

AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court District of Delaware on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO. 19-2246 (MN)	DATE FILED 12/10/2019	U.S. DISTRICT COURT District of Delaware
PLAINTIFF FLATFROG LABORATORIES AB		DEFENDANT PROMETHEAN LTD. and PROMETHEAN INC.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,282,035	5/7/2019	FLATFROG LABORATORIES AB 10/16/2020 - Third Amended Complaint filed. This patent is not a patent-in-suit in the Third Amended Complaint.
2		
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED 10/16/2020	INCLUDED BY ☒ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,606,414	3/31/2020	FLATFROG LABORATORIES AB 10/16/2020 - Third Amended Complaint filed. These patents are not patents-in-suit in the Third Amended Complaint.
2 10,606,416	3/31/2020	FLATFROG LABORATORIES AB
3 10,775,935 B2	9/15/2020	FLATFROG LABORATORIES AB
4 10,739,916 B2	8/11/2020	FLATFROG LABORATORIES AB
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT Dismissed - see attached
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CLERK John A. Cerino	(BY) DEPUTY CLERK /s/ Mark D. Buckson, Jr.	DATE 4/14/2022
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Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AO 120 (Rev. 08/10)

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PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,606,414	3/31/2020	FLATFROG LABORATORIES AB 10/16/2020 - Third Amended Complaint filed. These patents are not patents-in-suit in the Third Amended Complaint.
2 10,606,416	3/31/2020	FLATFROG LABORATORIES AB
3 10,775,935 B2	9/15/2020	FLATFROG LABORATORIES AB
4 10,739,916 B2	8/11/2020	FLATFROG LABORATORIES AB
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
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Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	09/15/2020	10775935	FFOG.053C4	3081

20995 7590 08/26/2020

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

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.

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

Aleksander Kocovski, Malmo, SWEDEN;
Flatfrog Laboratories AB, Lund, SWEDEN;
Hakan Bergstrom, Torna-Hallestad, SWEDEN;
Jens Thorvinger, Lund, SWEDEN;

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995 7590 08/18/2020 KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614			EXAMINER LAM, VINH TANG	
			ART UNIT 2628	PAPER NUMBER
			NOTIFICATION DATE 08/18/2020	DELIVERY MODE 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):

jayna.cartee@knobbe.com
efiling@knobbe.com

Response to Rule 312 Communication	Application No. 16/706,438	Applicant(s)
	Examiner	Art Unit

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

1. ☒ The amendment filed on 07 August 2020 under 37 CFR 1.312 has been considered, and has been:

- a) ☒ entered.
- b) ☐ entered as directed to matters of form not affecting the scope of the invention.
- c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

- d) ☐ disapproved. See explanation below.
- e) ☐ entered in part. See explanation below.

/C Bowen/

Charles Bowen

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

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	2008/0080811	04-03-2008	Deane, Peter	
	2	2011/0141062	06-16-2011	Yu et al.	
	3	2012/0170056	07-05-2012	Jakobsen et al.	
	4	2012/0223916	09-06-2012	Kukulj, Dax	
	5	2013/0300714	11-14-2013	Goh et al.	
	6	2015/0131010	05-14-2015	Sugiyama, Koichi	
	7	2019/0196657	10-08-2019	Skagmo et al.	
	8	2019/0196658	06-27-2019	Skagmo et al.	
	9	2019/0196659	06-27-2019	Skagmo et al.	
	10	2019/0025984	01-24-2019	Weilbacher et al.	
	11	9,001,086	04-07-2015	Saini, Amrinder Pal Singh	
	12	10,282,035	05-07-2019	Kocovski et al.	
	13	9,207,800	12-08-2015	Eriksson et al.	
	14	2015/0339000	11-26-2015	Lee et al.	
	15	2016/0306501	10-20-2016	Drumm et al.	
	16	2013/0155655	06-20-2013	Lee et al.	

Change(s) applied

to document,

/D.M./

8/12/2020

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
	17	EP 2325735 A2	05-25-2011	SAMSUNG ELECTRONICS CO LTD		
	18	WO 2016/130074 A1	08-18-2016	FLATFROG LABORATORIES AB		

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
	19	Extended European Search Report in European Application number 16873465.5, date June 25, 2019 in 9 pages.	

32980401

Examiner Signature	/VINH T LAM/	Date Considered	06/30/2020
*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.			

T¹ - Place a check mark in this area when an English language Translation is attached.Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 6

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 7 OF 30	Attorney Docket No.	FFOG.053C4

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
	175	8,963,886	02-24-2015	Wassvik	
	176	8,982,084	03-17-2015	Christiansson et al.	
	177	9,024,916	05-05-2015	Christiansson	
	178	9,035,909	05-19-2015	Christiansson	
	179	9,063,614	06-23-2015	Petterson et al.	
	180	9,063,617	06-23-2015	Eliasson et al.	
	181	9,086,763	07-21-2015	Johansson et al.	
	182	9,134,854	09-15-2015	Wassvik et al.	
	183	9,158,401	10-13-2015	Christiansson	
	184	9,158,415	10-13-2015	Song et al.	
	185	9,201,520 12/2015 10-08-2015		Benko et al.	
	186	9,213,445	12-15-2015	King et al.	
	187	9,274,645	03-01-2016	Christiansson et al.	
	188	9,280,237	03-08-2016	Kukulj	
	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 /VINH T LAM/	Date Considered 03/28/2020
*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.	

T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 7

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/



United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

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Sale Accounting Date:08/11/2020

Sale Item Reference Number

16706438

Effective Date

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Document Number

I20208AB40540978

Fee Code

1806

Fee Code Description

SUBMISSION- INFORMATION
DISCLOSURE STMT

Amount Paid

\$240.00

Payment Method

Deposit Account

TOUCH DEVICE**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.

BACKGROUNDField of the Invention

[0002] 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

[0003] In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. US4459476, 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.

[0004] 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.

[0005] These systems typically direct light to travel across the surface of the touch surface at a height of up to 5 mm.

[0006] 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.

[0007] 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 disproportionately 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.

[0008] 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.

[0009] 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.

[0010] 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

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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 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.

[0015] 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 plate 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.

[0016] 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.

[0017] 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

[0018] 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:

[0019] Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

[0020] Figures 2a-2d are cross-sectional views of embodiments of assemblies;

[0021] Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0022] Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0023] Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

[0024] Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 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;

[0025] Figure 4a is a perspective view of the first frame element;

[0026] Figure 4b 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;

[0027] Figure 4c is a side view showing screws 116a and 116b;

[0028] Figures 5a-5h are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

[0029] Figures 6 is a schematic cross section from a first direction of an embodiment of the assembly;

[0030] Figure 7 is a schematic side-view of another embodiment for providing curvature of plate 2;

[0031] Figure 8 shows an isometric view of a variation of the embodiment of figures 5a-5g;

[0032] Figure 9 is a diagram showing a top down view of an optical touch system and corresponding detection lines;

[0033] Figure 10a shows an isometric view of a flat touch surface of an optical touch system;

[0034] Figure 10b shows a section view of an optical touch system with a flat touch surface;

[0035] Figure 11a shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

[0036] Figure 11b 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;

[0037] Figure 11c 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;

[0038] Figure 11d shows an example of types of warpage that a touch panel may exhibit.

[0039] Figure 12a shows top view of a touch surface of an optical touch system;

[0040] Figure 12b 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;

[0041] Figure 12c 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;

[0042] Figure 12d 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;

[0043] Figure 13a 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;

[0044] Figure 13b 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;

[0045] Figure 14a 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;

[0046] Figure 14b 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;

[0047] Figure 15a 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;

[0048] Figure 15b 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;

[0049] Figure 16a 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;

[0050] Figure 16b 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;

[0051] Figure 17a 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;

[0052] Figure 17b 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;

[0053] Figure 18a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0054] Figure 18b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0055] Figure 19a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0056] Figure 19b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0057] Figure 20a shows top view of displacement contours for a touch surface according to an embodiment;

[0058] Figure 20b shows curvature of a touch surface along an x-axis according to the embodiment of figure 20a;

[0059] Figure 20c shows curvature of a touch surface along a y-axis according to the embodiment of figure 20a;

[0060] Figure 20d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 20a;

[0061] Figure 21a shows top view of displacement contours for a touch surface according to another embodiment;

[0062] Figure 21b shows curvature of a touch surface along an x-axis line according to the embodiment of figure 21a;

[0063] Figure 21c shows curvature of a touch surface along a y-axis line according to the embodiment of figure 21a;

[0064] Figure 21d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 21a.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0065] 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.

[0066] 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.

[0067] 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.

[0068] Figure 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.

[0069] 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 figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. In the following, the embodiments of figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in figures 6a-6c.

[0070] Figures 2a-2d illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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.

[0071] As is illustrated in figures 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

[0072] In one embodiment, elements 102, 103 (shown in the figure as comprising elements 103a and 103b) are formed from a single piece.

[0073] The second frame element 103a, 103b may be attached to the first frame element 102.

[0074] In the embodiments of figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Therefore, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

[0075] The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

[0076] The first frame element 102 may form a frame 109 (shown in figure 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.

[0077] As is illustrated in figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

[0078] In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

[0079] The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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.

[0080] In some embodiments, the second frame element 103a, 103b 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 101a, 101b 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

[0081] As is illustrated in figures 3a-3d, the first frame element 102 may be attached to the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b 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 figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in figure 3c and 3d. 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 101a, 101b 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.

[0082] Figures 2a-2d and 3a-3d 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 112a, 112b, and 112c) may be arranged around the frame 109, such as at each corner of the frame 109, which is illustrated as circles in figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c, 113a, 113b.

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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to displace the frame 109 away from panel 1, which is indicated with an arrow in figure 2d e.g. by having a thread in the frame 109 and pushing on the panel 1. At least one other of the screws 112b, 112c, 113b may be arranged to displace the frame 109 towards the panel 1, which is also indicated with an arrow in figure 2d. e.g. by having a thread in the panel and a hole in frame 109.

[0083] Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in figure 2a. In the illustrated embodiment, a first screw 112a is arranged between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

[0084] Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 115a of the longitudinal axis of the first screw 113a passes through the support portion 101b when viewed in cross-section, such as through the center thereof, as is illustrated in figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101b, i.e. an imaginary extension 115b of the longitudinal axis of the first screw 113b passes outside the support portion 101b when viewed in cross-section, as is illustrated in figure 2b.

[0085] As shown in figure 2d, the first screw 112a is arranged to displace the frame 109 away from panel 1. This may be enabled by a threaded hole 112i in the frame 102 which the first screw engages while a head of the screw abuts the panel 1. The second screw 112b is arranged to displace the frame 109 towards the panel. This may be enabled by a threaded hole 112f in the panel 1, which the second screw 112b engages while the head of the second screw 112b abuts the surface of the frame. By using screw 112a and/or 112b,

forces may be applied to frame 102 and/or panel 2 to control bending or rotation of the frame/panel.

[0086] Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of figure 2b, only two screws are required to control bending or rotation of the frame.

[0087] In figures 2a-2b, 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.

[0088] figure 2c illustrates that a combination the embodiment of figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Therefore, flexibility is provided for.

[0089] As is illustrated in figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Therefore, a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In the assembly illustrated in figure 3a, a net force is applied such that the frame is substantially flat and parallel with the panel 1. In the assembly illustrated in figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b 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.

[0090] Figures 4a-4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a, attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to figures 2a-2c and 3a-3d. 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 101a, 101b 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 103a, 103b such that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled.

[0091] As is illustrated in figure 4b, 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Therefore, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

[0092] When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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 101a, 101b 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 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane taken along the support portion 101a, 101b, such as at the free end or tip of the support portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b in the deflected or stressed state when assembled with the first frame element 102.

[0093] 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 figure 3a and 3b and figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single-spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b 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 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

[0094] 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 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.

[0095] 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 figure 5h, 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.

[0096] Figures 5a-5h illustrate embodiments of an assembly 200, which may be combined with the first frame element 102 described above. The embodiments shown in figures 5a-5h are shown inverted relative to the embodiments shown previously, with the plate 2 at the top.

[0097] As shown in figures 5a and 5b, 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 201a, 201b. 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 201a, 201b, 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 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in figure 5g.

[0098] In some embodiments, such as illustrated in figures 5c-5d, a gasket 205 (e.g. gaskets 205a, 205b, 205c, 205d, 205e) 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 201a of the first frame element 202. Also, a sealing 204a may be arranged on the support portion 201b of the second frame element 203.

[0099] 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 figures 5f-5g. 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 1.5-2.0mm at the ends and about 1 mm thinner at the center.

[0100] 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the

first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

[0101] A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in figure 5e.

[0102] 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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes

217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

[0103] Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Therefore, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen, wherein the center holes 217c, 218c 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.

[0104] 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 figures 4a-4c, the frame side may replace the second frame element of the embodiments of figures 4a-4c. Therefore, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

[0105] As illustrated in figure 6, a component (e.g. a sealing component 204a) may be provided between the support portion 201a and the plate 2. Figure 6 illustrates the resulting forces and torque generated when a force 220 is applied to second frame element 203a. 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.

[0106] In an embodiment shown in figure 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 103A. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b 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 103A. 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 103A.

[0107] In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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%.

[0108] 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.

[0109] 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.

[0110] Figure 9 illustrates a top plan view of an example of a touch-sensitive apparatus 99. Emitters 30a are distributed around the periphery of touch plate 10, to propagating light across touch surface 20. 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 propagate to a number of different detectors 30b on a plurality of light paths 50.

[0111] 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 30a and detectors 30b. 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 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.

[0112] 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 fiber. 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.

[0113] 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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b 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".

[0114] 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 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 determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

[0115] In the illustrated example, the apparatus 99 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.

[0116] Figure 10a 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 figure 10a. 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.

[0117] Figure 10b illustrates an example of a touch apparatus according to the prior art. Figure 10b 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 30a, 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 30b. 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.

[0118] Figure 11a illustrates an embodiment of touch plate 10 similar to that shown in figure 10a 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. Figure 11b shows a cross section view along the x axis of the touch plate 10 of figure 11a.~~

~~[0119] Figure 11c 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 α between the touch surface and the x axis is at the center point O of the touch surface.~~

~~[0120] Figure 11d shows the maximum allowed concave distance α and maximum allowed convexity β . The maximum allowed convexity β 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 β is a negative number in the present examples.~~

~~[0121] In one embodiment, the range of the distance α 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 α is 0-2.5 mm.~~

~~[0122] The maximum distance α is a positive number for a concave glass in the present examples. The curvature of the touch surface may therefore be modelled as:~~

~~$$F(x) = -\alpha + cx^2$$~~

~~{0123}~~ In the present example embodiment, a maximum distance α between the 1900 mm long cross section of the touch surface in figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$\text{F(x)} = 5.5 \times 10^{-5} \times x^2 - 2.0$$

~~{0124}~~ 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.

~~{0125}~~ Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 O 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 O on the touch surface. Therefore, the curvature of the plate along this axis can be measured from the distance of the touch surface from the y-axis.

~~{0126}~~ Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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 α between the touch surface and the x-axis is at the center point O. The maximum distance α is a positive number

for a concave glass in the present examples. The curvature of the touch surface may therefore be modelled as:

$$z(x,y) = -a + b * x^2 + c * x^2 * y^2 + d * y^2$$

[0127] 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.

[0128] 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):

$$z(x,y) = -2 + 5.56z - 0.6 * x^2 - 1.71z - 1.1 * x^2 * y^2 + 1.7z - 0.5 * y^2$$

[0129] 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:

$$z(x,y) = -2.5 + 5.56z - 0.6 * x^2 - 2.37z - 1.1 * x^2 * y^2 + 1.28z - 0.5 * y^2$$

[0130] Figure 13a 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 1310a 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

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. Figure 11b shows a cross-section view along the x-axis of the touch plate 10 of figure 11a.

[0119] Figure 11c 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.

[0120] Figure 11d 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.

[0121] 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.

[0122] 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:

$$F(x) = -a + cx^2$$

[0123] In the present example embodiment, a maximum distance a between the 1900 mm long cross section of the touch surface in figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$F(x) = 5.5 * 10^{-6} * x^2 - 2.0$$

[0124] 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.

[0125] Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 the y-axis.

