualify as suitable candidates for usage. i.e. The touch accuracy of the optical touch system when operating according to the first and second integration times of each of the candidates filter configurations is likely to be adequate. In this embodiment, the system may therefore select which filter configuration to use in dependence on characteristics other than the residual ambient light values. Preferably, the filter

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configuration having the shortest first and second integration times may be selected in order to allow the optical touch system to perform at the fastest frame rate in order to reduce touch latency. Alternatively, whilst the frame rate is maintained at a standard rate (e.g. 150 frames per second), the filter configuration having the shortest first and second integration times may be selected in order to allow the touch system to operate using the lowest power consumption possible. In figure 15, the system may select between a value of N at 44 for optimal performance, or N at 29 for shortest sampling periods (for optimal power consumption or shortest frame length).

8 - Operating the optical touch system in a data sampling mode using the first, second, and third integration time of the filter configuration having the optimal residual ambient light value.

In the data sampling mode, the system is configured to activate each of the emitters 30a in sequence, whereby the transmitted light energy can be measured at each detector that receives light from the activated emitter. Thereby, an energy value is measured for each detection line during the frame. According to the present embodiment, the system is configured to activate each emitter ON for a period of time corresponding to the second integration time. The period of time for which the emitter is activated ON is typically slightly longer (e.g. 1-20µs) than the second integration time to allow for rise and/or fall times of the emitter and detector. During the ON period, the system generates an ON sample value at each detector over the second integration time. The system is then configured to ensure that all emitters are OFF for a period of time corresponding to the first/third integration times between ON activations. During the OFF period, the system generates an OFF sample value at each detector over the first integration time. Preferably, a settling time is used between the ON and OFF periods corresponding to the rest period used between the sampling periods of the ambient light evaluation mode. An ambient-compensated energy value of each detection line is then determined to be the difference between the ON sample value and an average of the OFF sample value preceding the ON sample value and the OFF sample value recorded after the ON sample value. Alternatively, ambient-compensated energy value of each detection line may be determined according to a linear interpolation of A0 and A1 evaluated at the centre of S'.

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In an alternative embodiment, the system is configured to activate each emitter ON for a period of time corresponding to but shorter than the second integration time. The period of time for which the emitter is activated ON is slightly shorter (e.g. 1-20 μs) than the second integration time to allow for sampling the complete pulse including the rise and/or fall time of the pulse.

In one embodiment, the length of the first, second and third integration times affect the length of the frame, as the longer the first, second and third integration times are, the longer it takes to complete activation of all the emitters and the interspaced OFF periods. In some embodiments, the frame comprises a period of time reserved as slack, so that the variation of the first, second and third integration times does not require the frame length to be altered. Preferably, the third integration time can be reused as the first integration for the next detection line recorded for the same single detector.

In a preferred embodiment, the system is configured to not alter the first, second and third integration times used by the optical touch system whilst in the data sampling mode whilst a touch interaction with the touch system is occurring. As any touch interaction will necessarily significantly alter the detected touch signal during the interaction, the results of the ambient light evaluation mode can be disregarded or postponed for use until the touch interaction has finished.

In an embodiment in which the touch system utilises multiplexing of several emitters, the main difference is that the signal captured during the ON period comes from several emitters. The ambient reduction filter works in the same way as for non-multiplexing systems. In a multiplexing system there is an extra de-multiplexing step between ambient compensation and the transmission/interpolation/reconstruction steps.

Figure 17 shows a flow chart for a system according to a simpler variation of the embodiment shown in figure 16 in which two samples are recorded instead of three. According to this embodiment, the system executes the following steps whilst in ambient light evaluation mode:

1 - A sample A0 is recorded over a first integration time from a single detector 30b'.

2 - A sample S' is recorded over a second integration time, subsequent to the first integration time, from detector 30b'.

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3 - An ambient light filter function is applied to samples A O and S' to generate a residual ambient light value.

4 - Record the first integration time and second integration time and corresponding residual ambient light value in a memory as a 'filter configuration'.

5 - (Repeat at least once per frame) Modify the length of the first integration time and/or second integration time and repeat steps 1-4.

6 - Determine the filter configuration in the memory having the optimal residual ambient light value.

7 - Operating the optical touch system in a data sampling mode using the first integration time and second integration time of the filter configuration having the optimal residual ambient light value.

The above steps will now be described in detail.

1 - A sample A O is recorded over a first integration time from a single detector 30b' substantially as described in the previous embodiment.

2 - A sample S' is recorded over a second integration time, subsequent to the first integration time, from detector 30b' substantially as described in the previous embodiment.

3 - An ambient light filter function is applied to samples A O and S' to generate a residual ambient light value.

In a preferred embodiment, the ambient light filter function calculates the residual ambient light value according to the following equation:

A = Average of A O

S = Average of S'

Residual ambient light value = Magnitude of difference between A and S.

4 - Record the first integration time and second integration time and corresponding residual ambient light value in a memory as a 'filter configuration'.

The data may be stored in a datastore on signal processor 12. Each filter configuration comprises a first integration time, a second integration time, and a residual ambient light value.

5 - (Repeat at least once) Repeat steps 1-4 whilst modifying the length of the first integration time and/or second integration time.

Preferably, the first integration time and second integration time are the same length. Alternatively, both the first integration time and second integration time are

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varied in length in proportion to each other. For example, if the first integration time is made longer by 5%, the second integration time is made longer by 5% also. However, in some embodiments, the length of the first integration time may be varied independently of the length of the second integration time. Alternatively, the length of the second integration time may be varied independently of the length of the first integration time.

The number of repeats of steps 1-4 may be chosen in dependence on the number of different residual ambient light values that are needed.

6 - Determine the filter configuration in the memory having the optimal residual ambient light value.

As with the previous embodiment, the optimal filter configuration may also be selected as a function of the first, second and third integration times as well as the residual ambient light value.

7 - Operating the optical touch system in a data sampling mode using the first integration time and second integration time of the filter configuration having the optimal residual ambient light value.

According to the present embodiment, the system is configured to activate each emitter ON for a period of time corresponding to the second integration time. During the ON period, the system generates an ON sample value at each detector over the second integration time. The system is then configured to ensure that all emitters are OFF for a period of time corresponding to the first integration time between ON activations. During the OFF period, the system generates an OFF sample value at each detector over the first integration time. Preferably, a settling time is used between the ON and OFF periods corresponding to the rest period used between the sampling periods of the ambient light evaluation mode. An ambient-compensated energy value of each detection line is then determined to be the difference between the ON sample value and OFF sample value.

The touch determination process and the validation process according to the various embodiments disclosed herein may be implemented by a data processing device which is connected to sample measurement values from the detectors 30b, 31b, 32b. The device 140 may include an input for receiving the output signal. The device 140 may further include a data collection element (or means) for obtaining the

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current projection values, a generation element (or means) for generating absolute values, an interpolation element (or means) for generating a matched sinogram with absolute values, an error correction element for maintaining the relative signal transmission of affected interpolation points, a conversion element (or means) for converting the absolute values of the interpolation points into relative values, a reconstruction element (or means) for generating a current interaction pattern, and an output for outputting the current interaction pattern. The device 140 may include an input for receiving the output signal. The device 140 may further include an element (or means) for obtaining the ON values, an element (or means) for obtaining the OFF values, a compensation element (or means) for generating ambient-compensated ON values, a noise estimation element (or means) for computing a noise estimate, and a datastore.

The device 140 may be implemented by special-purpose software (or firmware) run on one or more general-purpose or special-purpose computing devices. In this context, it is to be understood that each "element" or "means" of such a computing device refers to a conceptual equivalent of a method step; there is not always a one-to-one correspondence between elements/means and particular pieces of hardware or software routines. One piece of hardware sometimes comprises different means/elements. For example, a processing unit may serve as one element/means when executing one instruction, but serve as another element/means when executing another instruction. In addition, one element/means may be implemented by one instruction in some cases, but by a plurality of instructions in some other cases. Naturally, it is conceivable that one or more elements (means) are implemented entirely by analog hardware components.

The software controlled device 140 may include one or more processing units, e.g. a CPU ("Central Processing Unit"), a DSP ("Digital Signal Processor"), an ASIC ("Application-Specific Integrated Circuit"), discrete analog and/or digital components, or some other programmable logical device, such as an FPGA ("Field Programmable Gate Array"). The device 140 may further include a system memory and a system bus that couples various system components including the system memory to the processing unit. The system bus may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory may include computer storage media in the form of volatile and/or non-volatile memory such as

read only memory (ROM), random access memory (RAM) and flash memory. The special-purpose software, the exclusion data, the reference values, and any other data needed during execution, may be stored in the system memory, or on other removable/non-removable volatile/non-volatile computer storage media which is included in or accessible to the computing device, such as magnetic media, optical media, flash memory cards, digital tape, solid state RAM, solid state ROM, etc. The data processing device 140 may include one or more communication interfaces, such as a serial interface, a parallel interface, a USB interface, a wireless interface, a network adapter, etc, as well as one or more data acquisition devices, such as an *A/D* converter. The special-purpose software may be provided to the device 140 on any suitable computer-readable medium, including a record medium, and a read-only memory.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and the scope of the appended claims.

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CLAIMS

1. A method of operating an optical touch apparatus (100), the optical touch apparatus comprising:

- a panel (10),
- a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors,
- a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal,

the optical touch apparatus being configured to operate in a data sampling mode operating in a sequence of repetitions, each repetition comprising the steps of:

- turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value,
- processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and
- processing the set of data samples to detect an interaction with the panel,
- the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of:
- generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and
- applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the method comprises the steps of:

- operating the optical touch apparatus according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions,
- selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and

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- operating the optical touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time.

2. The method of claim 1, wherein the filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between the second set of samples and the first set of samples.

3. The method of claim 2, wherein the optimal residual ambient light value corresponds to the residual ambient light value having the lowest magnitude.

4. The method of any preceding claim, wherein the first integration time is the same length as the second integration time.

5. The method of any preceding claim, wherein a first settling period occurs between the first integration time and the second integration time.

6. The method of any preceding claim, wherein the ambient light evaluation mode comprising the steps of:

- generating a first set of samples over a first integration time, a second set of samples over a second integration time, and a third set of samples over a third integration time using at least one detector (30b'), and
- applying an ambient light filter to the first, second, and third set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the touch apparatus is configured to operate in the data sampling mode with a timing configuration corresponding to the first, second, and third integration time of the determined the ambient light evaluation mode repetition.

7. The method of claims 6, wherein the first integration time is the same length as the third integration time.

8. The method of claims 6-7, wherein a second settling period occurs between the second integration time and the third integration time.

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9. The method of claims 6-8, wherein the second integration time corresponds to the integration time of the ON signal, the first integration time corresponds to integration time of the OFF signal preceding the ON signal, and the third integration time corresponds to integration time of the OFF signal following the ON signal.

10. The method of claims 6-9, wherein the ambient light filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and an average of the signal sampled over the first integration time and the signal sampled over the third integration time.

11. The method of claims 6-10, wherein the ambient light filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and a linear interpolation of the signal sampled over the first integration time and the signal sampled over the third integration time.

12. The method of any preceding claim wherein the steps of the ambient light evaluation mode are performed once per frame, more than once per frame, or less often than every frame.

13. The method of any preceding claim wherein the ambient light evaluation mode steps may be performed at the beginning, middle or end of every frame.

14. The method of any preceding claim wherein the residual ambient light value is determined for a plurality of the detectors of the touch apparatus and wherein the optimal residual ambient light value is determined as a function of the plurality of residual ambient light values.

15. The method of claim 14 wherein the function is an average or maximum of the residual ambient light values.

16. The method of any preceding claim wherein a total of number of different configurations of the first, second, and third integration times is greater than 2 and

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wherein the apparatus being configured to cycle through the total of number of configurations in subsequent ambient light evaluation mode repetitions.

17. The method of claim 16 wherein between 1 and 10 configurations of the total number of configurations are tested each frame.

18. The method of any preceding claim wherein the first, second or third integration time have a length of between 3µs to 30µs

19. The method of any preceding claim wherein first second or third integration times are changed in steps of between 0.1 µs and 20µs each ambient light evaluation mode repetitions.

20. The method of any preceding claim wherein the optimal residual ambient light value may also be selected as a function of the first and second integration times as well as the residual ambient light value.

21. The method of claim 20 wherein the residual ambient light value exceeding a performance threshold value and having the shortest first and second integration times may be selected as the optimal residual ambient light value.

22. The method of any preceding claim wherein the system is configured to not alter the first, second and third integration times used by the optical touch apparatus whilst operating in the data sampling mode whilst a touch interaction with the touch system is occurring.

23. An optical touch apparatus (100) comprising:

- a panel (10),
- a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors,
- a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal,

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the optical touch apparatus being configured to operate in a data sampling mode operating in a sequence of repetitions, each repetition comprising the steps of:

- turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value,
- processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and
- processing the set of data samples to detect an interaction with the panel,
- the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of:
- generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and
- applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the touch apparatus is configured to perform the following steps:

- operating according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions,
- selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and
- operating the touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time.

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AMENDED CLAIMS
received by the International Bureau on 23.04.2018

CLAIMS

1. A method of operating an optical touch apparatus (100), the optical touch apparatus comprising:

- a panel (10),
- a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors,
- a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal,

the optical touch apparatus being configured to operate in a data sampling mode operating in a sequence of repetitions, each repetition comprising the steps of:

- turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value,
- processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and
- processing the set of data samples to detect an interaction with the panel,

the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of:

- generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and
- applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the method comprises the steps of:

- operating the optical touch apparatus according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions,
- selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and
- operating the optical touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time.

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2. The method of claim 1, wherein the filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between the second set of samples and the first set of samples.

3. The method of claim 2, wherein the optimal residual ambient light value corresponds to the residual ambient light value having the lowest magnitude.

4. The method of any preceding claim, wherein the first integration time is the same length as the second integration time.

5. The method of any preceding claim, wherein a first settling period occurs between the first integration time and the second integration time.

6. The method of any preceding claim, wherein the ambient light evaluation mode comprising the steps of:

- generating a first set of samples over a first integration time, a second set of samples over a second integration time, and a third set of samples over a third integration time using at least one detector (30b'), and
- applying an ambient light filter to the first, second, and third set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the touch apparatus is configured to operate in the data sampling mode with a timing configuration corresponding to the first, second, and third integration time of the determined the ambient light evaluation mode repetition.

7. The method of claims 6, wherein the first integration time is the same length as the third integration time.

8. The method of claims 6-7, wherein a second settling period occurs between the second integration time and the third integration time.

9. The method of claims 6-8, wherein the second integration time corresponds to the integration time of the ON signal, the first integration time corresponds to integration time of

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the OFF signal preceding the ON signal, and the third integration time corresponds to integration time of the OFF signal following the ON signal.

10. The method of claims 6-9, wherein the ambient light filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and an average of the signal sampled over the first integration time and the signal sampled over the third integration time.

11. The method of claims 6-10, wherein the ambient light filter is configured to generate a residual ambient light value indicative of ambient light in dependence on the difference between a signal sampled over the second integration time and a linear interpolation of the signal sampled over the first integration time and the signal sampled over the third integration time.

12. The method of any preceding claim wherein the steps of the ambient light evaluation mode are performed once per frame, more than once per frame, or less often than every frame.

13. The method of any preceding claim wherein the ambient light evaluation mode steps may be performed at the beginning, middle or end of every frame.

14. The method of any preceding claim wherein the residual ambient light value is determined for a plurality of the detectors of the touch apparatus and wherein the optimal residual ambient light value is determined as a function of the plurality of residual ambient light values.

15. The method of claim 14 wherein the function is an average or maximum of the residual ambient light values.

16. The method of any preceding claim wherein a total of number of different configurations of the first, second, and third integration times is greater than 2 and wherein the apparatus being configured to cycle through the total of number of configurations in subsequent ambient light evaluation mode repetitions.

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17. The method of claim 16 wherein between 1 and 10 configurations of the total number of configurations are tested each frame.

18. The method of any preceding claim wherein the first, second or third integration time have a length of between 3µs to 30µs

19. The method of any preceding claim wherein first second or third integration times are changed in steps of between 0.1µs and 20µs each ambient light evaluation mode repetitions.

20. The method of any preceding claim wherein the optimal residual ambient light value may also be selected as a function of the first and second integration times as well as the residual ambient light value.

21. The method of claim 20 wherein the residual ambient light value exceeding a performance threshold value and having the shortest first and second integration times may be selected as the optimal residual ambient light value.

22. The method of any preceding claim wherein the system is configured to not alter the first, second and third integration times used by the optical touch apparatus whilst operating in the data sampling mode whilst a touch interaction with the touch system is occurring.

23. An optical touch apparatus (100) comprising:

- a panel (10),
- a plurality of emitters (30a, 31a, 32a) and a plurality of detectors (30b, 31b, 32b) arranged with respect to the panel, the plurality of detectors configured to receive light from the plurality of emitters thereby defining detection samples (D) of light transmitted between pairs of emitters and detectors,
- a controller coupled to the plurality of emitters to generate the signals and wherein each detector is configured to generate an output signal,

the optical touch apparatus being configured to operate in a data sampling mode operating in a sequence of repetitions, each repetition comprising the steps of:

- turning the emitters ON and OFF according to a timing configuration during each repetition such that the output signal for each detector is generated to comprise ON energy values for the detection samples (D) and at least one OFF energy value,

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- processing the output signals to generate a set of data samples, each data sample being generated to represent detected energy for one of the detection samples (D), and
- processing the set of data samples to detect an interaction with the panel,

the optical touch apparatus being further configured to operate in an ambient light evaluation mode comprising the steps of:

- generating a first set of samples over a first integration time and a second set of samples over a second integration time using at least one detector, and
- applying a filter to at least the first and second set of samples to generate a residual ambient light value indicative of ambient light noise,

wherein the touch apparatus is configured to perform the following steps:

- operating according to the ambient light evaluation mode for a plurality of repetitions, wherein the length of at least one of the first integration time and second integration time vary between repetitions,
- selecting the first integration time and/or second integration time that generated an optimal residual ambient light value, and
- operating the touch apparatus in the data sampling mode with a timing configuration corresponding to the selected first integration time and/or second integration time.

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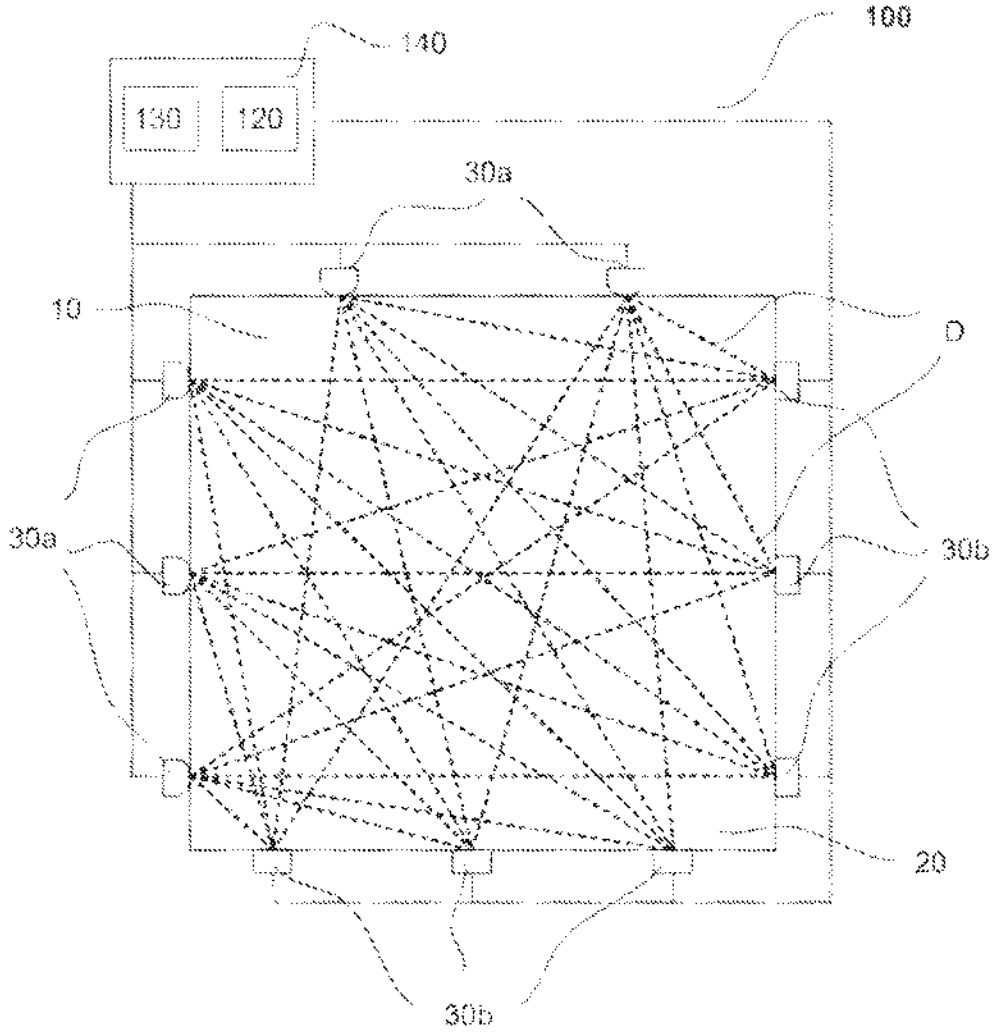


Figure 1

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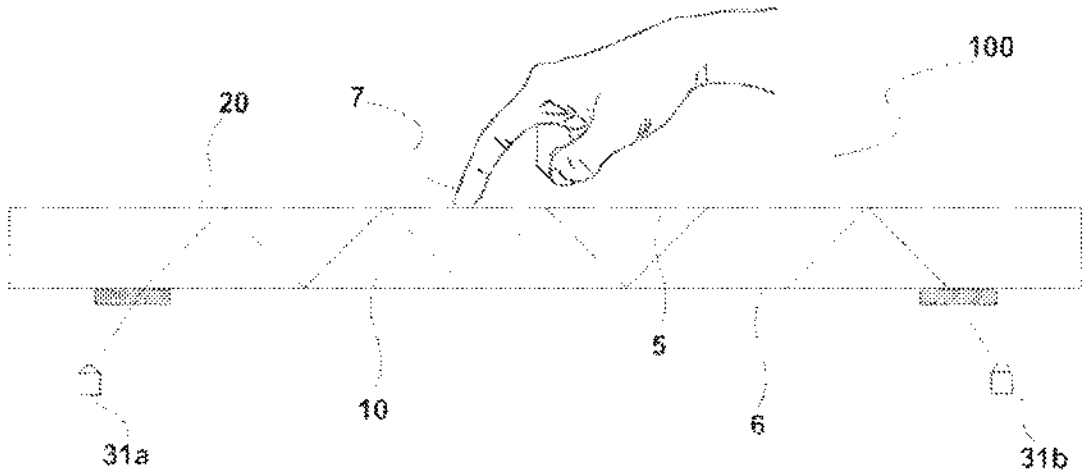


Figure 2

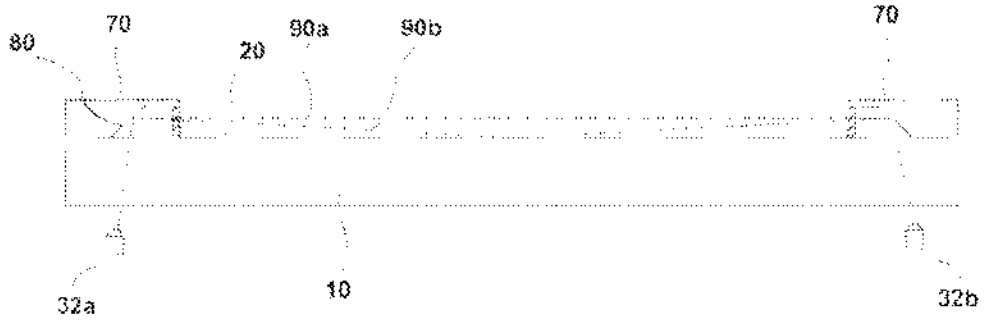


Figure 3

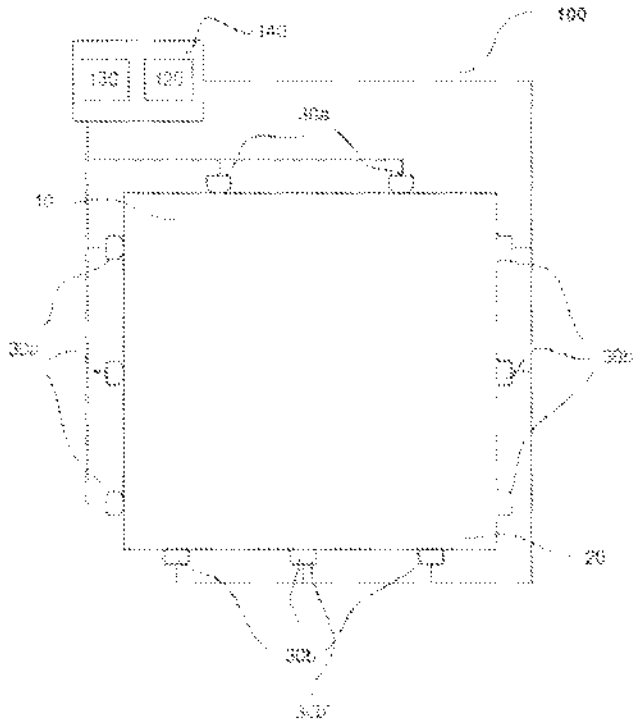


Figure 4a

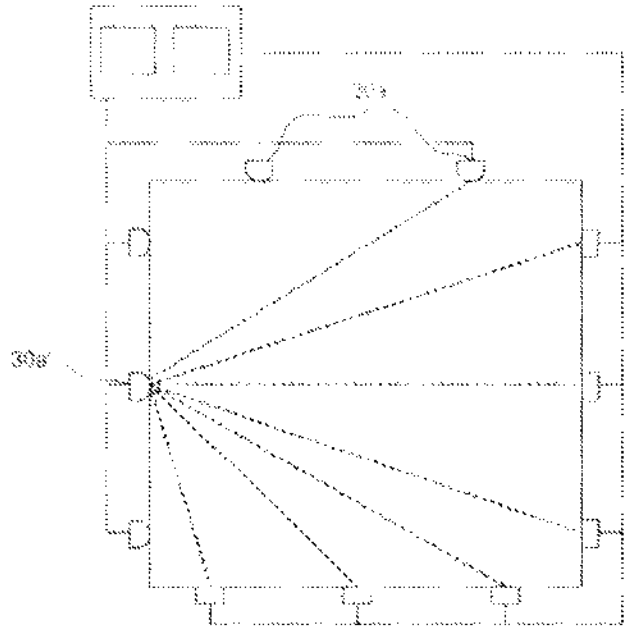


Figure 4b

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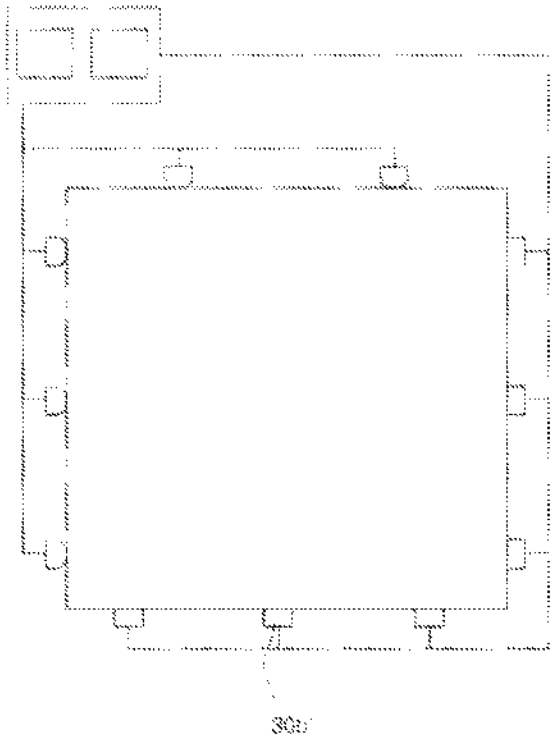


Figure 4c

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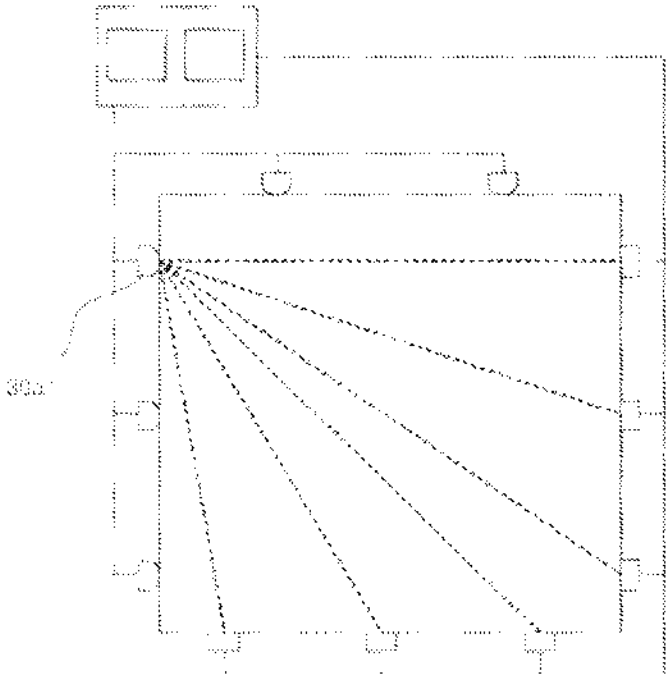


Figure 4d

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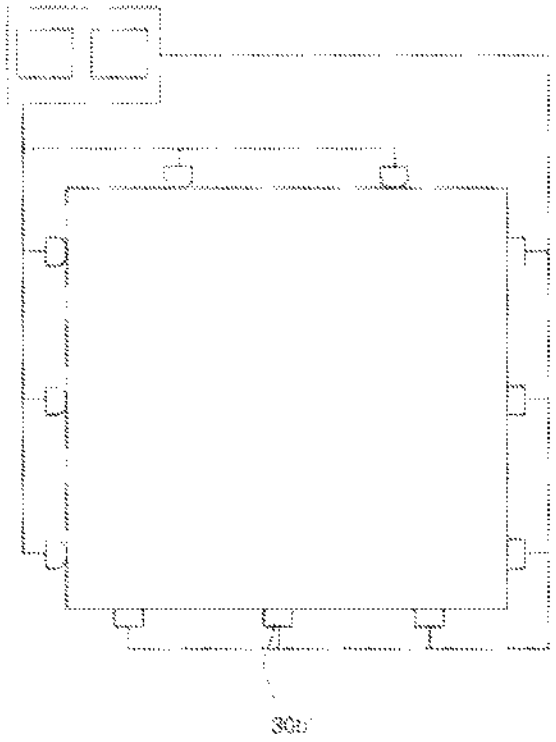


Figure 4e

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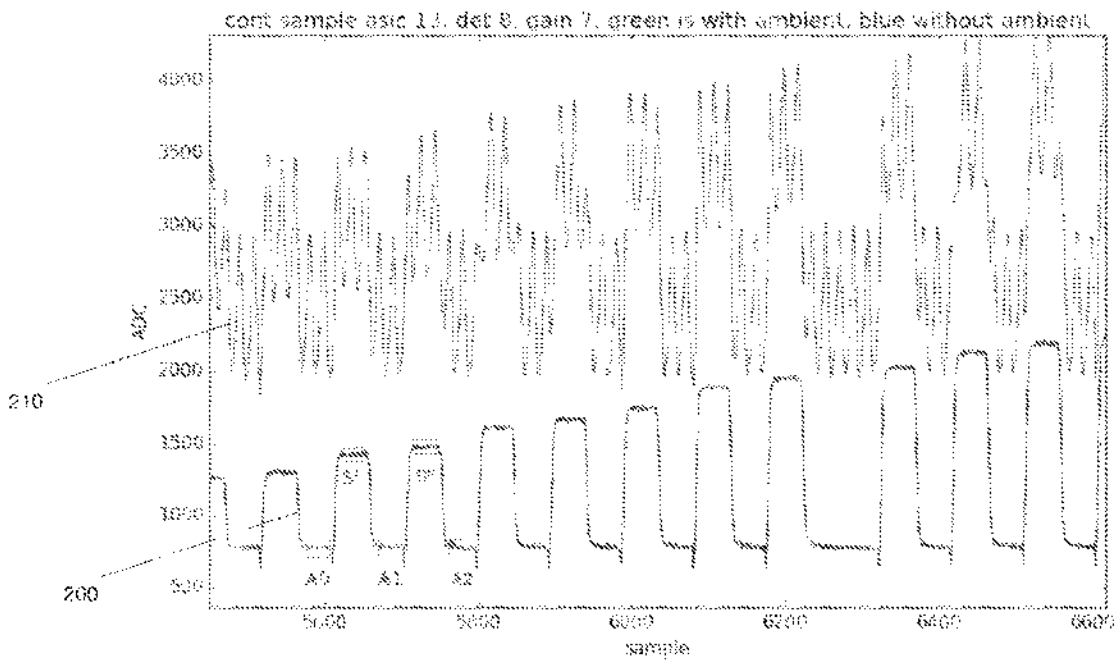


Figure 5

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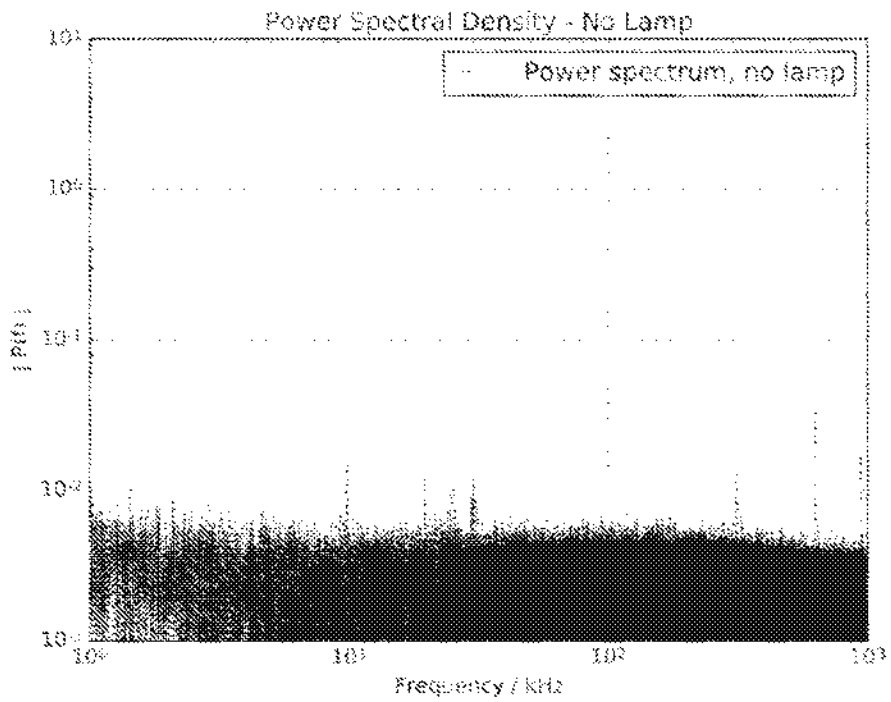

Power Spectral Density - No Lamp
Power spectrum, no lamp
Frequency / kHz

Figure 6

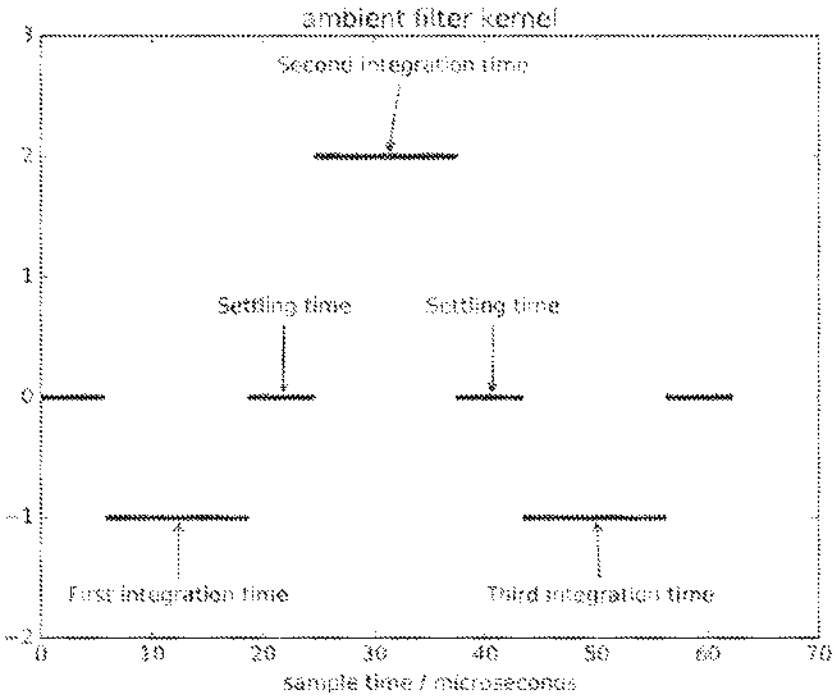

ambient filter kernel
Second integration time
Settling time
Settling time
First integration time
Third integration time
3
2
1
0
−1
−2
0
10
20
30
40
50
60
70
sample time / microseconds

Figure 7

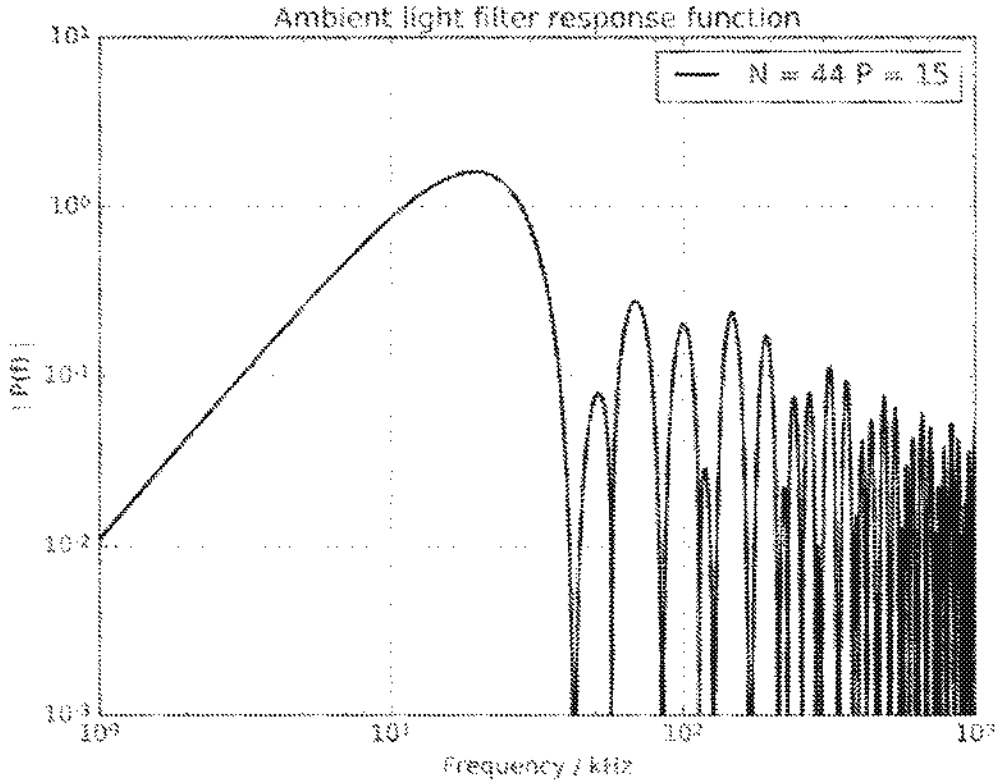


Figure 8

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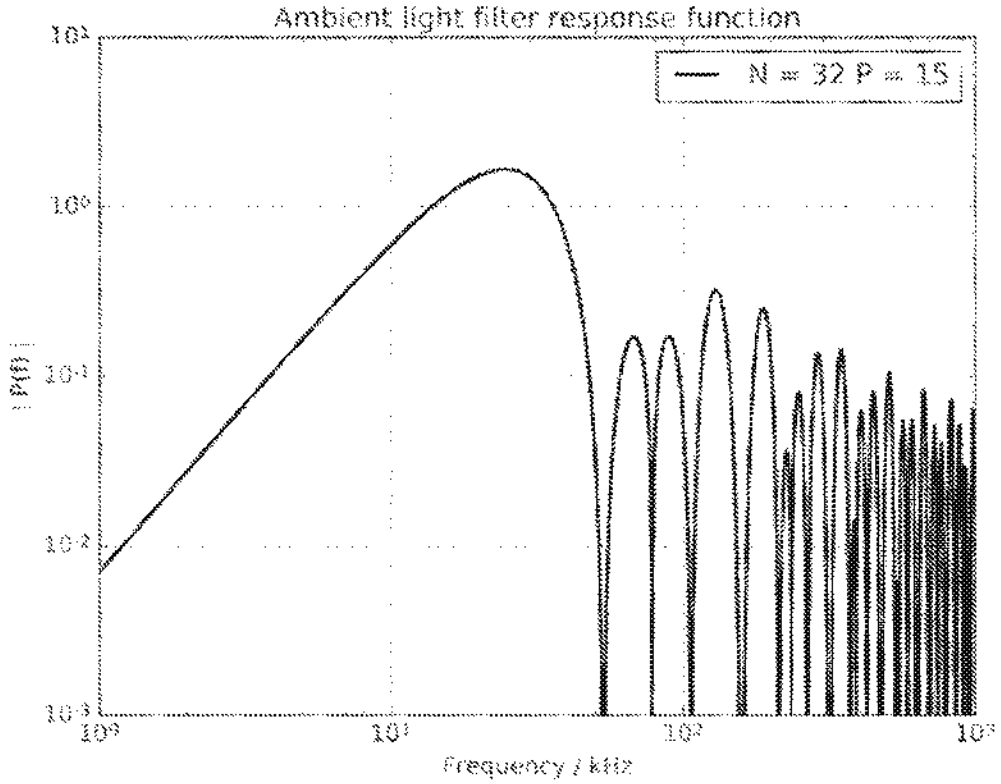

Ambient light filter response function
N = 32 P = 15
|H(f)|
Frequency / kHz

Figure 9

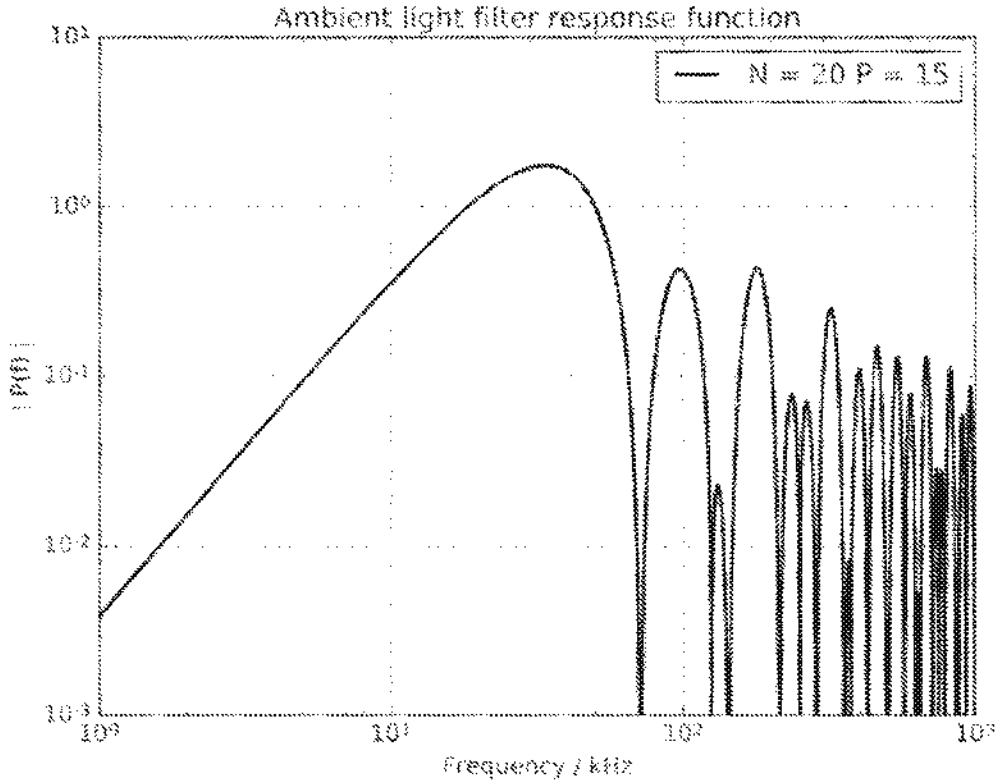

Ambient light filter response function
N = 20 P = 15
|H(f)|
Frequency / kHz

Figure 10

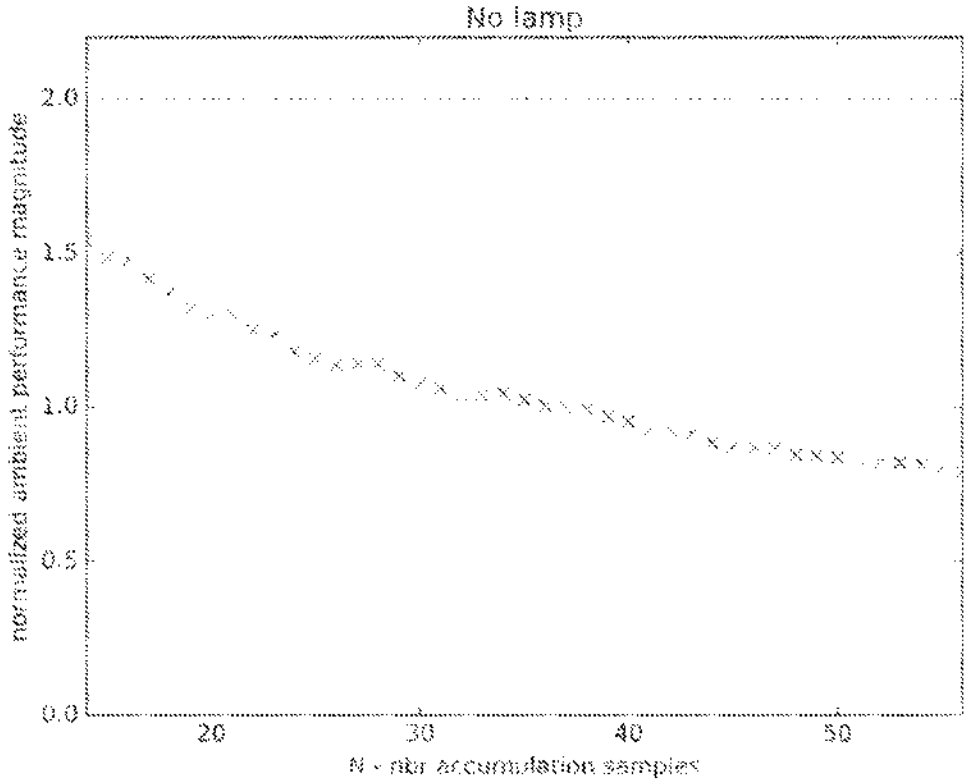

No lamp
normalized ambient performance magnitude
2.0
1.5
1.0
0.5
0.0
20
30
40
50
N - nbr accumulation samples

Figure 11

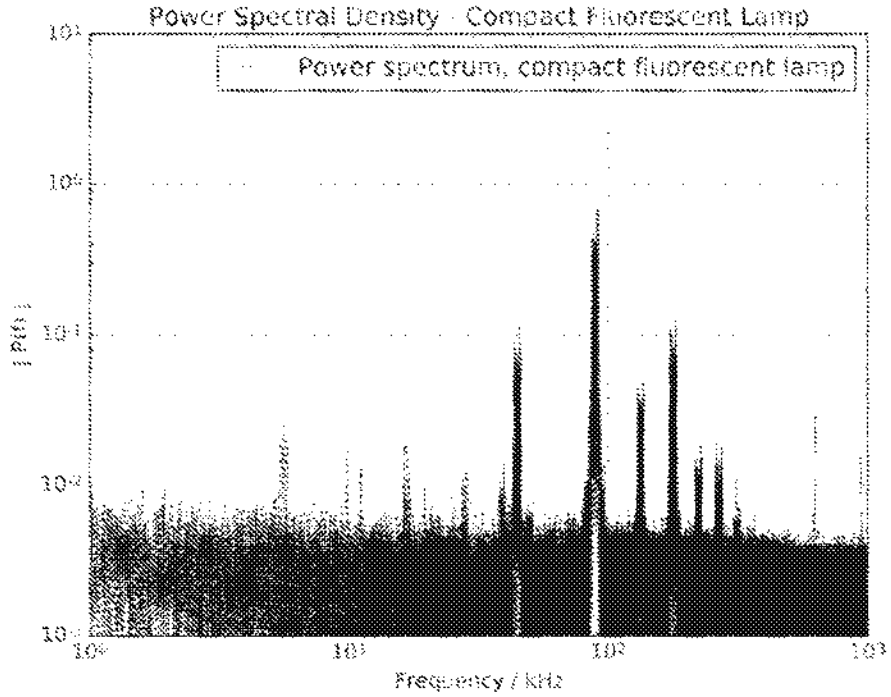

Power Spectral Density - Compact Fluorescent Lamp
Power spectrum, compact fluorescent lamp
Frequency / kHz

Figure 12

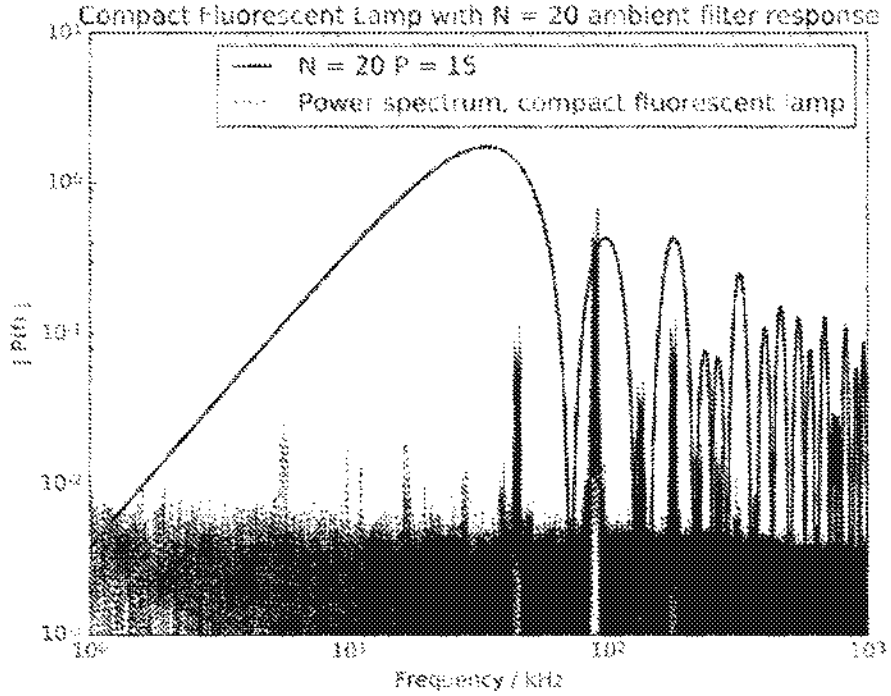


Figure 13a

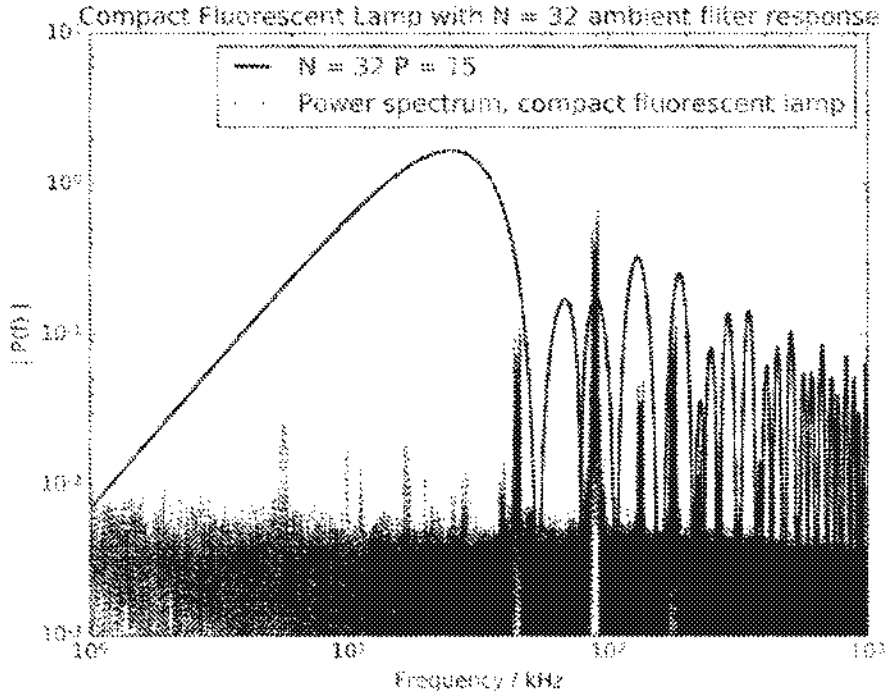


Figure 13b

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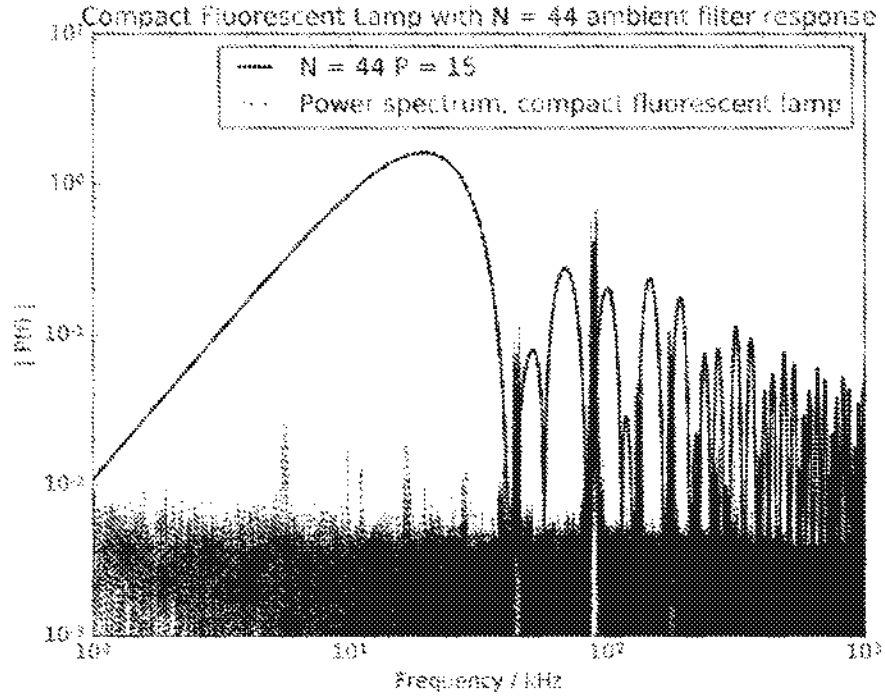

Compact Fluorescent Lamp with N = 44 ambient filter response
N = 44 P = 15
Power spectrum, compact fluorescent lamp
Frequency / kHz

Figure 14

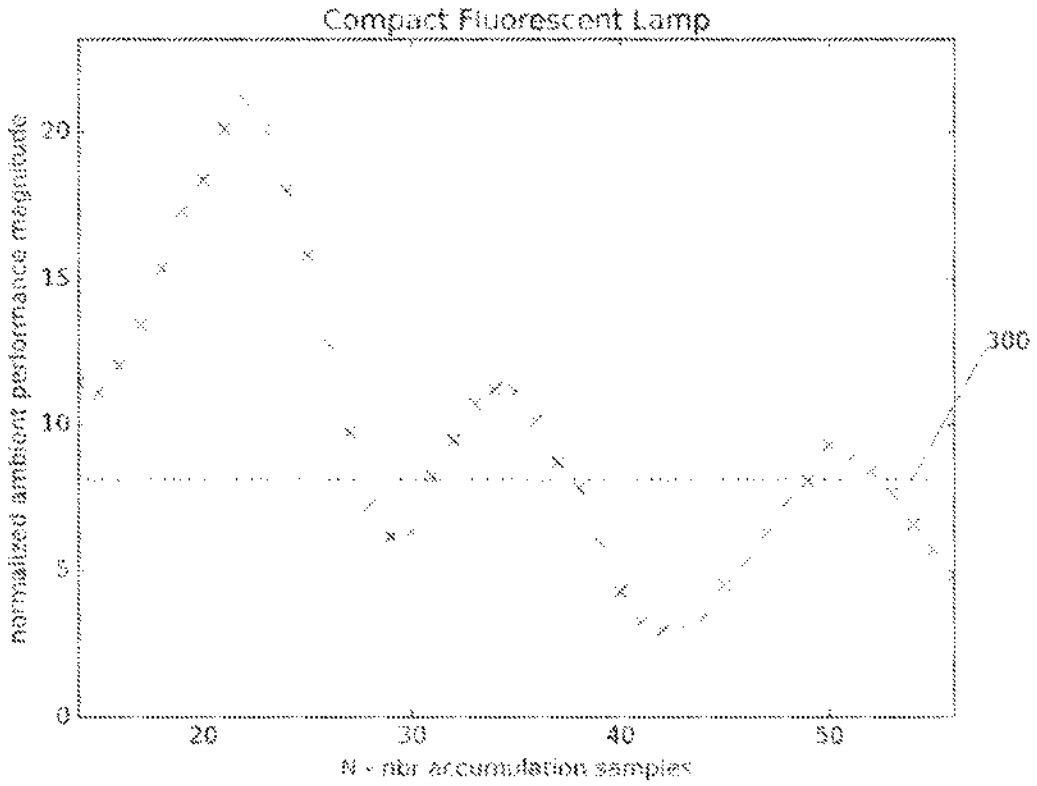

Compact Fluorescent Lamp
normalized ambient performance magnitude
20
15
10
5
0
20
30
40
50
N - nbr accumulation samples
300

Figure 15

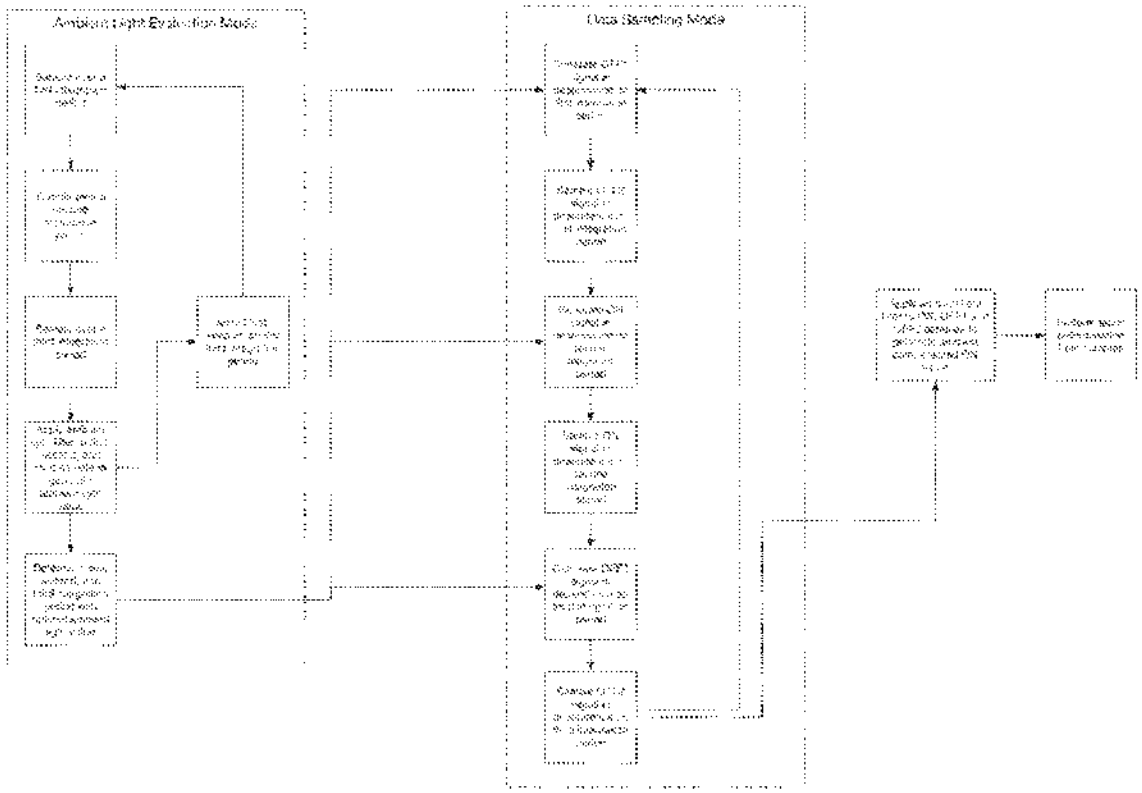


Figure 16

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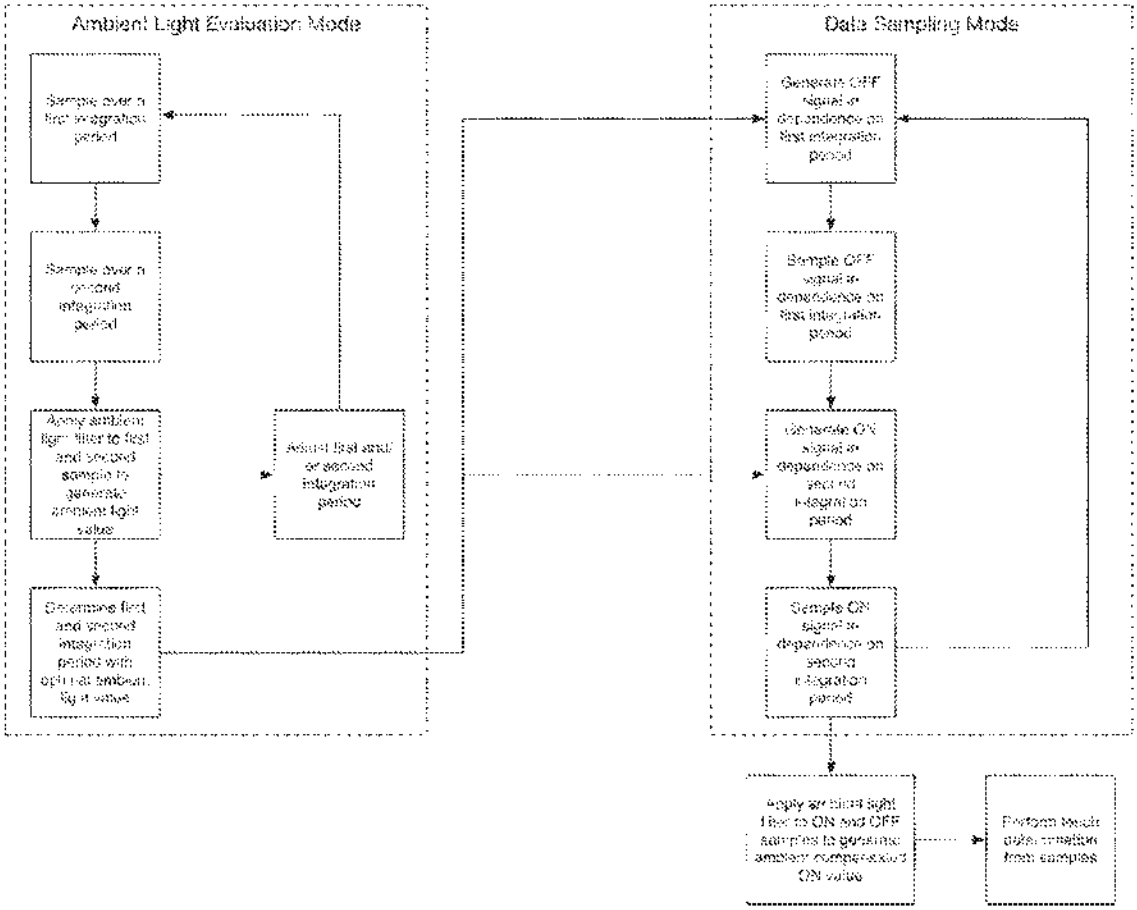


Figure 17

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/057201

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, COMPENDEX, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010084939 A1 (GEPNER JOSEPH E ET AL), 14 April 2011 (2011-04-14); abstract; paragraphs [0003]-[0005] --	1-23
A	WO 2013115710 A2 (FLATFROG LAB AB), 8 August 2013 (2013-08-08); abstract; page 26, line 9 - page 29, line 14 --	1-23
A	WO 2014104967 A1 (FLATFROG LAB AB), 3 July 2014 (2014-07-03); abstract; page 2, line 16 - page 4, line 5 --	1-23
A	US 2013135258 A1 (KING JEFFREY STAPLETON ET AL), 30 May 2013 (2013-05-30); abstract; paragraphs [0007]-[0012] --	1-23

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06-03-2018	06-03-2018

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Per Karlsson Telephone No. +46 8 782 28 00

Form PCT/ISA/210 (second sheet) (January 2015)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20090091554 A1 (KEAM NIGEL), 9 April 2009 (2009-04-09); abstract; paragraphs [0003]-[0004]	1-23

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Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/042 (2006.01)

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				US	8373679	B2	12/02/201 3
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				TW	201346683	A	16/1 1/201 3
				US	20140368471	A 1	18/12/2014
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				KR	201 00063765	A	11/06/201 0
				KR	101465835	B 1	26/1 1/2014
				US	8004502	B2	23/08/201 1
				WO	20090461 54	A3	02/07/2009

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Espacenet

CN100501657C Touch panel device and its locating method

Applicants: GUANGDONG WEICHUANG VIDEO AND [CN]

Inventors: CHUNJING ZHOU [CN];XIANGLIN XU [CN]

Classifications:
IPC ***G06F3/042;***

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Publication: CN100501657C· 2009-06-17

Published as: **CN101174191A;** CN100501657C

Touch panel device and its locating method

Abstract

The invention discloses the localization method of a kind of touch panel device and touch panel device, it is in conjunction with the infrared scan technology of infrared scan module and the camera technique of camera head, obtain the coordinate position of all possible touch point by the infrared scan technology, and in conjunction with the camera head shot picture, determine the coordinate of actual touch point and the color and the size of actual touch thing, color and size according to the actual touch thing, it can be to the independent tracing management of variant touch objects, and cost is low, simple in structure, response speed is fast and reliability is high.

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[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
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代理人 曾旻辉

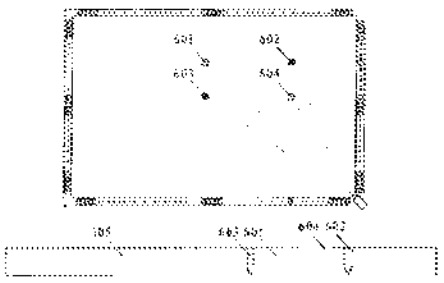
权利要求书 2 页 说明书 9 页 附图 4 页

[54] 发明名称

一种触摸屏装置及触摸屏装置的定位方法

[57] 摘要

本发明公开了一种触摸屏装置及触摸屏装置的定位方法，其结合红外扫描模块的红外扫描技术与摄像装置的摄像技术，通过红外扫描技术获取所有可能的触摸点的坐标位置，并结合摄像装置所拍摄的图片，确定实际的触摸点的坐标以及实际触摸物的颜色和大小，根据实际触摸物的颜色和大小，其可以对各不同的触摸物单独跟踪管理，成本低、结构简单、响应速度快且可靠性高。



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1、一种触摸屏装置，其特征在于，包括：

红外扫描模块，该红外扫描模块包括横向及纵向的红外发射模块、红外接收模块；

摄像装置，该摄像装置位于可拍摄到由所述红外扫描模块所组成的红外扫描网的位置、用于采集触模物数据；

主控制模块，用于收集所述红外接收模块采集的触摸数据及所述摄像装置所采集的触摸物数据，并计算实际触摸点信息，向主机设备发送，或者直接将所述收集的数据发送给所述主机设备，由所述主机设备计算出所述实际触摸点信息。

2、根据权利要求 1 所述的触摸屏装置，其特征在于，所述实际触摸点的信息包括所述实际触摸点的触摸坐标，或者所述实际触摸点的触摸坐标及所述实际触摸物的颜色和/或大小信息。

3、根据权利要求 1 所述的触摸屏装置，其特征在于，所述摄像装置位于横向发射模块和纵向发射模块的交界处。

4、根据权利要求 1 所述的触摸屏装置，其特征在于，所述摄像装置的光轴中心线平行于所述红外扫描网或者位于所述红外扫描网内。

5、根据权利要求 1 所述的触摸屏装置，其特征在于，通过采用至少一种方式以提高拍摄装置的清晰度：

增加外部光源辅助装置；

使用带高反光材料的触摸物和/或在所述触摸物上使用高反光材料的配件。

6、根据权利要求 1 至 5 任意一项所述的触摸屏装置，其特征在于，在同一个扫描周期内，所述摄像装置与所述红外扫描模块同步工作或者以先后顺序工作。

7、一种触摸屏装置的定位方法，其特征在于，包括步骤：

S101：启动红外扫描，在有触摸物存在的情况下，记录被所述触摸物所遮

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挡的红外接收管的位置信息；

S102：以可拍摄到红外扫描网的位置拍摄一幅图片，在有触摸物存在的情况下，根据所述图片分析所述触摸物的角度信息；

S103：根据所述位置信息，得出所有的可能的触摸点的位置组合，并结合所述步骤 S102 中的角度信息，分析出实际触摸物的数据信息，所述数据信息包括实际触摸物的触摸点的坐标信息。

8、根据权利要求 7 所述的定位方法，其特征在于：所述步骤 S101、S102 可以交换顺序或者同步进行。

9、根据权利要求 7 或 8 所述的定位方法，其特征在于：

在所述步骤 S102 中还包括：根据所述图片分析所述触摸物的颜色和/或大小信息；

在所述步骤 S103 中，所述数据信息还包括所述实际触摸物的颜色和/或大小信息。

10、根据权利要求 9 所述的定位方法，其特征在于：所述实际触摸物的颜色信息与其笔迹的颜色相对应和/或所述实际触摸物的大小信息与其笔迹的粗细相对应。

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一种触摸屏装置及触摸屏装置的定位方法

技术领域

本发明涉及触摸屏领域，特别涉及一种触摸屏装置及触摸屏装置的定位方法。

背景技术

触摸屏作为一种新型的计算机输入设备，使人机交互更为直观，由于给用户带来的极大地便利性，触摸屏技术除了应用于个人便携式信息产品外，应用领域已遍及信息家电、公共信息、电子游戏、办公自动化设备等各个领域。目前的无源触摸屏技术主要包括红外、电阻、电容、表面声波等几种，对于单点定位都比较成熟，例如用手指触摸显示屏幕即可操作主机等等，使用方便。但是若只能识别单点触摸，其本质上只是代替了传统的鼠标、键盘等输入设备，多点同时操作主机甚至是多人同时操作主机的应用需求将变得尤为突出，成为触摸屏技术未来的发展方向。

根据红外、电阻、电容、表面声波式的触摸屏实现的技术原理，在此基础上难以实现多点触摸，但将其硬件加以适当改进就可以实现多点定位技术，由于各种方式实现定位的技术原理及成本不同，改进所需的成本、难度及可靠性也必然不同。

公开号为 CN1942853A 的专利文献公开了一种具有透明电容传感介质的触摸面板。电容传感介质分布在不同的电极层总，层内的电极互相平行，层与层之间的电极相互垂直，从而组成了触摸屏的像素阵列，当屏幕被触摸时，电容传感节点产生电容变化，就会被监控电路检测到。这种触摸屏装置内部结构复杂，成本非常高，并且表面容易刮伤，造成永久性损坏，随着屏幕尺寸的增加，复杂程度和价格将成倍增加，所以多用于小尺寸触摸屏幕。公开号为 CN1912816A 的专利文献公开了一种基于摄像头的仅支持单点的触摸屏，它采用两个或以上的摄像头从不同角度对平行于显示屏幕的平面进行监控，根据所拍摄图片识别触摸动作，由于大角度取景会造成图片变形，而最终引起计算的触

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摸坐标数据不准，此外，这种方案只能识别单点触摸，不适应多点触摸的发展需求。

发明内容

本发明的目的在于提供一种结构简单、响应速度快、可靠性高且可支持多点触摸的触摸屏装置及触摸屏装置的定位方法。

为达到上述目的，本发明采用以下技术方案：

一种触摸屏装置，包括：

红外扫描模块，该红外扫描模块包括横向及纵向的红外发射模块、红外接收模块；

摄像装置，该摄像装置位于可拍摄到由所述红外扫描模块所组成的红外扫描网的位置，用于采集触摸物数据；

主控制模块，用于收集所述红外接收模块采集的触摸数据及所述摄像装置所采集的触摸物数据，并计算实际触摸点信息，向主机设备发送，或者直接将所述收集的数据发送给所述主机设备，由所述主机设备计算出所述实际触摸点信息。

一种触摸屏装置的定位方法，包括步骤：

S101：启动红外扫描，在有触摸物存在的情况下，记录被所述触摸物所遮挡的红外接收管的位置信息；

S102：以可拍摄到红外扫描网的位置拍摄一幅图片，在有触摸物存在的情况下，根据所述图片分析所述触摸物的角度信息；

S103：根据所述位置信息，得出所有的可能的触摸点的位置组合，并结合所述步骤 S102 中的角度信息，分析出实际触摸物的数据信息，所述数据信息包括实际触摸物的触摸点的坐标信息。

其中，所述步骤 S101、S102 可以交换顺序或者同步进行。

根据本发明的触摸屏装置及触摸屏装置的定位方法，其同时利用了红外扫

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描模块的红外扫描技术以及摄像装置的图像摄制技术，并结合这两种技术对触摸物进行分析，既支持单点触摸，也支持多点触摸，可以多人同时操作，结构简单、响应速度快且可靠性高。

附图说明

图 1 是本发明实施例的触摸屏装置的结构示意图；

图 2 是本发明实施例的红外扫描模块的工作原理示意图；

图 3 是本发明实施例中摄像装置工作原理示意图；

图 4 是本发明实施例的摄像装置拍摄方法示意图；

图 5 是本发明实施例的红外扫描模块扫描多点触摸示意图；

图 6 是本发明实施例的红外扫描模块结合摄像装置采集的多点触摸示意图；

图 7 是本发明实施例的触摸屏装置的定位方法的流程示意图。

具体实施方式

参见图 1 所示，是本发明实施例的触摸屏装置的结构示意图，如图所示，101 是纵向的红外发射模块，102 是横向的红外发射模块，103 是纵向的红外接收模块，104 是横向的红外接收模块，101、102、103 与 104 共同组成本发明中的红外扫描模块，105 是摄像装置，此外，106、107 是一对配对的红外管，108、109 是纵向和横向的红外扫描线，其中，所有的纵向红外扫描线几乎平行，所有的横向扫描线几乎平行，由横、纵两个方向的红外扫描线组成了红外扫描网。

其中，摄像装置可放置在任意一个地方或者角落，只需该摄像装置可拍摄到整个红外扫描网，此外，摄像装置的镜头的光轴中心线最好平行于所述红外扫描网构成的平面，或者该光轴中心线可直接位于该平面内。

在上述红外发射模块与红外接收模块中，每一对红外发射接收管都是同步工作的，一个红外管用于发射，一个红外管用于接收，用以检测在这一对红外发射接收管对应的扫描线上是否有遮挡物。红外发射模块按照一定的时序将所

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有红外发射管逐个点亮一段时间，使其逐个处于工作状态，而红外接收模块在同一时刻检测配对的接收管上的信号变化，以信号的有无或者强弱来判断是否有遮挡，在一个扫描周期内，所有的发射管点亮一次，所有的红外发射管可以先后点亮，也可以分区同时点亮，根据应用需要的不同而有所不同。当只有一个触摸点时，横向和纵向的红外扫描线被遮挡，接收模块检测到信号产生了变化，这样便唯一确定了两个扫描线的交点就是实际的触摸点；当有 N 个（N 大于或等于 2）触摸点时，在横纵两方向上最少都能检测到 N 个遮挡点，最多能检测 N^2 个触摸点，而仅仅根据遮挡点数据无法判断实际有多少个触摸点以及各触摸点的位置坐标，但能分析出所有可能的合理触摸点组合。

在同一个扫描周期内、摄像装置与红外扫描模块可以是同步工作也可以是以先后顺序工作，摄像装置从平行于红外扫描网的方向取景，取一定的高度即可，数据量非常小，然后从拍摄到的图片数据中提取触摸物的角度位置信息、颜色和大小信息。主控制模块根据摄像装置分析的数据与红外扫描模块得出的几种触摸点组合坐标综合分析，确定实际的触摸点坐标数据、各触摸物的颜色及大小，然后发送给主机设备，或者是、主控制器将收集到的摄像装置分析的数据以及红外扫描模块所得的坐标组合数据直接发送给主机设备，由主机设备计算分析坐标数据及触摸物的颜色和大小等其他数据、其中、主机设备可以是计算机。

参见图 2 所示、是本发明实施例的红外扫描模块工作原理示意图。在一个扫描周期内，所有的红外发射管被点亮一段时间，即在这一段时间内工作，所有的接收管检测一次信号变化、而在同一个时刻内，只有一对红外发射接收管在工作。在本发明的触摸屏装置工作之前，需对系统进行初始化，启动一次扫描，并将此时红外接收管所检测到的信号全部记录下来作为基准值，作为之后的判断依据，此后可进入正常的工作状态。在触摸屏装置正常工作的情况下，若没有触摸点，那么所有的红外接收管所检测到的信号均接近于各自的信号基准值或者相等，当有触摸点时，该触摸点所对应的红外接收管所检测到的信号就会与信号基准值相差较大，当这个相差值大于或者等于预定值时，即可判定存在触摸点。如图 2 所示、207 是一个触摸点，此时在纵向的红外扫描中，红外

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发射管 201 发射的红外线被遮挡，而红外接收管 203 此时检测到的信号与信号基准值相差较大，即大于或者等于预定值，主控制器将记录下信号发生变化的红外接收管的编号，而该编号可以进一步换算成虚拟的位置坐标。根据同样的原理，红外接收管 204 也将检测到信号发生了变化，且该变化值大于或者等于了预定值，主控制器计算出虚拟的位置坐标，由横、纵两个方向所检测到的虚拟坐标值即可确定触摸点，再将该虚拟的坐标映射为实际的触摸坐标。

参见图 3 所示，是本发明实施例的摄像装置的工作原理示意图，如图所示，摄像装置所放置的位置必须能够拍摄到整个的扫描网，也就是可以拍摄到整个屏幕。在没有触摸点的情况下，摄像装置仅能拍摄到红外触摸装置的内框，因此，可以以此为背景色，当有触摸的情况下，将拍摄到的照片与背景色进行对比分析，可提取出触摸物的角度信息、触摸物的颜色以及大小。

其中，角度位置的计算可以是以镜头的光轴中心线为准，以偏移的角度计算，也可以是以其他的任何以镜头为中心的线作为计算基准，虽然选取的计算基准不同，但最终均可换算成图 3 中 302 的角度信息，为了方便计算触摸物的实际大小，以镜头为中心将屏幕分成了若干个扇形区，在某一个扇形区内拍摄同一大小的触摸物的大小也相等，由于镜头的不同，在使用前需建立实物大小与距离的查询表或者计算公式。

如图 4 所示，是本发明实施例的摄像装置的拍摄方法示意图，如图所示，401 是横纵两个方向的红外扫描模块组成的红外扫描网平面，402 是显示设备平面，403 是摄像装置的镜头广轴中心线，该镜头广轴中心线平行于红外扫描网平面或在这个平面内，404、405 是摄像装置的取景范围，需可以拍摄到整个显示设备，406 是拍摄图片的高度，根据需要可以进行适当的调整，407 是触摸物，408 是摄像装置拍摄到的图片，其中图片中的触摸物可能只是实际触摸物的一部份。根据摄像装置所拍摄到的图片 408，从图片中提取出触摸物的颜色及大小，并根据触摸物距离图片的最左端或者最有短的距离查表或者计算得出触摸物的角度信息。这个计算过程可以是由摄像装置完成，摄像装置将计算所得结果发送给主控制模块，也可以是摄像装置将所拍得的图片发送给主控制模块，由主

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控制模块执行计算的过程。随后，主控制模块根据红外接收模块所采集的触摸数据，以及该图片中所采集的触摸物数据，综合计算出实际的触摸物的位置坐标、颜色以及大小，并发送给主机设备，或者是主控制模块将所采集的上述触摸数据和触摸物数据发送给主机设备，由主机设备计算出实际的触摸物的坐标、颜色以及大小。

根据触摸物的颜色以及大小等信息，主机设备可以对每个操作者的使用状态进行单独的跟踪管理，比如：无线的粗蓝色笔画出来的线是蓝色的粗线，用无线的细红色笔画出来的线是细红线，这使得在交互式的多媒体应用中显得更生动、直观，且还可以应用于其他各场合。

此外，由于在触摸屏的应用中，实时性的要求比较高，且摄像装置一般都采用摄像头，摄像头的曝光时间比较短，为了达到更好的拍摄效果，提高摄像装置的清晰度，可以采用以下几种方案：

1、在无线笔（相当于触摸物）上涂上高反光材料，即使用带高反光材料的触摸物或者是在触摸物上使用高反光材料的配件，例如中空的笔套，从而笔套可以方便地套在笔上或者手指上；

2、将摄像装置放置在横向发射模块和纵向发射模块的交界处，从而可以以红外发射管作为光源；

3、为摄像装置增加外部辅助光源。

如图 5 所示，是本发明实施例的红外扫描模块扫描多点触摸的示意图，502、503 分别为两个触摸点，按照红外扫描模块的扫描原理，红外接收模块将在红外接收管 505、506、507、508 处检测到红外信号变化超过了预定值，并可判定对应方位可能存在触摸物，由此，可能的触摸点最多有 4 个，即 501、502、503、504，但无法确定实际上有多少个触摸点，其可能的组合有以下几种：