[0126] Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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:

$$z(x, y) = -a + b * x^2 + c * x^2 y^2 + d * y^2$$

[0127] 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.

[0128] 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):

$$z(x,y) = -2 + 5.56e - 06 * x^2 - 4.74e - 11 * x^2 y^2 + 1.7e - 05 * y^2$$

[0129] 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:

$$z(x,y) = -2.5 + 5.56e - 06 * x^2 - 2.37e - 11 * x^2 * y^2 + 1.28e - 05 * y^2$$

[0130] Figure 13a 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 1310a 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, gracing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

[0131] Figure 13b 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 figure 13a. 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.

[0132] Figure 14a shows a section view of the embodiment of figure 13a. 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. Figure 14b shows the corresponding graph of figure 13b for the second point light source 1410.

[0133] Figure 15a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a third point light source 1510 are shown. Figure 15b shows the corresponding graph of figure 13b for the third point light source 1510. In this example, the detection signal boost is approximately 3.03.

[0134] Figure 16a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fourth point light source 1610 are shown. Figure 16b shows the corresponding graph of figure 13b for the fourth point light source 1610. In this example, the detection signal boost is approximately 2.71.

[0135] Figure 17a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fifth point light source 1710 are shown. Figure 17b shows the corresponding graph of figure 13b for the fifth point light source 1710. In this example, the detection signal boost is approximately 2.19.

[0136] Figures 13a-17b 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.

[0137] 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.

[0138] Figure 18a shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of figure 18a, a curved touch plate 10 has a width of 1900 mm along the x-axis and a height of 1070mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in figure 12a,4b). 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 α between the touch surface and the x-axis is 10mm. 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 10b 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 $|\text{parabolic deviation}| < 0.5$ mm.

[0139] 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.

[0140] Figure 18b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 18a.

[0141] 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	6.00	0.0	2.00	0.1	0.5

[0142] Convexity b is shown in figure 18a. Parabolic deviation is shown in figure 18b.

[0143] Figure 19a shows another graph of a mathematically defined parabolic curve and a similar glass to that of figure 18a but wherein the glass of figure 19a is out of range and not recommended for touch system production. One reason for the large concavity shown in figure 19a may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacturing. 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.

[0144] Figure 19b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 19a. The real-world parabolic touch surface of figure 19a 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.

[0145] Figure 20a shows an embodiment in which the touch surface forms a paraboloid. In figure 20a, 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

figure 20b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 20a, the curved touch plate 10 has a width of 1900mm along the x-axis and a height of 1070 mm along the y-axis.

[0146] Figures 20b-20d show optional parabola configurations for the embodiment shown in figure 20a. Figure 20b 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. Figure 20c 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. Figure 20d 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.

[0147] The embodiments shown in figure 20a-20d 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.

[0148] Figure 21a shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in figure 20a. As with figure 20a, figure 21a 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 figure 21b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 21a, 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 embodiments where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect parabolas. 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.

[0149] Figure 21b 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. Figure 21c 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. Figure 21d 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.

[0150] 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.

[0151] 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.

[0152] 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.

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Specification	FFOG053C4_CleanSpec.pdf	324850	no	31
			19600593e597c83d4f364c110bd1eeb63121d82e		

Warnings:

Information:					
2	Applicant Response to Pre-Exam Formalities Notice	FFOG053C4_RespNtcCorrected ApplPapers.pdf	121326	no	5
			f9142a5f7cb550d6b82178a74f01426ab0f5b1b5		
Warnings:					
Information:					
3	Specification	FFOG053C4_MarkedUpSpec. pdf	394872	no	35
			690655066824bbe26cbd62062018acce40e1aed1		
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Total Files Size (in bytes):			841048		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

TOUCH DEVICE**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.

BACKGROUNDField of the Invention

[0002] 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

[0003] In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. US4459476, 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.

[0004] 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.

[0005] These systems typically direct light to travel across the surface of the touch surface at a height of up to 5 mm.

[0006] 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.

[0007] 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 disproportionately 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.

[0008] 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.

[0009] 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.

[0010] 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

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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 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.

[0015] 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 plate 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.

[0016] 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.

[0017] 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

[0018] 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:

[0019] Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

[0020] Figures 2a-2d are cross-sectional views of embodiments of assemblies;

[0021] Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0022] Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0023] Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

[0024] Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 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;

[0025] Figure 4a is a perspective view of the first frame element;

[0026] Figure 4b 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;

[0027] Figure 4c is a side view showing screws 116a and 116b;

[0028] Figures 5a-5h are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

[0029] Figure 6 is a schematic cross section from a first direction of an embodiment of the assembly;

[0030] Figure 7 is a schematic side-view of another embodiment for providing curvature of plate 2;

[0031] Figure 8 shows an isometric view of a variation of the embodiment of figures 5a-5g;

[0032] Figure 9 is a diagram showing a top down view of an optical touch system and corresponding detection lines;

[0033] Figure 10a shows an isometric view of a flat touch surface of an optical touch system;

[0034] Figure 10b shows a section view of an optical touch system with a flat touch surface;

[0035] Figure 11a shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

[0036] Figure 11b 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;

[0037] Figure 11c 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;

[0038] Figure 11d shows an example of types of warpage that a touch panel may exhibit.

[0039] Figure 12a shows top view of a touch surface of an optical touch system;

[0040] Figure 12b 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;

[0041] Figure 12c 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;

[0042] Figure 12d 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;

[0043] Figure 13a 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;

[0044] Figure 13b 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;

[0045] Figure 14a 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;

[0046] Figure 14b 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;

[0047] Figure 15a 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;

[0048] Figure 15b 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;

[0049] Figure 16a 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;

[0050] Figure 16b 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;

[0051] Figure 17a 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;

[0052] Figure 17b 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;

[0053] Figure 18a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0054] Figure 18b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0055] Figure 19a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0056] Figure 19b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0057] Figure 20a shows top view of displacement contours for a touch surface according to an embodiment;

[0058] Figure 20b shows curvature of a touch surface along an x-axis according to the embodiment of figure 20a;

[0059] Figure 20c shows curvature of a touch surface along a y-axis according to the embodiment of figure 20a;

[0060] Figure 20d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 20a;

[0061] Figure 21a shows top view of displacement contours for a touch surface according to another embodiment;

[0062] Figure 21b shows curvature of a touch surface along an x-axis line according to the embodiment of figure 21a;

[0063] Figure 21c shows curvature of a touch surface along a y-axis line according to the embodiment of figure 21a;

[0064] Figure 21d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 21a.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0065] 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.

[0066] 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.

[0067] 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.

[0068] Figure 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.

[0069] 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 figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. In the following, the embodiments of figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in figures 6a-6c.

[0070] Figures 2a-2d illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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.

[0071] As is illustrated in figures 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

[0072] In one embodiment, elements 102, 103 (shown in the figure as comprising elements 103a and 103b) are formed from a single piece.

[0073] The second frame element 103a, 103b may be attached to the first frame element 102.

[0074] In the embodiments of figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Therefore, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

[0075] The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

[0076] The first frame element 102 may form a frame 109 (shown in figure 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.

[0077] As is illustrated in figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

[0078] In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

[0079] The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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.

[0080] In some embodiments, the second frame element 103a, 103b 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 101a, 101b 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

[0081] As is illustrated in figures 3a-3d, the first frame element 102 may be attached to the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b 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

figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in figure 3c and 3d. 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 101a, 101b 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.

[0082] Figures 2a-2d and 3a-3d 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 112a, 112b, and 112c) may be arranged around the frame 109, such as at each corner of the frame 109, which is illustrated as circles in figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c, 113a, 113b. 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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to displace the frame 109 away from panel 1, which is indicated with an arrow in figure 2d e.g. by having a thread in the frame 109 and pushing on the panel 1. At least one other of the screws 112b, 112c, 113b may be arranged to displace the frame 109 towards the panel 1, which is also indicated with an arrow in figure 2d. e.g. by having a thread in the panel and a hole in frame 109.

[0083] Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in figure 2a. In the illustrated embodiment, a first screw 112a is arranged

between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

[0084] Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 115a of the longitudinal axis of the first screw 113a passes through the support portion 101b when viewed in cross-section, such as through the center thereof, as is illustrated in figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101b, i.e. an imaginary extension 115b of the longitudinal axis of the first screw 113b passes outside the support portion 101b when viewed in cross-section, as is illustrated in figure 2b.

[0085] As shown in figure 2d, the first screw 112a is arranged to displace the frame 109 away from panel 1. This may be enabled by a threaded hole 112i in the frame 102 which the first screw engages while a head of the screw abuts the panel 1. The second screw 112b is arranged to displace the frame 109 towards the panel. This may be enabled by a threaded hole 112f in the panel 1, which the second screw 112b engages while the head of the second screw 112b abuts the surface of the frame. By using screw 112a and/or 112b, forces may be applied to frame 102 and/or panel 2 to control bending or rotation of the frame/panel.

[0086] Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of figure 2b, only two screws are required to control bending or rotation of the frame.

[0087] In figures 2a-2b, 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.

[0088] figure 2c illustrates that a combination the embodiment of figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Therefore, flexibility is provided for.

[0089] As is illustrated in figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Therefore, a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In

the assembly illustrated in figure 3a, a net force is applied such that the frame is substantially flat and parallel with the panel 1. In the assembly illustrated in figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b 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.

[0090] Figures 4a-4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a, attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to figures 2a-2c and 3a-3d. 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 101a, 101b 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 103a, 103b such that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled.

[0091] As is illustrated in figure 4b, 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Therefore, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

[0092] When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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 101a, 101b 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 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane taken along the support portion 101a, 101b, such as at the free end or tip of the support portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b in the deflected or stressed state when assembled with the first frame element 102.

[0093] 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 figure 3a and 3b and figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single-spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b 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 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

[0094] 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

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.

[0095] 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 figure 5h, 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.

[0096] Figures 5a-5h illustrate embodiments of an assembly 200, which may be combined with the first frame element 102 described above. The embodiments shown in figures 5a-5h are shown inverted relative to the embodiments shown previously, with the plate 2 at the top.

[0097] As shown in figures 5a and 5b, 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 201a, 201b. 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 201a, 201b, 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 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in figure 5g.

[0098] In some embodiments, such as illustrated in figures 5c-5d, a gasket 205 (e.g. gaskets 205a, 205b, 205c, 205d, 205e) 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 201a of the first frame element 202. Also, a sealing 204a may be arranged on the support portion 201b of the second frame element 203.

[0099] 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 figures 5f-5g. 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 1.5-2.0mm at the ends and about 1 mm thinner at the center.

[0100] 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

[0101] A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in figure 5e.

[0102] 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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes 217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

[0103] Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Therefore, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen,

wherein the center holes 217c, 218c 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.

[0104] 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 figures 4a-4c, the frame side may replace the second frame element of the embodiments of figures 4a-4c. Therefore, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

[0105] As illustrated in figure 6, a component (e.g. a sealing component 204a) may be provided between the support portion 201a and the plate 2. Figure 6 illustrates the resulting forces and torque generated when a force 220 is applied to second frame element 203a. 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.

[0106] In an embodiment shown in figure 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 103A. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b 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 103A. 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 103A.

[0107] In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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%.

[0108] 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.

[0109] 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.

[0110] Figure 9 illustrates a top plan view of an example of a touch-sensitive apparatus 99. Emitters 30a are distributed around the periphery of touch plate 10, to propagating light across touch surface 20. 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 propagate to a number of different detectors 30b on a plurality of light paths 50.

[0111] 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 30a and detectors 30b. 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 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.

[0112] 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 fiber. 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.

[0113] 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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b 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".

[0114] 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 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 determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

[0115] In the illustrated example, the apparatus 99 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.

[0116] Figure 10a 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 figure 10a. 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.

[0117] Figure 10b illustrates an example of a touch apparatus according to the prior art. Figure 10b 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 30a, 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 30b. 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.

[0118] Figure 11a illustrates an embodiment of touch plate 10 similar to that shown in figure 10a 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. Figure 11b shows a cross-section view along the x-axis of the touch plate 10 of figure 11a.

[0119] Figure 11c 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.

[0120] Figure 11d 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.

[0121] 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.

[0122] 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:

$$F(x) = -a + cx^2$$

[0123] In the present example embodiment, a maximum distance a between the 1900 mm long cross section of the touch surface in figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$F(x) = 5.5 * 10^{-6} * x^2 - 2.0$$

[0124] 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.

[0125] Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 the y-axis.

[0126] Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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:

$$z(x,y) = -a + b * x^2 + c * x^2 y^2 + d * y^2$$

[0127] 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.

[0128] 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):

$$z(x,y) = -2 + 5.56e-06 * x^2 - 4.74e-11 * x^2 y^2 + 1.7e-05 * y^2$$

[0129] 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:

$$z(x,y) = -2.5 + 5.56e-06 * x^2 - 2.37e-11 * x^2 * y^2 + 1.28e-05 * y^2$$

[0130] Figure 13a 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

1310a 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, gracing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

[0131] Figure 13b 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 figure 13a. 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.

[0132] Figure 14a shows a section view of the embodiment of figure 13a. 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. Figure 14b shows the corresponding graph of figure 13b for the second point light source 1410.

[0133] Figure 15a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a third point light source 1510 are shown. Figure 15b shows the corresponding graph of figure 13b for the third point light source 1510. In this example, the detection signal boost is approximately 3.03.

[0134] Figure 16a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fourth point light source 1610 are shown. Figure 16b shows the corresponding graph of figure 13b for the fourth point light source 1610. In this example, the detection signal boost is approximately 2.71.

[0135] Figure 17a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fifth point light source 1710 are shown. Figure 17b shows the corresponding graph of figure 13b for the fifth point light source 1710. In this example, the detection signal boost is approximately 2.19.

[0136] Figures 13a-17b 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.

[0137] 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.

[0138] Figure 18a shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of figure 18a, a curved touch plate 10 has a width of 1900 mm along the x-axis and a height of 1070mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in figure 12a,4b). 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 10mm. 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 10b 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 $|\text{parabolic deviation}| < 0.5$ mm.

[0139] 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.

[0140] Figure 18b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 18a.

[0141] 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	6.00	0.0	2.00	0.1	0.5

[0142] Convexity b is shown in figure 18a. Parabolic deviation is shown in figure 18b.

[0143] Figure 19a shows another graph of a mathematically defined parabolic curve and a similar glass to that of figure 18a but wherein the glass of figure 19a is out of range and not recommended for touch system production. One reason for the large concavity shown in figure 19a may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacturing. 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.

[0144] Figure 19b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 19a. The real-world parabolic touch surface of figure 19a 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.

[0145] Figure 20a shows an embodiment in which the touch surface forms a paraboloid. In figure 20a, 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 figure 20b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 20a, the curved touch plate 10 has a width of 1900mm along the x-axis and a height of 1070 mm along the y-axis.

[0146] Figures 20b-20d show optional parabola configurations for the embodiment shown in figure 20a. Figure 20b 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. Figure 20c 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. Figure 20d 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.

[0147] The embodiments shown in figure 20a-20d 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.

[0148] Figure 21a shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in figure 20a. As with figure 20a, figure 21a 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 figure 21b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 21a, 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 embodiments where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect parabolas. 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.

[0149] Figure 21b 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. Figure 21c 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. Figure 21d 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.

[0150] 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.

[0151] 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.

[0152] 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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First : Aleksander Kocovski
Inventor
App. No. : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Lam, Vinh Tang
Art Unit : 2628
Conf. No. : 3081

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS**Mail Stop Issue Fee**

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

Dear Commissioner:

In response to the Notice to File Corrected Application Papers mailed July 23, 2020, Applicant submits the following:

- (X) Notice to File Corrected Application Papers dated July 23, 2020
- (X) Marked-up Substitute Specification
- (X) Clean Substitute Specification

The substituted specification contains replacement pages 24-26 with legible text as required in the Notice to File Corrected Application Papers.

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

Application No.: 16/706438
Filing Date: December 6, 2019

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: August 7, 2020

By: Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

33206947



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.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995 7590 07/23/2020 KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614			EXAMINER LAM, VINH TANG	
			ART UNIT 2628	PAPER NUMBER
			NOTIFICATION DATE 07/23/2020	DELIVERY MODE 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):

jayna.cartee@knobbe.com
cfiling@knobbe.com



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 16706438
Applicant : Kocovski
Filing Date : 12/06/2019
Date Mailed : 07/23/2020

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), “all outstanding requirements” will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

*A copy of this notice **MUST** be returned with the reply. Please address response to
“Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450”.*

/Chris Harmon/
Publication Branch
Office of Data Management
(571) 272-4200

**IDENTIFICATION OF APPLICATION DEFICIENCIES
IN APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012**

- ☒ Applicant must provide legible text for the following item(s).
- ☒ Specification filed 12/06/2019, page(s) 24-26.
- ☐ Claims filed , claim(s) .
- ☐ Other: .
- ☐ Applicant must provide missing information on the following page(s) of the specification by amending the specification to add the missing text. No new matter may be added.
Page/line no(s).
- ☐ The specification refers to one or more applications by attorney docket number and does not show the U.S. application number(s). Applicant must supply the U.S. application number in place of each attorney docket number.
Page/line no(s).
- ☐ Applicant must provide an Abstract of the Disclosure.
- ☐ The Application Data Sheet (ADS dated) does not supply the inventor's city and/or does not supply the inventor's U.S. state and/or does not supply the inventor's country. Applicant must submit a signed, in accordance with 37 CFR 1.76(e) and 1.33(b), application data sheet that corrects this deficiency. To be in compliance with 37 CFR 1.76, the corrected application data sheet must identify the information being changed by using underlining for additions and strikethroughs or brackets for deletions.
- ☐ Other:



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
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995 7590 07/23/2020 KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614			EXAMINER LAM, VINH TANG	
			ART UNIT 2628	PAPER NUMBER
			NOTIFICATION DATE 07/23/2020	DELIVERY MODE 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):

jayna.cartee@knobbe.com
cfiling@knobbe.com



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 16706438
Applicant : Kocovski
Filing Date : 12/06/2019
Date Mailed : 07/23/2020

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), “all outstanding requirements” will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

*A copy of this notice **MUST** be returned with the reply. Please address response to
“Mail Stop Issue Fee, Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450”.*

/Chris Harmon/
Publication Branch
Office of Data Management
(571) 272-4200

**IDENTIFICATION OF APPLICATION DEFICIENCIES
IN APPLICATION FILED ON OR AFTER SEPTEMBER 16, 2012**

- ☒ Applicant must provide legible text for the following item(s).
- ☒ Specification filed 12/06/2019, page(s) 24-26.
- ☐ Claims filed , claim(s) .
- ☐ Other: .
- ☐ Applicant must provide missing information on the following page(s) of the specification by amending the specification to add the missing text. No new matter may be added.
Page/line no(s).
- ☐ The specification refers to one or more applications by attorney docket number and does not show the U.S. application number(s). Applicant must supply the U.S. application number in place of each attorney docket number.
Page/line no(s).
- ☐ Applicant must provide an Abstract of the Disclosure.
- ☐ The Application Data Sheet (ADS dated) does not supply the inventor's city and/or does not supply the inventor's U.S. state and/or does not supply the inventor's country. Applicant must submit a signed, in accordance with 37 CFR 1.76(e) and 1.33(b), application data sheet that corrects this deficiency. To be in compliance with 37 CFR 1.76, the corrected application data sheet must identify the information being changed by using underlining for additions and strikethroughs or brackets for deletions.
- ☐ Other:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor : Aleksander Kocovski
App. No : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Lam, Vinh Tang
Art Unit : 2628
Conf. No. : 3081

Mail Stop Issue Fee

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

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Dear Commissioner:

Applicant makes the following comments in response to the Examiner's description of allowable subject matter in the Notice of Allowance mailed on July 8, 2020.

Applicant respectfully disagrees with the Examiner's statement to the extent that it may characterize the language or scope of the claims pending in this application or in any other prior art referenced in the statement. Applicant notes that it is the language of the claims, not the Examiner's characterization of the language that determines the scope of the claims. Also, to the extent that there is any implication that the patentability of the claims rests on the recitation of a single feature or subset of features, Applicant respectfully disagrees with the Examiner's statement because it is the recited combination of features that makes the claims patentable.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: July 15, 2020

By: Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

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)

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.

20995 7590 07/08/2020
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

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.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081

TITLE OF INVENTION: TOUCH DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	10/08/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LAM, VINH TANG	2628	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/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 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 KNOBBE MARTENS
2 OLSON & BEAR, 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

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

FlatFrog Laboratories AB

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. 11-1410

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 /Harnik Shukla/

Date July 15, 2020

Typed or printed name Harnik Shukla

Registration No. 73,097

Electronic Patent Application Fee Transmittal

Application Number:	16706438			
Filing Date:	06-Dec-2019			
Title of Invention:	TOUCH DEVICE			
First Named Inventor/Applicant Name:	Aleksander Kocovski			
Filer:	Harnik Shukla/Jenny Kim			
Attorney Docket Number:	FFOG.053C4			
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	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt

EFS ID:	40012638
Application Number:	16706438
International Application Number:	
Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Jennifer Neat
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
Receipt Date:	15-JUL-2020
Filing Date:	06-DEC-2019
Time Stamp:	19:30:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 1000
RAM confirmation Number	E20207EJ31185837
Deposit Account	111410
Authorized User	Jennifer Neat

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)

Chemtronics v. FlatFrog

Chemtronics Exhibit 1013 Page 89

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Post Allowance Communication - Incoming	FFOG053C4_Comments.pdf	17858	no	1
			af7a83589499cca28aba2ba96538e3aad856a440		
Warnings:					
Information:					
2	Issue Fee Payment (PTO-85B)	FFOG053C4_IFee.pdf	211947	no	1
			a74b2e15f4fb47913245eea2b8bb4af31a0d4051		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30209	no	2
			61afd31b0df93d57d29a42177a9b420cd5e4ca7f		
Warnings:					
Information:					
Total Files Size (in bytes):			260014		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					



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

20995 7590 07/08/2020
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

EXAMINER	
LAM, VINH TANG	
ART UNIT	PAPER NUMBER
2628	

DATE MAILED: 07/08/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081

TITLE OF INVENTION: TOUCH DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	10/08/2020

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 and an extra copy of the form should be submitted. 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.

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.

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20995 7590 07/08/2020
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

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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.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081

TITLE OF INVENTION: TOUCH DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	10/08/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LAM, VINH TANG	2628	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/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 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,

1 _____

(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.

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. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	07/08/2020	EXAMINER	
KNOBBE MARTENS OLSON & BEAR LLP			LAM, VINH TANG	
2040 MAIN STREET			ART UNIT	
FOURTEENTH FLOOR			PAPER NUMBER	
IRVINE, CA 92614			2628	
DATE MAILED: 07/08/2020				

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.

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 enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/706,438	Applicant(s) Kocovski et al.	
	Examiner VINH T LAM	Art Unit 2628	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 06/18/2020.
☐ 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 See Continuation Sheet. 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)	5. ☒ Examiner's Amendment/Comment
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☒ Other <u>PTO-2323</u> .
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date _____.	

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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Continuation of 3. The allowed claim(s) is/are: 1,4,6-10,13 and 15-20

**UNITED STATES DEPARTMENT OF COMMERCE****U.S. Patent and Trademark Office**

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR/ PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
16/706,438	12/06/2019	Kocovski et al.	FFOG.053C4

KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614		EXAMINER	
		VINH T LAM	
		ART UNIT	PAPER
		2628	20200630

DATE MAILED: _____

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

1. Please DO NOT ENTER Amendment dated 06/18/2020.
2. Please ENTER EXAMINER'S AMENDMENTS (see attached).

/VINH T LAM/
Primary Examiner, Art Unit 2628

EXAMINER'S STATEMENT OF REASONS FOR ALLOWANCE

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.

Priority

2. Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119 (a)-(d). The certified copy has been filed in parent Application No. **SE 16302945**, filed on **07 Dec 2016**.

Allowable Subject Matter

3. Claims **1, 4, 6-10, 13, and 15-20** are allowed.

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

Christiansson et al. (US PGPub. 20130044073) teach a touch-sensitive apparatus comprises a panel configured to conduct signals from a plurality of peripheral incoupling points to a plurality of peripheral outcoupling points. Actual detection lines

are defined between pairs of incoupling and outcoupling points to extend across a surface portion of the panel. The signals may be in the form of light, and objects touching the surface portion may affect the light via frustrated total internal reflection (FTIR). A signal generator is coupled to the incoupling points to generate the signals, and a signal detector is coupled to the out-coupling points to generate an output signal. A data processor operates on the output signal to enable identification of touching objects. The output signal is processed (40) to generate a set of data samples, which are indicative of detected energy for at least a subset of the actual detection lines. The set of data samples is processed (42) to generate a set of matched samples, which are indicative of estimated detected energy for fictitious detection lines that have a location on the surface portion that matches a standard geometry for tomographic reconstruction. The set of matched samples is processed (44, 46) by tomographic reconstruction to generate data indicative of a distribution of an energy-related parameter within at least part of the surface portion.

CRAVEN-BARTLE et al. (US PGPub. 20150331546) teach 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

Art Unit: 2628

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 $\theta_{\min}$ to an upper angle limit $\theta_{\max}$.

The lower angle limit $\theta_{\min}$ is equal to or larger than a critical angle θ_c , which is given by

$\theta_c = \arcsin(1/n_{\text{panel}})$, with n_{panel} being the refractive index of the light transmissive panel

(1) at the outcoupling region.

The subject matter of the independent claims could either not be found or was not suggested in the prior art of record. The subject matter not found was a touch sensitive device including

“...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;

...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 ” (Claim 1)

“...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 greater than the first curvature when the plate is installed in the frame assembly, said second curvature is parabolic...” (Claim 10),

in combination with the other elements (or steps) of the device or apparatus and method recited in the claims.

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.”

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINH TANG LAM whose telephone number is (571) 270-3704. The examiner can normally be reached on Monday to Friday 8:00 AM to 5:00 PM.

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, Nitin K Patel can be reached on (571) 272-7677. 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.

/VINH T LAM/
Primary Examiner, Art Unit 2628

EXAMINER'S AMENDMENT

A. Authorization for this examiner's amendment was given in an interview with **Harnik Shukla** on **06/29/2020**.

B. The application has been amended as follows:

In the Claims:

1. (Currently Amended) 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 ~~perpendicular to the first edge~~ **extending between the second end point and a third end point; and**

~~a flat plane defined by the first edge and the second edge; and~~

~~wherein the touch surface includes a center 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** ~~such that the center point moves further away from the flat plane.~~

2. (CANCELLED).

3. (CANCELLED).

4. (Currently Amended) The method of Claim 1, wherein the ~~touch surface is concave~~ **first edge is curved and the second edge is curved**.

5. (CANCELLED).

6. (Original) 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.

7. (Previously Presented) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are defined along an edge of the plate.

8. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.
9. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.
10. (Currently Amended) 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 ~~having a center point;~~
~~a flat plane defined by a first edge of the touch surface and a second edge of the touch surface perpendicular to the first edge;~~
 - 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 ~~greater than the first curvature~~ when the plate is installed in the frame assembly, **said second curvature is parabolic;**

~~wherein the frame assembly is arranged to induce the second curvature such that the center point of the touch surface causes the center point to move further away from the flat plane, and~~

wherein the first curvature is concave.

11. (CANCELED).

12. (CANCELLED).

13. (Original) The touch sensing apparatus of claim 10, 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.

14. (CANCELLED).

15. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along an edge of the plate.

16. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

17. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

18. (Original) The touch sensing apparatus of claim 10, further comprising a gasket, wherein the plate is supported by the gasket proximate to an edge of the plate.
19. (Original) The apparatus of claim 18, wherein the gasket is configured to have varying thickness to match a curvature of the plate along the edge.
20. (Original) The apparatus of claim 10, wherein the second frame element is curved.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINH TANG LAM whose telephone number is (571) 270-3704. The examiner can normally be reached on Monday to Friday 8:00 AM to 5:00 PM.

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, Nitin K Patel can be reached on (571) 272-7677. 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.

/VINH T LAM/
Primary Examiner, Art Unit 2628

<i>Examiner-Initiated Interview Summary</i>	Application No. 16/706,438	Applicant(s) Kocovski et al.		
	Examiner VINH T LAM	Art Unit 2628	AIA (First Inventor to File) Status Yes	Page 1 of 2

All participants (applicant, applicants representative, PTO personnel):

1. VINH T LAM (Examiner); Telephonic 2. Harnik Shukla (Examiner); Telephonic

Date of Interview: 29 June 2020

Claims Discussed: 1 and 10

Prior Art Discussed: CRAVEN-BARTLE et al. (US PGPub. 20150331546).

Amendment proposed: Please see Examiner's Amendment.

Brief Description of the main topic(s) of discussion: 1. Amendments.
2. Allowable subject matters.
3. Examiner's Amendments.

Issues Discussed:

Item(s) under 35 U.S.C. 103:
Please see Examiner's Amendment.

/VINH T LAM/ Primary Examiner, Art Unit 2628	
<p>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</p> <p>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</p>	

U.S. Patent and Trademark Office
PTOL-413/413b (Rev. 01/01/2015)

Interview Summary

Paper No. 20200630

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.

<i>Notice of References Cited</i>	Application/Control No. 16/706,438		Applicant(s)/Patent Under Reexamination Kocovski et al.	
	Examiner VINH T LAM		Art Unit 2628	Page 1 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20150331546-A1	11-2015	CRAVEN-BARTLE; Thomas	G02B5/005	345/175
*	B	US-9063614-B2	06-2015	Pettersson; Robert	G06F3/0416	1/1
*	C	US-20120089348-A1	04-2012	Perlin; Kenneth	G06F3/0416	702/41
*	D	US-20120223916-A1	09-2012	Kukulj; Dax	G06F3/0428	345/175
*	E	US-20160295711-A1	10-2016	RYU; Hyunjong	H05K5/03	1/1
*	F	US-20130044073-A1	02-2013	Christiansson; Tomas	G06F3/042	345/173
*	G	US-20190025984-A1	01-2019	Weilbacher; Katherine	G02B6/102	1/1
*	H	US-20150309662-A1	10-2015	Wyrwas; John Michael	G06F3/042	345/175
*	I	US-20140225868-A1	08-2014	HUANG; YU-HSIANG	G02B13/18	345/175
*	J	US-10459589-B2	10-2019	Xu; Shifeng	G06F3/0446	1/1
*	K	US-9471170-B2	10-2016	Goertz; Magnus	G06F3/0416	1/1
*	L	US-9389730-B2	07-2016	Goertz; Magnus	G06F3/042	1/1
*	M	US-9195344-B2	11-2015	Goertz; Magnus	G06F3/0416	1/1

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Notice of References Cited</i>	Application/Control No. 16/706,438		Applicant(s)/Patent Under Reexamination Kocovski et al.	
	Examiner VINH T LAM		Art Unit 2628	Page 2 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-9128250-B2	09-2015	Charters; Robert Bruce	G02B6/4298	1/1
*	B	US-9052771-B2	06-2015	Goertz; Magnus	G06F3/0416	1/1
*	C	US-9035909-B2	05-2015	Christiansson; Tomas	G06F3/0421	345/175
*	D	US-8902196-B2	12-2014	Goertz; Magnus	G06F3/0416	345/173
*	E	US-8896575-B2	11-2014	Goertz; Magnus	G06F3/042	178/18.09
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

AFCP 2.0 Decision

Application No.

16/706,438

Applicant(s)

Kocovski et al.

Examiner

VINH T LAM

Art Unit

2628

AIA (FITF) Status

Yes

This is in response to the After Final Consideration Pilot request filed 18 June 2020.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

- ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.
- ☐ A non-broadening amendment to at least one independent claim was not submitted.
- ☐ The request is not the first proper AFCP 2.0 request submitted in response to the most recent final rejection.
- ☐ Other: _____

2. Proper Request

A. After final amendment submitted with the request will not be treated under AFCP 2.0.

The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

- ☐ The after final amendment will be treated under pre-pilot procedure.

B. Updated search and/or completed additional consideration.

The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

- ☒ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.
- ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action. See attached interview summary for further details.
- ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.
- ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.
- ☒ 5. Other: PTO-2323

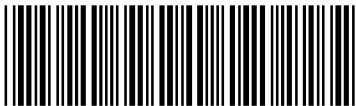
Examiner Note: Please attach an interview summary when necessary as described above.