（1）501、504；

（2）502、503；

（3）501、503、504；

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（4）501、502、504；

（5）501、502、503；

（6）502、503、504；

（7）501、502、503、504。

如此可见，仅仅根据红外扫描的方式无法确定实际的触摸点数。

如图 6 所示，是本发明实施例中红外扫描模块结合摄像装置所采集的多点触摸的示意图，605 是摄像装置所拍摄到的图片，601、602、603、604 是通过红外扫描所得到的可能的触摸物，602、603 是拍摄到的触摸物，从图片中提取出触摸物的偏离角度、颜色、以及大小，再结合红外扫描所得的结果，即可综合分析得出实际的触摸物有 602、603，排除了其他的可能，在分析出触摸物的坐标位置后，可计算出各触摸物偏离镜头的距离，再通过查表或者计算得出触摸物的实际大小，并将触摸物的坐标信息、颜色以及大小向主机设备发送。

如上所述，本发明的触摸屏装置同时利用到了红外扫描技术与图像摄制技术，从而可达到以下优点：

1、定位技术采用红外扫描为主，摄像采集为辅，响应速度快，且稳定可靠；

2、同时支持单点触摸和多点触摸，且由于可采集触摸物的颜色以及大小信息，可以分别跟踪每个触摸点，从而可以对不同的触摸物进行的同一个触摸动作做出不同的响应，使应用变得更灵活、生动；

3、成本低，安装方便，可应用于平板电视、前投、背投等系统，且特别适用于大屏幕显示系统。

参见图 7 所示，是本发明的触摸屏装置定位方法的流程示意图，如图所示，本发明的定位方法包括步骤：

S101：启动一次红外扫描，记录当前状态下的红外接收管所检测到的信号强度值；

S102：启动红外扫描，根据红外接收管所接收到的信号，判断是否存在遮

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挡触摸物，若有，记录当前的位置信息；

其中，上述判断是否存在遮挡物的方式可以是：

根据红外接收管是否检测到信号来判断是否具有遮挡物，若没有检测到任何信号，则可判定在这对红外发射接收管之间存在遮挡物，并记录当前的位置信息；

还可以是，根据红外接收管所接收到的信号，计算出该信号相对于所述记录的信号强度值的变化值，若变化值大于或者等于预定值，则判定存在遮挡触摸物，并记录当前的位置信息；

S103：以可拍摄到红外扫描网的位置拍摄一幅图片，并根据所述图片分析是否有触摸物，若有触摸物，分析所述触摸物的角度信息，并可分析出该触摸物的颜色以及大小信息；

S104：根据所述位置信息，得出所有的可能的触摸点的位置组合，并结合步骤 S103，分析出实际触摸物的数据信息，包括实际触摸物的坐标信息，还包括实际触摸物的颜色以及大小信息，其中上述分析过程可以是在触摸屏装置中进行，触摸屏装置分析完成后将分析结构发送给后续处理的主机设备，也可以是在进行后续处理的主机设备中进行。

S105：重复步骤 S102 至 S104。

其中，所述步骤 S103 与 S104 可以是以先后顺序进行，也可以是同时进行。

此外，在标注触摸物的触摸轨迹时，根据触摸物的颜色以及大小等信息，可以使标注的轨迹的颜色与大小与相应的触摸物的颜色与大小相对应，从而可以对每个操作者的使用状态进行单独的跟踪管理，例如：无缘的粗蓝色笔画出来的线是蓝色的粗线，用无缘的细红色笔画出来的线是细红线，这使得在交互式的多媒体应用中显得更生动、直观，且还可以应用于其他各场合。

根据本发明的定位方法，其可达到以下有以效果：

1、定位技术采用红外扫描为主，摄像采集为辅，响应速度快，且稳定可靠；

2、同时支持单点触摸和多点触摸，且由于可采集触摸物的颜色以及大小信

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息，可以分别跟踪每个触摸点，从而可以对不同的触摸物做出的同一个触摸动作做出不同的响应，使应用变得更灵活、生动。

以上所述的本发明实施方式，并不构成对本发明保护范围的限定。任何在本发明的精神和原则之内所作的修改、等同替换和改进等，均应包含在本发明的权利要求保护范围之内。

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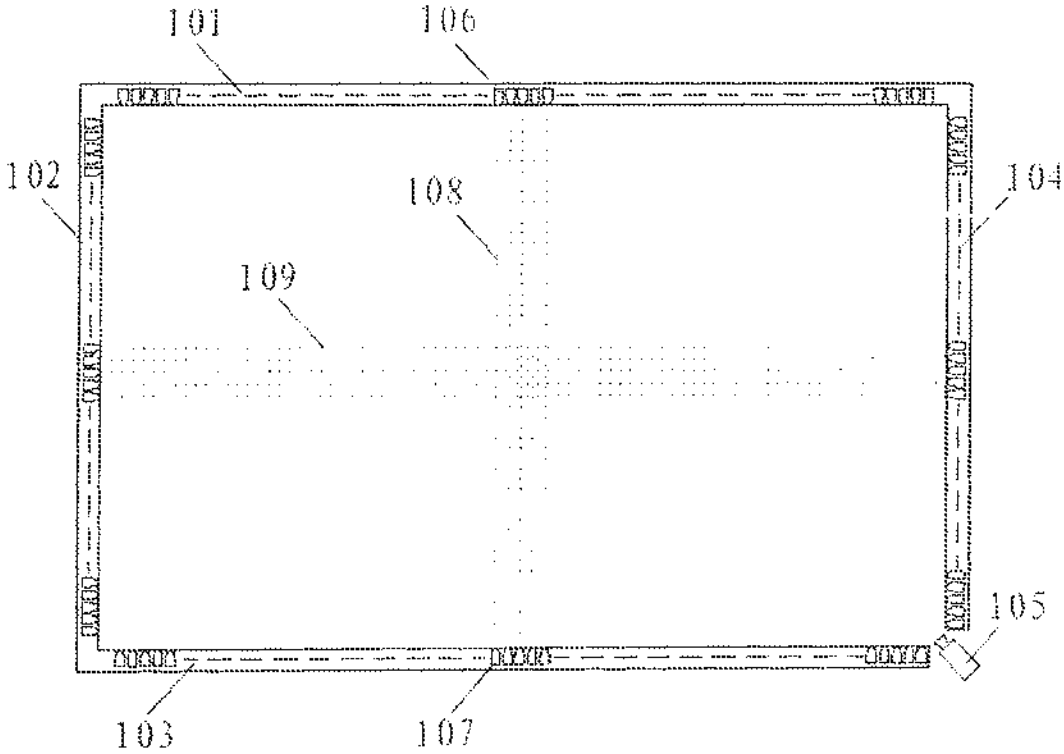


图 1

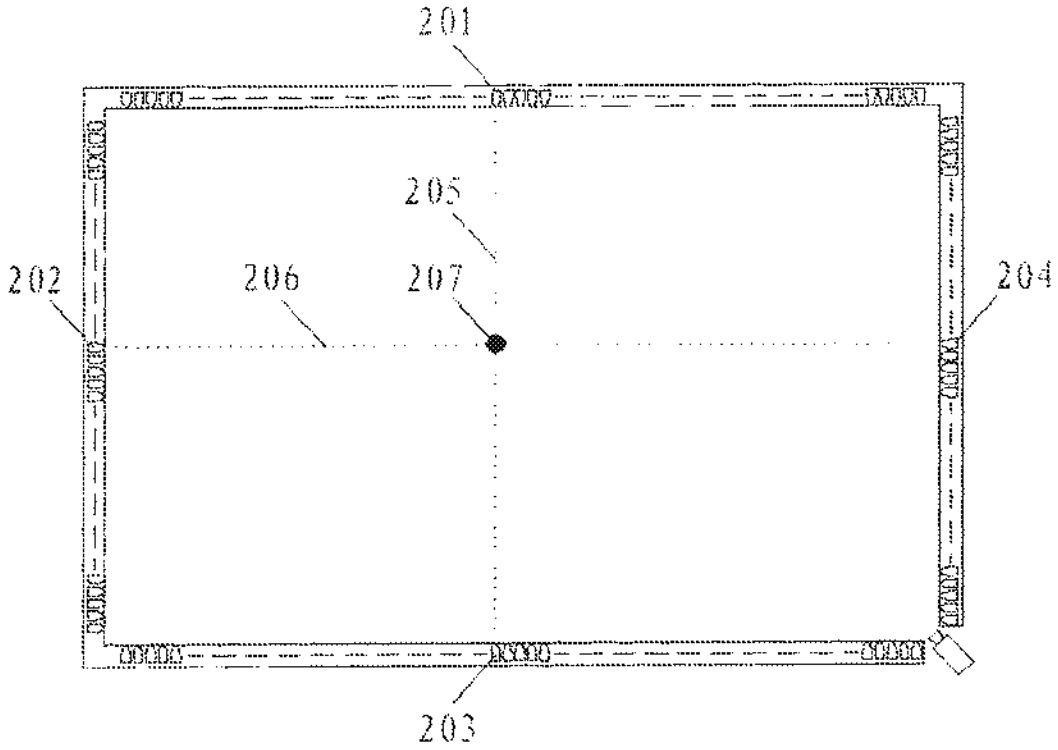


图 2

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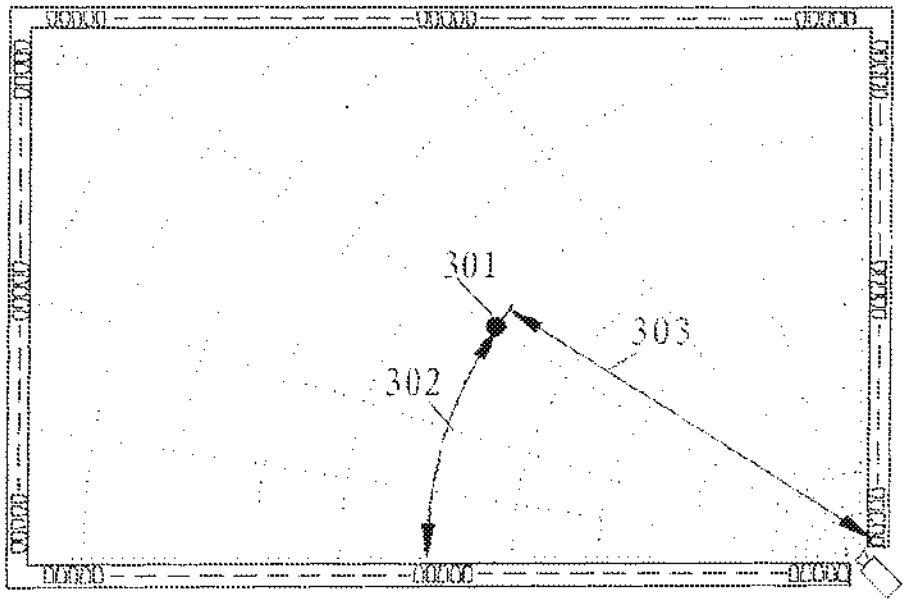


图 3

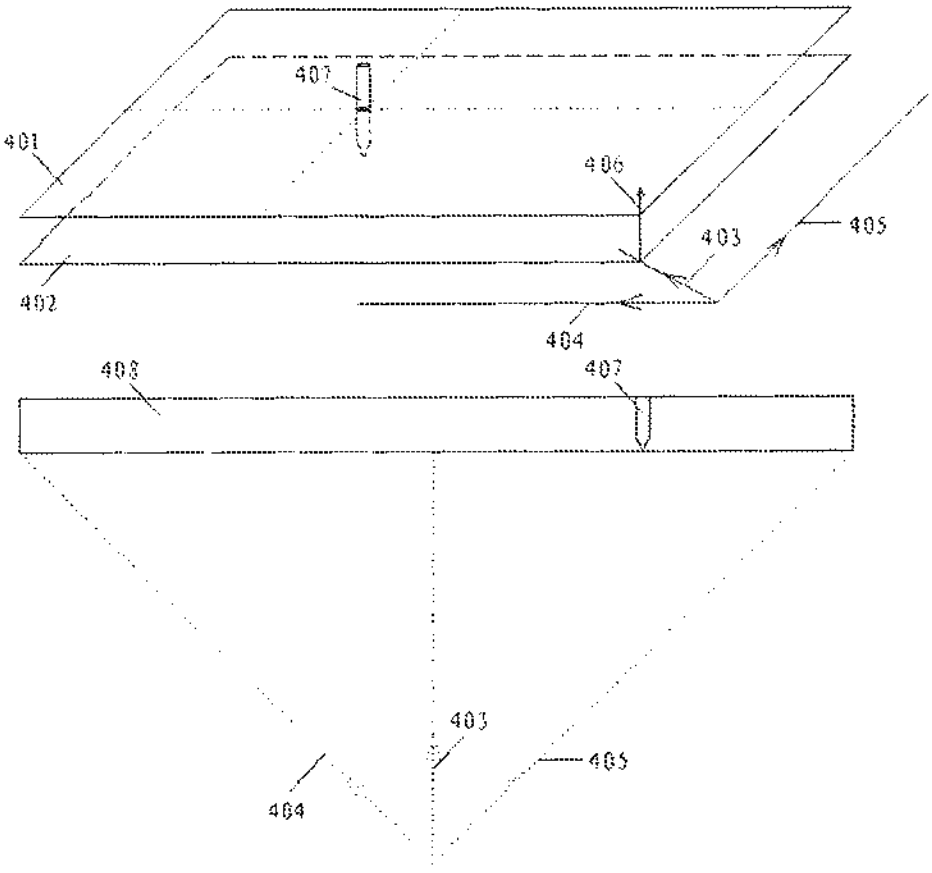


图 4

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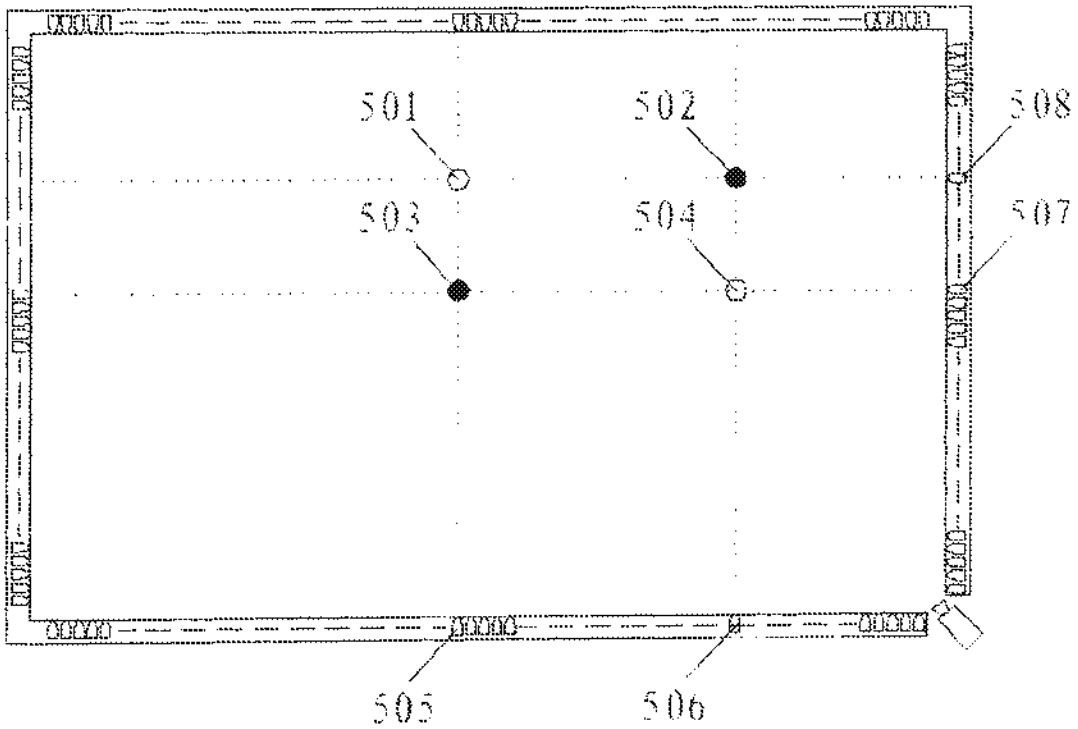


图 5

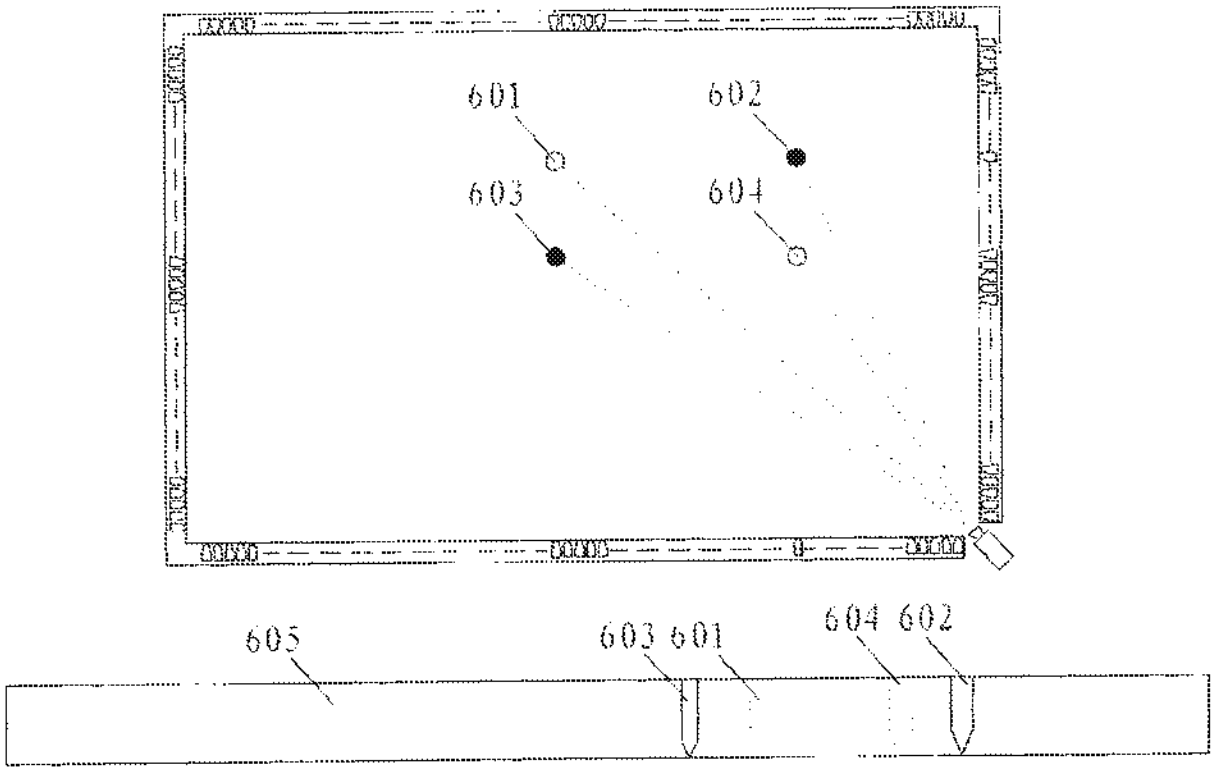


图 6

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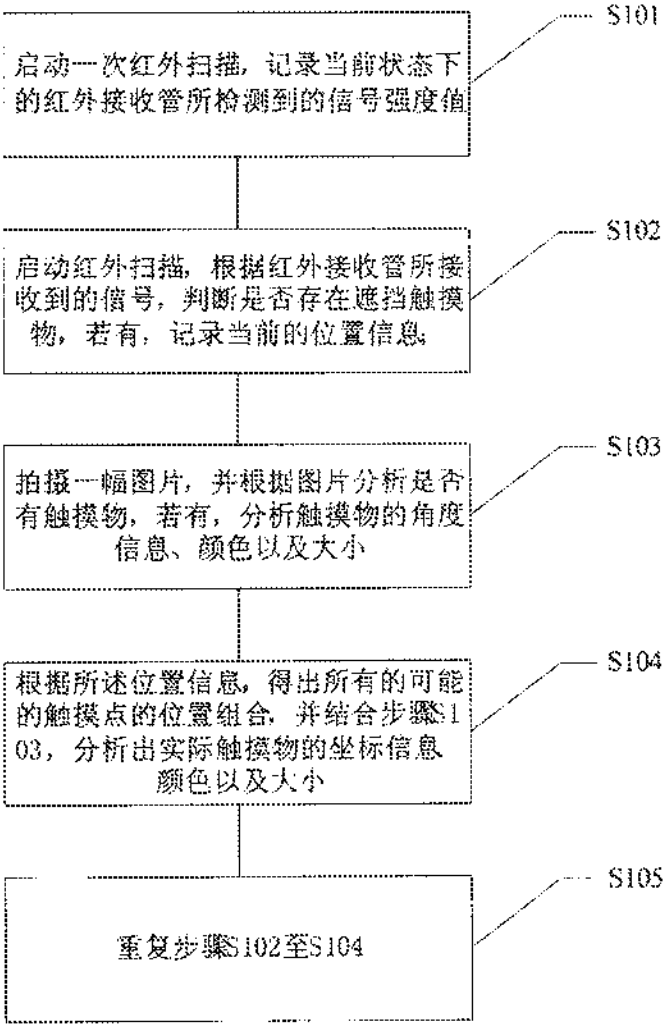


图 7

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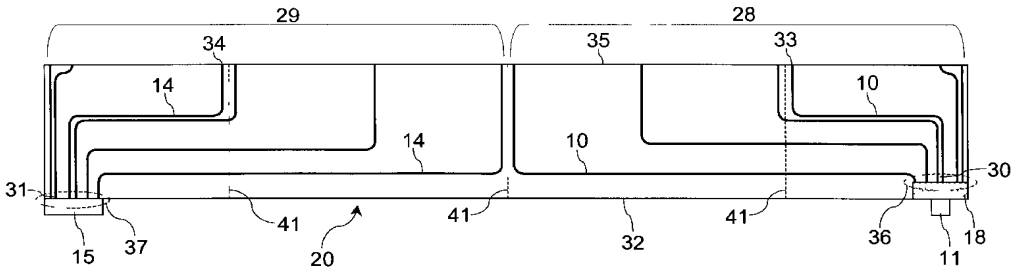
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(54) **Title:** WAVEGUIDE CONFIGURATIONS FOR OPTICAL TOUCH SYSTEMS



(57) **Abstract:** The present invention relates to waveguide structures and optical elements for use in an optical touch input device. The waveguide structures and optical elements allow for reduced bezel width and simplified assembly of optical touch input devices, and relaxed component tolerances.

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WAVEGUIDE CONFIGURATIONS FOR OPTICAL TOUCH SYSTEMS

FIELD OF THE INVENTION

The present invention relates to input systems, and in particular, optical touch systems having relatively reduced bezel dimensions. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of the common general knowledge in the field.

Touch input devices or sensors for computers and other consumer electronics devices such as mobile phones, personal digital assistants (PDAs) and hand-held games are highly desirable due to their extreme ease of use. In the past, a variety of approaches have been used to provide touch input devices. The most common approach uses a flexible resistive overlay, although the overlay is easily damaged, can cause glare problems, and tends to dim an underlying display, requiring excess power usage to compensate for such dimming. Resistive devices can also be sensitive to humidity, and the cost of the resistive overlay scales quadratically with perimeter. Another approach is capacitive touch, which also requires an overlay. In this case the overlay is generally more durable, but the glare and dimming problems remain.

In yet another common approach, a matrix of infrared light beams is established in front of a display, with a touch detected by the interruption of one or more of the beams. Such 'optical' touch input devices have long been known (US 3,478,220; US 3,673,327), with the beams generated by arrays of optical sources such as light emitting diodes (LEDs) and detected by corresponding arrays of detectors (such as

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phototransistors). They have the advantage of being overlay-free and can function in a variety of ambient light conditions (US 4,988,983), but have a significant cost problem in that they require a large number of source and detector components, as well as supporting electronics. Since the spatial resolution of such systems depends on the number of sources and detectors, this component cost increases with display size and resolution.

An alternative optical touch input technology, based on integrated optical waveguides, is disclosed in US 6,351,260, US 6,181,842 and US 5,914,709, and in US Patent Application Nos. 2002/0088930 and 2004/0201579. The basic principle of such a device is shown in Figure 1. In this optical touch input device, integrated optical waveguides ('transmit' waveguides) 10 conduct light from a single optical source 11 to integrated in-plane lenses 16 that collimate the light in the plane of a display and/or input area 13 and launch an array of light beams 12 across that display and/or input area 13. The light is collected by a second set of integrated in-plane lenses 16 and integrated optical waveguides ('receive' waveguides) 14 at the other side of the screen and/or input area, and conducted to a position-sensitive (i.e. multi-element) detector 15. A touch event (e.g. by a finger or stylus) cuts one or more of the beams of light and is detected as a shadow, with position determined from the particular beam(s) blocked by the touching object. That is, the position of any physical blockage can be identified in each dimension, enabling user feedback to be entered into the device. Preferably, the device also includes external vertical collimating lenses (VCLs) 17 adjacent to the integrated in-plane lenses 16 on both sides of the input area 13, to collimate the light beams 12 in the direction perpendicular to the plane of the input area.

The touch input devices are usually two dimensional and rectangular, with two arrays (X, Y) of transmit waveguides 10 along adjacent sides of the input area, and two

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corresponding arrays of receive waveguides 14 along the other two sides. As part of the transmit side, in one embodiment a single optical source 11 (such as an LED or a vertical cavity surface emitting laser (VCSEL)) launches light via some form of optical power splitter 18 into a plurality of waveguides that form both the X and Y transmit arrays. The X and Y transmit waveguides are usually fabricated on an L shaped substrate 19, and likewise for the X and Y receive waveguides, so that a single source and a single position-sensitive detector can be used to cover both X and Y dimensions. However in alternative embodiments, a separate source and/or detector may be used for each of the X and Y dimensions. For simplicity, Figure 1 only shows four waveguides per side of the input area 13; in actual touch input devices there will generally be sufficient waveguides for substantial coverage of the input area.

These prior art devices house the waveguide structures that form the X and Y transmit arrays within a protective bezel that surrounds the input area. Typically, the input area will coincide with a display, in which case the touch input device may be referred to as a 'touch screen'. Other touch input devices, sometimes referred to as 'touch panels', do not have a display. The present invention applies to both types of input device. As will be appreciated, the bezel width necessarily limits the display size within a given touch screen device, which may be a significant limitation for small devices such as mobile phones. A further problem is that, to minimise the bezel width, the distance between the in-plane lenses and the external VCLs should be minimised, leading to a high magnification optical system that is extremely susceptible to errors in the design, fabrication and placement of the external VCLs.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

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DISCLOSURE OF THE INVENTION

According to a first aspect the present invention provides a waveguide structure for an input device having an input area defining a plane, said waveguide structure having at least one optical waveguide adapted to carry a signal for said input device, said waveguide structure being configured such that, in use, said at least one optical waveguide extends entirely below said plane.

The input device typically includes a substantially planar input surface for receiving user input, and in the preferred embodiment, the input surface defines the plane of the input area. The input device also includes a periphery defined by one or more sides, and is preferably substantially rectangular in shape.

The signal may comprise an input signal or an output signal and is preferably light having a predetermined wavelength. The wavelength may be in the visible region of the spectrum or the infrared region of the spectrum. Desirably the wavelength is between 700 and 1000 nm.

The waveguide structure preferably includes a plurality of optical waveguides, wherein each optical waveguide extends entirely below the plane.

Preferably the waveguide structure is substantially flexible and formed from polymeric materials. Optimally, the waveguide structure is bendable through at least 90° without suffering mechanical damage. In a particularly preferred embodiment, the waveguide structure comprises a plurality of polymer optical waveguides fabricated on a flexible polymer substrate.

Preferably the waveguide structure extends around at least a portion of the periphery. Optionally the waveguide structure extends around adjacent sides of the periphery. However, in preferred embodiments the waveguide structure extends around the entire periphery.

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In preferred embodiments, the waveguide structure is disposed substantially perpendicularly to the plane of the input device. However, in other embodiments the waveguide structure extends underneath and substantially parallel to the plane of the input device, and preferably lies substantially within the periphery.

The waveguide structure is preferably configured such that, in use, the at least one optical waveguide passes through a maximum of two mutually perpendicular planes.

The waveguide structure may be formed as a substantially rectangular two-dimensional sheet. However, in other embodiments, the waveguide structure is formed as a substantially L-shaped two-dimensional sheet.

In a particular embodiment of the invention the waveguide structure comprises a plurality of input waveguides adapted to carry an input signal and a plurality of output waveguides adapted to carry an output signal. Preferably the input waveguides are grouped on the waveguide structure to define a transmit section, and the output waveguides are grouped on the waveguide structure to define a receive section. Typically, the input waveguides are referred to as transmit waveguides and the output waveguides referred to as receive waveguides. Each waveguide includes an input portion for receiving an input signal and an output portion for transmitting an output signal. Typically the waveguides are positioned such that the input portions of the transmit waveguides and the output portions of the receive waveguides are disposed on or proximate to a first side of the waveguide structure, and the output portions of the transmit waveguides and the input portions of the receive waveguides are disposed on or proximate to a second side of the waveguide structure, wherein the first and second sides are substantially mutually opposed. In this embodiment, the input portions of the transmit waveguides are grouped into an input array, and the output portions of the receive waveguides are grouped into an output array, each array extending along a

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portion of the first side. However, the output portions of the transmit waveguides and the input portions of the receive waveguides are spaced, preferably substantially evenly spaced, along substantially the entire length of the second side.

In other embodiments, the waveguides are positioned such that the input portions of the transmit waveguides and the output portions of the receive waveguides are disposed on or proximate to opposite sides of the waveguide structure, and the output portions of the transmit waveguides and the input portions of the receive waveguides are disposed on or proximate to a common side of the waveguide structure. Preferably the output portions of the transmit waveguides and the input portions of the receive waveguides are spaced, preferably substantially evenly spaced, along substantially the entire length of the common side.

The input array is suitably optically coupleable with a light source and the output array is optically coupleable with a light detector, which is preferably a position-sensitive detector.

In preferred embodiments the output portions of the transmit waveguides and the input portions of the receive waveguides include an integral structure, such as a planar lens. In other embodiments the integral structure may be a planar internally reflective mirror.

Preferably the waveguide structure includes at least one fold line defined by a line of weakness to assist in folding the waveguide structure about the periphery of an input device. In alternative embodiments, the fold line is a printed mark to assist in manual assembly with an input device and/or with an optical element. Alternatively, the printed mark is visible to a machine vision system when the waveguide structure is machine assembled with an input device.

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According to a second aspect the present invention provides an optical element for an input device having an input area defining a plane, said optical element comprising: a first reflective surface; and a connect portion adapted for connection to a waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device, said optical element being configured for use with said input device such that, in use, said first reflective surface is positioned above said plane to re-direct said signal to or from said optical waveguide, said connect portion being at least partially below said plane whereby said at least one optical waveguide extends entirely below said plane. The reflective surface may be a mirror adapted for optical communication with the connect portion. The mirror may be plane or arcuate in cross-section and is optionally metallised. However, in a preferred embodiment the first reflective surface is an internally reflective surface.

Preferably, the optical element further includes a body of light transmissive material for transmission of the signal between the connect portion and the first reflective surface, in which case the first reflective surface is an internally reflective surface. More preferably, the internally reflective surface is a totally internally reflective surface. Preferably the first reflective surface is curved thereby to focus the signal in a direction substantially perpendicular to the plane of the input device. Alternatively, the first reflective surface may be planar so that it does not focus the signal.

In further aspects, the optical element includes a second reflective surface that, in use, is positioned below the plane of the input device. An optical element having a second reflective surface is particularly useful when the waveguide structure extends underneath and substantially parallel to the plane of the input device. Preferably, the second reflective surface is an internally reflective surface, more preferably a totally internally reflective surface. The second reflective surface may be curved so as to focus

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the signal in a direction substantially perpendicular to the plane of the input device. Preferably, the second reflective surface is curved in a cylindrical fashion so as to focus a plurality of signals associated with a plurality of optical waveguides. Alternatively, the second reflective surface may be planar.

In preferred embodiments, the optical element is formed as a strip of plastics material substantially transparent to the signal light (e.g. in the infrared region of the spectrum) and opaque to light at other wavelengths (e.g. ambient visible light). The optical element is preferably injection moulded or extruded. Additionally, in a preferred form the optical element is substantially rigid.

When formed as a strip of plastics material, the first reflective surface of the optical element is preferably arcuate in cross section thereby to focus a plurality of signals associated with a plurality of optical waveguides.

In the preferred embodiments where the optical element further includes a body of light transmissive material between the connect portion and the first reflective surface, the optical element includes an optical surface through which light passes as it transits the input area. In some embodiments, this optical surface will be planar. Alternatively, it may be arcuate in cross section to form a lens portion thereby to focus the signal in a direction substantially perpendicular to the plane of the input device. Preferably, the optical surface is curved in a cylindrical fashion so as to focus a plurality of signals associated with a plurality of optical waveguides. Irrespective of the precise shape of the optical surface, the optical element is preferably shaped such that, in use, the exterior angle between the input device and the optical surface is greater than 90°. In related aspects, the optical element includes a recess such that the optical element is releasably attachable with the input device. Further, the waveguide structure may be fixedly attached to the optical element by, for example, gluing.

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According to a third aspect the present invention provides an apparatus comprising: an input device having an input area defining a plane and having a periphery; a waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device; and one or more optical elements extending along at least a portion of said periphery and in optical communication with said at least one waveguide, each optical element extending from a position below said plane to a position above said plane such that, in use, each said optical element transmits said input signal or said output signal to or from said input area to said at least one waveguide extending entirely below said plane.

According to a fourth aspect the present invention provides a method of transmitting input and output signals for an input device, said input device having an input area defining a plane and having a periphery, said method comprising: providing at least one waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device, said at least one optical waveguide extending entirely below said plane; providing one or more optical elements along at least a portion of said periphery; and optically coupling said waveguide structure with a respective optical element such that, in use, each said optical element transmits said input signal or said output signal to or from said input area to a respective waveguide extending entirely below said plane.

According to a fifth aspect the present invention provides a method of reducing bezel width in an input device, said input device having an input area defining a plane and having a periphery, said method comprising: providing at least one waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device; providing one or more optical elements along at least a portion of said periphery; and optically coupling said at least one optical waveguide

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with a respective optical element such that, in use, each said optical element transmits said input signal or said output signal to or from said at least one optical waveguide; wherein said at least one optical waveguide is terminated at a position below said plane, and wherein said optical elements extend from above said plane to a position below said plane.

Unless the context clearly requires otherwise, throughout the description and the claims, the words 'comprise', 'comprising', and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of 'including, but not limited to'.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates a typical prior art waveguide-based optical touch screen sensor;

Figure 2 is a plan view of one embodiment of a waveguide structure according to the present invention;

Figure 3 is a plan view of another embodiment of a waveguide structure according to the present invention;

Figure 4 is a plan view of yet a further embodiment of a waveguide structure according to the present invention, wherein the waveguide includes a recess to accommodate electrical connections to a display that the waveguide structure surrounds;

Figure 5 is a perspective view of one half of the waveguide structure embodiment shown in Figure 2, shown folded into an L-configuration and ready to be engaged to a display;

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Figure 6 is a perspective view of the waveguide structure embodiment shown in Figure 2 engaged to a display;

Figure 7 is a top view of the waveguide structure embodiment shown in Figure 3 engaged to a display;

Figure 8 is a plan view of another embodiment a waveguide structure according to the invention;

Figure 9 is an underside view of a display showing a pair of the waveguide structure embodiments shown in Figure 8 engaged thereto;

Figure 10 is a sectional side view of one embodiment of an optical element according to the present invention shown engaged to a display and having a waveguide structure optically engaged thereto, and directing light from the waveguide across the upper surface of the display;

Figure 11 is a view similar to Figure 10 but showing another embodiment of an optical element according to the present invention;

Figure 12 is a view similar to Figure 10 but showing a further embodiment of an optical element according to the present invention;

Figure 13 is a view similar to Figure 10 but showing yet another embodiment of an optical element according to the present invention;

Figure 14 is a sectional side view of another embodiment of an optical element according to the present invention shown engaged to a display and having a waveguide structure optically engaged thereto, wherein the waveguide structure is positioned beneath and parallel to the display;

Figure 15 is a view similar to Figure 14 but showing another embodiment of an optical element according to the present invention;

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Figure 16 is an exploded perspective view of a display, a waveguide structure according to the invention and an optical element according to the invention;

Figure 17 is a sectional side view of a prior art waveguide-based optical touch input device showing the relatively wide bezel dimension required to accommodate the waveguide structure and associated optics;

Figure 18 is a sectional side view of the combined waveguide structure and optical element of one embodiment of the present invention engaged to a display showing the relatively reduced bezel dimensions required; and

Figures 19(a) and 19(b) show plan and side views of a typical prior art assembly of a transmit waveguide and an external vertical collimating lens.

PREFERRED EMBODIMENT OF THE INVENTION

Referring initially to Figures 2 to 9, a waveguide structure 20 for an input device in the form of a touch screen 21 is formed as a substantially two-dimensional sheet comprising a plurality of waveguides adapted to carry input signals or output signals for the touch screen 21. The touch screen 21 is substantially rectangular in shape and includes a substantially planar input surface 23 for receiving user input, such as the touch of a finger or a stylus. In this embodiment the input surface 23 coincides with the outer surface of a display 24 (such as a liquid crystal display (LCD)). In other embodiments the input surface may coincide with the outer surface of a transparent protective cover in front of a display.

In the various embodiments as shown in Figures 2 to 4, the substantially rectangular waveguide structure 20 is formed from a resilient plastics material that is substantially flexible. Preferably the waveguide structure 20 is repeatably and reversibly bendable through at least 90° without being mechanically damaged. For example,

Figure 5 shows one half of the waveguide structure 20 shown in Figure 2 folded into an L-configuration and ready to be engaged to a display. Figure 6 shows the entire waveguide structure 20 of Figure 2 engaged to the periphery 25 of a display 24, and Figure 7 shows waveguide structure 20 of Figure 3 or Figure 4 engaged to the periphery 25 of a display 24. In the embodiment shown in Figure 8, the waveguide structure 20 is configured as an 'L', rather than a substantially rectangular sheet as shown in Figures 2 to 4. This embodiment is particularly useful when, as shown in Figure 9, the waveguide structure is engaged to the underside of a display 24.

The waveguide structure 20 preferably comprises a plurality of optical waveguides comprising a photo-curable polymer material fabricated on a flexible polymer substrate, for example by a method disclosed in US Patent Application No 11/742,194 entitled 'Methods for fabricating polymer optical waveguides on large area panels'. Briefly, this document describes methods for fabricating polymer optical waveguides comprising a three layer structure, wherein at least one of the optical layers is deposited by a two-stage deposition process whereby the second step is a spinning process. The invention disclosed in US 11/742,194 is of particular relevance to the volume production of polymer optical waveguides on large area substrates.

As shown in Figure 6, the waveguide structure 20 is configured such that, in use, the waveguide structure 20 extends around at least a portion of the periphery 25 of a display 24. Preferably the waveguide structure 20 extends around the entire periphery 25 and is disposed substantially perpendicularly to the input surface 23 of a touch screen 21. Importantly, the waveguide structure 20 is engaged to a touch screen 21 such that each of the waveguides 10, 14 extends entirely below the input surface 23 of the touch screen.

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In other waveguide substrate configurations, the waveguide structure 20 is a two-dimensional sheet that extends underneath and substantially parallel to the input surface 23 of a touch screen 21. One such configuration comprises four waveguide structures 20, each extending along an edge of the touch screen 21. However, in preferred configurations as shown in Figures 8 and 9, the waveguide structure 20 is formed on a pair of L-shaped substrates 26 that extend underneath and substantially parallel to the input surface 23 of a touch screen 21. It will be appreciated that preferably the L-shaped substrates 26 lie substantially within the periphery 25 of the touch screen. However, the L-shaped substrates could also exceed the periphery 25 of the touch screen. In other embodiments, the waveguide structures 20 may lie underneath as well as extend along at least a portion of the periphery 25 of a touch screen 21, however, not extend above the input surface 23 of the touch screen. Irrespective of the particular embodiment, it will be understood that the waveguide structures 20 of the present invention are configured such that, in use, the waveguides pass through a maximum of two mutually perpendicular planes.

Referring again to the embodiment as shown in Figure 2, the waveguide structure 20 comprises a plurality of transmit waveguides 10 adapted to carry a plurality of light signals from a light source 11, and a plurality of receive waveguides 14 adapted to carry a plurality of output signals to a multi-element detector 15. The transmit waveguides 10 are grouped on the waveguide structure 20 to define a transmit section 28, and the receive waveguides 14 are grouped to define a receive section 29. Each of the waveguides 10 and 14 includes an input portion for receiving an input signal and an output portion for transmitting an output signal. The transmit and receive waveguides 10 and 14 are positioned on the waveguide structure 20 such that the input portions 30 of the transmit waveguides 10 and the output portions 31 of the receive waveguides 14 are

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disposed on or proximate to a first side 32 of the waveguide structure 20, and the output portions 33 of the transmit waveguides 10 and the input portions 34 of the receive waveguides 14 are disposed on or proximate to a second side 35 of the waveguide structure 20, the first and second sides 32 and 35 being mutually opposed. Further, the input portions 30 of the transmit waveguides 10 are grouped into an input array 36, and the output portions 31 of the receive waveguides 14 are grouped together into an output array 37, with each array 36 and 37 extending along only a portion of the first side 32 for coupling with a source 11 or detector 15 respectively. It should be understood that the input array 36 of transmit waveguides 10 may include a splitter 18 for distribution of optical power to the transmit waveguides 10. In contrast, the output portions 33 of the transmit waveguides 10 and the input portions 34 of the receive waveguides 14 are spaced, preferably substantially evenly spaced, along substantially the entire length of the second side 35. However, it will be appreciated that the spacing may be selected for the particular application. It will be further appreciated that for clarity, only a few transmit waveguides 10 or receive waveguides 14 are shown in each of Figures 2 to 6 and 8 to 9.

Referring again to the embodiments as shown in Figures 3 and 4, the waveguides are positioned such that the input portions 30 of the transmit waveguides 10 and the output portions 31 of the receive waveguides 14 are disposed on or proximate to opposite sides of the waveguide structure 20. The output portions 33 of the transmit waveguides 10 and the input portions 34 of the receive waveguides 14 are disposed on or proximate to a common side 35 of the waveguide structure 20 and spaced along substantially the entire length of the common side. Preferably the waveguides are substantially evenly spaced, however it will be appreciated that the spacing may be selected for the particular application.

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As shown in Figures 2 to 4, the input array 36 is optically coupleable with a light source 11 for supplying a light signal and the output array 37 is optically coupleable with a suitable multi-element light detector 15. The light has a predetermined wavelength that may, for example, be in the infrared region of the spectrum, preferably between 700 and 1000 nm. Alternatively, the predetermined wavelength may be in the visible region of the spectrum.

Referring in particular to the embodiment as shown in Figure 8, the output array 37 is disposed at the terminus of one leg of the L-shaped waveguide structure 20, and the input portions 34 of the receive waveguides 14 are substantially evenly spaced along substantially the entire length of the two outer edges 39 of the L-shaped substrate 26, thereby to define an L-shaped receive section. It will be appreciated that, apart from the inclusion of an optical splitter 18, an essentially identical arrangement to that shown in Figure 8 would function as a transmit L-shaped waveguide structure.

Additionally, waveguide structures can be overlapped to ensure that the entire periphery 25 of a touch screen 21 is accessible to either the transmit section 28 or receive section 29 of a waveguide structure 20. For example, the waveguide structures shown in Figure 3 and Figure 4 can be folded around the periphery 25 of the touch screen 21 with a source 11 and a detector 15 overlapped in one corner, as clearly shown in Figure 7. A source 11 and detector 15 could be located on a single chip. It should be noted that the waveguide structure shown in Figure 2 requires a source 11 and a detector 15 to be located below the touch screen 21, whereas the waveguide structures shown in Figures 3 and 4 allow a source 11 and a detector 15 to be located beside the touch screen 21. The latter two waveguide structures may be preferable if it is important to minimise the depth of the device as a whole. In yet another configuration, the receive-side waveguide structure shown in Figure 8 and a similar transmit-side waveguide structure

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can be engaged in overlapping fashion to the underside of a display 24, as shown in Figure 9. It will be appreciated that this overlapping arrangement may require a degree of flexibility in each waveguide structure for out-of-plane bending, but this will be trivial if, as preferred, the substrates 26 are composed of plastics materials.

For clarity, the waveguide structures 20 illustrated in Figures 2 to 6 and 8 to 9 show the output portions 33 of the transmit waveguides 10 and the input portions 34 of the receive waveguides 14 extending to edge(s) 35 or 39 of each structure. In some embodiments this will indeed be the case. In other embodiments, the output portions 33 or the input portions 34 (or both) each include an integral structure for collimating the light beams in the plane of the input surface 23. Generally the integral structure is in the form of a planar lens 16, as shown in Figure 1 and Figure 16. Alternatively, the integral structure may be a planar internally reflective mirror, as disclosed in US patent publication No 2006/0188196, entitled 'Waveguide design incorporating reflective optics'.

In the waveguide structures 20 shown in Figures 2 to 4, the transmit waveguides 10 and receive waveguides 14 are provided on a single substantially rectangular strip designed to be folded around the entire periphery of the touch screen. It will be appreciated that the larger the touch screen, the longer the rectangular strip needs to be, however this will be limited by the size of the substrate used for waveguide fabrication. The waveguide fabrication techniques disclosed in US Patent Application No 11/742,194 will clearly be applicable to this situation. If substrate size is a limitation it is of course possible to fabricate the transmit waveguides and receive waveguides on separate substantially rectangular strips, each of which would be folded around two sides of the periphery, for example as shown in Figure 5.

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Irrespective of whether the transmit waveguides and receive waveguides are fabricated on separate strips or a single strip, a key advantage of fabricating the waveguides on rectangular strips, as shown in Figures 2 and 3, compared to the prior art L-shaped waveguide structures as shown in Figure 1, is that it is significantly easier to singulate rectangular structures than L-shaped structures with a dicing saw. In particular, the interior sides of an L-shaped structure are difficult to cut with a dicing saw. It will be noted that the waveguide structure shown in Figure 4 has a recess 61, designed to facilitate electrical connections to the touch screen 21. The recess 61 will complicate the singulation process, but since there are no transmit waveguide outputs 33 or receive waveguide inputs 34 along the side 62 incorporating the recess 61, that side can be shaped with a cruder stamping process while the straight sides are diced. Similarly, an advantage of the L-shaped configuration shown in Figure 8 compared to the prior art L-shaped configuration shown in Figure 1 is that the inner edges 38 of the L-shaped waveguide structure of the invention, having no receive waveguide inputs 34, can be shaped with a cruder stamping process while the outer edges 39 can be diced with a dicing saw. It will be appreciated that even if the transmit waveguides 10 and receive waveguides 14 terminate in an integral structure such as a planar lens 16 with a curved optical interface (as shown in Figure 1), it is desirable to cut the substrate as close as possible to the optical interface; this requires the precision of a dicing saw and is not suited to a stamping process.

As discussed above with regard to Figures 5 to 7, the waveguide structures 20 are preferably substantially flexible for assisting in folding around the periphery 25 of a touch screen 21. In the embodiments shown in Figures 2 to 4, a waveguide structure 20 includes at least one fold line 41 defined by a line of weakness to assist in the installation around a touch screen 21. In alternative embodiments, the fold line 41 is a

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printed mark visible to a machine vision system when the waveguide structure 20 is machine assembled with a touch screen 21. Alternatively the printed mark may assist with manual assembly of the waveguide structure 20 with a touch screen 21.

Turning now to Figures 10 to 15, an optical element 42 for a touch screen 21 is shown comprising a first reflective surface 43 for reflecting a light signal 44 in a direction substantially parallel to the input surface 23, coincident with the outer surface of a display 24, and a connect portion 45 adapted for connection to the waveguide structure 20. The optical element 42 is configured for use with a touch screen 21 such that, in use, the first reflective surface 43 is positioned above the input surface 23 of a touch screen 21 to re-direct a light signal 44 to or from the waveguide structure 20. Preferably the connect portion 45 is at least partially below the input surface 23.

The optical element 42 further includes a body of light transmissive material 46 for transmission of a light signal 44 between the connect portion 45 and the first reflective surface 43.

In other embodiments, as shown in Figures 14 and 15, the optical element 42 further includes a second reflective surface 47 that, in use, is positioned below the input surface 23, and where the waveguide structure 20 extends underneath and substantially parallel to the input surface.

It will be appreciated that an optical element 42 could be constructed such that one or both of the reflective surfaces are externally reflective (i.e. conventional) mirrors rather than internally reflective surfaces. However a construction where an optical element 42 has internally reflective surfaces, as shown for example in Figures 10 to 15, is preferred for robustness and ease of manufacture (by injection moulding for example). Further, an externally reflective mirror would need to be metallised, whereas the internally reflective surfaces may not need to be metallised if the condition for total

internal reflection is met. Those skilled in the art will understand that this can be ensured by appropriate design of the optical element.

As shown in Figure 16, an optical element 42 is preferably formed as an elongate strip of plastics material substantially transparent to the signal light (e.g. infrared light). Desirably, the optical element 42 is opaque to light of other wavelengths (e.g. ambient visible light if the signal comprises infrared light). The optical element 42 may be injection moulded or extruded and is preferably substantially rigid.

The first internally reflective surface 43 may be curved thereby to focus a light signal 44 in a direction substantially perpendicular to the plane of the input surface 23, as shown for example in Figures 10 to 12 and 15. Alternatively, the first reflective surface 43 may be planar, as shown for example in Figures 13 and 14. The second reflective surface 47, where present, may likewise be curved or planar. If either the first or second reflective surfaces are curved, they are preferably curved in a cylindrical fashion so as to focus a plurality of signals associated with a plurality of waveguides.

As shown in Figures 10 to 15, the optical element 42 has an optical surface 48 through which light 44 passes as it transits a touch screen 21. In some embodiments, for example as shown in Figures 10, 12 and 15, this optical surface 48 may be planar. Alternatively, as shown for example in Figures 11, 13 and 14, it may be curved to form a lens portion 49 so as to focus a light signal 44 in a direction substantially perpendicular to the plane of the input surface 23. Preferably, the lens portion 49 is curved in a cylindrical fashion so as to focus a plurality of signals associated with a plurality of waveguides. Irrespective of the precise shape of the optical surface 48, the optical element 42 is preferably shaped such that, in use, the exterior angle between the input surface 23 and the optical surface 48 is greater than or equal to 90° (as shown in Figures 10, 12, 13 and 15 for example), to minimise the build-up of dirt over time which could

potentially obscure the optical surface 48. In other embodiments, optical elements engaged to the transmit and receive sections of the waveguide structure have different optical surfaces. For example, the transmit-side optical elements may have a planar optical surface 48 and the receive-side optical elements may have an optical surface in the form of a lens 49.

Preferably the optical element 42 includes a recess 50 such that the optical element 42 is releasably attachable to a display 24. In certain embodiments the optical element 42 is configured as a single piece having physical dimensions matching the periphery 25 of a display 24 such that the optical element 42 is adapted to 'clip' onto the display. Alternatively, the optical element 42 can be glued onto a display 24. In other embodiments the optical element 42 may be configured as two L-shaped pieces each adapted to clip around two adjacent sides of a display, or as four straight pieces each adapted to be attached to one side of a display 24 (as shown in Figure 16).

The waveguide structure 20 may be fixedly attached to the optical element 42 by gluing. However, it will be appreciated that any method of attachment that provides sufficient and stable optical communication between the waveguides 10, 14 and the optical element 42 will be suitable.

A particularly preferred design for an optical element 42 is shown in Figure 13, with an internally reflective surface 43, a recess 50 and an optical surface 48 comprising a lens portion 49. In this particular design, the internally reflective surface 43 is a plane surface inclined at an angle 61 of 49° to the horizontal, and the lens portion 49 forms an exterior angle of approximately 90° with the input surface 23 such that there is no re¬entrant cavity between the two where dirt may collect. Because the internally reflective surface 43 is angled at 49° to the horizontal, instead of 45°, the lens portion 49 is still able to collimate the signal light 44 parallel to the input surface 23. By way of specific

example, the dimensions 62, 63, 64, 65, 66, 67 and 68 of the optical element 42 are 3.9mm, 10mm, 4.4mm, 30mm, 6mm, 6.4mm and 3.6mm respectively, and the lens portion 49 has a radius of curvature of 7.2mm. Furthermore, the waveguide structure 20 is oriented such that its waveguides are on the surface adjacent to the connect portion 45.

Referring now to Figure 16, an apparatus for use in an input device is shown comprising a touch screen 21, a pair of waveguide structures 20, and four optical elements 42. The pair of waveguide structures 20 correspond to a transmit waveguide structure and a receive waveguide structure which, together, extend along substantially the entire periphery 25 of a display 24. The four optical elements 42 are engaged to the waveguide structures 20 in use and are in optical communication with respective waveguides of the waveguide structures 20. However, it will be appreciated that a pair of L-shaped optical elements, or a one-piece optical element would also be suitable. It will be appreciated that each of the optical elements 42 extends from a position below the input surface 23 to a position above the input surface 23 such that each optical element 42 transmits input or output signals to or from the input area 13 of a touch screen 21 between respective waveguides of the waveguide structures 20, which extend entirely below the input surface 23. The planar lenses 16 of each waveguide can be seen in Figure 16. These lenses 16 collimate light into and from the optical elements 42, such that signal beams passing across the input surface 23 of a touch screen 21 are focused in the plane of the input surface. It will be noted that in this particular configuration, unlike the configuration shown in Figure 13, the waveguide structures 20 are positioned between the display 24 and the optical elements 42.

In one example, the present invention includes a method of transmitting input and output signals for a touch screen device. The method comprises providing a waveguide structure 20, providing one or more optical elements 42, and then optically

coupling the waveguide structure 20 with a respective optical element 42 such that, in use, each optical element 42 transmits input or output signals to or from the input area 13 of a touch screen 21 to a respective waveguide of a waveguide structure 20 extending entirely below the input surface 23.

In a further example, referring to Figure 17 (prior art) and Figure 18, the present invention includes a method of reducing the width 54 of a bezel 51 in a touch screen 21. The method comprises providing a waveguide structure 20, providing one or more optical elements 42, and then optically coupling the waveguide structure 20 with a respective optical element 42 such that, in use, each said optical element 42 transmits an input or output signal 44 to or from the waveguide structure 20. The optical elements 42 extend from above the input surface 23 to a position below the input surface and the waveguides of each waveguide structure 20 are terminated at a position below the input surface.

It will be appreciated that the present invention provides a substantially reduced bezel dimension 54 (Figure 18) compared with prior art devices (Figure 17). The bezel requirements for the present invention (Figure 18) essentially comprise a thin raised 'lip' 52 surrounding a display 24. In contrast, the bezel requirements for prior art devices (Figure 17) comprise a relatively wide raised flange 53 surrounding a display 24.

In yet a further example, the present invention includes a method of reducing the tolerance required of an optical element used to provide focussing of optical signals in a direction substantially perpendicular to the plane of an input device. To illustrate, Figures 19(a) and 19(b) show plan and side views of a typical prior art assembly of an output portion 33 of a transmit waveguide 10 having an external vertical collimating lens (VCL) 17, wherein the transmit waveguide 10 and VCL 17 are mounted on a common base 71. An essentially identical arrangement is normally present on the receive side.

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Typically, a transmit waveguide 10 comprises a substrate 72, a lower cladding layer 73, a core layer 74 and an upper cladding layer 75, with the core layer 74 terminating with an integrated planar lens 16 that collimates the light signal 44 in the plane of an adjoining input area. Note that for clarity the substrate 72, lower cladding layer 73 and upper cladding layer 75 have been omitted from Figure 19a. It will be appreciated that a light signal 44 launched from the end face 76 of a planar lens 16 will diverge in the direction perpendicular to the plane of the input area. As a consequence it is often desirable for the light signal 44 to be focussed in this direction as well. However, such 'out of plane' focussing requires a lens having curvature in that direction, which is difficult to shape reliably with photolithographic techniques. Consequently an external lens is employed for this task, for example a VCL 17. The VCL is generally curved in a cylindrical fashion so as to focus a plurality of signals associated with a plurality of waveguides.

It will be appreciated that the gap 77 between the end face 76 of the planar lens 16 and the curved face 78 of a VCL 17 contributes to the overall bezel width in a prior art device, and should ideally be minimised. However this requires the VCL to be a relatively powerful lens, i.e. to have a small radius of curvature. Those skilled in the art of micro-optics will understand that such a high magnification optical system is extremely susceptible to errors in the design and manufacture of a VCL, and in its placement with respect to the waveguides.

Certain embodiments of the present invention on the other hand provide such 'out of plane' focussing, via an optical element 42, as shown in Figures 10 to 15. For example, 'out of plane' focusing may be provided by a lens portion 49, a first reflective surface 43, a second reflective surface 47 or a combination of the above. Particularly notable are the embodiments shown in Figures 13 and 14, where 'out of plane' focussing

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is provided by a lens portion 49, such that the distance between the waveguides in the waveguide structure 20 and the lens portion 49 is greatly increased compared to the gap 77 of the prior art device. An optical element 42 may be designed such that two or more of the lens portion 49, first reflective surface 43 and second reflective surface 47 provide the 'out of plane' focussing in combination, as shown for example in Figure 11. Such an arrangement may further relax the tolerances required for the optical element, since an optical system comprising two or more weaker focussing elements in series is generally more tolerant to alignment 'errors' than a system of equivalent magnification comprising a single relatively more powerful optical element.

It will be appreciated that the illustrated apparatus of the present invention provides many advantages over prior art devices, including but not limited to the following:

1.) Mounting the waveguide structure and the optical element of the present invention to a touch screen allows the bezel dimensions to be relatively reduced compared to prior art devices.

2.) The waveguide structures of the present invention provide a number of cost savings compared to prior art L-shaped waveguide structures. For example, from a manufacturing perspective it is relatively simpler to singulate a waveguide structure configured in rectangular strips than an L-shaped waveguide structure.

3.) Assembling an input device utilising the waveguide structures and optical elements of the present invention is relatively cheaper compared to prior art devices. Additionally, the present invention requires relatively fewer components than prior art devices.

4.) The configuration of the waveguide structure of the present invention means that the source and detector can be physically located adjacent to each other or,

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preferably, on the same chip. This simplifies the layout of the internals of the input device and reduces production costs.

5.) From an aesthetics perspective, a thin bezel 'lip' surrounding the touch screen is more appealing than a relatively wide flange surrounding the touch screen.

6.) The optical element with the waveguide structure attached thereto can be fabricated as a single unit having physical dimensions matching the periphery of the touch screen. The optical element can then be simply clipped onto the touch screen thereby avoiding alignment issues and simplifying installation and reducing the installation costs.

7.) The apparatus and methods of the present invention enable a relatively larger touch screen to be provided on the device for the same overall dimensions because the bezel space requirements are now reduced. This satisfies the intent of many designers, which is to make the touch display of comparable width to the device itself. The advantage of this is that the user obtains the largest possible display size for a given device size, which is both practical and aesthetically pleasing.

8.) The apparatus and methods of the present invention relax the tolerances on the design, manufacture and placement of optical elements used to focus the optical signals in the direction perpendicular to the input area.

9.) The present invention may be used in conjunction with other transmit or receive optics. For example US Patent No 7,099,553 discloses a touch input device where the signal light is launched across the input area by an L-shaped light pipe with a plurality of reflective facets, instead of discrete transmit-side optical waveguides 10. In this sort of device the waveguide structures and optical elements of the present invention could still be used on the receive side.

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In yet another alternative, the waveguide structures and optical elements of the present invention could be used on the transmit side of an optical input device, and with the receive waveguides 14 and multi-element detector 15 replaced by one or more arrays of discrete detectors.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

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CLAIMS:

1. A waveguide structure for an input device having an input area defining a plane, said waveguide structure having at least one optical waveguide adapted to carry a signal for said input device, said waveguide structure being configured such that, in use, said at least one optical waveguide extends entirely below said plane.

2. A waveguide structure according to claim 1 wherein said input device includes a substantially planar input surface for receiving user input.

3. A waveguide structure according to claim 2 wherein said plane is coincident with said input surface.

4. A waveguide structure according to any one of the preceding claims wherein said input device includes a periphery defined by one or more sides.

5. A waveguide structure according to any one of the preceding claims wherein said signal comprises an input signal or an output signal.

6. A waveguide structure according to any one of the preceding claims wherein said signal is light having a predetermined wavelength.

7. A waveguide structure according to any one of the preceding claims wherein each said at least one optical waveguide extends entirely below said plane.

8. A waveguide structure according to any one of the preceding claims wherein said waveguide structure is configured such that, in use, said at least one optical waveguide passes through a maximum of two mutually perpendicular planes.

9. A waveguide structure according to any one of the preceding claims wherein said waveguide structure is formed from polymeric materials.

10. A waveguide structure according to any one of the preceding claims wherein said waveguide structure is formed as a substantially rectangular sheet.

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11. A waveguide structure according to any one of the preceding claims wherein said waveguide structure is substantially flexible.

12. A waveguide structure according to claim 11 wherein said waveguide structure is bendable through at least 90°.

13. A waveguide structure according to any one of claims 4-12 wherein said waveguide structure extends around adjacent sides of said periphery.

14. A waveguide structure according to any one of claims 4-13 wherein said waveguide structure extends around the entire said periphery.

15. A waveguide structure according to any one of the preceding claims wherein said waveguide structure is disposed substantially perpendicularly to said plane of said input device.

16. A waveguide structure according to any one of the preceding claims wherein said waveguide structure comprises a plurality of transmit waveguides adapted to carry an input signal to said input device or a plurality of receive waveguides adapted to carry an output signal from said input device, or both.

17. A waveguide structure according to claim 16 wherein said transmit waveguides are grouped on said waveguide structure to define a transmit section, and/or said receive waveguides are grouped on said waveguide structure to define a receive section.

18. A waveguide structure according to claim 16 or claim 17 wherein each said waveguide includes an input portion for receiving an input signal and an output portion for transmitting an output signal.

19. A waveguide structure according to claim 18 wherein said waveguides are positioned such that said input portions of said transmit waveguides and said output portions of said receive waveguides are disposed on or proximate to a first side of said waveguide structure, and said output portions of said transmit waveguides and said input

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portions of said receive waveguides are disposed on or proximate to a second side of said waveguide structure.

20. A waveguide structure according to claim 19 wherein said first and second sides are substantially mutually opposed.

21. A waveguide structure according to claim 19 or claim 20 wherein said input portions of said transmit waveguides are grouped into an input array, and said output portions of said receive waveguides are grouped into an output array, each said array extending along a portion of said first side.

22. A waveguide structure according to any one of claims 19 to 21 wherein said output portions of said transmit waveguides and said input portions of said receive waveguides are substantially evenly spaced along substantially the entire length of said second side.

23. A waveguide structure according claim 18 wherein said waveguides are positioned such that said input portions of said transmit waveguides and said output portions of said receive waveguides are disposed on or proximate to opposite sides of said waveguide structure, and said output portions of said transmit waveguides and said input portions of said receive waveguides are disposed on or proximate to a common side of said waveguide structure.

24. A waveguide structure according claim 23 wherein said output portions of said transmit waveguides and said input portions of said receive waveguides are substantially evenly spaced along substantially the entire length of said common side.

25. A waveguide structure according to any one of the preceding claims wherein said waveguide structure includes at least one fold line defined by a line of weakness or a printed indicium.

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26. A waveguide structure according to any one of claims 4 to 9 wherein said waveguide structure is formed as a substantially L-shaped sheet.

27. A waveguide structure according to claim 26 wherein said waveguide structure extends underneath and substantially parallel to said plane of said input device.

28. A waveguide structure according to claim 26 or claim 27 wherein said waveguide structure lies substantially within said periphery.

29. A waveguide structure according to any one of claims 26 to 28 wherein said waveguide structure comprises a plurality of transmit waveguides adapted to carry an input signal to said input device, or a plurality of receive waveguides adapted to carry an output signal from said input device.

30. A waveguide structure according to claim 29 wherein each said waveguide includes an input portion for receiving an input signal and an output portion for transmitting an output signal.

31. A waveguide structure according to claim 30 wherein said waveguides are positioned such that said input portions of said transmit waveguides or said output portions of said receive waveguides are disposed on or proximate to a first side of said waveguide structure.

32. A waveguide structure according to claim 31 wherein said first side is the terminus of a leg of said L-shaped sheet.

33. A waveguide structure according to any one of claims 30 to 32 wherein said output portions of said transmit waveguides or said input portions of said receive waveguides are substantially evenly spaced along substantially the entire outer edges of said L-shaped sheet.

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34. A waveguide structure according to any one of claims 18 to 24 and 30 to 33 wherein said input portions of said transmit waveguides are grouped into an input array, or said output portions of said receive waveguides are grouped into an output array.

35. A waveguide structure according to claim 34 wherein said input array is optically coupleable with a light source.

36. A waveguide structure according to claim 34 wherein said output array is optically coupleable with a light detector.

37. A waveguide structure according to any one of claims 18 to 24 and 30 to 36 wherein said output portions of said transmit waveguides or said input portions of said receive waveguides include an integral structure.

38. A waveguide structure according to claim 37 wherein said integral structure is a planar lens.

39. A waveguide structure according to claim 37 wherein said integral structure is a planar internally reflective mirror.

40. An optical element for an input device having an input area defining a plane, said optical element comprising:

a first reflective surface; and

a connect portion adapted for connection to a waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device,

said optical element being configured for use with said input device such that, in use, said first reflective surface is positioned above said plane to re-direct said signal to or from said optical waveguide, said connect portion being at least partially below said plane whereby said at least one optical waveguide extends entirely below said plane.

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41. An optical element according to claim 40 further including a body of light transmissive material for transmission of said signal between said connect portion and said first reflective surface.

42. An optical element according to claim 40 or claim 41 wherein said first reflective surface focuses said signal in a direction substantially perpendicular to said plane.

43. An optical element according to any one of claims 40 to 42 further including a second reflective surface, such that, in use, said second reflective surface is positioned below said plane.

44. An optical element according to claim 43 wherein said first and/or said second surface is an internally reflective surface.

45. An optical element according to any one of claims 40 to 44 wherein said optical element is formed as a strip of plastics material substantially transparent to light of the infrared or visible region of the spectrum.

46. An optical element according to any one of claims 40 to 45 wherein said optical element is substantially transparent to light of the infrared region of the spectrum and opaque to ambient visible light.

47. An optical element according to any one of claims 40 to 46 wherein said optical element is substantially rigid.

48. An optical element according to any one of claims 40 to 47 further including an optical surface.

49. An optical element according to claim 48 wherein said optical surface is a lens portion.

50. An optical element according to claim 49 wherein said lens portion is arcuate in cross-section.

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51. An optical element according to any one of claims 40 to 50 further including a recess such that said optical element is attachable to said input device.

52. An optical element according to any one of claims 40 to 51 wherein said waveguide structure is fixedly attached to said optical element.

53. An apparatus comprising:

an input device having an input area defining a plane and having a periphery;

a waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device; and

one or more optical elements extending along at least a portion of said periphery and in optical communication with said at least one waveguide, each optical element extending from a position below said plane to a position above said plane such that, in use, each said optical element transmits said input signal or said output signal to or from said input area to said at least one waveguide extending entirely below said plane.

54. A method of transmitting input and output signals for an input device, said input device having an input area defining a plane and having a periphery, said method comprising:

providing at least one waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device, said at least one optical waveguide extending entirely below said plane;

providing one or more optical elements along at least a portion of said periphery; and

optically coupling said waveguide structure with a respective optical element such that, in use, each said optical element transmits said input signal or said output signal to or from said input area to a respective waveguide extending entirely below said plane.

55. A method according to claim 59 wherein each said optical waveguide extends entirely below said plane.

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56. A method of reducing bezel width in an input device, said input device having an input area defining a plane and having a periphery, said method comprising:

providing at least one waveguide structure having at least one optical waveguide adapted to carry an input signal or an output signal for said input device;

providing one or more optical elements along at least a portion of said periphery; and

optically coupling said at least one optical waveguide with a respective optical element such that, in use, each said optical element transmits said input signal or said output signal to or from said at least one optical waveguide;

wherein said at least one optical waveguide is terminated at a position below said plane, and wherein said optical elements extend from above said plane to a position below said plane.

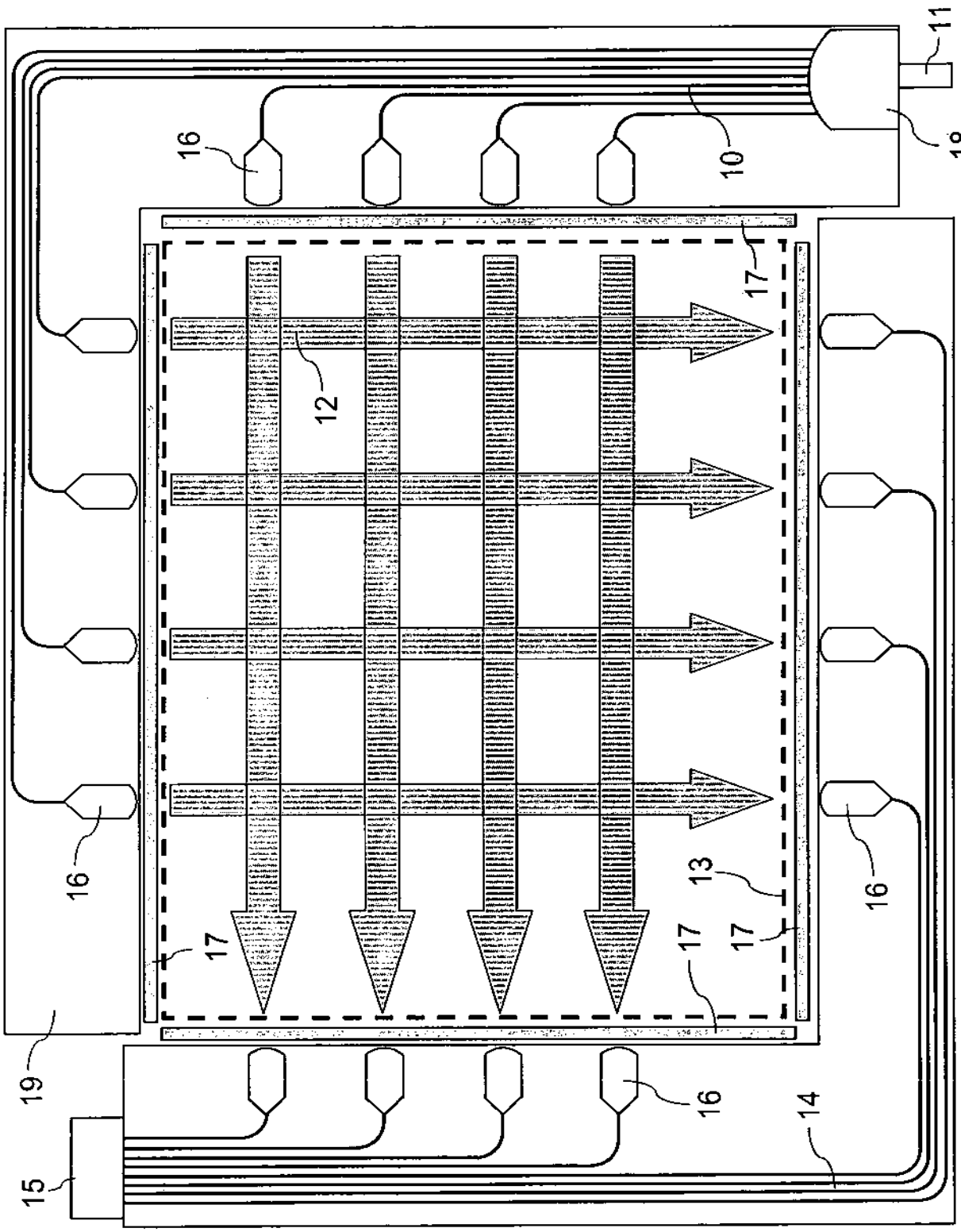


Fig. 1

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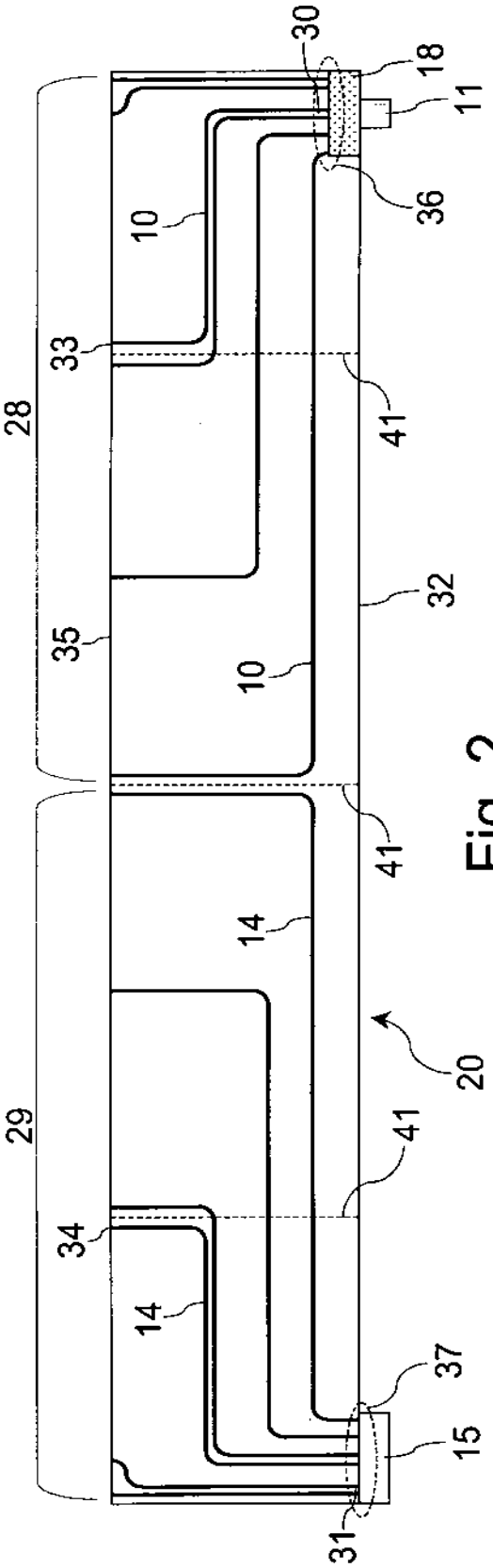


Fig. 2

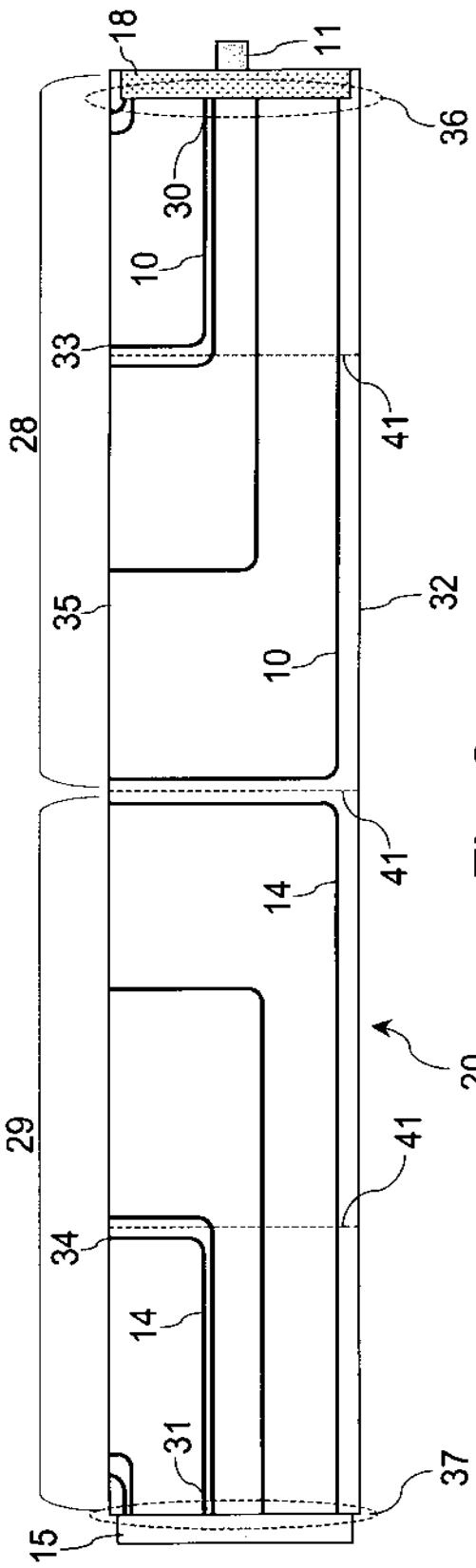


Fig. 3

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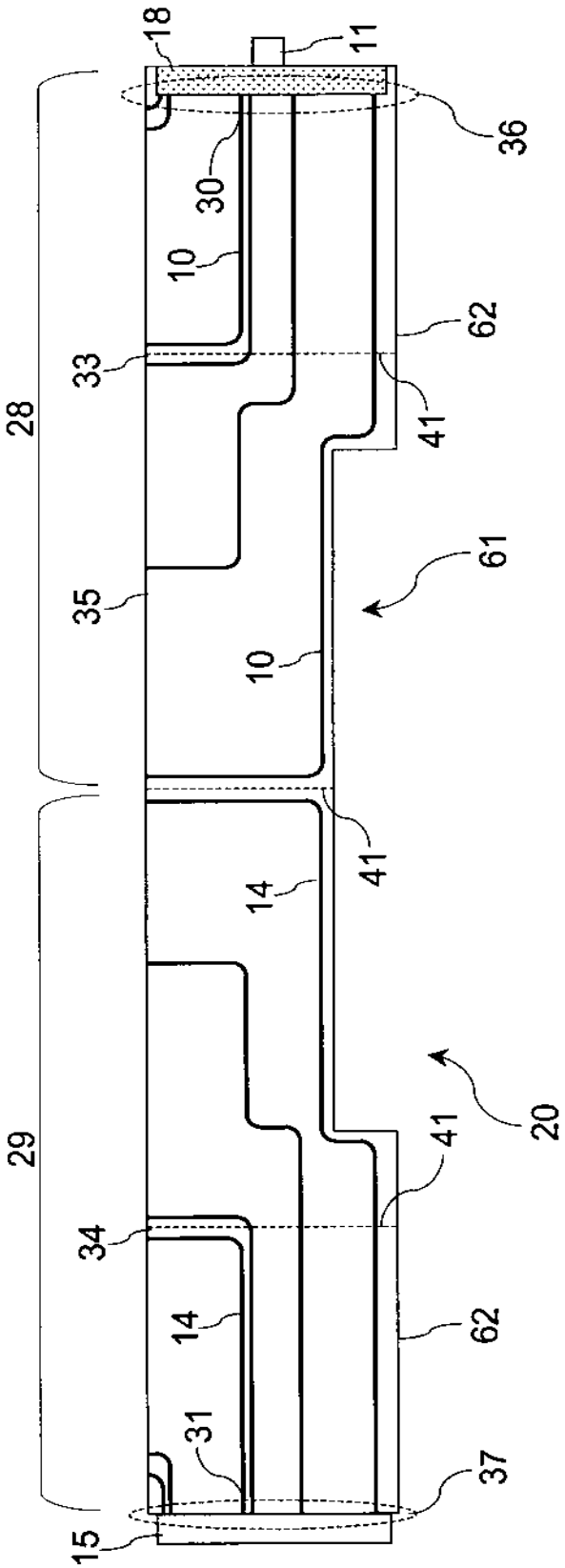


Fig. 4

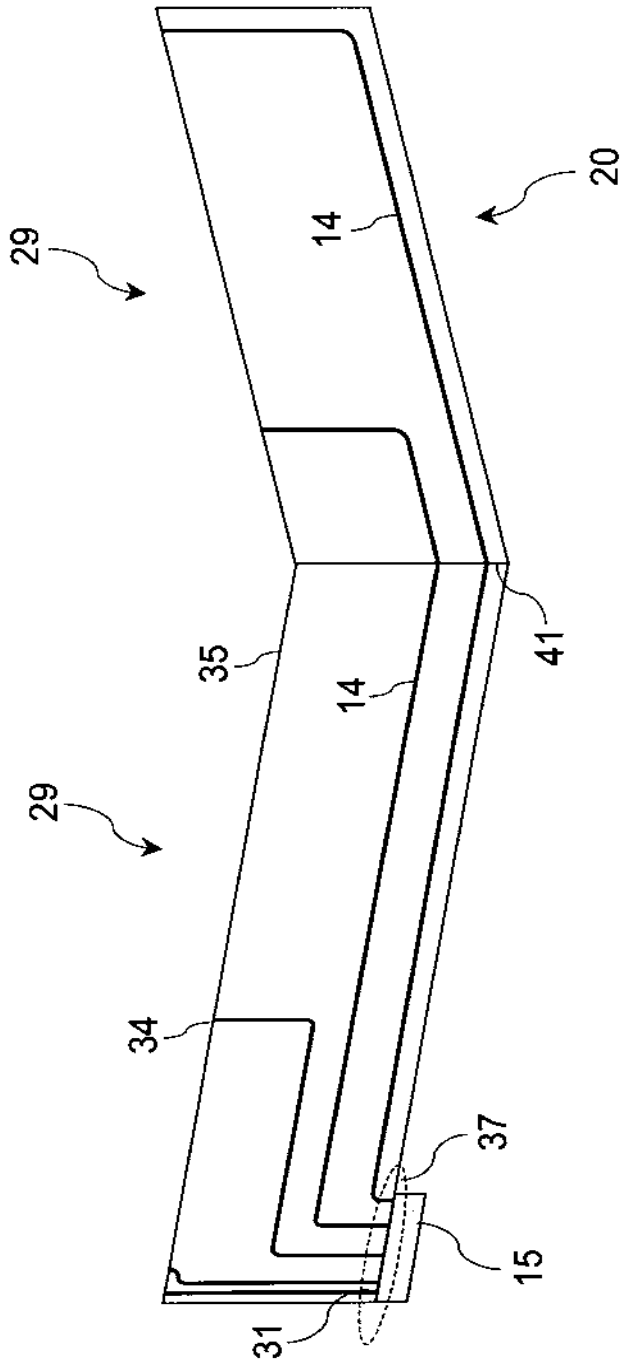


Fig. 5

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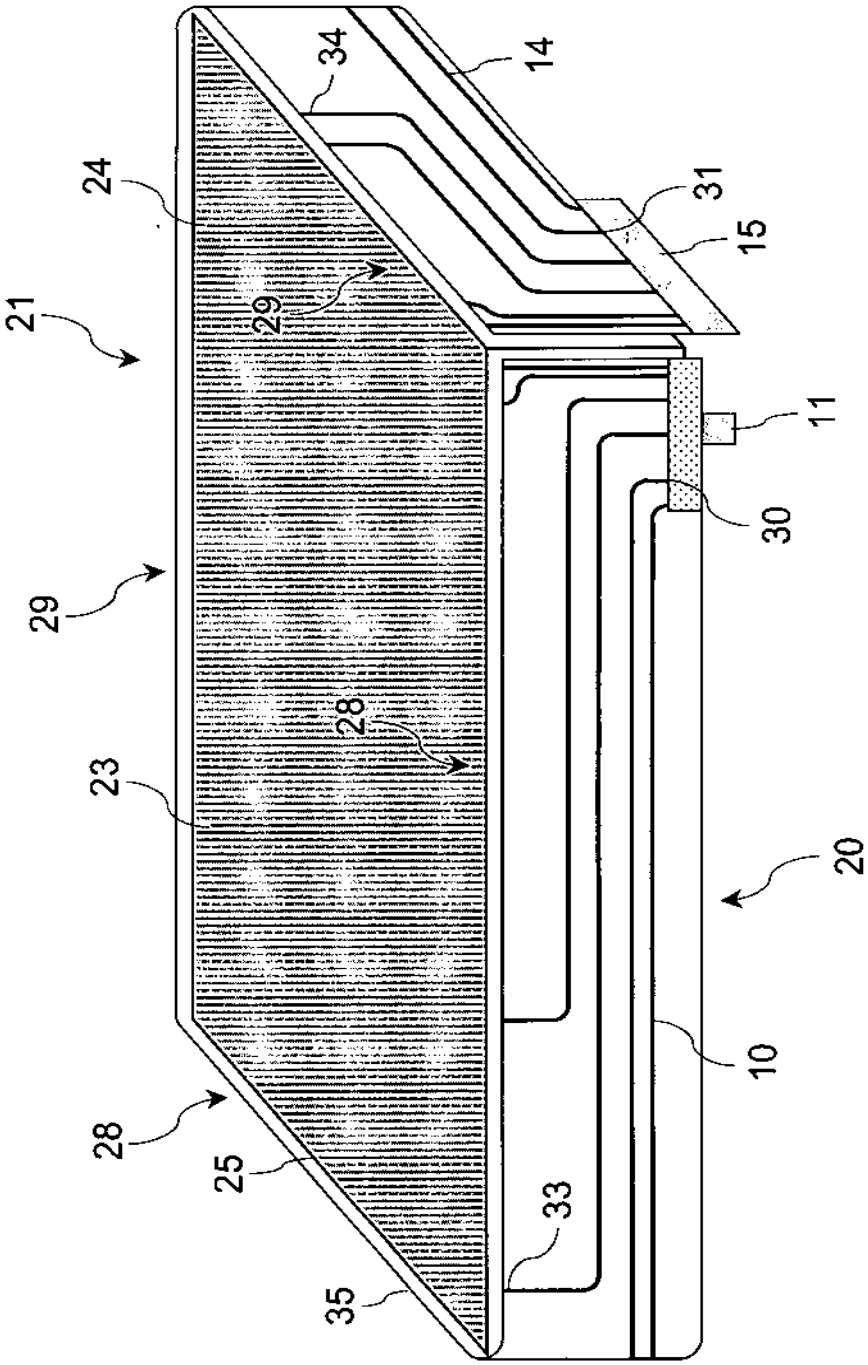