Issue Classification 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.	
	Examiner VINH T LAM	Art Unit 2628	

CPC						
Symbol					Type	Version
G06F	/	3	/	0421	F	2013-01-01
G06F	/	1	/	1652	I	2013-01-01
G06F	/	1	/	16	I	2013-01-01
G06F	/	3	/	041	I	2013-01-01
G06F	/	2203	/	04102	A	2013-01-01
G06F	/	2203	/	04103	A	2013-01-01

CPC Combination Sets					
Symbol				Type	Set
	/		/		

None		Total Claims Allowed:	
(Assistant Examiner)	(Date)	14	
/VINH T LAM/ Primary Examiner, Art Unit 2628	30 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

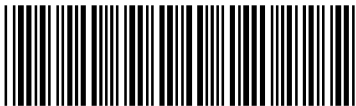
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CLAIMED			
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NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

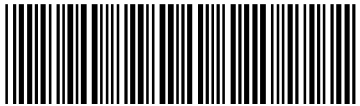
CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

None		Total Claims Allowed:	
(Assistant Examiner)	(Date)	14	
/VINH T LAM/ Primary Examiner, Art Unit 2628 (Primary Examiner)	30 June 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

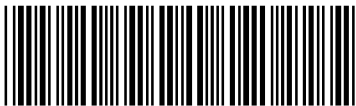
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CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	7	10	13	19										
-	2	-	11	14	20										
-	3	-	12												
2	4	8	13												
-	5	-	14												
3	6	9	15												
4	7	10	16												
5	8	11	17												
6	9	12	18												

None	Total Claims Allowed:	
(Assistant Examiner)	(Date)	14
/VINH T LAM/ Primary Examiner, Art Unit 2628	30 June 2020	O.G. Print Claim(s) O.G. Print Figure
(Primary Examiner)	(Date)	1 1

<i>Index of Claims</i> 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	01/22/2020	03/27/2020	06/30/2020						
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-	2	✓	-	-						
-	3	✓	-	-						
2	4	✓	✓	=						
-	5	✓	✓	-						
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10	16	✓	✓	=						
11	17	✓	✓	=						
12	18	✓	✓	=						
13	19	✓	✓	=						
14	20	✓	✓	=						

Search Notes 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

CPC - Searched*		
Symbol	Date	Examiner
G06F3/0421 G06F2203/04103	06/30/2020	vl

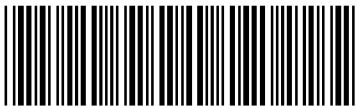
CPC Combination Sets - Searched*		
Symbol	Date	Examiner

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
Search inventor'(s)' name(s). No ODP.	01/22/2020	vl
Search technical terms and synonyms.	06/30/2020	vl
Search IDS.	06/30/2020	vl
Search Foreign Patent Literature(s) and NPL (ip.com).	06/30/2020	vl
Search CPC.	06/30/2020	vl
Search EAST.	06/30/2020	vl
Review amendment and argument.	06/30/2020	vl

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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<i>Search Notes</i> 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
Search all of the above.	Search all of the above.	06/30/2020	

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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Bibliographic Data

Application No: 16/706,438

Foreign Priority claimed: ☒ Yes ☐ No

35 USC 119 (a-d) conditions met: ☒ Yes ☐ No ☒ Met After Allowance

Verified and Acknowledged:

/VINH T LAM/

V.T.L

Examiner's Signature

Initials

Title:

TOUCH DEVICE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/06/2019	345	2628	FFOG.053C4
RULE			

APPLICANTS

Flatfrog Laboratories AB, Lund, SWEDEN

INVENTORS

Aleksander Kocovski Malmo, SWEDEN

Hakan Bergstrom Torna-Hallestad, SWEDEN

Jens Thorvinger Lund, SWEDEN

CONTINUING DATA

This application is a CON of 16403283 05/03/2019

16403283 is a CON of 16190907 11/14/2018 PAT 10282035

16190907 is a CON of PCT/SE2017/051233 12/07/2017

FOREIGN APPLICATIONS

SWEDEN 1630294-5 12/07/2016

IF REQUIRED, FOREIGN LICENSE GRANTED**

12/30/2019

STATE OR COUNTRY

SWEDEN

ADDRESS

KNOBBE MARTENS OLSON & BEAR LLP

2040 MAIN STREET

FOURTEENTH FLOOR

IRVINE, CA 92614

UNITED STATES

FILING FEE RECEIVED

\$5,860

Doc Code: A.NE.AFCP

Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

**CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE
AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0**

Practitioner Docket No.: FFOG.053C4	Application No.: 16/706438	Filing Date: December 6, 2019
First Named Inventor: Aleksander Kocovski	Title: TOUCH DEVICE	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:
 - Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
 - The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
 - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
 - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
 - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
 - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature /Harnik Shukla/	Date June 18, 2020
Name (Print/Typed) Harnik Shukla	Practitioner Registration No. 73,097

Note: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. 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.

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

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	2008/0080811	04-03-2008	Deane, Peter	
	2	2011/0141062	06-16-2011	Yu et al.	
	3	2012/0170056	07-05-2012	Jakobsen et al.	
	4	2012/0223916	09-06-2012	Kukulj, Dax	
	5	2013/0300714	11-14-2013	Goh et al.	
	6	2015/0131010	05-14-2015	Sugiyama, Koichi	
	7	2019/0196657	10-08-2019	Skagmo et al.	
	8	2019/0196658	06-27-2019	Skagmo et al.	
	9	2019/0196659	06-27-2019	Skagmo et al.	
	10	2019/0025984	01-24-2019	Weilbacher et al.	
	11	9,001,086	04-07-2015	Saini, Amrinder Pal Singh	
	12	10,282,035	05-07-2019	Kocovski et al.	
	13	9,207,800	12-08-2015	Eriksson et al.	
	14	2015/0339000	11-26-2014	Lee et al.	
	15	2016/0306501	10-20-2016	Drumm et al.	
	16	2013/0155655	06-20-2013	Lee 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
	17	EP 2325735 A2	05-25-2011	SAMSUNG ELECTRONICS CO LTD		
	18	WO 2016/130074 A1	08-18-2016	FLATFROG LABORATORIES AB		

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
	19	Extended European Search Report in European Application number 16873465.5, date June 25, 2019 in 9 pages.	

32980401

Examiner Signature	/VINH T LAM/	Date Considered	06/30/2020
*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.			

T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 123

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 2	Attorney Docket No.	FFOG.053C4

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	2015/0373864 A1	12-24-2015	Jung	
	2	2013/0321740 A1	12-5-2013	An et al.	
	3	2016/0154533 A1	06-02-2016	Eriksson et al.	
	4	2011/0080361 A1	04-07-2011	Miller et al.	
	5	2019/0235701 A1	08-01-2019	Han et al.	
	6	9,024,896 B2	05-05-2015	Chen	
	7	4,751,379	06-14-1988	Sasaki et al.	
	8	2013/0234991 A1	09-12-2013	Sparf	

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
	9	WO 2014/065601	05-01-2014	LG Electronics Inc.		
	10	WO 2018/106176	06-14-2018	FlatFrog Laboratories AB		
	11	EP 3535640 A1	09-11-2019	FlatFrog Laboratories AB		
	12	EP 2765622 A2	08-13-2014	LG Electronics Inc.		
	13	WO 2013/159472	10-31-2013	Shenzhen Timelink Technology Co., LTD.		X

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
	14	Report on the Filing or Determination of an Action Regarding a Patent or Trademark. For U.S. Patent No. 10,282,035, U.S. District of Delaware, dated December 10, 2019, in 1 page.	
	15	Civil Cover Sheet FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., dated December 10, 2019, in 1 page.	
	16	Complaint for Patent Infringement, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019, in 83 pages.	
	17	Executed Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	18	Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	

Examiner Signature	/VINH T LAM/	Date Considered	06/30/2020
*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.			

T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 124

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L./

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 2 OF 2	Attorney Docket No.	FFOG.053C4

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
	19	Summons in a Civil Action to Promethean Ltd., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	20	Defendants' Answer to Second Amended Complaint and Defendant Promethean Inc.'s Counterclaims Against FlatFrog Laboratories AB., C.A. No. 19-2246, dated May 22, 2020, in 29 pages.	

32775336

Examiner Signature /VINH T LAM/	Date Considered 06/30/2020
*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.	

T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 125

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L./

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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S7	35	((("KOCOVSKI") near3 ("Aleksander")) OR ((("BERGSTROM") near3 ("Hakan")) OR ((("THORVINGER") near3 ("Jens")))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2019/01/31 16:47
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EAST Search History (Prior Art)

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S45	4	(S43 S44) and parabolic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 12:28
S46	42,514	(first second\$3 another different third) same (edge\$1 point\$1 axis axes line\$1 end\$1 surface\$1 face\$1) same (parabolic)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 12:53
S47	32,264	S46 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 12:57
S48	13	S47 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 12:57
S49	865	(first second\$3 another different) same (frame\$1 chasis enclosure\$1 portion\$1 area\$1 region\$1 zone\$1 area\$1 curve\$1 curvature\$1 arc\$1 bend\$3 bent) same (parabolic) same (before after) same (assembl\$3 manufactur\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:08

EAST Search History (Prior Art)

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EAST Search History (Prior Art)

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S54	11	S53 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:16

EAST Search History (Prior Art)

S55	404	("20200110508" "20200064966" "20190079638" "20190079637" "10282035" "20190092411" "2020512607" "110114737" "208506715" "20190196659" "20190196657" "20190196658" "20190196660" "110494286" "10390446" "20200027462" "10390445" "20170119134" "20170119133" "20170303407" "201908252" "10437389" "20170119135" "20170303408" "110663015" "200526149" "10327349" "20170303422" I273898 "20190012032" "20200117302" "20190332217" "111116021" "20200117303" "20190012033" "20180134141" "20150133886" "20150234434" "201342148" "20030088061" "2020518495" "9204565" "210639598" "201712649" I616857 "2004531716" "210270851" "20090090070" "201712385" I600938 "10073198" "20170082784" "201035823" "2011516754" "203786693" "20170086169" I590107 M486808 "20140057935" "20090064555" "201602495" RE45475 "20190278413" "101976132" "2453840" WO2013118769 "20140041782" "20160083318" "5918786" "100536726" "1925772" "8104208" "111292618" "2012267751" "10606416" "20120312941" "5630764" "20160213173" "10558067" "10028600" "20090303190" "2008306580" "102077696" "2017181819" "201419236" "106646962" "201115225" "104808843" I380195 "20180074359" "5958952" I611382 "100982555" "209765471" "2008306580" "20170075896" "20150234511" "2004232248" "104808843" "10345858" "9513735" "2013103026" "20110027039" "20170060188" "2015219387" "20190278136" "20100014026" "20120070418" "20190265758" "105321429" "20070119084" "2011516754" "200912200" "20020149571" "8390756" "110544427" "20150054762" "20150378072" "20140097636" "7109976" "106023809" "9483130" "101635297" "20140113720" "103810945" "210378258" "20040212583" "2414490" "201708896" I489351 "20090193699" "210244319" "7421810" "20140091910" "103777382" "20080278460" "104205028" "20060086025" "9495891" "101519987" "2004296378" "20160055578" "106502439" "20160035681" "105321429" "10098245" "2007518472" "103810944" "20180199447" I548907 "2010527100" "20140126227" "8842366" "102044471" "110520293" "201506498").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:17
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top 200

EAST Search History (Prior Art)

S56	309	S55 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:22
S57	5	S56 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:22
S58	2	16/190907.app.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/06/30 13:22

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S32	193	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (surface fac\$3))	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:20
S33	181	S32 and @ad<"20161207"	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:21
S34	29	S33 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:22

/V.T.L./ (06/30/2020)

FFOG.053C4

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First : Aleksander Kocovski
Inventor
App. No. : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Lam, Vinh Tang
Art Unit : 2628
Conf. No. : 3081

**AMENDMENT SUBMITTED WITH AFTER FINAL CONSIDERATION PILOT
PROGRAM REQUEST****Mail Stop AF**

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

Dear Commissioner:

In response to the Office Action mailed April 7, 2020, the Applicant respectfully requests the above-identified application be amended as follows:

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0		
Practitioner Docket No.: FFOG.053C4	Application No.: 16/706438	Filing Date: December 6, 2019
First Named Inventor: Aleksander Kocovski	Title: TOUCH DEVICE	
<p>APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.</p> <ol style="list-style-type: none"> 1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (<i>e.g.</i>, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c). 2. The above-identified application contains an outstanding final rejection. 3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect. 4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection. 5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response. 6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web). 7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, <i>e.g.</i>, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.] 8. By filing this certification and request, applicant acknowledges the following: <ul style="list-style-type: none"> • Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0. • The examiner will verify that the AFCP 2.0 submission is compliant, <i>i.e.</i>, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions: <ul style="list-style-type: none"> ○ The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, <i>e.g.</i>, by mailing an advisory action. ○ If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview. <ul style="list-style-type: none"> ▪ The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate. ▪ If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116. 		
Signature /Harnik Shukla/	Date June 18, 2020	
Name (Print/Typed) Harnik Shukla	Practitioner Registration No. 73,097	
<p>Note: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.</p>		
☒ * Total of <u>1</u> 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.

REMARKS

By way of summary, Claims 1, 4-11, 13, and 15-20 were pending in this application. In the present amendment, Applicant has amended Claims 1 and 10 without prejudice or disclaimer to previously pending versions thereof. Accordingly, Claims 1, 4-11, 13, and 15-20 remain pending.

Rejections of Claims Under 35 U.S.C. § 103

The Office Action rejected independent Claims 1 and 10 under 35 U.S.C. § 103 as being unpatentable over U.S. Pub. No. 2012/0223916 to Kukulj ("Kukulj") in view of U.S. Pub. No. 2013/0044073 to Christiansson ("Christiansson"). The Office Action rejected the dependent claims based at least on the above cited references. Applicant respectfully traverses these rejections, the characterizations of the pending claims and the cited references and each and every implicit and explicit potential for reliance on Official Notice. In the interest of expediting prosecution, Applicant has amended the independent claims as shown above. The dependent claims are addressed in the "Dependent Claims" section below.

As discussed during the Interview, Applicant has incorporated the Examiner's suggested amendments into the independent claims. Based at least on the amendments and the discussion during the Interview, Applicant respectfully asserts that the cited references fail to teach or suggest all the limitations of amended Claims 1 and 10. The dependent claims are patentable for the same reasons articulated above with respect to their independent claims. The dependent claims are also patentable because of the additional features recited therein.

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. 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: June 18, 2020

By: Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

33007233

Application No.: 16/706438
Filing Date: December 6, 2019

Summary of the Interview

Applicant's representative, Harnik Shukla, attended a telephonic interview with Examiner Lam on June 9, 2020. Mr. Shukla discussed claim interpretation and the cited references, Kukulj and Christiansson. Examiner Lam proposed claim amendments to advance prosecution. No agreement was reached.

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. (Currently Amended) 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; and

a second edge perpendicular to the first edge; ~~and~~

~~a flat plane defined by the first edge and the second edge; and~~

~~wherein the touch surface includes a center 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 ~~such that the center point moves further away from the flat plane.~~

2. (CANCELLED)

3. (CANCELLED)

4. (Previously Presented) The method of Claim 1, wherein the touch surface is concave.

5. (Original) The method of claim 1, wherein the curvature is parabolic concave.

6. (Original) 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.
7. (Previously Presented) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are defined along an edge of the plate.
8. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.
9. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.
10. (Currently Amended) 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 having a center point;
 - a flat plane defined by a first edge of the touch surface and a second edge of the touch surface perpendicular to the first edge, wherein the center point is separated from the flat plane by a distance;
 - 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 in

~~the touch surface greater than the first curvature when the plate is installed in the frame assembly, said second curvature is parabolic and induced to change the distance of the center point with respect the flat plane when the plate is installed in the frame assembly;~~

~~wherein the frame assembly is arranged to induce the second curvature such that the center point of the touch surface causes the center point to move further away from the flat plane, and~~

~~wherein the first curvature is concave.~~

11. (Previously Presented) The touch sensing apparatus of claim 10, wherein the touch surface is parabolic concave.

12. (CANCELLED)

13. (Original) The touch sensing apparatus of claim 10, 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.

14. (CANCELLED)

15. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along an edge of the plate.

16. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

17. (Previously Presented) The touch sensing apparatus of claim 10, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

18. (Original) The touch sensing apparatus of claim 10, further comprising a gasket, wherein the plate is supported by the gasket proximate to an edge of the plate.

19. (Original) The apparatus of claim 18, wherein the gasket is configured to have varying thickness to match a curvature of the plate along the edge.

20. (Original) The apparatus of claim 10, wherein the second frame element is curved.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor : Aleksander Kocovski
App. No. : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Lam, Vinh Tang
Art Unit : 2628
Conf. No. : 3081

**AMENDMENT SUBMITTED WITH AFTER FINAL CONSIDERATION PILOT
PROGRAM REQUEST****Mail Stop AF**

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

Dear Commissioner:

In response to the Office Action mailed April 7, 2020, the Applicant respectfully requests the above-identified application be amended as follows:

Electronic Acknowledgement Receipt

EFS ID:	39764755
Application Number:	16706438
International Application Number:	
Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Fabiola Esmerio
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
Receipt Date:	18-JUN-2020
Filing Date:	06-DEC-2019
Time Stamp:	18:16:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	After Final Consideration Program Request	FFOG053C4_AFCPrequest.pdf	226885	no	2
			1cd46fae2b2598dec19db0ac90871807dd679bc7		

Warnings:

Information:					
2		FFOG053C4_OAR.pdf	39418	yes	7
			4f456fb87523121a173c874ae03acdfd7bc1680b		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Applicant Arguments/Remarks Made in an Amendment		6	7	
	Applicant summary of interview with examiner		5	5	
	Claims		2	4	
	Response After Final Action		1	1	
Warnings:					
Information:					
Total Files Size (in bytes):			266303		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

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 16/706,438	Filing Date 12/06/2019	☐ To be Mailed
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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), (l), 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)	RATE (\$)	ADDITIONAL FEE (\$)
AMENDMENT	06/18/2020		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	x \$100 = 0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0	x \$460 = 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
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	
	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".						/TARA J WITCHER/
*** 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

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	2008/0080811	04-03-2008	Deane, Peter	
	2	2011/0141062	06-16-2011	Yu et al.	
	3	2012/0170056	07-05-2012	Jakobsen et al.	
	4	2012/0223916	09-06-2012	Kukulj, Dax	
	5	2013/0300714	11-14-2013	Goh et al.	
	6	2015/0131010	05-14-2015	Sugiyama, Koichi	
	7	2019/0196657	10-08-2019	Skagmo et al.	
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- **Park, Seung-kwon**
Gyeonggi-do (KR)
- **Kang, Jung-min**
Seoul (KR)
- **Jeong, Ki-jun**
Seoul (KR)
- **Lee, Dong-ho**
Seoul (KR)

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(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**
Suwon-si
Gyeonggi-do 442-742 (KR)

(74) Representative: **Grootscholten, Johannes A.M.**
Arnold & Siedsma
Sweelinckplein 1
2517 GK Den Haag (NL)

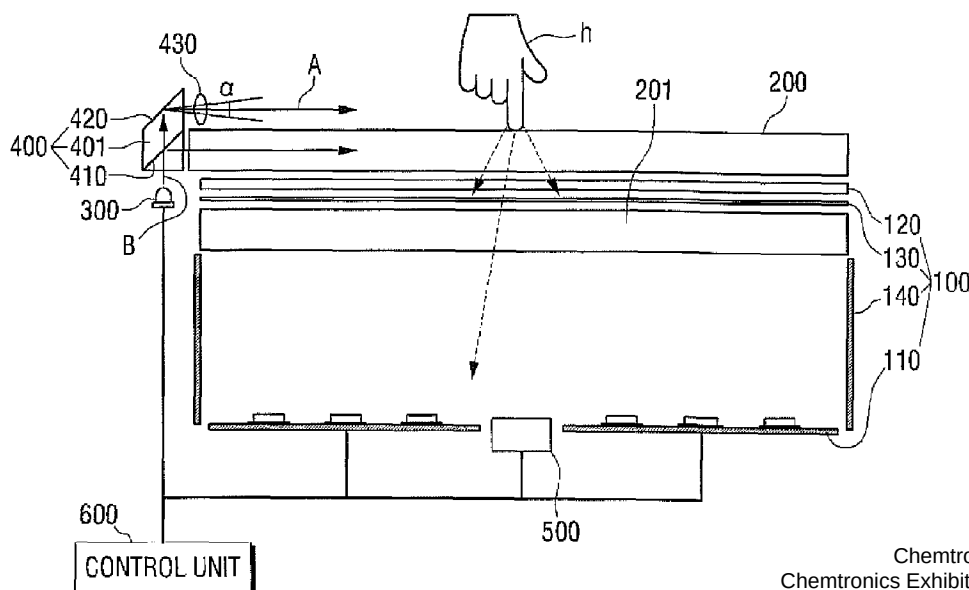
(72) Inventors:
• **Seo, Young-kwang**
Seoul (KR)

(54) **Multi-touch detecting apparatus and method for LCD display apparatus**

(57) A multi-touch detecting apparatus includes a liquid crystal display (LCD) module which includes an LCD panel and a backlight unit (BLU), a plurality of infrared light sources which emits infrared light toward the LCD

module, an infrared light detecting camera which is disposed proximate a rear surface of the LCD panel, and detects infrared light reflected from an object on the LCD panel, and a control unit which turns off the BLU when the infrared light detecting camera is turned on.

FIG. 1



Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Korean Patent Application No. 10-2009-0113392, filed November 23, 2009 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

[0002] Apparatuses and methods consistent with exemplary embodiments relate to a multi-touch detecting of two or more touched positions, for example, on touch screens and electronic blackboards, and more particularly, to a multi-touch detecting applicable to a liquid crystal display (LCD) apparatus.

2. Description of the Related Art

[0003] Touch screen displays are used in portable electronic devices, such as mobile phones, portable multimedia players (PMPs), personal digital assistants (PDAs), and the like. In general, the touch screen technology detects change in voltage or electrical resistance at a point touched by a finger or an object using a single point detecting method. However, the single point detection technology cannot be used with the display apparatuses which detect various inputs at the same time, such as with the electronic blackboards.

[0004] Recently, in order to overcome this shortcoming, multi-touch screen technology to detect the multi-inputs in the projection devices has been developed. The related art multi-touch screen technology methods include a Fourier transform infrared spectroscopy (FTIR) scheme using an infrared light source and an infrared light detecting camera, a Rear Diffused Illumination (Rear-DI) scheme, and an LED-Light Plane (LED-LP) scheme.

[0005] In the FTIR scheme, a plurality of infrared light sources is disposed on the edge of a touch screen. Infrared light emitted from the infrared light sources moves within the interior of a transparent panel which is in contact with a finger of a user. When the infrared light is scattered at a point touched by the finger, an infrared light detecting camera disposed under the transparent panel detects the scattered and reflected infrared light, so that the presence of the touch can be detected. The amount of scattered infrared light correlates with an area touched by the finger.

[0006] In the FTIR scheme, an area touched by the finger is comparatively easily detected since the infrared light is scattered around the center of the area touched by the finger. Accordingly, the center of the touched area can be measured easily and quickly. However, if the fin-

ger which is in contact with the transparent panel drags itself on the transparent panel, an area touched by the finger is altered. Accordingly, the amount of scattered infrared light detected by the infrared light detecting camera may be reduced, and the detection capability of the infrared light detecting camera may be diminished. Therefore, it may be difficult to track points touched by the finger through the camera vision processing. In order to solve this problem, a compliant layer may be disposed on the front surface of a transparent panel. However, to have such layer added to the LCD apparatuses is not desirable and difficult to implement.

[0007] In the Rear-DI scheme, an infrared light source and an infrared light detecting camera to detect infrared light emitted from the infrared light source are disposed on the same plane. The infrared light detecting camera detects infrared light reflected by a touch by a finger or an object and detects a touched point. However, in an LCD apparatus, a plurality of optical sheets is piled in an LCD module, so that the infrared light is attenuated while going through the optical sheets. Thus, the detection capability of the infrared light detecting camera may be diminished unless the optical sheets are modified. This makes it difficult to apply the Rear-DI structure to LCD apparatuses.

[0008] The LED-LP scheme is a modification of the FTIR scheme. In LED-LP scheme, the infrared light moves along the front surface of the transparent panel. Under this structure, the shortcoming of the FTIR scheme in tracking the points touched by the finger can be overcome, but it is difficult to detect the center of a point touched by the finger, similar to the Rear-DI scheme.

[0009] As described above, the FTIR, Rear-DI, and LED-LP schemes are technologies related to a multi-touch detecting apparatus which can be applied to a projection system. However, it is difficult to apply these schemes to an LCD system in the same manner.

[0010] Further, in the LCD system, an LCD panel does not have a light emitting function, so a backlight unit (BLU) using cold cathode fluorescent lamps (CCFLs) or light emitting diodes (LEDs) is used. However, since the BLU has an invisible IR band which overlaps with a near IR band of 650nm or more and an IR band 800nm or more, the BLU may operate as a background noise for an infrared light detecting camera. Furthermore, the camera contrast ratio of the infrared light detecting camera may be reduced due to the light emitted by the BLU.

[0011] Therefore, there is a need for a multi-touch detecting apparatus and method which can be applied to an LCD apparatus and avoid influence of a BLU.

SUMMARY

[0012] Exemplary embodiments address at least the above problems and/or disadvantages and other disadvantages not described above. Also, an exemplary embodiment is not required to overcome the disadvantages described above, and an exemplary embodiment may

not overcome any of the problems described above.

[0013] An aspect of an exemplary embodiment provides a multi-touch detecting apparatus and method which can be applied to an LCD apparatus and avoid influence of a BLU.

[0014] According to an aspect of an exemplary embodiment, there is provided a multi-touch detecting apparatus including an LCD module which includes an LCD panel and a BLU, a plurality of infrared light sources which emit infrared light toward the LCD module, an infrared light detecting camera which is disposed under the LCD panel, and detects infrared light reflected from an object on the LCD panel, and a control unit which turns off the BLU when the infrared light detecting camera is turned on.

[0015] The multi control unit may control on-timing of the BLU using an off signal of the infrared light detecting camera as a trigger signal.

[0016] The LCD module may include a transparent panel, which is touched by a user, at an uppermost surface thereof, and the infrared light sources may emit the infrared light parallel to an inside and a surface of the transparent panel.

[0017] The multi-touch detecting apparatus may further include an optical unit which is disposed on a light path of the infrared light sources and moves the infrared light emitted from the infrared light sources so as to be parallel to an inside and a surface of the transparent panel.

[0018] The optical unit may include a beam splitter which reflects the infrared light incident from the infrared light sources so as to separately go through the inside and the surface of the transparent panel, and a collimate member which is disposed on one of a light incident surface and a light emergent of the beam splitter so as to secure straightness of the infrared light.

[0019] There is at least one infrared light detecting camera at the BLU, and the at least one infrared light detecting camera is disposed in the center of the BLU. As the case may be, two or three infrared light detecting cameras may be disposed at the BLU at regular intervals.

[0020] According to an aspect of an exemplary embodiment, the beam splitter may include a first surface which reflects infrared light having a first wavelength and transmits infrared light having the remaining wavelength, and a second surface which reflects all incident light, and the beam splitter may allow the infrared light having the first wavelength to go through the inside of the transparent panel and allow the infrared light having the remaining wavelength to move parallel along the surface of the transparent panel.

[0021] According to an aspect of another exemplary embodiment, the beam splitter may include a first surface which transmits infrared light having a first wavelength and reflects infrared light having the remaining wavelength, and a second surface which reflects all incident light, and the beam splitter may allow the infrared light having the first wavelength to go through the inside of

the transparent panel and allow the infrared light having the remaining wavelength to move parallel along the surface of the transparent panel.

[0022] According to an aspect of another exemplary embodiment, the infrared light sources may be arranged around the transparent panel on a plurality of lines. The infrared light sources include a first line to move the infrared light in the inside of the transparent panel, and a second line to move the infrared light on the surface of the transparent panel.

[0023] According to an aspect of another exemplary embodiment, the BLU may use a direct-type lighting method, and the infrared light sources may be disposed on the same plane as the BLU and be formed in two-dimensional arrays so as to have regular intervals with light sources of the BLU.

[0024] According to an aspect of another exemplary embodiment, the BLU may use an edge-type lighting method, and the multi-touch detecting apparatus may further include a reflection unit which reflects infrared light reflected from the object toward the infrared light detecting camera.

[0025] The reflection unit may include a first reflection mirror which reflects infrared light which penetrates the backlight units and is reflected from the object, and a second reflection mirror which reflects the infrared light reflected from the first reflection mirror toward the infrared light detecting camera.

[0026] The infrared light detecting camera may be disposed separately from the BLU.

[0027] The infrared light sources, according to exemplary embodiments, may be disposed on a single side of the transparent panel, on two sides of the transparent panel facing each other, or on four sides of the transparent panel.

[0028] The infrared light sources may be turned on or off concurrently in association with the infrared light detecting camera.

[0029] The infrared light sources may have a horizontal light angle of the infrared light larger than a vertical light angle with respect to the transparent panel.

[0030] The transparent panel may be a transparent acrylic material or a hardened protection glass, and the LCD module may include a white reflector which is disposed at a wall thereof and focuses light of the BLU.

[0031] According to an aspect of another exemplary embodiment, there is provided a multi-touch detecting method including emitting infrared light from an infrared light source toward an LCD module including a BLU, turning on an infrared light detecting camera and turning off the BLU, detecting infrared light reflected from an object on the LCD module, and turning off the infrared light detecting camera and turning on the BLU.

[0032] The emitting the infrared light may include guiding the emitted infrared light to an inside and a surface of a transparent panel which is disposed on the LCD module including the BLU, and in the emitting the infrared light, when the infrared light detecting camera is turned

on, the infrared light source may be turned on.

[0033] When the infrared light detecting camera is turned off, the infrared light source may be turned off.

[0034] The timing when the infrared light detecting camera is turned on may depend on an amount of infrared light which is scattered and incident from the infrared light source, and an amount of adjacent noise, and an on-off period of the BLU may be greater than at least 30Hz.

[0035] According to one or more exemplary embodiments, the multi-touch detecting apparatus can provide optical design capable of supporting both the FTIR scheme and the LED-LP scheme, and thus support dynamic finger movement detection as well as static finger movement detection.

[0036] In addition, the multi-touch detecting apparatus can detect an infrared light detecting signal without interference with an optical sheet, a transparent panel, a back-light unit, and a white reflector which are installed in the LCD module.

[0037] Furthermore, the period in which the infrared light detecting camera is exposed changes in association with on-off operation of the BLU, so the multi-touch detecting apparatus does not receive influence by the BLU. Therefore, precise position tracking of a touch point can be enabled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The above and/or other aspects will be more apparent by describing certain exemplary embodiments with reference to the accompanying drawings, in which:

FIG. 1 is a schematic perspective view of a multi-touch detecting apparatus according to an exemplary embodiment;

FIG. 2 is a schematic perspective view of a multi-touch detecting apparatus according to an exemplary embodiment;

FIG. 3 is a schematic perspective view of a multi-touch detecting apparatus according to an exemplary embodiment;

FIG. 4 is a schematic perspective view of a multi-touch detecting apparatus according to an exemplary embodiment;

FIG. 5 is a schematic perspective view of a multi-touch detecting apparatus according to an exemplary embodiment;

FIG. 6 is a graph illustrating on-off control of an infrared light source, an infrared light detecting apparatus, and a BLU of the multi-touch detecting apparatuses according to an exemplary embodiment; and
FIG. 7 is a flow chart illustrating a multi-touch detecting method according to an exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0039] Certain exemplary embodiments are described

in greater detail below with reference to the accompanying drawings.

[0040] In the following description, like drawing reference numerals are used for the like elements, even in different drawings. The matters defined in the description, such as detailed construction and elements, are provided to assist in a comprehensive understanding of exemplary embodiments. However, exemplary embodiments can be practiced without those specifically defined matters.