Fig. 6

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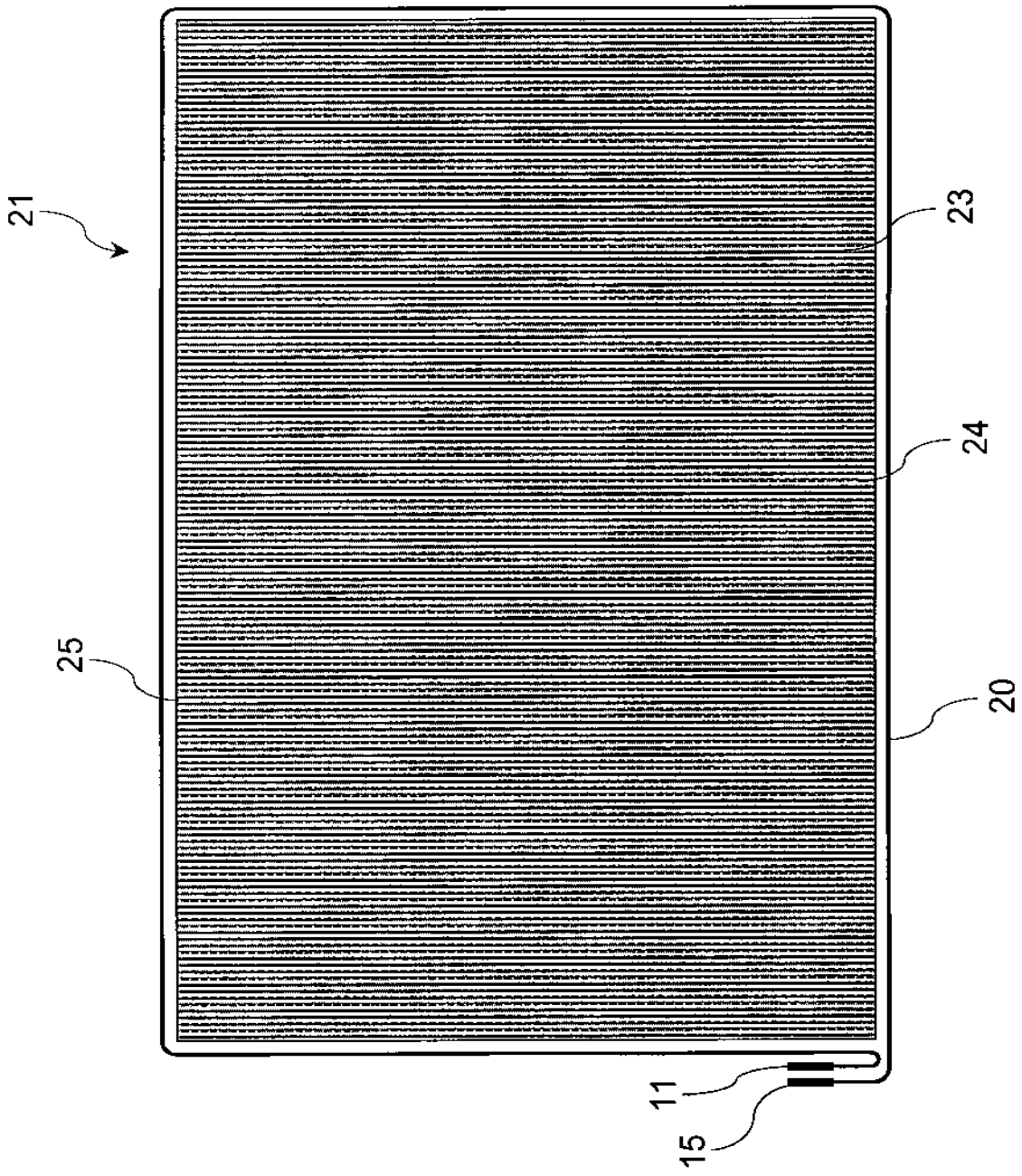


Fig. 7

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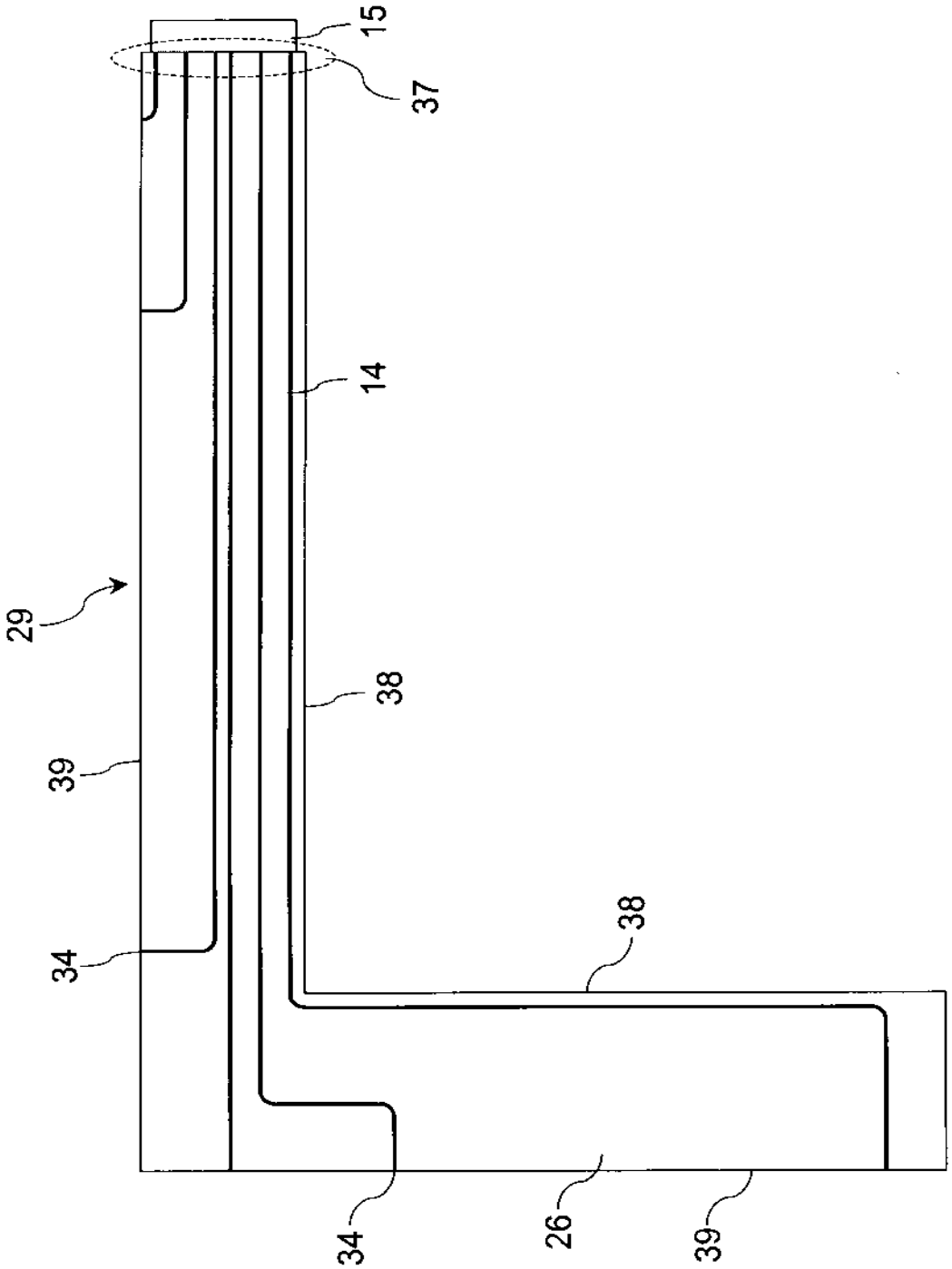


Fig. 8

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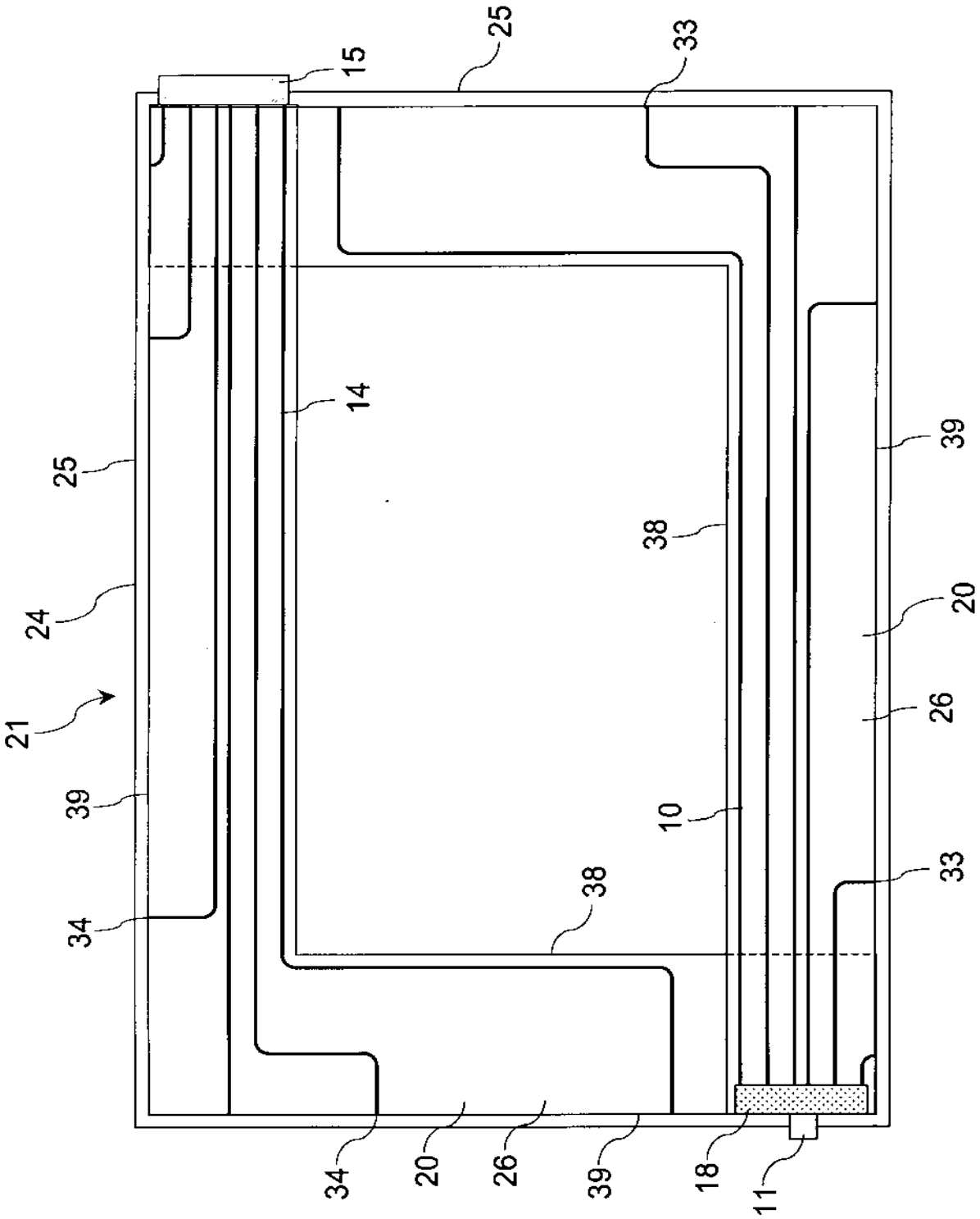


Fig. 9

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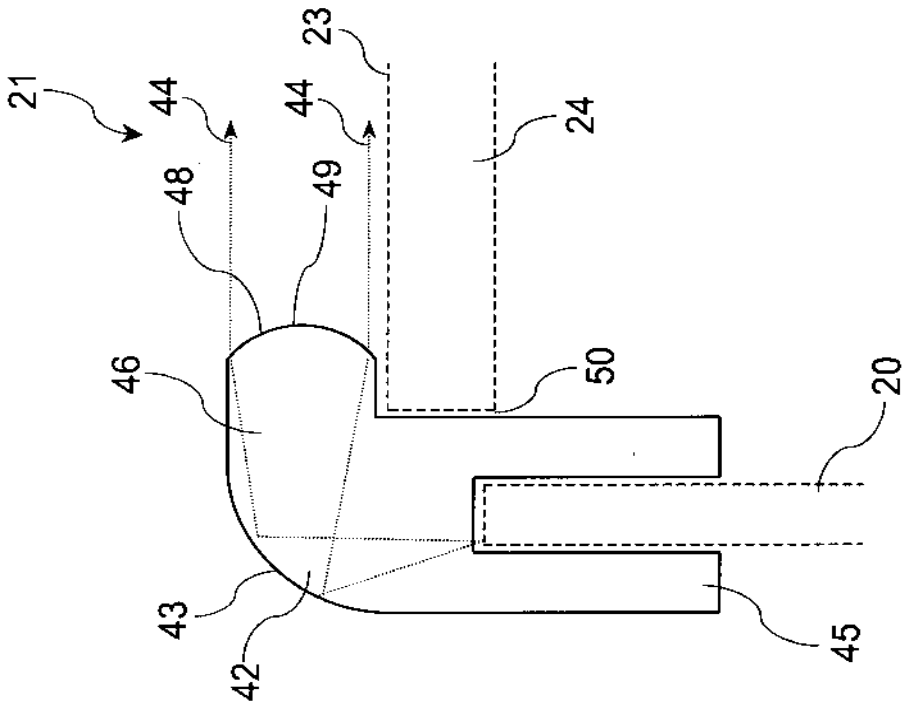


Fig. 11

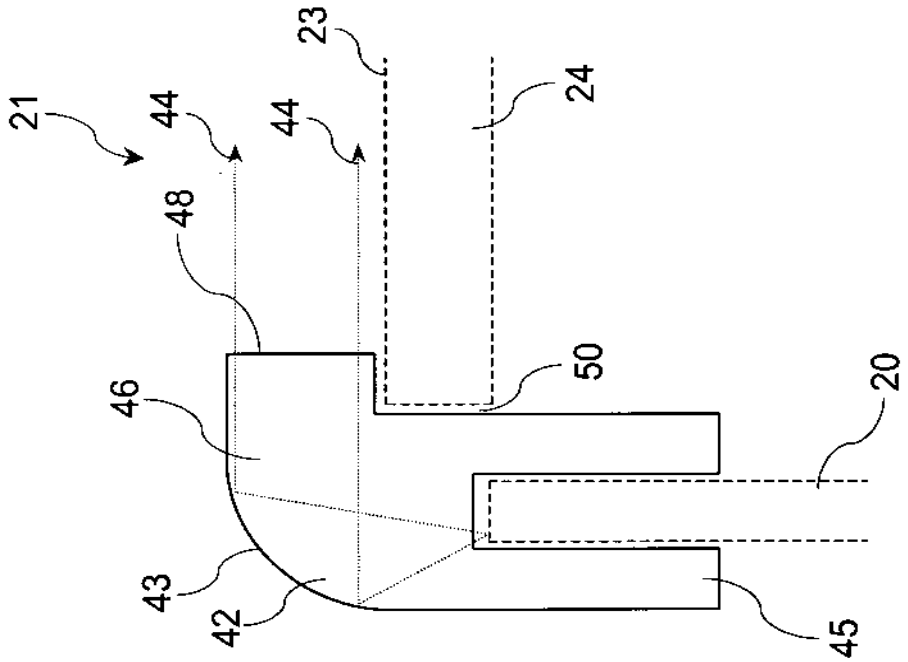


Fig. 10

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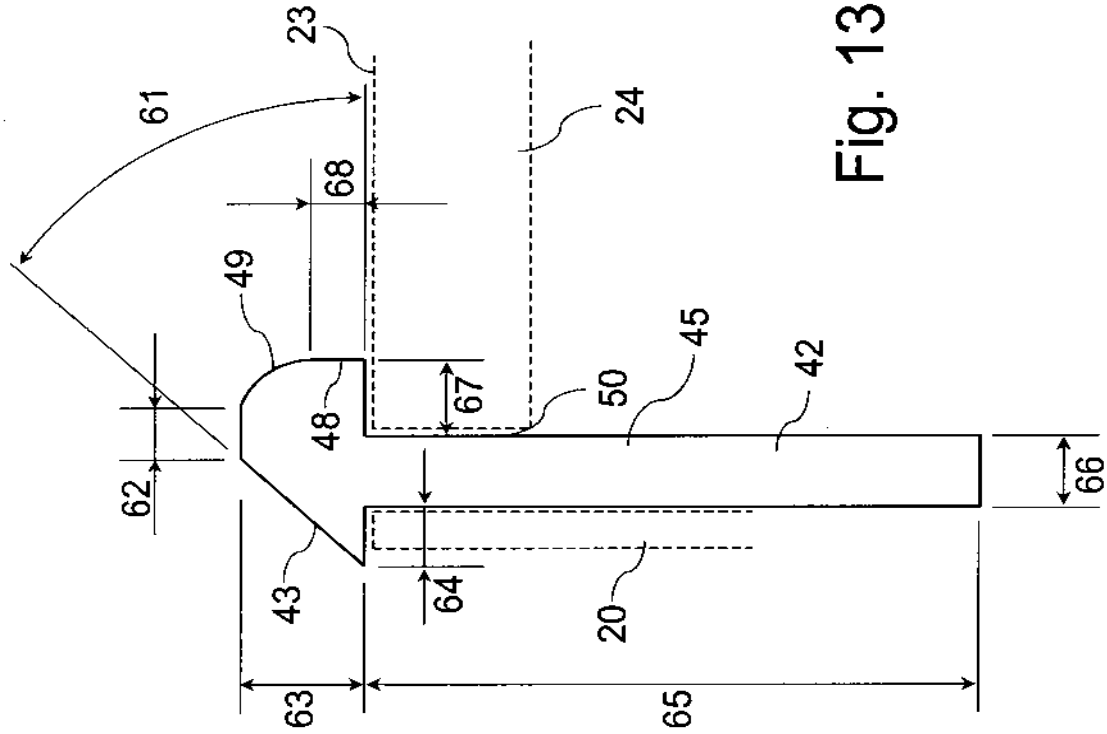


Fig. 13

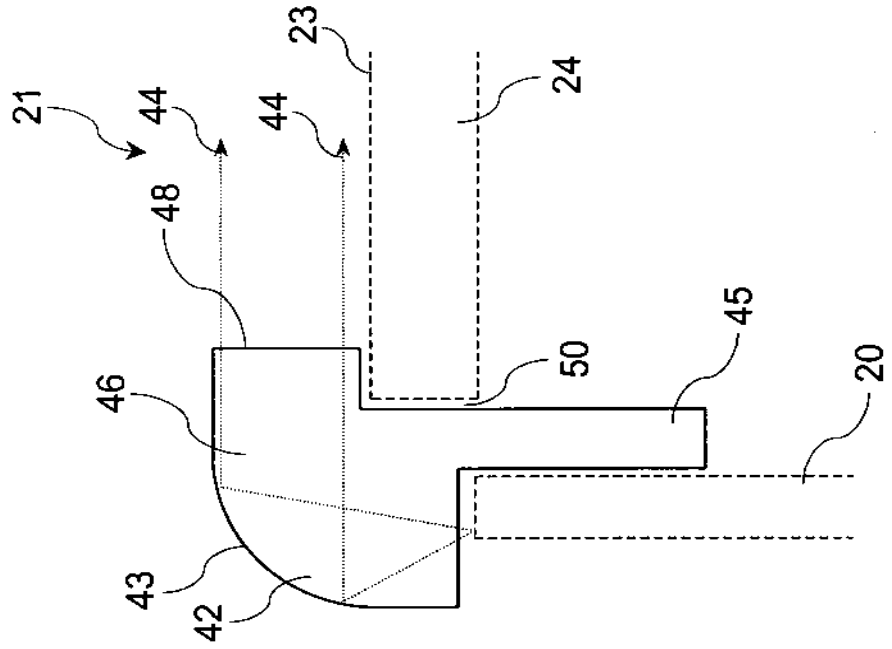


Fig. 12

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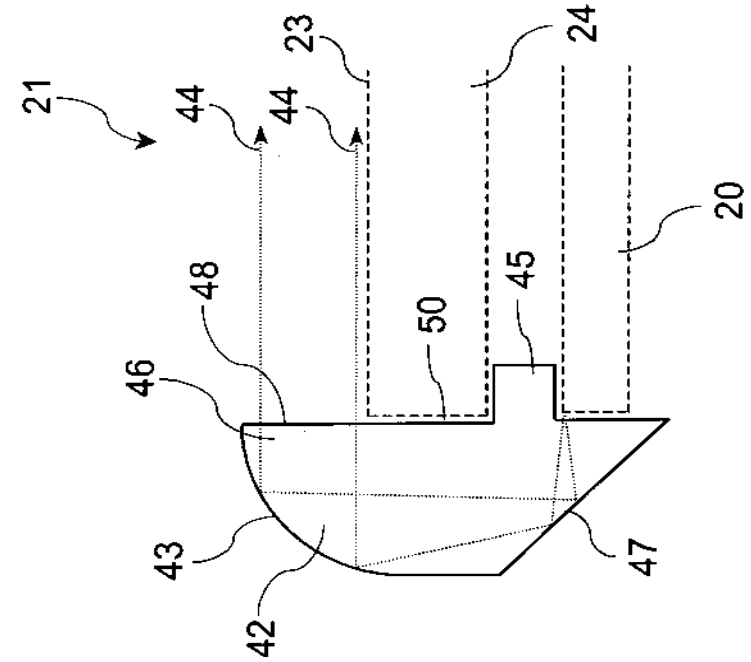


Fig. 15

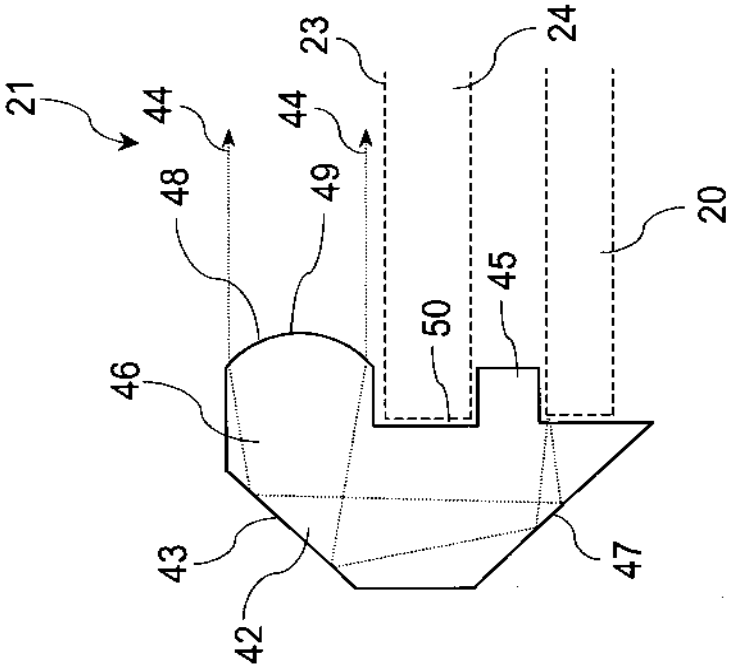


Fig. 14

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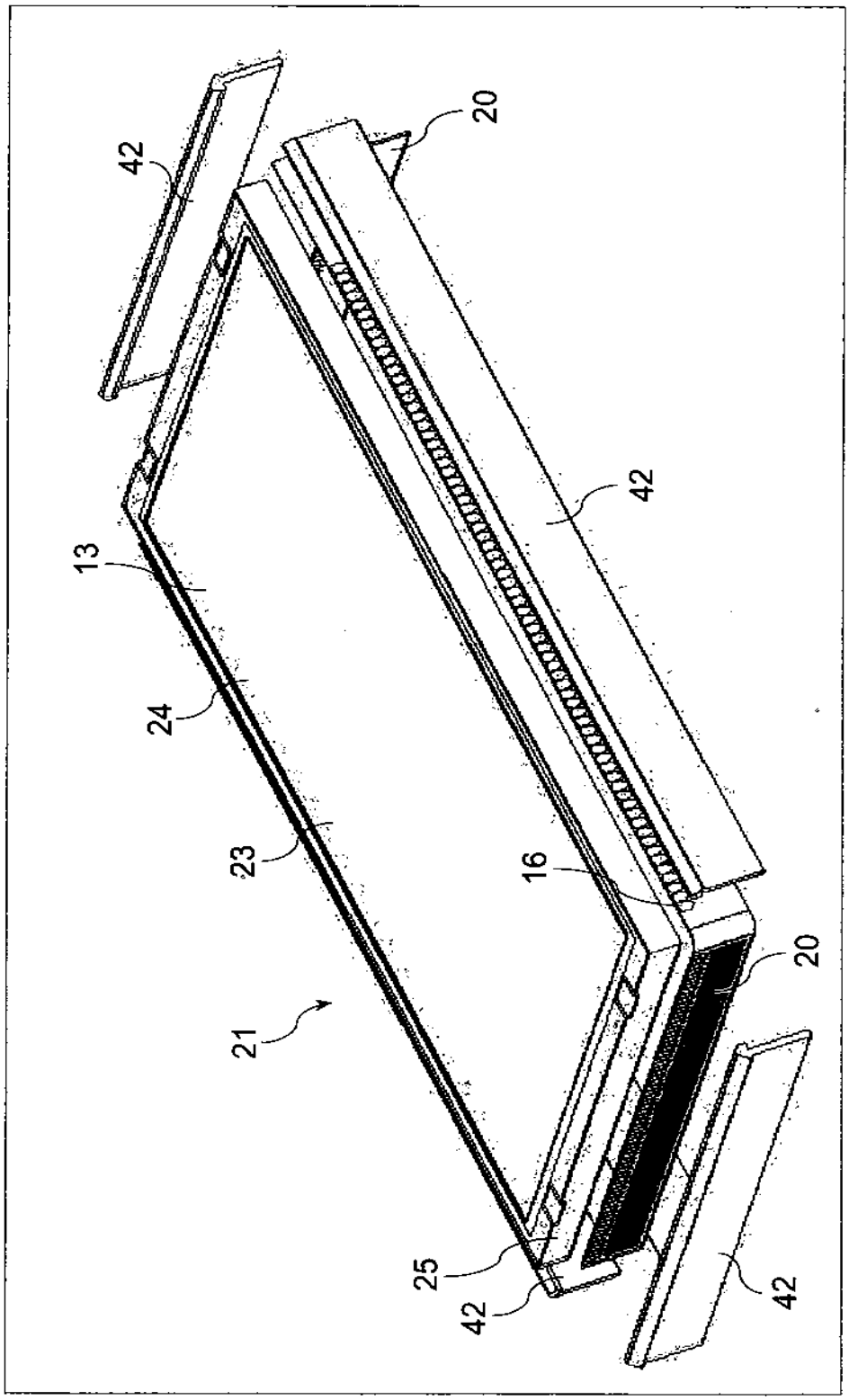


Fig. 16

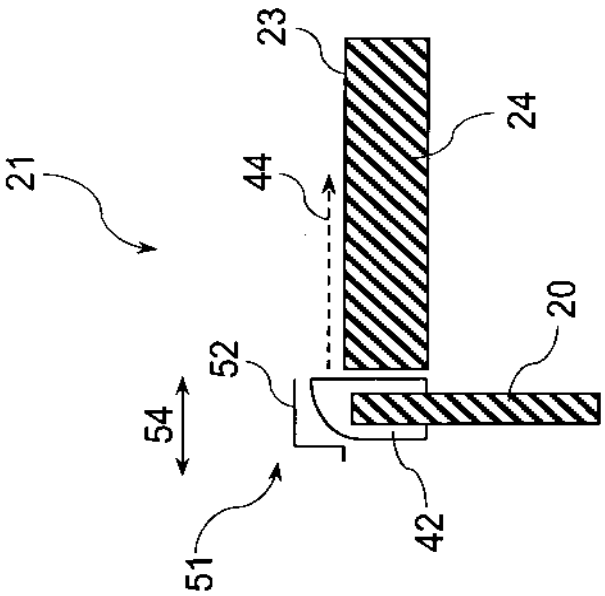


Fig. 18

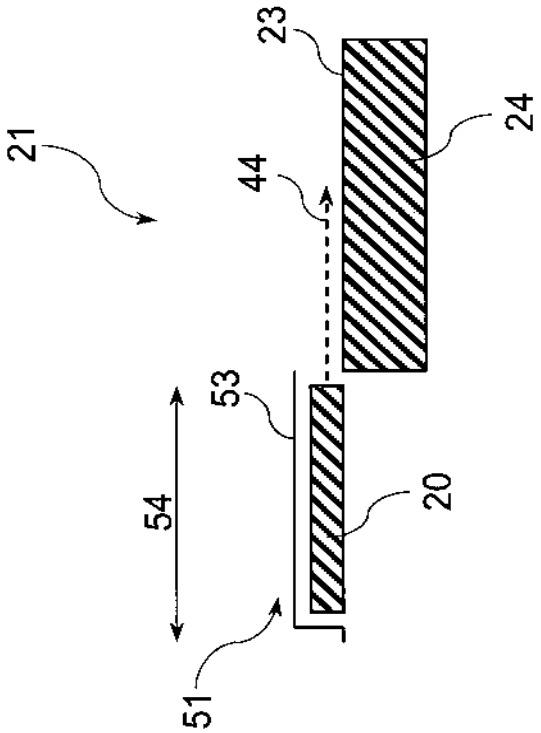


Fig. 17 (prior art)

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Fig. 19a (prior art)

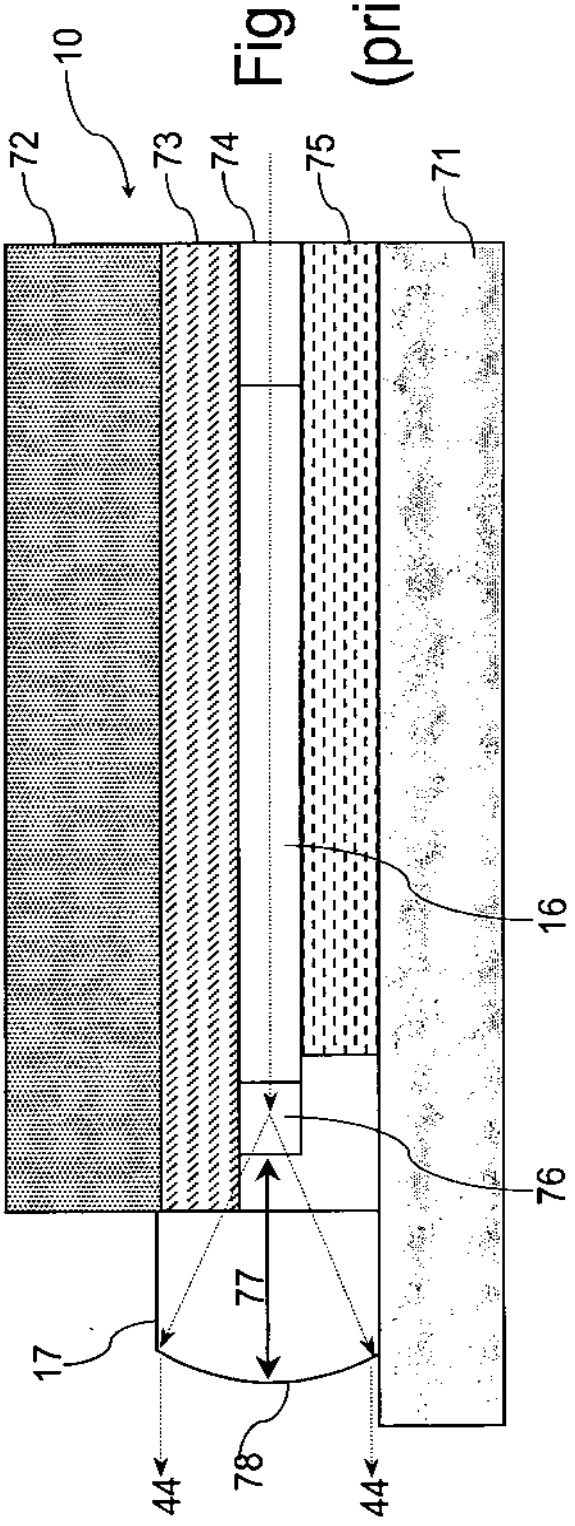


Fig. 19b (prior art)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001390

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

G06F 3/041 (2006.01) *G06F 3/042* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI, PCT Gazette, USPTO Web Patent Database "touchscreen, waveguide etc."

C DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0001653 A1 (SMITS) 5 January 2006 Entire document.	1-25,34-42,45,47-50,52-56
X	US 2006/0002655 A1 (SMITS) 5 January 2006 Entire document.	1-25,34-42,45,47-50,52-56
X	US 2005/0271319 A1 (GRAHAM) 8 December 2005 Entire document.	1,2,4-10,13,14,16-19,21 22,26,29-31,33-38,53-56
A	WO 2002/095668 A1 (PALM, INC.) 28 November 2002 Entire document.	

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 November 2007	14 NOV 2007

Name and mailing address of the ISA/AU	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2007/001390

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	2006/0001653	**KR**	2007003956	US	2006002655	WO	2006004764
		WO	2006004775				
US	2005/0271319	**CN**	1993640	KR	2007004149	US	2007154133
		WO	2005121852				
WO	2002/095668	**us**	6992659	US	2002175901		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX

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INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Daniel Skagmo
App. No.	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Examiner	:	Unassigned
Art Unit	:	2621
Conf. No.	:	8380

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. References numbered 1-593, 673-798, 816-836 are of record in U.S. patent application No. 16/834,905 , filed March 30, 2020, which is relied upon for an earlier filing date under 35 USC 120. Accordingly, copies of references numbered 1-593, 673-798, 817-837 are not submitted pursuant to 37 CFR 1.98(d). Any foreign references may also include English abstract(s) and/or machine translation(s), but no representation is made as to their accuracy.

If the Examiner would like additional information regarding these references or if anything is unclear, the Examiner is invited to contact the undersigned for assistance.

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Notification of Related Litigation Filing

Submitted herewith in the above-identified application is an Information Disclosure Statement listing references for consideration. These references are being submitted pursuant to MPEP § 2001.06(c) in that U.S. Patent Nos. 10,282,035, 10,606,414, and 10,606,416, are currently involved in litigation, namely, *FLATFROG LABORATORIES AB vs. PROMETHEAN*

LTD. AND PROMETHEAN INC., (C.A. No. 19-2246-MN). One or more of these patents may be related, or claimed as part of the priority claim of the present application, or may claim a priority benefit of applications and patents that are part of the present application's claim for priority under 35 U.S.C. § 120.

To the best of the undersigned's understanding, the references submitted herewith represent documents or document portions that are non-confidential as defined by any protective order governing information exchanged between the parties to the litigation mentioned above.

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This Information Disclosure Statement is being filed before the receipt of a First Office Action on the merits, and presumably no fee is required. If a First Office Action on the merits was mailed before the mailing date of this Statement, the Commissioner is authorized to charge the fee set forth in 37 CFR 1.17(p) to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: April 2, 2021

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34701774

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/989,292	08/10/2020	Daniel Skagmo	FFOG.054C6

CONFIRMATION NO. 8380

20995
KNOBBE MARTENS OLSON & BEAR LLP
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FOURTEENTH FLOOR
IRVINE, CA 92614

PUBLICATION NOTICE

OC000000124553769

Title:TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Publication No.US-2021-0096691-A1
Publication Date:04/01/2021

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/989,292	08/10/2020	2621	1980	FFOG.054C6	17	1

CONFIRMATION NO. 8380

UPDATED FILING RECEIPT

20995
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

OC000000122222644

Date Mailed: 12/23/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

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Applicant(s)

FlatFrog Laboratories AB, Lund, SWEDEN;

Power of Attorney: The patent practitioners associated with Customer Number 20995

Domestic Priority data as claimed by applicant

This application is a CON of 16/834,905 03/30/2020 PAT 10739916
which is a CON of 16/191,177 11/14/2018 PAT 10606416
which is a CON of PCT/SE2018/050109 02/06/2018

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
SWEDEN 1730085-6 03/28/2017 Access Code Provided

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/989,292**

Projected Publication Date: 04/01/2021

Non-Publication Request: No

Early Publication Request: No

Title

TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Preliminary Class

345

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/989,292

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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Prioritetsbevis
Certificate of priority

Svensk patentansökan
Swedish Patent Application

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This is to certify that the annexed is a true copy of the documents as originally filed with the Swedish Patent and Registration Office in connection with the following patent application.

(71)	Sökande Applicant (s)	FlatFrog Laboratories AB, Lund, SE
(21)	Patentansökningsnummer Patent application number	1730085-6
(86)	Ingivningsdag Filing date	2017-03-28

Patent- och registreringsverket 2017-03-29
Swedish Patent and Registration Office

Marie Nilsson

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Touch sensing apparatus

Technical Field

The present invention relates to touch-sensing apparatus that operate by propagating light by diffusive light scattering above a thin light transmissive panel, and in particular to optical and mechanical solutions for defining the light paths and control of curvature of the light transmissive panel. The present invention relates furthermore to a method of assembling a touch sensing apparatus.

Background Art

In one category of touch-sensitive panels known as 'above surface optical touch systems', a set of optical emitters are arranged around the periphery of a touch surface to emit light that is reflected to travel and travel above the touch surface. A set of light detectors are also arranged around the periphery of the touch surface to receive light from the set of emitters from above the touch surface. An object that touches the touch surface will attenuate the light on one or more propagation paths of the light and cause a change in the light received by one or more of the detectors. The location (coordinates), shape or area of the object may be determined by analysing the received light at the detectors.

In a variant of such 'above surface optical touch system', illustrated in Fig. 1, the emitters 301 are arranged on a substrate 304, and light from the emitters travel above the touch surface 302 of the panel 305 via reflection or scattering on an edge reflector or diffusor 303. The light will then continue until deflected by a corresponding edge reflector at an opposing edge of the light transmissive panel, where the light will be scattered back down through the transmissive panel and onto the detectors. A problem with such previous systems is the cumbersome alignment between the components thereof, which makes assembly more difficult and costly. Sub-optimal alignment results in signal loss, which moreover is an inherent problem in previous solutions due to the multiple components involved in the light scattering process. Another issue affecting the signal and scattering of the light in the touch sensing apparatus is uncontrolled glass warpage, i.e. distortions of the curvature of the light transmissive panel which will affect the light path and the detection process. While it is critical to accurately control such distortions, previous solutions incorporate complex

solutions that may not allow to fully optimize glass warpage control in a mass production line without limiting the throughput of the production.

Some prior art systems rely on coupling and propagation of collimated light across the light transmissive panel. Such systems are however cumbersome to reliably implement due to the small tolerances with respect to the alignment of the components thereof. E.g. the light emitters- and detectors need to be precisely aligned in relation to various lenses and reflect the light via concave and/or convex reflection and/or refraction to get the desired collimation. Such precise alignment may be difficult to achieve in mass production. The use of collimated light, or light reflected by means of specular reflection, also adds to this complexity, which in turn results in a more expensive and less compact system. Furthermore, to reduce system cost, it may be desirable to minimize the number of electro-optical components.

Summary

An objective is to at least partly overcome one or more of the above identified limitations of the prior art.

One objective is to provide a touch-sensitive apparatus based on "above-surface" light propagation which is robust and easy to assemble.

Another objective is to provide an "above-surface"-based touch-sensitive apparatus with efficient use of light.

One or more of these objectives, and other objectives that may appear from the description below, are at least partly achieved by means of touch-sensitive apparatuses according to the independent claims, embodiments thereof being defined by the dependent claims.

According to a first aspect a touch sensing apparatus is provided comprising a light transmissive panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the light transmissive panel. The light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are arranged above the touch surface and are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the light transmissive panel extends.

According to a second aspect a touch sensing apparatus is provided comprising a light transmissive panel extending in a plane having a normal axis, the light transmissive panel defining a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the light transmissive panel,

wherein the light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The touch sensing apparatus comprises a sealing window arranged around the perimeter, wherein the sealing window comprises a first surface facing the light emitters or the light detectors and an opposite second surface arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface of the sealing window, facing the light transmissive panel, and an opposite top surface of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance so that the second surface forms an angle relative the normal axis, and wherein the second surface comprises a light collimating surface configured to collimate light propagating above the touch surface.

According to a third aspect a method of assembling a touch sensing apparatus is provided comprising; attaching a substrate having a plurality of light emitters and detectors to a carrier; attaching the carrier around a perimeter of a light transmissive panel and arranging the substrate to extend in a direction parallel with a normal axis of a plane in which the light transmissive panel extends, whereby the plurality of light emitters and detectors are arranged above the touch surface.

Further examples of the invention are defined in the dependent claims, wherein features for the second aspect of the disclosure are as for the first aspect mutatis mutandis.

Some examples of the disclosure provide for a touch sensing apparatus that is easier to manufacture and assemble.

Some examples of the disclosure provide for a touch sensing apparatus with fewer steps of assembly.

Some examples of the disclosure provide for a touch sensing apparatus that is less costly to manufacture.

Some examples of the disclosure provide for a facilitated alignment of emitters and detectors of touch sensing apparatus.

Some examples of the disclosure provide for facilitated control of the curvature of the touch surface of a touch sensing apparatus.

Some examples of the disclosure provide for a more robust touch sensing apparatus.

Some examples of the disclosure provide for a touch sensing apparatus that is more reliable to use.

Some examples of the disclosure provide for a touch sensing apparatus that has a better signal-to-noise ratio of the detected light.

Some examples of the disclosure provide for a more compact touch sensing apparatus.

Still other objectives, features, aspects and advantages of the present disclosure will appear from the following detailed description, from the attached claims as well as from the drawings.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

Brief Description of Drawings

These and other aspects, features and advantages of which examples of the invention are capable of will be apparent and elucidated from the following description of examples of the present invention, reference being made to the accompanying drawings, in which;

Fig. 1 is a section view of a touch sensing apparatus according to the prior art;

Fig. 2 is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

Fig. 3 is a schematic illustration, in a perspective side view, of a touch sensing apparatus according to one example;

Fig. 4a is a schematic illustration, in a side view of Fig. 2, of a touch sensing apparatus according to one example;

Fig. 4b is a schematic illustration of a magnified section of Fig. 4a, according to one example;

Fig. 4c is a schematic illustration of a magnified section of Fig. 4a, according to one example;

Fig. 5a is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

Fig. 5b is a schematic illustration of a magnified section of Fig. 5a, according to one example;

Fig. 6 is a flow chart of a method of assembling a touch sensing apparatus according to one example.

Detailed Description of Example Embodiments

In the following, embodiments of the present invention will be presented for a specific example of a touch-sensitive apparatus. Throughout the description, the same reference numerals are used to identify corresponding elements.

Fig. 1 schematically illustrates a variant of an 'above surface optical touch system', as discussed in the Background Art section above ,where the light from the emitters 301 travel above the touch surface 302 of the panel 305 via reflection on an edge reflector 303.

Fig. 2 schematically illustrate a touch sensing apparatus 100 comprising a light transmissive panel 101 that defines a touch surface 102. A plurality of light emitters 103 and detectors 103' are arranged along a perimeter 104 of the light transmissive panel 101. The light emitters 103 are arranged to emit a respective beam of emitted light 105 above the touch surface 102. I.e. while the touch surface 102 extends along a plane 108, having a normal axis 107 directed towards a user performing touch operations on the touch surface 102, the emitted light 105 travels along the plane 108 but at a certain distance from the touch surface 102 in the direction of the normal axis 107, as schematically illustrated with respect to light beam 105, 105', in e.g. Fig. 2. Light 105, 105', can thus travel across the touch surface 102, between opposite sides thereof, without being reflected inside the light transmissive panel 101 itself. The light detectors 103' are arranged to receive detection light 105' from the emitted light 105. Fig. 2 illustrates a section of the touch sensing apparatus 100 adjacent the perimeter 104 of the light transmissive panel 101. In this section, the emitters and detectors 103, 103', are shown in the same view, as well as the emitted and detected light 105, 105', for clarity of presentation. The plurality of light emitters and detectors 103, 103', are arranged above the touch surface 102 and are connected to a substrate 106 extending in a direction 107' parallel with a normal axis 107 of a plane 108 in which the light transmissive panel extends. By having the substrate 106 extending in parallel with the normal axis 107 it is provided for conveniently arranging the plurality of emitters and detectors 103, 103', above the touch surface 102 to achieve a compact footprint in the direction of the plane 108 of the touch sensing apparatus 100 around the perimeter 104 while achieving a direct light path of the emitted or detected light 105, 105', above and across and touch surface 102. Thus, the emitted light 105 does not have to be reflected in order to diffusively spread above and across the touch surface 102, and a detector 103' may directly receive detection light 105' by being correspondingly positioned above the touch surface 102 at an opposite position anywhere around the perimeter 104. The amount of available light that can be utilized for the detection and characterization of an object

touching the touch surface 102 can thus be maximized, and the signal to noise ratio can be improved. The touch sensing apparatus 100 may comprise a sealing window 126 as illustrated in Fig. 2, shielding the emitters and detectors 103, 103', from the outside. The emitted and detected light 105, 105', may thus only have to propagate through the sealing window 126 along the light path between the emitters and detectors 103, 103'. The sealing window 126 provides sealing around the perimeter 104 of the light transmissive panel 101 and protects the emitters and detectors 103, 103' and the display.

Having the substrate extending in the direction 107' being parallel with the normal axis 107 and the emitters and detectors 103, 103', arranged above the touch surface 102 provides for a less complex alignment to maximize the detection performance of the touch sensing apparatus 100. The position of the substrate 106 in the direction of the normal axis 107 can be accurately varied to achieve optical alignment with respect to the emitters and detectors 103, 103'. The ability to achieve an accurate positioning of the substrate 106, and consequently the emitters and detectors 103, 103', attached thereto, is also due to the increased accuracy by which the dimensions of the substrate 106 can be defined along the direction of the substrate 106 aligned with the normal axis 107 in Fig. 2. I.e. the substrate 106 is elongated and extends in a longitudinal direction 123 (Fig. 4a) around the perimeter 104 of the light transmissive panel 101, and it has a short-side extending in parallel with the normal axis 107. The short-side of the substrate 106, illustrated in the cross-sectional view of Fig. 2, may be manufactured to smaller tolerances, and by aligning this side with the normal axis 107, the tolerances for the alignment of the emitters and detectors 103, 103', along the normal axis 107 can be improved. The alignment can thus be both improved, and facilitated as discussed above. The latter advantage also provides for facilitated and less costly mass production of the touch sensing apparatus 100 and the various touch base display systems in which it may be implemented.

The substrate 106 may extend at least partly above the touch surface 102, whereby the plurality of light emitters and detectors 103, 103', are connected to a portion 109 of the substrate extending above the touch surface 102. This further provides for achieving a more robust alignment of the emitters and detectors 103, 103', relative to the light transmissive panel 101, by being directly joined to the substrate 106, and thereby simultaneously arranged above the touch surface 102. It may be conceivable however that the emitters and detectors 103, 103', are connected to the substrate 106 via connection elements (not shown) extending between the substrate 106 and to a position above the touch surface 102.

The substrate 106 may be fixed to a carrier 110 mounted around the perimeter 104 of the light transmissive panel 101, as schematically illustrated in Figs. 1 – 2. By directly joining the substrate 106 to the carrier 110 provided around the perimeter 104, the assembly of the touch sensing apparatus 100 may be further facilitated, as the amount of components can be kept at a minimum. For example, the substrate 106 can be accurately fixed in relation to the carrier 110, due to the small tolerances possible in the direction of the substrate 106 aligned in parallel with the normal axis 107 in Fig. 1, as discussed above. The carrier 110 may for example comprise a cavity 116, as discussed further below, being precisely dimensioned to accommodate the width of the substrate 106 along the direction 107', i.e. the short-side of the substrate 106. Then, accurate positioning of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 is possible as the carrier 110 is mounted around the perimeter 104 thereof. The carrier 110 may extend substantially in the direction 107' parallel with the normal axis 107, as with the substrate 107, to achieve a compact mounting around the perimeter 104.

Having the substrate 106 fixed to the carrier 110 allows also for having the carrier 110 wired as an electrical ground reference layer of the substrate 106.

The carrier 110 may be arranged to at least partly enclose edges 111 of the light transmissive panel 101, as shown in the example of Fig. 1. This provides for further increasing the robustness of the touch sensing apparatus 100, and improving the accuracy of the alignment of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 since the carrier 110, having the emitters and detectors 103, 103', fixed thereto, may also be directly supporting the light transmissive panel 101 around the perimeter 104. The carrier 110 may comprise a slot in which the light transmissive panel 101 is fitted around the perimeter 104.

The carrier 110 may comprise fixing elements 112 configured to attach the carrier 110 to a display unit 113, 121. The display unit may comprise a display support 121 and a display panel 113, which collectively is referred to as a display unit in the present disclosure. Having the carrier 110 attachable to the display unit 113, 121, by fixing elements 112, advantageously provides for further facilitating the assembly of the touch sensing apparatus 100 to a display unit, since the carrier 110 can be directly joined to the latter. Alignment is thus facilitated, due to the minimum amount of components needing such alignment to each other. The robustness of the touch sensing apparatus 100 is further improved, while mass production is made less complex due the minimized number of assembly steps. The fixing elements 112 may comprise any elements configured to provide for fixing of the position of the carrier 110 to the

display unit 113, 121. In the examples shown in Figs. 1 - 2, the carrier 110 has openings 115, 115', 115'', discussed further below, which may be aligned with corresponding openings 127 of a support of the display unit 121, through which mounting elements 114 may be positioned for the fixing. It is conceivable however that the carrier 110 has other types of recesses or protrusions which may interlock with a corresponding mating surface of the display unit 113, 121.

The fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the carrier 110. Thus, besides from fixing the position of the carrier 110 relative to the display unit 113, 121, the fixing elements 112 may also fix or at least support the position of the substrate 106 in relation to the carrier 110. It is conceivable that the substrate 106 may first be arranged in relation to the carrier 110, and the fixing elements 112 may be arranged to support and strengthen the fixing therebetween, while simultaneously fixing the carrier 110 to the display unit 113, 121. This may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100. From a similar aspect, the fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the display unit 113, 121. This may be seen as a consequence from the above, i.e. the fixing elements 112 contributing to the fixing of the substrate 106 to the carrier 110, which in turn is fixed to the display unit 113, 121. It is however conceivable that the fixing elements 112 may fix the substrate 106 directly to the display unit 113, 121, in which case the carrier 110 may act as a further support for the substrate 106.

In one example, as discussed further below, the substrate 106 may comprise second openings 118 which provides for such fixing or support. As mentioned, this may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100.

The fixing elements 112 may be configured to interlock with a mounting element 114 for locking the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. Figs. 2 – 3 show examples of having an elongated mounting element 114 joining the carrier 110 and/or the substrate 106 to the display unit 113, 121. The mounting element 112 may however comprise any fastening element configured to exert a force between the carrier 110 and/or the substrate 106 to the display unit 113, 121, such as pins, bolts, screws, clips, clamps, locks, bars, rods, anchors, latches, clasps.

The fixing elements 112 may comprise openings 115, 115', 115'', as illustrated in Figs. 2 – 3. The carrier 110 may form a cavity 116 having walls 117 at least partly enclosing the substrate 106, illustrated in the example of Fig. 2. This may provide for increased stability of the fixing of the position of the

substrate 106 in relation to the carrier 110. At least one of the walls 117 may comprise at least one of the openings 115, 115', 115'', as further illustrated in Fig. 2. Being able to directly fix the walls 117 of the carrier 110 enclosing the substrate 106 to the display unit 121, 113, provides for further simplifying manufacturing, and at the same time further increase the accuracy of the alignment of e.g. the emitters and detectors 103, 103', in relation to the light transmissive panel 101, since the minimized number of intermediate mounting components improves tolerance control. I.e. build-up of mounting errors in each assembly step is reduced and controlled. It is conceivable that the walls 117 may be fixed to the display unit 113, 121, by other fixing elements 112, such as recesses or protrusions interlocking with correspondingly mating surfaces of the display unit 113, 121, and/or fastening elements as exemplified above.

The fixing elements 112 may comprise openings 115, 115', 115'', 118, arranged in the carrier 110 and in the substrate 106. First openings 115, 115', 115'' of the carrier 110 may be aligned with second openings 118 of the substrate 106, as illustrated in the example of Fig. 2. The first and second openings 115, 115', 115'', 118 may be configured to receive a mounting element 114 configured to lock the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. This provides for further facilitated and improved alignment and assembly, and increased robustness. In the example of Fig. 2, the carrier 110 encloses the substrate 106 such that two opposite openings 115, 115'', of the carrier are arranged on either side of the substrate 106, but it is conceivable that the carrier 110 may be arranged on one side only of the substrate 106.

The carrier 110 may be configured to be attachable to the display unit 121, 113, at an adjustable position 119, 119', along a direction 117'' parallel to the normal axis. A distance 120 between the light transmissive panel 101 and the display unit 113 along the normal axis 107 may thus be variable upon attaching the carrier to the display unit 113, 121 at at least two different adjustable positions 119, 119'. For example, turning to Fig. 3, the carrier 110 is attached at a first position 119 to the support of the display unit 121, via fixing unit 112. The first position 119 provides for the given distance 120 between the panel of the display unit 113. The distance 120 may then be decreased by instead attaching the carrier 110 at a second position 119' which is off-set with respect to the first position 119 in the positive direction of the normal axis 107, or the direction 107'' as illustrated in Fig. 3. If the fixing point to the support of the display unit 121 remains constant, e.g. at the opening 127 of a support 121 as illustrated, the carrier 110 will be moved in the opposite direction to the normal axis 107 and the distance 120 will be decreased. Having the carrier 110 being attachable

to the display unit 121, 113, at an adjustable position 119, 119', along a direction 117'' parallel to the normal axis 107, thus provides for simple and efficient adjustment of the position of the light transmissive panel 101.

Besides from overall controlling the distance 120, as discussed, such adjustment provides for efficiently controlling and varying the curvature of the light transmissive panel 101. I.e. varying the distance 120 as discussed at a second intermediate location 128', between opposite ends of the carrier 110, along the longitudinal direction 123, while maintaining the distance 120 at the opposite ends, such as at a first location 128, will affect the curvature of the carrier 110, and thereby the curvature of the light transmissive panel 101. E.g. decreasing the distance 120 at the second location 128' can produce a more concave shape, i.e. a decreased radius of curvature, of the carrier 110 and the light transmissive panel 101, in the direction of the normal axis 107. Increasing the distance 120 between the mentioned opposite ends can instead increase the radius of curvature in the direction of the normal axis 107. The curvature or warping of the light transmissive panel 101 can thus be controlled efficiently an in a facilitated manner, which is advantageous for increasing throughput in mass-production of displays incorporating the touch sensing apparatus 100 while keeping the warp of the light transmissive panel 101 under control. An optimized curvature of the light transmissive panel 101 increases the reliability and accuracy of the touch sensing apparatus 100.

The fixing elements 112 may be configured to attach the carrier 110 to the display unit 121 at the adjustable positions 119, 119', along the direction 117'' parallel to the normal axis 107. Thus, the fixing units 112 be arranged at the different adjustable positions 119, 119', to adjust the distance 120 and the curvature of the a light transmissive panel 101 while providing for securely attaching the carrier to the display unit 113, 121. The fixing elements 112 may thus be arranged at least at the first and second locations 128, 128', along the longitudinal direction 123 as discussed above, where each of the locations in the longitudinal direction 123 may have at least two adjustable positions 119, 119', as illustrated in the example of Fig. 3.

The openings 115, 115', of the carrier 110 may be separated along a direction 117'' parallel to the normal axis 107, as illustrated in Fig. 3. Alternatively, or in addition, the carrier 110 may be attachable to a plurality of second openings 122 in a display support 121 of the display unit, where the plurality of second openings 122 are separated along the normal axis 107. Thus, the position 119, 119', may be remained fixed while the carrier 110 is attached to the support 121 at the various second openings 122, to adjust the curvature of the light transmissive panel 101 and/or the distance 120 as

discussed above. Although the examples in Figs. 2 – 3, show openings 115, 115', 115'', 127, it is conceivable that the attachment between the carrier 110 and the display unit 121, 113, is provided by other fixing elements 112 as exemplified above.

The carrier 110 may be formed from a single monolithic piece of material. The structural integrity and the stability of the carrier 110 can thereby be increased, which further optimizes the parameters discussed above with respect to alignment, robustness, ease of assembly etc. One example of a possible process by which the carrier can be formed as a single piece of material is an extrusion process, but it is conceivable that the carrier 110 may be formed from other hot or cold metal or polymer working processes such as drawing, rolling, or molding processes.

The substrate 106 may extend in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. Fig. 4a illustrates a view of a plurality of substrates 106, 106', extending along the longitudinal direction 123. The light transmissive panel 101 and the carrier 110 holding the substrates have been excluded in the view for clarity of presentation. The substrates 106, 106', may comprise secondary fixing units 124, 124', configured for variably attaching the position of each of the substrates 106, 106', on the carrier 110 along the longitudinal direction 123 and/or in the direction of the normal axis 107. This provides for more accurately adjusting the position of the substrates 106, 106', in relation to the light transmissive panel 101. While each of the substrates 106, 106', may be within tolerances, the accumulated error obtained when several substrates 106, 106' are connected along the longitudinal direction 123 may exceed the total tolerance of the full length of the light transmissive panel 101. Such accumulation of errors may be effectively prevented by having secondary fixing units 124, 124', as elucidated above. The secondary fixing units 124, 124', may be provided on various locations on the substrates 106, 106', to allow for adjusting the position, such as on opposite ends thereof.

The touch sensing apparatus 100 may comprise vertical alignment units 135 arranged between adjacent substrates 106, 106', extending in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. The vertical alignment units 135 are configured to variably position the adjacent substrates 106, 106', in the direction of the normal axis 107 so that an angle 136 between the adjacent substrates 106, 106', can be adjusted. Fig. 4b schematically illustrates a vertical alignment unit 135 positioned between adjacent substrates 106, 106', to vary the position thereof in the direction of the normal axis 107, i.e. along arrows 137, so that the angle 136 may be set to a

desired value. The vertical alignment unit 135 thus provides for facilitating the alignment of the plurality of substrates 106, 106', to e.g. the curvature of the light transmissive panel 101. For example, if the light transmissive panel 101 is concave in the direction of the normal axis 107, initially parallel substrates 106, 106', may be angled to closely follow the concave shape of the light transmissive panel 101 by increasing the angle 136 between the substrates 106, 106', as schematically illustrated in Fig. 4b. The position of the emitters and detectors 103, 103', on the substrates 106, 106', may thus remain at an optimized vertical position relative the light transmissive panel 101 for various curvatures thereof. The vertical alignment unit 135 may comprise various units configured to change the position of the adjacent substrates 106, 106', in the direction of the normal axis 107, such as bolts, screws, pins, or any other elements that can provide an offset at the ends of the substrates 106, 106'.

The touch sensing apparatus 100 may comprise force distributing units 138 positioned between adjacent substrates 106, 106', configured to provide a fixing force therebetween, as schematically illustrated in Fig. 4c. The force distributing units 138 may provide for improving and facilitating the fixing of the substrates 106, 106', to the carrier, without the need for dedicated fixing elements such as screws, bolts, etc to each end of respective substrates 106, 106', thereby reducing the amount of such fixing elements, which facilitates the assembly of the touch sensing apparatus 100.

The touch sensing apparatus may thus comprise a plurality of substrates 106, 106', extending in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. A first substrate 106 of the plurality of substrates may comprises a connection unit 125 configured to directly interlock with a subsequent connection unit 125' of a subsequent substrate 106' when arranged adjacent said subsequent substrate, as schematically illustrated in Fig. 4a. It is thereby possible to directly connect subsequent substrates 106, 106', and eliminate the need for intermediate connectors, which further provides for facilitating the assembly of the touch sensing apparatus 100.

The touch sensing apparatus 100 may comprise a sealing window 126 as schematically illustrated in Figs. 5a-b. The sealing window 126 may be arranged around the perimeter 104 of the light transmissive panel 101. The sealing window 126 may comprise a first surface 129 facing the light emitters 103 or the light detectors 103', and an opposite second surface 130 arranged adjacent the touch surface 102. Emitted or detected light thus propagates between the first and second surface 129, 130. At least one of the first and second surfaces 129, 130, may comprises a light collimating surface 129, 130, configured to collimate light propagating above the touch surface 102. I.e.

emitted light 105 will be collimated by the sealing window 126, so that the light propagating above the touch surface 102 will be collimated. Detectors 103' will receive the collimated light which will be focused through a corresponding sealing window 126. As the emitters and detectors 103, 103', are arranged above the touch surface 102 and are connected to a substrate 106 extending in a direction parallel with a normal axis 107, it is possible to provide for a very precise and improved alignment thereof in relation to the sealing window 126, which allows for achieving collimated light in a highly optimized manner, and an associated increase in signal strength since more of the emitted light can be collected by the detectors 103'. The emitted light is collimated in a direction parallel with the plane 108 in which the light transmissive panel 101 extends. Collimating the light with sealing window 126 also allows for reducing the aperture of the sealing window 126, i.e. the thickness of the sealing window 126 in the direction of the normal axis 107, while still detecting a sufficient amount of light. This provides for reducing the amount of ambient light reaching the detectors 103', thus improving the signal to noise ratio.

Turning to Fig. 5b, the second surface 130 may extend in the direction of the normal axis 107 between a base surface 131 of the sealing window 126, facing the light transmissive panel 101, and an opposite top surface 132 of the sealing window 126. The base surface 131 may be offset from the top surface 132 along the direction of the plane 108 with an offset distance 133 so that the second surface 130 forms an angle 134 relative the normal axis 107. As further illustrated in Fig. 5b, the second surface may comprises the light collimating surface 130. Thus, in addition to having a convex shape as illustrated in Fig. 5b, the second surface 130 is arranged to assume a tilted configuration as provided by the offset distance 133. Having such angled configuration provides for reducing the impact of Fresnel reflexes. The Fresnel reflexes otherwise generate additional unwanted light paths that will reduce the apparent attenuation on some detection lines, especially when they run parallel to and near a sealing window 126. These Fresnel reflexes may also result in artifacts and false touch information. By having an angled and/or curved second surface 130 of the sealing window 126, the light may instead bounce off the second surface 130 with such an angle so that it leaves the plane 108, and thereby not interfere with the detection of the remaining light.

A sealing window 126 as described above can provide for the advantageous effects as described for touch sensing apparatuses having a plurality of light emitters and detectors arranged in a multitude of configurations, not limited to the configurations described in relation to Figs. 2 and 3 exemplified above. A touch sensing apparatus 100 is thus provided comprising

a light transmissive panel 101 extending in a plane 108 having a normal axis 107, wherein the light transmissive panel defines a touch surface 102. The touch sensing apparatus 100 comprises a plurality of light emitters 103 and detectors 103' arranged along a perimeter 104 of the light transmissive panel, wherein the light emitters are arranged to emit a respective beam of emitted light 105 above the touch surface, wherein the light detectors are arranged to receive detection light 105' from the emitted light. The touch sensing apparatus 100 comprises a sealing window 126 arranged around the perimeter, wherein the sealing window comprises a first surface 129 facing the light emitters or the light detectors and an opposite second surface 130 arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface 131 of the sealing window, facing the light transmissive panel, and an opposite top surface 132 of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance 133 so that the second surface forms an angle 134 relative the normal axis, and wherein the second surface comprises a light collimating surface 130 configured to collimate light propagating above the touch surface.

The first surface 129, facing the emitters or detectors 103, 103', may also be angled, with an angle 134', as schematically illustrated in Fig. 5a, to provide for the desired light path from or towards the emitters or detectors 103, 103', respectively. The first surface 129 may also comprise a light collimating surface and have a convex shape towards the emitters or detectors 103, 103', as illustrated in Fig. 5a, in addition to being arranged at an angle 134'. The angles 134, 134', may be in the range of 2-10 degrees relative to the normal axis 107 to provide for a particularly advantageous reduction of Fresnel reflexes. An angle greater than 2 degrees avoids Fresnel reflexes and an angle of less that 10 degrees reduces the light field height.

The sealing window 126 may comprise a fixing element 139 configured to interlock to carrier 110. In the example in Fig. 5a, the fixing element comprises a protrusion 139 arranged to interlock with a corresponding recess in the carrier 110. Mounting and fixing of the sealing window 126 may thus be facilitated and improved since the fixing element 139 may snap into the carrier 110, without needing to have separate fixing units or adhesives joining the sealing window 126 to the carrier 110. It is conceivable that the fixing element 139 may comprise any other shape, such as a recess, for interlocking with a corresponding mating surface of the carrier 110.

The sealing window 126 may be formed from a single monolithic piece of material, thus providing for a robust sealing window 126 and a stable attachment to the carrier 110 and the light transmissive panel 101. The sealing window 126 may be formed by an extrusion process. In one embodiment, the sealing window is formed from two separate materials. A first material, such as a dyed PMMA or similar NIR transparent material, is used for a transparent section and a second material, such as a compressible light blocking material, is used for for sealing off the E/D compartment. This may be achieved by e.g. using a co-extrusion process.

A further mounting unit 140 may be provided between the sealing window 126 and the light transmissive panel 101, as schematically illustrated in Fig. 5a. The mounting unit 140 may comprise a resilient material that allows the sealing window 126 to assume a secure fixed position relative the light transmissive panel 101. The sealing window 126 may have a corresponding groove into which the mounting unit 140 may be securely positioned.

A method 200 of assembling a touch sensing apparatus 100 is provided. Fig. 6 illustrates steps of the method 200. The order in which the steps of the method 200 are described and illustrated should not be construed as limiting and it is conceivable that the steps can be performed in varying order. The method 200 comprises fixing 201 a substrate 106 having a plurality of light emitters 103 and detectors 103' to a carrier 110, and attaching 202 the carrier 110 around a perimeter 104 of a light transmissive panel 101. The method further comprises arranging 203 the substrate to extend in a direction 107' parallel with a normal axis 107 of a plane 108 in which the light transmissive panel 101 extends, whereby the plurality of light emitters and detectors 103, 103', are arranged above the touch surface 102. The method 200 thus provides for a facilitated assembly of the touch sensing apparatus 100 while achieving optimal alignment, robustness, and accuracy as described above in relation to Figs. 2 – 3.

As mentioned, the carrier 110 may be formed from a single monolithic piece of material, and the carrier may form a cavity 116 having walls 117 at least partly enclosing the substrate 106. At least one of the walls 117 may comprise openings 115, 115', 115''. The method 200 may comprise fixing 204 the carrier 106 to a display unit 121, 113, by fixing mounting elements 114 through the openings 115, 115', 115'', thereby providing for the above mentioned advantages.

The method 200 may comprise adjusting 205 a distance 120 between the light transmissive panel 101 and a display unit 113, 121, along the normal axis 107 by attaching 207 the carrier 110 to the display unit 113, 121, at at least two

different adjustable positions 119, 119', along a direction 117'' parallel to the normal axis 107. Control of the distance 120 is improved and facilitated, and may thereby be more easily optimized to various applications of the touch sensing apparatus 100.

The method 200 may comprise adjusting 208 a radius of curvature of the light transmissive panel 101 in the direction of the normal axis 107 by attaching 209 the carrier 110 to a display unit 113, 121, at at least two different adjustable positions 119, 119', along a direction 117'' parallel to the normal axis 107. Control of the curvature of the light transmissive panel 101 is thus improved as described above.

The invention has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope and spirit of the invention, which is defined and limited only by the appended patent claims.

For example, the specific arrangement of emitters and detectors as illustrated and discussed in the foregoing is merely given as an example. The inventive coupling structure is useful in any touch-sensing system that operates by transmitting light, generated by a number of emitters, inside a light transmissive panel and detecting, at a number of detectors, a change in the received light caused by an interaction with the transmitted light at the point of touch.

CLAIMS

1. A touch sensing apparatus (100), comprising:

a light transmissive panel (101) that defines a touch surface (102),

a plurality of light emitters (103) and detectors (103') arranged along a perimeter (104) of the light transmissive panel,

wherein the light emitters are arranged to emit a respective beam of emitted light (105) above the touch surface, wherein the light detectors are arranged to receive detection light (105') from the emitted light,

wherein the plurality of light emitters and detectors are arranged above the touch surface and are connected to a substrate (106) extending in a direction (107') parallel with a normal axis (107) of a plane (108) in which the light transmissive panel extends.

2. Touch sensing apparatus according to claim 1, wherein the substrate extends at least partly above the touch surface, whereby the plurality of light emitters and detectors are connected to a portion (109) of the substrate extending above the touch surface.

3. Touch sensing apparatus according to claim 1 or 2, wherein the substrate is fixed to a carrier (110) mounted around the perimeter of the light transmissive panel.

4. Touch sensing apparatus according to claim 3, wherein the carrier is arranged to at least partly enclose edges (111) of the light transmissive panel.

5. Touch sensing apparatus according to claim 3 or 4, wherein the carrier comprises fixing elements (112) configured to attach the carrier to a display unit (113, 121).

6. Touch sensing apparatus according to claim 5, wherein the fixing elements are configured to attach the position of the substrate in relation to the carrier and/or in relation to the display unit.

7. Touch sensing apparatus according to any of claims 5 - 6, wherein the fixing elements are configured to interlock with a mounting element (114) for locking the position of the carrier and/or the substrate to the display unit.

8. Touch sensing apparatus according to any of claims 5 - 7, wherein the fixing elements comprise openings (115, 115', 115''), wherein the carrier forms a cavity (116) having walls (117) at least partly enclosing the substrate, and wherein at least one of the walls comprises at least one of said openings.

9. Touch sensing apparatus according to any of claims 5 – 6, or 8, wherein the fixing elements comprise openings (115, 115', 115'', 118) arranged in the carrier and in the substrate, wherein first openings (115, 115', 115'') of the carrier are aligned with second openings (118) of the substrate, the first and second openings being configured to receive a mounting element (114) configured to lock the position of the carrier and/or the substrate to the display unit.

10. Touch sensing apparatus according to any of claims 5 - 9, wherein the carrier is configured to be attachable to the display unit at an adjustable position (119, 119') along a direction (117'') parallel to the normal axis, whereby a distance (120) between the light transmissive panel and the display unit along the normal axis is variable upon attaching the carrier to the display unit at at least two different adjustable positions (119, 119').

11. Touch sensing apparatus according to claim 10, wherein the fixing elements are configured to attach the carrier to the display unit at the adjustable positions along the direction (117'') parallel to the normal axis.

12. Touch sensing apparatus according to claim 8 or 9, wherein the openings (115, 115') are separated along a direction (117'') parallel to the normal axis, and/or

wherein the carrier is attachable to a plurality of second openings (122) in a display support (121) of the display unit, the plurality of second openings being separated along the normal axis.

13. Touch sensing apparatus according to any of claims 3 - 12, wherein the carrier is formed from a single monolithic piece of material.

14. Touch sensing apparatus according to any of claims 1 – 13, wherein the substrate extends in a longitudinal direction (123) along the perimeter of the light transmissive panel, the substrate comprising secondary fixing units (124, 124') configured for variably attaching the position of the substrate on the carrier along the longitudinal direction and/or in the direction of the normal axis.

15. Touch sensing apparatus according to any of claims 1 - 14, comprising vertical alignment units (135) arranged between adjacent substrates (106, 106') extending in a longitudinal direction (123) along the perimeter of the light transmissive panel, wherein the vertical alignment units are configured to variably position the adjacent substrates in the direction of the normal axis so that an angle (136) between the adjacent substrates is adjustable.

16. Touch sensing apparatus according to any of claims 1 - 15, comprising a plurality of substrates (106, 106') extending in a longitudinal direction (123) along the perimeter of the light transmissive panel, wherein a first substrate (106) of said plurality of substrates comprises a connection unit (125) configured to directly interlock with a subsequent connection unit (125') of a subsequent substrate (106') when arranged adjacent said subsequent substrate.

17. Touch sensing apparatus according to any of claims 1 - 16, comprising a sealing window (126) arranged around the perimeter of the light transmissive panel, wherein the sealing window comprises a first surface (129) facing the light emitters or the light detectors and an opposite second surface (130) arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, and

wherein at least one of the first and second surfaces comprises a light collimating surface (129, 130) configured to collimate light propagating above the touch surface.

18. Touch sensing apparatus according to claim 17, wherein the second surface extends in the direction of the normal axis between a base surface (131) of the sealing window, facing the light transmissive panel, and an opposite top surface (132) of the sealing window,

wherein the base surface is offset from the top surface along the direction of the plane with an offset distance (133) so that the second surface forms an angle (134) relative the normal axis, and wherein the second surface comprises a light collimating surface (130).

19. A touch sensing apparatus (100), comprising:

a light transmissive panel (101) extending in a plane (108) having a normal axis (107), the light transmissive panel defining a touch surface (102),

a plurality of light emitters (103) and detectors (103') arranged along a perimeter (104) of the light transmissive panel, wherein the light emitters are arranged to emit a respective beam of emitted light (105) above the touch surface, wherein the light detectors are arranged to receive detection light (105') from the emitted light,

a sealing window (126) arranged around the perimeter, wherein the sealing window comprises a first surface (129) facing the light emitters or the light detectors and an opposite second surface (130) arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface,

wherein the second surface extends in the direction of the normal axis between a base surface (131) of the sealing window, facing the light transmissive panel, and an opposite top surface (132) of the sealing window,

wherein the base surface is offset from the top surface along the direction of the plane with an offset distance (133) so that the second surface forms an angle (134) relative the normal axis, and wherein the second surface comprises a light collimating surface (130) configured to collimate light propagating above the touch surface.

20. Touch sensing apparatus according to claim 19, wherein the first surface and/or second surface form a curved edge convex to the sealing window (126).

21. A method (200) of assembling a touch sensing apparatus (100), comprising:

attaching (201) a substrate (106) having a plurality of light emitters (103) and detectors (103') to a carrier (110),

attaching (202) the carrier around a perimeter (104) of a light transmissive panel (101) and arranging (203) the substrate to extend in a direction (107') parallel with a normal axis (107) of a plane (108) in which the light transmissive panel extends, whereby the plurality of light emitters and detectors are arranged above the touch surface.

22. Method according to claim 21, wherein the carrier if formed from a single monolithic piece of material, the carrier forming a cavity (116) having walls (117) at least partly enclosing the substrate, wherein at least one of the walls comprise openings (115, 115', 115''), the method comprising

fixing (204) the carrier to a display unit (121, 113) by fixing mounting elements (114) through said openings.

23. Method according to claim 21 or 22, comprising

adjusting (205) a distance (120) between the light transmissive panel and a display unit (121, 113) along the normal axis by

attaching (207) the carrier to the display unit at at least two different adjustable positions (119, 119') along a direction (117'') parallel to the normal axis.

24. Method according to any of claims 21 - 23, comprising

adjusting (208) a radius of curvature of the light transmissive panel in the direction of the normal axis by

attaching (209) the carrier to a display unit at at least two different adjustable positions (119, 119') along a direction (117'') parallel to the normal axis.

ABSTRACT

A touch sensing apparatus is disclosed comprising a light transmissive panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the light transmissive panel. The light emitters are arranged to emit a respective beam of emitted light that travels above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are arranged above the touch surface and are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the light transmissive panel extends. A method of assembling a touch sensing apparatus is also disclosed.

Elected for publication: Fig. 2

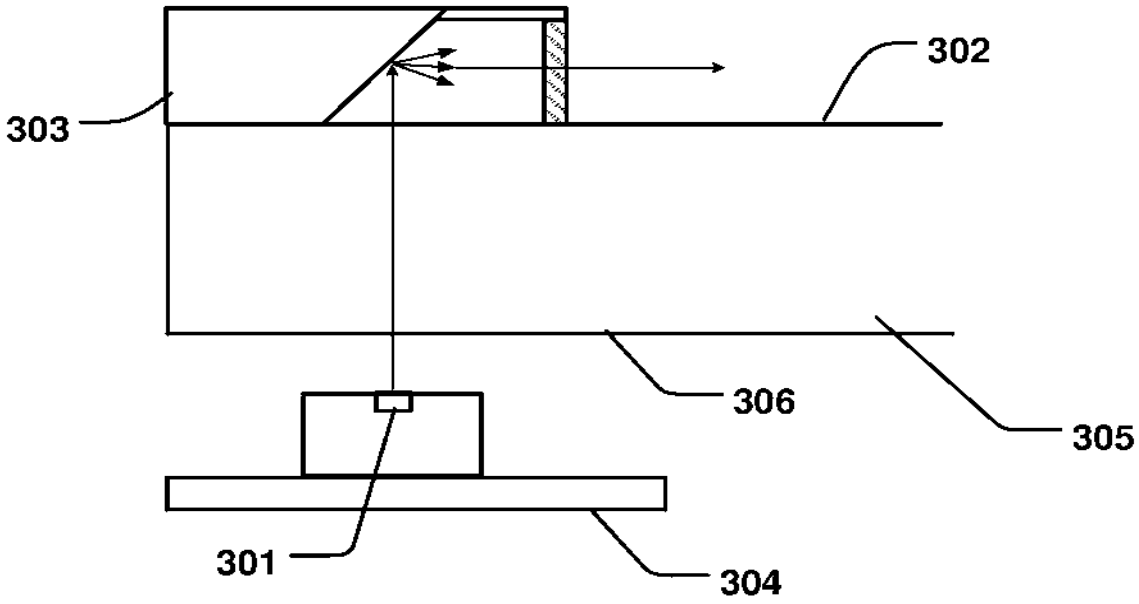


Fig. 1

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1288

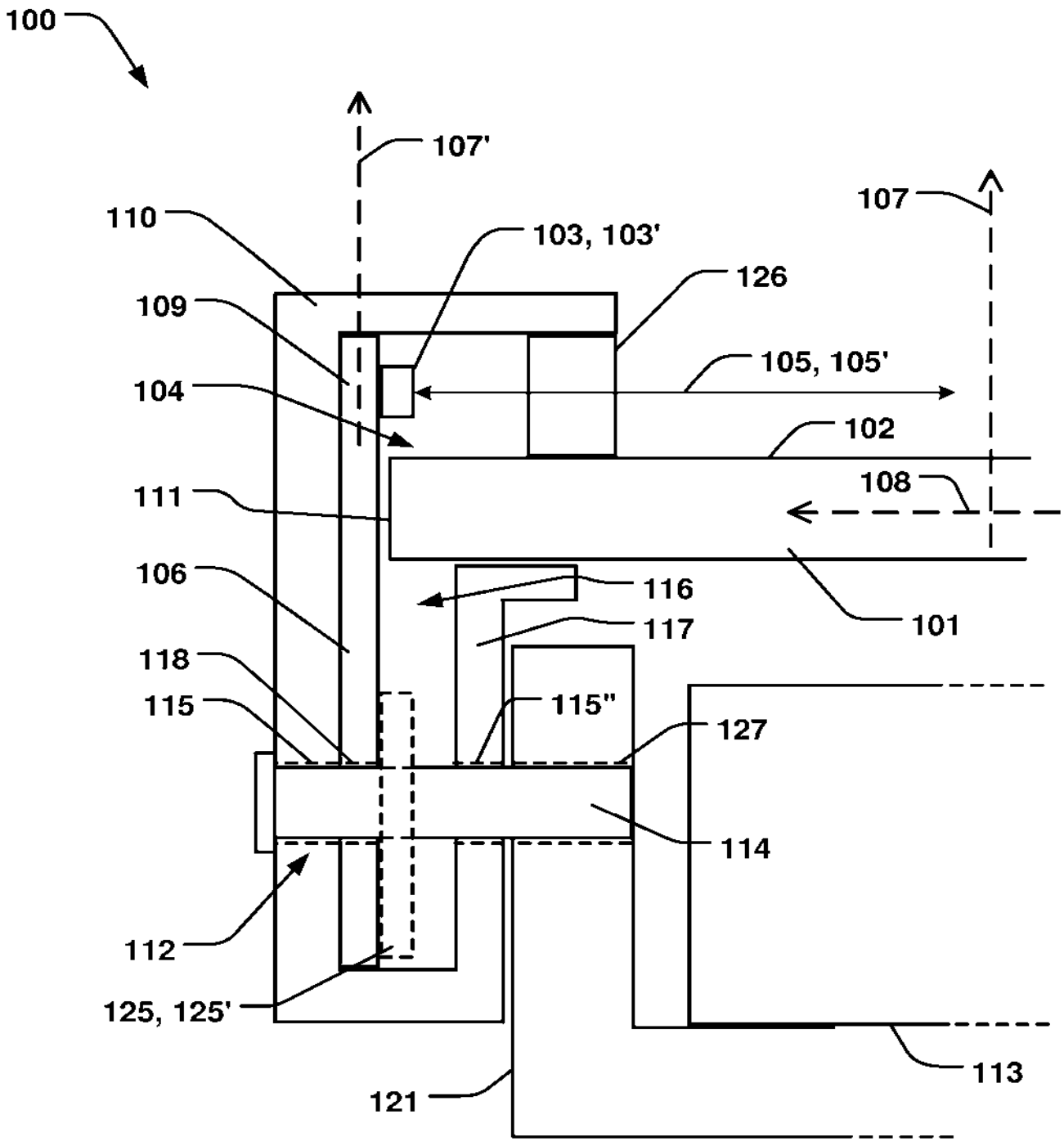

100
107'
107
110
103, 103'
126
109
105, 105'
104
102
108
111
106
116
117
101
118
115
115"
127
114
112
125, 125'
113
121

Fig. 2

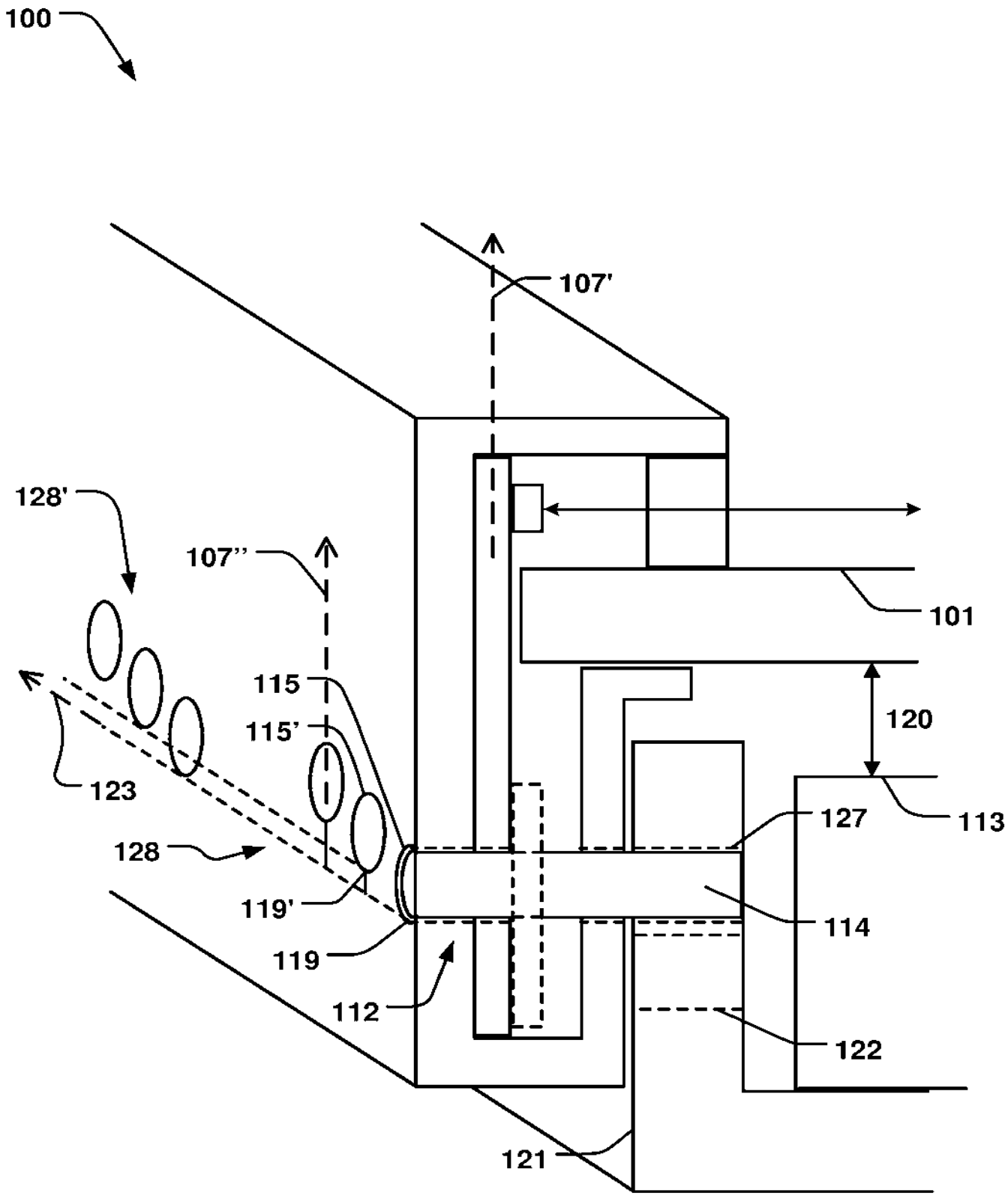

100
107'
128'
107''
101
115
115'
120
123
127
113
128
119'
114
119
112
122
121

Fig. 3

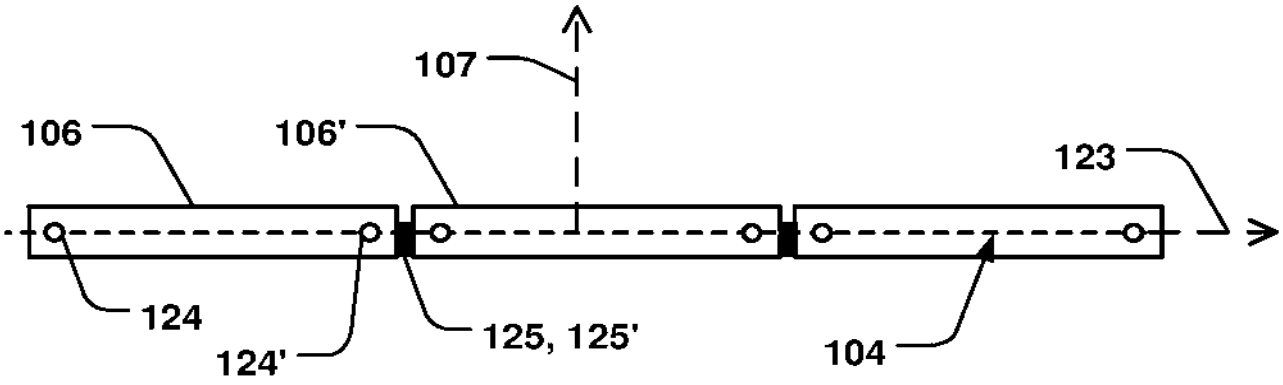


Fig. 4a

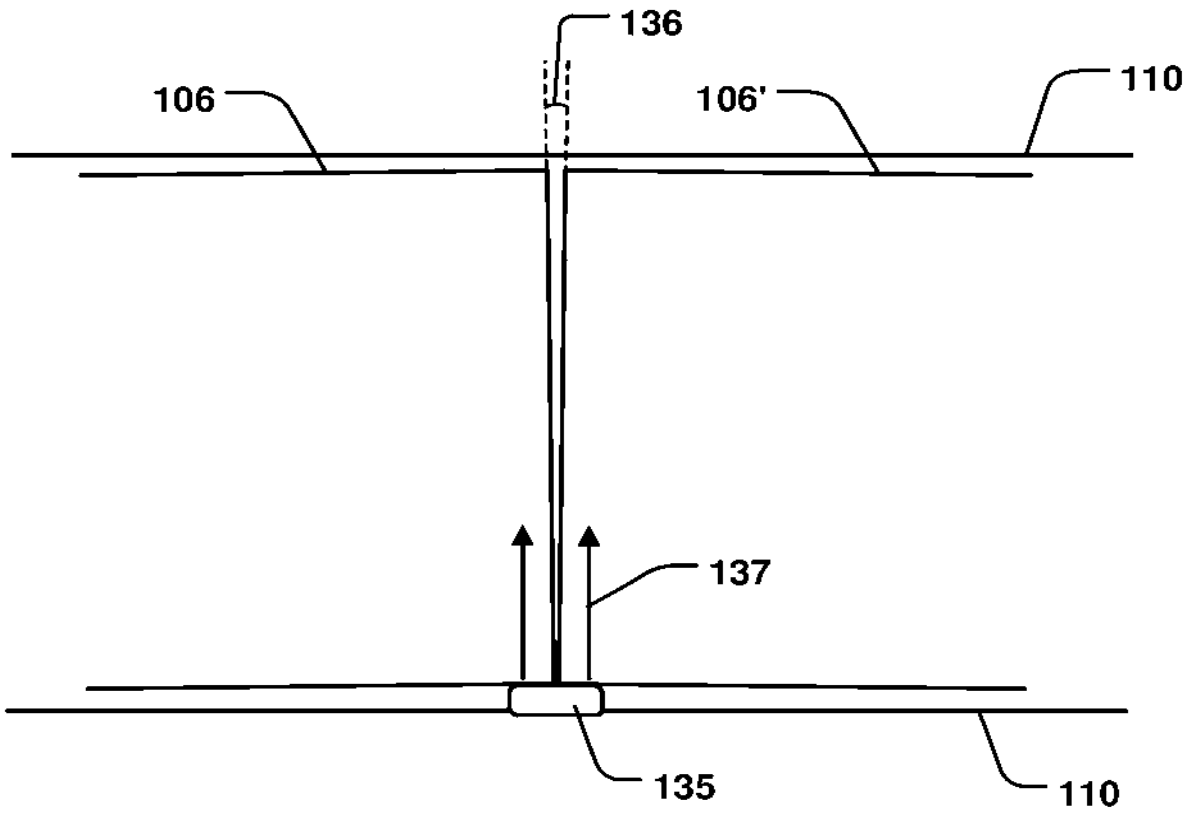


Fig. 4b

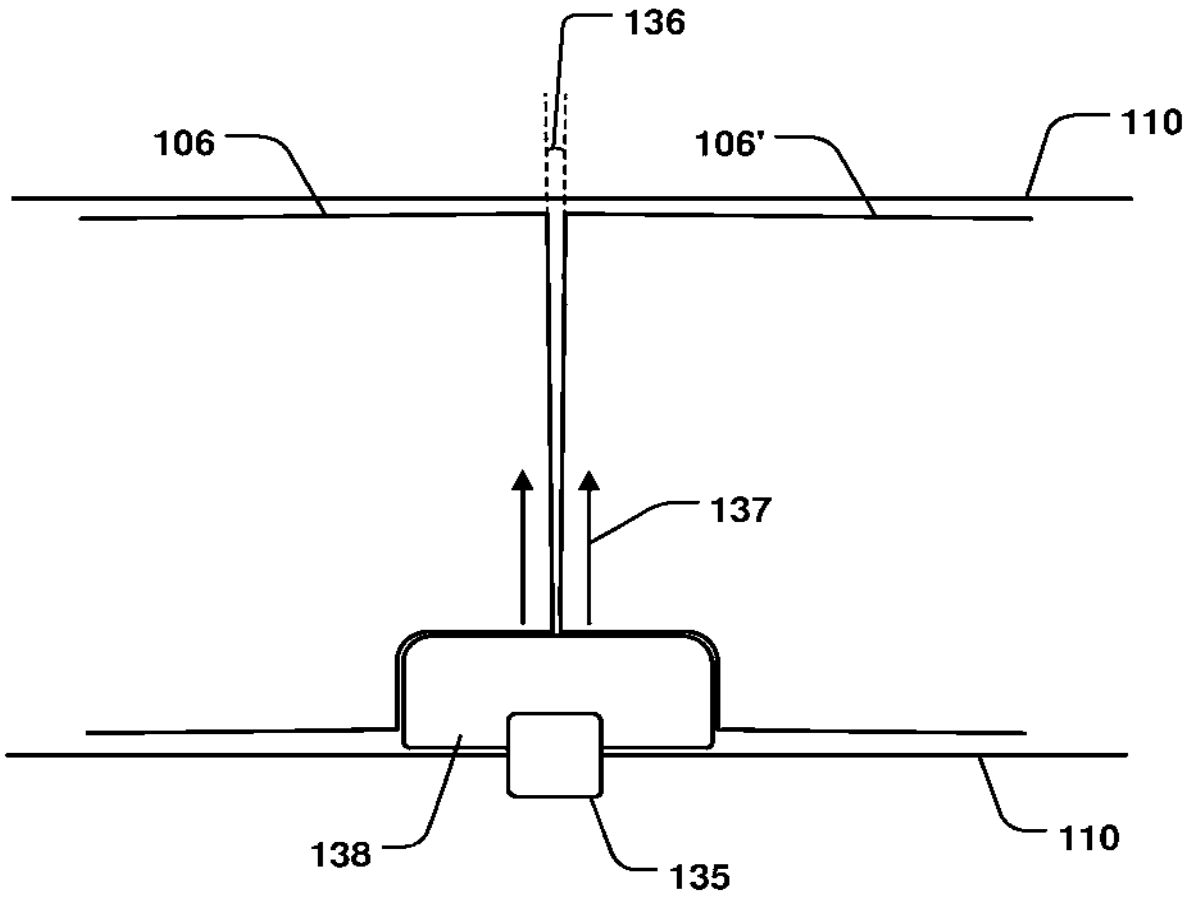


Fig. 4c

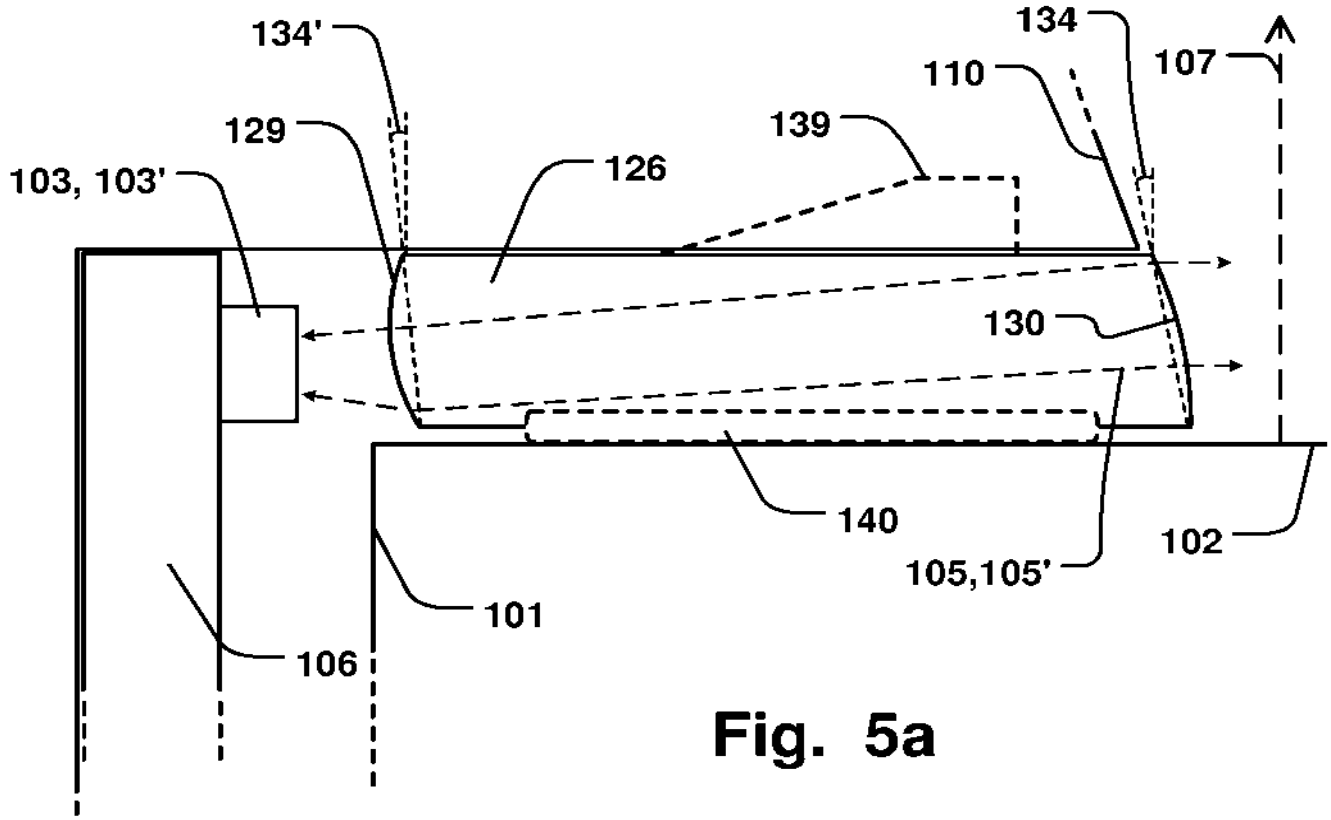


Fig. 5a

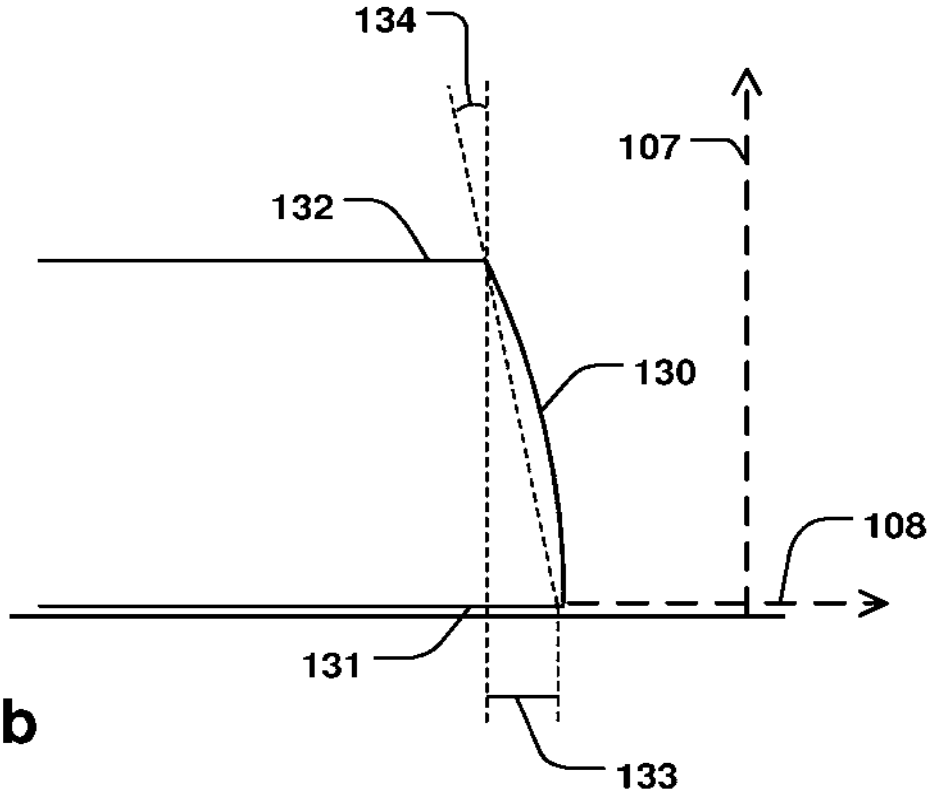


Fig. 5b

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1293

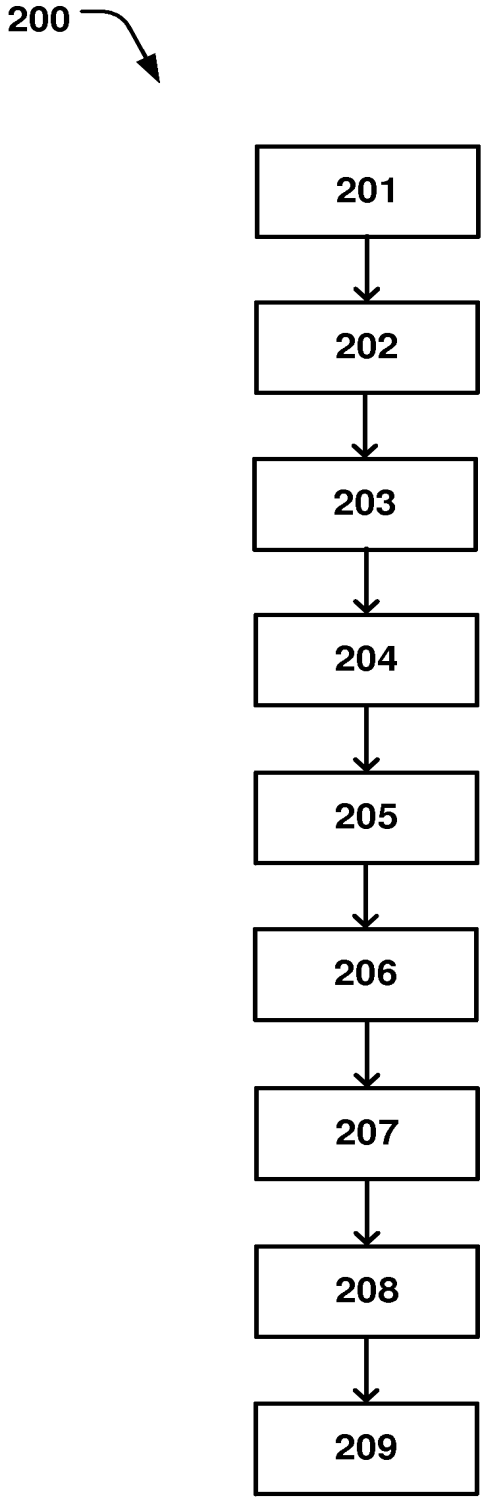


Fig. 6

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1294

United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :C46575

Sale Accounting Date:12/22/2020

Sale Item Reference Number
16989292

Effective Date
12/16/2020

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I2020BLD43358323	1051	LATE FILING FEE FOR OATH OR DECLARATION	$160.00	Deposit Account

RESPONSE TO FORMALITIES NOTICE

Inventor	:	Daniel Skagmo
App. No.	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Art Unit	:	2621
Conf No.	:	8380

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The above-captioned application was filed lacking at least one item that would advance the application to examination. Enclosed in compliance with 37 CFR 1.53(f) are the following:

(X) A Preliminary Amendment in 5 pages including Replacement Drawings.

(X) A Declaration in 5 pages.

(X) A Rescission of Prior Disclaimers and Request to Revisit Art in 1 page.

(X) Fees will be paid via EFS Web. Any extension of time will be requested by payment of the appropriate extension fee.

The Commissioner is hereby authorized to charge any additional fees which may be required, now or in the future, or credit any overpayment, to Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 16, 2020

By:/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

33692820

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor	:	Daniel Skagmo
App. No.	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Examiner	:	Unassigned
Art Unit	:	2621
Conf. No.	:	8380

PRELIMINARY AMENDMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Preliminary to examination on the merits, please amend the above-identified U.S. application as follows:

Chemtronics v. FlatFrog
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AMENDMENTS TO THE CLAIMS

The following listing of claims replaces all prior versions thereof. Changes are shown below in highlighted form, where insertions appear as underlined text (e.g., insertions) while deletions appear as strikethrough text (e.g., ~~deletions~~) or double brackets (e.g., [[deletions]]).

1. - 5. (Canceled)

6. (NEW) A touch sensing apparatus comprising:

a panel comprising a touch surface, a back surface, and an edge surface;

a plurality of light emitters and detectors arranged along a perimeter of the panel;

a substrate, wherein an emitter is mounted on the substrate and is configured to transmit light in a plane above the touch surface and perpendicular to a normal of the touch surface;

a support structure configured to support the substrate;

wherein the support structure is formed from a single monolithic piece comprising:

a first portion extending parallel to the edge surface and above and below the touch surface; and

a second portion extending parallel to the touch surface to overlap with at least a portion of the touch surface.

7. (NEW) The touch sensing apparatus according to claim 6, wherein the support structure comprises a cavity, wherein the substrate is arranged in the cavity.

8. (NEW) The touch sensing apparatus according to claim 6, wherein the substrate is fixed to the first portion of the support structure.

9. (NEW) The touch sensing apparatus according to claim 6, wherein the single monolithic piece of the support structure comprises a third portion extending parallel to the first portion, wherein the substrate is arranged between the first portion and the third portion.

10. (NEW) The touch sensing apparatus according to claim 9, wherein the substrate is fixed to the third portion.

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11. (NEW) The touch sensing apparatus according to claim 6, wherein the support structure is configured to attach to a display support, wherein the display support is configured to support a display.

12. (NEW) The touch sensing apparatus according to claim 11, wherein the support structure comprises a recess configured to interlock with a corresponding mating surface of the display support

13. (NEW) The touch sensing apparatus according to claim 6, wherein the support structure is formed from an extrusion process, drawing process, rolling process, or molding process.

14. (NEW) The touch sensing apparatus according to claim 6, comprising an optical element configured to be secured between the touch surface and the second portion of the support structure, wherein the optical element comprises a first surface facing the emitter and being configured to receive the transmitted light from the emitter and a second surface configured to receive light propagating across a touch interacting portion of the touch surface.

15. (NEW) The touch sensing apparatus according to claim 14, wherein the first surface is tilted relative to the normal axis of the touch surface.

16. (NEW) The touch sensing apparatus according to claim 14, wherein the optical element is configured to slide between the touch surface and the second portion of the support structure.

17. (NEW) The touch sensing apparatus according to claim 14, wherein the optical element comprises a protrusion and/or recess to interlock with a corresponding mating surface of the second portion.

18. (NEW) The touch sensing apparatus according to claim 17, wherein the protrusion and/or recess is configured to snap into the second portion.

19. (NEW) The touch sensing apparatus according to claim 14, wherein the optical element is configured to be secured to the second portion along a third surface and wherein a fourth surface, opposite the third surface, contacts the touch surface.

20. (NEW) The touch sensing apparatus according to claim 14, wherein the fourth surface contacts only the touch surface.

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21. (NEW) The touch sensing apparatus according to claim 14, wherein the optical element is configured to be secured against the touch surface by only the second portion.

22. (NEW) The touch sensing apparatus according to claim 14, wherein the optical element contacts only the second

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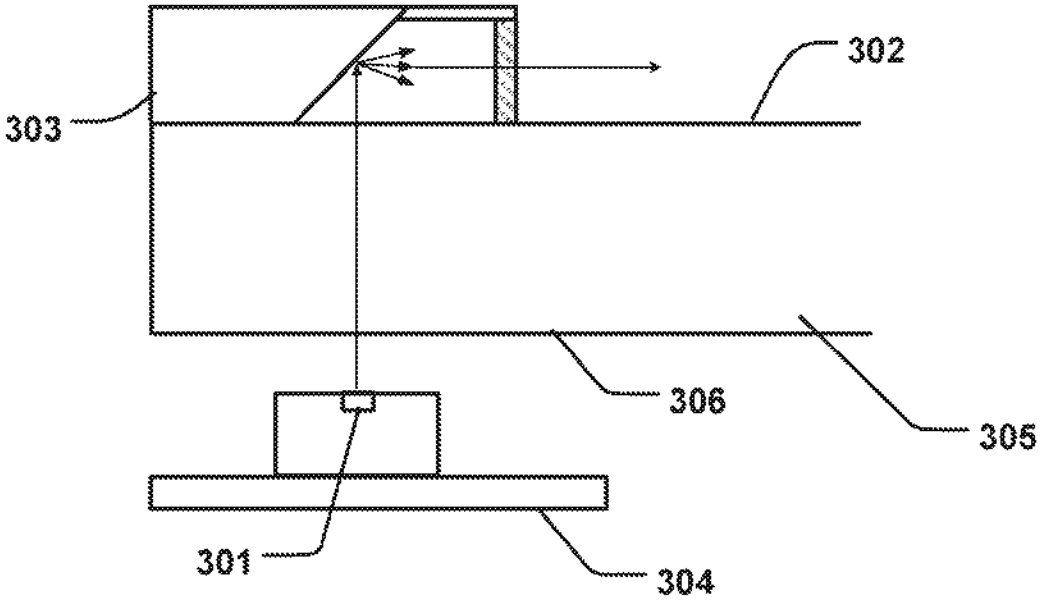


Fig. 1a

Electronic Patent Application Fee Transmittal

Application Number:	16989292
Filing Date:	10-Aug-2020
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Filer:	Harnik Shukla/Jenny Kim
Attorney Docket Number:	FFOG.054C6

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 2 months with $0 paid	1252	1	640	640
Miscellaneous:				
		Total in USD ($)		**2460**

Electronic Acknowledgement Receipt

EFS ID:	41409375
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Melanie Terrazas
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.054C6
Receipt Date:	16-DEC-2020
Filing Date:	10-AUG-2020
Time Stamp:	20:32:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2460
RAM confirmation Number	E2020BFK33302747
Deposit Account	111410
Authorized User	Melanie Terrazas

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	ffog54c6_decs.pdf	1352156 db7e0423893abfa685b63eb18a0b23ebbc9ee12e	no	5
Warnings:					
Information:					
2	Miscellaneous Incoming Letter	ffog54c6_hakim.pdf	15887 52a978a13d83e947d226f659499e8c5fa201c79f	no	1
Warnings:					
Information:					
3	Applicant Response to Pre-Exam Formalities Notice	ffog54c6_mparts_rev.pdf	18459 af6cd9afd15bb9dce577a84660572f03eeb68dcb	no	1
Warnings:					
Information:					
4		ffog54c6_preamend-rev.pdf	108875 72f53fcd501c2edd4ab91d0a7509100906263884	yes	8

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Claims	2	4
Drawings-only black and white line drawings	5	5
Applicant Arguments/Remarks Made in an Amendment	6	7
Drawings-only black and white line drawings	8	8

Warnings:

Information:

5	Fee Worksheet (SB06)	fee-info.pdf	37549 37b7a925430821dfaffc4aefc8f391d9bea1d94c	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	1532926

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.054C2

Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Inventors: Daniel Skagmo, Robert Ehn, Hakan Bergstrom

Declaration

This Declaration is directed to U.S. or International Application No. **16/191177**, filed November 14, 2018 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries related to **TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY** (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been filed or prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application"), and ASSIGNOR desires to assign or confirm assignment of the Work and the Application to the below identified Assignee.

AND WHEREAS, **FlatFrog Laboratories AB,** with its principal place of business at **Scheelevägen 15 A Lund SE 223 63** (hereinafter the "ASSIGNEE"), desires to acquire or confirm ownership of the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges that ASSIGNOR has sold, assigned, transferred, and set over, and by these presents does hereby sell, assign, transfer, and set over, unto said ASSIGNEE, **its** successors, legal representatives, and assigns, the entire right, title, and interest throughout the world in and to the Application and the Work, including: all provisional applications relating to the Work and the Application (including but not limited to Sweden Application No(s). **SE 1730085-6**, filed **March 28, 2017** (respectively if plural applications)); all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the Application, including, all divisions, continuations, continuations-in-part, and reissues, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof; and all rights of priority under International Conventions and any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals, and reissues thereof.

ASSIGNOR hereby authorizes and requests the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all related Letters Patent to the ASSIGNEE, **its** successors, legal representatives, and assigns.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, **its** successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will: communicate to said ASSIGNEE, **its** successors, legal representatives, and assigns any facts known to ASSIGNOR respecting the Work; testify in any legal proceeding; assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto; sign/execute all lawful papers; authorize the filing of, execute, and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications; and generally do everything possible to aid the ASSIGNEE, **its** successors, legal representatives, and assigns, to obtain and enforce proper patent protection for the Work in all countries.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.054C2

Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Inventors: Daniel Skagmo, Robert Ehn, Hakan Bergstrom

Legal Name of Inventor: Daniel Skagmo

Signature: Daniel Skagmo Date: Feb 17, 2020

Witnessed by: _____

Witness Name (printed): _____

Legal Name of Inventor: Robert Ehn

Signature: _____ Date: Feb 17, 2020

Witnessed by: _____

Witness Name (printed): _____

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.054C2

Title: TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Inventors: Daniel Skagmo, Robert Ehn, Hakan Bergstrom

Legal Name of Inventor: Hakan Bergstrom

Signature: Håkan Bergström Date: Feb 18, 2020

Witnessed by: _____

Witness Name (printed): _____

32212076

RESCISSION OF ANY PRIOR DISCLAIMERS AND REQUEST TO REVISIT ART

Inventor	:	Daniel Skagmo
App. No.	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Examiner	:	Unassigned
Art Unit	:	2621
Conf. No.	:	8380

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The claims of the present application are different and possibly broader in scope than the claims pursued in the parent application(s). To the extent any prior amendments or characterizations of the scope of any claim or referenced art could be construed as a disclaimer of any subject matter supported by the present disclosure, Applicant hereby rescinds and retracts such disclaimer. Accordingly, the references previously considered in the parent application(s) may need to be re-visited.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

Knobbe, Martens, Olson & Bear, LLP

Dated: December 16, 2020

/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404

34064591

AMENDMENTS TO DRAWINGS

Please replace page 1 of the drawings with the replacement sheet submitted herewith as an Appendix. The replacement sheet of drawings contains formalized versions of the current drawings and does not alter the current drawings in any substantive manner. No drawings have been added or removed. Therefore, no new matter has been added in the replacement sheet of drawings.

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1313

REMARKS

Applicant has canceled claims 1-5 and added new claims 6-22. No new matter has been added. Please enter the amendments prior to examination on the merits.

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present application.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 16, 2020

By:/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

33692853

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1314

APPENDIX

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1315

STATEMENT REGARDING PRIORITY DOCUMENT
PURSUANT TO 37 CFR 1.55(h)

Inventor	:	Daniel Skagmo
App. No	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Examiner	:	Unassigned
Art Unit	:	2621
Conf. No.	:	8380

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The present application is a Continuation of Application No. 16/834,905, which is a Continuation of Application No. 16/191,177, which is a continuation of PCT/SE2018/050109. The certified priority document(s) have been filed and acknowledged by the Office in Application No. 16/834,905. Applicant wishes to rely upon the previously submitted priority documents as provided for under 37 CFR 1.55(h).

The priority claim has been properly identified in an Application Data Sheet within the later of either four months from the actual filing date or 16 months from priority. As such, no fee is believed to be required.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 9, 2020

By:/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404

34012514

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1316

Electronic Acknowledgement Receipt

EFS ID:	41341761
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Fabiola Esmerio
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.054C6
Receipt Date:	09-DEC-2020
Filing Date:	10-AUG-2020
Time Stamp:	19:14:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	FFOG054C6_stmt.pdf	16593 1ce1df09afd9e16829af9d45e5b3379844aaca72	no	1

Warnings:

Information:	
Total Files Size (in bytes):	16593

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/989292
	Filing Date	August 10, 2020
	First Named Inventor	Daniel Skagmo
	Art Unit	2621
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	FFOG.054C6

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number *Number - Kind Code (if known)* Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	5,515,083	05-07-1996	Casebolt et al.	
	2	7,528,898	05-05-2009	Hashimoto	
	3	9,317,146	04-19-2016	Hufnagel	
	4	2011/0316005	12-29-2011	Murao et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document *Country Code-Number-Kind Code* Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T[1]
	5	CN 203453994 U	02-26-2014	SHANDONG GETTOP ACOUSTIC CO., LTD.		X
	6	CN 205384833 U	07-13-2016	CHANGSHA ENVIRONMENTAL PROTECTION COLLEGE		X-Abs.
	7	JP H05190066 A	07-30-1993	MATSUSHITA ELECTRIC IND CO LTD		X-Abs.
	8	WO 2014/044181 A1	03-27-2014	BEIJING IRTOUCH SYSTEMS CO LTD		
	9	WO 2015/123322 A1	08-20-2015	APPLE INC		

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[1]

33765895

Examiner Signature	Date Considered

*__Examiner:__ Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

T[1] - Place a check mark in this area when an English language Translation is attached.

INFORMATION DISCLOSURE STATEMENT

First Inventor	:	Daniel Skagmo
App. No.	:	16/989292
Filed	:	August 10, 2020
For	:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Examiner	:	Unassigned
Art Unit	:	2621
Conf. No.	:	8380

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

References and Listing

Pursuant to 37 CFR 1.56, an Information Disclosure Statement listing references is provided herewith. Copies of any listed foreign and non-patent literature references are being submitted. Any foreign references may also include English abstract(s) and/or machine translation(s), but no representation is made as to their accuracy.

If the Examiner would like additional information regarding these references or if anything is unclear, the Examiner is invited to contact the undersigned for assistance.

No Disclaimers

To the extent that anything in the Information Disclosure Statement or the listed references could be construed as a disclaimer of any subject matter supported by the present application, Applicant hereby rescinds and retracts such disclaimer.

Notification of Related Litigation Filing

Submitted herewith in the above-identified application is an Information Disclosure Statement listing references for consideration. These references are being submitted pursuant to MPEP § 2001.06(c) in that U.S. Patent Nos. 10,282,035, 10,606,414, and 10,606,416, are currently involved in litigation, namely, *FLATFROG LABORATORIES AB vs. PROMETHEAN LTD. AND PROMETHEAN INC.*, (C.A. No. 19-2246-MN). One or more of these patents may be related, or claimed as part of the priority claim of the present application, or may claim a priority

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benefit of applications and patents that are part of the present application's claim for priority under 35 U.S.C. § 120.

To the best of the undersigned's understanding, the references submitted herewith represent documents or document portions that are non-confidential as defined by any protective order governing information exchanged between the parties to the litigation mentioned above.

Timing of Disclosure

This Information Disclosure Statement is being filed before the receipt of a First Office Action on the merits, and presumably no fee is required.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: October 27, 2020

By:/Harnik Shukla/_____
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Chemtronics Exhibit 1002 Page 1321

Electronic Acknowledgement Receipt

EFS ID:	40963746
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Jenny Kim
Filer Authorized By:	Harnik Shukla
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Receipt Date:	27-OCT-2020
Filing Date:	10-AUG-2020
Time Stamp:	19:44:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	CN_203453994U_wAbs.pdf	621382 8900e3e9866b5bb68364ab80a7d5560b963d18ae	no	8

Warnings:

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Information:					
2	Foreign Reference	CN_205384833U_wAbs.pdf	413973 9ced9e8353a6192b9e74ab36f6e6785c529 11851	no	7
Warnings:					
Information:					
3	Foreign Reference	JPH05190066A_wabs.pdf	220557 529b7a0315ff95b08dc85ac16532274ffb92 488a	no	4
Warnings:					
Information:					
4	Foreign Reference	WO_2014044181A1.pdf	570614 9caa2d435331b34955653d02437f544b312 ae4af	no	13
Warnings:					
Information:					
5	Foreign Reference	WO_2015123322A1.pdf	1500129 0a86005b1ffe12e383e3d0658c44c6868fc4 bff2	no	82
Warnings:					
Information:					
6		IDS_FFOG054C6.pdf	48075 be0634cec1fd810b17a644fa6f74942a3fa08 8fb	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Information Disclosure Statement (IDS) Form (SB08)	3	3
	Transmittal Letter	1	2

Warnings:	
Information:	
Total Files Size (in bytes):	3374730

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Espacenet

CN203453994U Light guiding device for implementing light path of optical touch panel and optical touch panel

Applicants: SHANDONG GETTOP ACOUSTIC CO

Inventors: DAI WEITAO

Classifications:
IPC ***F21V8/00; G06F3/042;*** *F21Y107/00; F21Y115/10;*

Priorities: CN201320422589U 2013-07-16

Application: CN203453994U·2013-07-16

Publication: CN203453994U·2014-02-26

Published as: CN203453994U

Light guiding device for implementing light path of optical touch panel and optical touch panel

Abstract

The utility model discloses a light guiding device for implementing a light path of an optical touch panel and the optical touch panel. The light guiding device for implementing the light path of the optical touch panel comprises a closed shell, a light guiding strip, focusing lenses and LED lamp modules, wherein the light guiding strip is arranged in an inner cavity of the closed shell, the focusing lenses are arranged at the two ends of the light guiding strip respectively, the LED lamp modules are arranged at the two ends of the closed shell respectively, the focusing lenses and the LED lamp modules are arranged in the closed shell, light emitted by the LED lamp modules generate direct beams through the focusing lenses, and the direct beams enter the light guiding strip. According to the light guiding device for implementing the light path of the optical touch panel and the optical touch panel, due to the facts that the light emitted by the LED lamp modules generate the direct beams through the focusing lenses, and the LED lamp modules are placed in the lightproof closed shell, loss of the light cannot happen, when the direct beams are transmitted in the light guiding strip, attenuation can be reduced, the brightness of the portion, in the middle area of the light guiding strip, of the light path can be consistent with the brightness of the portions, at the two ends of the light guiding strip, of the light path, the brightness and the consistency of the light guiding strip can be improved, and locating accuracy can be ensured.

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(19)中华人民共和国国家知识产权局

(12)实用新型专利

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代理人 王宝筠

(51)Int.Cl.
F21V 8/00(2006.01)
G06F 3/042(2006.01)
F21Y 101/02(2006.01)

权利要求1页 说明书3页 附图2页

(54)实用新型名称

一种实现光学触控屏光路的导光装置及光学触控屏

(57)摘要

本实用新型公开提供了一种实现光学触控屏光路的导光装置及光学触控屏，该导光装置包括：封闭壳体、设置在所述封闭壳体内腔中的导光条、设置在所述导光条两端的聚焦镜头及设置在所述封闭壳体两端的LED灯组件，所述聚焦镜头和所述LED灯组件设置在所述封闭壳体内，所述LED灯组件发出光线经所述聚焦镜头后产生直射光束进入所述导光条内。该导光装置的LED灯组件发出光线经聚焦镜头后产生直射光束，并且将LED灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路强度与两端保持一致，提高导光条的强度和一致性，进而保证定位精度。



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1. 一种实现光学触控屏光路的导光装置，其特征在于，包括：封闭壳体、设置在所述封闭壳体内腔中的导光条、设置在所述导光条两端的聚焦镜头及设置在所述封闭壳体两端的LED灯组件，所述聚焦镜头和所述LED灯组件设置在所述封闭壳体内，所述LED灯组件发出光线经所述聚焦镜头后产生直射光束进入所述导光条内。

2. 根据权利要求1所述的导光装置，其特征在于，所述封闭壳体为不透光的密闭结构。

3. 根据权利要求1所述的导光装置，其特征在于，所述导光条包括：导光载体、反光纸和热缩管，所述反光纸为U型，一面开口为出光面。

4. 根据权利要求3所述的导光装置，其特征在于，所述导光载体的截面为正方形或长方形的条状物，其材料为PMMA材料，其表面披覆或包裹反光材料。

5. 根据权利要求3所述的导光装置，其特征在于，所述反光纸和/或热缩管的长度长于所述导光载体，形成容纳光源的空腔，使所述光源发出的光线无损失的进入到所述导光载体内。

6. 根据权利要求3所述的导光装置，其特征在于，所述导光载体的背对出光面外表面设置有白色MARK点作为漫反射光源。

7. 一种光学触控屏，包括：显示画面的显示装置，其特征在于，还包括上述权利要求1-6任意一项权利要求中所述的实现光学触控屏光路的导光装置。

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一种实现光学触控屏光路的导光装置及光学触控屏

技术领域

[0001] 本实用新型涉及光学触控技术领域，更具体的说，是涉及一种实现光学触控屏光路的导光装置及光学触控屏。

背景技术

[0002] 目前，光学触控技术产品的光路实现主要是利用光源直接射入一种导光条，从而使这种导光条发出所需光线的自发光技术，即在导光条两端直接加 LED 灯作为光源，光线射入导光条，使导光条从光面发出所需光线形成摄像头扑捉图像的光路，因此，导光条的亮度对触控产品性能的影响至关重要。

[0003] 在上述使用的 LED 灯存在入射角度的问题，光线在导光条传输中因为多次反射会快速衰减，产生光线损失，导致导光条中间区域的光路亮度较弱，难以做到导光条的高亮度和一致性，具体原理，请见附图 1，为现有技术中光线触控技术产品中导光条的光路实现的结构示意图，由于 LED 光源设置在导光条两侧，光线经过导光条内反射衰减，导致导光条两端和中间的亮度不一致，出现两端亮中间暗的情况，而光学触控技术是使用摄像头扑捉光路的阴影变化产生图像计算遮挡物位置，光路暗的地方会影响定位精度。

[0004] 因此，本实用新型提供一种实现光学触控屏光路的导光装置及光学触控屏，以解决现有技术中光线衰减导致导光条中间区域的光路亮度较弱，难以做到导光条的高亮度和一致性，从而提高定位精度，是本领域技术人员亟待解决的问题。

实用新型内容

[0005] 有鉴于此，本实用新型提供一种实现光学触控屏光路的导光装置及光学触控屏，以解决现有技术中光线衰减导致导光条中间区域的光路亮度较弱，难以做到导光条的高亮度和一致性，从而提高定位精度的问题。

[0006] 为实现上述目的，本实用新型提供如下技术方案：

[0007] 一种实现光学触控屏光路的导光装置，包括：封闭壳体、设置在所述封闭壳体内腔中的导光条、设置在所述导光条两端的聚焦镜头及设置在所述封闭壳体两端的 LED 灯组件，所述聚焦镜头和所述 LED 灯组件设置在所述封闭壳体内，所述 LED 灯组件发出光线经所述聚焦镜头后产生直射光束进入所述导光条内。

[0008] 其中，所述封闭壳体为不透光的密闭结构。

[0009] 其中，所述导光条包括：导光载体、反光纸和热缩管，所述反光纸为 U 型，一面开口为出光面。

[0010] 其中，所述导光载体的截面为正方形或长方形的条状物，其材料为 PMMA 材料，其表面披覆或包裹反光材料。

[0011] 其中，所述反光纸和 / 或热缩管的长度长于所述导光载体，形成容纳光源的空腔，使所述光源发出的光线无损失的进入到所述导光载体内。

[0012] 其中，所述导光载体的背对出光面外表面设置有白色 MARK 点作为漫反射光源。

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[0013] 本实用新型还公开了一种光学触控屏，包括：显示画面的显示装置，还包括上述所述的实现光学触控屏光路的导光装置。

[0014] 经由上述的技术方案可知，与现有技术相比，本实用新型公开提供了一种实现光学触控屏光路的导光装置及光学触控屏，该导光装置包括：封闭壳体、设置在所述封闭壳体内腔中的导光条、设置在所述导光条两端的聚焦镜头及设置在所述封闭壳体两端的 LED 灯组件，所述聚焦镜头和所述 LED 灯组件设置在所述封闭壳体内，所述 LED 灯组件发出光线经所述聚焦镜头后产生直射光束进入所述导光条内。该导光装置的 LED 灯组件发出光线经聚焦镜头后产生直射光束，并且将 LED 灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路亮度与两端保持一致，提高导光条的亮度和一致性，进而保证定位精度。

附图说明

[0015] 为了更清楚地说明本实用新型实施例或现有技术中的技术方案，下面将对实施例或现有技术描述中所需要使用的附图作简单地介绍，显而易见地，下面描述中的附图仅仅是本实用新型的实施例，对于本领域普通技术人员来讲，在不付出创造性劳动的前提下，还可以根据提供的附图获得其他的附图。

[0016] 图 1 为现有技术中光线触控技术产品中导光条的光路实现的结构示意图；

[0017] 图 2 为本实用新型实施例公开的一种实现光学触控屏光路的导光装置的结构示意图；

[0018] 图 3 为本实用新型实施例公开的导光条的剖视结构示意图；

[0019] 图 4 为本实用新型实施例公开的导光条的主视结构示意图。

具体实施方式

[0020] 下面将结合本实用新型实施例中的附图，对本实用新型实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本实用新型一部分实施例，而不是全部的实施例。基于本实用新型中的实施例，本领域普通技术人员在没有做出创造性劳动前提下所获得的所有其他实施例，都属于本实用新型保护的范围。

[0021] 本实用新型公开提供了一种实现光学触控屏光路的导光装置及光学触控屏，该导光装置包括：封闭壳体、设置在封闭壳体内腔中的导光条、设置在导光条两端的聚焦镜头及设置在封闭壳体两端的 LED 灯组件，聚焦镜头和 LED 灯组件设置在封闭壳体内，LED 灯组件发出光线经聚焦镜头后产生直射光束进入导光条内。该导光装置的 LED 灯组件发出光线经聚焦镜头后产生直射光束，并且将 LED 灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路亮度与两端保持一致，提高导光条的亮度和一致性，进而保证定位精度。

[0022] 请参阅附图 2，为本实用新型实施例公开的一种实现光学触控屏光路的导光装置的结构示意图。本实用新型实施例公开了一种实现光学触控屏光路的导光装置，该导光装置包括：封闭壳体 1、设置在封闭壳体 1 内腔中的导光条 2、设置在导光条 2 两端的聚焦镜头 3 及设置在封闭壳体 1 两端的 LED 灯组件 4，聚焦镜头 3 和 LED 灯组件 4 设置在封闭壳体 1 内，LED 灯组件 4 发出光线经聚焦镜头 3 后产生直射光束进入导光条 2 内。该导光装置的

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LED 灯组件发出光线经聚焦镜头后产生直射光束，并且将 LED 灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路亮度与两端保持一致，提高导光条的亮度和一致性，进而保证定位精度。

[0023] 优选的，上述所述封闭壳体 1 为不透明的密闭结构，保证 LED 灯发出的光线全部经过聚焦镜头，防止 LED 发出光线损失，最大量的变为直线光线，射进导光条内。

[0024] 优选的，请参阅附图 3 和附图 4，图 3 为本实用新型实施例公开的导光条的剖视结构示意图，图 4 为本实用新型实施例公开的导光条的主视结构示意图。上述所述导光条 2 包括：导光载体 5、反光纸 6 和热缩管 7，反光纸 6 为 U 型，一面开口为出光面，导光载体 5 的截面为正方形或长方形的条状物，其材料为 PMMA 材料或其他高透光材料，其表面披覆或包裹反光材料，将反光纸 6 和 / 或热缩管 7 的长度长于导光载体 5，形成容纳光源的空腔，使光源发出的光线无损失的进入到导光载体 5 内，导光载体 5 的背对出光面外表面设置有白色 MARK 点作为漫反射光源。

[0025] 上述公开的实现光学触控屏光路的导光装置的原理：LED 灯组件发出光线经聚焦镜头后产生直射光束，并且将 LED 灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路亮度与两端保持一致，提高导光条的亮度和一致性，进而保证定位精度。

[0026] 在上述公开的一种实现光学触控屏光路的导光装置的基础上，本实用新型还公开了一种光学触控屏，该光学触控屏包括：显示画面的显示装置，还包括上述所述的实现光学触控屏光路的导光装置。

[0027] 综上所述，本实用新型公开提供了一种实现光学触控屏光路的导光装置及光学触控屏，该导光装置包括：封闭壳体、设置在封闭壳体内腔中的导光条、设置在导光条两端的聚焦镜头及设置在封闭壳体两端的 LED 灯组件，聚焦镜头和 LED 灯组件设置在封闭壳体内，LED 灯组件发出光线经聚焦镜头后产生直射光束进入导光条内。该导光装置的 LED 灯组件发出光线经聚焦镜头后产生直射光束，并且将 LED 灯组件放置于不透光的封闭壳体内，使光线不会产生损失，光束在导光条中传输时，衰减会变小，使导光条中间区域的光路亮度与两端保持一致，提高导光条的亮度和一致性，进而保证定位精度。

[0028] 对所公开的实施例的上述说明，使本领域专业技术人员能够实现或使用本实用新型。对这些实施例的多种修改对本领域的专业技术人员来说将是显而易见的，本文中所定义的一般原理可以在不脱离本实用新型的精神或范围的情况下，在其它实施例中实现。因此，本实用新型将不会被限制于本文所示的这些实施例，而是要符合与本文所公开的原理和新颖特点相一致的最宽的范围。

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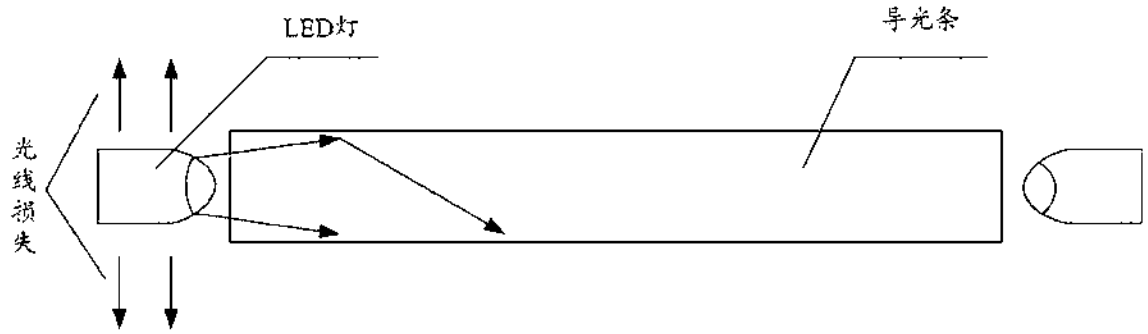


图 1

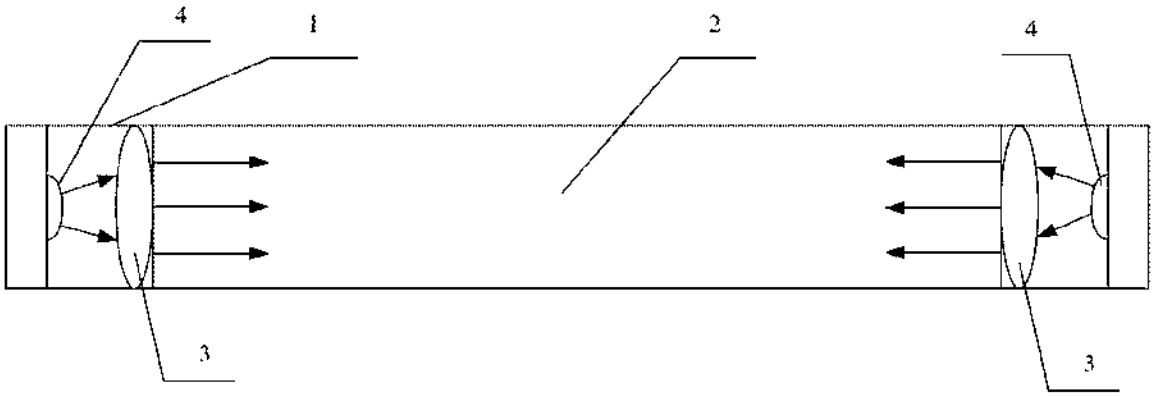


图 2

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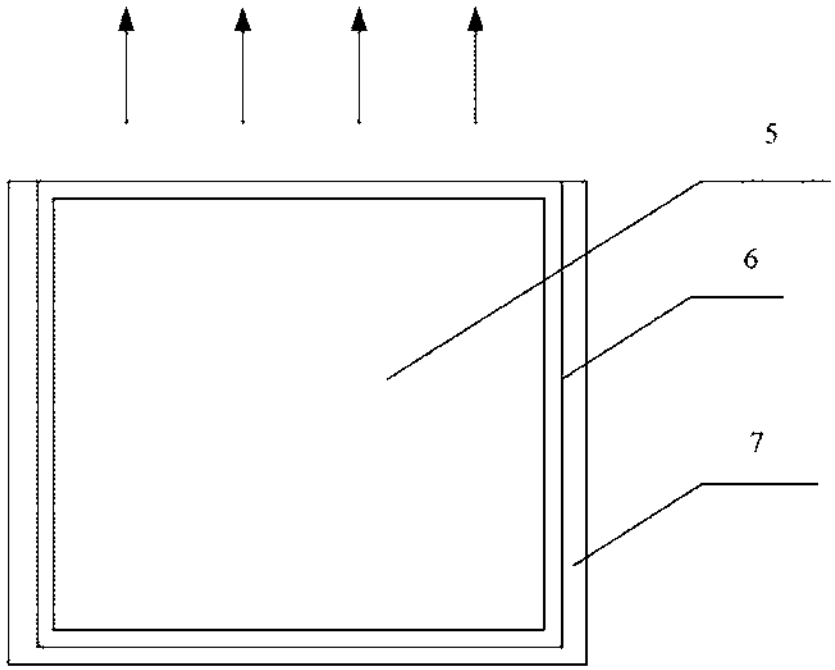


图 3

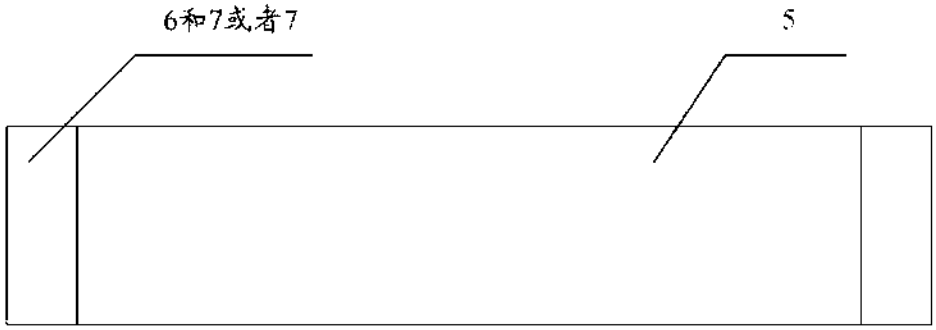


图 4

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Espacenet

CN205384833U Intelligent tourism electron photo holder frame

Applicants: CHANGSHA ENV PROT COLLEGE

Inventors: DUAN XILIAN

Classifications:
IPC ***G06F3/041; G09F9/00;***

Priorities: CN201620191664U 2016-03-06

Application: CN205384833U 2016-03-06

Publication: CN205384833U 2016-07-13

Published as: CN205384833U

Intelligent tourism electron photo holder frame

Abstract

The utility model discloses an intelligent tourism electron photo holder frame, including base (1), support (4) and photo holder frame main part, on the base that the support set up, be equipped with the horizontally pivot in the photo holder frame main part, the pivot is installed on the support, and the rotation of axes can be revoluted to the photo holder frame main part on the support, the front of photo holder frame main part is touch display screen (5), be equipped with a plurality of buttons (3) on the base, photo holder frame main part top is equipped with lens hood (8) and lighting device, and lighting device includes that it covers (10) to follow LED lamp strip (9) and the printing opacity arranged at photo holder frame main part top border, be equipped with on the base and be used for opening and closing the switch of LED lamp strip and the light adjusting knob who is used for adjusting the luminance of LED lamp strip, the both sides of photo holder frame main part are equipped with the speaker. This intelligent tourism electron photo holder frame integrated level is high, the function is abundant, easily promote implementation, still has desk lamp illumination function, and the practicality is strong.

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(12)实用新型专利

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(51)Int.Cl.
G09F 9/00(2006.01)
G06F 3/041(2006.01)

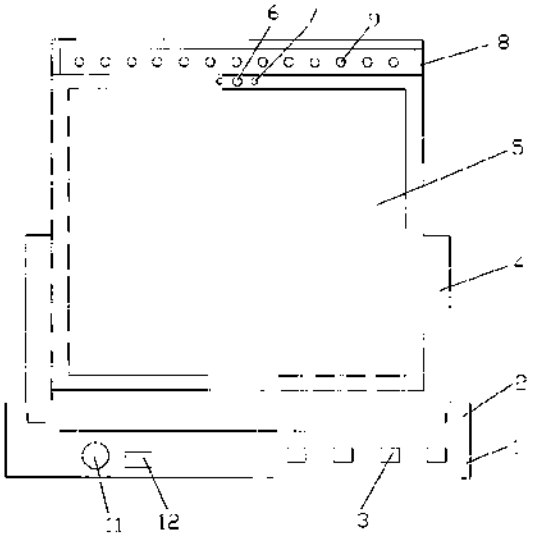
权利要求书1页 说明书2页 附图2页

(54)实用新型名称

智能型旅游电子相框

(57)摘要

本实用新型公开了一种智能型旅游电子相框，包括底座(1)、支架(4)和相框主体；支架设置的底座上，相框主体上设有水平的转轴，转轴安装在支架上，相框主体能在支架上绕转轴旋转；相框主体的正面为触摸显示屏(5)；底座上设有多个按键(3)；相框主体顶部设有遮光罩(8)和照明装置，照明装置包括沿相框主体顶部边沿布置的LED灯条(9)和透光罩(10)；底座上设有用于开启和关闭LED灯条的开关和用于调节LED灯条亮度的调光旋钮；相框主体的两侧设有扬声器。该智能型旅游电子相框集成度高、功能丰富、易于推广实施，还具有台灯照明功能，实用性强。



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1. 一种智能型旅游电子相框，其特征在于，包括底座(1)、支架(4)和相框主体；支架设置的底座上，相框主体上设有水平的转轴，转轴安装在支架上；

相框主体的正面为触摸显示屏(5)；

底座上设有多个按键(3)；

相框主体顶部设有遮光罩(8)和照明装置，照明装置包括沿相框主体顶部边沿布置的LED灯条(9)和透光罩(10)；底座上设有用于开启和关闭LED灯条的开关和用于调节LED灯条亮度的调光旋钮；

相框主体的两侧设有扬声器；

底座中还集成有蓝牙通信模块、WIFI通信模块、3G或4G通信模块；

底座内还设有电池和存储器。

2. 根据权利要求1所述的智能型旅游电子相框，其特征在于，所述的底座上还设有光驱(2)；相框主体的背面设有后置摄像头。

3. 根据权利要求1或2所述的智能型旅游电子相框，其特征在于，相框主体的顶部的边沿处还设有前置摄像头(6)和闪光灯(7)；闪光灯为2个。

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智能型旅游电子相框

技术领域

[0001] 本实用新型涉及一种智能型旅游电子相框。

背景技术

[0002] 现有的旅游纪念相框的功能较为单一，一般具有静态的非电子的画面，展示风光和当地人文的功能较为单一；而普通的电子相框，虽然比较成熟，但是只具备相框功能，不具有其他的辅助的实用功能，因此，为了丰富旅游纪念品市场，以及为了改善普通电子相框的功能，有必要设计一种智能型旅游电子相框。

实用新型内容

[0003] 本实用新型所要解决的技术问题是提供一种智能型旅游电子相框，该智能型旅游电子相框集成度高、功能丰富、易于推广实施，具有台灯功能。

[0004] 实用新型的技术解决方案如下：

[0005] 一种智能型旅游电子相框，包括底座1、支架4和相框主体；支架设置的底座上，相框主体上设有水平的转轴，转轴安装在支架上，相框主体能在支架上绕转轴旋转；

[0006] 相框主体的正面为触摸显示屏5；

[0007] 底座上设有多个按键3；

[0008] 相框主体顶部设有遮光罩8和照明装置，照明装置包括沿相框主体顶部边沿布置的LED灯条9和透光罩10；底座上设有用于开启和关闭LED灯条的开关和用于调节LED灯条亮度的调光旋钮；透光罩固定在LED灯条的前方；

[0009] 相框主体的两侧设有扬声器；

[0010] 底座中还集成有蓝牙通信模块、WiFi通信模块、3G或4G通信模块；

[0011] 底座内还设有电池和存储器。电池用于为触摸显示屏等模块供电，底座与相框主体的导电为现有成熟技术，存储器用于存储视频、图片等电子资料。

[0012] 所述的底座上还设有光驱2；相框主体的背面设有后置摄像头。

[0013] 相框主体的顶部的边沿处还设有前置摄像头6和闪光灯7；闪光灯为2个。

[0014] 相框主体的背面设有太阳能电池板；智能型旅游电子相框摆在书桌上能获取太阳能为电池充电。

[0015] 相框主体上还设有扬声器，底座上还设有SD卡插口、USB插口等，用于连接U盘或SD卡，USB接口还可以为手机等电子产品充电，底座上还设有连接充电器的充电接口，为电池充电。

[0016] 有益效果：

[0017] 本实用新型的智能型旅游电子相框，首先相框主体能相对底座旋转，即能调整屏幕角度，便于使用者获得最佳的观赏视角，通过触摸显示屏，使用者能查看图片、视频，能获得全方位的对于旅游区的视听感受，光驱能播放关于旅游区的DVD，USB接口和SD卡插口便于使用者导入和导出多媒体资料，摄像头以及WiFi、3G、4G模块的配置，使得该智能型旅游

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电子相框能在家里进行视频聊天，访问互联网等，太阳能电池板的采用，能进一步节约能耗。另外，本实用新型的一大特色就是照明功能，遮光罩、灯条以及透光罩与可旋转的相框主体相适配，再加上能调光，非常适合作为台灯使用，非常方便家庭和办公室使用。遮光罩能防止光线向左右发散，增强照明效果，遮光罩还便于改善屏幕的显示效果。总而言之，这种智能型旅游电子相框功能丰富，集成度高，制造成本低，方便实用，是一种展示效果丰富的旅游纪念品，还兼具台灯照明功能，结构新颖，构思巧妙。

附图说明

[0018] 图1是本实用新型的智能型旅游电子相框的总体结构示意图；

[0019] 图2是灯罩以及照明模块的结构及位置关系示意图(剖面图)。

[0020] 标号说明：1-底座，2-光驱，3-按键，4-支架，5-触摸显示屏，6-前置摄像头，7-闪光灯，8-遮光罩，9-LED灯条，10-透光罩，11-调光旋钮，12-开关。

具体实施方式

[0021] 以下将结合附图和具体实施例对本实用新型做进一步详细说明：

[0022] 实施例1：

[0023] 如图1-2所示，一种智能型旅游电子相框，包括底座1、支架4和相框主体；支架设置的底座上，相框主体上设有水平的转轴，转轴安装在支架上，相框主体能在支架上绕转轴旋转；

[0024] 相框主体的正面为触摸显示屏5；

[0025] 底座上设有4个按键3；

[0026] 相框主体顶部设有遮光罩8和照明装置，照明装置包括沿相框主体顶部边沿布置的LED灯条9和透光罩10；底座上设有用于开启和关闭LED灯条的开关和用于调节LED灯条亮度的调光旋钮；

[0027] 相框主体的两侧设有扬声器；

[0028] 底座中还集成有蓝牙通信模块、WiFi通信模块、3G和4G通信模块；

[0029] 底座内还设有电池和存储器。电池用于为触摸显示屏等模块供电，底座与相框主体的导电为现有成熟技术，存储器用于存储视频、图片等电子资料。

[0030] 所述的底座上还设有光驱2；相框主体的背面设有后置摄像头。

[0031] 相框主体的顶部的边沿处还设有前置摄像头6和闪光灯7；闪光灯为2个。

[0032] 相框主体的背面设有太阳能电池板；智能型旅游电子相框摆在书桌上能获取太阳能为电池充电。

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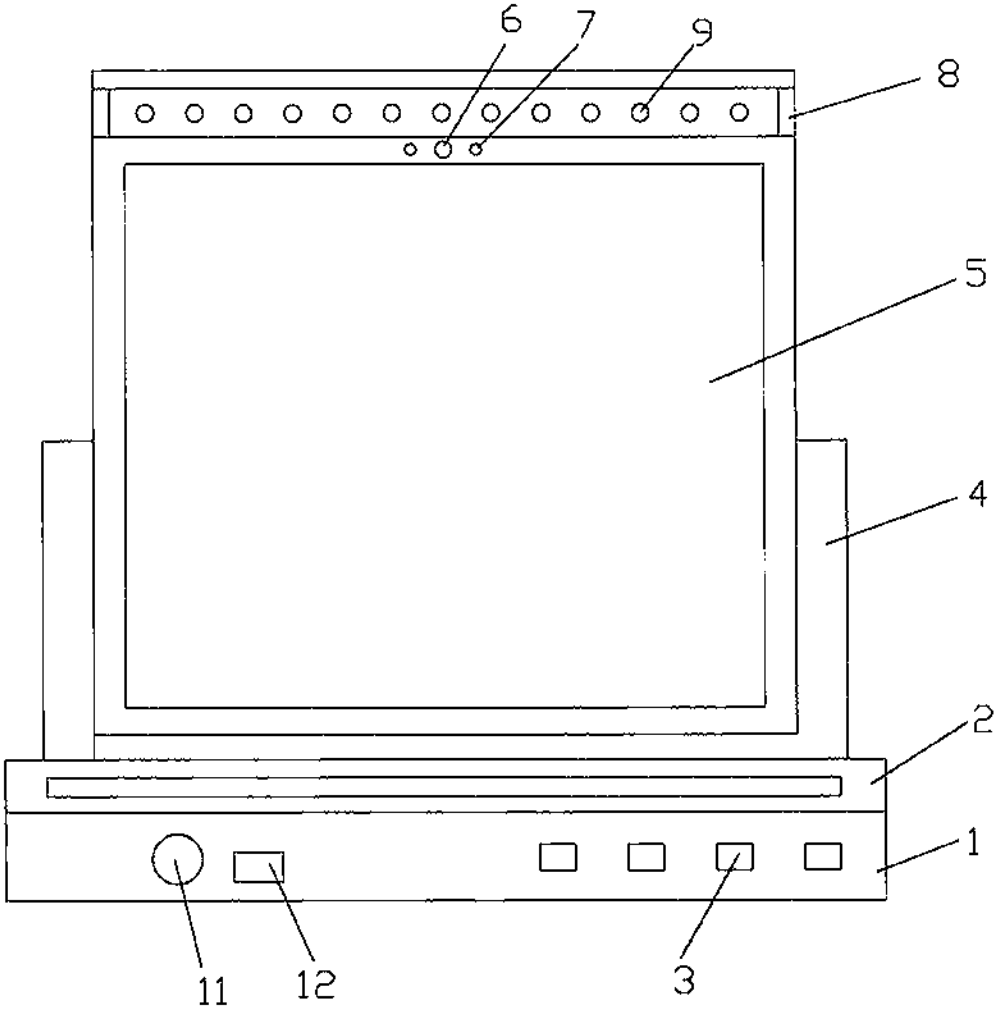


图1

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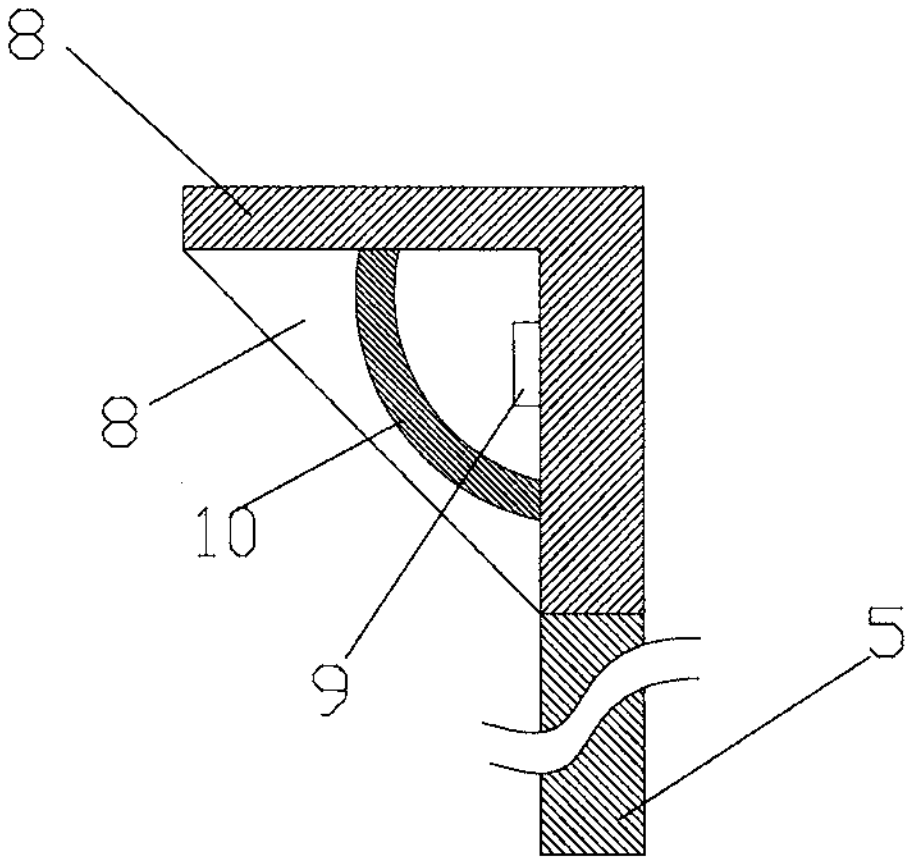


图2

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Espacenet

JPH05190066A LIGHT SHIELDING PLATE DEVICE OF TOUCH SWITCH

Applicants: MATSUSHITA ELECTRIC IND CO LTD

Inventors: AIMONO JIRO

Classifications:

IPC ***G06F3/03; G06F3/042; H01H35/00; H03K17/78; H03K17/96;*** (IPC1-7): G06F3/03; H01H35/00; H03K17/78; H03K17/96;

Priorities: JP459592A 1992-01-14

Application: JPH05190066A 1992-01-14

Publication: JPH05190066A 1993-07-30

Published as: JPH05190066A

LIGHT SHIELDING PLATE DEVICE OF TOUCH SWITCH

Abstract

PURPOSE:To separate a light shielding plate without damaging parts even if trouble is generated in a light receiving element while preventing backlash by providing an optical element holder with a projection for fitting while providing the light shielding plate with a hole for positioning and fitting and a spring part. CONSTITUTION:After mounting an optical element holder 2 a printed board 3 a luminous element 4 and light-receiving element 5 are inserted into the board 3 while from thereabove a light shielding plate 1 is fitted along the outline of the holder 2. Then, degrees of freedom in the X, Y directions are regulated by fitting the projections 22, 23 of a holder 2 into a hole 12 for positioning and an elliptic hole 13 for stopping rotation respectively. Further, a degree of freedom in the Z-direction for an angle hole 14 positioned between the notches 15 is regulated by getting over a projection 24 having a wedge type sectional shape for float-stopping in the Z-direction. Further, a spring part 16 removes the backlash by pressing-down of the elements 4, 5 while eliminating its own backlash by the reaction. In the case of separating the plate 1 from the holder 2, it can be simply done by taking off the hole from the projection 24.

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Ｇ０６Ｆ　3/03	３３０	Ｆ　7927－5Ｂ		
Ｈ０３Ｋ　17/78		Ｎ　7827－5Ｊ		
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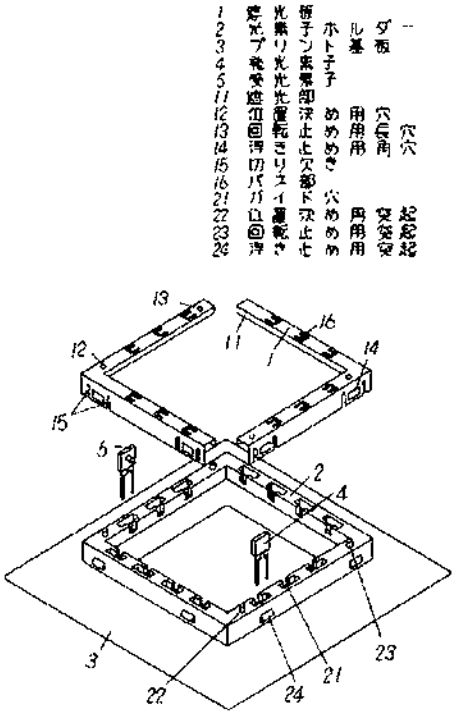
(74)代理人　弁理士　小鍜治　明　（外２名）

(54)【発明の名称】　タッチスイッチの遮光板装置

(57)【要約】

【目的】　プリント基板に電子部品と同じ方向から組み込める受発光素子のガイド用ホルダーと遮光板を取りつけ、受発光素子の部品交換時に部品を破壊することなくホルダーと遮光板とを分離しかつ、嵌め合わせ特有のガタのない構造をしたタッチスイッチの遮光板装置を提供することを目的とする。

【構成】　光素子ホルダー２に位置決め用突起２２と回転止め用突起２３を有し、かつ遮光板１に位置決め用穴１２と回転止め用長穴１３とを設け、それらの突起と穴とを嵌合させることによりＸ、Ｙ方向の動きを規制し、光素子ホルダー２の側面に浮き止め用突起２４と遮光板１の側面に浮き止め用角穴１４とを設け、その突起と角穴とを嵌合させることによりＺ方向の浮きを規制して接合・分離するとともに、バネ部１６にて発光素子４、受光素子５を押さえることにより遮光板１も同時にガタをなくすことができる。



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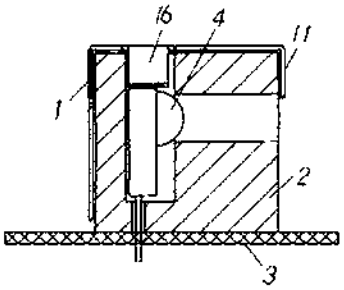
【特許請求の範囲】
【請求項１】　プリント基板上に受発光素子の姿勢をガイドする枠状の光素子ホルダーを設け、前記光素子ホルダーには嵌合用の突起を設け、前記光素子ホルダーの上から受発光素子を押さえかつ光軸方向以外の方向からの光を遮る遮光板を設け、この遮光板に位置決め嵌合用の穴を設けるとともにバネ性を付加してなるタッチスイッチの遮光板装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は画像表示装置に使用される光センサー方式のタッチスイッチの遮光板装置に関する。
【０００２】
【従来の技術】近年、コンピュータ用端末とか、車載用オーディオ・ビジュアル機器の入力装置としてタッチスイッチが広く利用されている。
【０００３】以下に従来のタッチスイッチの遮光板装置について、図面を参照しながら説明する。
【０００４】図３に示すように、従来のタッチスイッチ装置はプリント基板３に取りつけられた枠状の光素子ホルダー２に発光素子４がマウントされるとともに、遮光部１１を有する遮光板１が枠状になってカバーされている。
【０００５】以上のように構成された従来のタッチスイッチ装置の遮光板１は、光素子ホルダー２に取りつけるために接着するような方法がとられていた。
【０００６】
【発明が解決しようとする課題】しかしながら上記従来の構成では、受発光素子にトラブルが発生した場合メンテナンスできないという問題点を有していた。
【０００７】本発明は上記従来の問題点を解決するもので、受発光素子にトラブルが発生しても部品を破損することなく光素子ホルダーから遮光板を分離できかつ、受発光素子および光素子ホルダーとの取りつけ時のガタをなくしたタッチスイッチの遮光板装置を提供することを目的とする。
【０００８】
【課題を解決するための手段】上記目的を達成するために本発明のタッチスイッチの遮光板装置は、光素子ホルダーには嵌合用の突起を設け、遮光板のほうには位置決め嵌合用の穴と部品同士のガタを防ぐバネ部とを設けた構成を有している。
【０００９】
【作用】本発明は上記した構成において、光素子ホルダーに上から被せるだけで接合でき、受発光素子の交換が必要になったときも遮光板と光素子ホルダーとを容易に分離できることとなる。
【００１０】
【実施例】以下本発明の一実施例について、図面を参照しながら説明する。図１に示すように本実施例のタッチスイッチ装置は、遮光板１に設けられた遮光部１１、位置決め用穴１２、回転止め用長穴１３、Ｚ方向の浮き止め用角穴１４、切り欠き１５、バネ部１６などを設け、一方、光素子ホルダー２には、受発光素子のガイド穴２１、遮光板の位置決め用突起２２、遮光板の回転止め用突起２３、Ｚ方向の浮き止め用突起２４などを設け、プリント基板３にとりつけられている。ここで発光素子４と受光素子５が光素子ホルダー２に取りつけられている。
【００１１】以上の構成要素よりなるタッチスイッチ装置の遮光板について、図１，２を用いてその作用を説明する。
【００１２】まず、プリント基板３に光素子ホルダー２を取りつけたあとで、発光素子４および受光素子５を挿入する。その上から遮光板１を光素子ホルダー２の外形に沿って嵌め込む。位置決め用穴１２、回転止め用長穴１３がそれぞれ光素子ホルダー２の突起２２，２３と嵌合することによりＸ，Ｙ方向の自由度が規制される。また、切り欠き１５に挟まれた角穴１４は、楔形の断面形状をもつＺ方向の浮き止め用突起２４を乗り越えることによってＺ方向の自由度が規制される。ここで、切り欠き１５は遮光板を変形させないためのものである。
【００１３】また、バネ部１６は発光素子４および受光素子５を押さえてそのガタをなくしかつ、その反力で自身のガタをもなくすることができる。
【００１４】さらに、光素子ホルダー２と遮光板１とを分離する場合は角穴１４を浮き止め用突起２４からはずせば簡単に分離できる。
【００１５】
【発明の効果】以上の実施例から明らかなように本発明によれば、プリント基板に電子部品と同じ方向から実装できるので自動組み立てに対応でき、また、接合の解除や再接合も容易に行え、嵌め合わせにて発生するガタをなくすことができるという優れたタッチスイッチの遮光板装置を実現できるものである。
【図面の簡単な説明】
【図１】本発明の一実施例のタッチスイッチ装置の斜視図
【図２】同タッチスイッチ装置の遮光板の断面図
【図３】従来のタッチスイッチ装置の遮光板の断面図
【符号の説明】
１　遮光板
２　光素子ホルダー
３　プリント基板
４　発光素子
５　受光素子
１６　バネ部

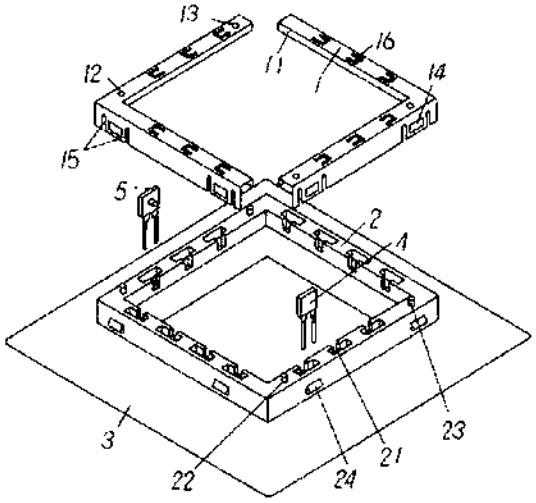
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【図１】

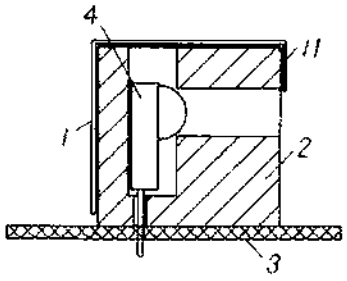
1 ケース
2 ダボ
3 ホトダイオード
4 ホトトランジスタ
5 光ファイバ
11 位置決め穴
12 位置決め穴
13 位置決め穴
14 位置決め穴
15 位置決め穴
16 位置決め穴
21 起き上がり防止突起
22 起き上がり防止突起
23 起き上がり防止突起
24 起き上がり防止突起

【図２】





【図３】



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Espacenet

WO2014044181A1 INFRARED TOUCH SCREEN

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Inventors: LIU XINBIN [CN],SHANG XIAODONG [CN],WU YANGQUN [CN]

Classifications:
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CPC **G06F3/0428 (EP);**

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INFRARED TOUCH SCREEN

Abstract

An infrared touch screen, comprising a frame and a touch panel (13); the frame comprises a casing (11) and a circuit board (12); the casing (11), the circuit board (12) and the touch panel (13) are sequentially superimposed; the circuit board (12) is provided with an electronic component (14) and an infrared emitting/receiving element (15) thereon; the infrared emitting/receiving element (15) is located between the circuit board (12) and the touch panel (13). The infrared touch screen is utilized to avoid the loss of the infrared light emitted by an infrared emitting element, thus intensifying the infrared light emitted by the infrared emitting element.