[0041] FIG. 1 illustrates an example of a multi-touch detecting apparatus according to an exemplary embodiment.

[0042] As illustrated in FIG. 1, the multi-touch detecting apparatus may include an LCD module 100, a transparent panel 200, an infrared light source 300, an optical unit 400, an infrared light detecting camera 500, and a control unit 600. Although the multi-touch detecting apparatus illustrated in a horizontal position for convenience of explanation, it should be understood that the multi-touch detecting apparatus may be disposed in a vertical position.

[0043] The LCD module 100 may include a BLU 110, an LCD panel 120, a filter layer 130, and a white reflector 140. The BLU 110 may use a direct-type lighting method using a CCFL or a plurality of LEDs, as illustrated in FIGS. 1 to 3, or may use an edge-type lighting method using a plurality of LEDs disposed at the edge-type of a light guide plate, as illustrated in FIG. 5. The filter layer 130 is interposed between the LCD panel 120 and the BLU 110 to transmit light emitted from the BLU 110 toward the LCD panel 120 uniformly. The white reflector 140 is used for the LCD module 100 having the direct-type light BLU 110, as illustrated in FIGS. 1 to 3, to guide the light emitted from the BLU 110 to the LCD panel 120. If there is no white reflector 140, some or most of the emitted light, which is not transmitted directly to the LCD panel 120, may become a light loss and, thus, the brightness of the display apparatus may decrease. Therefore, the white reflector 140 is installed when the direct-type light BLUs are used.

[0044] The transparent panel 200 is disposed on the front surface of the LCD module 100 to prevent damage of the LCD module 100 and enable a user to touch a screen displayed on the LCD module 100. The transparent panel 200 may be formed of a transparent acrylic material, or of a material such as a hardened protection glass. The transparent panel 200 may be spaced a predetermined distance apart from the LCD panel 120 to be prevented from being deformed by heat of the LCD panel 120. In addition, if the transparent panel 200 is spaced a predetermined distance apart from the LCD panel 120, the problem of damaging the LCD panel 120 caused when the transparent panel 200 is touched by a finger and becomes in contact with the LCD panel 120, can be prevented.

[0045] A lower transparent panel 201 formed of the same material as the transparent panel 200 may be

formed proximate a rear surface of the LCD panel 120 to be spaced a predetermined distance apart from the LCD panel 120. The lower transparent panel 201 supports the LCD panel 120 and the filter layer 130 disposed proximate the rear surface of the LCD panel 120, and may be formed of a hardened protection glass. For example, the lower transparent panel 201 may be formed of a transparent material.

[0046] A plurality of infrared light sources 300 may be arranged at regular intervals along a single line or two lines. Since the LCD module 100 has a square shape in general, the infrared light sources 300 may be disposed around the transparent panel 200 on the LCD module 100 or proximate the LCD module 100. The infrared light sources 300 may be disposed at one side of the transparent panel 200, at two opposite sides facing each other, or at four sides.

[0047] The direction in which the infrared light sources 300 emit the infrared light can be implemented in various ways according to an exemplary embodiment. Design and presence of the optical unit 400 depend on the infrared light emitting direction and arrangement of the infrared light sources 300. Detailed description is provided below.

[0048] The infrared light sources 300 may have a horizontal light angle greater than a vertical light angle (α) with respect to the direction of the infrared light shown by an arrow A moving along a lengthwise direction of the transparent panel 200 in FIG. 1. With this structure, the infrared light which propagates in the interior of the transparent panel 200 or along the front surface of the transparent panel 200 may be substantially parallel to the lengthwise direction of the transparent panel 200, so that the detection of an object (h), such as the finger of the user, which is in contact with the transparent panel 200 can be effectively performed. The greater the horizontal light angle, the fewer the number of infrared light sources 300 may be used. However, if the horizontal light angle is excessively large, the detection capability may be reduced. Therefore, the horizontal light angle may be smaller and the appropriate number of infrared light sources 300 may be used.

[0049] The optical unit 400 directs the infrared light emitted from the infrared light sources 300 to propagate through the interior of the transparent panel 200 and along the front surface of the transparent panel 200 at the same time. While the infrared light propagates through the interior of the transparent panel 200 and along the front surface of the transparent panel 200 in this manner at the same time, the infrared light propagating through the interior of the transparent panel 200 is scattered around a touch point of an object touching the transparent panel 200 and is used to detect the static movement caused by the finger. The infrared light propagating in parallel along the front surface of the transparent panel 200 is scattered at the contour line of the touch point of an object touching the transparent panel 200 and is used to detect tracking of the dynamic movement

caused by the finger.

[0050] A reflection surface of the optical unit 400 is set according to the direction and arrangement of the infrared light sources 300. If the infrared light sources 300 are arranged on a plurality of lines, the optical unit 400 may be omitted. However, the optical unit 400 may be provided to reduce the number of infrared light sources 300. If the optical unit 400 is used, the number of infrared light sources 300 may be reduced approximately in half as compared with the case that the optical unit 400 is not used.

[0051] The optical unit 400 may include a beam splitter 401 and a collimating member 430. The collimating member 430 may include a collimating function sheet, or may be implemented as a collimating lens. The beam splitter 401 may include a first surface 410 and a second surface 420. The reflection and penetration properties of the first and second surfaces 410 and 420 depend on the arrangement and emitting direction of the infrared light sources 300.

[0052] For example, in an exemplary embodiment shown in FIG. 1, the infrared light sources 300 emit infrared light upwards in a direction of an arrow B. In this case, the first surface 410 reflects infrared light having a first wavelength of the infrared light emitted from the infrared light sources 300 so that the infrared light having the first wavelength propagates in the interior of the transparent panel 200 and the remaining infrared light penetrates the first surface 410 and propagates toward the second surface 420. The second surface 420 reflects the infrared light incident to the second surface 420 so that the infrared light propagates along the front surface of the transparent panel 200. The infrared light reflected by the second surface 420 passes through the collimating member 430 to become parallel light, and propagates along the front surface of the transparent panel 200, maintaining substantial straightness.

[0053] In an exemplary embodiment shown in FIG. 2, the infrared light sources 300 emit infrared light substantially parallel to the lengthwise direction of the transparent panel 200. In this case, the first surface 410' transmits infrared light having a first wavelength of the infrared light emitted from the infrared light sources 300 so that the infrared light having the first wavelength propagates through the interior of the transparent panel 200. The first surface 410' reflects the remaining infrared light so that the remaining infrared light propagates toward the second surface 420', is reflected by the second surface 420', and propagates along the front surface of the transparent panel 200. The infrared light reflected by the second surface 420' passes through the collimating member 430 to become parallel light, and propagates along the front surface of the transparent panel 200, maintaining substantial straightness.

[0054] For example, the wavelength of the infrared light distinguished by the first surfaces 410 and 410' may be one of 850nm, 880nm, and 940nm.

[0055] If the infrared light sources 300 are arranged

on a plurality of lines or are disposed on the same plane as the BLU 110, the optical unit 400 may be omitted.

[0056] According to exemplary embodiments shown in FIGS. 3 to 5, infrared light sources 300 emit infrared light toward a transparent panel 200 without a separate carrier.

[0057] For example, as shown in FIGS. 3 and 5, infrared light emitted from a first light source array 310 propagates in the interior of the transparent panel 200, and infrared light emitted from a second light source array 320 propagates along the front surface of the transparent panel 200. In this case, an optical unit may be omitted.

[0058] According to an exemplary embodiment shown in FIG. 4, the infrared light sources 300 may be arranged in two-dimensional arrays. In this case, since the infrared light sources 300 and an infrared light detecting camera 500 are disposed on the same plane, an optical unit may be omitted.

[0059] In exemplary embodiments shown in FIGS. 1 to 3, there is a single infrared light detecting camera 500 disposed in the center of the BLU 110 to sense infrared light reflected from an object which is in contact with the surface of the transparent panel 200. Alternatively, two or more infrared light detecting cameras 500 may be disposed behind the transparent panel 200 at regular intervals.

[0060] In an exemplary embodiment of FIG. 5, an infrared light detecting camera 500 installed in an LCD module 100 having edge-type light BLU 110' is disposed on an external wall of the LCD module 100. The BLU 110' uses first and second reflection mirrors 510 and 520, and the thickness of the display apparatus can be reduced. The edge-type light BLU 110' may be slimmer than the direct-type light BLU 110. The infrared light detecting camera 500 may be disposed at a position capable of reducing the thickness of the display apparatus. In an exemplary embodiment, a light path is formed using the first and second reflection mirrors 510 and 520, but this is merely an example. Three or more reflection mirrors may be used, or just a single reflection mirror may be used.

[0061] The control unit 600 concurrently turns on or off the BLU 110, 110', the infrared light sources 300, and the infrared light detecting camera 500, and optimizes the signal-to-noise ratio (SNR) performance.

[0062] That is, at an exposed timing at which the infrared light detecting camera 500 is turned on and detects the infrared light, the control unit 600 turns off the BLU 110, 110'. Accordingly, when the BLU 110, 110' is turned off, the infrared light detecting camera 500 detects infrared light reflected from an object which is in contact with the transparent panel 200. If the infrared light detecting camera 500 is turned off, the control unit 600 turns on the BLU 110, 110'.

[0063] An on-off control trigger signal of the control unit 600 may use an external trigger signal which uses a microcontroller, or may use a signal which is transmitted to the components, such as the infrared light sources 300,

the infrared light detecting camera 500, or the BLU 110, 110'.

[0064] The operation of the control unit 600 is described in detail with reference to FIGS. 6 and 7.

[0065] At time sections and shown in the graph 610 of FIG. 6, the BLU 110, 110' is turned on. The infrared light sources 300 and the infrared light detecting camera 500 are turned off as shown in graphs 620 and 630, respectively.

[0066] When the display apparatus starts operating, the control unit 600 turns on the infrared light sources 300 (S10).

[0067] Subsequently, infrared light emitted from the infrared light sources 300 is guided to propagate in the interior of the transparent panel 200 and along the front surface of the transparent panel 200. There are various methods for guiding the infrared light to propagate in the interior of the transparent panel 200 and along the front surface of the transparent panel 200 as described above (S20).

[0068] Using the on-signal of the infrared light sources 300 as a trigger signal, the control unit 600 turns off the BLU 110, 110' and turns on the infrared light detecting camera 500 (S30) as illustrated by the graph 630 at time section , thereby making an exposed state. Accordingly, since the BLU 110, 110' is turned off, infrared light reflected from a finger or an object (h) which is in contact with the surface of the transparent panel 200, can be input to the infrared light detecting camera 500 without interference and disturbance with the infrared band of the BLU 110, 110'.

[0069] If the BLU 110, 110' is turned on and the infrared light detecting camera 500 is turned on, the noise of the near IR band and the IR band included in the light of the BLU 110, 110' may be mixed with the infrared light reflected from the object (h), so that the infrared light detecting camera 500 may not detect a touch point of the object (h) with precision. However, if the BLU 110, 110' is turned off and the infrared light detecting camera 500 is turned on, the noise interference may be mitigated or eliminated.

[0070] In particular, if the infrared light sources 300 are turned on at time section as shown in the graph 620 of FIG. 6, it is possible to emit infrared light having high peak strength, so that the SNR of the infrared light detecting camera 500 can be enhanced during the detection of the touch of the finger or object (h) at time section .

[0071] The length of time section for detecting the finger or the object (h) depends on the amount of infrared light reflected from the finger or the object (h) which is touching the surface of the transparent panel 200, and the amount of noise. The stronger the reflected infrared light, the shorter the detecting time. However, if excessively strong infrared light is used, the infrared light may affect other electronic devices. Therefore, the strength of infrared light may be set appropriately. At time section, since the BLU 110, 110' is turned off, the display apparatus may look dark, so the time section may be set to

be short. Therefore, the strength of infrared light should not be excessively low. The infrared peak strength of the infrared light sources 300 varies according to the system.

[0072] Reiteration of on-off time section may be considered according to the optical-electrical circuit property of the infrared light sources 300, the infrared light detecting camera 500, and the BLU 110, 110'.

[0073] At time section in FIG. 6, if the detection of the infrared light is complete, the control unit 600 turns on the BLU 110, 110' and turns off the infrared light detecting camera 500 (S40).

[0074] Subsequently, the control unit 600 turns off the infrared light sources 300 (S50). The infrared light sources 300 can be controlled to be in a continuous-wave mode in which the infrared light sources 300 are always turned on, but it is not appropriate for the infrared light sources 300 to always emit infrared light. Infrared light is generally used for remote controllers for controlling electronic devices, so if the infrared light sources 300 always emit infrared light, the infrared light may be confused with control signals of other electronic devices and may cause malfunction.

[0075] Subsequently, the infrared light sources 300 are turned on when the infrared light detecting camera 500 is turned on and the BLU 110, 110' is turned off.

[0076] As described above, the BLU 110, 110' is turned on and off periodically. If the on-off period of the BLU 110 is slow, the user may feel the flicker of the screen of the display apparatus. Therefore, the on-off period of the BLU 110 may be set to be fast. For example, the on-off period of the BLU 110, 110' may be set to be faster than 30Hz.

[0077] The foregoing exemplary embodiments and advantages are merely exemplary and are not to be construed as limiting. The present teaching can be readily applied to other types of apparatuses. Also, the description of the exemplary embodiments is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

Claims

1. A multi-touch detecting apparatus comprising:

a liquid crystal display (LCD) module which comprises an LCD panel and a backlight unit (BLU);
a plurality of infrared light sources which emits infrared light toward the LCD module;
an infrared light detecting camera which is disposed behind the LCD panel and detects infrared light reflected from an object on the LCD panel; and
a control unit which turns off the BLU when the infrared light detecting camera is turned on.

2. The multi-touch detecting apparatus according to

claim 1, wherein the control unit controls on-timing of the BLU using an off signal of the infrared light detecting camera as a trigger signal.

3. The multi-touch detecting apparatus according to claim 1, wherein the LCD module comprises a transparent panel, which is touched by a user, at an uppermost surface thereof.

4. The multi-touch detecting apparatus according to claim 3, wherein the plurality of infrared light sources emits the infrared light parallel to an interior surface and the uppermost surface of the transparent panel.

5. The multi-touch detecting apparatus according to claim 3, further comprising:

an optical unit which is disposed on a light path of the plurality of infrared light sources and directs the infrared light emitted from the plurality of infrared light sources to be parallel to an interior surface and to the uppermost surface of the transparent panel.

6. The multi-touch detecting apparatus according to claim 5, wherein the optical unit comprises:

a beam splitter which reflects the infrared light incident from the plurality of infrared light sources so as to separately propagate inside and along the uppermost surface of the transparent panel; and

a collimating member which is disposed on one of light incident surfaces of the beam splitter so as to secure straightness of the infrared light.

7. The multi-touch detecting apparatus according to claim 6, wherein the beam splitter comprises a first surface which reflects infrared light having a first wavelength and transmits infrared light having remaining wavelengths, and a second surface which reflects all incident light, and allows the infrared light having the first wavelength to propagate through the inside of the transparent panel and allows the infrared light having the remaining wavelengths to propagate parallel along the uppermost surface of the transparent panel.

8. The multi-touch detecting apparatus according to claim 6, wherein the beam splitter comprises a first surface which transmits infrared light having a first wavelength and reflects infrared light having remaining wavelengths, and a second surface which reflects all incident light, and allows the infrared light having the first wavelength to propagate through the inside of the transparent panel and allows the infrared light having the remaining wavelengths to propagate parallel along the uppermost surface of the

transparent panel.