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(81) 指定国 (除另有指明，要求每一种可提供的国家保护)：AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, ML, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

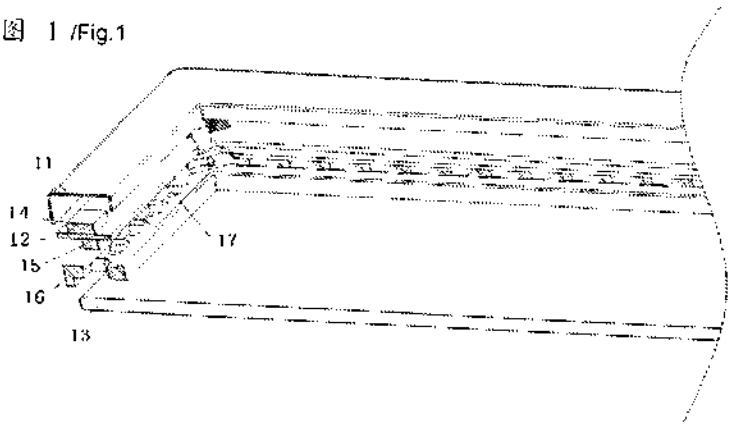
(84) 指定国 (除另有指明，要求每一种可提供的地区保护)：ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE,

[见续页]

(54) Title: INFRARED TOUCH SCREEN

(54) 发明名称：红外触摸屏

图 1 /Fig.1



(57) Abstract: An infrared touch screen, comprising a frame and a touch panel (13); the frame comprises a casing (11) and a circuit board (12); the casing (11), the circuit board (12) and the touch panel (13) are sequentially superimposed; the circuit board (12) is provided with an electronic component (14) and an infrared emitting/receiving element (15) thereon; the infrared emitting/receiving element (15) is located between the circuit board (12) and the touch panel (13). The infrared touch screen is utilized to avoid the loss of the infrared light emitted by an infrared emitting element, thus intensifying the infrared light emitted by the infrared emitting element.

(57) 摘要：一种红外触摸屏，该红外触摸屏包括边框和触摸面板 (13)，所述边框包括外壳 (11) 和电路板 (12)，所述外壳 (11)、电路板 (12) 和触摸面板 (13) 依次叠加，所述电路板 (12) 上设置有电子元器件 (14) 和红外收发元件 (15)，其中，所述红外收发元件 (15) 位于所述电路板 (12) 和所述触摸面板 (13) 之间。利用该红外触摸屏避免了红外发射元件发出的红外光线的损失，使得红外发射元件发出的红外光线加强。

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IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)。

本国际公布：

— 包括国际检索报告(条约第21条(3))。

红外触摸屏

技术领域

本发明涉及一种红外触摸屏。

背景技术

红外触摸屏因为工作稳定、使用寿命长等优点，大量应用在各种环境中。

目前，红外触摸屏包括安装在显示器的前面的触摸面板和含有电路板的边框，所述触摸面板诸如可以由玻璃制成，并用于覆盖在显示器上，边框围在所述触摸面板的外侧，在边框内的电路板上除了要设置电子元器件，还在电路板的四条边的上方排布红外发射元件和红外接收管。一般情况下红外发射元件和红外接收管设置在边框的相对的两条边上，从而在边框围住的触摸面板上形成交叉的红外矩阵。用户在触摸红外触摸屏的触摸面板时，手指就会挡住经过该位置的横竖红外线，从而判断出触摸点在屏幕的位置。

然而，现有的红外触摸屏的电路板，红外发射元件和红外接收管都设置在电路板的上方，从红外发射元件发出的红外光线会由于散射而造成光强损失。

发明内容

针对现有技术中存在的上述问题，本发明提供了一种红外触摸屏，能够减少红外发射元件发出的红外光线的光强损失。

为达到上述目的，本发明采用如下技术方案：

一种红外触摸屏，该红外触摸屏包括边框和触摸面板，所述边框包括外壳和电路板，所述外壳、电路板和触摸面板依次叠加，所述电路板上设置有电子元器件和红外收发元件，其中，所述红外收发元件位于所述电路板与所述触摸面板之间。

优选地，所述电路板设置在所述触摸面板的边缘的内侧。

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优选地，所述电路板设置在所述触摸面板的外侧。

优选地，所述电子元器件和所述红外收发元件都位于所述电路板与所述触摸面板之间。

优选地，所述电子元器件位于所述电路板与所述外壳之间。

优选地，所述边框还包括透光框，所述透光框位于所述电路板与所述触摸面板之间。

优选地，所述透光框具有和所述红外收发元件相匹配的多个避位孔或避位槽。

优选地，所述红外收发元件包括红外接收元件和红外发射元件，所述边框还包括凸透镜，所述凸透镜位于所述边框的设置有所述红外接收元件的边的内侧。

利用本发明提供的红外触摸屏，由于将红外发射元件密封在电路板与触摸面板之间，一方面由于密封空间避免了红外发射元件发出的红外光线的损失，另一方面，触摸面板通常由透明玻璃制成，红外发射元件设置在电路板与触摸面板之间，使得红外发射元件发出的红外光线中照射到玻璃表面的光线可以被玻璃表面反射回红外发射元件，从而使得发出的红外光线加强。

附图说明

图 1 是根据本发明的触摸屏的结构的立体框图。

具体实施方式

下面将结合本发明实施例中的附图，对本发明实施例中的技术方案进行清楚、完整地描述，显然，所描述的实施例仅仅是本发明的一部分实施例，而不是全部的实施例。基于本发明中的实施例，本领域普通技术人员在没有做出创造性劳动的前提下所获得的所有其他实施例，都属于本发明保护的范围。

参考图 1，本发明提供了一种红外触摸屏，该红外触摸屏包括边框和触摸面板 13，所述边框包括外壳 11 和电路板 12，所述外壳 11、电路板 12 和触摸面板 13 依次叠加，所述电路板 12 上设置有电子元器件 14 和红外收

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发元件 15，其中，所述红外收发元件 15 位于所述电路板 12 与所述触摸面板 13 之间。

根据本发明的触摸屏，红外收发元件 15 设置在电路板 12 与所述触摸面板 13 之间，也就是设置在电路板 12 的下面，而不是在电路板 12 的上面，一方面由于将红外收发元件中的红外发射元件密封在电路板下方，例如密封在电路板与触摸面板 13 之间，避免了红外发射元件发出的红外光线的损失，另一方面，触摸面板 13 通常由透明玻璃制成，红外发射元件设置在电路板 12 的下面，使得红外发射元件发出的红外光线中照射到玻璃表面的光线可以被玻璃表面反射回红外发射元件，从而使得发出的红外光线加强。

根据一种实施方式，所述电路板 12 可以设置在所述触摸面板 13 的边缘的内侧。这样，在触摸面板 13 的上方依次叠加边框的电路板 12 和外壳 11，而不是像现有技术一样将边框设置到触摸面板 13 外并和触摸面板 13 搭接。其中，所述触摸面板 13 诸如可以由透明玻璃或胶合板等材料制成。利用该技术方案，通过将带有电路板 12 的边框设置在触摸面板 13 的边缘的内侧，也就是设置在触摸面板 13 的上方，而不是设置在触摸面板 13 的外侧，从而不再需要在边框上留出与触摸面板 13 搭接的区域，减少了边框的宽度，实现了超窄边框的触摸屏。

根据另一种实施方式，所述电路板 12 也可以设置在所述触摸面板 13 的外侧，例如可以通过搭接和触摸面板 13 相连接。这样由于带有电路板 12 的边框设置在触摸面板 13 的外侧，而不是设置在触摸面板 13 的上方，可以降低边框的高度，使得触摸屏的厚度变薄。

根据一种实施方式，所述电子元器件 14 和所述红外收发元件 15 可以都位于所述电路板 12 与所述触摸面板 13 之间。由于电子元器件 14 和红外收发元件 15 位于同一侧，可以减少电路板 12 的厚度，从而减少触摸屏边框的厚度。

根据另一种实施方式，所述电子元器件 14 可以位于所述电路板 12 与所述外壳 11 之间。此时，电子元器件 14 和红外收发元件 15 位于所述电路板 12 的两面。

优选地，所述边框还可以包括透光框 16，所述透光框 16 位于所述电路板 12 与所述触摸面板之间。所述透光框 16 可以具有和所述红外收发元

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件 15 相匹配的多个避位孔或避位槽 17，以用于将电路板 12 中的红外收发元件 15 容纳在该避位孔或避位槽 17 中。所述透光框 16 用于过滤除了红外光线以外的环境光，避免了环境光对触摸屏的干扰。

优选地，所述红外收发元件 15 包括红外接收元件和红外发射元件，所述边框还包括凸透镜，所述凸透镜位于所述边框的设置有所述红外接收元件的边的内侧。通过在红外接收元件的前方设置有凸透镜，能够将射入的红外光线进行汇聚，从而使得红外光线信号增强，进而可以提高红外触摸屏的性能。

利用本发明提供的红外触摸屏，由于将红外发射元件密封在电路板下，一方面由于密封空间避免了红外发射元件发出的红外光线的损失，另一方面，触摸面板通常由透明玻璃制成，红外发射元件设置在电路板的下面，使得红外发射元件发出的红外光线中照射到玻璃表面的光线可以被玻璃表面反射回红外发射元件，从而使得发出的红外光线加强。

以上所述，仅为本发明的具体实施方式，但本发明的保护范围并不局限于此，任何熟悉本领域技术的技术人员在本发明公开的技术范围内，可轻易想到的变化或替换，都应涵盖在本发明的保护范围之内。因此，本发明的保护范围应以所述权利要求的保护范围为准。

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权利要求

1、一种红外触摸屏，该红外触摸屏包括边框和触摸面板，所述边框包括外壳和电路板，所述外壳、电路板和触摸面板依次叠加，所述电路板上设置有电子元器件和红外收发元件，其特征在于，所述红外收发元件位于所述电路板与所述触摸面板之间。

2、根据权利要求 1 所述的红外触摸屏，其特征在于，所述电路板设置在所述触摸面板的边缘的内侧。

3、根据权利要求 1 所述的红外触摸屏，其特征在于，所述电路板设置在所述触摸面板的外侧。

4、根据权利要求 1 所述的红外触摸屏，其特征在于，所述电子元器件和所述红外收发元件都位于所述电路板与所述触摸面板之间。

5、根据权利要求 1 所述的红外触摸屏，其特征在于，所述电子元器件位于所述电路板与所述外壳之间。

6、根据权利要求 卜5 中任一项权利要求所述的红外触摸屏，其特征在于，所述边框还包括透光框，所述透光框位于所述电路板与所述触摸面板之间。

7、根据权利要求 6 所述的红外触摸屏，其特征在于，所述透光框具有和所述红外收发元件相匹配的多个避位孔或避位槽。

8、根据权利要求 1 所述的红外触摸屏，其特征在于，所述红外收发元件包括红外接收元件和红外发射元件，所述边框还包括凸透镜，所述凸透镜位于所述边框的设置有所述红外接收元件的边的内侧。

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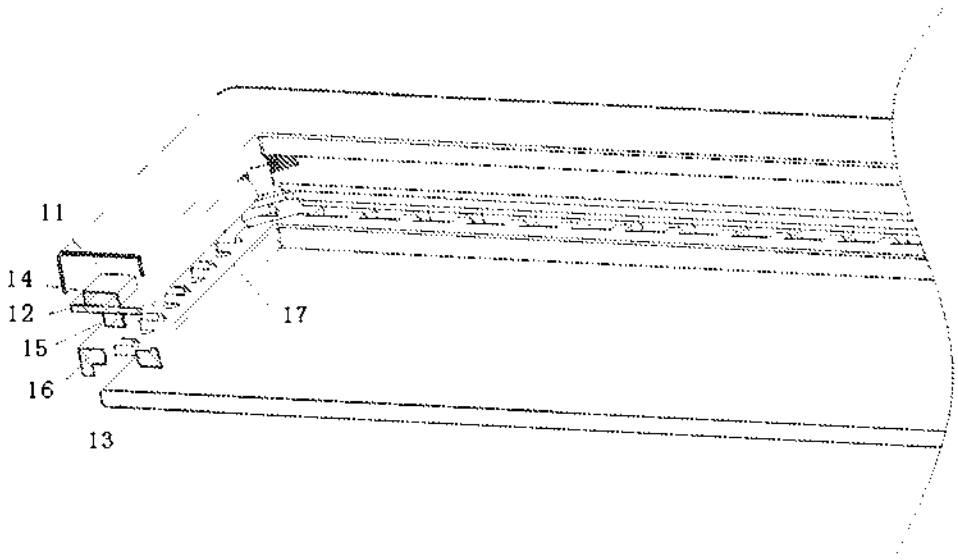


图 1

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INTERNATIONAL SEARCH REPORT

Intemational application No.
PCT/CN2013/083727

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/042 (2006.01) i

According to Intemational Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G06F 3/042

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, DWPI, SIPOABS: infrared, touch+, circuit 2d (board or plate or card)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 202771401 U (BEIJING IROUCH NEW TECHNOLOGY CO., LTD.) 06 March 2013 (06.03.2013) claims 1-8	1-8
X	CN 201000622 Y (HE, Wei) 02 January 2008 (02.01 .2008) description, page 4, embodiment 2 and figure 4	1-6
Y		7,8
Y	CN 102419667 A (BEIJING IROUCH NEW TECHNOLOGY CO., LTD.) 18 April 2012 (18.04.2012) description, paragraphs [0030]-[0032] and figures 1-3	7
Y	CN 201097368 Y (BEIJING IROUCH NEW TECHNOLOGY CO., LTD.) 06 August 2008 (06.08.2008) description, page 4 and figure 2	8
PX	CN 202677356 U (SHAOXING ARTS&SCI ACADEMY) 16 January 2013 (16.01 .2013) description, pages 1 and 2, figures 1 and 2	1-8
A	JP 5-189123 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 30 July 1993 (30.07.1993) the whole document	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 December 2013 (03.12.2013)	26 December 2013 (26.12.2013)
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer ZHENG, Lifen Telephone No. (86-10) 62414200

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN20 13/083727

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 202771401 U	06.03.2013	None	
CN 201000622 Y	02.01.2008	None	
CN 102419667 A	18.04.2012	EP 2587351 A2	01.05.2013
		KR 20130046341 A	07.05.2013
		US 2013106783 A1	02.05.2013
CN 201097368 Y	06.08.2008	None	
CN 202677356 U	16.01.2013	CN 102760014 A	31.10.2012
JP 5-189123 A	30.07.1993	None	

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国际检索报告

国际申请号
PCT/CN20 13/083727

A. 主题的分类

G06F 3/042 (2006.01) i

按照国际专利分类(ipC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: G06F3/042

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词 (如使用))

CNABS, DWPI, SIPOABS: 红外, 触摸，电路板，infrared, touch+, circuit 2d (board or plate or card)

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
PX	CN 202771401 U (北京汇冠新技术股份有限公司)06.3 月 2013 (06.03.2013) 权利要求 1-8	1-8
X	CN 201000622 Y (贺伟)02. 1 月 2008 (02.01.2008) 说明书第 4 页实施例 2，	1-6
Y	附图 4	7,8
Y	CN 102419667 A (北京汇冠新技术股份有限公司)18.4 月 2012 (18.04.2012) 说明书第 30 段至第 32 段，附图 1-3	7
Y	CN 201097368 Y (北京汇冠新技术有限公司)06.8 月 2008 (06.08.2008) 说明书第 4 页，附图 2	8
PX	CN 202677356 U (绍兴文理学院)16. 1 月 2013 (16.01.2013) 说明书第 1-2 页，附图 1-2	1-8
A	JP 5-189123 A (松下电器产业株式会社)30.7 月 1993 (30.07. 1993) 全文	1-8

☐ 其余文件在 C 栏的续页中列出。 ☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的¾¾之后公布的在先申请或赫 」

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件 (如具体说明的)

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相¾¾虫, 但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
03. 12 月 2013 (03. 12.2013)	26.12 月 2013 (26.12.2013)
ISA/CN 的名称和邮寄地址： 中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号： (86-10)62019451	受权官员 郑丽芬 电话号码：(86-10) 62414200

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国际检索报告

关于同族专利的信息

国际申请号
PCT/CN2013/083727

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN 202771401 U	06.03.2013	无	
CN 201000622 Y	02.01.2008	无	
CN 102419667 A	18.04.2012	EP 258735 1A2	01.05.2013
		KR 20130046341 A	07.05.2013
		US2013 106783 A I	02.05.2013
CN 201097368 Y	06.08.2008	无	
CN 202677356 U	16.01.2013	CN 102760014 A	31.10.2012
JP 5-189123 A	30.07. 1993	无	

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(19) World Intellectual Property Organization
International Bureau

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20 August 2015 (20.08.2015)

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(10) International Publication Number
WO 2015/123322 A1

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(21) International Application Number:
PCT/US20 15/0 1545 1

(22) International Filing Date:
11 February 2015 (11.02.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

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61/941,988	19 February 2014 (19.02.2014)	US
62/047,645	8 September 2014 (08.09.2014)	US

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(72) Inventors: **FILIZ, Sinan;** One Infinite Loop, MS: **83-T,** Cupertino, CA 95014 (US). **GRUNTHANER, Martin, P.;** One Infinite Loop, MS: **83-T,** Cupertino, CA 95014 (US). **SMITH, John, Stephen;** One Infinite Loop, MS: **83-T,** Cupertino, CA 95014 (US). **OGATA, Charley, T.;** One Infinite Loop, MS: **83-T,** Cupertino, CA 95014 (US). **SAUER, Christian, M.;** One Infinite Loop, MS: **83-T,** Cupertino, CA 95014 (US). **CHOI, Shin, John;** One Infinite Loop, MS: 83-T, Cupertino, CA 95014 (US). **BUTLER, Christopher, J.;** One Infinite Loop, MS: 83-T, Cupertino, CA 95014 (US). **MARTISAUSKAS, Steven, J.;** One Infinite Loop, MS: 83-T, Cupertino, CA 95014 (US).

(74) Agents: **HEMENWAY, S., Craig** et al; 410 Seventeenth Street, Suite 2200, Denver, CO 80202 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

[Continued on nextpage]

(54) Title: FORCE DETERMINATION EMPLOYING SHEET SENSOR AND CAPACITIVE ARRAY

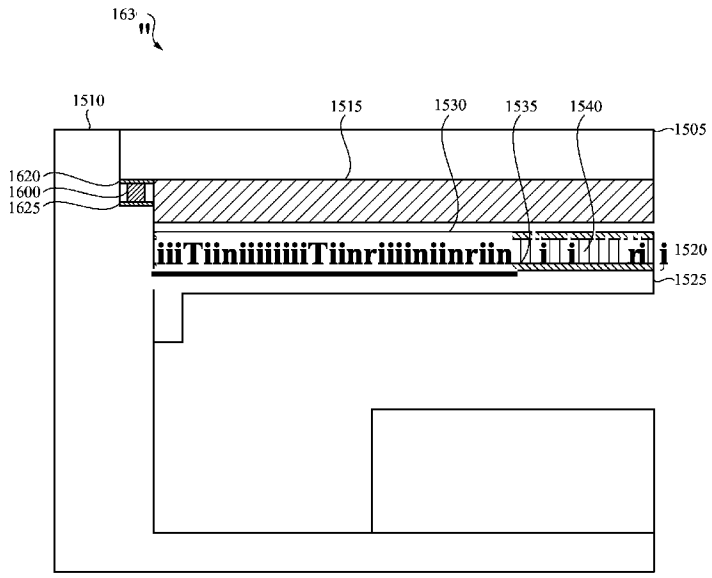


FIG. 16

(57) Abstract: A device configured to sense a touch on a surface of the device. The device includes a cover and a force-sensing structure disposed below the cover. The force-sensing structure may be positioned below a display and used in combination with other force-sensing elements to estimate the force of a touch on the cover of a device.

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SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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FORCE DETERMINATION EMPLOYING SHEET SENSOR AND CAPACITIVE ARRAY

Cross-Reference to Related Applications

[0001] This Patent Cooperation Treaty patent application claims priority to U.S. Provisional Patent Application No. 62/047,645, filed September 8, 2014 and titled "Force Determination Employing Sheet Sensors and Capacitive Array," U.S. Provisional Patent Application No. 61/941,988, filed February 19, 2014 and titled "Force Determination Employing Sheet Sensors and Capacitive Array," and U.S. Provisional Patent Application No. 61/939,252, filed February 12, 2014 and titled "Force Determination Employing Multiple Force-Sensing Structures," the disclosure of each of which is incorporated by reference in its entirety.

Technical Field

[0002] This application generally relates to systems and methods sensing the force of a touch, and in particular to a capacitive force sensor integrated with a device for detecting and measuring the amount or magnitude of a touch applied to a surface of the device.

Background

[0003] Touch devices can be generally characterized as devices that are capable of receiving touch input on the surface of the device. The input may include the location of one or more touches on the device, which may be interpreted as a command, gesture, or other type of user input. In one example, touch input on a touch device may be relayed to an a computing system and used to interpret user interaction with a graphical user interface (GUI), including, for example, selecting elements on a display, reorienting or repositioning elements on a display, entering text, and user input. In another example, touch input on a touch device may be relayed to a computer system and used to interpret a user's interaction with an application program. The user's interaction may include, for example, the manipulation of audio, video, photographs, presentations, text, and the like.

[0004] Typically, touch input on a touch device is limited to the location of a touch on the device. However, in some cases, it may be advantageous to also detect and measure the force of a touch that is applied to the device. For example, it might be advantageous for a user to be able to manipulate a computer-generated object on a display in a first way using a relatively light touch and, alternatively, interact with the object a second way using a relatively heavy or sharper touch. By way of example, it might be advantageous for a user to move a computer-generated object on the display using a relatively light touch and then, alternatively, select or invoke a command with respect to the same computer using a

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relatively heavy or sharper touch. More generally, it might be advantageous for the user to be able to provide input in multiple ways depending on the force of the touch. For example, a user may provide input that is interpreted a first way for a light touch, a second way for a medium touch, and a third way for a heavy touch, and so on. Additionally, it might be advantageous for the user to be able to provide an analog input using a varying amount of force. This type of input may be useful for controlling, for example, a gas pedal on a simulated car or a control surface of an airplane in a flight simulator, or similar applications. It may be further advantageous for the user to be able to provide input, such as simulated body movements or otherwise, in a virtual reality (VR) simulation (possibly with haptic feedback), or in an augmented reality program. It might be further advantageous to use the force of a touch to interpret the relative degree (e.g., force) and locations of multiple touches that are provided to multiple user interface objects or elements that are in use on a touch device at the same time. For example, the force of a touch could be used to interpret multiple touches due to a user pressing more than one element in an application for playing a musical instrument. In particular, the force of multiple touches may be used for interpreting multiple touches by a user on the keys of a piano. Similarly, the force of multiple touches can be used to interpret a user's multiple touches in an application for controlling a motor vehicle (having separate controls for accelerating, braking, signaling, and turning).

Summary

[0005] This application provides techniques, which can be used to measure or determine the amount or magnitude of force applied, and changes in the amount or magnitude of force applied, by a user contacting a touch device (such as a touch-sensitive surface, one example of which is a touch display), or other pressure-sensitive input elements (such as a virtual analog control or keyboard), or other input device. These techniques can be incorporated into various devices using touch recognition, touch elements of a GUI, and touch input or manipulation in an application program, such as touch devices, touch pads, and touch screens. This application also provides systems and techniques that can be used to measure or determine the amount or magnitude of force applied, and changes in the amount or magnitude of force applied, by the user when contacting a touch device, and in response thereto, provide additional functions available to a user of a touch device.

[0006] Certain embodiments described herein are directed to a force sensor, also referred to as a "force-sensing structure" or a "force sensitive sensor." The force sensor may be integrated with the housing of an electronic device, one example of which is a touch sensitive electrical device or simply a touch device. A sample force sensor may include an upper portion and a lower portion separated by a compressible element or by an air gap.

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The upper portion may include an upper body connected to an upper capacitive plate and the lower portion may include a lower body connected to a lower capacitive plate. In some cases, the upper portion and the lower portion form a capacitor that can be used to measure or detect an amount or magnitude of applied force. The compressible element is typically formed form a compliant or springy material. In some cases, the compressible element is referred to as a "deformable middle body," an intermediate element, or a "compressible layer." In some cases, the force sensor includes other force-sensing elements, such as a resistive strain gauge, piezoelectric element, and the like.

[0007] Some example embodiments are directed to an electronic device having a cover, a display positioned below the cover, and a force-sensing structure disposed below the display. The force-sensing structure may include an upper capacitive plate, a compressible element disposed on one side of the upper capacitive plate, and a lower capacitive plate disposed on a side of the compressible element that is opposite the upper capacitive plate. The force-sensing structure may also include a plate affixed to and supporting the force-sensing structure. In some embodiments, the electronic device also includes sensing circuitry that is operatively coupled to the force-sensing structure. The sensing circuitry may be configured to estimate the force of a touch on the cover based on a change in capacitance between the upper capacitive plate and the lower capacitive plate of the force-sensing structure.

[0008] In some embodiments, the force-sensing structure is separated from the display by a compliant layer including an air gap. In some cases, the force-sensing structure is separated from the display by a compliant layer comprised of compressible foam. The force-sensing structure may be separated from the display by a compliant layer comprised of an array of compliant pillars and an optically transparent fluid.

[0009] In some embodiments, the electronic device also includes a housing having a bezel surrounding the cover and a gasket disposed in a gap between the cover and the bezel. The device may also include an oleophobic coating disposed over at least a portion of the gap.

[0010] Some example embodiments are directed to an electronic device including a housing, a cover disposed within an opening of the housing, and a strain-sensitive gasket disposed between the cover and the housing along a perimeter of the cover. The device may also include a force-sensing structure disposed below the cover. The device may also include a plate fixed relative to the housing and supporting the force-sensing structure. In some cases, the strain-sensitive gasket includes a gasket upper capacitive plate, a gasket

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lower capacitive plate, and a gasket compressible element disposed between the gasket upper capacitive plate and the gasket lower capacitive plate.

[0011] In some embodiments, the electronic device also includes a display disposed between the cover and the force-sensing structure, and a compressible layer comprising an air gap between the display and the force-sensing structure. In some implementations, the air gap of the compressible layer is configured to at least partially collapse in response to a force of a touch that exceeds a first threshold. The first threshold may be less than a second threshold that corresponds to a maximum force that can be detected by the strain-sensitive gasket.

[0012] In some embodiments, the electronic device also includes a display disposed between the cover and the force-sensing structure, and a compressible layer between the display and the force-sensing structure. In some cases, the compressible layer may be configured to at least partially collapse in response to a force of a touch that exceeds a first threshold. The first threshold may be less than a second threshold that corresponds to a maximum force that can be detected by the strain-sensitive gasket.

[0013] In some embodiments, the force-sensing structure includes: an upper capacitive plate, a lower capacitive plate; and a compressible element disposed between the upper capacitive plate and the lower capacitive plate. In some embodiments, the force-sensing structure includes a strain gauge and/or a piezoelectric element.

[0014] Some example embodiments are directed to an electronic device including a cover, a capacitive sense layer positioned below the cover, and a compressible layer below the capacitive sense layer. In some embodiments, the compressible layer comprises an air gap. The electronic device may also include a force-sensing structure disposed below the compressible layer, which includes an upper capacitive plate, a compressible element disposed on one side of the upper capacitive plate, and a lower capacitive plate disposed on a side of the compressible element that is opposite the upper capacitive plate. Some embodiments include a plate positioned below the force-sensing structure and supporting the force-sensing structure.

[0015] In some embodiments, the electronic device includes a display positioned below the cover. The device may also include a backlight positioned below the display. The capacitive sense layer may be disposed between the display and the backlight.

[0016] In some embodiments, the electronic device includes sensing circuitry that is operatively coupled to the capacitive sense layer and the force-sensing structure. The sensing circuitry may be configured to estimate the force of a touch on the cover based on a

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change in mutual capacitance between the capacitive sense layer and the upper capacitive plate of the force-sensing structure. In some embodiments, the sensing circuitry may be configured to obtain a first capacitance between the upper capacitive plate and the lower capacitive plate of the force sensing structure. The circuitry may also be configured to obtain a second capacitance between the upper capacitive plate and the capacitive sense layer. The circuitry may also be configured to generate an estimate of a force of a touch on the cover using the first and second capacitances.

[0017] While multiple embodiments are disclosed, including variations thereof, still other embodiments of the present disclosure will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the disclosure. As will be realized, the disclosure is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present disclosure. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Brief Description of the Drawings

[0018] FIG. 1 depicts an example touch device.

[0019] FIG. 2A depicts a cross-sectional view taken along line 1-1 of FIG. 1, of an example touch device having a force-sensing structure.

[0020] FIG. 2B depicts a cross-sectional view taken along line 1-1 of FIG. 1, of an example touch device having an alternative force-sensing structure.

[0021] FIG. 3 depicts a cross-sectional view taken along line 2-2 of FIG. 2, of an example touch device having a force-sensing structure.

[0022] FIG. 4 depicts a cross-sectional view taken along line 2-2 of FIG. 2, of an example touch device having a force-sensing structure.

[0023] FIG. 5 depicts a cross-sectional view taken along line 2-2 of FIG. 2, of an example touch device having a force-sensing structure.

[0024] FIG. 6 depicts a cross-sectional view of an embodiment of a touch device having a capacitive force sensor.

[0025] FIG. 7 depicts another embodiment of a touch device having a capacitive force sensor.

[0026] FIG. 8 depicts a cross sectional view of another embodiment of a touch device having a capacitive force sensor.

[0027] FIG. 9 depicts an exemplary communication between a touch I/O device and a computing system.

[0028] FIG. 10 depicts a schematic of a system including a force sensitive touch device.

[0029] FIG. 11A depicts an example method of operation.

[0030] FIG. 11B depicts another example method of operation.

[0031] FIG. 12 depicts a force-sensitive structure having an electrical connector tail.

[0032] FIG. 13 depicts a cross-sectional view of an electrical connector tail.

[0033] FIG. 14 depicts an example method of manufacturing a force-sensitive structure having an electrical connector tail.

[0034] FIG. 15A depicts a sample cross-section of another force-sensitive structure incorporated into an electronic device.

[0035] FIG. 15B depicts a sample cross-section of still another force-sensitive structure incorporated into an electronic device.

[0036] FIG. 15C depicts a sample cross-section of yet another force-sensitive structure incorporated into an electronic device.

[0037] FIGS. 15D-15E depict a portion of the cross-section of FIG. 15C in greater detail.

[0038] FIG. 16 depicts a sample cross-section of an electronic device incorporating two force-sensitive structures.

[0039] FIG. 17 depicts a sample cross-section of an electronic device incorporating a multi-layered sheet force sensor, coupled with a capacitive sensing array positioned in a display stack.

Detailed Description

[0040] Generally, embodiments may take the form of an electronic device capable of sensing force and distinguishing between multiple different levels of force, beyond simple binary sensing. Some embodiments may have an enclosure incorporating a force sensor therein (e.g., a force-sensitive sensor, a force-sensing element, or force-sensing structure).

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The force sensor may be incorporated in, for example in a groove, cutout, or aperture formed in one or more sidewalls or other surfaces of the device. The force-sensing element may extend along an entire periphery, sidewall, or set of sidewalls in certain embodiments. For example, the force sensor may encircle an interior cavity formed within the device, or may otherwise extend around an interior of the device. As force is exerted on an exterior of the device, such as an upper surface, the force sensor may detect the force and generate a corresponding input signal to the device.

[0041] Some embodiments may incorporate multiple force sensors spaced about a perimeter of the electronic device, rather than a single force-sensing structure or element. Further, the multiple force sensors need not form a continuous array or structure, but may be discretely spaced from one another. The number of force sensors may vary between embodiments, as may the spacing. Each force sensor may sense a force exerted on an adjacent or nearby surface within a certain region of the device. Thus, a force exerted at a point that is between two underlying force sensors may be sensed by both.

[0042] Generally, the force sensor or device may include one or more capacitive plates, traces, flex, or the like that are separated by a compressible element (e.g., a compliant member). As a force is transmitted through the device enclosure and to the force sensor, the compressible element may compress, thereby bringing the capacitive plates closer together. The change in distance between the capacitive plates may increase a measured capacitance therebetween. A circuit may measure this change in capacitance and output a signal that varies with the change in capacitance. A processor, integrated circuit or other electronic element may correlate the change in capacitance to a force exerted on the enclosure, thereby facilitating the detection, measurement, and use of force as an input to an electronic device. Although the term "plate" may be used to describe the capacitive elements, it should be appreciated that the capacitive elements need not be rigid but may instead be flexible (as in the case of a trace or flex).

1. Terminology

[0043] The following terminology is exemplary, and not intended to be limiting in any way.

[0044] The text "applied force", and variants thereof, generally refers to the force of a touch applied to a surface of the device. Generally, the degree, amount, or magnitude of the applied force can be detected and measured using the techniques described herein. The degree, amount, or magnitude of an applied force need not have any particular scale. For example, the measure of applied force can be linear, logarithmic, or otherwise nonlinear, and can be adjusted periodically (or otherwise, such as aperiodically, or otherwise from time to

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time) in response to one or more factors, either relating to applied force, location of touch, time, or otherwise.

[0045] The text "finger", and variants thereof, generally refers to a user's finger, or other body part. For example and without limitation, a "finger" can include any part of the user's finger or thumb and any part of the user's hand. A "finger" may also include any covering on the user's finger, thumb, or hand.

[0046] The text "touch," and variants thereof, generally refers to the act of an object coming into contact with a surface of a device. The object may include a user's finger, a stylus or other pointing object. Example objects include, a hard stylus, a soft stylus, a pen, finger, thumb or other part of the user's hand. A "touch" typically has an applied force and a location that can detected and measured using the techniques described herein.

[0047] After reading this document, those skilled in the art would recognize that these statements of terminology would be applicable to techniques, methods, physical elements, and systems (whether currently known or otherwise), including extensions thereof inferred or inferable by those skilled in the art after reading this application. Likewise, it should be appreciated that any dimensions set forth herein are meant to be examples only, and may change from embodiment to embodiment.

2. Force-Sensitive Device

[0048] In one embodiment, a force sensitive device and system can include a cover glass element, such as a relatively transparent (in most or all locations) substance capable of isolating circuitry or other internal elements of the touch device from external objects. The term "glass" refers to the relatively hard sheet-like qualities of the material and does not limit the material of the cover glass element to only glass materials. The cover glass element may be made from a variety of materials including, for example, glass, treated glass, plastic, treated plastic, and sapphire. In many cases, the cover glass is transparent, however it is not necessary that the cover glass be completely or even partially transparent. The cover glass can be disposed in a substantially rectilinear shape, such as to cover the circuit for the touch device and to serve as a touch plate for the user. The cover glass may also be formed in a variety of other shapes depending on the application.

[0049] In some embodiments, the cover glass is integrated with or attached to a transparent or non-transparent touch sensor that is configured to detect the location of a touch. The transparent touch sensor may be a capacitive touch sensor formed from one or more arrays of transparent conductive lines. For example, the transparent touch sensor may be a mutually capacitive touch sensor formed from two arrays of transverse transparent

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conductive lines operatively coupled to touch sensing circuitry. Such a transparent touch sensor may be able to detect and track multiple touches on the surface of the cover glass. The touches may include multiple finger touches, multiple stylus touches, or a combination of different types of touches on the cover glass. Other types of transparent touch sensors may also be used, including, for example, self-capacitive touch sensors, resistive touch sensors, and the like.

[0050] In one embodiment, the cover glass element is coupled to a frame or housing for the touch device, such as a case constructed of metal, elastomer, plastic, a combination thereof, or some other substance. In such cases, the frame for the touch device can include a shelf or ledge on which the cover glass element is positioned. The cover glass is typically positioned above the circuitry for the touch device. For example, the frame can include a shelf on which an edge of the cover glass element is positioned, with the (or some of the) remainder of the cover glass element positioned over the circuitry for the touch device.

[0051] In many of the embodiments described herein, a force sensor, (e.g. a force-sensing structure, force-sensing element, or force sensitive sensor), is positioned below the cover glass and the shelf or ledge of the frame or housing. The force sensor typically includes a compressible element and is configured to detect and measure a relative displacement between the cover glass and the frame or housing. As previously mentioned, the amount that the cover glass is displaced can be used to estimate the applied force. The following embodiments are directed to different techniques and methods of detecting and measuring this displacement.

3. Exemplary Devices having a Force Sensor

[0052] FIG. 1 depicts an exemplary device 100 that incorporates one or more force-sensing structures, as described herein. With respect to FIG. 1, the device 100 is depicted as a tablet computing device, but it should be appreciated that it may also be any of a number of other devices, including a mobile phone, portable computer, wearable device, touch screen, and the like. The device 100 may have an enclosure 102 including multiple sidewalls and a bezel 106. In other embodiments, the device 100 may be flush-mounted into a larger surface or enclosure and so the device may lack an identifiable bezel or sidewalk

[0053] As shown in FIG. 1, the electronic device 100 includes an electronic display, located beneath a cover glass 104, for conveying graphical and/or textual information to the user. The electronic display may include a liquid crystal display (LCD), organic light omitting diode (OLED), or other electronic display component. In some embodiments, the display

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may be omitted. For example, the cover glass may be placed over a control button or track pad that is not configured to convey graphical and/or textual information to the user. (In such a case, the cover glass may not be transparent.)

[0054] As shown in FIG. 1, the device includes multiple ports and mechanisms for electrically and mechanically coupling the device to external devices or elements. The input mechanisms, ports, and the like may vary between versions, types and styles of the electronic device 100. Accordingly, they are shown in FIG. 1 only as examples of such devices and in sample positions.

[0055] FIG. 2A depicts a cross-sectional view taken along line 1-1, shown in FIG. 1. The cross-sectional view depicts the interior of a device 100 having one type of force-sensing structure. A central portion of the enclosure 102 may enclosure electronic circuitry, mechanical structures, and other internal elements. As shown in the figure, a bezel 106 is formed around the perimeter of the device 100.

[0056] A ledge 202 may be formed along the perimeter of the bezel 106. The exact dimensions of the ledge 202 may vary between embodiments. In this embodiment, the ledge 202 includes a width configured to support the base of a force-sensing structure 200. The base of the force-sensing structure 200 may abut and attach to the top of the ledge 202 in certain embodiments. Likewise, as shown in FIG. 2A, an inner edge of the force-sensing structure 200 may be parallel and approximately aligned with an inner surface of the bezel 106. In other embodiments, the inner edge of the force-sensing structure 200 may be offset from an inner edge of the bezel 106.

[0057] As shown in FIG. 2A, a single force-sensing structure 200 may encircle the entirety of the inner cavity of the enclosure 102. That is, the force-sensing structure 200 may extend along the entirety of the perimeter of the device and along the ledge 202. Thus, it may be appreciated that the force-sensing structure 200 may be formed as a single unit or element.

[0058] FIG. 2B depicts an alternate cross-sectional view taken along line 1-1, shown in FIG. 1. As shown in FIG. 2B, the device 100b includes an alternative force-sensing structure 200b. In the alternative embodiment of FIG. 2B, multiple force-sensing structures 200b may be placed at different locations along the perimeter of the bezel 106. In this example, a force-sensing structure 200b is placed at or near each edge of the bezel 106 of the electronic device 100b. Additionally, a force-sensing structure 200c is placed at each of the corners of the bezel. Thus, in the example device 100b shown in FIG. 2B, there are eight force-sensing structures (200b, 200c).

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[0059] With regard to FIG. 2B, it should be appreciated that more or fewer force-sensing structures 200b may be used. For example, three force-sensing structures 200b may be used and a location of a force may be triangulated by comparing the outputs of each device. Alternately, an array of more than four force-sensing structures 200b may be used in a device. Additionally, each of the force-sensing structures shown in FIG. 2B may represent a number of individual force-sensing structures in a linear or two-dimensional array, for example. Accordingly, the number and positioning of the various force-sensing structures 200b depicted in FIG. 2B is merely exemplary and other variations are possible.

[0060] FIG. 3 depicts a cross-sectional view taken along 2-2 of the electronic device 100, as shown in FIG. 2A. As shown in FIG. 3, the physical relationship between the cover glass 104, bezel 106, and force-sensing structure 300 is shown in more detail, although it should be appreciated that the exact geometry, sizes, tolerances, positions and the like may vary. As shown in FIG. 3, the force-sensing structure 300 may be mounted or otherwise be positioned beneath a portion of the cover glass 104. A display element 304 may likewise be positioned beneath the cover glass 104. In some embodiments, the force-sensing structure 300 may be concealed from external view by an ink or print layer deposited on the cover glass between the cover glass 104 and the force-sensing structure 300. In other embodiments, the ink or print layer may be omitted.

[0061] In some embodiments, the display element 304 may act as an shield to electrically isolate the force-sensing structure from other components within the electronic device. Likewise, a shield may be formed on the ledge 202 and portion of the housing 102 adjacent the gap 302 in order to electrically isolate the force-sensing structure 300 from external signals, or at least reduce the impact of external noise on the force-sensing structure. The shield layers may be deposited by physical vapor deposition, as one non-limiting example. Further, any or all of the shield layers may extend into the interior of the electronic device to connect to a common or system ground. For example, the shield layer may extend from the ledge down the interior wall of the enclosure 102 to a system ground.

[0062] In certain embodiments, the ledge and/or portion of the housing may themselves act as shielding structures, rather than having any shield formed thereon. It should be appreciated that one or more of the various shield layers/structures may be electrically tied to one another in certain embodiments, although this is not necessary.

[0063] As shown in FIG. 3, the bezel 106 is adjacent to the ledge 202, which is recessed from the surface of the bezel 106 and is configured to support the force-sensing structure 300. As shown in FIG. 3, a gap 302 may exist between the interior edge of the bezel 106

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and the outer edge of the cover glass 104. The gap may allow free movement of the cover glass 104 with respect to the enclosure 102.

[0064] In certain embodiments, a portion or all of the surfaces of the gap 302 may be coated with an oleophobic material. The oleophobic material may serve as a barrier against, or repel, oils, dust, dirt and other similar materials from entering the gap 302 and/or impacting the force-sensing structure 300. In this fashion the coating may serve to maintain operation of the force-sensing structure over time. Coatings other than an oleophobic coating may be used; other dust- and/or oil- and/or dirt-repellent coatings may be used in different embodiments.

[0065] As shown in FIG. 3, the force-sensing structure 300 includes multiple layers. In this example, the force-sensing structure includes an upper portion 310 and a lower portion 320 separated by a deformable middle body or compressible element 330. The upper portion 310 includes an upper body 311 which may be formed from a layer of polyimide flex material. The upper portion 310 also includes an upper capacitive plate 312 formed from a layer of copper bonded to or deposited on the upper body 311. Likewise, the lower portion 320 includes a lower body 321 which may also be formed from a layer of polyimide flex material. The lower portion 320 also includes a lower capacitive plate 322 formed from a layer of copper bonded to or deposited on the lower body 321. In this example, the polyimide flex material is approximately 0.05 millimeters thick. However, other thicknesses and other materials may be used to form the force-sensing structure 300.

[0066] As shown in FIG. 3, a capacitance (shown by the capacitor symbol) may be formed between the upper and lower capacitive plates 312, 322, which, in this example, are separated by the compressible element 330. In this example, the compressible element 300 is formed from a silicone material approximately 0.2 millimeters thick with a tolerance of plus or minus 0.09 millimeters. In other embodiments, the compressible element 300 may be formed from a different material and have a different thickness.

[0067] The force-sensing structure 300 depicted in FIG. 3 can be used to detect and measure a user-applied force. For example, a user may press down on the cover glass 104 (or on an upper surface of the electronic device 100, in embodiments lacking a display and/or cover glass) to exert a force on the device 100. The cover glass 104 may move downward in response to the force, compressing the compressible element 330 of the force-sensing structure 300. In some cases, the compressible element 330 becomes flattened by the compression resulting the in first and second capacitive plates 312, 322 moving closer together. As a result, the capacitance between the first and second capacitive plates 312, 322 may change. As previously mentioned, a change in capacitance may produce an

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electrical signal or change in an electrical signal, which may be detected and measured by associated circuitry and may be used to estimate the force exerted on the cover glass 104 by the user.

[0068] As shown in FIG. 3, the upper and lower capacitive plates 312, 322 may extend outward from the upper and lower bodies 311, 321, respectively. That is, at certain locations along the length of the force-sensing structure 300, a portion of the capacitive plates 312, 322 may be bare and exposed. The exposed portion of the capacitive plates may facilitate connection to a wire, conduit, or other electrical connection and allow signals to be communicated between the force-sensing structure 300 and associated electronic circuitry in order to measure capacitance changes and estimate force.

[0069] In some embodiments, a second, auxiliary structure may be formed within the device 100 or within a segment of the force-sensing structure. The auxiliary structure may also include an upper capacitive plate and a lower capacitive plate separated by a compressible element. However, the auxiliary structure may not be configured to be compressed by the cover glass 104, and instead may serve as a reference capacitance used to account for changes in environmental conditions surrounding the device. For example, the elasticity and/or compressibility of the compressible element (e.g., a silicone material) may vary due to changes in the amount of absorbed moisture. In this case, it may be advantageous to use an auxiliary structure to measure (directly or indirectly) changes in the physical properties of the compressible element to account for changes in the moisture content. In one example, the auxiliary structure may form a capacitor with the upper and lower capacitive plates separated by a compressible element. The capacitor may be connected to a second electrical circuit that monitors the capacitance between the plates of the auxiliary structure separately from any force-sensitive structure. The auxiliary structure may be positioned in a part of the device such that it does not experience any (or very little) compression when a user presses down on the cover glass but is still exposed to the same or a similar environment as the force-sensing structure. Thus, any changes in the capacitance between the plates of the auxiliary structure may be purely due to absorbed moisture and/or aging of the compressible element (e.g., a silicone material). The output signal from the auxiliary structure may be used to adjust readings from force-sensitive structure to compensate for changes in the environmental conditions that affect the physical properties of the compressible element.

[0070] FIGS. 4 and 5 depict alternative embodiments of a force-sensitive structure. Specifically, FIG. 4 depicts a force-sensitive structure 400 having an upper portion 410 including an upper body 411 attached to an upper capacitive plate 412. The force-sensitive

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structure 400 also includes a lower portion 420 including a lower body 421 attached to a lower capacitive plate 422. The upper and lower portions 410, 420 are separated by a compressible element 430 and form a capacitor that can be used to detect a force applied to the cover glass 104. In the example depicted in FIG. 4, the upper and lower capacitive plates 412, 422 do not extend beyond the upper and lower bodies 411, 421. In this case, electrical communication with the force-sensitive structure 400 may be facilitated by an electrical terminal or conduit located within the profile of the force-sensitive structure 400.

[0071] FIG. 5 depicts another alternative embodiment of an electronic device 100 incorporating a force-sensitive structure 500. In this embodiment, an environmental seal 550 may be positioned between the cover glass 104 and the force-sensitive structure 500 to prevent ingress of moisture, dust, dirt, and other potential environmental contaminants. The environmental seal 550 may be formed, for example, from an extruded compliant material, such as Buna rubber, Viton, EPDM, or the like. In some cases, the environmental seal 550 is formed as a bead of sealant material that cures after being applied to an element of the device 100.

[0072] Optionally, as shown in FIG. 5, the device may also include a support 552 positioned between the seal 550 and the cover glass 104 to provide a bonding surface for the environmental seal 550. In this example, the support 552 is attached to the cover glass 104 and, therefore, is movable with respect to the enclosure 102. Thus, as a force is applied to the cover glass 104, the cover glass 104, optional support 552, and seal 550 may all move downward to compress the force-sensing structure 500. Thus, in the present embodiment, the seal 550 can be used to isolate the force-sensing structure 500 from moisture and external debris while still allowing operation force-sensing structure 500. In addition to or in place of the seal 550, the device 100 may also include one or more wiping seals located between an edge of the cover glass 104 and a portion of the enclosure 102. Furthermore, a baffle seal or membrane may be installed between the cover glass 104 and a portion of the enclosure 102, the baffle seal configured to prevent contaminates from entering the internal portion of the device 100.

[0073] In some embodiments, the environmental seal 550 is compliant and in other embodiments, the environmental seal 550 is not compliant and may be rigid. A rigid seal may be advantageous by transmitting force to the force-sensing structure 500 directly, while a compliant or flexible seal may compress somewhat before transmitting any force. Either type of seal may be used, although the output of the force-sensitive structure 500 may be affected by compression of a flexible seal.

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[0074] FIG. 6 depicts another alternative embodiment of a device having a capacitive force sensor. As shown in FIG. 6, a touch device case 605 (e.g., housing) can be shaped and positioned to hold a cover glass element 610. For example, the touch device case 605 can include a rectilinear frame, such as having a shape of a picture frame, with the cover glass element 610 having the shape of a picture cover (as would occur if a picture were placed below the cover glass element 610). The touch device case 605 can include a backing (not shown) or a midframe element (not shown), which can stabilize the touch device case 605 against bending, warping, or other physical distortion. The touch device case 605 can also define a space in which circuitry for the touch device (as described herein) can be positioned. This has the effect that the circuitry for the touch device can be protected against foreign contaminants or unwanted touching, and against bending or warping, or other electrical or physical effects that might possibly cause circuitry errors or other problems for the touch device.

[0075] As shown in FIG. 6, the touch device case 605 can include an outer edge 615, such as can be defined by an outer lip or a protrusion upward from a baseline of the touch device case 605, and which can be positioned to prevent excess slippage or other movement of the cover glass element 610 in either an X or Y direction. In this context, a Z direction generally indicates a direction substantially normal (likely to be at a 90 degree angle, but this is not required) to a plane of the cover glass element 610 and a top surface of the touch device, while the X and Y directions generally indicate directions substantially within the same plane of the cover glass element 610 (likely to be at 90 degree angles with respect to each other, but this is not required).

[0076] As shown in FIG. 6, the cover glass element 610 and the outer edge 615 define a cover glass gap 620 between them, with the effect that the cover glass element 610 does not bump or rub against the touch device case 605. In one embodiment, the touch device can include an optional elastomer 625, or other substance, positioned between the cover glass element 610 and the outer edge 615. This can have the effect of providing shock absorption in the event of a sudden acceleration of the cover glass element 610 in the direction of the outer edge 615, such as in the event the touch device is dropped, hit, kicked, or otherwise catastrophically moved. For example, the elastomer 625 can be disposed around the edges of the cover glass element 610, with the effect of forming an O-ring shape or similar shape. The elastomer 625 can also have the effect of preventing, or at least militating against, foreign object damage that might be caused by dust or other objects slipping between the cover glass element 610 and the outer edge 615.

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[0077] As shown in FIG. 6, the touch device case 605 includes a cover glass shelf 630, such as can be defined by an inner lip or internal protrusion inward from the outer edge 615 of the touch device case 605, and which can be positioned to support the cover glass element 610. For example, the cover glass element 610 can rest on the cover glass shelf 630, which can prevent the cover glass element 610 from slipping down into the circuitry for the touch device. In alternative embodiments, the touch device case 605 can include a midframe (not shown), such as can be defined by an internal support element positioned to support the cover glass element 610. For example, the midframe can include a relatively solid (absent optional holes) element positioned to support at least some of the circuitry for the touch device.

[0078] As shown in FIG. 6, the device includes a force-sensing structure 600. In this example, the force-sensing structure 600 includes a first upper portion comprising a first pressure sensitive adhesive (PSA) layer 635, having a thickness of about 100 microns and a first flex circuit 640. The first flex circuit 640 includes a set of drive/sense lines configured to conduct electric signals and/or act a capacitive plate. The force-sensing structure 600 also includes a lower portion comprising a second PSA layer 645, such as also having a thickness of about 100 microns, and a second flex circuit 650 also having conductive drive/sense lines for conducting signals and acting as a capacitive plate. The first flex circuit 640 and the second flex circuit 650 are configured to operate in response to control by the drive/sense lines and can form a capacitive sensor. As explained above with respect to previous embodiments, changes in the capacitance between the upper and lower portions of the force-sensing structure 600 may be related to an amount of deflection or change in distance between the first flex circuit 640 and the second flex circuit 650. (In other embodiments, one or more strain gauges can be used instead of a capacitive sensor.) In one example, if the cover glass element 610 is tilted (such as by pressure or other applied force), the first flex circuit 640 and the second flex circuit 650 can become closer or become farther away, depending on location with respect to the axis and location of tilt. As further described herein, the first flex circuit 640 and the second flex circuit 650 can be replicated in several locations on the touch device case 605.

[0079] The force-sensing structure 600 is typically operatively connected to a force-sensing circuit configured to detect and measure changes in capacitance. By measuring changes in capacitance, the force-sensing circuit can be used to estimate relative displacement of one or more force-sensing structures which, in tum can be used to determine an axis and location of tilt of the cover glass element 610. Furthermore, the changes in capacitance can be used to estimate a force applied to the cover glass element 610. In some embodiments, the force-sensing circuit includes or is coupled to a processor.

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[0080] In one embodiment, a region between the first flex circuit 640 and the second flex circuit 650 can define a substantially empty space (that is, filled with air). In alternative embodiments, the region between the first flex circuit 640 and the second flex circuit 650 can include a compressible layer 655. For a first example, the space between the first and second flex circuits 640, 650 can include a set of spring elements interspersed within the space. In this case, the first flex circuit 640 and the second flex circuit 650 are held apart by spring forces and do not generally touch. For a second example, the compressible layer 655 can include a microstructure constructed at least in part from silicone, such as a set of silicone pyramids or a set of silicone springs, also with the effect that the first flex circuit 640 and the second flex circuit 650 are held apart by a spring force and do not generally touch.

[0081] As described generally above, the cover glass element 610 may include a transparent touch sensor that is configured to detect the location of one or more touches. As mentioned previously, the transparent touch sensor may be formed from one or more arrays of transparent conductive lines coupled to touch sensor circuitry. Types of transparent touch sensors that may be integrated into the cover glass element 610, include, without limitation, mutual capacitive sensors, self-capacitive touch sensors, and resistive touch sensors.

[0082] In one embodiment, an area of the cover glass element 610 above the first flex circuit 640 and the second flex circuit 650 can be covered with an ink mask 660. In one embodiment, the ink mask 660 is disposed below the cover glass element 610 and above the first flex circuit 640. This has the effect that a user of the touch device does not generally see either the first flex circuit 640 or the second flex circuit 650, or any of the elements coupling them to the touch device case 605, the cover glass element 610, or any circuits for touch device (not shown). For example, the touch device can include a surface 665, which can include a surface of the cover glass element 610 in places where the ink mask 660 is absent, and can include a surface of the ink mask where the ink mask 660 is present. As described above, a Z direction 670 can indicate a direction substantially normal to the surface 665 of the touch device.

[0083] In one embodiment, the interaction between the cover glass element 610 and the outer edge 615 may result in a set of forces at the outer edge of the cover glass element 610. In some embodiments, a force-sensing structure 600 (or alternatively a strain gauge) is placed at two or more edges of the cover glass element 610. Each of the two or more force-sensing structures may be operatively coupled to force-sensing circuitry in the touch device and can be used to detect and measure these forces. Additionally, by estimating the relative displacement in each of the two or more force-sensing structures, the circuit can be used to determine a normal vector to the cover glass element 610 that represents a location of

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applied force (that is, a location of the normal vector) as well as an amount applied force (that is, a magnitude of the normal vector).

[0084] In one embodiment, the normal vector can be determined in response to an amount of tilt of the cover glass element or an amount of pressure at a X and the Y location. For example, a set of displacements can be measured using two or more force-sensing structures located at one or more edges on the perimeter of the cover glass element. In one embodiment, the displacements are proportional or can be correlated to one or more applied forces. A total force Fz can be determined in response to the individual forces at the edges of the cover glass element, and a centroid location (xO, yO) can be determined based on a correlation between the individual forces. Thus, using two or more force-sensing structures, a total force Fz and central location (xO, yO) can be computed that correlates to the actual force exerted on the cover glass element. Additionally, signals generated by multiple force-sensing structures can be coupled with the output of a touch sensor (potentially integrated into the cover glass elements) to resolve both the location a magnitude (applied force) for multiple finger touches on a cover glass element.

[0085] FIG. 7 depicts another exemplary embodiment of a device having a capacitive force sensor. The device may include a touch-sensitive region 710, which may (or may not) coincide with a display region such as an LED, LCD or OLED display. In this example, the touch-sensitive region 710 is formed from a transparent touch sensor integrated with the cover glass element 610.

[0086] FIG. 7 depicts, the touch device as viewed from above and includes the touch device case 605, the cover glass element 610, and the outer edge 615. The touch device also includes a home button 705, and a touch-sensitive region 710 (in which the touch device can determine a location of one or more touches using, for example, a capacitive touch sensor). The home button 705 may be partially or fully within the touch-sensitive region 710, or may be located outside the touch-sensitive region 710.

[0087] In one embodiment, the shape of the touch device can be indicated by a pair of centerlines 715, such as an X direction centerline 715x and a Y direction centerline 715y. The touch device can include, along one or more edges, such as bordering the touch-sensitive region 710, a set of force sensors 700. The force sensors 700may be formed from one or more capacitive force sensors similar to those as described with respect to FIGS. 3-6. Alternatively, the force sensors 700 may include other devices capable of sensing applied force, such as a strain gauge.

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[0088] As shown in FIG. 7, a device may include a plurality of force sensors 700 located along one or more edges of the perimeter of the touch-sensitive region 710. Each force sensor 700 includes at least two capacitive plates separated by a compressible intermediate layer. In one embodiment, the set of force sensors 700 can be disposed substantially outside a transparent portion of the touch-sensitive region 710. For example, the force sensors 700 may be located under an ink mask 660 (such as similar to or like that described with reference to the FIG. 6). In such cases, the force sensors 700 can be positioned with a gauge spacing 725 between pairs of the force sensors 700, and with an edge spacing 730 between individual ones of the force sensors 700 and an edge the touch device. In alternative embodiments, the force sensors 700 may be positioned beneath a display stack or located in another position with respect to the touch-sensitive region 710. The force sensors 700 may be evenly spaced from one another, spaced at uneven intervals, at repeating intervals, or as necessary. Likewise, the force sensors 700 may be positioned along all sides of the touch-sensitive region 710, at corners of the device, along less than all sides of the touch-sensitive region 710, or along a single edge of the touch-sensitive region 710. Accordingly, the sensor distribution shown in FIG. 7 is meant to be a sample, partial distribution and not limiting.

[0089] In one embodiment, each force sensor 700 is coupled to force-sensing circuitry that is configured to measure an amount of capacitance between a first flex circuit and a second flex circuit, which may be correlated to estimate a distance between the first flex circuit and the second flex circuit. The relative position of the first and second flex circuits may be similar to the configuration depicted in FIG. 6, discussed above. Similar to embodiments described above, an amount of capacitance between the first sensing element defined on the first flex circuit and the second sensing element defined on the second flex circuit can be detected and measured using force detection circuitry, which may include a processor. In such cases, the amount of applied force can be correlated to a relative change in distance between the first flex circuit and the second flex circuit, relative to a rest position when there is no force applied to the cover glass element 610. It should be appreciated that each force sensor 700 may be formed from first and second flex circuits, or may be a separate element.

[0090] In an alternative embodiment, each force sensor 700 is coupled to force-sensing circuitry that is configured to measure an amount of resistance between the first flex circuit and the second flex circuit. For example, the first and second flex circuits may be coupled by resistive layer. By measuring the resistance or change in resistance, the force-sensing circuitry can be used to determine a distance between the first flex circuit and the second flex circuit. For example, an amount of resistance between the first flex circuit and the

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second flex circuit can be correlated to a distance between the first flex circuit and the second flex circuit. This may occur when, for example the compressible, resistive layer is formed from a material that has a variable resistivity dependent on its thickness or an amount of compression. In one such case, the compressible, resistive layer includes a microstructure that has a resistance that increases like a spring force, similar to a strain gauge. The force-sensing circuitry may estimate the distance between the flex circuits by measuring the resistance or changes to the resistance in the compressible, resistive layer.

[0091] With reference to FIG. 7, the force sensors 700 can be operatively coupled to force-sensing circuitry (including a processor) that is configured to determine a set of distances (at distinct locations along the edge of the cover glass element 110) corresponding to the set of force sensors 700. That is, the force-sensing circuitry can estimate the distance between the first flex circuit and the second flex circuit based on the measured capacitance at each force sensor. In one embodiment, the displacements at each sensor 700 correlate to applied forces at the locations of those force sensors 700. Similar to the technique described above with respect to FIG. 6, a total force Fz can be determined based on an estimate of the individual forces, and a centroid location (xO, yO) can be determined based on a weighting of the estimate of the individual forces. In one embodiment, the total force Fz and the centroid location (xO, yO) is calibrated such that a set of computed forces and moments in response to the values of the total force Fz and the centroid location (xO, yO) best matches the observed values for displacements and forces at each of the set of force sensors 700. Thus, using multiple force sensors, a total force Fz and central location (xO, yO) can be computed that correlates to the actual force exerted on the device. Additionally, signals generated by multiple force sensors can be coupled with the output of a touch sensor (potentially integrated into the cover glass elements) to resolve both the locations and magnitudes (due to applied forces) for multiple finger touches on the device.

[0092] FIG. 8 depicts another exemplary embodiment of a device having a capacitive force sensor. In particular, the device depicted in FIG. 8 includes a cover glass element that is deformable.

[0093] As shown in FIG. 8, a cover glass element 805 can be coupled to a frame element 810, which can be coupled to a touch device frame 815. In one embodiment, there is a spatial separation between the cover glass element 805 and the frame element 810. For a first example, the cover glass element 805 can have a thickness of about 0.90 mm, although this particular thickness is merely exemplary and is not required. For a second example, the frame element 810 can include an elastomer, a plastic, or include construction from other substances. The cover glass element 805 can also be positioned above a display stack 820,

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such as a display stack from a touch device and adapted to provide a graphical or text display.

[0094] In one embodiment, the display stack 820 can be positioned above a reflector sheet 825 including an electrode pattern, such as can be used for drive and sense lines in a rectilinear capacitive array or individual sensor structures in an array. The reflector sheet 825 can be positioned above an air gap 830, such as can be used for capacitance between the reflector sheet 825 and another element. For example, the air gap 830 can have a thickness of about 0.10 mm, although this particular thickness is merely exemplary and is not required.

[0095] In one embodiment, the air gap 830 can be positioned above a circuit 835 having capacitive traces or elements, which may include a set of drive and sense traces/elements or be formed from an array of individual sensing traces/elements. For example, the circuit 835 can have a thickness of about 0.10 mm, although this particular thickness is merely exemplary and is not required.

[0096] In one embodiment, the circuit 835 can be positioned above a pressure sensitive adhesive (PSA) element 840. For example, the PSA element 840 can have a thickness of about 0.03 mm, although this particular thickness is merely exemplary and is not required. Further, a primer may be used between PSA and the housing to affix the structure to the housing. The structure may be optically aligned with the housing prior to bonding.

[0097] In one embodiment, the PSA element 840 can be positioned above a midplate element 845. For a first example, the midplate element 845 can have a thickness of about 0.25 mm, although this particular thickness is merely exemplary and is not required. For a second example, the midplate element 845 can be supportive of the elements coupled thereto and below the air gap 830.

[0098] In one embodiment, the cover glass element 805, the display stack 820, and related elements can be relatively deformable. This can have the effect that applied force to the surface of the touch device can cause a change in distance between elements near the air gap 830, and a change in measured capacitance by circuits positioned near the air gap 830. For example, a set of drive and sense lines, or an array of individual sensing elements, could be positioned in the reflector sheet 825 or in the circuit 835, can measure a capacitance across the air gap 830.

[0099] In such cases, the capacitance across the air gap 830 would be subject to change in response to deformation of the cover glass element 805, the display stack 820, and related elements. This would have the effect that elements positioned near the air gap 830

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would be able to measure the change in capacitance, and would be able to determine an amount or magnitude of an applied force in response thereto.

[0100] In some embodiments, multiple force sensors may be formed over the area of the cover glass element 805. In one embodiment, the set of force sensors can be positioned in a rectilinear array, such as an array in which each one of the force sensors is positioned at an [X, Y] location over the area of the cover glass element 805. For example, each one of the force sensors can include a capacitive force sensor exhibiting mutual capacitance between drive and sensor elements, or exhibiting self-capacitance. In another example, each one of the sensors can include a resistive strain gauge exhibiting a change in resistance in response to applied force, such as a resistive strain gauge as described with respect to FIG. 6, above.

[0101] In one embodiment, the applied force can affect each force sensor that is substantially near the applied force. The applied force affects each such force sensor differently depending on an amount of the applied force and a distance between the [X, Y] location of the applied force and the [X, Y] location of the affected force sensor. This has the effect that a processor or other circuit in the touch device can determine a mapping of applied force, and in response thereto, a set of [X, Y] locations and a Z displacement of the cover glass element 805. For example, particular Z displacement of points along the edges of the cover glass element 805 (or within a touch-sensitive region) can be used to determine the [X, Y] location of the applied force. In one embodiment, the cover glass element 805 may be approximately 700 microns thick, although this thickness may vary between embodiments.

[0102] In one embodiment, the same or similar information can be used to determine the [X, Y] location and Z displacement of more than one such applied force. In such cases where multiple forces are applied, a processor or other circuit in the touch device can determine a centroid of applied force, from which the touch device can determine one or more individual forces. For example, from this information, a processor or other circuit can determine one or more [X, Y] locations where force is being applied, and an amount or magnitude of force being applied at each such location.

[0103] In one embodiment, the interaction between the cover glass element 805 and the air gap 830 defines a set of forces at each location of applied force. A processor or other circuit in the touch device can measure these forces, such as using one or more capacitive sensing elements (as described herein) or using one or more strain gauges, distributed at locations throughout cover glass element 805. In response to those forces, the circuit can

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determine a set of normal vectors to the cover glass element 805 representing one or more locations of applied force and one or more amounts or magnitudes of the applied force.

[0104] In one embodiment, the locations of applied force can be determined in response to the distribution of sensed applied force at each location on the cover glass element 805, as described above, at each of the X and the Y locations, thus assigning each such location a Z amount of applied force. For a first example, a total centroid of applied force can be determined in response to the distribution of sensed applied force. The processor or other circuit can then locate each individual likely applied force, identify its amount of force, and subtract out that identified force from the sensed applied force at each location. This can have the effect of providing the processor or other circuit with a way to identify each applied force individually, until all such individual applied forces have been found.

[0105] In one embodiment, an amount or magnitude of force can be determined at each of a set of distinct locations at which a distinct force sensor is disposed below the cover glass element 805. For example, in one embodiment, the force sensors can be disposed in a grid below the cover glass element 805. Having the amount of force at each such location, a weighted centroid of that set of force amounts can be computed using a weighted sum of the locations at which each applied force is measured. Having determined such a centroid, the processor can determine a nearest local maximum force, either in response to the nearest maximum force sensor, or in response to a touch location sensor, or both. Having determined a nearest local maximum force, the processor can subtract that force and its expected effect on each force sensor, and repeat the process until each individual applied force is determined. In alternative embodiments, other and further techniques could be used in addition or instead.

4. Force-Sensitive Device System

[0106] FIG. 9 depicts an exemplary communication between a touch I/O device and a computing system. In this example, the touch I/O device 901 includes one or more sensors for detecting a touch by an operator or user. The touch device 901 transmits electronic signals from the one or more sensors to a computing system 903 over a communication channel 902. An example computing system 903 is described below with respect to FIG. 10 and includes one or more computer processors and computer-readable memory for storing computer-executable instructions. The touch I/O device, communication channel 902 and computing system 903 may all be integrated together as a part of the same touch device.

[0107] As shown in FIG. 9, embodiments may include touch I/O device 901 that can receive touch input and force input (such as possibly including touch locations and applied

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force at those locations) for interacting with computing system 903 via wired or wireless communication channel 902. Touch I/O device 901 may be used to provide user input to computing system 903 in lieu of or in combination with other input devices such as a keyboard, mouse, or possibly other devices. In alternative embodiments, touch I/O device 901 may be used in conjunction with other input devices, such as in addition to or in lieu of a mouse, trackpad, or possibly another pointing device. One or more touch I/O devices 901 may be used for providing user input to computing system 903. Touch I/O device 901 may be an integral part of computing system 903 (e.g., touch screen on a laptop) or may be separate from computing system 903.

[0108] Touch I/O device 901 may include a touch sensitive and/or force sensitive panel which is wholly or partially transparent, semitransparent, non-transparent, opaque or any combination thereof. Touch I/O device 901 may be embodied as a touch screen, touch pad, a touch screen functioning as a touch pad (e.g., a touch screen replacing the touchpad of a laptop), a touch screen or touchpad combined or incorporated with any other input device (e.g., a touch screen or touchpad disposed on a keyboard, disposed on a trackpad or other pointing device), any multi-dimensional object having a touch sensitive surface for receiving touch input, or another type of input device or input/output device.

[0109] In one example, touch I/O device 901 is a touch screen that may include a transparent and/or semitransparent touch-sensitive and force-sensitive panel at least partially or wholly positioned over at least a portion of a display. (Although, the touch sensitive and force sensitive panel is described as at least partially or wholly positioned over at least a portion of a display, in alternative embodiments, at least a portion of circuitry or other elements used in embodiments of the touch sensitive and force sensitive panel may be at least positioned partially or wholly positioned under at least a portion of a display, interleaved with circuits used with at least a portion of a display, or otherwise.) According to this embodiment, touch I/O device 901 functions to display graphical data transmitted from computing system 903 (and/or another source) and also functions to receive user input. In other embodiments, touch I/O device 901 may be embodied as an integrated touch screen where touch sensitive and force sensitive components/devices are integral with display components/devices. In still other embodiments a touch screen may be used as a supplemental or additional display screen for displaying supplemental or the same graphical data as a primary display and to receive touch input, including possibly touch locations and applied force at those locations.

[0110] Touch I/O device 901 may be configured to detect the location of one or more touches or near touches on device 901 , and where applicable, force of those touches, based

on capacitive, resistive, optical, acoustic, inductive, mechanical, chemical, or electromagnetic measurements, in lieu of or in combination or conjunction with any phenomena that can be measured with respect to the occurrences of the one or more touches or near touches, and where applicable, force of those touches, in proximity to the touch I/O device 901. Software, hardware, firmware or any combination thereof may be used to process the measurements of the detected touches, and where applicable, force of those touches, to identify and track one or more gestures. A gesture may correspond to stationary or non-stationary, single or multiple, touches or near touches, and where applicable, force of those touches, on touch I/O device 901. A gesture may be performed by moving one or more fingers or other objects in a particular manner on touch I/O device 901 such as tapping, pressing, rocking, scrubbing, twisting, changing orientation, pressing with varying pressure and the like at essentially the same time, contiguously, consecutively, or otherwise. A gesture may be characterized by, but is not limited to a pinching, sliding, swiping, rotating, flexing, dragging, tapping, pushing and/or releasing, or other motion between or with any other finger or fingers, or any other portion of the body or other object. A single gesture may be performed with one or more hands, or any other portion of the body or other object by one or more users, or any combination thereof.

[01 11] Computing system 903 may drive a display with graphical data to display a graphical user interface (GUI). The GUI may be configured to receive touch input, and where applicable, force of that touch input, via touch I/O device 901. Embodied as a touch screen, touch I/O device 901 may display the GUI. Alternatively, the GUI may be displayed on a display separate from touch I/O device 901. The GUI may include graphical elements displayed at particular locations within the interface. Graphical elements may include but are not limited to a variety of displayed virtual input devices including virtual scroll wheels, a virtual keyboard, virtual knobs or dials, virtual buttons, virtual levers, any virtual UI, and the like. A user may perform gestures at one or more particular locations on touch I/O device 901 which may be associated with the graphical elements of the GUI. In other embodiments, the user may perform gestures at one or more locations that are independent of the locations of graphical elements of the GUI. Gestures performed on touch I/O device 901 may directly or indirectly manipulate, control, modify, move, actuate, initiate, or generally affect graphical elements such as cursors, icons, media files, lists, text, all or portions of images, or the like within the GUI. For instance, in the case of a touch screen, a user may directly interact with a graphical element by performing a gesture over the graphical element on the touch screen. Alternatively, a touch pad generally provides indirect interaction. Gestures may also affect non-displayed GUI elements (e.g., causing user interfaces to appear) or may affect other actions within computing system 903 (e.g., affect a state or mode of a GUI, application, or operating system). Gestures may or may not be performed

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on touch I/O device 901 in conjunction with a displayed cursor. For instance, in the case in which gestures are performed on a touchpad, a cursor (or pointer) may be displayed on a display screen or touch screen and the cursor may be controlled via touch input, and where applicable, force of that touch input, on the touchpad to interact with graphical objects on the display screen. In other embodiments in which gestures are performed directly on a touch screen, a user may interact directly with objects on the touch screen, with or without a cursor or pointer being displayed on the touch screen.

[0112] Feedback may be provided to the user via communication channel 902 in response to or based on the touch or near touches, and where applicable, force of those touches, on touch I/O device 901 . Feedback may be transmitted optically, mechanically, electrically, olfactory, acoustically, haptically, or the like or any combination thereof and in a variable or non-variable manner.

[0113] As previously mentioned, the touch I/O device, communication channel 902, and the computing system 903 may all be integrated into a touch device or other system. The touch device or system may be a portable or non-portable device, including, but not limited to, a communication device (e.g., mobile phone, smart phone), a multi-media device (e.g., MP3 player, TV, radio), a portable or handheld computer (e.g., tablet, netbook, laptop), a desktop computer, an all-in-one desktop, a peripheral device, or any other (portable or non-portable) system or device adaptable to the inclusion of system architecture depicted in FIG. 10, including combinations of two or more of these types of devices.

[0114] FIG. 10 depicts a block diagram of one embodiment of system 1000 that generally includes one or more computer-readable mediums 1001 , processing system 1004, Input/Output (I/O) subsystem 1006, electromagnetic frequency circuitry, such as possibly radio frequency (RF) or other frequency circuitry 1008 and audio circuitry 1010. These components may be coupled by one or more communication buses or signal lines 1003. Each such bus or signal line may be denoted in the form 1003-X, where X can be a unique number. The bus or signal line may carry data of the appropriate type between components; each bus or signal line may differ from other buses/lines, but may perform generally similar operations.

[0115] It should be apparent that the architecture shown in FIG. 10 is only one example architecture of system 1000, and that system 1000 could have more or fewer components than shown, or a different configuration of components. The various components shown in FIG. 10 can be implemented in hardware, software, firmware or any combination thereof, including one or more signal processing and/or application specific integrated circuits.

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[0116] Shown in FIG. 10, RF circuitry 1008 is used to send and receive information over a wireless link or network to one or more other devices and includes well-known circuitry for performing this function. RF circuitry 1008 and audio circuitry 1010 are coupled to processing system 1004 via peripherals interface 1016. Interface 1016 includes various known components for establishing and maintaining communication between peripherals and processing system 1004. Audio circuitry 1010 is coupled to audio speaker 1050 and microphone 1052 and includes known circuitry for processing voice signals received from interface 1016 to enable a user to communicate in real-time with other users. In some embodiments, audio circuitry 1010 includes a headphone jack (not shown).

[0117] Peripherals interface 1016 couples the input and output peripherals of the system to processor 1018 and computer-readable medium 1001. One or more processors 1018 communicate with one or more computer-readable mediums 1001 via controller 1020. Computer-readable medium 1001 can be any device or medium that can store code and/or data for use by one or more processors 1018. Medium 1001 can include a memory hierarchy, including but not limited to cache, main memory and secondary memory. The memory hierarchy can be implemented using any combination of RAM (e.g., SRAM, DRAM, DDRAM), ROM, FLASH, magnetic and/or optical storage devices, such as disk drives, magnetic tape, CDs (compact disks) and DVDs (digital video discs). Medium 1001 may also include a transmission medium for carrying information-bearing signals indicative of computer instructions or data (with or without a carrier wave upon which the signals are modulated). For example, the transmission medium may include a communications network, including but not limited to the Internet (also referred to as the World Wide Web), intranet(s), Local Area Networks (LANs), Wide Local Area Networks (WLANs), Storage Area Networks (SANs), Metropolitan Area Networks (MAN) and the like.

[0118] One or more processors 1018 run various software components stored on medium 1001 to perform various functions for system 1000. In some embodiments, the software components include operating system 1022, communication module (or set of instructions) 1024, touch and applied force processing module (or set of instructions) 1026, graphics module (or set of instructions) 1028, and one or more applications (or set of instructions) 1030. Each of these modules and above noted applications correspond to a set of instructions for performing one or more functions described above and the methods described in this application (e.g., the computer-implemented methods and other information processing methods described herein). These modules (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise rearranged in various embodiments. In some embodiments, medium 1001 may store a subset of the modules and

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data structures identified above. Furthermore, medium 1001 may store additional modules and data structures not described above.

[01 19] Operating system 1022 includes various procedures, sets of instructions, software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

[0120] Communication module 1024 facilitates communication with other devices over one or more external ports 1036 or via RF circuitry 1008 and includes various software components for handling data received from RF circuitry 1008 and/or external port 1036.

[0121] Graphics module 1028 includes various known software components for rendering, animating and displaying graphical objects on a display surface. In embodiments in which touch I/O device 1012 is a touch sensitive and force sensitive display (e.g., touch screen), graphics module 1028 includes components for rendering, displaying, and animating objects on the touch sensitive and force sensitive display.

[0122] One or more applications 1030 can include any applications installed on system 1000, including without limitation, a browser, address book, contact list, email, instant messaging, word processing, keyboard emulation, widgets, JAVA-enabled applications, encryption, digital rights management, voice recognition, voice replication, location determination capability (such as that provided by the global positioning system, also sometimes referred to herein as "GPS"), a music player, and otherwise.

[0123] Touch processing module 1026 includes various software components for performing various tasks associated with touch I/O device 1012 including but not limited to receiving and processing touch input and applied force input received from I/O device 1012 via touch I/O device controller 1032. In some cases, the touch processing module 1026 includes computer instructions for operating the force sensor 1060. For example, the touch processing module 1026 may include instructions for performing one or more operations described below with respect to processes 1100 and 1150 of FIGS. 11A-B. In some cases, the touch processing module 1026 includes parameters or settings that may be implemented in the operation of the force sensor 1060.

[01 24] I/O subsystem 1006 is coupled to touch I/O device 1012 and one or more other I/O devices 1014 for controlling or performing various functions. Touch I/O device 1012 communicates with processing system 1004 via touch I/O device controller 1032, which includes various components for processing user touch input and applied force input (e.g., scanning hardware). One or more other input controllers 1034 receives/sends electrical

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signals from/to other I/O devices 1014. Other I/O devices 1014 may include physical buttons, dials, slider switches, sticks, keyboards, touch pads, additional display screens, or any combination thereof.

[0125] If embodied as a touch screen, touch I/O device 1012 displays visual output to the user in a GUI. The visual output may include text, graphics, video, and any combination thereof. Some or all of the visual output may correspond to user-interface objects. Touch I/O device 1012 forms a touch-sensitive and force-sensitive surface that accepts touch input and applied force input from the user. Touch I/O device 1012 and touch screen controller 1032 (along with any associated modules and/or sets of instructions in medium 1001) detects and tracks touches or near touches, and where applicable, force of those touches (and any movement or release of the touch, and any change in the force of the touch) on touch I/O device 1012 and converts the detected touch input and applied force input into interaction with graphical objects, such as one or more user-interface objects. In the case in which device 1012 is embodied as a touch screen, the user can directly interact with graphical objects that are displayed on the touch screen. Alternatively, in the case in which device 1012 is embodied as a touch device other than a touch screen (e.g., a touch pad or trackpad), the user may indirectly interact with graphical objects that are displayed on a separate display screen embodied as another I/O device 1014.

[0126] In embodiments in which touch I/O device 1012 is a touch screen, the touch screen may use LCD (liquid crystal display) technology, LPD (light emitting polymer display) technology, OLED (organic LED), or OEL (organic electro luminescence), although other display technologies may be used in other embodiments.

[0127] Feedback may be provided by touch I/O device 2012 based on the user's touch, and applied force, input as well as a state or states of what is being displayed and/or of the computing system. Feedback may be transmitted optically (e.g., light signal or displayed image), mechanically (e.g., haptic feedback, touch feedback, force feedback, or the like), electrically (e.g., electrical stimulation), olfactory, acoustically (e.g., beep or the like), or the like or any combination thereof and in a variable or non-variable manner.

[0128] System 1000 also includes power system 1044 for powering the various hardware components and may include a power management system, one or more power sources, a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator and any other components typically associated with the generation, management and distribution of power in portable devices.

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[0129] In some embodiments, peripherals interface 1016, one or more processors 1018, and memory controller 1020 may be implemented on a single chip, such as processing system 1004. In some other embodiments, they may be implemented on separate chips.

[0130] In one embodiment, an example system includes a force sensor 1060 integrated with the touch I/O device 2012. The force sensor 1060 may include one or more of the force-sensitive structures described above with respect to any one of the example embodiments. Generally, the force sensor 1060 is configured to generate an electronic signal or response that can be interpreted or processed as a magnitude of force of a touch on touch O/I device 1012. In some cases, the force sensor 1060 transmits electronic signals directly to the touch I/O device via signal line 1003-10. The signals may be relayed to the force sensor controller 1061 in the I/O subsystem 1006. In some cases, the force sensor 1060 transmits signals directly to the force sensor controller 1061 via signal line 1003-11 without passing through the touch I/O device 1012.