9. The multi-touch detecting apparatus according to claim 1, wherein the infrared light detecting camera is disposed at the BLU. 5
10. The multi-touch detecting apparatus according to claim 9, wherein the infrared light detecting camera is disposed in a center of the BLU. 10
11. The multi-touch detecting apparatus according to claim 9, further comprising a plurality of infrared light detecting cameras disposed at the BLU.
12. The multi-touch detecting apparatus according to claim 3, wherein the plurality of infrared light sources comprises a first light source array which emits infrared light parallel along an interior surface of the transparent panel, and a second light source array which is disposed above the first light source array and emits infrared light parallel to the uppermost surface of the transparent panel. 15 20
13. The multi-touch detecting apparatus according to claim 1, wherein the BLU uses an edge lighting method, the multi-touch detecting apparatus further comprises a reflection unit which reflects infrared light reflected from the object toward the infrared light detecting camera, the reflection unit comprising: 25 30
 - a first reflection mirror which reflects infrared light which penetrates the backlight unit and is reflected from the object; and
 - a second reflection mirror which reflects the infrared light reflected from the first reflection mirror toward the infrared light detecting camera, wherein the infrared light detecting camera is disposed outside the BLU. 35 40
14. The multi-touch detecting apparatus according to claim 3, wherein the plurality of infrared light sources is disposed on a single side of the transparent panel.
15. A multi-touch detecting method comprising: 45
 - emitting infrared light from an infrared light source toward a liquid crystal display (LCD) module comprising a backlight unit (BLU);
 - turning on an infrared light detecting camera and turning off the BLU; 50
 - detecting infrared light reflected from an object on the LCD module; and
 - turning off the infrared light detecting camera and turning on the BLU, 55
 - wherein the emitting the infrared light comprises guiding the emitted infrared light to an inside and along a surface of a transparent panel which is

disposed on the LCD module comprising the BLU, and wherein in the emitting the infrared light, when the infrared light detecting camera is turned on, the infrared light source is turned on.

FIG. 1

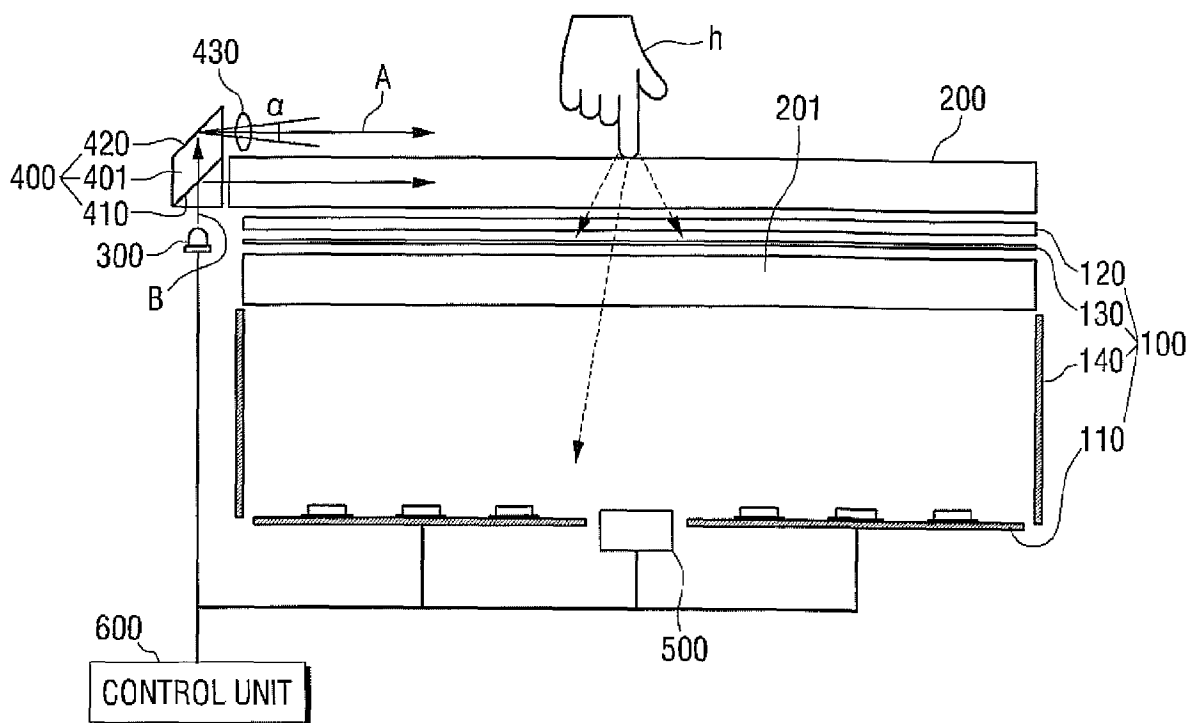


FIG. 2

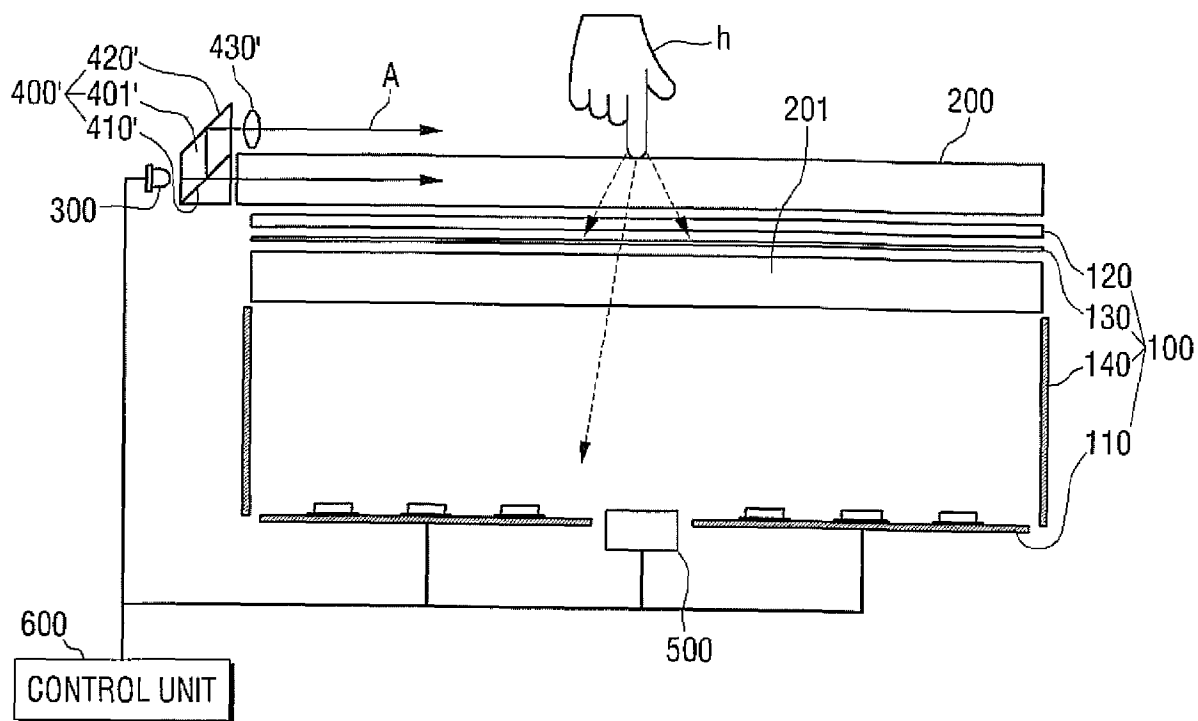


FIG. 3

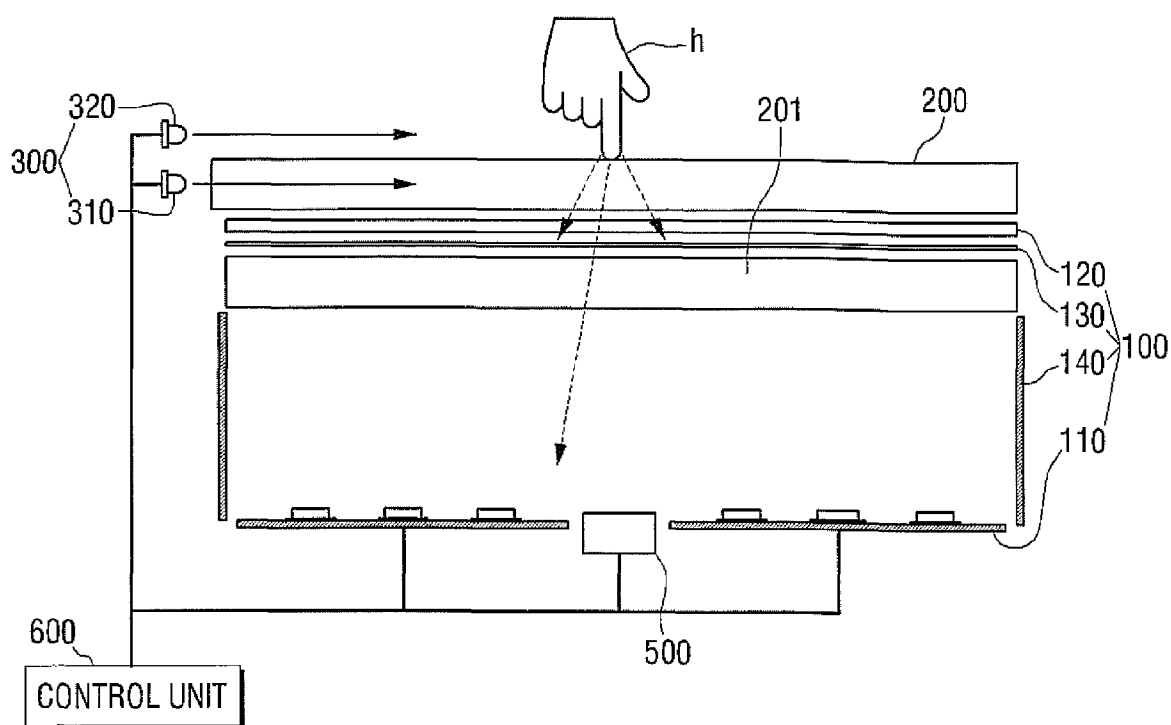


FIG. 4

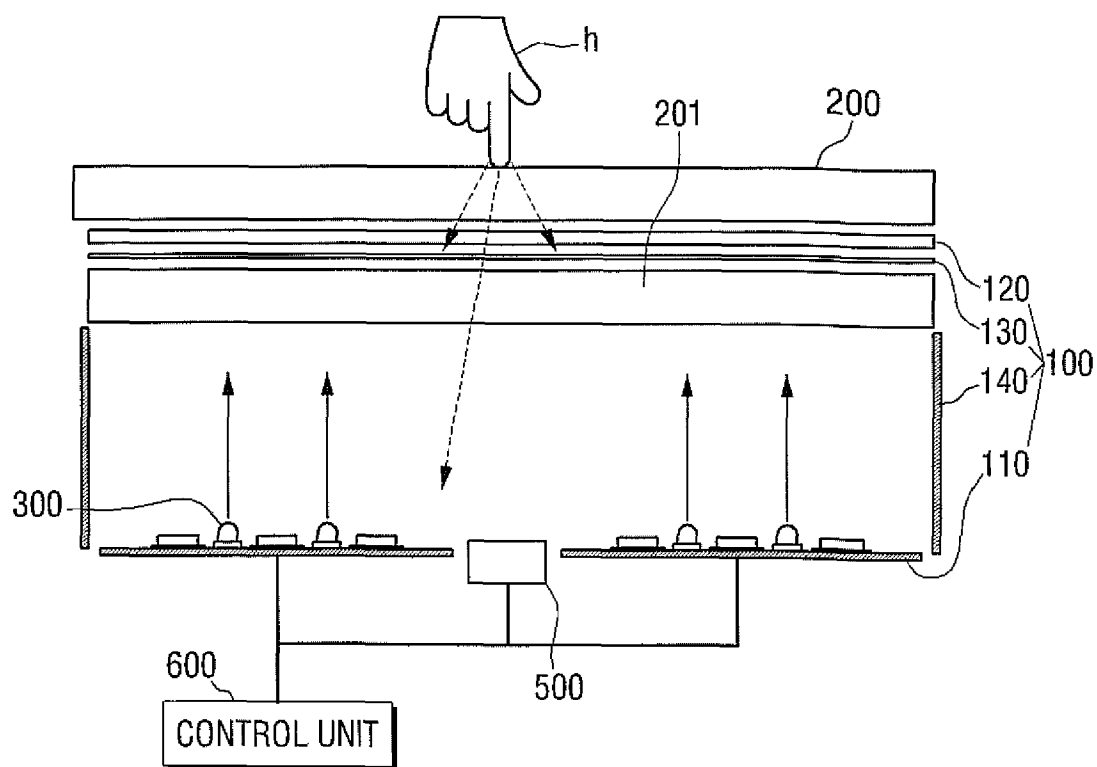


FIG. 5

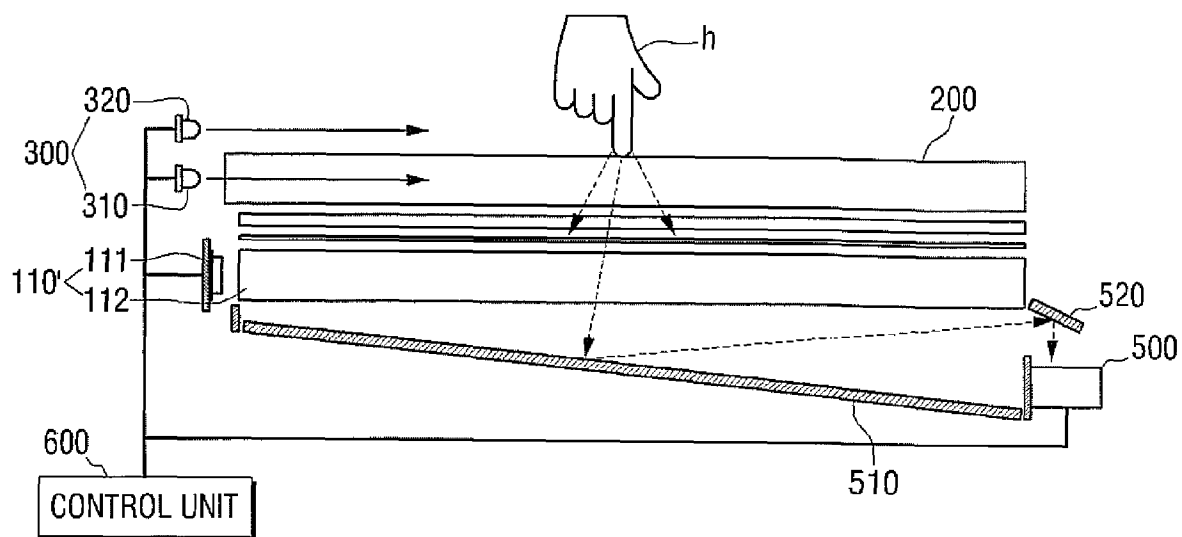


FIG. 6

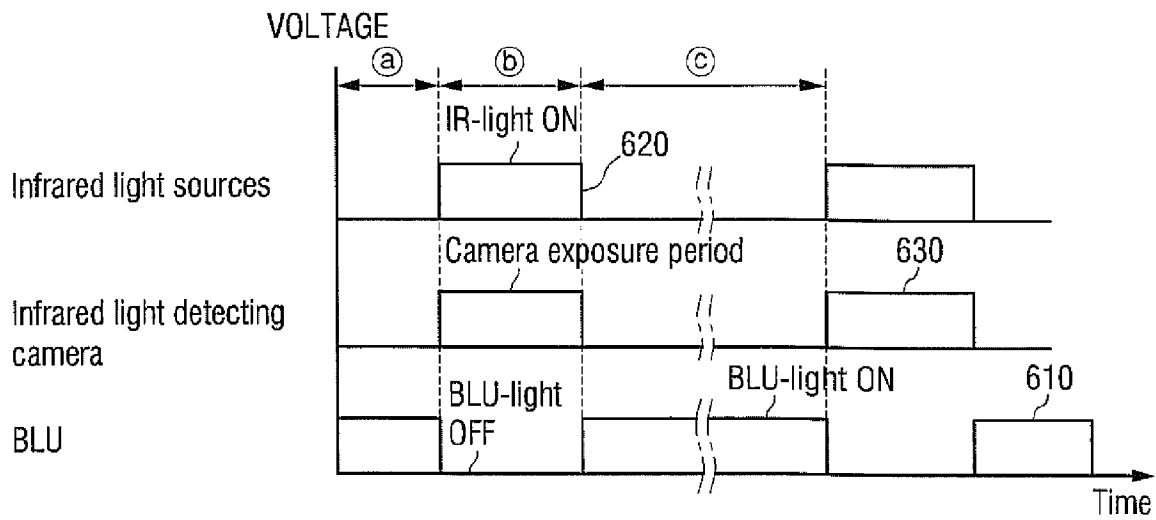
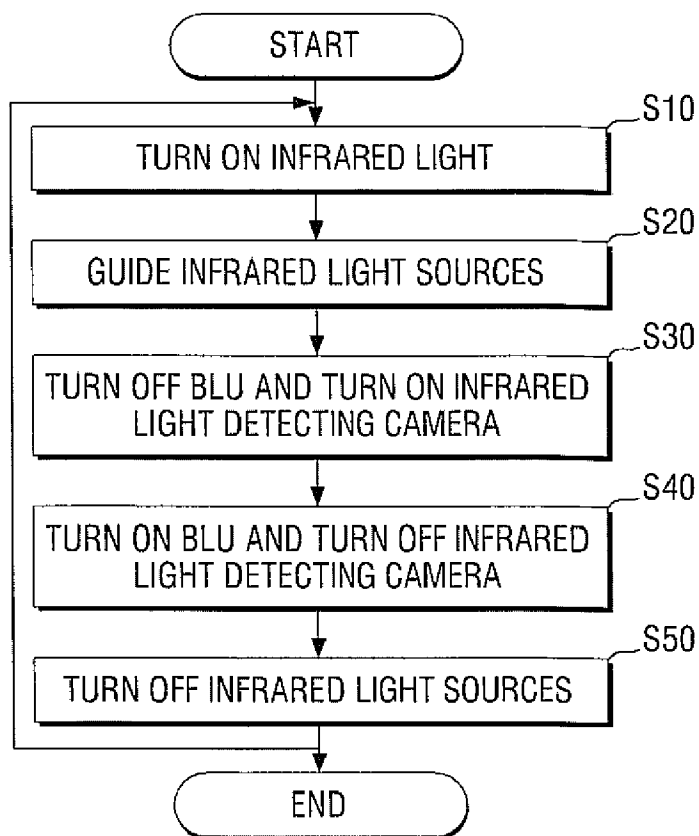


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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(71) Applicant: **FLATFROG LABORATORIES AB**
[SE/SE]; Scheelevägen 15A, 223 63 Lund (SE).