[0131] The force sensor controller 1061 either alone or in combination with one or more of the processors (e.g., processor 1018 or secure processor 1040) may serve as the force sensing circuitry for the force sensor 1060. In particular, the force sensor controller 1061 can be coupled to a processor or other computing device, such as the processor 1018 or the secure processor 1040. In one example, the force sensor controller 1061 is configured to calculate and estimated force based on electronic signals generated by the force sensor 1060. Data regarding estimated force may be transmitted to the processor 1018 or secure processor 1040 for use with other aspects of the system 1000, such as the touch processing module 1026. In one example, the force sensor controller 1061 performs signal processing on the electronic signal that is produced by the force sensor 1060, including, for example, analog to digital conversion, filtering, and sampling operations. In some cases, other processors in the system 1000 (e.g., processor 1018 or secure processor 1040) that calculate an estimated force based on the processed signal. As a result, the system 1000 can utilize signals or data produced by the force sensor controller 1061, which can be measured, calculated, computed, or otherwise manipulated. In one embodiment, the output of the force sensor 1060 is used by one or more processors or other computing devices, coupled to or accessible to the force sense controller 1061 or the touch I/O device, such as the processor 1018, the secure processor 1040, or otherwise. Additionally, output from the force sensor 1060 can be used by one or more analog circuits or other specialized circuits, coupled to or accessible to the force sensor controller 1061 or the touch I/O device 1012.

[0132] After reading this application, those skilled in the art would recognize that techniques for obtaining information with respect to applied force and contact on a touch I/O

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device, and using that associated information to determine the magnitude and locations of applied force and contact on a touch I/O device, is responsive to, and transformative of, real-world data such as attenuated reflection and capacitive sensor data received from applied force or contact by a user's finger, and provides a useful and tangible result in the service of detecting and using applied force and contact with a touch I/O device. Moreover, after reading this application, those skilled in the art would recognize that processing of applied force and contact sensor information by a computing device includes substantial computer control and programming, involves substantial records of applied force and contact sensor information, and involves interaction with applied force and contact sensor hardware and optionally a user interface for use of applied force and contact sensor information.

[0133] Certain aspects of the embodiments described in the present disclosure may be provided as a computer program product, or software, that may include, for example, a computer-readable storage medium or a non-transitory machine-readable medium having stored thereon instructions, which may be used to program a computer system (or other electronic devices) to perform a process according to the present disclosure. A non-transitory machine-readable medium includes any mechanism for storing information in a form (e.g., software, processing application) readable by a machine (e.g., a computer). The non-transitory machine-readable medium may take the form of, but is not limited to, a magnetic storage medium (e.g., floppy diskette, video cassette, and so on); optical storage medium (e.g., CD-ROM); magneto-optical storage medium; read only memory (ROM); random access memory (RAM); erasable programmable memory (e.g., EPROM and EEPROM); flash memory; and so on.

[0134] While the present disclosure has been described with reference to various embodiments, it will be understood that these embodiments are illustrative and that the scope of the disclosure is not limited to them. Many variations, modifications, additions, and improvements are possible. More generally, embodiments in accordance with the present disclosure have been described in the context of particular embodiments . Functionality may be separated or combined in procedures differently in various embodiments of the disclosure or described with different terminology. These and other variations, modifications, additions, and improvements may fall within the scope of the disclosure as defined in the claims that follow.

5. Methods of Operation

[0135] FIG. 11A depicts an exemplary process for operating a device having a force sensor. The process may be applied using the force sensors described above with respect to FIGS. 2A, 2B, 3-8, discussed above.

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[0136] FIG. 11A depicts an exemplary flow chart for a process 1100 that includes flow points and operational steps or functions. Although these flow points and operations are shown in a particular order, in the context of a more generalized technique, there is no particular requirement that the order of the operations must be followed as shown. For example, the flow points and operations could be performed in a different order, concurrently, in parallel, or otherwise. Similarly, although these flow points and operations are shown performed by a general purpose processor in a device, in the context of a more generalized approach, there is no particular requirement for any such limitation. For example, one or more such operations could be performed by a special purpose processor, by another circuit, or be offloaded to other processors or other circuits in other devices, such as by offloading those functions to nearby devices using wireless technology or by offloading those functions to cloud computing functions. In some cases, prior to performing the operations of process 1100, the electronic device has been turned on and the operating system has been loaded and is running. Also, the relevant hardware including, for example, touch screen sensors, display devices, and force sensor devices may have been powered and may have been initialized.

[0137] At operation 1105, a force is applied to a location [X, Y] on the cover glass of the device. The force may be applied using either a finger or other pointing devices, such as a stylus or pen. In some cases, multiple touches may be applied to the cover glass of the device. For example, a multi-touch gesture or command may be input on the cover glass resulting in a net applied force.

[0138] At operation 1110, an electrical signal is detected and measured in response to the applied force. In one example, force-sensing circuit (which may include a processor) in the device measures a value from one or more force sensors in response to the applied force. In one embodiment, as described above with respect to FIGS. 2A, 2B, and 3-5, a force-sensing circuit detects a change in the capacitance at one or more force-sensing structures. The change in capacitance may be correlated or used to estimate a deflection in the cover glass resulting from the applied force. In another embodiment, as described with respect to FIG. 6, the force-sensing circuit estimates an amount of tilt applied to the cover glass based on a signal or signals received from one or more force sensors. In yet another embodiment, as described with respect to FIG. 7, the force-sensing circuit is used to detect a change in capacitance between capacitive sensors (or with respect to a single sensor, in a self-capacitance mode) at a set of distinct locations below the cover glass. The change in capacitance can be used to estimate the displacement on the cover glass resulting from the applied force.

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[0139] At operation 1115, the location of the one or more touches is determined. In one example, the force-sensing circuit determines one or more locations at which the force is being applied to the cover glass element based on the signal or signals received from one or more force sensors. The location may be determined by, for example, comparing the output from multiple force sensors and using the output to triangulate or estimate a location of the applied force.

[0140] At operation 1120, the amount or magnitude of the force being applied at each location is estimated. For example, the force-sensing circuit may be used to determine an amount or magnitude of force being applied at each measured location, such as using the weighted centroid technique described with respect to the FIG. 8. In some embodiments, the operations of method 1100 are repeated multiple times. In some embodiments, the operations of method 1100 are repeated so long as the force sensitive device is powered on.

[0141] FIG. 11B depicts another process for operating a device having a force sensor. The process may be applied using the force sensors described above with respect to FIGS. 2A, 2B, 3-8, discussed above.

[0142] FIG. 11B depicts another exemplary flow chart for a process 1150 that includes flow points and operational steps or functions. Although these flow points and operations are shown in a particular order, in the context of a more generalized technique, there is no particular requirement that the order of the operations must be followed as shown. Similarly, although these flow points and operations are shown performed by a general purpose processor in a device, in the context of a more generalized approach, there is no particular requirement for any such limitation. In some cases, prior to performing the operations of process 1150, the electronic device has been turned on and the operating system has been loaded and is running. Also, the relevant hardware including, for example, touch screen sensors, display devices, and force sensor devices may have been powered and may have been initialized.

[0143] At operation 1155, a charge signal is transmitted to a force-sensitive structure. In a typical implementation, the charge signal includes a series of charge pulses is transmitted to one of the capacitive plates in a force-sensitive structure. Each charge pulse comprises a momentary change in the voltage applied to the capacitive plates of the force-sensitive structure resulting in an induced current across the plates. In some instances, the charge signal is an alternating current (AC) that is applied across the capacitive plates of the force-sensing structure. In many cases, if the charge signal is a discrete charge pulse, the charge pulse is transmitted at regular intervals during the operation of the device. If the charge signal is an alternating current, the charge signal may be transmitted continuously during

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operation. In either case, operation 1155 is typically performed simultaneously with operations 1160, 1165, and 1170, described below.

[0144] At operation 1160, a first capacitance is measured for the force-sensitive structure. Typically, the capacitance is measured while the force-sensitive structure is in an uncompressed or unactuated state. For example, the measurement of operation 1160 may be taken when the device is stationary and is not being touched by an operator. In some cases, multiple measurements are taken over a period of time and a composite or average capacitance value is determined.

[0145] At operation 1165, a force is applied to the device. In accordance with the embodiments described above with respect to FIGS. 2A, 2B, 3-8, a user may touch the cover glass of a device applying a force at a location on the cover glass. The user may touch the device with a finger, stylus, pen, or the like. In some cases, multiple touches are applied to the cover glass at the same time in accordance with a multi-touch gesture or user input. In accordance with the embodiments described above with respect to FIGS. 2A, 2B, 3-8, an applied force typically results in the compression or deflection of a force-sensitive structure resulting in a relative change in position of the two capacitive plates.

[0146] At operation 1170, a second capacitance is measured for the force-sensitive structure. Typically, the capacitance is measured while the force-sensitive structure is in a compressed or deflected state due to the force applied in operation 1165, described above. In some cases, multiple measurements are taken over a period of time and a composite or representative capacitance value is determined.

[0147] At operation 1175, a force is estimated using the first and second capacitance measurements. In accordance with the embodiments described above with respect to FIGS. 2A, 2B, 3-8, an applied force results in a change in the position of the two capacitive plates, thus changing the capacitance of the force-sensitive structure. In operation 1175, the change in capacitance is correlated with or used to compute an estimated force. For example, if compressible element of a force-sensitive structure behaves as a linear force spring, the change in capacitance (which is proportional to the change in distance between the capacitive plates) will be proportional to the change in force. Because the material properties, such as the spring rate, of the compressible element are known the amount of force can be estimated as the difference between the first and second capacitance measurements multiplied by a constant. In some embodiments, the operations of method 1150 are repeated multiple times. In some embodiments, the operations of method 1150 are repeated so long as the force sensitive device is powered on.

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6. Electrical Connection to a Force Sensor and Method of Manufacturing

[0148] In accordance with certain embodiments described above, a capacitive force sensor typically includes a force-sensitive stack having two capacitive plates separated by an intermediate, compressible element. In a typical implementation, a charge signal is applied to at least one of the capacitive plates and a capacitive measurement is taken. To deliver both the charge signal (drive signal) and receive the capacitive measurement (sense signal) from the capacitive plates, the force-sensitive structure is typically connected to other elements of the system by an electrical connection. To facilitate assembly during manufacturing, it may be advantageous that the electrical connection be a detachable electrical connection formed from a flexible conduit.

[0149] FIG. 12 depicts an example touch device 1200 having two force-sensing structures 1210, 1220 located around the perimeter of a display element 1202 or a portion thereof. The two force-sensing structures 1210, 1220 are electrically connected to an electrical connector tail 1250. In this example, each of the two force-sensing structures (1210, 1220) is formed from a first and second capacitive plate separated by an intermediate, compressible element. Generally, the force-sensing structures 1210 and 1220 can be used to determine a magnitude of a touch on a surface of the device. As explained above with respect to FIGS. 3-5, a force applied to the device compresses or deforms the compressible element, changing the distance between the first and second capacitive plates. The change in distance can be measured as a change in capacitance between the two plates using force-sensing circuitry. Accordingly, the two structures 1210, 1220 cooperate to sense a force; in this manner, they may be referred to as either separately or together as a "force-sensing structure."

[0150] The electrical connector tail 1250 can be used to electrically couple the two force-sensing structures 1210, 1220 with the force-sensing circuitry, which may be located on a separate circuit component within the device. In some cases, it may be advantageous that the electrical connector tail 1250 is formed from a flexible conduit to facilitate connection with the force-sensing circuitry. For example, the electrical connector tail 1250 may be formed from a laminate of polyimide materials that have been printed or formed with electrical conductive traces. In some cases, it may be further advantageous that the flexible conduit be configured to bend easily to facilitate routing within the limited space of the device enclosure. To improve the flexibility or bend radius of the connector tail 1250, it may be advantageous to eliminate or remove the intermediate, compressible element in at least an end portion of the connector tail 1250. Removing the intermediate, compressible element

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may also facilitate electrical connection with one or more internal surfaces of the electrical connector tail 1250.

[0151] FIG. 13 depicts a cross-sectional view along line 3-3 of the electrical connector tail 1250. As shown in FIG. 13, the electrical connector tail 1250 is formed from four circuit layers 1211, 1212, 1221, 1222. In this example, each of the circuit layers includes at least one flexible dielectric layer and at least one flexible conductive layer. The flexible dielectric layer may be formed from a polyimide sheet and the electrical conductive layer may be formed from a metal film or metallized trace material. Further, in this example, each of the circuit layers is electrically connected with a capacitive plate of one of the force-sensitive structures 1210, 1220 (depicted in FIG. 12). For example, the electrical conductive layer of circuit layer 1211 may be electrically connected to a first (upper) capacitive plate of the force-sensitive structure 1210. Similarly, the electrical conductive layer of circuit layer 1212 may be electrically connected to a second (lower) capacitive plate of the force-sensitive structure 1210. Similarly, the circuit layers 1221 and 1222 are electrically connected to a first (upper) and a second (lower) capacitive plate, respectively, of the force sensitive structure 1220. In this example, each of the circuit layers 1211, 1221, 1222, and 1212 are electrically coupled to a respective terminal 1213, 1223, 1224, and 1214.

[0152] Alternatively, one or more of the circuit layers 1211, 1221, 1222, and 1212 may serve as a ground layer for the force-sensitive structure 1250. In one example either of both of the outer circuit layers 1211 or 1212 are held at a constant voltage during the operation of the sensor to act as an electromagnetic shield. In some cases, the outer circuit layers 1211 or 1212 are connected to ground during the operation of the sensor to facilitate electromagnetic shielding. One or more of the outer circuit layers may serve as a ground shield, depending on the location of the source of the interference. In some cases, one or more additional ground shield circuit layers are added to the force-sensitive structure. These additional ground shield layers may be added, for example, to the outer surfaces of the outer circuit layers 1211 and 1212. In one example, the conductive traces in any ground shield layer may extent substantially across the entire surface of the circuit layer to maximize the area that is shielded by the ground shield layer.

[0153] As shown in FIG. 13, the two circuit layers 1211 and 1221 are separated from the other two circuit layers 1212, and 1222 by the intermediate compressible layer 1230. In this example, the compressible layer 1230 serves as the compressible element in the force sensors 1210, 1220. As also shown in FIG. 13, the compressible layer 1230 does not extend into an end portion 1255 of the electrical connector tail 1250. As shown in FIG. 13, a

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void region 1350 is formed between the pairs of circuit layers. In some embodiments, the tail may lack any intermediate compressible layer.

[0154] As explained above, this configuration may be advantageous from a few aspects. First, because there is no material connection between the upper and lower pairs of circuit layers, the bendability of the electrical connector tail 1250 is improved, which may facilitate a smaller bending radius. Additionally, because there is no material between the pairs of circuit layers, additional internal electrical terminals 1223 and 1224 may be used for electrical connections. This reduces the need for circuit vias or additional electrical routing that may otherwise be required to electrically connect the electrical conductive layers of internal circuit layers 1221 , 1222 to an external terminal.

[0155] The tail 1250 may extend from the force-sensing structures 1210, 1220 and bend one or more times to connect to a flex or other electrical connection within the device. As one non-limiting example, the tail 1250 or, more appropriately, the flexible dielectric and flexible conductive layers may bend in a serpentine fashion to each an interconnect. Two separate structures may form the tail; each such structure may be formed from one flexible dielectric and one flexible conductive layer. Generally, the two tail structures may follow different paths insofar as one extends from the upper force-sensing structure 1210 and one from the lower force-sensing structure 1220. Nonetheless, the constituent structures of the tail 1250 are typically routed such that they do not experience any force exerted on a cover glass, housing or other external force-sensitive surface. Thus, the tail 1250 may not present a secondary path for an exerted force to bypass the force sensor which, in turn, may increase the accuracy of the force sensor. Likewise, other components of the electronic device may be structured such that they do not absorb or divert force exerted against a force-sensitive surface of the electronic device.

[0156] While the device 1200 depicted in FIG. 12 includes two force-sensing structures located around the periphery of a display element 1202, an alternative embodiment may include only a single force-sensing structure. In this case, the electrical connector tail may only include two conductive layers (on two circuit layers). In other alternative embodiments, a device may include more than two force-sensing structures and the electrical connector tail may have multiple conductive layers to facilitate connection with each of the force-sensing structures.

[0157] FIG. 14 depicts an example process 1400 for manufacturing a force sensor having an electrical connector tail. The process 1400 can be used to manufacture the force sensors 1210, 1220 having an electrical connector tail 1250 in accordance with the embodiments of

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FIGS. 12 and 13. The process 1400 may also be used to manufacture force sensors having a variety of configurations, including configurations having a single pair of conductive layers.

[0158] In operation 1405, a first circuit layer is obtained. In this example, the first circuit layer comprises at least a first flexible conductive layer and a first flexible dielectric layer. With reference to FIG. 13, the first circuit layer may include one of either of the circuit layers pairs 1211, 1221 or 1222, 1212. In some cases, the first circuit layer may be obtained by forming the first conductive layer on the first dielectric layer. The conductive layer may be formed by, for example, bonding a metal foil to a surface of the first dielectric layer. In some cases, the conductive layer may be formed by a deposition or sputtering process that deposits a conductive material onto the dielectric layer. In one example, the conductive layer also forms one or more of the capacitive plates used for the force sensor. In some cases, the first circuit layer is pre-manufactured and obtained as a sheet or die-cut component.

[0159] In operation 1410, a second circuit layer is obtained. In this example, the second circuit layer also comprises at least a second flexible conductive layer and a second flexible dielectric layer. With reference to FIG. 13, the second circuit layer may also include one of either circuit layer pairs 1211, 1221 or 1222, 1212 (that is also separated from the first circuit layer by the intermediate compressible layer 1230). As described above, the first circuit layer may be obtained by forming the first conductive layer on the first dielectric layer by laminating a metal foil or depositing a conductive material onto a surface of the dielectric layer. The second circuit layer may also be pre-manufactured as a sheet or die-cut component.

[0160] In operation 1415, a laminate structure is formed. In particular, a laminate structure is formed such that the compressible layer is disposed between the first and second circuit layers. With reference to FIG. 13, an exemplary laminate structure includes the four circuit layers 1211, 1221, 1222, 1212 and the compressible layer 1230. In many cases, other layers are formed as part of the laminate structure. For example, additional circuit layers, adhesive layers, and coatings may be formed as part of the laminate structure. In particular, an adhesive layer is typically used to bond the intermediate compressible layer with the other, adjacent components of the laminate structure. It is not necessary that either the first or second circuit layers (obtained in operations 1405 and 1410) be immediately adjacent or bonded directly to the compressible layer.

[0161] Operation 1415 may be performed by, for example, placing pressure sensitive adhesive (PSA) layers between the components of the laminate structure. The laminate may then be subjected to a pressing operation to bond the layers. In some cases, heat or

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other curing techniques may be employed to bond the layers together. In some embodiments, the PSA may be applied, all layers bonded, and then the structure die cut to its final form.

[0162] Operation 1415 may also be performed using an injection or insertion molding process. In this case, the first and second circuit layers may be laminated or pre-formed with other layers or components. The layers may then be placed in opposite halves of an injection mold cavity and the intermediate compressible layer may be formed between the layers by injecting a molten or liquid material into the injection mold. In one example, a spacer element is placed between the first in second circuit layers to hold the first and second circuit layers against the respective halves of the injection mold. The spacer element may be approximately the same thickness as the final dimension of the compressible layer. In one example, the spacer element is compressible and is slightly larger than the final dimension of the compressible layer to be injection molded between the first and second circuit layers. In this case, the spacer element exerts a force against the first and second circuit layers, which are pressed against respective cavity walls of the injection mold. By pressing the circuit layers against the cavity walls, the injected molded material is more likely to fill the area between the circuit layers rather than filling an area between the circuit layers and the cavity walls. In one example, multiple spacer elements are used, each spacer element formed from a semi-circular ring. The spacer elements may be placed near the injection point of the mold, which is typically near the center of the part. The spacer elements can then be removed by die-cutting the center portion of the part, which may also facilitate the creation of a viewing area for the display.

[0163] As part of operation 1415, one or more electrical vias may be formed between the various layers of the laminate structure. In some cases, electrical vias are formed through the compressible layer to connect circuit layers that are disposed on opposite sides of the compressible layer. The vias may be formed by, for example, the addition of conductive pillar elements that electrically connect the conductive layers of different circuit layers. Additionally or alternatively, conductive regions within the compressible layer may be formed and then reflowed or otherwise electrically connected with conductive layers of the laminate structure.

[0164] In some cases, the laminate structure that is formed in operation 1415 is cut to form the force sensor having an electrical connector tail. For example, if the first and second circuit layers (obtained in operations 1405 and 1410) are formed as a solid sheet of material, the laminate structure may be die cut to form the desired geometric profile features of the force sensor. Specifically, a center portion may be cut out of the middle of the laminate

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structure to facilitate installation with a display element. Thus, the display element will be visible through the hole created in the middle of the laminate structure. As mentioned above, if the laminate structure includes spacer elements used for an injection molding process, they may be removed by this die cutting operation. Additional cuts may be performed to form the connector tail portion of the force sensor.

[0165] The cutting operation may be optional if, for example, the first and second circuit layers (obtained in operations 1405 and 1410) have been pre-cut or have been formed in the desired geometric profile shape. In this case, operation 1415 may also include an indexing operation to align the layers of the laminate structure.

[0166] In operation 1420, a portion of the compressible layer is removed from the laminate structure. In this example, a portion of the compressible layer located in an end portion of electrical connector tail is removed from the laminate structure leaving a void region between the first and second circuit elements. As explained above with respect to FIGS. 12 and 13, removal of the compressible layer may improve the flexibility or bendability of the laminate structure. It may also provide access to terminals or electrical connections on circuit layers that are internal to the laminate structure.

[0167] Removing the compressible layer may be accomplished using one or more techniques. In a first example, the compressible layer is perforated or pre-cut near the end portion of the electrical connector tail. Also, within the end portion of the electrical connector tail, the pressure sensitive adhesive or other bonding layer may be omitted between the compressible layer and the adjacent layers of the laminate structure. In this case, the pre-cut or perforation and the absence of a bonding layer allows the portion of the compressible layer in the end portion of the electrical connector tail to be removed.

[0168] In a second example, one or more layers of the laminate structure are delaminated or stripped from the compressible layer exposing the compressible layer. In this case, as secondary cut operation may be performed to remove the portion of the compressible layer in the end portion of the electrical connector tail.

[0169] In a third example, the compressible layer may be cut from the end portion of the electrical connector tail without first delaminating or stripping layers of the laminate structure. For example, the portion of the compressible layer within the end portion of the connector tail may be removed by passing a knife or cutting implement between the layers of the laminate structure.

[0170] As an alternative to operation 1420, the laminate structure may be formed such that the end portion of the electrical connector tail does not include the compressible layer.

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For example, if the laminate structure is formed using an injection or insertion molding process, an insert mold element may be placed in the end portion of the electrical connector tail preventing the formation of a compressible layer in this region. In this case, the laminate structure is formed with a void region between the first and second circuit layers.

[0171] As described above, the process 1400 may also be used to manufacture force sensors having a variety of configurations, including configurations having a single pair of conductive layers. For example, a force sensor having only two circuit layers (one on each side of the intermediate compressible layer) may be formed using process 1400. Alternatively, a force sensor having multiple circuit layers formed on either side of the intermediate compressible layer may also be formed using process 1400.

[0172] The operations of process 1400 are provided as one example. However, a force sensor may also be formed by omitting one or more of the operations described above. For example, depending on how the laminate structure is created, it may not be necessary to perform operation 1420 to remove a portion of the compressible layer.

[0173] In certain embodiments, the tail may be connected to a flex, circuit board or other electronic contact. In some embodiments, the entire force-sensing structure may be placed into an oven to bond the tail to the electrical contact through, for example, a surface-mount technology (SMT) process. In some embodiments, the SMT process may heat the tail (or portions thereof) and/or the electrical contact to 200 degrees or more. This elevated temperature may have deleterious effects on the silicone of the force-sensing structure, however. Thus, the force-sensing structure may be placed in a heat-resistant envelope, pouch or other container with the tail extending outwardly therefrom. Thus, when the oven is heated for the SMT process, the tail may be heated to the appropriate temperature while the silicone and other layers of the force-sensing structure may be maintained at a temperature that does not cause damage. Further, it should be appreciated that the force-sensing structure may not be singulated or cut into its final form prior to heating in the oven.

[0174] FIG. 15A depicts another embodiment 1500 of a force-sensing electronic device. Similar to other embodiments described herein, the embodiment 1500 may include and electronic device having a cover 1505 positioned over a display stack 1515, which may be configured to detect the touch of a force on the surface of the cover 1505. The cover 1505 may be formed from a variety of materials including, for example, glass, polycarbonate or other plastic, sapphire and the like. The display stack 1515 may include a liquid crystal display (LCD), organic light omitting diode (OLED), or other electronic display component.

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[0175] In some embodiments, the cover 1505 may move with respect to the housing 1510. When a force is exerted on the cover 1505, by, for example, the touch of a user, the cover 1505 may travel downwardly. It should be appreciated that the entirety of the cover 1505 may travel in such a fashion, rather than only deflecting locally while edges of the cover 1505 remain substantially immobile. Whether the cover 1505 deflects locally or not may depend on the relative stiffness of the cover 1505 and the components/elements positioned below the cover 1505.

[0176] In some embodiments, the downward travel of the cover 1505 likewise moves the display stack 1515 downward, which in turn may impact and/or compress a sheet sensor 1520 positioned beneath the display stack 1515. The sheet sensor 1520 may include a capacitive-plate type force sensor, strain gauge sensor, or other force-sensitive sensor, and may generally be referred to as a force sensing structure, sensor, or sheet sensor. In general, the sheet sensor 1520 may extend over a substantial portion of the display stack 1515. In some cases, the sheet sensor 1520 is formed from an array or series of force-sensing elements that are disposed throughout the area of the sheet sensor 1520.

[0177] As shown in FIG. 15A, the sheet sensor 1520 may substantially abut the display stack 1515. In some embodiments, the sheet sensor 1520 may be separated therefrom by an air gap and/or other components or layers in certain embodiments. In some embodiments, the sheet sensor 1520 may be affixed directly to an element of the display stack 1515.

[0178] The sheet sensor 1520 may be supported by a plate 1525 positioned below the sensor 1520 opposite the side facing the display stack 1515. In some embodiments the plate 1525 may be rigid or substantially rigid, while in other embodiments the plate 1525 may be flexible. Typically, although not necessarily, the sheet sensor 1520 is affixed to the plate 1525. In some embodiments, the plate 1525 may be fixed relative to the housing 1510 of the device. In some embodiments, the plate 1525 may be a mid-plate providing structural support and/or stiffness to the housing 1510 of the electronic device 1500, while in other embodiments the plate 1525 may be used primarily or solely to support the sheet sensor 1520. In still other embodiments, other electronic components (not shown) may share the plate 1525 with the sheet sensor 1520.

[0179] As the cover 1505 and display stack 1515 move downward, the sheet sensor 1520 may be compressed. This compression may be sensed by the sheet senor 1520 and a corresponding output generated. For example, the sheet sensor 1502 may have first and second capacitive plates or arrays 1530, 1535 (as used herein, the term "plate" is intended to cover an array as well) defining an upper surface and a lower surface of the sheet sensor,

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or otherwise positioned in an upper and lower region of the sensor. The first and second capacitive plates 1530, 1535 may be separated from one another by a compressible inner layer 1540, such as silicone or a compliant gel or polymer.

[0180] In some embodiments, the first and second capacitive plates 1530, 1535 are operatively coupled to a sensing circuit that is configured to estimate the force of a touch on the cover based on a change in capacitance between the first and second capacitive plates 1530, 1535. In some implementations, sensing circuit is configured to generate a drive signal or electrical current that is used to detect and measure changes in capacitance between the first and second capacitive plates 1530, 1535. As the first capacitive plate 1530 moves toward the second capacitive plate 1535, the reduction in distance may correspond to a change in capacitance between the plates, which may be correlated to the force exerted on the cover 1505.

[0181] It should be appreciated that the sheet sensor 1520 may operate as a self-capacitance or mutual capacitance sensor to measure force in this fashion. Accordingly, in a mutual capacitance configuration, one of the first and second capacitive plates may be a drive plate and the other may be a sense plate. In a self-capacitance configuration, one of the first and second plates maybe a ground or shield layer while the other is a sense plate. Further, one or both plates of the sheet sensor 1520 may be formed in a pixel pattern (as may the sheet sensor 1520 itself) in order to locally register the application of a force and provide a localized region at which a force is applied.

[0182] In an embodiment having a flexible or deflectable plate 1525 supporting the sheet sensor 1520, changes in capacitance may still be measured so long as the layers of the sensor sheet 1520 compress, even if the plate 1525 itself flexes. Similarly, in embodiment having an air gap between the sheet sensor 1520 and display stack 1515, a force of a touch may not be sensed until the display stack moves far enough to compress or impact the sheet sensor.

[0183] It should be appreciated that the sheet sensor 1520, as shown in FIG. 15A, need not be transparent insofar as it is located beneath the display stack 1515. Further, such a configuration may be suitable not only for use with a display stack having an LED or LCD display, but also with a display stack incorporating an OLED display layer.

[0184] FIG. 15B depicts an alternative embodiment 1500B of the embodiment shown in FIG. 15A. In this embodiment 1500B, foam 1545 or other compliant material or compliant layer may be placed between the display stack 1515 and sheet sensor 1520. The foam 1545 may generally stiffen the display stack 1515 and/or cover 1505 and thus prevent the

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entire stack/glass from moving downward. Instead, when a force is exerted on the cover 1505, the foam 1545 may deform locally and thereby concentrate the deformation and/or force in a localized region, which may in turn enhance the force-sensing capabilities of the embodiment 1500B. It should be appreciated that any suitable material may be placed between the display stack 1515 and the sheet sensor 1520; foam is but one example material.

[0185] In some embodiments, a compliant environmental gasket 1550 or seal may be positioned between the cover 1505 and housing 1510. The compliant gasket may prevent the ingress of dirt, dust and the like into the interior of the electronic device 1500B, but may still permit downward travel of the cover 1505 and display stack 1515. In alternative embodiments, the gasket 1550 may be relatively rigid and may cooperate with the foam 1545 (or operate in the absence of the foam 1545) to restrict downward motion of the cover 1505 at one or more edges, with the net result that the cover may deflect locally instead of traveling as a whole. Force may still be sensed in such an embodiment through localized compression of the sheet sensor 1520.

[0186] In some embodiments, a portion or all of the region occupied by the gasket 1550 may be coated with an oleophobic material. The oleophobic material may serve as a barrier against, or repel, oils, dust, dirt and other similar materials from entering the housing 1510 and/or impacting the force-sensing structure 1520. In this fashion the coating may serve to maintain operation of the force-sensing structure over time. Coatings other than an oleophobic coating may be used; other dust- and/or oil- and/or dirt-repellent coatings may be used in different embodiments.

[0187] FIG. 15C depicts still another embodiment of a force-sensitive electronic device 1500. This embodiment is generally similar to that of FIG. 15B, except for the structure of the sheet sensor 1520C. Here, the sheet sensor 1520C may be patterned from one or more strain gauges rather than taking the form of a capacitive sensor. Individual strain gauges may be arranged in an array, grid, or other pattern to form the sheet sensor 1520C. The strain gauges may be formed from a material that changes electrical properties or produces an electrical response due to a deflection of the sheet sensor 1520C. The strain gauges may be formed, for example, from a resistive material, piezoelectric resistive material, piezoelectric material, and the like. The strain gauges may also be formed as an array of strain gauge elements, each element comprised of a series of traces or patterns that may be configured to detect a localized strain or deflection.

[0188] As force is exerted on the cover 1505, it is transferred through the display stack 1515, through the foam 1545 (or other compliant layer), and to the strain gauge(s) of the

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sheet sensor 1520C. The strain gauges may experience an increase in strain due to the exerted force; this increase in strain may be correlated to determine the magnitude of the exerted force as generally described elsewhere herein. In some embodiments, the sheet sensor 1520C is operatively coupled to sense circuitry that is configured to monitor and detect changes in an electrical property or measure and electrical response of the strain gauges of the sheet sensor 1520C. For example, the sense circuitry may be configured to detect a change in resistance and/or charge due to a deflection of the sensor sheet 1520C.

[0189] In the embodiments shown in FIGS. 15A-15C, the cover and display stack are generally free to translate with respect to the housing. In some embodiments, the cover and/or display stack may be adhered to the housing or otherwise fixed with respect to the housing, such that force exerted on the cover causes local deformation of the cover rather than translation. In such embodiments, force may be relatively localized insofar as the boundary conditions of the cover prevent motion. Since the cover may still deflect locally, a force may still be transmitted through the various layers and sensed by the force sensor (e.g., the sheet sensor).

[0190] FIG. 15D depicts a close-up of area 15D in FIG. 15C, showing one embodiment of a compliant layer 1545D positioned between the sheet sensor 1520 and the base of the display stack 1515. In the cross-sectional view of the electronic device 1500 shown in FIG. 1, the compliant layer 1545D is formed from a series or array of pillar-like structures 1560 sandwiched between an upper compliant substrate 1555 and a lower rigid substrate 1565 made of glass or the like. (In some embodiments, the lower substrate may also be compliant). In certain embodiments, the upper sheet 1555 may be formed from silicone, as may the pillar structures 1555. A sheet sensor 1520C is located beneath the lower substrate 1565. In the present embodiment, the sheet sensor 1520C is formed of one or more strain gauges, as discussed above with respect to FIG. 15C. The sheet sensor 1520C may be supported by a sense plate 1525, as generally discussed above.

[0191] In some implementations, the pillar structures 1555 may deform under downward pressure exerted on the compliant layer 1545C by the display stack 1515, or any other element of the electronic device 1500C that exerts pressure on the compliant layer 1545D. One or more void spaces 1550 may be defined between and/or around the pillars 1555. For example, adjacent pillars 1550 may be separated by a void space 1560 and each void space 1560 may be separate and distinct. As another option, a single void space 1560 may encompass all the pillars 1555. Different configurations of void spaces and pillar structures are thus contemplated.

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[0192] As the pillar structures 1555 deform, the top sheet 1555 moves closer to the bottom sheet 1565 and the resistance of the pillar structure to further collapse increases. Further, the strain exerted on the sheet sensor 1520C through the compliant layer 1545D generally increases, causing the strain gauge output to increase. This increase in output may be correlated to a force exerted on the exterior of the housing.

[0193] In some embodiments, the void space or spaces 1550 may be filled with an optically transparent or near-transparent fluid, gel or the like (collectively, "fluid"). In some embodiments, the fluid may be optically indexed matched to the optical index of the pillar structures. That is, in certain embodiments, the index of refraction of the fluid may match or approximate that of the pillar structures 1555. In such an embodiment, the combination of fluid in the void spaces 1550 and pillar structures 1560 may render the compliant layer 1545D optically transparent and/or near-invisible. This may be useful when the display is an OLED display, for example.

[0194] In yet another embodiment and as shown in FIG. 15E, the compliant layer 1545D may separate a lower capacitive sensing array 1570 from an upper capacitive sensing array 1575. In such an embodiment 1500E, the capacitive sensing arrays 1570, 1575 may operate as described elsewhere herein, such that one array is a drive array (or reference array) and one is a sense array. The compliant layer 1545D may serve to prevent the two layers from approaching too close to one another and thus prevent, or at least reduce the likelihood of, contact between the two layers and/or excessive capacitive coupling between the two layers, which may result in inaccurate force measurement.

[0195] FIG. 16 depicts a partial cross-section of another embodiment of a force-sensing electronic device 1630. This embodiment may include a force-sensing structure 1600 similar to that shown in FIGs. 2A and 3, and described elsewhere herein. For example, the force-sensing structure 1500 may be configured with multiple capacitive layers separated by a deformable middle body, as generally discussed with respect to FIG. 3 and/or the variants shown in FIGs. 4-6. The force-sensing structure 1600 may take the form of a gasket any may be located between the cover 1505 and a housing 1510. In one embodiment, the portion of the housing 1510 adjacent the cover 1505 may include a bezel or bezel portion.

[0196] The force-sensing structure 1600 may extend partly or fully about a perimeter of the electronic device, cover, and/or portion of either. Alternately, multiple force-sensing structures 1600 may cooperate to extend partly or fully about a perimeter of the electronic device 1630, cover, and/or portion of either. In some embodiments, the force-sensing structure 1600 may be configured to prevent the ingress of contaminants into the interior of the housing 1510 and, therefore, may also function as a gasket. In some cases, the

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combination gasket and sensor is referred to as a strain-sensitive gasket or gasket force-sensing structure.

[0197] As with prior embodiments, the force-sensing structure 1600 may capacitively sense a distance between the first and second plates 1620, 1625 or other sensor structures; the output of the force-sensing structure 1600 may be correlated to a force by a sensing circuit, processor, or other electronic component of the force-sensing electronic device 1630. In some embodiments, the force-sensing structure 1600 is operatively coupled to sense circuitry that is configured to detect and measure changes to an electrical property of the force-sensing structure 1600, which may be correlated to the force of a touch on the cover 1505.

[0198] In addition to the force-sensing structure 1600 generally positioned between the cover 1505 and bezel or housing 1510, the present embodiment may incorporate a force-sensitive sheet sensor 1520. The sheet sensor 1520 is generally similar in configuration and operation to any of the sheet sensors described above with respect to FIGs. 15A-15D.

[0199] As shown in FIG. 16, the sheet sensor 1520 may be separated from the display stack by a small air gap. Additionally or alternatively, the sheet sensor 1520 may be separated from the display stack by a compressible layer similar to the compressible layer described above with respect to FIGS. 15B-E. When the cover 1505 and display stack 1515 deflect in response to a force, the gasket force-sensing structure 1600 may compress and sense force, as generally described herein. To prevent bottoming out of the cover and display stack when a force is applied away from the edges of the cover, the sheet sensor 1520 may be included. When the display stack and cover deform sufficiently, they may contact the sheet sensor 1520 and transmit force thereto. The two force sensors 1600 and 1520 may cooperate to determine a force. For example, the output of both force sensors may be taken and manipulated to determine the force exerted on the cover. In this manner, the dynamic force sensing range of the device 1500 may be extended to sense and react to forces that would otherwise be sufficiently large to cause the cover to bottom out and the single gasket sensor 1600 to register a maximum value. In some embodiments, the air gap is configured to at least partially collapse in response to a force of a touch that exceeds a first threshold. In some implementations, the first threshold is less than a second threshold that corresponds to a maximum force that can be practically or reliably detected by gasket force-sensing structure 1600.

[0200] FIG. 17 depicts yet another embodiment of an electronic device 1700 that may employ a sheet or pad sensor 1520 for capacitively measuring a force exerted on a cover 1505 (or, in other embodiments, a portion of a housing or a different type of input surface).

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Generally, the structure and operation of the sheet sensor 1520 is similar to that described herein with respect to prior figures.

[0201] In addition to the upper and lower capacitive arrays of the sheet sensor 1520, a second capacitive sense layer/array 1705 may be placed within the display stack 1515. In one embodiment, the second capacitive sense layer 1705 may be formed from indium-tin-oxide, silver nanowire, PEDOT, or any other suitable conductive material. In certain embodiments, it may be desirable for the second capacitive sense layer 1705 to be transparent.

[0202] In the embodiment 1700 of FIG. 17, the second capacitive sense layer 1705 may be placed relative to the display stack 1515. The capacitive sense layer 1705 may, in some instances, function as a capacitive touch sensor for sensing the location of a touch on the cover 1505. In some embodiments, the capacitive sense layer 1705 is positioned above a backlight unit 1710. If the second capacitive sense layer 1705 is transparent or nearly so, it may not interfere with the operation of the backlight unit 1710 and/or the remainder of the display stack 1515.

[0203] As shown in FIG. 17, an air gap may be located between the capacitive sense layer 1705 and the sheet sensor 1520. Additionally or alternatively, the sheet sensor 1520 may be separated from the capacitive sense layer 1705 by a compressible layer similar to the compressible layer described above with respect to FIGS. 15B-E.

[0204] As a force is exerted on the cover 1505 (or housing or input surface, in some embodiments), the cover and display stack 1515 are moved closer to the sheet sensor 1520. Thus, the second capacitive sense layer 1705 is likewise moved closer to the sheet sensor 1520. Accordingly, a capacitance between at least a portion of the second capacitive sense layer 1705 and the upper capacitive array 1530 of the sheet sensor 1520 may increase with such motion. Further, because the cover 1505, display stack 1515 and second capacitive sense layer 1705 may deform locally in response to the force, the capacitance may increase (or increase more) in the general region corresponding to the exerted force. This change in capacitance may be used to estimate the applied force, as generally described elsewhere herein.

[0205] Under sufficient force, the backlight unit 1710 (or other base of the display stack) will contact the upper surface of the sheet sensor 1520. Once this occurs, the capacitance between the second capacitive sense layer 1705 and the upper capacitive array 1530 of the sheet sensor 1520 will generally reach a maximum value. Additional force may cause the sheet sensor 1520 to compress, thereby moving at least a portion of the upper capacitive

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array 1530 closer to the lower capacitive array 1535 and increasing a capacitance between these two elements, at least within a given region. Thus, even though the capacitance between the second capacitive sense layer 1705 and the upper capacitive array 1530 may be at maximum or near-maximum value, the increase in capacitance between the arrays 1530, 1535 of the sheet sensor 1520 may be used to determine estimates of an exerted force.

[0206] In some embodiments, sensing circuitry is operatively coupled to the capacitive sense layer 1705 and the sheet sensor 1520. The sensing circuitry may be configured to estimate the force of a touch on the cover based on a change in mutual capacitance between the capacitive sense layer 1705 and the upper and/or capacitive plate of the sheet sensor 1520. In some embodiments, the sensing circuitry may be configured obtain a first capacitance between the upper capacitive plate and the lower capacitive plate of the sheet sensor and also obtain a second capacitance between the upper capacitive plate and the capacitive sense layer. An estimate of a force of a touch on the cover may be computed or generated using the first and second capacitances measured using the sensing circuitry.

[0207] It may be considered, then, that the capacitance between the second capacitive sense layer 1705 and the upper capacitive array 1530 may be used to determine or estimate an exerted force between zero and some first threshold value, and the capacitance between the upper and lower capacitive arrays 1530, 1535 of the sheet sensor 1520 may be used to determine an exerted force between the first threshold value and a second threshold value. This combination of sensing structures may provide force sensing about a wider range of values than may be achieved by the use of a single sensor.

[0208] It should be appreciated that embodiments described herein may measure changes in force, thereby providing a non-binary or even substantially continuous input to an associated electronic device, corresponding to changes in distance or less than 2 microns between two capacitive structures or arrays. Thus, although one or both of the capacitive structures or arrays may move with respect to the other, the motion may be imperceptible to a human interacting with the device. Changes in distance on the measure of nanometers may correspond to approximately one gram of force being exerted on a surface, as one non-limiting example.

[0209] While the present disclosure has been described with reference to various embodiments, it will be understood that these embodiments are illustrative and that the scope of the disclosure is not limited to them. Many variations, modifications, additions, and improvements are possible. More generally, embodiments in accordance with the present disclosure have been described in the context of particular embodiments. Functionality may

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be separated or combined in procedures differently in various embodiments of the disclosure or described with different terminology. These and other variations, modifications, additions, and improvements may fall within the scope of the disclosure as defined in the claims that follow.

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CLAIMS

We claim:

1. An electronic device comprising:

a cover;

a display positioned below the cover;

a force-sensing structure disposed below the display, wherein the force-sensing structure comprises:

an upper capacitive plate;

a lower capacitive plate disposed below the upper capacitive plate; and

a compressible element disposed between the upper and lower capacitive plates; and

a plate affixed to and supporting the force-sensing structure.

2. The electronic device of claim 1, further comprising:

sensing circuitry that is operatively coupled to the force-sensing structure, wherein the sensing circuitry is configured to estimate the force of a touch on the cover based on a change in capacitance between the upper capacitive plate and the lower capacitive plate.

3. The electronic device of claim 1, wherein the force-sensing structure is separated from the display by a compliant layer including an air gap.

4. The electronic device of claim 1, wherein the force-sensing structure is separated from the display by a compliant layer comprised of compressible foam.

5. The electronic device of claim 1, wherein the force-sensing structure is separated from the display by a compliant layer comprised of an array of compliant pillars and an optically transparent fluid.

6. The electronic device of claim 1, further comprising:

a housing having a bezel surrounding the cover;

a gasket disposed in a gap between the cover and the bezel; and

an oleophobic coating disposed over at least a portion of the gap.

7. An electronic device comprising:

a housing;

a cover disposed within an opening of the housing;

a strain-sensitive gasket disposed between the cover and the housing along a perimeter of the cover; and

a force-sensing structure disposed below the cover.

8. The electronic device of claim 7, further comprising a plate fixed relative to the housing and supporting the force-sensing structure.

9. The electronic device of claim 7, wherein the strain-sensitive gasket comprises:

a gasket upper capacitive plate;

a gasket lower capacitive plate; and

a gasket compressible element disposed between the gasket upper capacitive plate and the gasket lower capacitive plate.

10. The electronic device of claim 7, further comprising:

a display disposed between the cover and the force-sensing structure; and

a compressible layer comprising an air gap between the display and the force-sensing structure.

11. The electronic device of claim 10, wherein:

the air gap of the compressible layer is configured to at least partially collapse in response to a force of a touch that exceeds a first threshold; and

the first threshold is less than a second threshold that corresponds to a maximum force that can be detected by the strain-sensitive gasket.

12. The electronic device of claim 7, further comprising:

a display disposed between the cover and the force-sensing structure; and

a compressible layer between the display and the force-sensing structure, wherein the compressible layer is configured to at least partially collapse in response to a force of a touch that exceeds a first threshold, and

the first threshold is less than a second threshold that corresponds to a maximum force that can be detected by the strain-sensitive gasket.

13. The electronic device of claim 7, wherein the force-sensing structure comprises:

an upper capacitive plate;

a lower capacitive plate; and

a compressible element disposed between the upper capacitive plate and the lower capacitive plate.

14. The electronic device of claim 7, wherein the force-sensing structure comprises a strain gauge.

15. An electronic device comprising:

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a cover;

a capacitive sense layer positioned below the cover;

a compressible layer below the capacitive sense layer; and

a force-sensing structure disposed below the compressible layer, wherein the force-sensing structure comprises:

an upper capacitive plate;

a compressible element disposed on one side of the upper capacitive plate; and

a lower capacitive plate disposed on a side of the compressible element that is opposite the upper capacitive plate.

16. The electronic device of claim 15, further comprising:

a plate positioned below the force-sensing structure and supporting the force-sensing structure.

17. The electronic device of claim 15, wherein the compressible layer comprises an air gap.

18. The electronic device of claim 15, further comprising:

a display positioned below the cover; and

a backlight positioned below the display, wherein the capacitive sense layer is disposed between the display and the backlight.

19. The electronic device of claim 15, further comprising:

sensing circuitry that is operatively coupled to the capacitive sense layer and the force-sensing structure, wherein the sensing circuitry is configured to estimate the force of a touch on the cover based on a change in mutual capacitance between the capacitive sense layer and the upper capacitive plate of the force-sensing structure.

20. The electronic device of claim 19, wherein the sensing circuitry is configured to:

obtain a first capacitance between the upper capacitive plate and the lower capacitive plate of the force sensing structure;

obtain a second capacitance between the upper capacitive plate and the capacitive sense layer; and

generate an estimate of a force of a touch on the cover using the first and second capacitances.

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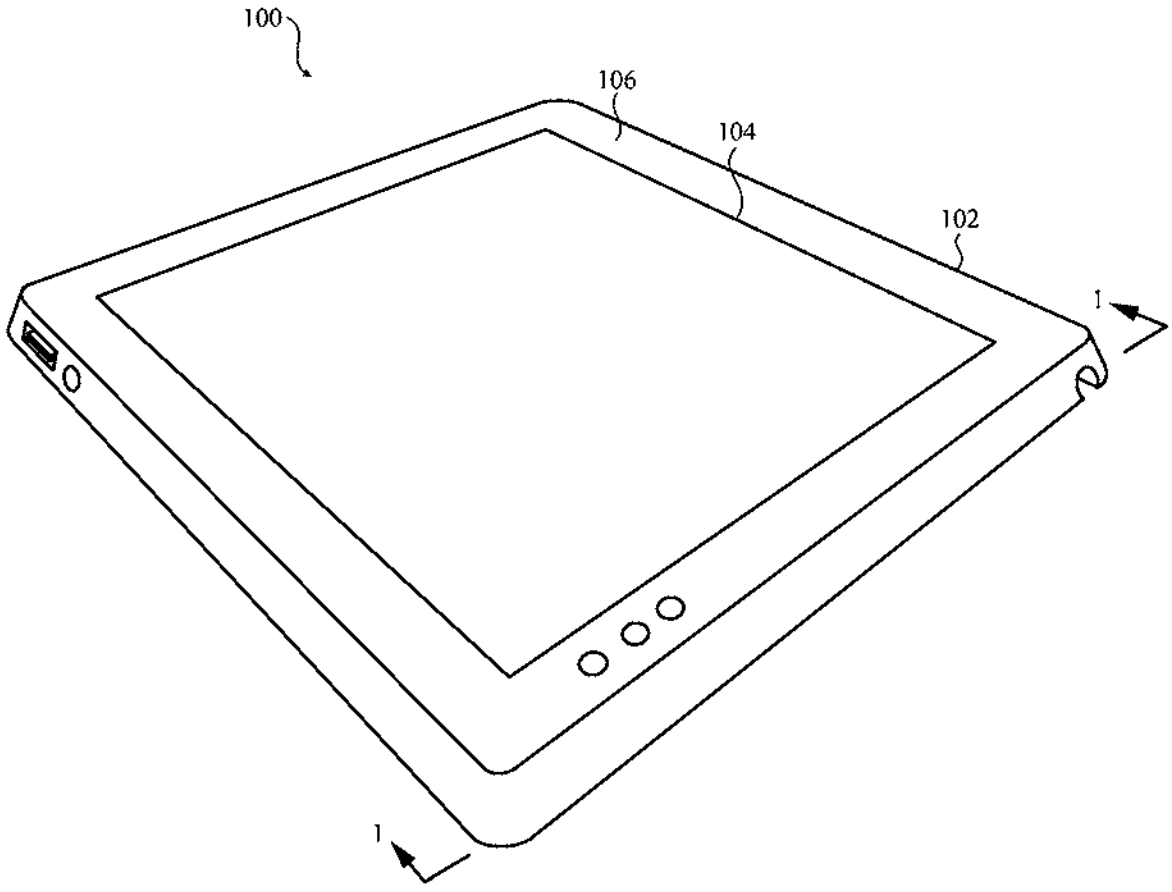
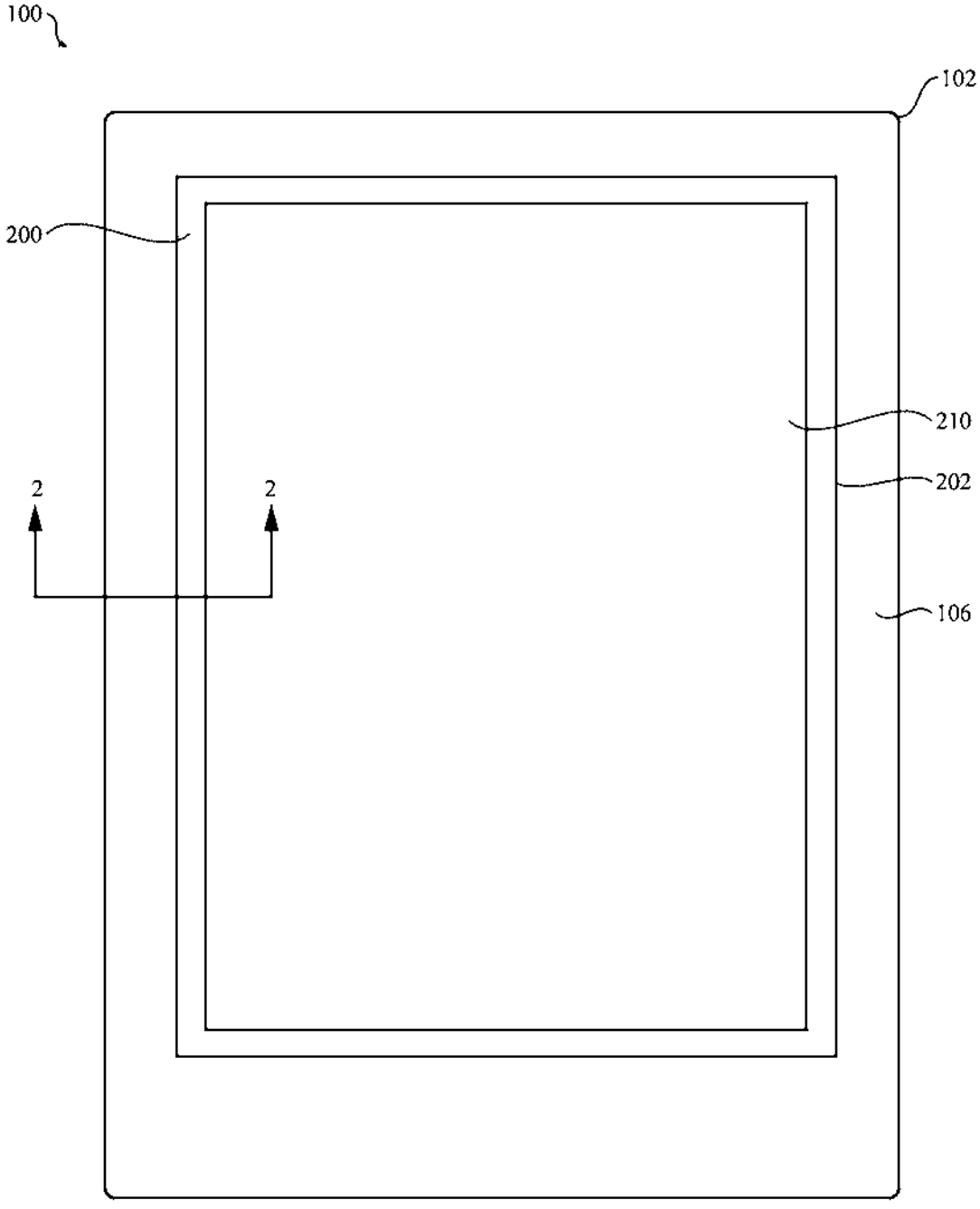


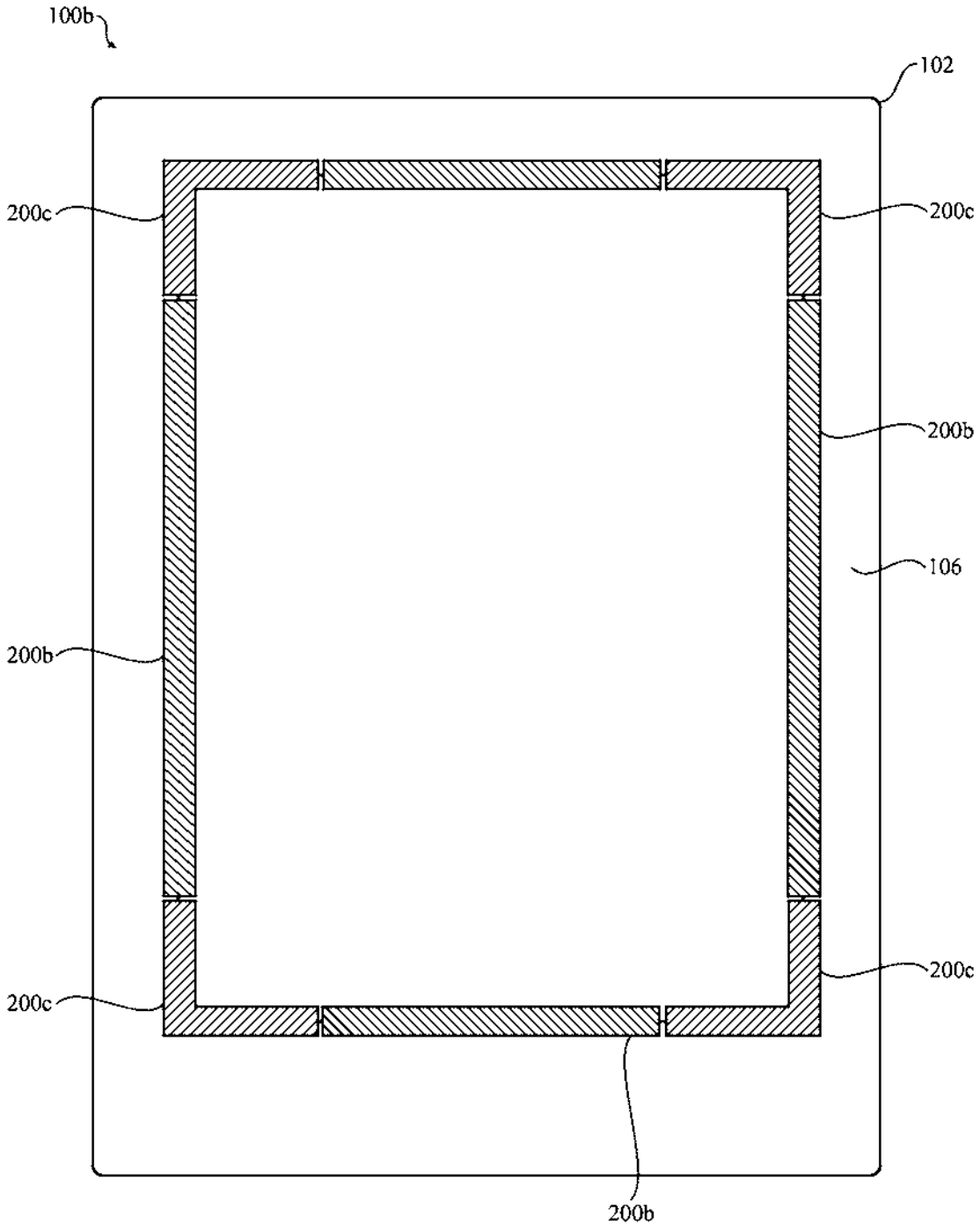
FIG. 1

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SECTION 1-1
FIG. 2A

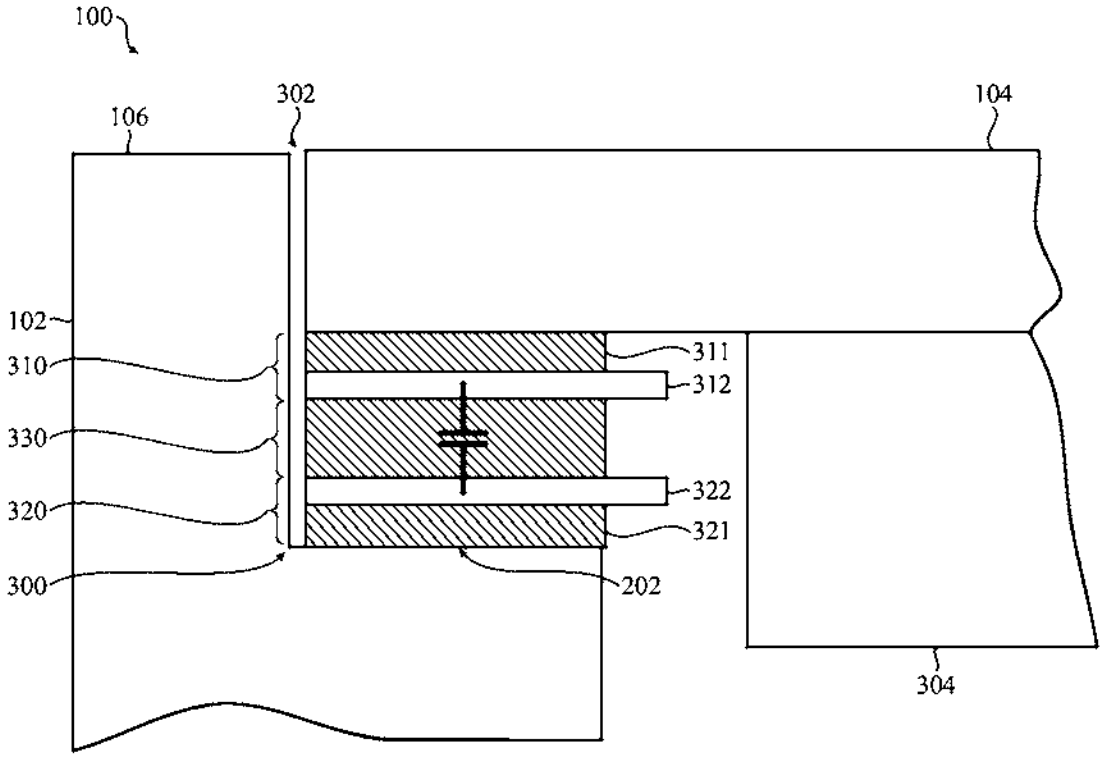
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SECTION 1-1

FIG. 2B

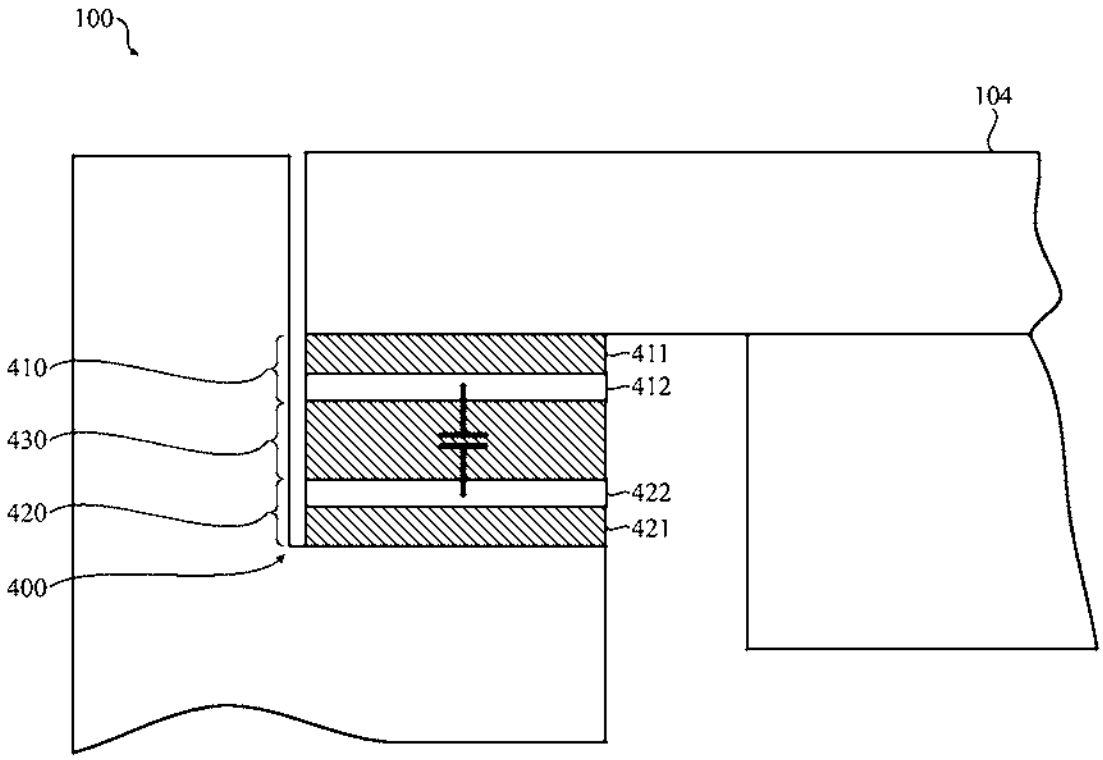
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SECTION 2-2

FIG. 3

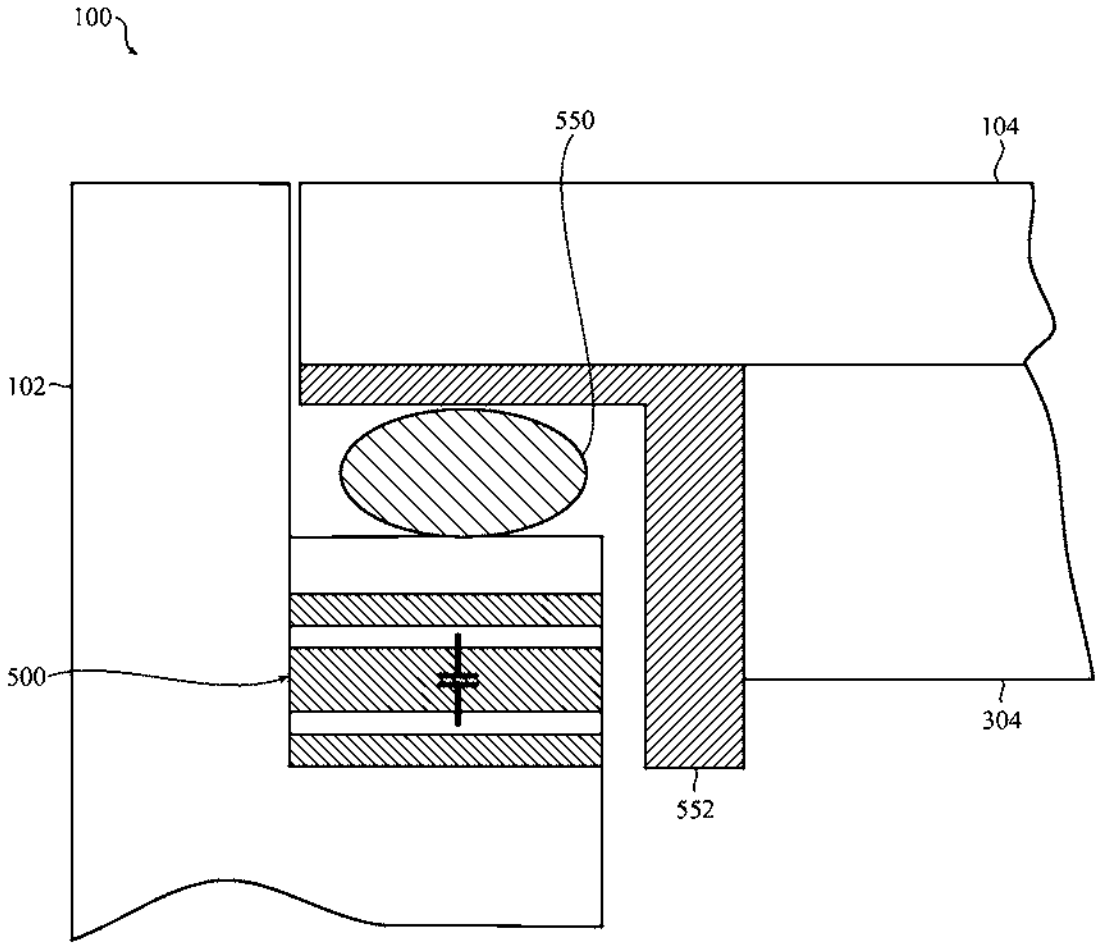
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SECTION 2-2

FIG. 4

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SECTION 2-2

FIG. 5

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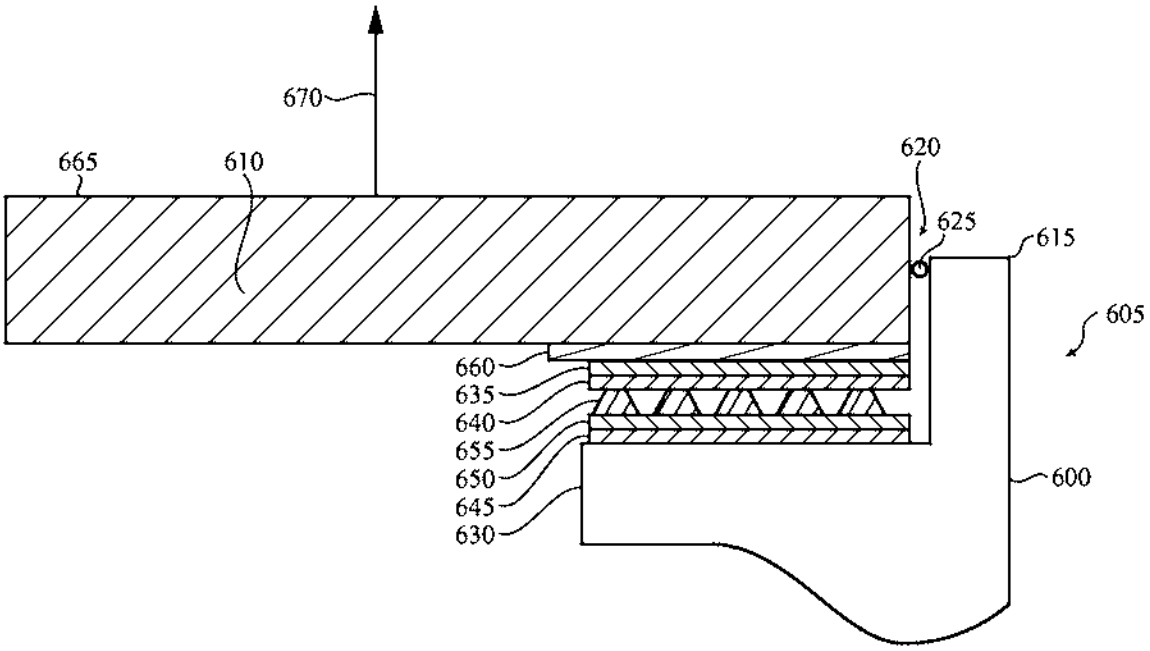


FIG. 6

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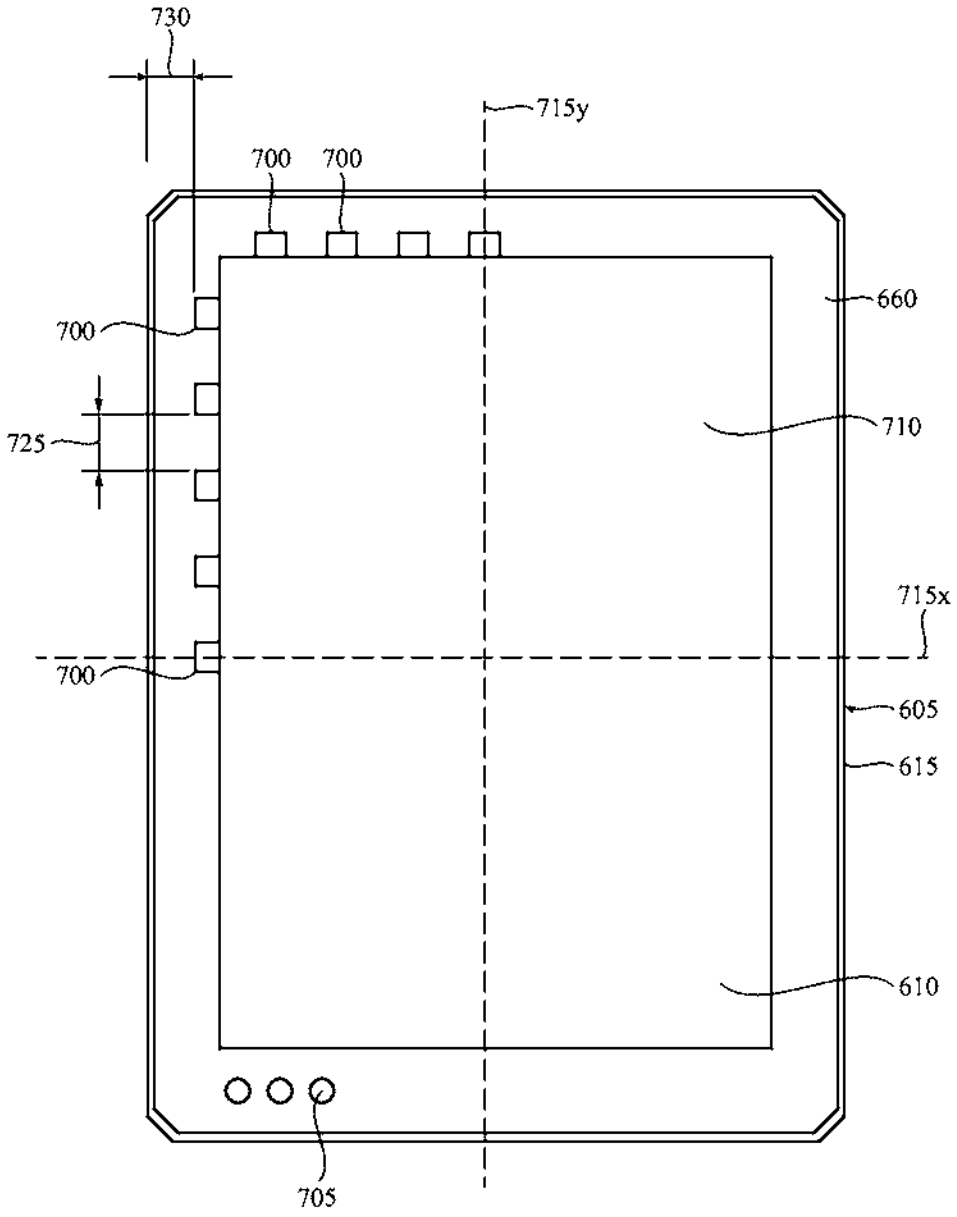


FIG. 7

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1419

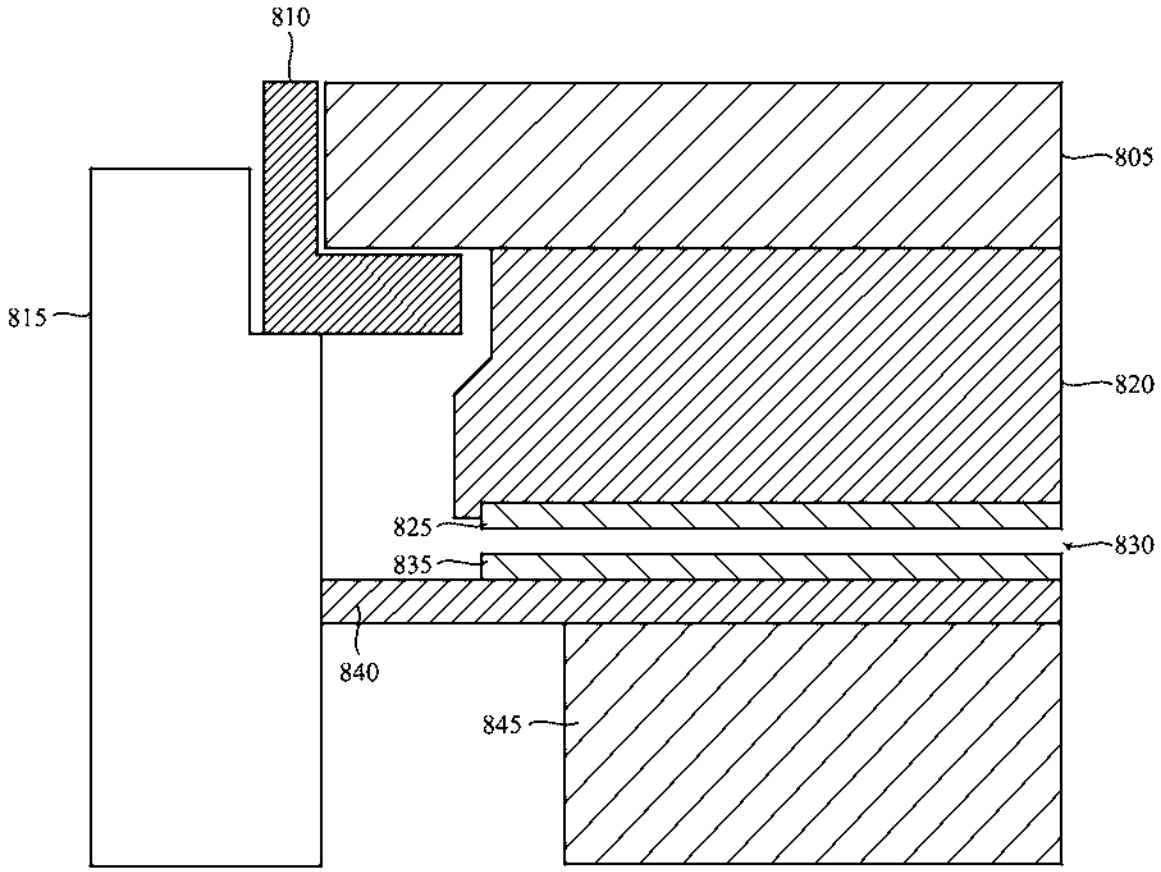


FIG. 8

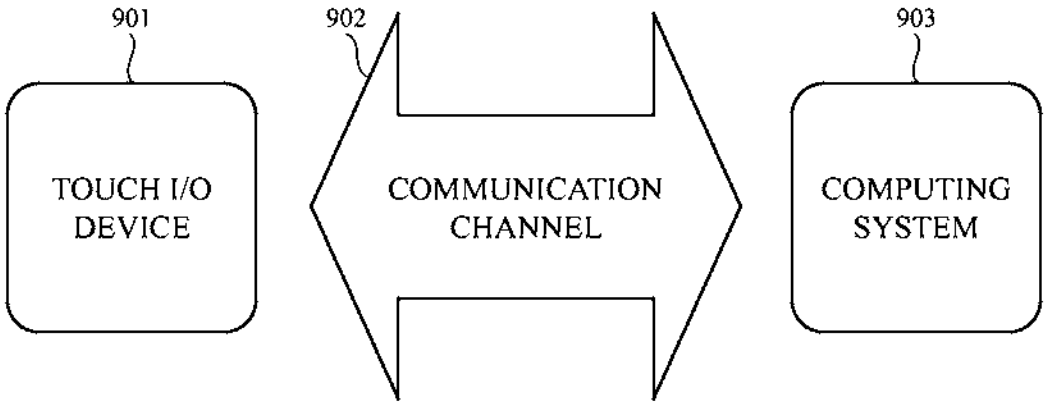


FIG. 9

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1421

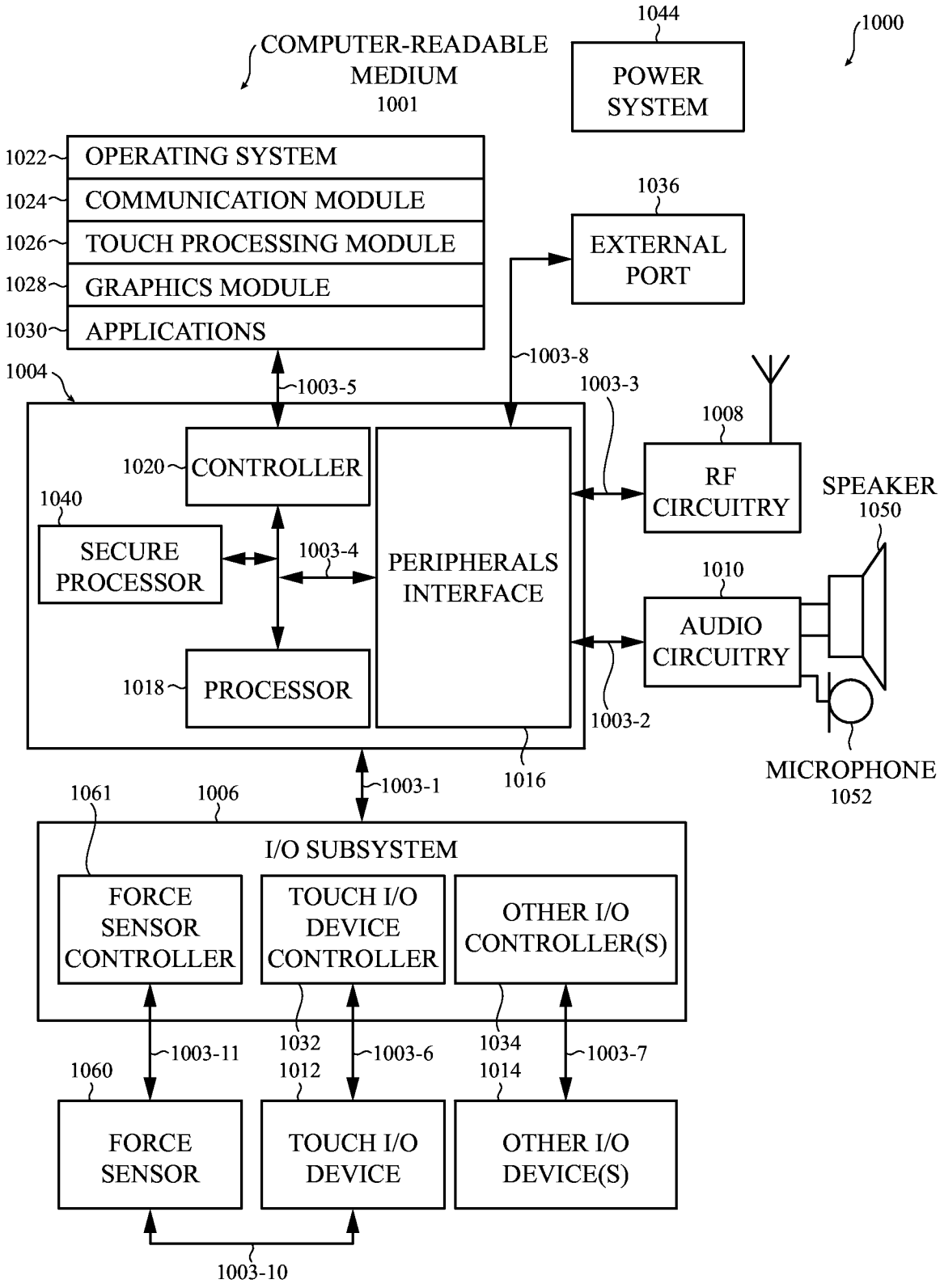


FIG. 10

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1422

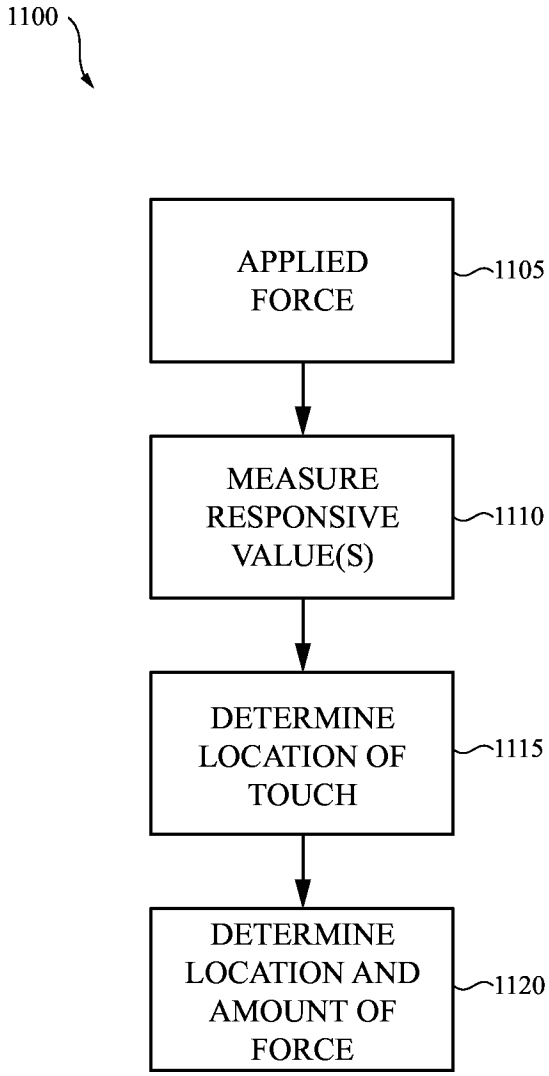

1100
APPLIED FORCE
1105
MEASURE RESPONSIVE VALUE(S)
1110
DETERMINE LOCATION OF TOUCH
1115
DETERMINE LOCATION AND AMOUNT OF FORCE
1120

FIG. 11A

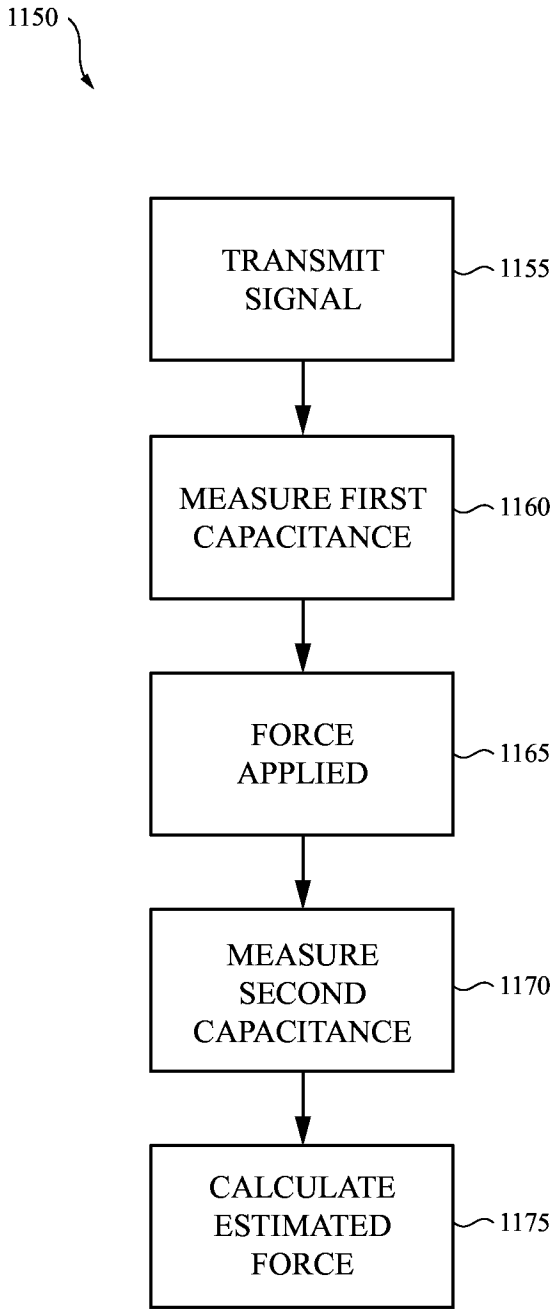

1150
TRANSMIT SIGNAL
1155
MEASURE FIRST CAPACITANCE
1160
FORCE APPLIED
1165
MEASURE SECOND CAPACITANCE
1170
CALCULATE ESTIMATED FORCE
1175

FIG. 11B

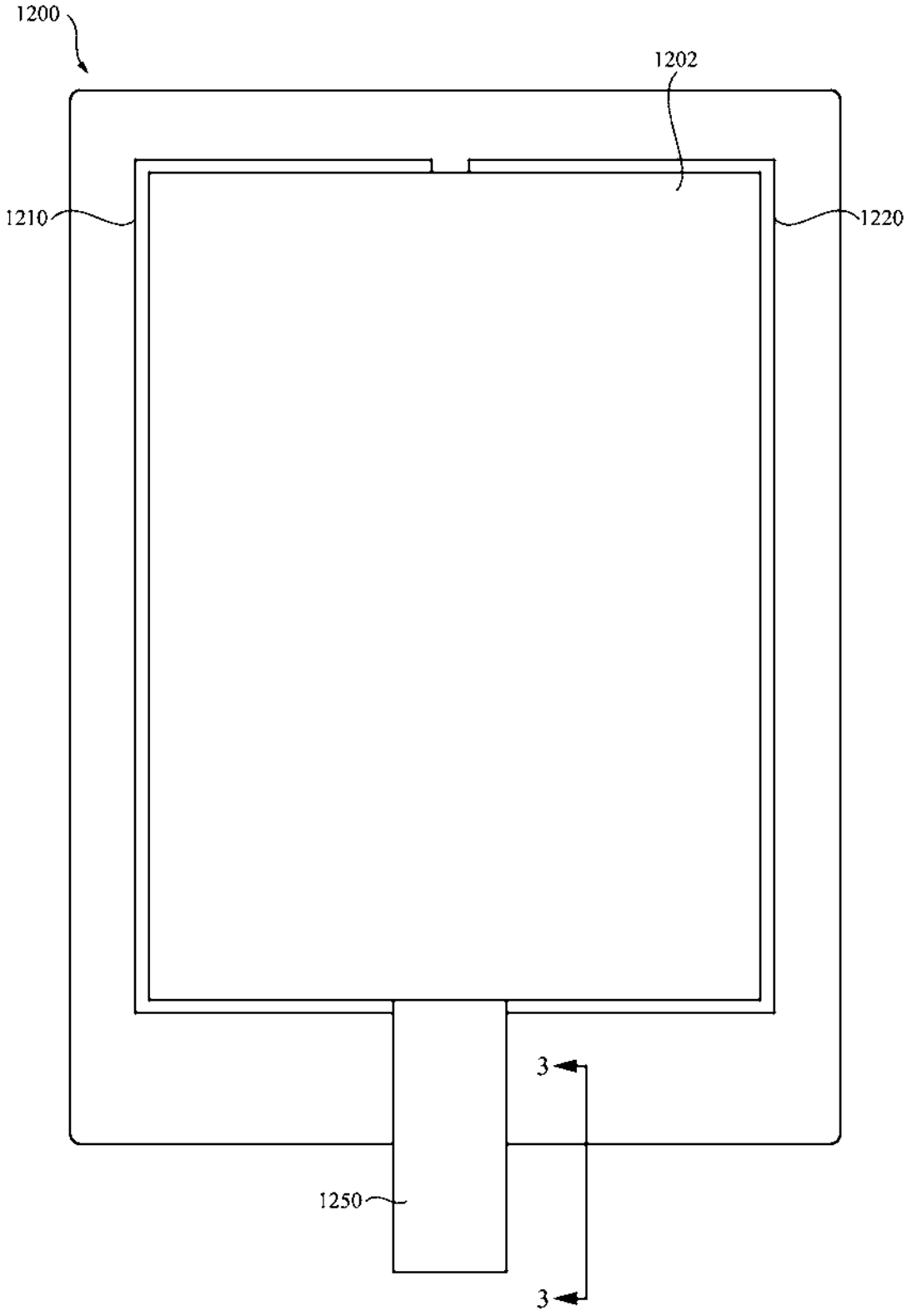
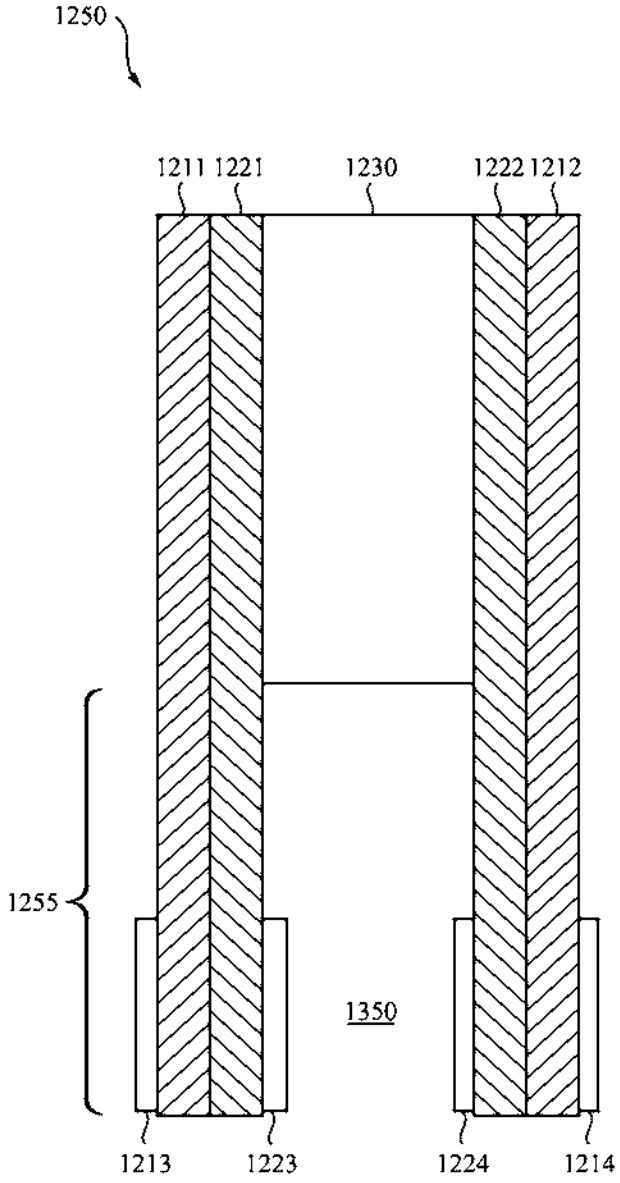


FIG. 12

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1425



SECTION 3-3

FIG. 13

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1426

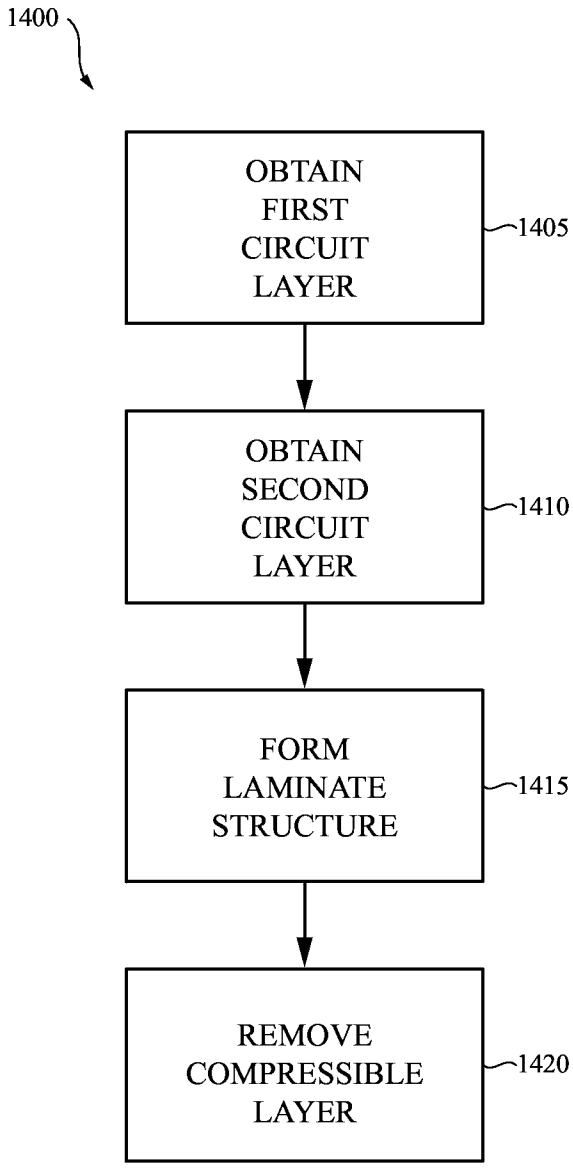


FIG. 14

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1427

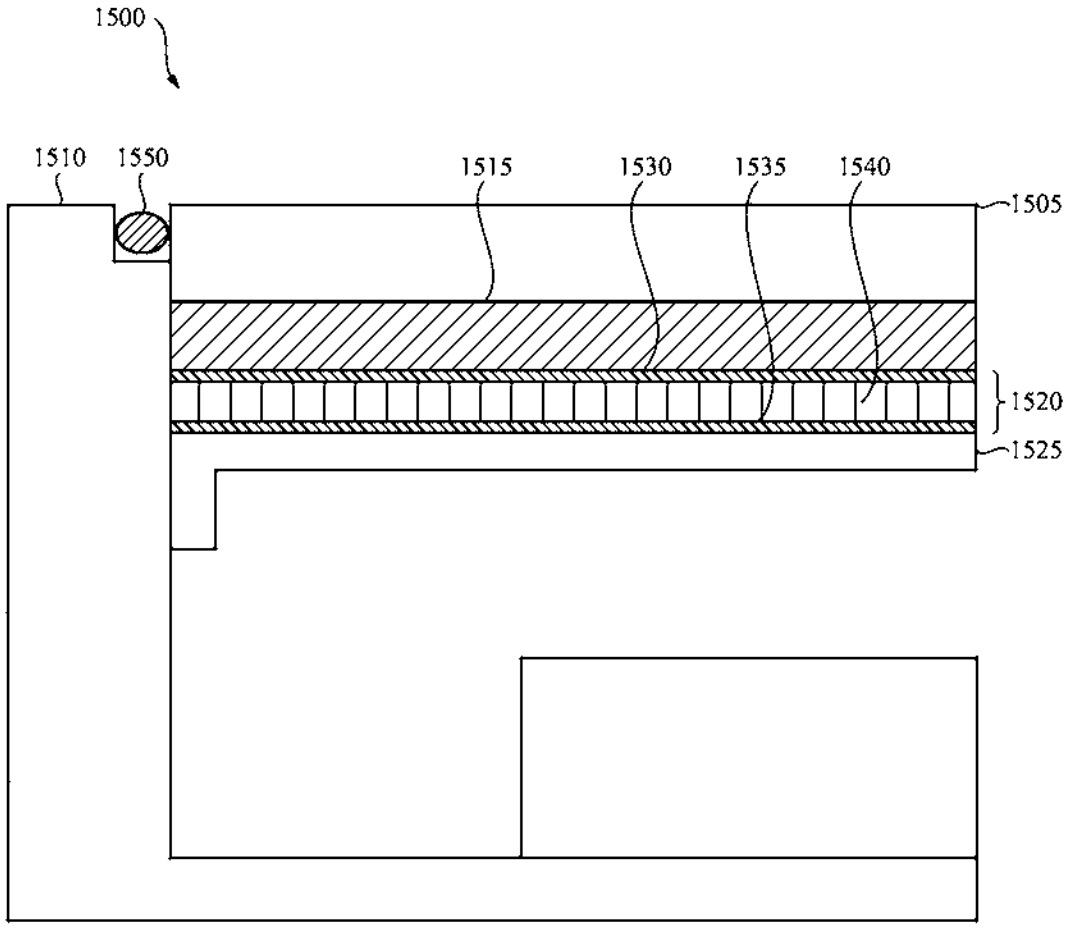


FIG. 15A

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1428

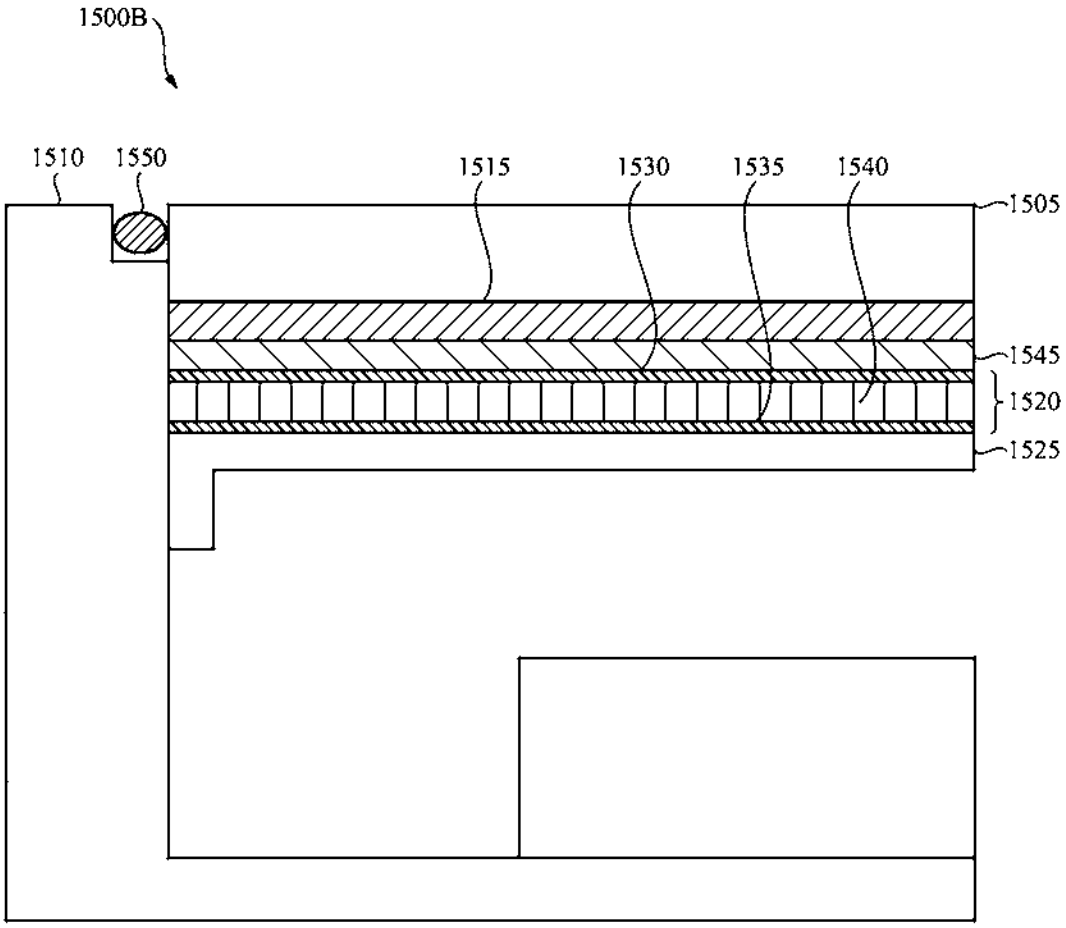


FIG. 15B

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1429

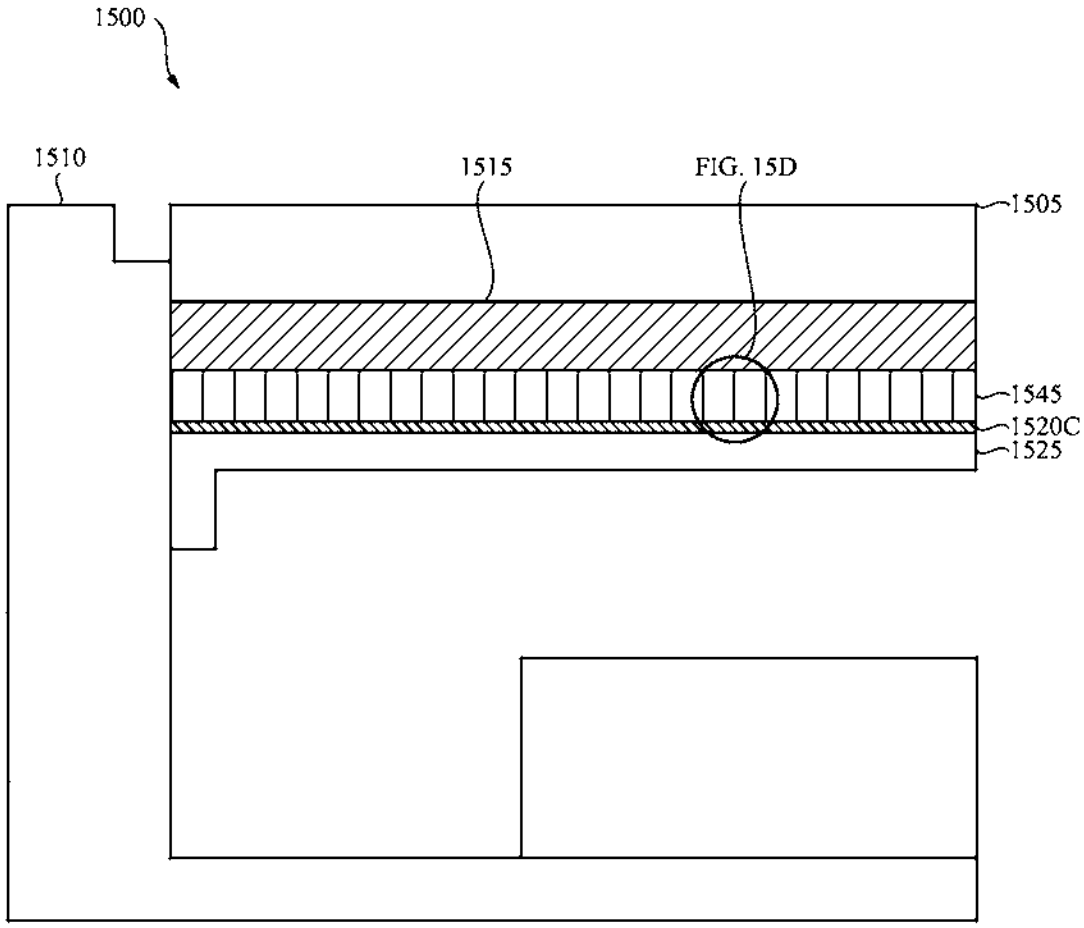


FIG. 15C

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1430

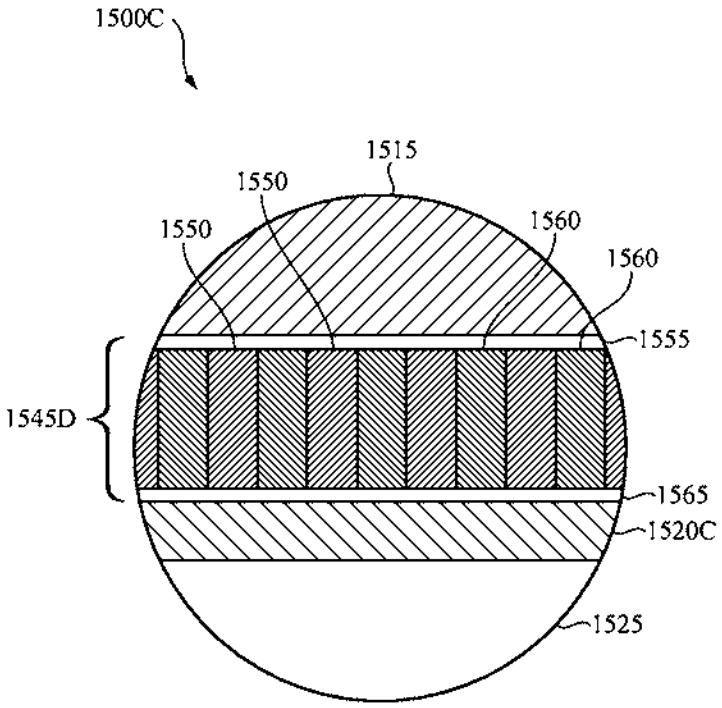


FIG. 15D

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1431

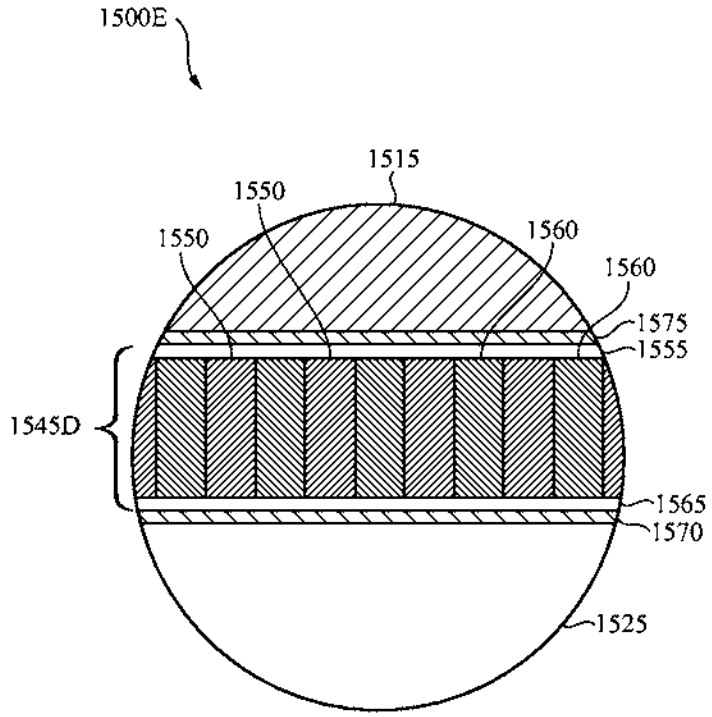


FIG. 15E

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1432

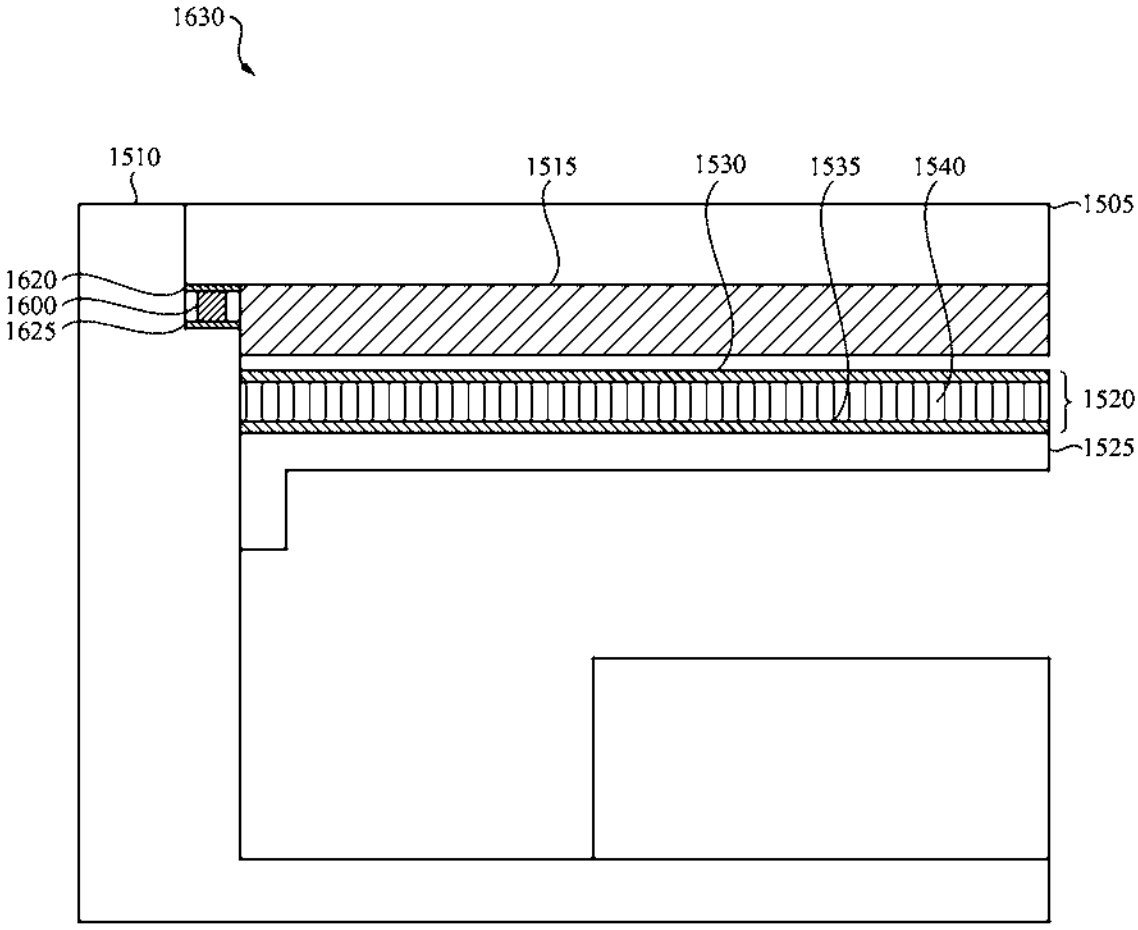


FIG. 16

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1433

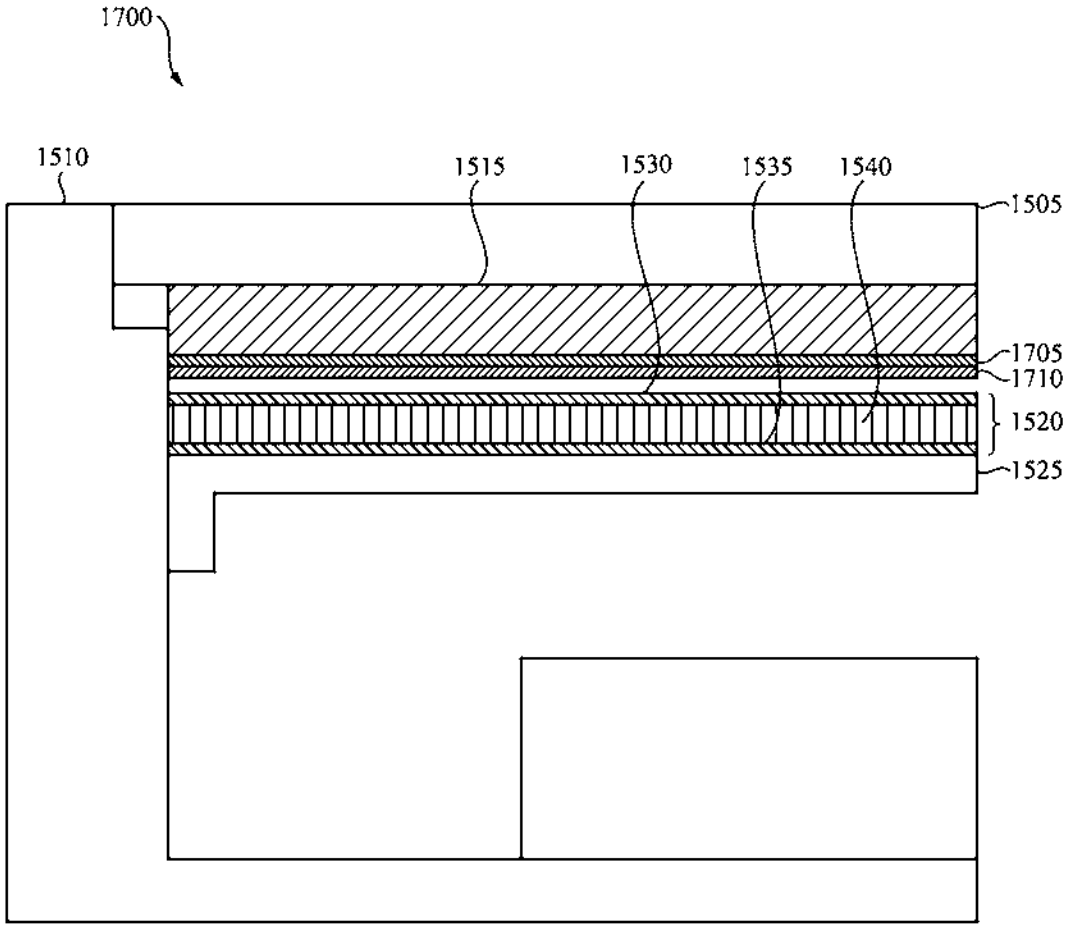


FIG. 17

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1434

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/015451

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/Q41 G06F3/044
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/197753 A1 (HOTELLING STEVEN P [US]] 7 September 2006 (2006-09-07) paragraphs [0107] , [0114], [0119]; figures 19,21,23	1-6
X.P	W0 2014/124173 A1 (CHANGELL0 ENTPR LLC [US]) 14 August 2014 (2014-08-14) paragraphs [0006], [0007], [0048], [0054] - [0056]	1-6
A	US 2013/135244 A1 (LYNCH STEPHEN BRIAN [US] ET AL) 30 May 2013 (2013-05-30) paragraphs [0026], [0028], [0029]; figures 4,5	1-6
A	US 8 577 644 B1 (KS0NDZYK PETR0 [US] ET AL) 5 November 2013 (2013-11-05) column 11, line 63 - column 12, line 3; figure 4	1-6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) orwhich is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2015	23/07/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Thibaudeau, Jean

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Chemtronics Exhibit 1002 Page 1435

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US20 15/0 1545 1

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see addi tional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-6

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6

   Device comprising a cover, a display, a force-sensing structure below the display and a plate supporting the force sensing structure.

   ---

2. claims: 7-14

   Device comprising a housing, a cover, a force-sensing structure below the cover and a strain-sensitive gasket between the cover and the housing.

   ---

3. claims: 15-20

   Device comprising a cover, a capacitive sense layer below the cover, a compressible layer below the capacitive sense layer and a force-sensing structure below the compressible layer, said force sensing structure comprising an upper and a lower capacitive plate and a compressible element.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/015451

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006197753 Al	07-09-2006	AU 2006218381 Al	08-09 -2006
		AU 2007101054 A4	13-12 -2007
		CA 2600326 Al	08-09 -2006
		CN 101432677 A	13-05 -2009
		CN 103336562 A	02-10 -2013
		DE 202006020369 Ul	21- 05-2008
		DE 212006000028 Ul	20-12 -2007
		EP 1877889 A2	16-01 -2008
		HK 1122460 A2	15-05 -2009
		HK 1122461 A2	15- 05-20O9
		JP 5550211 B2	16- 07-2014
		JP 2008537615 A	18-09 -20O8
		JP 2012142033 A	26-07 -2012
		JP 2014042334 A	06- 03-2014
		KR 20070110114 A	15-11 -2007
		KR 2013QO19Q18 A	25-02 -2013
		KR 20130108470 A	02-10 -2013
		KR 2O15Q011Q15 A	29-01 -2015
		KR 20150069036 A	22- 06-2015
		US 2006197753 Al	07- 09-2O06
		US 2008088602 Al	17- 04-2008
		US 2015153895 Al	04-06 -2015
		Wo 2006094308 A2	08- 09-2006
Wo 2014124173 Al	14-·08-·-2014	NONE	
us 2013135244 Al	30-·05-·-2013	US 2013135244 Al	30-·-05-·-2013
		US 2015103050 Al	16-·-04-2015
us 8577644 Bl	05-·11-·-2013	US 8577644 Bl	05-·-11-·-2013
		US 9043183 Bl	26-·-05-·-2015
		W0 2014143200 Al	18-·-09-·-2014

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Chemtronics Exhibit 1002 Page 1438

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/989,292	08/10/2020	Daniel Skagmo	FFOG.054C6

CONFIRMATION NO. 8380

20995
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

FORMALITIES LETTER

OC000000119252906

Date Mailed: 08/17/2020

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings submitted to the Office are not electronically reproducible because portions of figures 1a are missing and/or blurry.
  - The application contains a section in the specification containing the brief description of the figures, but is missing the description of Figure(s) **1** as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9). A brief description of each drawing figure presented is required to satisfy this requirement.
    - To add a brief description of a figure, a proper substitute specification in compliance with 37 CFR 1.121(b)(3) and 1.125, providing a brief description of each drawing figure presented, must be submitted. See also 37 CFR 1.77(b)(9).

  Note: If applicant wishes to delete the undescribed figure, replacement sheets must be submitted to renumber the figure(s) consecutively.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

- The statutory basic filing fee is missing.

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- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **300** basic filing fee.
- $ **160** surcharge.
- $ **660** search fee.
- $ **760** examination fee.
- $(**0**) previous unapplied payment amount.
- $ **1880** TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Daniel Skagmo
  Robert Ehn
  Hakan Bergstrom

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Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/tqlam/

Chemtronics v. FlatFrog
Chemtronics Exhibit 1002 Page 1441

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/989,292

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	5 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1720

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/989,292	08/10/2020	2621	0.00	FFOG.054C6	5	1

CONFIRMATION NO. 8380

FILING RECEIPT

20995
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

OC000000119252905

Date Mailed: 08/17/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Daniel Skagmo, Malmo, SWEDEN;
Robert Ehn, Lund, SWEDEN;
Hakan Bergstrom, Torna-Hallestad, SWEDEN;

Applicant(s)

FlatFrog Laboratories AB, Lund, SWEDEN;

Power of Attorney: The patent practitioners associated with Customer Number 20995

Domestic Priority data as claimed by applicant

This application is a CON of 16/834,905 03/30/2020 PAT 10739916
which is a CON of 16/191,177 11/14/2018 PAT 10606416
which is a CON of PCT/SE2018/050109 02/06/2018

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
SWEDEN 1730085-6 03/28/2017 Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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Chemtronics Exhibit 1002 Page 1443

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 08/14/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/989,292**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

Preliminary Class

345

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor

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community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

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Chemtronics Exhibit 1002 Page 1446

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Unknown
Filing Date	Herewith
First Named Inventor	Daniel Skagmo
Title	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	FFOG.054C6

SIGNATURE of Applicant or Patent Practitioner

Signature	/Harnik Shukla/	Date (Optional)	
Name	Harnik Shukla	Registration Number	73,097
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 20995

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

FlatFrog Laboratories AB

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	
Name	Dhwani Vyas		
Title	CEO		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	40239746
Application Number:	16989292
International Application Number:	
Confirmation Number:	8380
Title of Invention:	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY
First Named Inventor/Applicant Name:	Daniel Skagmo
Customer Number:	20995
Filer:	Harnik Shukla/Kealani Aguon
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.054C6
Receipt Date:	10-AUG-2020
Filing Date:	
Time Stamp:	16:07:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	FFOG054C6_ADS.pdf	1256639 f963ef2c350cab031a49b1dea155b439e3c215b1	no	9

Warnings:

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Information:					
2		FFOG054C6_SPEC.pdf	161401 06c287ea44f88b2cbee8ce0aae1c4ae94bcd30f6	yes	35

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	33
	Claims	34	34
	Abstract	35	35

Warnings:					
Information:					
3	Drawings-only black and white line drawings	FFOG054C6_FIGS.pdf	713627 5f37f032fb889482e593770ae7dc572466c29703	no	18
Warnings:					
Information:					
4	Power of Attorney	FFOG054C6_POA.pdf	1280031 22995c678e57c75ab64ab826c31a56e833f02be8	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3411698		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Daniel		Skagmo	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Malmo	Country of Residence i	SE

Mailing Address of Inventor:

Address 1	Isbergs Gata 10A 1601
Address 2	
City	Malmo
State/Province	
Postal Code	211 19
Country i	SE

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Robert		Ehn	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Lund	Country of Residence i	SE

Mailing Address of Inventor:

Address 1	FlatFrog Laboratories AB
Address 2	Scheelevagen 15 A Alfa 2
City	Lund
State/Province	
Postal Code	223 63
Country i	SE

Inventor 3 Remove

Legal Name

Chemtronics v. FlatFrog
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PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Hakan		Bergstrom	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Torna-Hallestad	Country of Residence [i]	SE

Mailing Address of Inventor:

Address 1	Akestorpsvagen 42		
Address 2			
City	Torna-Hallestad	**State/Province**	
Postal Code	247 95	**Country** [i]	SE

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	20995		
Email Address	efiling@knobbe.com	Add Email	Remove Email

Application Information:

Title of the Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY		
Attorney Docket Number	FFOG.054C6	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	18	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country [i]

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	20995		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/834905	2020-03-30

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/834905	Continuation of	16/191177	2018-11-14	10606416	2020-03-31

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16/191177	Continuation of	PCT/SE2018/050109	2018-02-06

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
1730085-6	SE	2017-03-28	A5E2

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	FlatFrog Laboratories AB		
Mailing Address Information For Applicant:			
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	FFOG.054C6
	Application Number	
Title of Invention	TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY	

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TOUCH SENSING APPARATUS AND METHOD FOR ASSEMBLY

INCORPORATION BY REFERENCE TO ANY PRIORITY APPLICATIONS

[0001] Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57.

BACKGROUND

Field of the Invention

[0002] The present invention relates to touch-sensing apparatus that operate by propagating light by diffusive light scattering above a panel, and in particular to optical and mechanical solutions for defining the light paths and control of curvature of the panel. The present invention relates furthermore to a method of assembling a touch sensing apparatus.

Background of the Invention

[0003] In one category of touch-sensitive panels known as 'above surface optical touch systems', a set of optical emitters are arranged around the periphery of a touch surface to emit light that is reflected to travel above the touch surface. A set of light detectors are also arranged around the periphery of the touch surface to receive light from the set of emitters from above the touch surface. An object that touches the touch surface will attenuate the light on one or more propagation paths of the light and cause a change in the light received by one or more of the detectors. The location (coordinates), shape or area of the object may be determined by analysing the received light at the detectors.

[0004] In a variant of such 'above surface optical touch system', illustrated in Fig. 1a in cross-section, the emitters 301 are arranged on a substrate 304, and light from the emitters travel above the touch surface 302 of the panel 305 via reflection or scattering on an edge reflector or diffusor 303. As shown in top-down view figure 1b, the light will then continue until deflected by a corresponding edge reflector at an opposing edge of the light transmissive panel, where the light will be scattered back down through the transmissive panel and onto the detectors 306.

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[0005] Detectors 306 are distributed around the periphery of touch surface 302, to receive part of the propagating light. The light from each of emitters 301 will thereby propagate inside the transmissive panel 305 to a number of different detectors 306 on a plurality of light paths D. In the illustrated example, the apparatus 300 also includes a controller 320 which is connected to selectively control the activation of the emitters 301 and, possibly, the readout of data from the detectors 306. Depending on implementation, the emitters 301 and/or detectors 306 may be activated in sequence or concurrently. The signal processor 330 and the controller 320 may be configured as separate units, or they may be incorporated in a single unit. One or both of the signal processor 330 and the controller 320 may be at least partially implemented by software executed by a processing unit 340.

[0006] A problem with such previous systems is the cumbersome alignment between the components thereof, which makes assembly more difficult and costly. Sub-optimal alignment results in signal loss, which moreover is an inherent problem in previous solutions due to the multiple components involved in the light scattering process. Another issue affecting the signal and scattering of the light in the touch sensing apparatus is uncontrolled glass warpage, i.e. distortions of the curvature of the light transmissive panel which will affect the light path and the detection process. While it is critical to accurately control such distortions, previous solutions incorporate complex solutions that may not allow to fully optimize glass warpage control in a mass production line without limiting the throughput of the production.

[0007] Some prior art systems rely on coupling and propagation of collimated light across the light transmissive panel. Such systems are however cumbersome to reliably implement due to the small tolerances with respect to the alignment of the components thereof. E.g. the light emitters- and detectors need to be precisely aligned in relation to various lenses and reflect the light via concave and/or convex reflection and/or refraction to get the desired collimation. Such precise alignment may be difficult to achieve in mass production. The use of collimated light, or light reflected by means of specular reflection, also adds to this complexity, which in turn results in a more expensive and less compact system. Furthermore, to reduce system cost, it may be desirable to minimize the number of electro-optical components.

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SUMMARY OF THE INVENTION

[0008] An objective is to at least partly overcome one or more of the above identified limitations of the prior art.

[0009] One objective is to provide a touch-sensitive apparatus based on "above-surface" light propagation which is robust and easy to assemble.

[0010] Another objective is to provide an "above-surface"-based touch-sensitive apparatus with efficient use of light.

[0011] One or more of these objectives, and other objectives that may appear from the description below, are at least partly achieved by means of touch-sensitive apparatuses according to the independent claims, embodiments thereof being defined by the dependent claims.

[0012] According to a first aspect, a touch sensing apparatus is provided comprising a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel. The light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the panel extends.

[0013] Preferably the plurality of light emitters and detectors are arranged above the touch surface.

[0014] Preferably the substrate extends at least partly above the touch surface, whereby the plurality of light emitters and detectors are connected to a portion of the substrate extending above the touch surface.

[0015] Preferably the substrate is fixed to a carrier mounted around the perimeter of the panel.

[0016] Preferably the carrier is arranged to at least partly enclose edges the panel.

[0017] Preferably the carrier comprises fixing elements configured to attach the carrier to a display unit.

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[0018] Preferably the fixing elements are configured to attach the position of the substrate in relation to the carrier and/or in relation to the display unit.

[0019] Preferably the fixing elements are configured to interlock with a mounting element for locking the position of the carrier and/or the substrate to the display unit.

[0020] Preferably the fixing elements comprise openings, wherein the carrier forms a cavity having walls at least partly enclosing the substrate, and wherein at least one of the walls comprises at least one of said openings.

[0021] Preferably the fixing elements comprise openings arranged in the carrier and in the substrate, wherein first openings of the carrier are aligned with second openings of the substrate, the first and second openings being configured to receive a mounting element configured to lock the position of the carrier and/or the substrate to the display unit.

[0022] Preferably the carrier is configured to be attachable to the display unit at an adjustable position along a direction parallel to the normal axis, whereby a distance between the panel and the display unit along the normal axis is variable upon attaching the carrier to the display unit at at least two different adjustable positions.

[0023] Preferably the fixing elements are configured to attach the carrier to the display unit at the adjustable positions along the direction parallel to the normal axis.

[0024] Preferably the openings are separated along a direction parallel to the normal axis, and/or wherein the carrier is attachable to a plurality of second openings in a display support of the display unit, the plurality of second openings being separated along the normal axis.

[0025] Preferably the carrier is formed from a single monolithic piece of material.

[0026] Preferably the substrate extends in a longitudinal direction along the perimeter of the panel, the substrate comprising secondary fixing units configured for variably attaching the position of the substrate on the carrier along the longitudinal direction and/or in the direction of the normal axis.

[0027] Preferably vertical alignment units are arranged between adjacent substrates extending in a longitudinal direction along the perimeter of the panel, wherein the vertical alignment units are configured to variably position the adjacent substrates in the direction of the normal axis so that an angle between the adjacent substrates is adjustable.

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[0028] Preferably a plurality of substrates extend in a longitudinal direction along the perimeter of the panel, wherein a first substrate of said plurality of substrates comprises a connection unit configured to directly interlock with a subsequent connection unit of a subsequent substrate when arranged adjacent said subsequent substrate.

[0029] Preferably a sealing window is arranged around the perimeter of the panel, wherein the sealing window comprises a first surface facing the light emitters or the light detectors and an opposite second surface arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, and wherein at least one of the first and second surfaces comprises a light collimating surface configured to collimate light propagating above the touch surface.

[0030] Preferably the second surface extends in the direction of the normal axis between a base surface of the sealing window, facing the panel, and an opposite top surface of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance so that the second surface forms an angle relative the normal axis, and wherein the second surface comprises a light collimating surface.

[0031] According to a second aspect, a touch sensing apparatus is provided comprising a panel extending in a plane having a normal axis, the panel defining a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel, wherein the light emitters are arranged to emit a respective beam of emitted light above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The touch sensing apparatus comprises a sealing window arranged around the perimeter, wherein the sealing window comprises a first surface facing the light emitters or the light detectors and an opposite second surface arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface of the sealing window, facing the panel, and an opposite top surface of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance so that the second surface forms an angle relative the normal axis, and

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wherein the second surface comprises a light collimating surface configured to collimate light propagating above the touch surface.

[0032] Preferably the first surface and/or second surface form a curved edge convex to the sealing window.

[0033] According to a third aspect, a method of assembling a touch sensing apparatus is provided comprising; attaching a substrate having a plurality of light emitters and detectors to a carrier; attaching the carrier around a perimeter of a panel and arranging the substrate to extend in a direction parallel with a normal axis of a plane in which the panel extends.

[0034] Preferably the plurality of light emitters and detectors are arranged above the touch surface.

[0035] Preferably the carrier if formed from a single monolithic piece of material, the carrier forming a cavity having walls at least partly enclosing the substrate, wherein at least one of the walls comprise openings, the method comprising fixing the carrier to a display unit by fixing mounting elements through said openings.

[0036] Preferably the method comprises adjusting a distance between the panel and a display unit along the normal axis by attaching the carrier to the display unit at at least two different adjustable positions along a direction parallel to the normal axis.

[0037] Preferably the method comprises adjusting a radius of curvature of the panel in the direction of the normal axis by attaching the carrier to a display unit at at least two different adjustable positions along a direction parallel to the normal axis.

[0038] According to a fourth aspect there is provided a touch sensing apparatus, comprising: a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel and the light emitters are arranged to emit a respective beam of emitted light above the touch surface, and the light emitters are arranged to receive detection light from the emitted light, a substrate on which the plurality of light emitters and detectors are mountable; and a sealing window sealable against at least one surface of the touch sensing apparatus for sealing a cavity around the plurality of light emitters and detectors wherein the sealing window comprises at least one reference surface for aligning the substrate with respect to the sealing window.

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[0039] Preferably the sealing window is sealable between the touch surface and a surface of the substrate.

[0040] Preferably the surface of substrate is a surface of a carrier for protecting components of the touch sensing apparatus.

[0041] Preferably the carrier comprises an upper portion which overlaps a portion of the perimeter of the panel and the sealing window is sealable between the touch surface and the underside of the overlapping upper portion.

[0042] Preferably the at least one reference surface is arranged to engage with a reciprocal reference surface on the substrate.

[0043] Preferably the at least one reference surface comprises a first portion for aligning in a first direction and a second portion for aligning in a second direction.

[0044] Preferably the at least one reference surface aligns the sealing window with respect to the substrate in a plane parallel with the touch surface.

[0045] Preferably the at least one reference surface aligns the sealing window with respect to the substrate at a height above the touch surface.

[0046] Preferably the sealing window comprises at least one resiliently deformable seal engagable with the substrate.

[0047] Preferably the resiliently deformable seal comprises the at least one reference surface.

[0048] Preferably the seal is extrudable along one or more surfaces of the sealing window.

[0049] Preferably the at least one reference surface substantially extends the entire length of the sealing window.

[0050] Preferably the sealing window and / or the substrate comprise a projection having a cross-sectional shape for positive engagement with a reciprocal hole in the substrate and / or sealing window and the at least one reference surface is part of the projection.

[0051] Preferably the sealing window and / or the substrate comprise a resiliently deformable projection wherein the projection comprises the at least one reference surface comprises and the projection is deformable on engagement with the substrate and / or sealing window and forms a snap-fit engagement therebetween.

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[0052] Preferably the sealing window comprises a plurality of reference surfaces.

[0053] Preferably the at least one reference surface comprises at least one discrete upstanding projection for engagement with reciprocal hole in the substrate.

[0054] Preferably the at least one upstanding projection is one or more of, pegs, hooks, latches, clamps or fasteners.

[0055] According to a fifth aspect there is provided a method of manufacture of the touch sensing apparatus comprising: mounting a plurality of light emitters and detectors to a substrate, attaching the substrate around a perimeter of a panel; and mounting a sealing window against at least one surface of the touch sensing apparatus for sealing a cavity around the plurality of light emitters and detectors wherein the sealing window comprises at least one reference surface for aligning the substrate with respect to the sealing window.

[0056] Further examples of the invention are defined in the dependent claims, wherein features for the second aspect of the disclosure are as for the first aspect mutatis mutandis.

[0057] Some examples of the disclosure provide for a touch sensing apparatus that is easier to manufacture and assemble.

[0058] Some examples of the disclosure provide for a touch sensing apparatus with fewer steps of assembly.

[0059] Some examples of the disclosure provide for a touch sensing apparatus that is less costly to manufacture.

[0060] Some examples of the disclosure provide for a facilitated alignment of emitters and detectors of touch sensing apparatus.

[0061] Some examples of the disclosure provide for facilitated control of the curvature of the touch surface of a touch sensing apparatus.

[0062] Some examples of the disclosure provide for a more robust touch sensing apparatus.

[0063] Some examples of the disclosure provide for a touch sensing apparatus that is more reliable to use.

[0064] Some examples of the disclosure provide for a touch sensing apparatus that has a better signal-to-noise ratio of the detected light.

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[0065] Some examples of the disclosure provide for a more compact touch sensing apparatus.

[0066] Still other objectives, features, aspects and advantages of the present disclosure will appear from the following detailed description, from the attached claims as well as from the drawings.

[0067] It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0068] These and other aspects, features and advantages of which examples of the invention are capable of will be apparent and elucidated from the following description of examples of the present invention, reference being made to the accompanying drawings, in which;

[0069] Fig. 1a is a section view of a touch sensing apparatus according to the prior art;

[0070] Fig. 1b is a top-down view of a touch sensing apparatus according to the prior art;

[0071] Fig. 2 is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

[0072] Fig. 3 is a schematic illustration, in a perspective side view, of a touch sensing apparatus according to one example;

[0073] Fig. 4a is a schematic illustration, in a side view of Fig. 2, of a touch sensing apparatus according to one example;

[0074] Fig. 4b is a schematic illustration of a magnified section of Fig. 4a, according to one example;

[0075] Fig. 4c is a schematic illustration of a magnified section of Fig. 4a, according to one example;

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[0076] Fig. 5a is a schematic illustration, in a cross-sectional side view, of a touch sensing apparatus according to one example;

[0077] Fig. 5b is a schematic illustration of a magnified section of Fig. 5a, according to one example;

[0078] Fig. 6 is a flow chart of a method of assembling a touch sensing apparatus according to one example;

[0079] Figure 7 is a schematic exploded perspective view of different layers of the touch-sensing apparatus according to one example;

[0080] Figure 8 is a perspective schematic view of through a cross section of the touch sensing apparatus according to one example;

[0081] Figure 9 is a cross sectional view of the touch sensing apparatus according to one example;

[0082] Figure 10 is a cross sectional view of the touch sensing apparatus according to one example;

[0083] Figure 11 is a cross sectional view of the touch sensing apparatus according to one example;

[0084] Figure 12 is a perspective schematic view of through a cross section of the touch sensing apparatus according to one example;

[0085] Figure 13 is a schematic perspective view of the touch sensing apparatus according to one example;

[0086] Figure 14 is a cross sectional view of the touch sensing apparatus according to one example;

[0087] Figures 15a to 15d are magnified cross-sectional views of the touch sensing apparatus according to different examples; and

[0088] Figure 16 is a schematic perspective view of the touch sensing apparatus according to one example.

DETAILED DESCRIPTION

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[0089] In the following, embodiments of the present invention will be presented for a specific example of a touch-sensitive apparatus 100. Throughout the description, the same reference numerals are used to identify corresponding elements.

[0090] Fig. 1 schematically illustrates a variant of an 'above surface optical touch system', as discussed in the Background Art section above ,where the light from the emitters 301 travel above the touch surface 302 of the panel 305 via reflection on an edge reflector 303. Figure 1b illustrates a top plan view of figure 1a in an example of a touch-sensitive apparatus 100.

[0091] Fig. 2 schematically illustrate a touch sensing apparatus 100 comprising a light transmissive panel 101 that defines a touch surface 102. In some embodiments the light transmissive panel 101 is located above a display 130 and permits light generated by the display 130 to propagate therethrough. However in other embodiments the light transmissive panel 101 can comprise light blocking material and does not permit the transmission of light therethrough. For example, the touch sensing apparatus 100, can be a trackpad or another touch interface which is remote from the display unit 130. Hereinafter the term "light transmissive panel" 101 will be used to describe either a light transmissive panel 101 or a solid, opaque panel 101.

[0092] A plurality of light emitters 103 and detectors 103' are arranged along a perimeter 104 of the light transmissive panel 101. The light emitters 103 are arranged to emit a respective beam of emitted light 105 above the touch surface 102. I.e. while the touch surface 102 extends along a plane 108, having a normal axis 107 directed towards a user performing touch operations on the touch surface 102, the emitted light 105 travels parallel with plane 108 and at a certain distance from the touch surface 102 in the direction of the normal axis 107, as schematically illustrated with respect to light beam 105, 105', in e.g. Fig. 2. Light 105, 105', can thus travel across the touch surface 102, between opposite sides thereof, without being reflected inside the light transmissive panel 101 itself.

[0093] In other embodiments, the plurality of light emitters 103 and detectors 103' are optionally arranged along a perimeter 104 of the light transmissive panel 101 at a different height. In some embodiments, the light emitters 103 and / or detectors 103' are arranged to emit a respective beam of emitted light 105 below the touch surface 102 and the

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light beams are guided around the light transmissve panel 101. The light beams can be guided around the light transmissive panel 101 with additional reflective components (not shown). For the purposes of brevity, the embodiments discussed hereinafter refer to the plurality of light emitters 103 and detectors 103' being arranged above the touch surface 102, but the embodiments also include the arrangement where the plurality of light emitters 103 and detectors 103' are mounted below the touch surface 102.

[0094] The light detectors 103' are arranged to receive detection light 105' from the emitted light 105. Fig. 2 illustrates a section of the touch sensing apparatus 100 adjacent the perimeter 104 of the light transmissive panel 101. In this section, the emitters and detectors 103, 103', are shown in the same view, as well as the emitted and detected light 105, 105', for clarity of presentation. The plurality of light emitters and detectors 103, 103', are arranged above the touch surface 102 and are connected to a substrate 106 extending in a direction 107' parallel with a normal axis 107 of a plane 108 in which the light transmissive panel extends. By having the substrate 106 extending in parallel with the normal axis 107, the plurality of emitters and detectors 103, 103' are conveniently arranged, above the touch surface 102 to achieve a compact footprint in the direction of the plane 108 of the touch sensing apparatus 100 around the perimeter 104, while achieving a direct light path for the emitted or detected light 105, 105', above and across and touch surface 102. Thus, the emitted light 105 does not have to be reflected in order to diffusively spread above and across the touch surface 102, and a detector 103' may directly receive detection light 105' by being correspondingly positioned above the touch surface 102 at an opposite position anywhere around the perimeter 104. The amount of available light that can be utilized for the detection and characterization of an object touching the touch surface 102 can thus be maximized, and the signal to noise ratio can be improved. The touch sensing apparatus 100 may comprise a sealing window 126 as illustrated in Fig. 2, shielding the emitters and detectors 103, 103', from the outside. The emitted and detected light 105, 105', may thus only have to propagate through the sealing window 126 along the light path between the emitters and detectors 103, 103'. The sealing window 126 provides sealing around the perimeter 104 of the light transmissive panel 101 and protects the emitters and detectors 103, 103' and the display.

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[0095] Having the substrate extending in the direction 107' being parallel with the normal axis 107 and the emitters and detectors 103, 103', arranged above the touch surface 102 provides for a less complex alignment to maximize the detection performance of the touch sensing apparatus 100. The position of the substrate 106 in the direction of the normal axis 107 can be accurately varied to achieve optical alignment with respect to the emitters and detectors 103, 103'. The ability to achieve an accurate positioning of the substrate 106, and consequently the emitters and detectors 103, 103', attached thereto, is also due to the increased accuracy by which the dimensions of the substrate 106 can be defined along the direction of the substrate 106 aligned with the normal axis 107 in Fig. 2. I.e. the substrate 106 is elongated and extends in a longitudinal direction 123 (Fig. 4a) around the perimeter 104 of the light transmissive panel 101, and it has a short-side extending in parallel with the normal axis 107. The short-side of the substrate 106, illustrated in the cross-sectional view of Fig. 2, may be manufactured to smaller tolerances, and by aligning this side with the normal axis 107, the tolerances for the alignment of the emitters and detectors 103, 103', along the normal axis 107 can be improved. The alignment can thus be both improved, and facilitated as discussed above. The latter advantage also provides for facilitated and less costly mass production of the touch sensing apparatus 100 and the various touch base display systems in which it may be implemented.

[0096] The substrate 106 may extend at least partly above the touch surface 102, whereby the plurality of light emitters and detectors 103, 103', are connected to a portion 109 of the substrate extending above the touch surface 102. This further provides for achieving a more robust alignment of the emitters and detectors 103, 103', relative to the light transmissive panel 101, by being directly joined to the substrate 106, and thereby simultaneously arranged above the touch surface 102. It may be conceivable however that the emitters and detectors 103, 103', are connected to the substrate 106 via connection elements (not shown) extending between the substrate 106 and to a position above the touch surface 102.

[0097] The substrate 106 may be fixed to a carrier 110 mounted around the perimeter 104 of the light transmissive panel 101, as schematically illustrated in Figs. 1 – 2. By directly joining the substrate 106 to the carrier 110 provided around the perimeter 104, the

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assembly of the touch sensing apparatus 100 may be further facilitated, as the amount of components can be kept at a minimum. For example, the substrate 106 can be accurately fixed in relation to the carrier 110, due to the small tolerances possible in the direction of the substrate 106 aligned in parallel with the normal axis 107 in Fig. 1, as discussed above. The carrier 110 may for example comprise a cavity 116, as discussed further below, being precisely dimensioned to accommodate the width of the substrate 106 along the direction 107', i.e. the short-side of the substrate 106. Then, accurate positioning of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 is possible as the carrier 110 is mounted around the perimeter 104 thereof. The carrier 110 may extend substantially in the direction 107' parallel with the normal axis 107, as with the substrate 107, to achieve a compact mounting around the perimeter 104. In some embodiments the carrier 110 may also be the substrate 106 or the emitters and detectors 103, 103' are mounted directly to the carrier 110.

[0098] Having the substrate 106 fixed to the carrier 110 allows also for having the carrier 110 wired as an electrical ground reference layer of the substrate 106.

[0099] The carrier 110 may be arranged to at least partly enclose edges 111 of the light transmissive panel 101, as shown in the example of Fig. 1. This provides for further increasing the robustness of the touch sensing apparatus 100, and improving the accuracy of the alignment of the emitters and detectors 103, 103', in relation to the light transmissive panel 101 since the carrier 110, having the emitters and detectors 103, 103', fixed thereto, may also be directly supporting the light transmissive panel 101 around the perimeter 104. The carrier 110 may comprise a slot in which the light transmissive panel 101 is fitted around the perimeter 104.

[0100] The carrier 110 may comprise fixing elements 112 configured to attach the carrier 110 to a display unit 113, 121. The display unit may comprise a display support 121 and a display panel 113, which collectively is referred to as a display unit in the present disclosure. Having the carrier 110 attachable to the display unit 113, 121, by fixing elements 112, advantageously provides for further facilitating the assembly of the touch sensing apparatus 100 to a display unit, since the carrier 110 can be directly joined to the latter. Alignment is thus facilitated, due to the minimum amount of components needing such

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alignment to each other. The robustness of the touch sensing apparatus 100 is further improved, while mass production is made less complex due the minimized number of assembly steps. The fixing elements 112 may comprise any elements configured to provide for fixing of the position of the carrier 110 to the display unit 113, 121. In the examples shown in Figs. 1 - 2, the carrier 110 has openings 115, 115', 115'', discussed further below, which may be aligned with corresponding openings 127 of a support of the display unit 121, through which mounting elements 114 may be positioned for the fixing. It is conceivable however that the carrier 110 has other types of recesses or protrusions which may interlock with a corresponding mating surface of the display unit 113, 121.

[0101] The fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the carrier 110. Thus, besides from fixing the position of the carrier 110 relative to the display unit 113, 121, the fixing elements 112 may also fix or at least support the position of the substrate 106 in relation to the carrier 110. It is conceivable that the substrate 106 may first be arranged in relation to the carrier 110, and the fixing elements 112 may be arranged to support and strengthen the fixing therebetween, while simultaneously fixing the carrier 110 to the display unit 113, 121. This may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100. From a similar aspect, the fixing elements 112 may be configured to fix the position of the substrate 106 in relation to the display unit 113, 121. This may be seen as a consequence from the above, i.e. the fixing elements 112 contributing to the fixing of the substrate 106 to the carrier 110, which in turn is fixed to the display unit 113, 121. It is however conceivable that the fixing elements 112 may fix the substrate 106 directly to the display unit 113, 121, in which case the carrier 110 may act as a further support for the substrate 106.

[0102] In one example, as discussed further below, the substrate 106 may comprise second openings 118 which provides for such fixing or support. As mentioned, this may further provide for increasing the stability and ultimately accuracy of the touch sensing apparatus 100.

[0103] The fixing elements 112 may be configured to interlock with a mounting element 114 for locking the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. Figs. 2 – 3 show examples of having an elongated mounting element 114

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joining the carrier 110 and/or the substrate 106 to the display unit 113, 121. The mounting element 112 may however comprise any fastening element configured to exert a force between the carrier 110 and/or the substrate 106 to the display unit 113, 121, such as pins, bolts, screws, clips, clamps, locks, bars, rods, anchors, latches, clasps.

[0104] The fixing elements 112 may comprise openings 115, 115', 115'', as illustrated in Figs. 2 – 3. The carrier 110 may form a cavity 116 having walls 117 at least partly enclosing the substrate 106, illustrated in the example of Fig. 2. This may provide for increased stability of the fixing of the position of the substrate 106 in relation to the carrier 110. At least one of the walls 117 may comprise at least one of the openings 115, 115', 115'', as further illustrated in Fig. 2. Being able to directly fix the walls 117 of the carrier 110 enclosing the substrate 106 to the display unit 121, 113, provides for further simplifying manufacturing, and at the same time further increase the accuracy of the alignment of e.g. the emitters and detectors 103, 103', in relation to the light transmissive panel 101, since the minimized number of intermediate mounting components improves tolerance control. I.e. build-up of mounting errors in each assembly step is reduced and controlled. It is conceivable that the walls 117 may be fixed to the display unit 113, 121, by other fixing elements 112, such as recesses or protrusions interlocking with correspondingly mating surfaces of the display unit 113, 121, and/or fastening elements as exemplified above.

[0105] The fixing elements 112 may comprise openings 115, 115', 115'', 118, arranged in the carrier 110 and in the substrate 106. First openings 115, 115', 115'' of the carrier 110 may be aligned with second openings 118 of the substrate 106, as illustrated in the example of Fig. 2. The first and second openings 115, 115', 115'', 118 may be configured to receive a mounting element 114 configured to lock the position of the carrier 110 and/or the substrate 106 to the display unit 113, 121. This provides for further facilitated and improved alignment and assembly, and increased robustness. In the example of Fig. 2, the carrier 110 encloses the substrate 106 such that two opposite openings 115, 115'', of the carrier are arranged on either side of the substrate 106, but it is conceivable that the carrier 110 may be arranged on one side only of the substrate 106.

[0106] The carrier 110 may be configured to be attachable to the display unit 121, 113, at an adjustable position 119, 119', along a direction 117'' parallel to the normal axis. A

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distance 120 between the light transmissive panel 101 and the display unit 113 along the normal axis 107 may thus be variable upon attaching the carrier to the display unit 113, 121 at at least two different adjustable positions 119, 119'. For example, turning to Fig. 3, the carrier 110 is attached at a first position 119 to the support of the display unit 121, via fixing unit 112. The first position 119 provides for the given distance 120 between the panel of the display unit 113. The distance 120 may then be decreased by instead attaching the carrier 110 at a second position 119' which is off-set with respect to the first position 119 in the positive direction of the normal axis 107, or the direction 107'' as illustrated in Fig. 3. If the fixing point to the support of the display unit 121 remains constant, e.g. at the opening 127 of a support 121 as illustrated, the carrier 110 will be moved in the opposite direction to the normal axis 107 and the distance 120 will be decreased. Having the carrier 110 being attachable to the display unit 121, 113, at an adjustable position 119, 119', along a direction 117'' parallel to the normal axis 107, thus provides for simple and efficient adjustment of the position of the light transmissive panel 101.

[0107] Besides from overall controlling the distance 120, as discussed, such adjustment provides for efficiently controlling and varying the curvature of the light transmissive panel 101. I.e. varying the distance 120 as discussed at a second intermediate location 128', between opposite ends of the carrier 110, along the longitudinal direction 123, while maintaining the distance 120 at the opposite ends, such as at a first location 128, will affect the curvature of the carrier 110, and thereby the curvature of the light transmissive panel 101. E.g. decreasing the distance 120 at the second location 128' can produce a more concave shape, i.e. a decreased radius of curvature, of the carrier 110 and the light transmissive panel 101, in the direction of the normal axis 107. Increasing the distance 120 between the mentioned opposite ends can instead increase the radius of curvature in the direction of the normal axis 107. The curvature or warping of the light transmissive panel 101 can thus be controlled efficiently an in a facilitated manner, which is advantageous for increasing throughput in mass-production of displays incorporating the touch sensing apparatus 100 while keeping the warp of the light transmissive panel 101 under control. An optimized curvature of the light transmissive panel 101 increases the reliability and accuracy of the touch sensing apparatus 100.

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[0108] The fixing elements 112 may be configured to attach the carrier 110 to the display unit 121 at the adjustable positions 119, 119', along the direction 117'' parallel to the normal axis 107. Thus, the fixing units 112 be arranged at the different adjustable positions 119, 119', to adjust the distance 120 and the curvature of the a light transmissive panel 101 while providing for securely attaching the carrier to the display unit 113, 121. The fixing elements 112 may thus be arranged at least at the first and second locations 128, 128', along the longitudinal direction 123 as discussed above, where each of the locations in the longitudinal direction 123 may have at least two adjustable positions 119, 119', as illustrated in the example of Fig. 3.

[0109] The openings 115, 115', of the carrier 110 may be separated along a direction 117'' parallel to the normal axis 107, as illustrated in Fig. 3. Alternatively, or in addition, the carrier 110 may be attachable to a plurality of second openings 122 in a display support 121 of the display unit, where the plurality of second openings 122 are separated along the normal axis 107. Thus, the position 119, 119', may be remained fixed while the carrier 110 is attached to the support 121 at the various second openings 122, to adjust the curvature of the light transmissive panel 101 and/or the distance 120 as discussed above. Although the examples in Figs. 2 – 3, show openings 115, 115', 115'', 127, it is conceivable that the attachment between the carrier 110 and the display unit 121, 113, is provided by other fixing elements 112 as exemplified above.

[0110] The carrier 110 may be formed from a single monolithic piece of material. The structural integrity and the stability of the carrier 110 can thereby be increased, which further optimizes the parameters discussed above with respect to alignment, robustness, ease of assembly etc. One example of a possible process by which the carrier can be formed as a single piece of material is an extrusion process, but it is conceivable that the carrier 110 may be formed from other hot or cold metal or polymer working processes such as drawing, rolling, or molding processes.

[0111] The substrate 106 may extend in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. Fig. 4a illustrates a view of a plurality of substrates 106, 106', extending along the longitudinal direction 123. The light transmissive panel 101 and the carrier 110 holding the substrates have been excluded in the view for

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clarity of presentation. The substrates 106, 106', may comprise secondary fixing units 124, 124', configured for variably attaching the position of each of the substrates 106, 106', on the carrier 110 along the longitudinal direction 123 and/or in the direction of the normal axis 107. This provides for more accurately adjusting the position of the substrates 106, 106', in relation to the light transmissive panel 101. While each of the substrates 106, 106', may be within tolerances, the accumulated error obtained when several substrates 106, 106' are connected along the longitudinal direction 123 may exceed the total tolerance of the full length of the light transmissive panel 101. Such accumulation of errors may be effectively prevented by having secondary fixing units 124, 124', as elucidated above. The secondary fixing units 124, 124', may be provided on various locations on the substrates 106, 106', to allow for adjusting the position, such as on opposite ends thereof.

[0112] The touch sensing apparatus 100 may comprise vertical alignment units 135 arranged between adjacent substrates 106, 106', extending in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. The vertical alignment units 135 are configured to variably position the adjacent substrates 106, 106', in the direction of the normal axis 107 so that an angle 136 between the adjacent substrates 106, 106', can be adjusted. Fig. 4b schematically illustrates a vertical alignment unit 135 positioned between adjacent substrates 106, 106', to vary the position thereof in the direction of the normal axis 107, i.e. along arrows 137, so that the angle 136 may be set to a desired value. The vertical alignment unit 135 thus provides for facilitating the alignment of the plurality of substrates 106, 106', to e.g. the curvature of the light transmissive panel 101. For example, if the light transmissive panel 101 is concave in the direction of the normal axis 107, initially parallel substrates 106, 106', may be angled to closely follow the concave shape of the light transmissive panel 101 by increasing the angle 136 between the substrates 106, 106', as schematically illustrated in Fig. 4b. The position of the emitters and detectors 103, 103', on the substrates 106, 106', may thus remain at an optimized vertical position relative the light transmissive panel 101 for various curvatures thereof. The vertical alignment unit 135 may comprise various units configured to change the position of the adjacent substrates 106, 106', in the direction of the normal axis 107, such as bolts, screws, pins, or any other elements that can provide an offset at the ends of the substrates 106, 106'.

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[0113] The touch sensing apparatus 100 may comprise force distributing units 138 positioned between adjacent substrates 106, 106', configured to provide a fixing force therebetween, as schematically illustrated in Fig. 4c. The force distributing units 138 may provide for improving and facilitating the fixing of the substrates 106, 106', to the carrier, without the need for dedicated fixing elements such as screws, bolts, etc to each end of respective substrates 106, 106', thereby reducing the amount of such fixing elements, which facilitates the assembly of the touch sensing apparatus 100.

[0114] The touch sensing apparatus may thus comprise a plurality of substrates 106, 106', extending in a longitudinal direction 123 along the perimeter 104 of the light transmissive panel 101. A first substrate 106 of the plurality of substrates may comprises a connection unit 125 configured to directly interlock with a subsequent connection unit 125' of a subsequent substrate 106' when arranged adjacent said subsequent substrate, as schematically illustrated in Fig. 4a. It is thereby possible to directly connect subsequent substrates 106, 106', and eliminate the need for intermediate connectors, which further provides for facilitating the assembly of the touch sensing apparatus 100.

[0115] The touch sensing apparatus 100 may comprise a sealing window 126 as schematically illustrated in Figs. 5a-b. The sealing window 126 may be arranged around the perimeter 104 of the light transmissive panel 101. The sealing window 126 may comprise a first surface 129 facing the light emitters 103 or the light detectors 103', and an opposite second surface 130 arranged adjacent the touch surface 102. Emitted or detected light thus propagates between the first and second surface 129, 130. At least one of the first and second surfaces 129, 130, may comprises a light collimating surface 129, 130, configured to collimate light propagating above the touch surface 102. I.e. emitted light 105 will be collimated by the sealing window 126, so that the light propagating above the touch surface 102 will be collimated. Detectors 103' will receive the collimated light which will be focused through a corresponding sealing window 126. As the emitters and detectors 103, 103', are arranged above the touch surface 102 and are connected to a substrate 106 extending in a direction parallel with a normal axis 107, it is possible to provide for a very precise and improved alignment thereof in relation to the sealing window 126, which allows for achieving collimated light in a highly optimized manner, and an associated increase in signal

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strength since more of the emitted light can be collected by the detectors 103'. The emitted light is collimated in a direction parallel with the plane 108 in which the light transmissive panel 101 extends. Collimating the light with sealing window 126 also allows for reducing the aperture of the sealing window 126, i.e. the thickness of the sealing window 126 in the direction of the normal axis 107, while still detecting a sufficient amount of light. This provides for reducing the amount of ambient light reaching the detectors 103', thus improving the signal to noise ratio.

[0116] Turning to Fig. 5b, the second surface 130 may extend in the direction of the normal axis 107 between a base surface 131 of the sealing window 126, facing the light transmissive panel 101, and an opposite top surface 132 of the sealing window 126. The base surface 131 may be offset from the top surface 132 along the direction of the plane 108 with an offset distance 133 so that the second surface 130 forms an angle 134 relative the normal axis 107. As further illustrated in Fig. 5b, the second surface may comprises the light collimating surface 130. Thus, in addition to having a convex shape as illustrated in Fig. 5b, the second surface 130 is arranged to assume a tilted configuration as provided by the offset distance 133. Having such angled configuration provides for reducing the impact of Fresnel reflexes. The Fresnel reflexes otherwise generate additional unwanted light paths that will reduce the apparent attenuation on some detection lines, especially when they run parallel to and near a sealing window 126. These Fresnel reflexes may also result in artifacts and false touch information. By having an angled and/or curved second surface 130 of the sealing window 126, the light may instead bounce off the second surface 130 with such an angle so that it leaves the plane 108, and thereby not interfere with the detection of the remaining light.

[0117] A sealing window 126 as described above can provide for the advantageous effects as described for touch sensing apparatuses having a plurality of light emitters and detectors arranged in a multitude of configurations, not limited to the configurations described in relation to Figs. 2 and 3 exemplified above. A touch sensing apparatus 100 is thus provided comprising a light transmissive panel 101 extending in a plane 108 having a normal axis 107, wherein the light transmissive panel defines a touch surface 102. The touch sensing apparatus 100 comprises a plurality of light emitters 103 and

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detectors 103' arranged along a perimeter 104 of the light transmissive panel, wherein the light emitters are arranged to emit a respective beam of emitted light 105 above the touch surface, wherein the light detectors are arranged to receive detection light 105' from the emitted light. The touch sensing apparatus 100 comprises a sealing window 126 arranged around the perimeter, wherein the sealing window comprises a first surface 129 facing the light emitters or the light detectors and an opposite second surface 130 arranged adjacent the touch surface, whereby the emitted or detected light propagates between the first and second surface, wherein the second surface extends in the direction of the normal axis between a base surface 131 of the sealing window, facing the light transmissive panel, and an opposite top surface 132 of the sealing window, wherein the base surface is offset from the top surface along the direction of the plane with an offset distance 133 so that the second surface forms an angle 134 relative the normal axis, and wherein the second surface comprises a light collimating surface 130 configured to collimate light propagating above the touch surface.

[0118] The first surface 129, facing the emitters or detectors 103, 103', may also be angled, with an angle 134', as schematically illustrated in Fig. 5a, to provide for the desired light path from or towards the emitters or detectors 103, 103', respectively. The first surface 129 may also comprise a light collimating surface and have a convex shape towards the emitters or detectors 103, 103', as illustrated in Fig. 5a, in addition to being arranged at an angle 134'. The angles 134, 134', may be in the range of 2-10 degrees relative to the normal axis 107 to provide for a particularly advantageous reduction of Fresnel reflexes. An angle greater than 2 degrees avoids Fresnel reflexes and an angle of less that 10 degrees reduces the light field height.

[0119] The sealing window 126 may comprise a fixing element 139 configured to interlock to carrier 110. In the example in Fig. 5a, the fixing element comprises a protrusion 139 arranged to interlock with a corresponding recess in the carrier 110. Mounting and fixing of the sealing window 126 may thus be facilitated and improved since the fixing element 139 may snap into the carrier 110, without needing to have separate fixing units or adhesives joining the sealing window 126 to the carrier 110. In some circumstances, it is preferable not to use an adhesive because the adhesive may not be resilient in high temperatures. Use of an adhesive for fixing the sealing window 126 can be problematic because the uncured adhesive

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allows for relative movement between the components and precise alignment may be difficult. It is conceivable that the fixing element 139 may comprise any other shape, such as a recess, for interlocking with a corresponding mating surface of the carrier 110.

[0120] Alternative embodiments of the sealing window 126 will now be described in reference to Figure 7 to 16.

[0121] Figure 7 shows an exploded perspective schematic view of the touch sensing apparatus 100. The dotted line shows the normal axis 107 of the touch surface 102 at the center of the light transmissive panel 101. For the purposes of clarity, the exploded perspective view in Figure 7 shows the separate components side by side, but the dotted line of the normal axis 107 represents the order of how the components stack together. As mentioned previously the carrier 110 may extend substantially in the direction parallel with the normal axis 107. In this way the carrier 110 comprises a downwardly projecting skirt 700 from the upper surface 702.

[0122] The sealing window 126 is mountable on the carrier 110 and this will be discussed in further detail below. The sealing window 126 comprises a similar shape to the arrangement of the plurality of light emitters 103 and detectors 103' (not shown in Figure 7 for the purposes of clarity). The sealing window 126 is mounted such that the plurality of light emitters 103 and detectors 103' are between the sealing window 126 and the skirt 700. As shown in Figure 7, the sealing window 126 is a rectangular loop structure.

[0123] In some embodiments, the sealing window 126 may be formed from a single monolithic piece of material, thus providing for a robust sealing window 126 and a stable attachment to the carrier 110 and the light transmissive panel 101. The sealing window 126 may be formed by an extrusion process. In one embodiment, the sealing window is formed from two separate materials. A first material, such as a dyed PMMA or similar NIR transparent material, is used for a transparent section and a second material, such as a compressible light blocking material, is used for sealing off the E/D compartment. This may be achieved by e.g. using a co-extrusion process.

[0124] In other embodiments, the sealing window 126 is formed from a plurality of longitudinal pieces (not shown) and joined together to form a rectangular arrangement. Each longitudinal piece may be a single monolithic piece of material. Considering the sealing

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window 126 in Figure 7, the arrangement as shown in Figure 7 is formed from four pieces of extruded sealing window material 126. The four pieces are then joined together to construct the rectangular loop as shown in Figure 7. The four pieces of the extruded sealing window 126 can be adhered together with glue, or fastened together with screws, clips, clamps or any other suitable fastener. The glue can be applied and cured before the sealing window 126 is slid into the carrier 110 or the glue can be left to cure once the sealing window 126 is positioned in the carrier 110. Alternatively the four pieces are not fastened or glued together and are held in position with a friction fit.

[0125] The sealing window 126, once assembled, is sandwiched between the upper surface 702 of the carrier 110 and the light transmissive panel 101. In some embodiments, the sealing window 126 is slid into position between the carrier 110 and the light transmissive panel 101. Figure 8 shows the direction A in which the sealing window 126 is moved with respect to the carrier 110 and the light transmissive panel 101. In this embodiment the sealing window 126 is slid in a direction parallel with the plane of the light transmissive panel 101. In other embodiments, discussed in more detail below, the sealing window 126 can be inserted into the carrier 110 in a different direction such as parallel to the normal axis 107 and perpendicular to the touch surface 102.

[0126] In some embodiments the light transmissive panel 101 is not required to be light transmissive. For example the touch surface 102 can be on a medium through which light does not propagate. In some embodiments the touch surface 102 can be part of a surface which does not require light from a display unit 113, 121 to be visible there through. That is, the touch sensing apparatus 100 is remote from the display unit 113, 121 and the display unit 113, 121 is not stacked together with the other components as shown in Figure 7. In this way the light transmissive panel 101 can be considered to be a panel 101. For the purposes of clarity, the panel 101 has been referred to as a light transmissive panel 101, but all the embodiments are also applicable to a panel comprising an opaque or light blocking material.

[0127] Turning to Figure 8, the construction of the carrier 110, the sealing window 126 and the light transmissive panel will now be discussed in more detail. Figure 8 shows a partial perspective cross-sectional view of the touch sensing apparatus 100. In

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particular Figure 8 is magnified to show the arrangement between the carrier 110, the sealing window 126 and the light transmissive panel 101.

[0128] The sealing window 126 comprises a dual purpose. Firstly, the sealing window 126 provides sealing around the perimeter 104 of the light transmissive panel 101 and protects the emitters and detectors 103, 103' and the edge of the light transmissive panel 101. This means that the sealing window 126 prevents ingress of dirt, water and other contaminants into the interior of the touch sensing apparatus 100. This helps protect the internal components such as the plurality of emitters and detectors 103, 103'. Secondly, the sealing window 126 allows light from the emitters and detectors 103, 103' to propagate therethrough. In some embodiments, as discussed in reference to Figure 5a, the sealing window can optionally comprise optical elements for refracting, deflecting, diverting or focusing the light beams therethrough. However in other embodiments, the sealing window is optically passive and does not comprise any optical elements for refracting, deflecting, diverting or focusing the light beams therethrough.

[0129] As can be seen from Figure 8, an upper sealing surface 800 of the sealing window 126 engages with an interior underside surface 802 of the carrier 110. The upper surface 702 of the carrier 110 is arranged to project over the light transmissive panel 101. In this way the carrier 110 overlaps a portion of the light transmissive panel 101 around the perimeter of the light transmissive panel 101. The portion 810 of the upper surface 702 that overlaps with the light transmissive panel 101 is indicated by a bracket in Figure 8. The overlapping portion 810 of the carrier 110 provides protection for the perimeter light transmissive panel 101 from shock and other physical forces. The overlapping portion 810 also provides an overhang on which the sealing window 126 can be mounted. The interior underside surface 802 of the carrier is an opposite face to the upper surface 702. A lower sealing surface 804 of the sealing window 126 engages with the touch surface 102.

[0130] In order to aid the sealing, the sealing window 126 optionally comprises one or more deformable seals or integral gaskets 806, 808 mounted on the upper sealing surface 800 and the lower sealing surface 804 respectively. The deformable seals 806, 808 are arranged to deform when the light transmissive panel 101 is urged towards the carrier 110. The deformable seals 806, 808 are extruded along the longitudinal length of the sealing

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window 126. In some embodiments the deformable seals 806, 808 are integral with the sealing window 126. As mentioned previously, in some embodiments the deformable seals 806, 808 can be manufactured at the same time as the sealing window 126 in a co-extrusion process. Alternatively the deformable seals 806, 808 are mounted and adhered to the sealing window 126 after the sealing window 126 has been extruded. In some embodiments the deformable seals 806, 808 are made from a thermoplastic elastomer (TPE). The deformable seals 806, 808 can be colored black to block transmission of light from the sealing window 126. The deformable seals 806, 808 can be any suitable color or material for absorbing light and minimizing light in-coupling.

[0131] In some embodiments the sealing window 126 is configured to be mounted between two surfaces for sealing and protecting the emitters and detectors 103, 103' from the outside environment. In some embodiments the sealing window 126 is arranged to seal against the touch surface 102 and the interior underside surface 802 of the carrier 110. In other embodiments the sealing window 126 can be mounted between any other surface to provide a sealed cavity 116 around the emitters and detectors 103, 103'. In some embodiments the sealing window 126 seals between the interior underside surface 802 and other surface. The other surface does not need to be the touch surface 102. Instead the other surface is another interior surface of the carrier 110 such as a surface on which the substrate 106 is mounted on. In some other embodiments the sealing window 126 is mounted and sealed against another components and neither of the touch surface 102 and the interior underside surface 802. In some embodiments the sealing window 126 is sealable against at least one surface of the touch sensing apparatus 100 for sealing a cavity 116 around the plurality of light emitters and detectors 103, 103'. In some embodiments the carrier 110 may also be the substrate 106 or the emitters and detectors 103, 103' are mounted directly to the carrier 110.

[0132] In some embodiments the sealing window 126 comprises at least one reference surface 812 for aligning the sealing window 126 with respect to the carrier 110. The reference surface 812 will be discussed in further detail with respect to Figure 9 for the purposes of clarity.

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[0133] Figure 9 is a schematic cross-sectional view of the touch sensing apparatus 100. The sealing window 126 is inserted between the light transmissive panel 101 and the carrier 110. The upper deformable seal 806 comprises a reference surface 812 for aligning the sealing window 126 with respect to the carrier 110. The upper deformable seal 806 comprises a projection 814 which projects upwardly from the upper deformable seal 806 and the sealing window 126. In this way, the reference surface 812 is upright with respect to the sealing window 126. The projection 814 also optionally comprises a chamfer 816 in addition to the reference surface 812.

[0134] The chamfer 816 means that the deformable upper seal 806 does not snag on the carrier 110 when the sealing window 126 is inserted between the carrier 110 and the light transmissive panel 101. Accordingly as the sealing window 126 is pushed into place, the chamfer 816 urges against the interior underside surface 802 of the carrier 110. Initially, the deformable upper seal 806 is squashed between the carrier 110 and the light transmissive panel 101 when the sealing window 126 is being forced between the carrier 110 and the light transmissive panel 101.

[0135] The sealing window 126 is pushed towards a notch 820 located in the interior underside surface 802 of the carrier 110. In some embodiments, the notch 820 is a groove that extends around the periphery of the carrier 110. The notch 820 comprises a reciprocal reference surface 818 for aligning with the reference surface 812 of the projection 814. In particular, the notch 820 is a reference point for indicating that the sealing window 126 is inserted underneath the overlapping portion 810 sufficiently to form a seal and protect the internal components of the touch sensing apparatus 100. The notch 820 is positioned a predetermined distance from the edge 822 of the carrier 110. In some embodiments the predetermined distance is at least half the width of the sealing window 126.

[0136] When the sealing window 126 pushed sufficiently between the carrier 110 and the light transmissive panel 101, the deformed projection 814 is located within the notch 820. At this point when the sealing window 126 is located in the correct position with respect to the carrier 110, the reference surface 812 abuts against a reciprocal reference surface 818 in the notch 820 in the carrier 110.

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[0137] The compressed projection 814 resiles and expands once located in the notch 820. In this way, the project 814 snaps into position and positively engages with the notch 820. When the sealing window 126 is located and the projection 814 snaps into place, the sealing window 126 makes an audible "click". Additionally or alternatively the snapping of the projection 814 into position provides a tactile feedback during assembly that the sealing window 126 is seated correctly.

[0138] The size of the notch 820 is slightly larger than the dimensions of the projection 814. Accordingly the projection 814 fits snugly within the notch 820. This means that the frictional forces between the carrier 110, the light transmissive panel 101 and the sealing window 126 are sufficient to hold the sealing window 126 in place. Adhesive is not required to fix the sealing window 126 in place. However in some embodiments adhesive is optionally used in addition to the snap-fit positive engagement.

[0139] In some embodiments the reference surface 812 abuts against the reciprocal reference surface 818. This means that the sealing window 126 opposes the direction A by virtue of the engaged reference surfaces 812, 818. Removal of the sealing window 126 may only be achieved with a special tool which compresses the projection 814.

[0140] Once the sealing window 126 has been seated correctly in the carrier 110, the reference surfaces 812, 818 maintain the alignment between the carrier 110 and the sealing window 126. The deformable seals 806, 808 maintain the relative position of the sealing window 126 with respect to the carrier and prevents lateral movement in a plane parallel to the light transmissive panel 101. Furthermore, the reference surfaces 812, 818 ensure that the sealing window 126 is maintained at a certain height above the touch surface 102.

[0141] The shape and size of the deformable seal 806, 808 can be varied. Another embodiment with such a variation is shown in Figure 10. Figure 10 shows a cross sectional side view of the touch sensing apparatus 100. The arrangement is the same as shown in reference to Figures 8 and 9, except the cross sectional shape of the deformable seal 806, 808 is different. In this embodiment the projection 1002 comprises a curved upwardly projecting bulge 1002 on the upper deformable seal 806. The bulge 1002 comprises a curved reference surface 1004 which engages with one or more reciprocal reference surfaces 818 of the notch

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820. The curved reference surface 1004 functions in a similar way to the chamfer 814 as described in reference to the previous embodiment when inserting the sealing window 126 between the light transmissive panel 101 and the carrier 110. The bulge 1002 has dimensions which are substantially the same width as the width of the notch 820 so that the sealing window 126 does not experience lateral movement in a direction parallel with the plane of the light transmissive panel 101. The lower seal 808 optionally comprises a similar bulge 1006 for engaging and sealing against the touch surface 102. By making the upper seal 806 and the lower seal 808 have the same cross section, manufacture can be simplified because the same die (not shown) can be used during extrusion of the deformable seals 806, 808.

[0142] Advantageously the shape of the projection 1002 means that the sealing window 126 can be removed with a similar magnitude of force to the force needed for insertion during assembly. Accordingly removal of the sealing window 126 may not require a tool. This can make maintenance which requires removal of the sealing window 126 easier.

[0143] Another embodiment is shown in Figure 11. Figure 11 shows a cross sectional side view of the touch sensing apparatus 100. Figure 11 is the same as shown in Figure 10 except that there is an additional projection and notch. The first notch 1100 and first bulge 1104 are substantially the same as the notch 820 and the bulge 1002 as discussed in reference to Figure 10. In addition, there is a second notch 1102 and a second bulge 1106. Likewise the lower seal 808 comprises similar first and second bulges 1108, 1110. Having two projecting bulges 1104, 1106 means that there are two points of sealing engagement between the sealing window 126 and the light transmissive panel 101 and the carrier 110 respectively. This means that there will be less rotation of the sealing window 126 about the deformable seal 806, 808. Accordingly, the tolerances needed to accommodate rotational movement of the sealing window about the longitudinal axis of the sealing window can be lower. There is also an increased surface area of the deformable seals 806, 808 and therefore the deformable seals will cool quicker during manufacture.

[0144] In another embodiment, the first and second bulges 1104, 1106 engage with a single notch 820 as shown in Figure 10. The dotted line between the first and second notches 1100, 1102 represents a single notch, similar to the notch 820 in Figure 10. In this case the first bulge 1104 engages a first reciprocal reference surface 1114 and the second

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bulge 116 engages with a second reciprocal reference surface 1112. The first and second reciprocal reference surfaces 1114, 1112 are walls of the notch 820.

[0145] Another embodiment will now be discussed in reference to Figure 12. Figure 12 shows a schematic perspective and cross-sectional view of the touch sensing apparatus 100. The arrangement as shown in Figure 12 is the same as shown in Figures 8 and 9 except that the deformable seal 806 comprises a plurality of discrete projections 1200, 1202, 1204. Each of the projections is deformable and is inserted between the light transmissive panel 101 and the carrier 110 in the same way as described with respect to the previous embodiments. The carrier 110 comprises a serious of reciprocal recesses (not shown for clarity) to receive a respective projection 1200, 1202, 1204. In this way less deformable material is required to perform the alignment function. The projections may be adhered to the deformable seal material 806 or the projections can be extruded. Each of the projections 1200, 1202, 1204 comprise a reference surface for aligning the projection and the sealing window 126 with the reciprocal recess in the carrier 110. In some embodiments the projections 1200, 1202, 1204 can comprise any suitable cross sectional shape. For example, the projections can comprise an oval curved cross section, similar to the bulges shown in the embodiments discussed in reference to Figures 10 and 11.

[0146] Figure 13 shows yet another embodiment. Figure 13 shows a schematic exploded perspective view of the touch sensing apparatus 100. For the purposes of clarity the light transmissive panel 101 is not shown. The sealing window 126 is the same as described in reference to the previous embodiments. The upper deformable seal 806 is mounted on the upper sealing surface 800. In contrast to the previous embodiments, the deformable seal 806 does not comprise upward projections comprising a reference surface. Instead the sealing window 126 comprises positioning pegs 1300, 1302 for engagement in the reciprocal positioning holes 1304, 1306 located in the carrier 110. In this way the reference surfaces are separate from the deformable seal 806.. Each of the positioning pegs 1300, 1302 comprises a reference surface 1308, 1310 for aligning the sealing window 126. In this way as the sealing window is slid underneath the carrier 110 in the direction A, the pegs 1300, 1302 slot into the positioning holes 1304, 1306. The holes 1304, 1306 are blind holes and when the reference surfaces 1308, 1310 abut the end of the blind holes 1304, 1306, the sealing window 126 is in

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the correct position. The holes 1304, 1306 are deep enough such that the sealing window 126 is completely under the carrier 110, similar to the arrangement shown in the previous embodiments.

[0147] Figure 14 shows another embodiment. Figure 14 shows a cross sectional side view of the touch sensing apparatus 100. The arrangement as shown in Figure 14 is the same as shown in Figures 8 and 9 except that the projection 1400 is formed on the carrier 110 and the notch 1402 is formed in the upper deformable seal 806. In this embodiment the projection 1400 is rigid and downwardly projects from the carrier 110. The notch 1402 is deformable and snaps into position when the notch 1402 is in positive engagement with the projection 1400 and reference surfaces are in engagement. The sealing window 126 is inserted between the carrier and the light transmissive panel 101 in the same way as discussed previously.

[0148] In alternative embodiments, the carrier 110, the light transmissive panel 101 and the sealing window 126 are assembled in a different order. The components are the same as described in reference to the previous embodiments. Turning to Figures 15a – 15d and Figure 16 the alternative method of assembly will now be discussed.

[0149] Figures 15a – 15d show a side cross section of the touch sensing apparatus 100. The light transmissive panel 101 has been omitted for clarity. The sealing window 126 is pushed towards the carrier 110 in direction B. That is, a direction which is parallel to normal axis 107. Figure 15a shows two deformable projections 1500, 1502 which have a snap-fit engagement with reciprocal grooves in the carrier. The deformable projections 1500, 1502 have a cross sectional shape that snaps into the reciprocal holes when the sealing window is seated correctly in the carrier 110.

[0150] Figure 15b shows a similar arrangement to Figure 15a except that there is a single projection 1504 which does not have a snap-fit engagement. Optionally, positive engagement is provided by the projection 1504 having a snug friction fit. When the sealing window 126 cannot move any further with respect to the carrier 110, the projection 1504 will abut the reciprocal surface of the hole in the carrier 110 and the sealing window will be seated correctly.

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[0151] Figures 15c and 15d show stepwise engagement of the same arrangement. The deformable seal 806 comprises snap-fit latches 1506, 1508 which bend and snap into place once the sealing window is fully seated in the carrier 110.

[0152] Once the sealing window 126 and the carrier 110 are assembled, then the light transmissive panel 101 is mounted in the carrier 110.

[0153] Figure 16 shows a schematic exploded perspective view of the carrier 110 and the sealing window 126. The arrangement as shown in Figure 16 is the same as shown in Figure 13, except that the relative movement of the sealing window 126 with the respect to the carrier 110 during assembly is perpendicular. That is, along direction B parallel with the normal axis 107. Similar to the embodiment as shown in Figure 13, the sealing window 126 comprises a plurality of reference surfaces which are not part of the deformable seal 806. Each of pegs 1600, 1606 and snap-fit latches 1602, 1604 comprises a reference surface for alignment. Figure 16 shows pegs 1600, 1606 for engagement with holes 1608, 1610. Figure 16 also shows resiliently deformable latches 1604, 1602 for snap-fit engagement with holes 1612 and 1614.

[0154] A further mounting unit 140 may be provided between the sealing window 126 and the light transmissive panel 101, as schematically illustrated in Fig. 5a. The mounting unit 140 may comprise a resilient material that allows the sealing window 126 to assume a secure fixed position relative the light transmissive panel 101. The sealing window 126 may have a corresponding groove into which the mounting unit 140 may be securely positioned.

[0155] A method 200 of assembling a touch sensing apparatus 100 is provided. Fig. 6 illustrates steps of the method 200. The order in which the steps of the method 200 are described and illustrated should not be construed as limiting and it is conceivable that the steps can be performed in varying order. The method 200 comprises fixing 201 a substrate 106 having a plurality of light emitters 103 and detectors 103' to a carrier 110, and attaching 202 the carrier 110 around a perimeter 104 of a light transmissive panel 101. The method further comprises arranging 203 the substrate to extend in a direction 107' parallel with a normal axis 107 of a plane 108 in which the light transmissive panel 101 extends, whereby the plurality of light emitters and detectors 103, 103', are arranged above the touch surface

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102. The method 200 thus provides for a facilitated assembly of the touch sensing apparatus 100 while achieving optimal alignment, robustness, and accuracy as described above in relation to Figs. 2 – 3.

[0156] As mentioned, the carrier 110 may be formed from a single monolithic piece of material, and the carrier may form a cavity 116 having walls 117 at least partly enclosing the substrate 106. At least one of the walls 117 may comprise openings 115, 115', 115''. The method 200 may comprise fixing 204 the carrier 106 to a display unit 121, 113, by fixing mounting elements 114 through the openings 115, 115', 115'', thereby providing for the above mentioned advantages.

[0157] The method 200 may comprise adjusting 205 a distance 120 between the light transmissive panel 101 and a display unit 113, 121, along the normal axis 107 by attaching 207 the carrier 110 to the display unit 113, 121, at at least two different adjustable positions 119, 119', along a direction 117'' parallel to the normal axis 107. Control of the distance 120 is improved and facilitated, and may thereby be more easily optimized to various applications of the touch sensing apparatus 100.

[0158] The method 200 may comprise adjusting 208 a radius of curvature of the light transmissive panel 101 in the direction of the normal axis 107 by attaching 209 the carrier 110 to a display unit 113, 121, at at least two different adjustable positions 119, 119', along a direction 117'' parallel to the normal axis 107. Control of the curvature of the light transmissive panel 101 is thus improved as described above.

[0159] The invention has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope and spirit of the invention, which is defined and limited only by the appended patent claims.

[0160] For example, the specific arrangement of emitters and detectors as illustrated and discussed in the foregoing is merely given as an example. The inventive coupling structure is useful in any touch-sensing system that operates by transmitting light, generated by a number of emitters, inside a light transmissive panel and detecting, at a number of detectors, a change in the received light caused by an interaction with the transmitted light at the point of touch.

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WHAT IS CLAIMED IS:

1. A touch sensing apparatus, comprising:

a plate comprising a touch surface, a back surface, and an edge surface;

a support structure extending parallel to the edge surface of the plate, said support structure extending above the touch surface, said support structure configured to support an emitter, wherein the emitter is positioned on the support structure to transmit light in a plane above the touch surface and perpendicular to a normal of the touch surface; and

an optical element positioned above the touch surface, said optical element comprising a first surface configured to receive the transmitted light directly from the emitter and a second surface configured to receive light propagating across a touch interacting portion of the touch surface.

2. The touch sensing apparatus of Claim 1, wherein the first surface of the optical element comprises a light collimating surface.

3. The touch sensing apparatus of Claim 1, wherein the optical element comprises glass or plastic.

4. The touch sensing apparatus of Claim 1, wherein the support structure is one element of a frame assembly, wherein the frame assembly comprises a plurality of frame elements.

5. The touch sensing apparatus of Claim 4, wherein the plurality of frame elements comprise a first element including:

a first portion extending parallel to the edge surface of the plate in a direction perpendicular to a normal of the touch surface;

a second portion extending parallel to the touch surface and covering a portion of the touch surface, wherein the second portion is separated from the touch surface by a spacing; and

a retaining member in the second portion, wherein the retaining member is configured to secure the optical element in the spacing between the first element and the touch surface.

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ABSTRACT OF THE DISCLOSURE

A touch sensing apparatus is disclosed comprising a panel that defines a touch surface, a plurality of light emitters and detectors arranged along a perimeter of the panel. The light emitters are arranged to emit a respective beam of emitted light that travels above the touch surface, wherein the light detectors are arranged to receive detection light from the emitted light. The plurality of light emitters and detectors are arranged above the touch surface and are connected to a substrate extending in a direction parallel with a normal axis of a plane in which the panel extends. A method of assembling a touch sensing apparatus is also disclosed.

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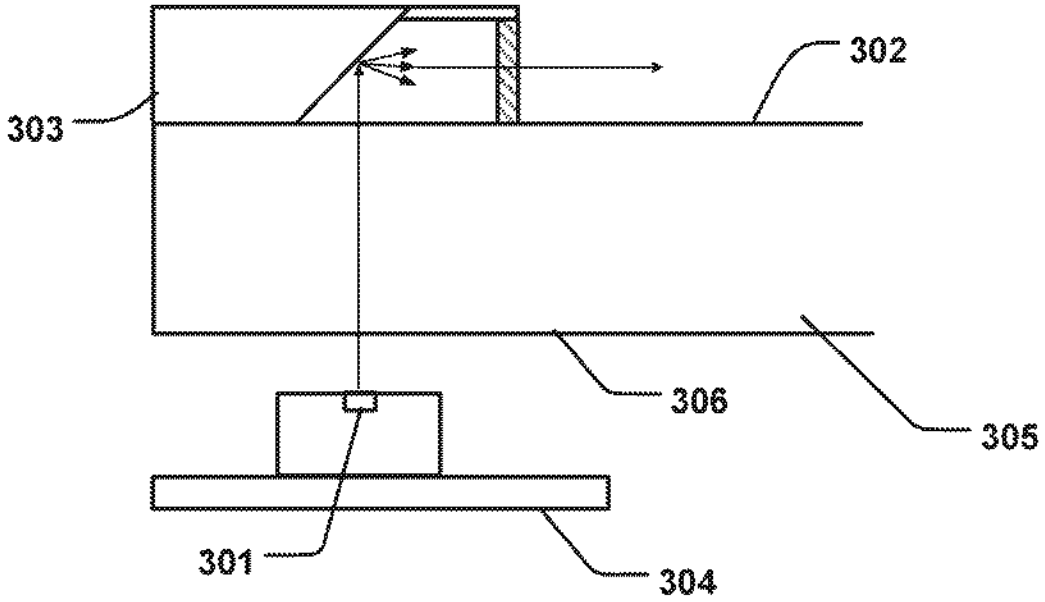


Fig. 1

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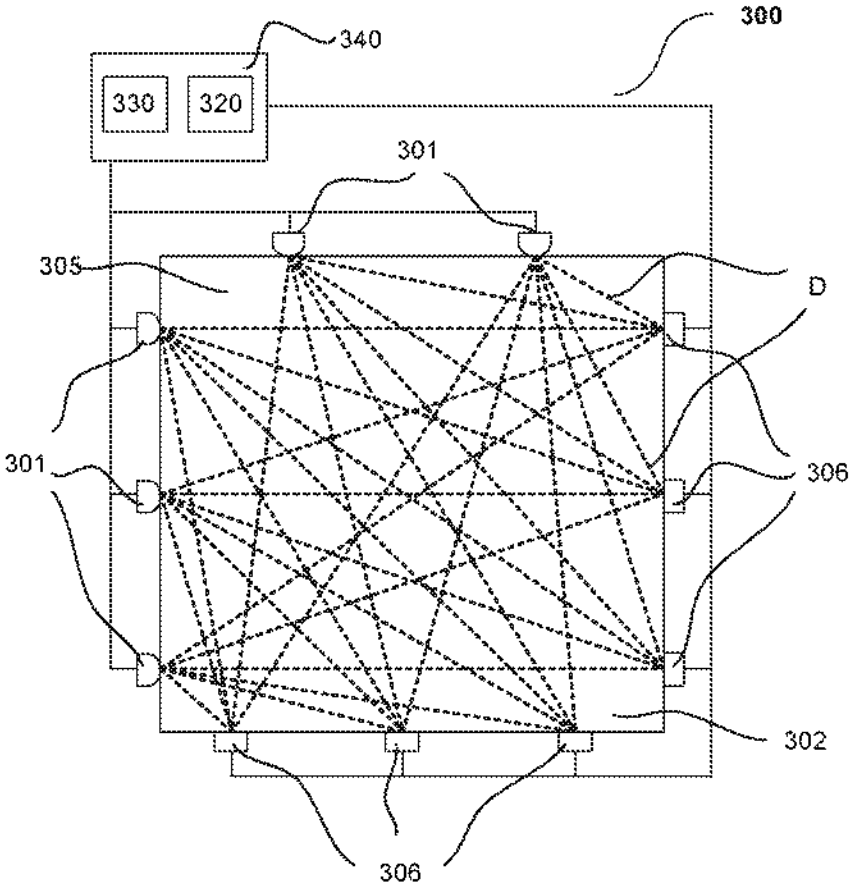


Fig. 1b

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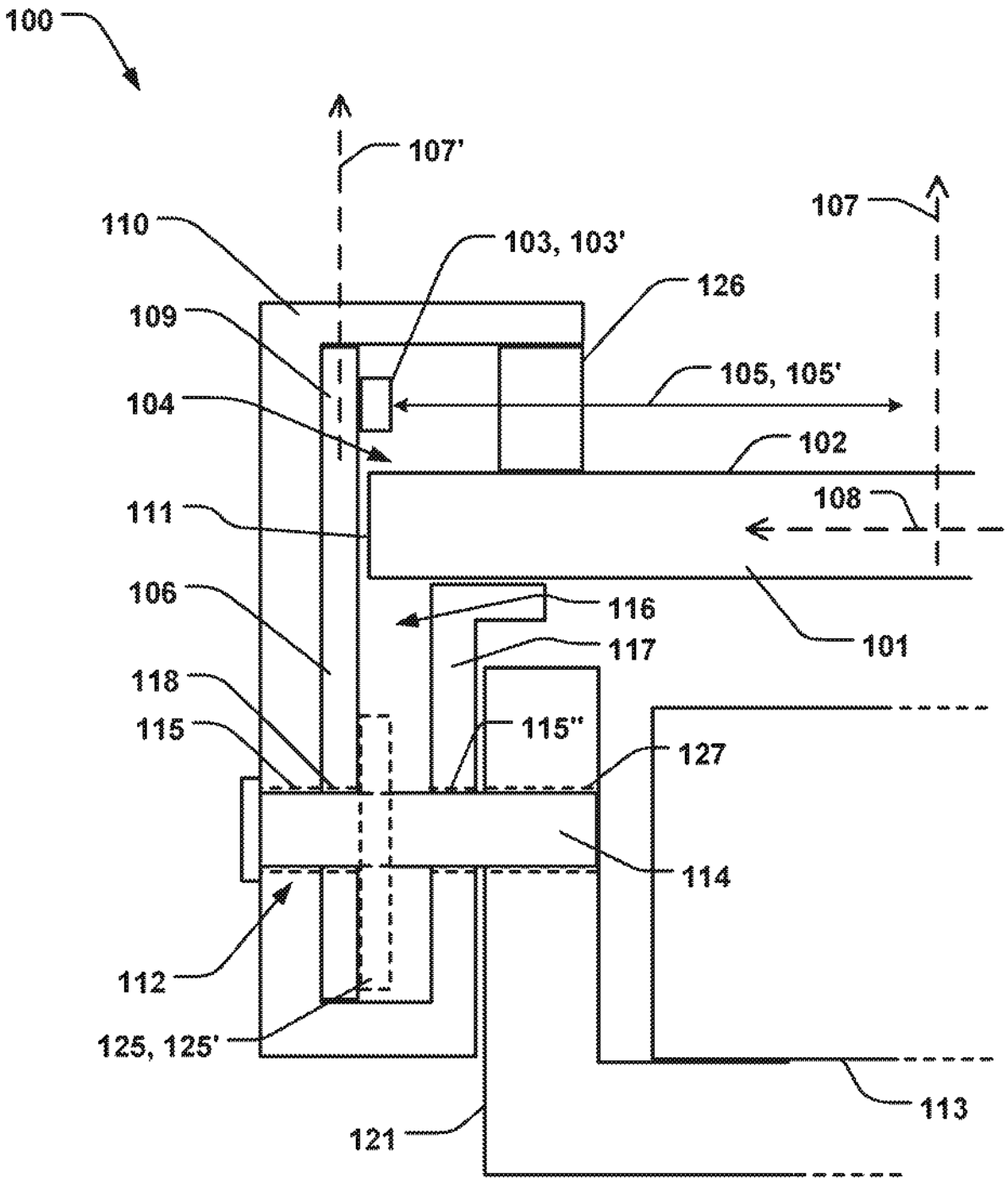


Fig. 2

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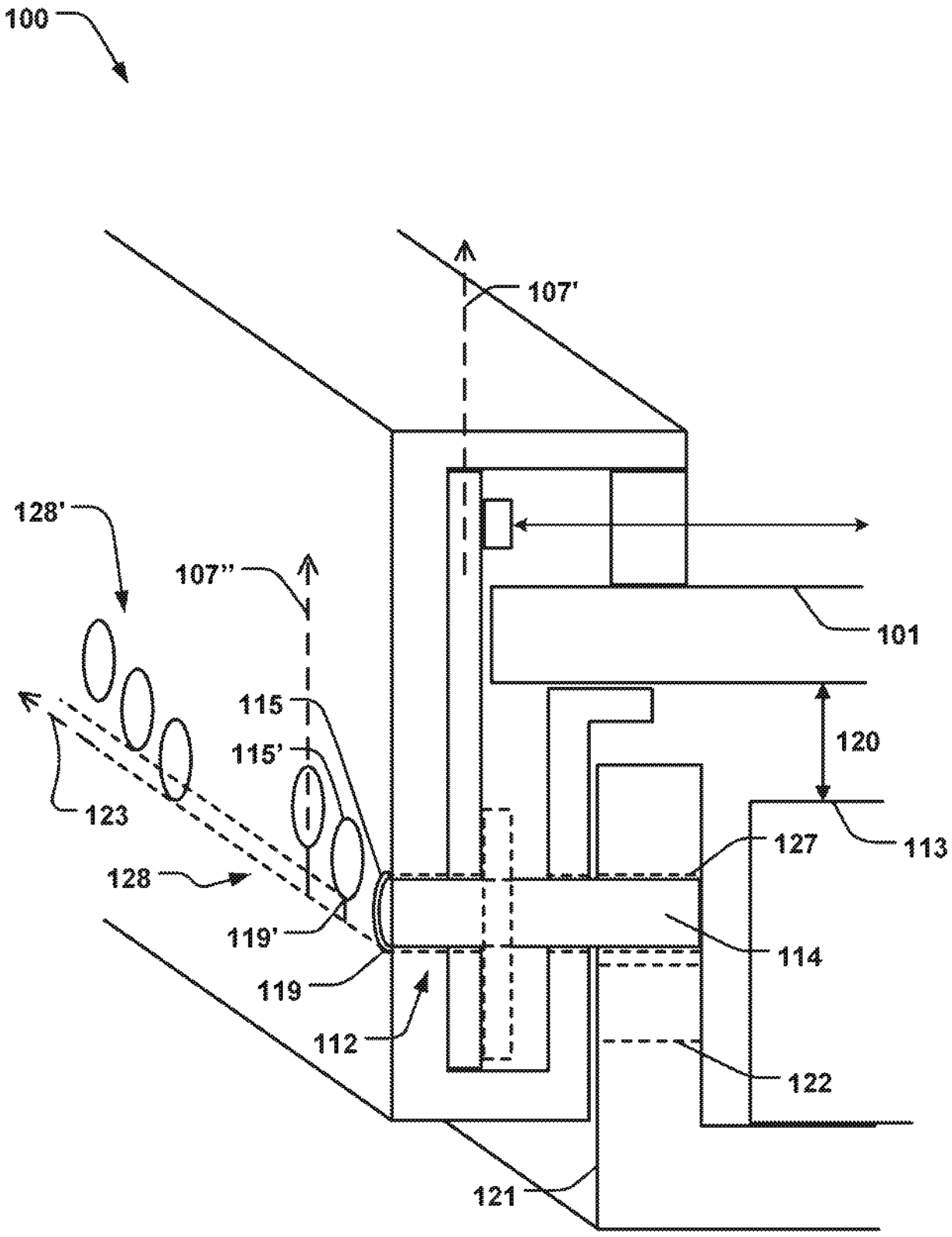


Fig. 3

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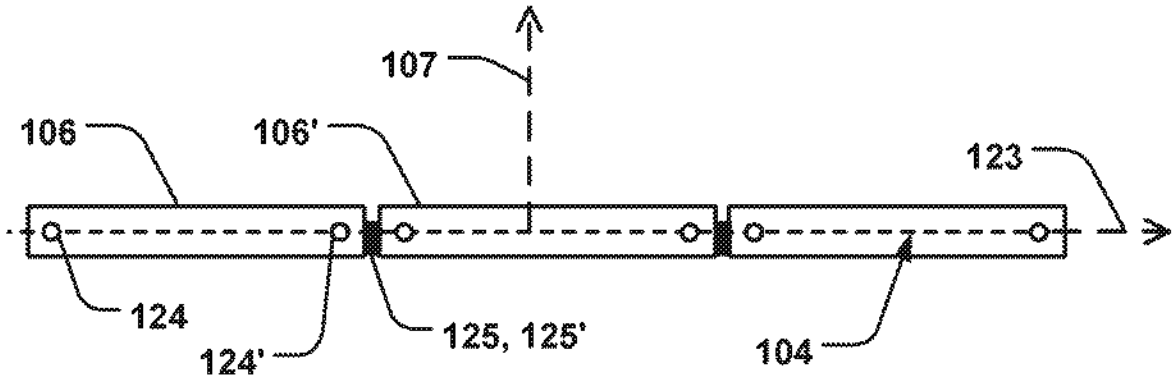


Fig. 4a

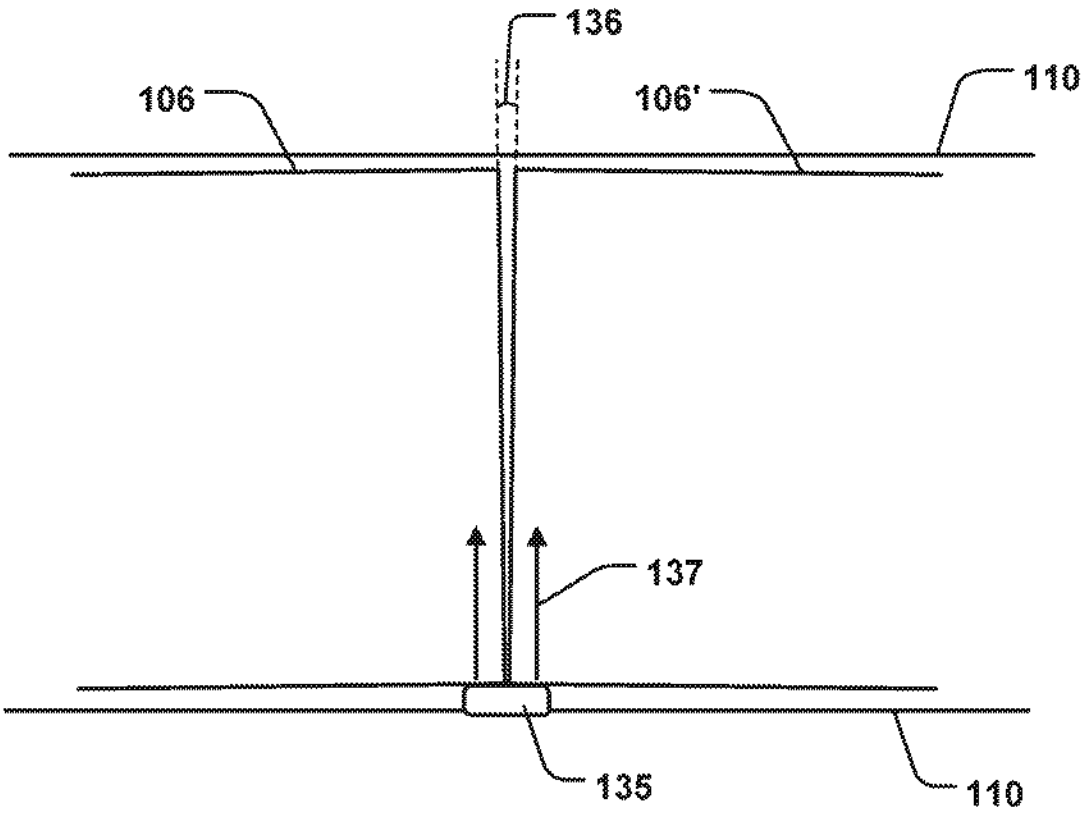


Fig. 4b

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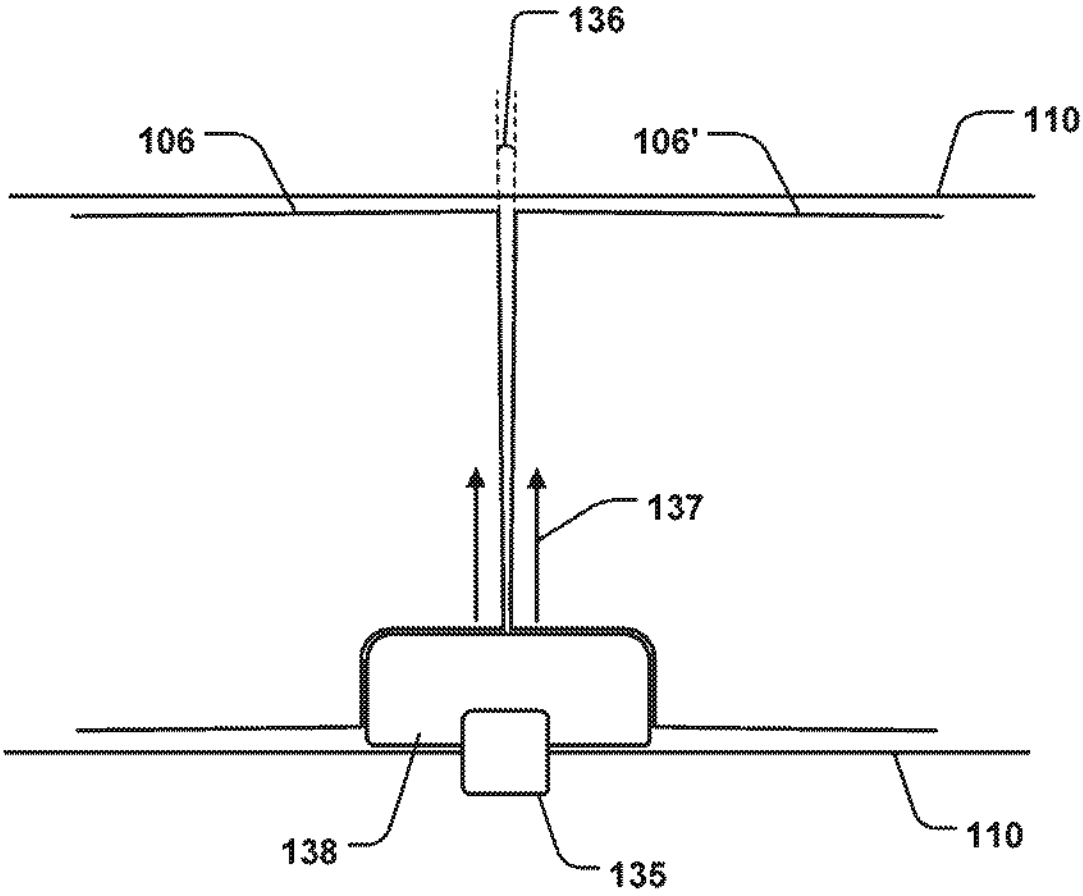


Fig. 4c

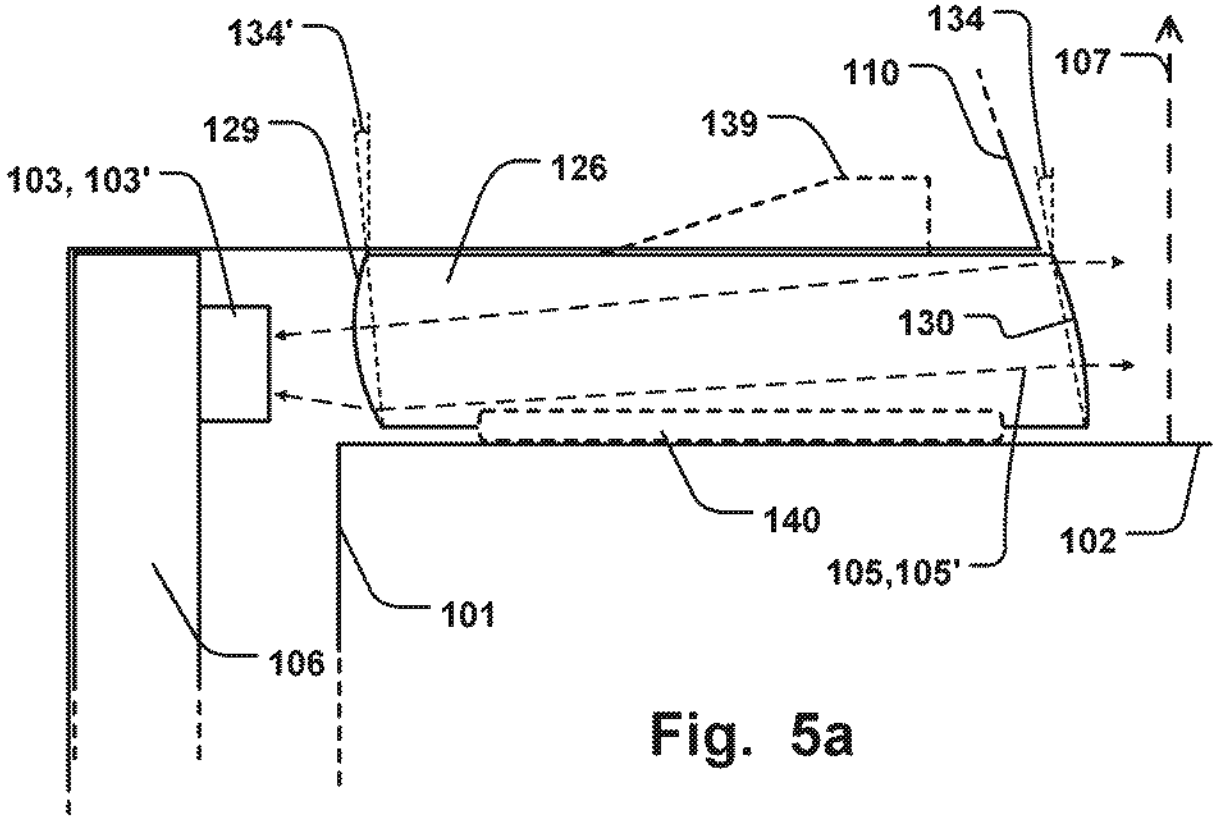


Fig. 5a

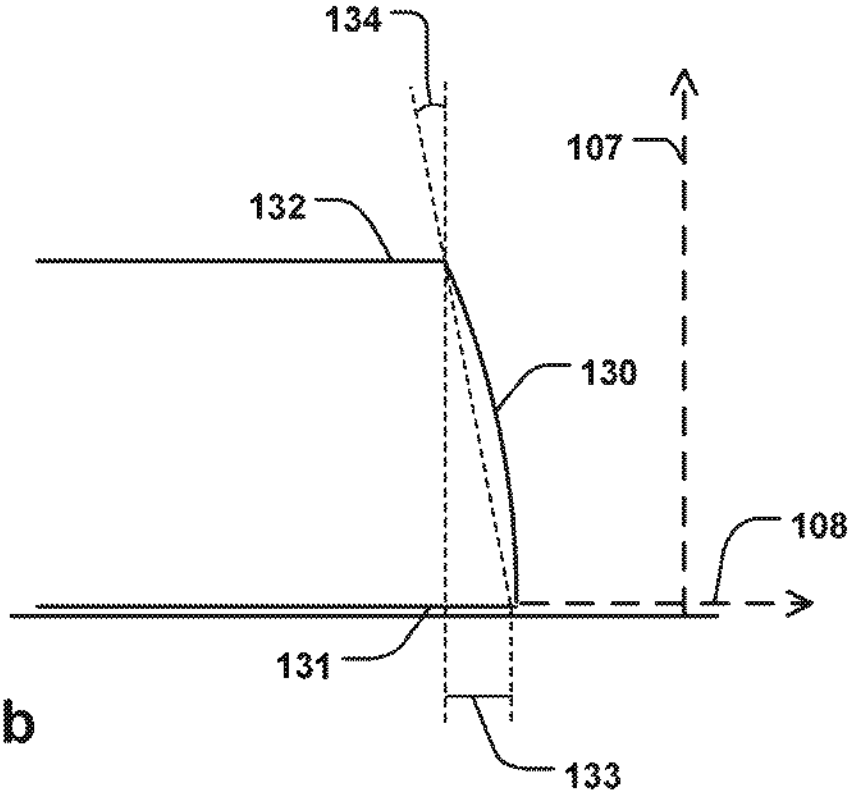


Fig. 5b

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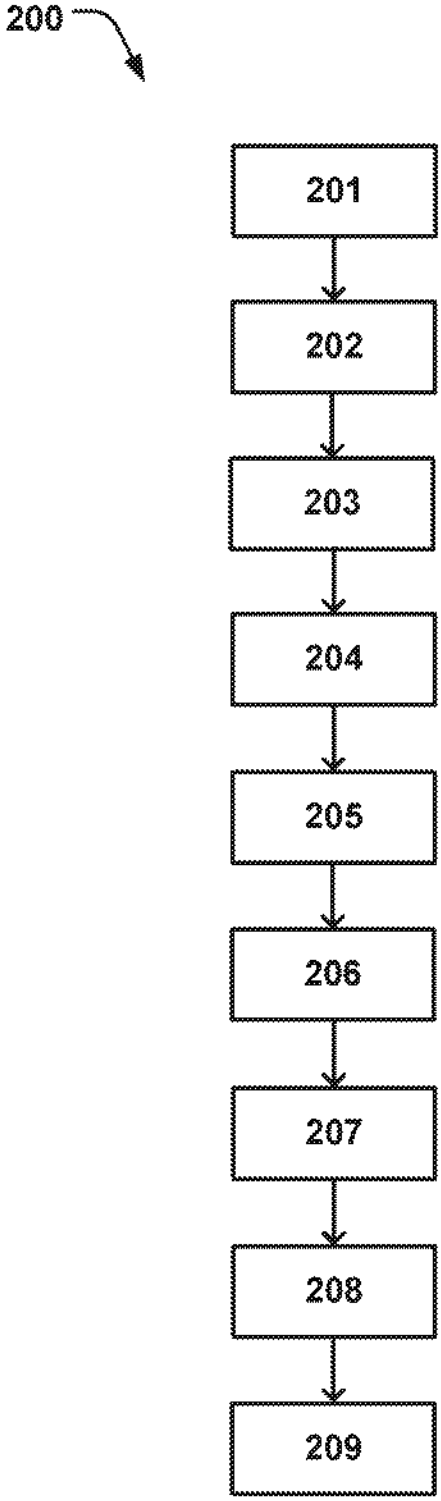


Fig. 6

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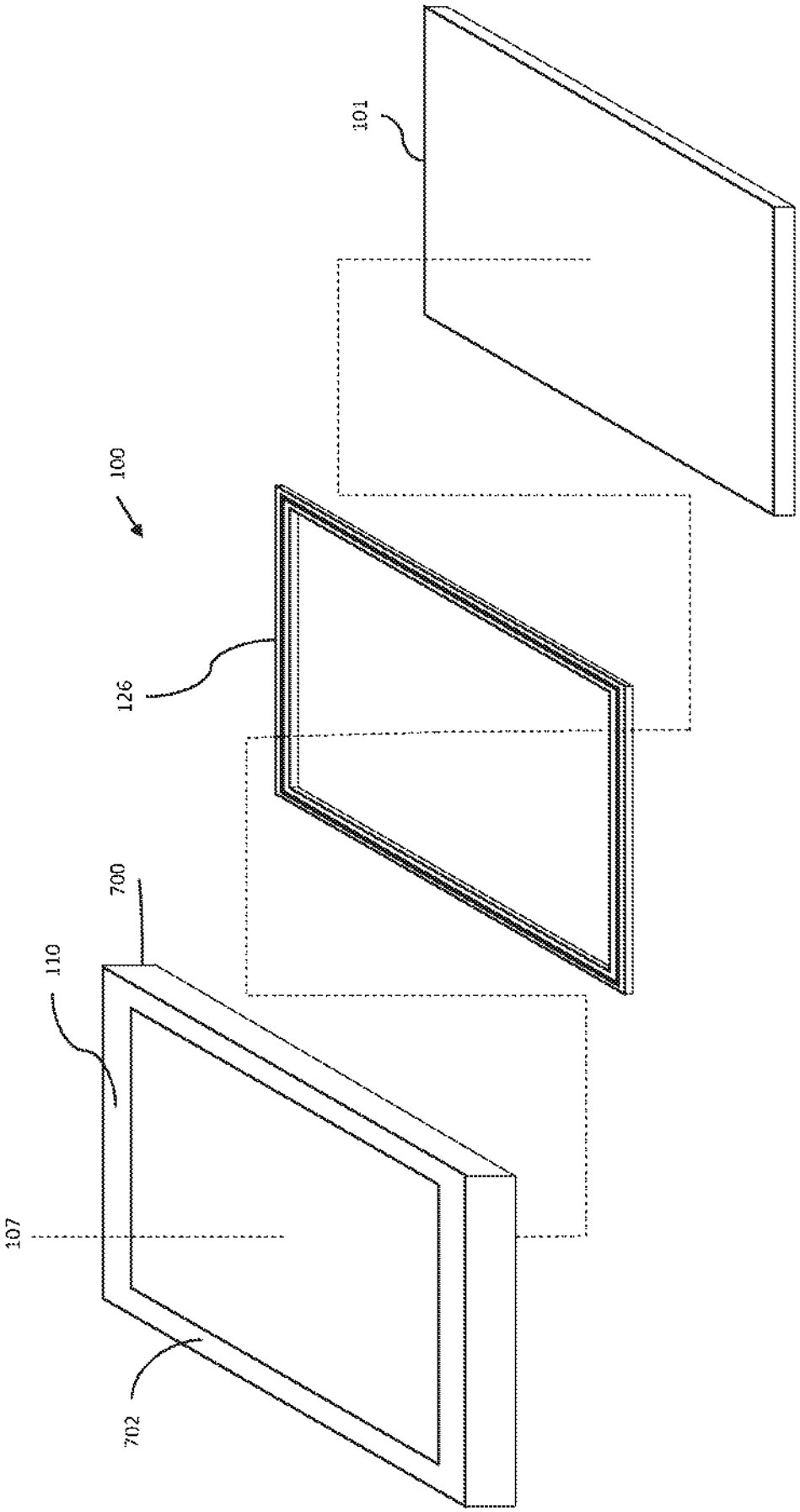


Figure 7

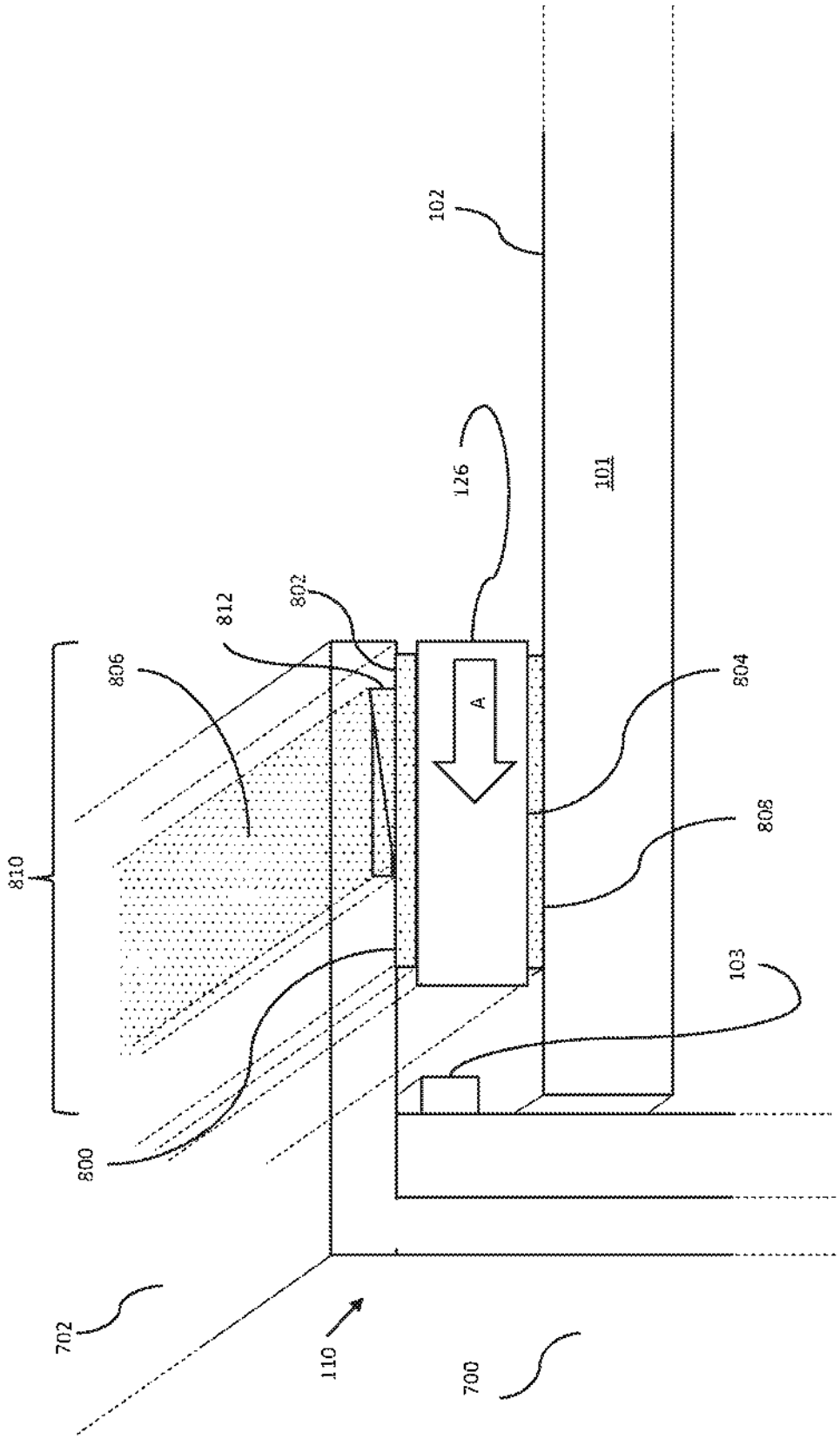


Figure 8

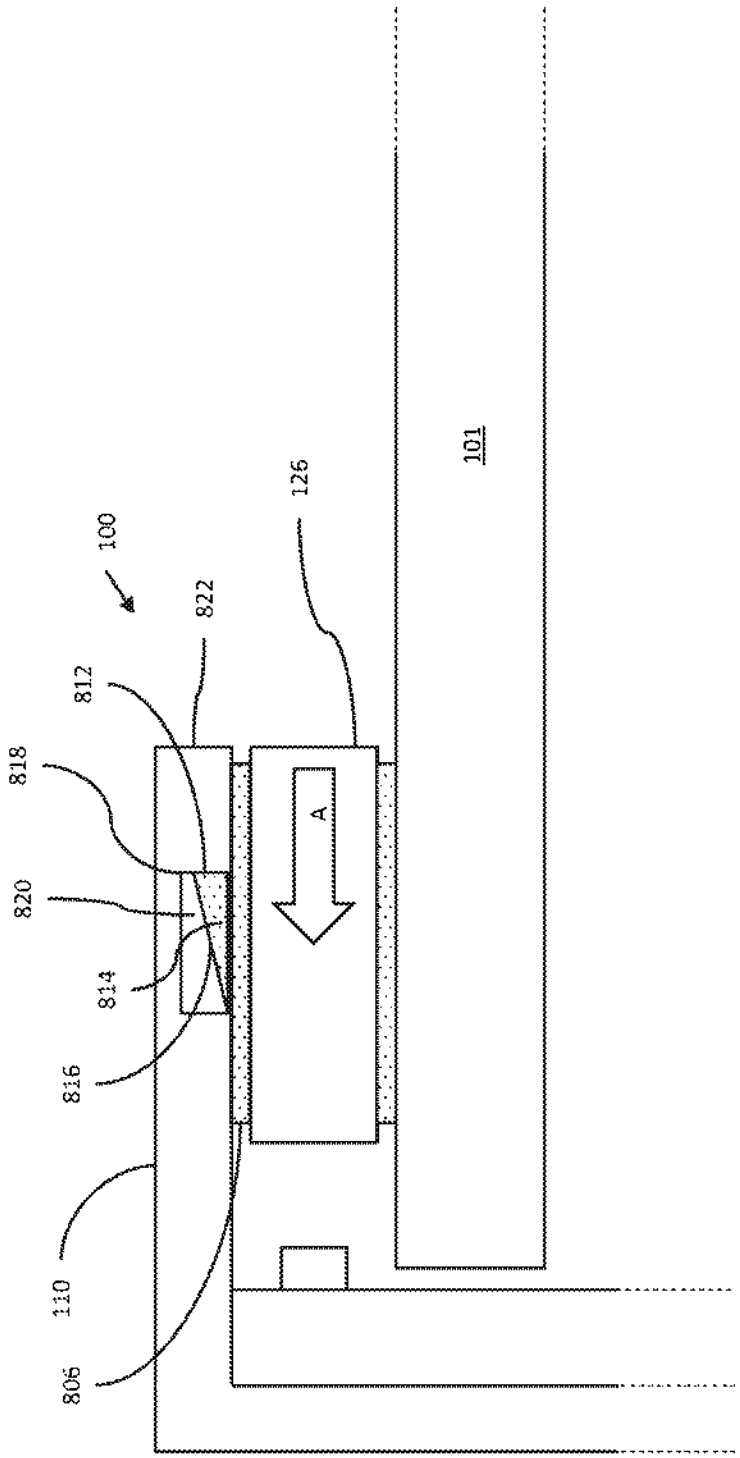


Figure 9

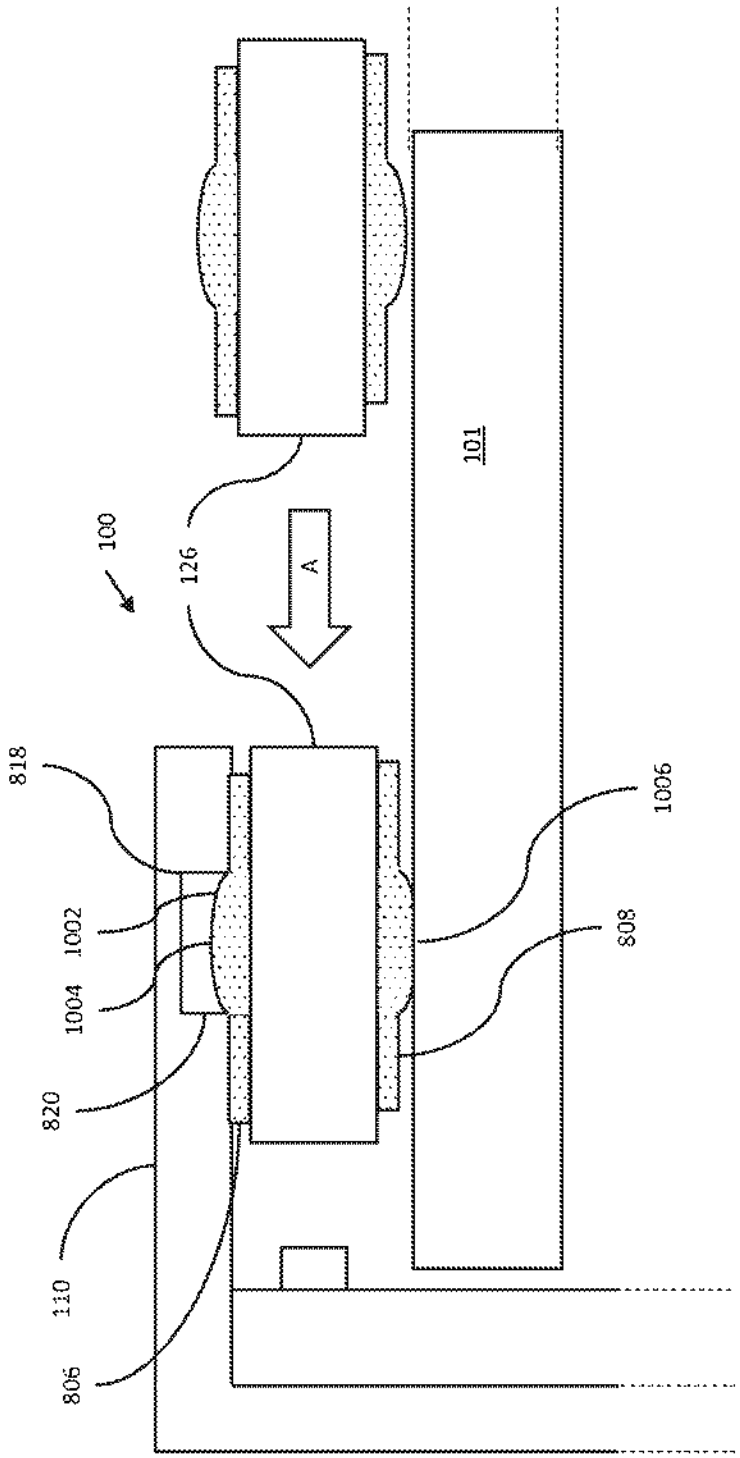


Figure 10

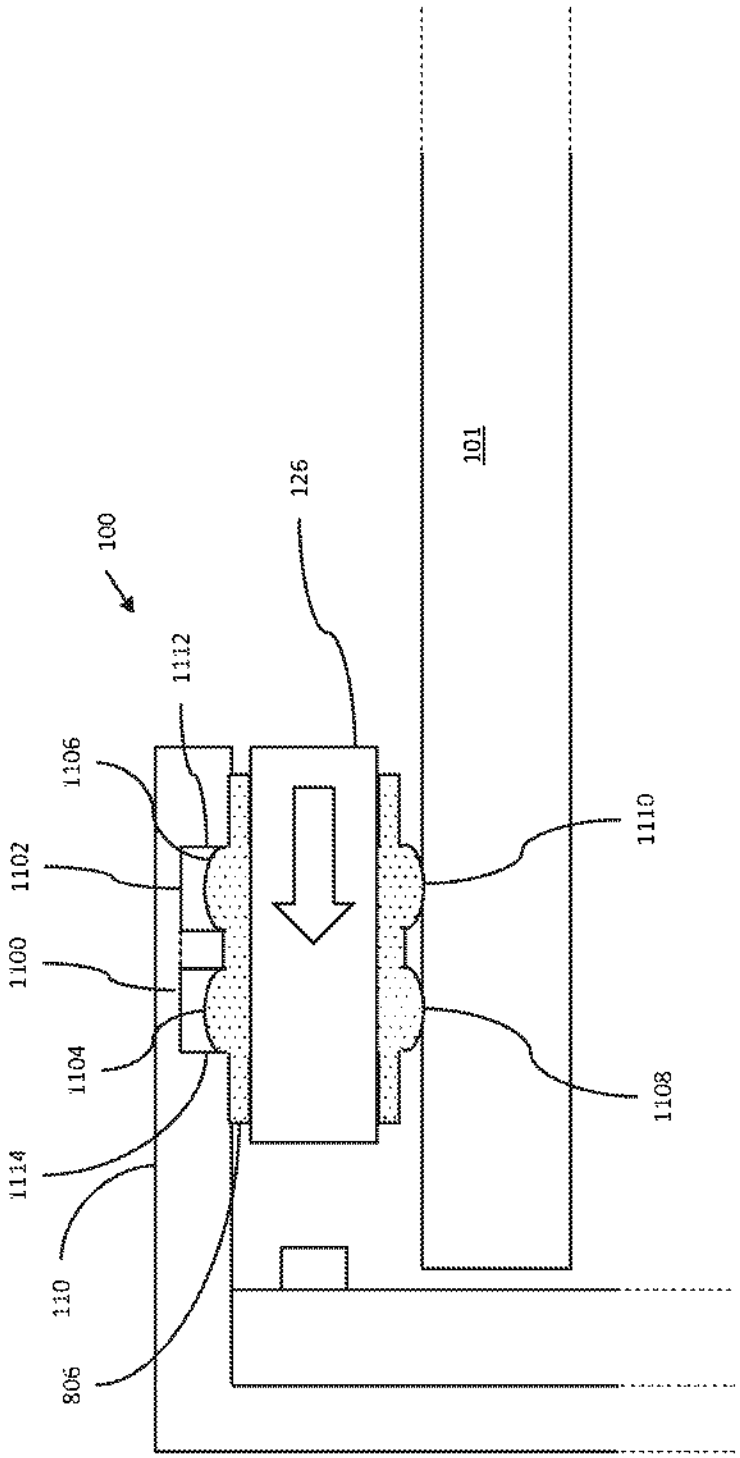


Figure 11

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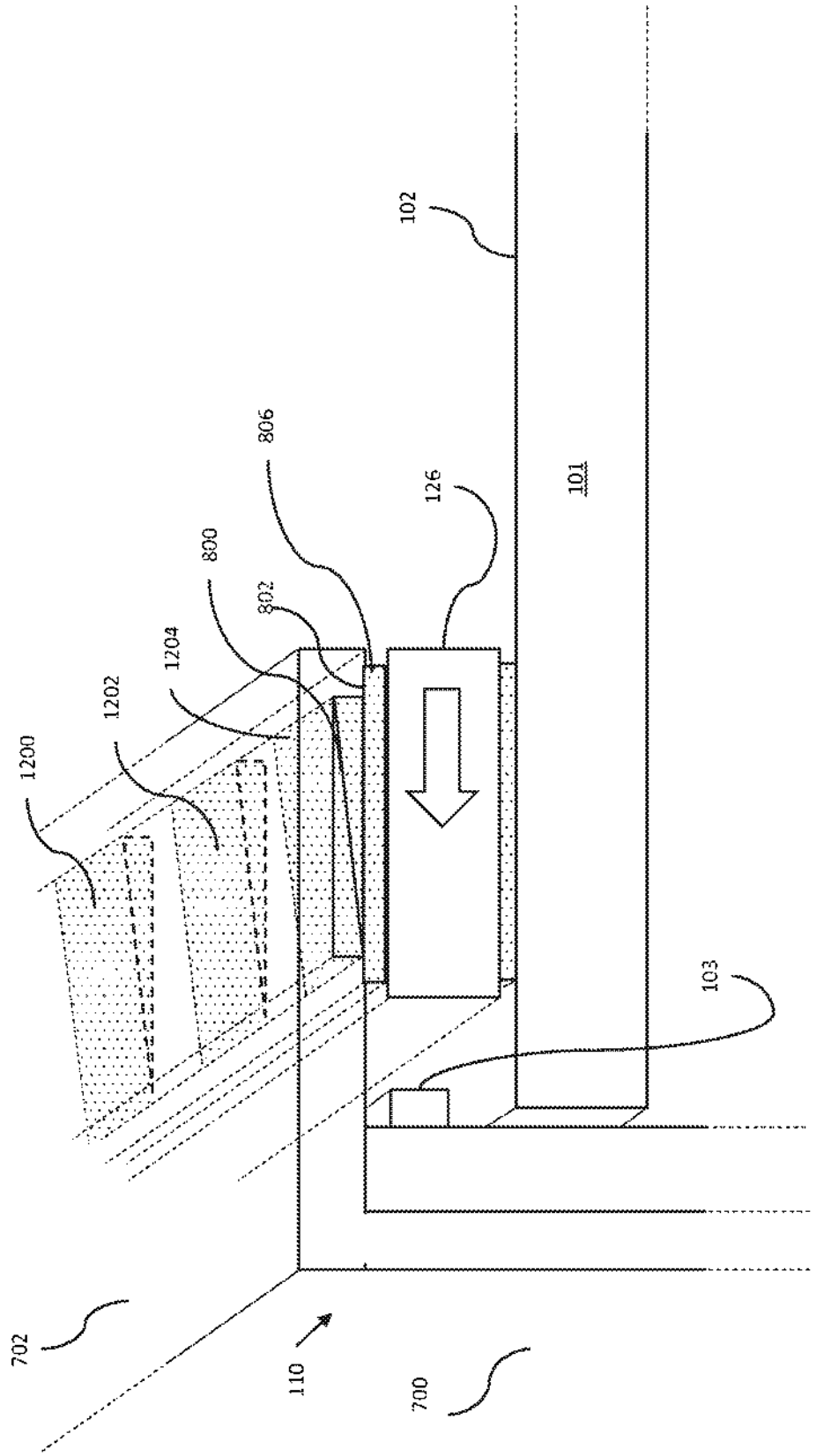


Figure 12

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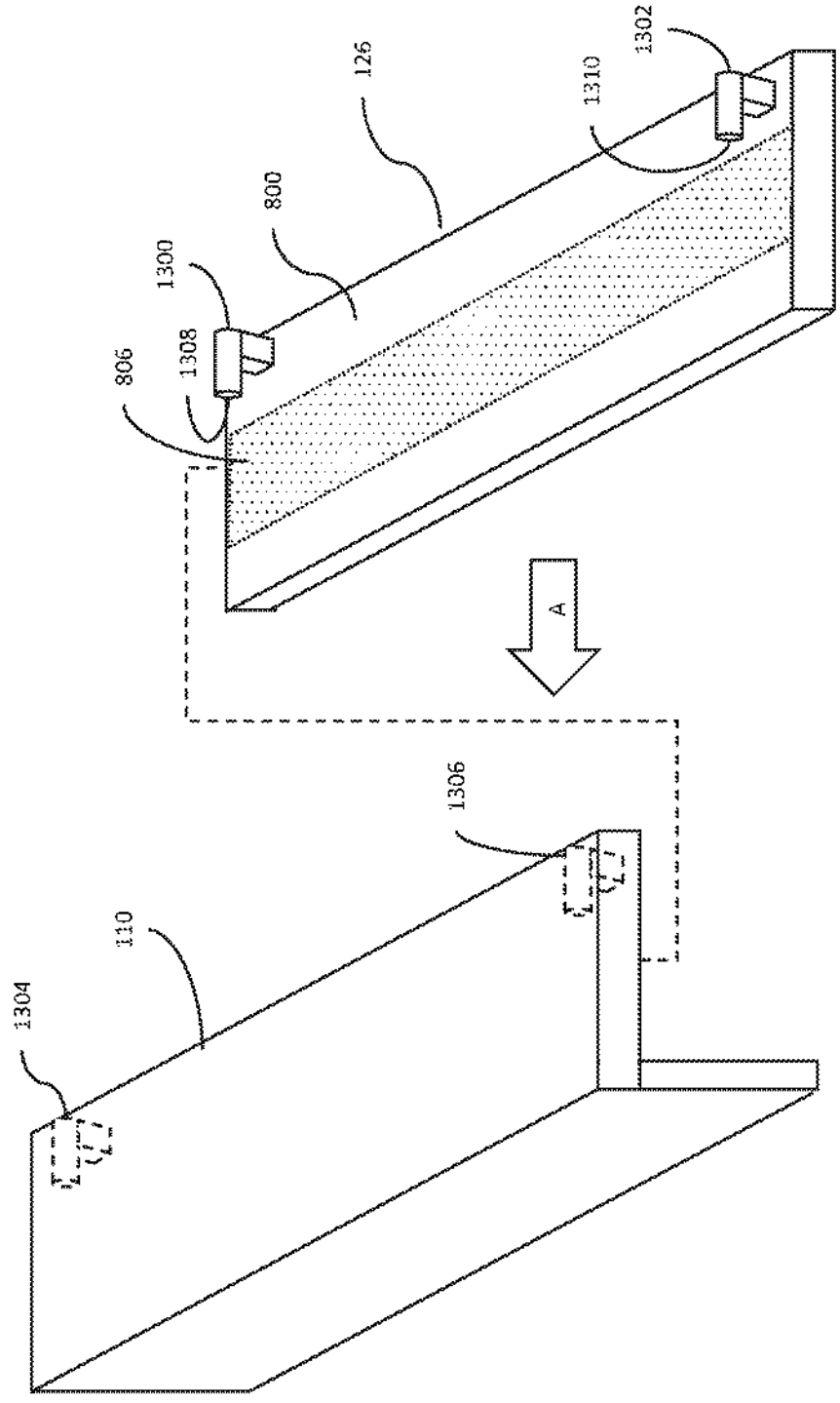


Figure 13

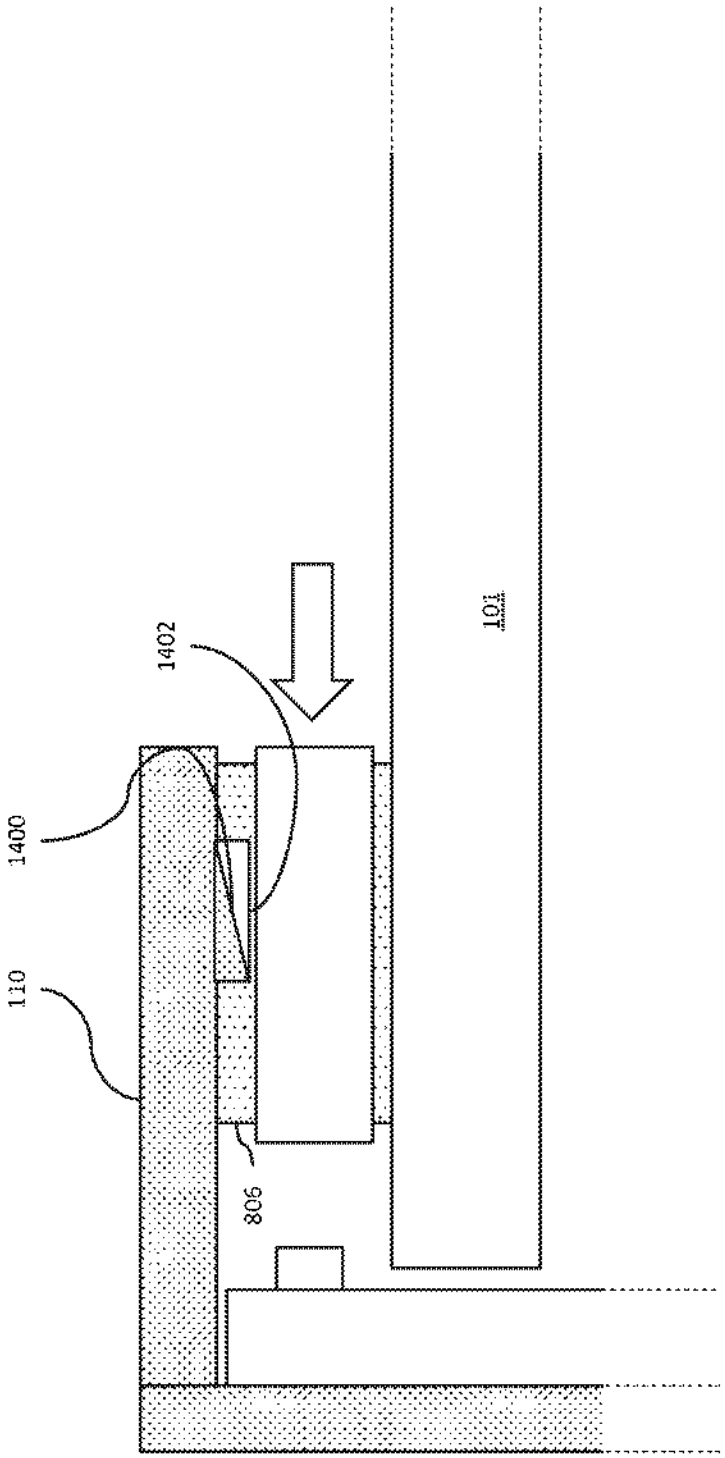


Figure 14

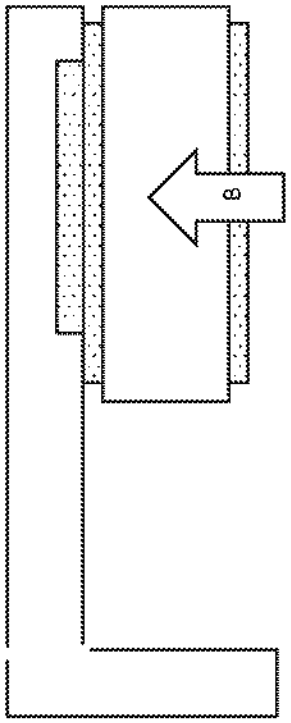


Figure 15b

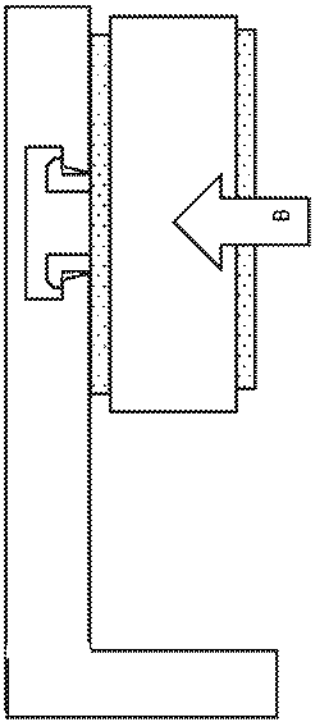


Figure 15d

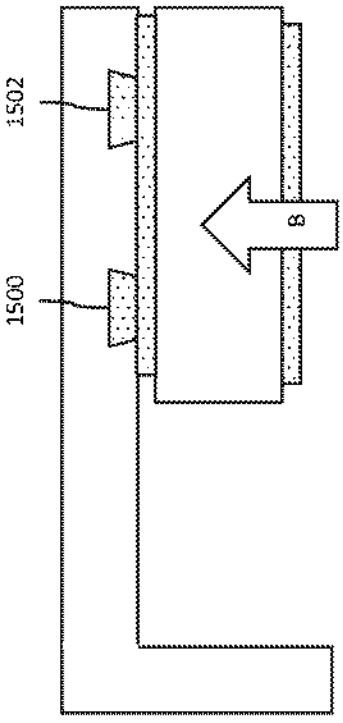


Figure 15a

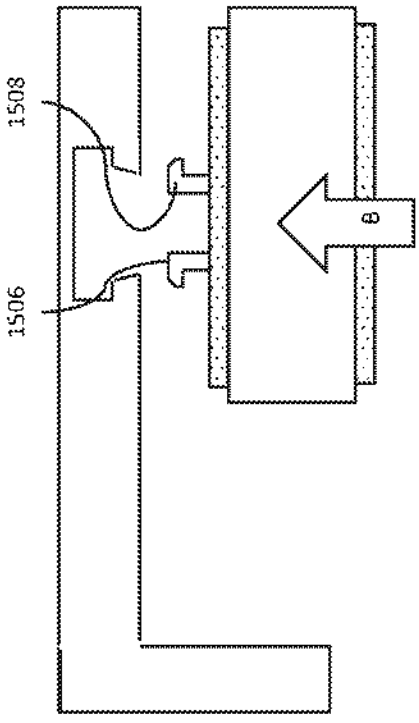


Figure 15c

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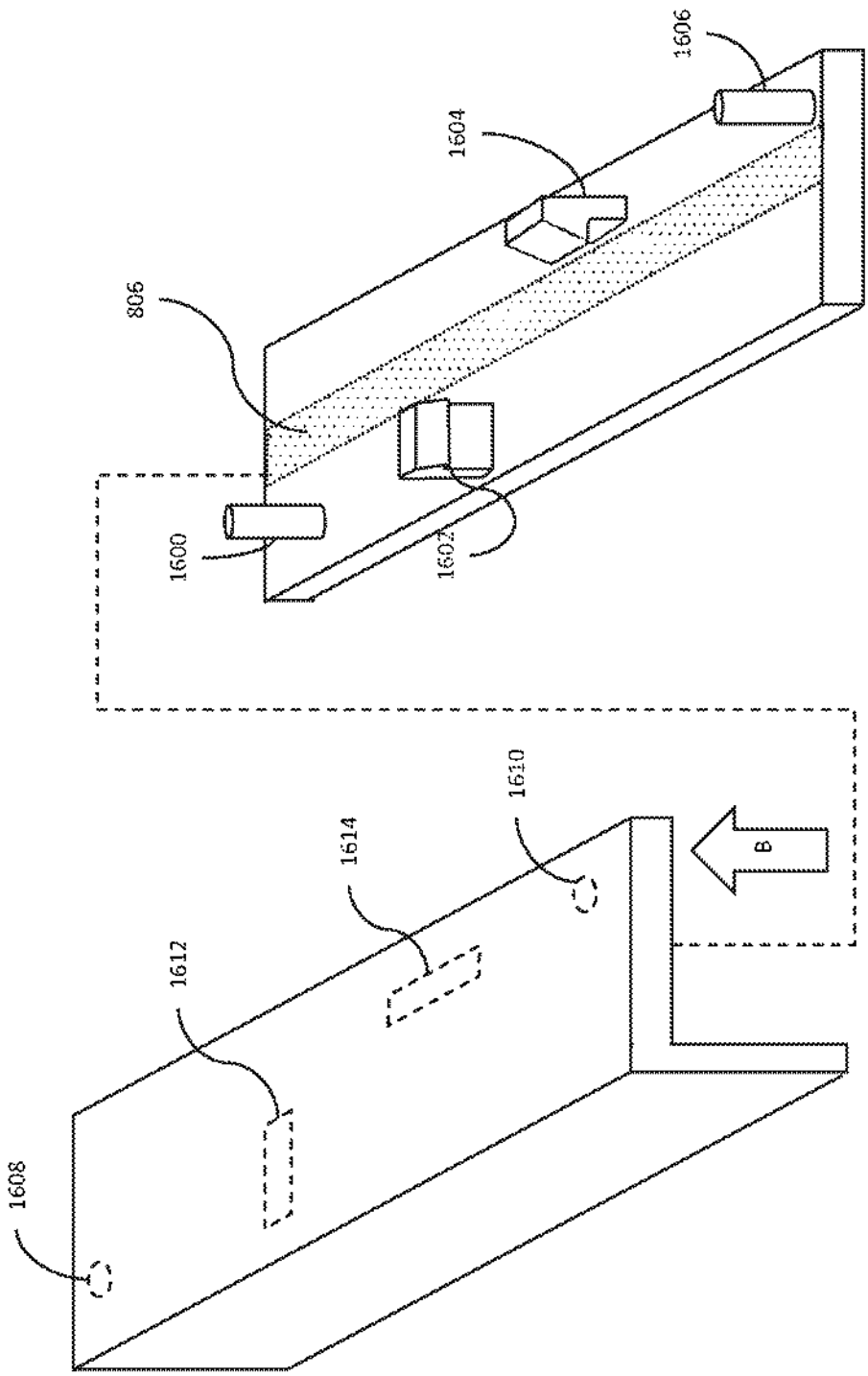


Figure 16