(72) Inventors: **WASSVIK, Ola**; Smedjemala, 341 76 Ryssby (SE). **BERGSTRÖM, Hakan**; Åkestorpsvägen 42, 247 95 Torna-hallestad (SE). **KARLSSON, Ivan**; Platslagarevägen 3 C, 227 30 Lund (SE). **CRAVEN-BARTLE, Thomas**; Östervang 12, 247 32 Södra Sandby (SE).

(74) Agent: **KIPA AB**; P O Box 1065, 25110 Helsingborg (SE).

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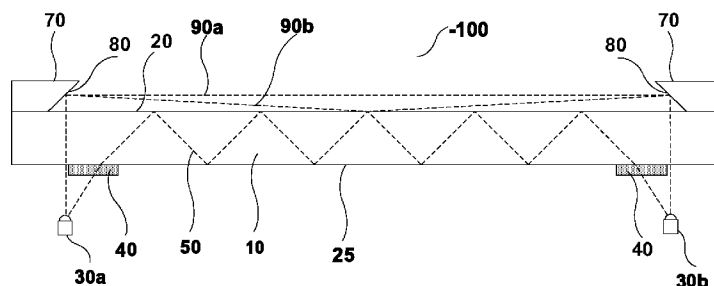


Figure 3

(57) Abstract: An embodiment of the invention provides a touch sensing apparatus, comprising: a light transmissive element (10) that defines a touch surface; a set of emitters (30a) arranged around the periphery of the touch surface to emit beams of light into the light transmissive element, wherein a first portion of the beams (50) of light propagate inside the light transmissive element while illuminating the touch surface such that an object touching the touch surface causes an attenuation of the propagating light, and wherein a second portion of the beams (90) of light pass out of the light transmissive element and are reflected to travel above the touch surface, a set of light detectors (30b) arranged around the periphery of the touch surface to receive light from the set of emitters from the transmissive element and from above the touch surface, wherein each light detector is arranged to receive light from more than one emitter.

Optical touch system comprising means for projecting and detecting light beams above and inside a transmissive panel

Technical Field

[0001] The present invention generally relates to improved touch determination on touch surfaces of optical touch-sensing systems, and in particular in relation to FTIR-based (frustrated total internal reflection) touch systems.

Background Art

[0002] In one category of touch-sensitive panels known as 'above surface optical touch systems' and known from e.g. US4459476, 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 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.

[0003] 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. Thus, each emitter creates more than one light path across the touch surface. A large number of light paths are created by sequentially activating different emitters around the periphery of the touch surface, and detecting the light received from each emitter by a plurality of optical receivers. Thereby, it is possible to reduce the number of emitters and receivers for a given surface area or spatial resolution, or to enable simultaneous location detection of more than one touching object (multi-touch detection).

[0004] If the display screen is contaminated by e.g. fingerprints, the optical transmission path may become unintentionally interrupted and the information retrieved from the system erroneous or incomplete as the contaminated surface becomes insensitive to touches. If contaminants are collected in front of one of the emitters or detectors there will always be blocked or occluded light paths.

[0005] Another category of touch-sensitive panels known as 'in-glass optical systems' is now described and is also known from e.g. US8581884.

[0006] Figure 1 illustrates an example of a touch-sensitive apparatus 100 that is based on the concept of FTIR (Frustrated Total Internal Reflection), also denoted "FTIR system". 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.

[0007] In the example of figure 1, the propagation channel is defined between the touch surface 20 and bottom surface 25 of the transmissive panel 10, where the touch surface 20 allows the propagating light to interact with touching object 60 and thereby defines the touch surface 20. This is achieved by injecting the light into the transmissive panel 10 via coupling element 40 such that the light is reflected by total internal reflection (TIR) in the touch surface 20 as it propagates through the transmissive panel 10. The light may be reflected by TIR on the bottom surface 25 or against a reflective coating thereon. Upon reaching coupling element 40 on a far side of the panel, the light is coupled out of transmissive panel 10 and onto detectors 30b. The touch-sensitive apparatus 100 may be designed to be overlaid on or integrated into a display device or monitor.

[0008] US8553014 describes an attempt to combine the above surface and in-glass optical systems described above. US8553014 describes an optical coupling technique for introducing light into a transmissive panel and above a transmissive panel simultaneously. However, the in-coupling component shown in figure 126 of US8553014 is a complex prism and appears to rely on total internal reflection and diffraction to couple the light above the touch surface. Such an arrangement would be highly tolerance sensitive, making the optical signal highly sensitive to, for example, the load on the touch surface, the tolerances of process used to mount the prism to the transmissive panel, and the manufacturing of both the transmissive panel and the prism. Furthermore, the spread of the light in a plane parallel to the transmissive panel is limited to a range of less than 80 degrees as light outside this range will be diffracted up and away from the panel. Such a system is best suited to a rectangular grid of detection lines, such as described in US4459476 above. Furthermore, a complex prism as described in US8553014 would be both expensive to manufacture and bulky, taking up valuable space underneath and to the side of the transmissive panel.

Summary of invention

[0009] It is an objective of the invention to at least partly overcome one or more of the above-identified limitations of the prior art.

[0010] 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.

- [001 1] An embodiment of the invention provides a touch sensing apparatus, comprising: a light transmissive element that defines a touch surface; a set of emitters arranged around the periphery of the touch surface to emit beams of light into the light transmissive element, wherein a first portion of the beams of light propagate inside the light transmissive element while illuminating the touch surface such that an object touching the touch surface causes an attenuation of the propagating light, and wherein a second portion of the beams of light pass out of the light transmissive element and are reflected to travel above the touch surface, a set of light detectors arranged around the periphery of the touch surface to receive light from the set of emitters from the transmissive element and from above the touch surface, 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 light detectors, a light energy value for each light path; to generate a transmission value for each light path based on the light energy value; and to operate an image reconstruction algorithm on at least part of the thus-generated transmission values so as to determine the position of the object on the touch surface.

Brief description of drawings

- [0012] Embodiments of the invention will now be described in more detail with reference to the accompanying schematic drawings.
- [0013] Figure 1 shows a cross section of an FTIR-based touch-sensitive apparatus according to the prior art.
- [0014] Figure 2 is a top plan view of an FTIR-based touch-sensitive apparatus.
- [001 5] Figure 3 shows a section view of an extended FTIR touch system according to an embodiment of the present invention.
- [0016] Figure 4 shows a top plan view of an extended FTIR touch system according to an embodiment of the present invention.
- [0017] Figure 5 shows the narrow detection lines within transmissive panel 10.
- [0018] Figure 6 shows the broad detection lines above transmissive panel 10.
- [001 9] Figure 7 shows the signal profile of detection lines 95 and detection lines 96.
- [0020] Figure 8 shows an embodiment of the present invention in which the touch surface is curved.
- [0021] Figure 9 shows an embodiment of the present invention with deflectors set back from the edge of the active area.
- [0022] Figure 10 shows an embodiment of the present invention having a dust shield.
- [0023] Figure 11 shows an embodiment of the present invention having a first set of emitters and detectors for projecting light above transmissive panel 10

and a second set of emitters and detectors for projecting light into transmissive panel 10.

[0024] Figure 12 shows a top plan view of the Figure 11.

[0025] Figure 13 shows a variation of figure 11 wherein the emitters are configured to simultaneously project light above and into transmissive panel 10.

[0026] Figure 14 shows a variation of figure 11 wherein the detectors are configured to simultaneously receive light from above and from within transmissive panel 10.

Description of embodiments

[0027] Before describing embodiments of the invention, a few definitions will be given.

[0028] 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.

[0029] An "interaction" occurs when the touch object affects a parameter measured by the sensor.

[0030] A "touch" denotes a point of interaction as seen in the interaction pattern.

[0031] Throughout the following description, the same reference numerals are used to identify corresponding elements.

Main Embodiment

[0032] Figure 2 illustrates a top plan view of figure 1 in an example of a touch-sensitive apparatus 100 that is based on the concept of FTIR. Emitters 30a are distributed around the periphery of touch surface 20, to project light into the transmissive panel 10 such that at least part of the light is captured inside the transmissive panel 10 for propagation by internal reflection in the propagation channel. 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 inside the transmissive panel 10 to a number of different detectors 30b on a plurality of light paths D.

[0033] Even if the light paths D correspond to light that propagates by internal reflections inside the panel 1, the light paths D 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 2. Thus, the detection lines D correspond to a projection of the light paths D onto the touch surface 20. Thereby, the emitters 30a and detectors 30b collectively define a grid of detection lines D ("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.

[0034] 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 fiber. 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.

[0035] 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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b on the individual detection lines D. Whenever an object touches a detection line D, the received energy on this detection line is decreased or "attenuated".

[0036] 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 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 determination are found in WO2009/077962, WO201 1/04951 1, WO201 1/139213, WO201 2/050510, and WO201 3/062471 , all of which are incorporated herein by reference.

- [0037] 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.
- [0038] Figure 3 illustrates an embodiment of the invention extending the FTIR system of figure 1 to include touch detection lines above touch surface 20.
- [0039] As with figure 1, figure 3 shows an embodiment of the invention in which light travels inside a transmissive panel 10, from light emitters 30a to 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 beam 50 propagates by internal reflections. In figure 3, the propagation channel is defined between the touch surface 20 and bottom surface 25 of the transmissive panel 10, where the touch surface 20 allows the propagating light beam 50 to interact with touching object 60 and thereby defines the touch surface 20. This is achieved by injecting the light into the transmissive panel 10 via coupling element 40 such that the light is reflected by total internal reflection (TIR) in the touch surface 20 as it propagates through the transmissive panel 10. The light beam 50 may be reflected by TIR on the bottom surface 25 or against a reflective coating thereon. Upon reaching coupling element 40 on a far side of the panel, the light is coupled out of transmissive panel 10 and onto detectors 30b. The touch-sensitive apparatus 100 may be designed to be overlaid on or integrated into a display device or monitor.
- [0040] Figure 3 further illustrates that a portion of the 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 the light exits transmissive panel 10 through touch surface 20 and is reflected by reflector surface 80 of edge reflector 70 to travel along path 90a 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. The feature of

the transmitting the light from the emitters 30a to reflector surface 80 via transmissive panel 10 has a number of advantages over the solutions presented by the prior art. In particular, manufacture of touch-sensitive apparatus 100 becomes significantly less expensive. This feature allows an arrangement where nothing is in contact with the edges of the transmissive panel 10, allowing expensive finishing (where the transmissive panel 10 is formed from glass) to regulate the edges of the glass to be avoided. Furthermore, fastening of the components to the transmissive panel 10 is simplified and optical tolerances are improved.

[0041] Figure 4 shows a top plan view of the embodiment of figure 3. As viewed from above, light beam 50 travelling through transmissive panel 10 originates from where the light is coupled into the transmissive panel 10 by coupling element 40 at in-coupling point 45. Light beam 90 travelling above touch surface 20 (along path 90a, path 90b) originates from reflector surface focal point 80a of reflector surface 80 where the light emitted from emitters 30a and having passed through transmissive panel 10 is reflected across touch surface 20. The distance travelled by the (un-collimated) light from emitters 30a to reflector surface focal point 80a is greater than the distance travelled by the light from emitters 30a to in-coupling point 45. Consequently, the spread of light reflected from the reflector surface focal point 80a is broader than the spread of light entering the transmissive panel 10 at in-coupling point 45. The resulting effect is equivalent to that of using a wider emitter for emitting the above surface light beam 90 than that of light beam 50, travelling inside the glass. A corresponding effect occurs at the detector end, wherein the light arriving at detectors 30b via the above surface route is reflected onto detectors 30b from a broader area than the area of in-coupling point 45, providing the equivalent effect of broader detectors 30b.

[0042] The result is that detection lines derived from light beam 90 are broader than detection lines derived from light beam 50. Figure 5 and figure 6 show the difference in detection lines 95 derived from the light travelling within the glass and detection lines 96 derived from light travelling above the touch surface. In figure 5, detection lines 95 have a width corresponding to the short distance travelled to the in-coupling point 45 from emitters 30a. In figure 6, detection lines 96 have a width corresponding to the extra distance travelled to reflector surface focal point 80a from emitters 30a.

[0043] A stylus and a finger may have very large differences in size (or width as viewed from the perspective of a detection line). A stylus may typically provide a width of 2mm to 5mm, whereas a finger may provide a width of 5mm to 15mm. However, the size of a decoded touch will depend on the convolution of the detection line and the object. It is preferable to have wider detection lines above the glass, both in order to provide better cover the touch surface 20 and to get a broadened stylus interaction since this may

increase the resolution. However, broadening of detection lines will reduce the ability to separate two closely spaced touch objects, potentially a key requirement for multi-touch systems.

[0044] Therefore, a solution with different detection line widths above and within the glass is required. Figure 7 shows a signal profile of a narrow detection line overlaid on a wide detection line. Narrow detection lines 95 have a signal profile corresponding to signal profile 150 and wide detection lines 96 have a signal profile corresponding to signal profile 160.

[0045] Since a stylus will usually be used as a single touch object, broader detection lines are possible. Wide detection lines 96 with a width larger than 4 mm and possibly up to 20 mm are advantageous, although 4mm-6mm is preferred.

[0046] For narrow detection lines 95 designed to resolved multiple touching objects such as fingers, broadening must be kept down to a size less than or comparable to the touching objects. The width of narrow detection lines 95 is also usually limited by the width of emitters 30a and detectors 30b. Narrow detection lines 95 should be less than 5mm in width. In a preferred embodiment, detection lines 95 are between 2mm and 3mm wide.

[0047] In one embodiment, reflector surface 80 is a diffusive reflecting surface. In a preferred embodiment, reflector surface 80 is a lambertian diffusive reflecting surface preferably providing a scattering of greater than 90%. Suitable materials for reflector surface 80 may include Titanium oxide paint or Microcellular foamed reflector MCPET. The advantage of using a diffusive reflecting surface is that it makes the optical system less sensitive to production, mounting and load tolerances than a specular reflector or lens. This allows the touch-sensitive apparatus 100 to be cheaper and simpler to produce. Furthermore, a diffusive reflector surface 80 also allows broader and overlapping detection lines.

[0048] The amount of light reflected by reflector surface 80 may be controlled by adjusting the size of reflector surface 80. A reflector surface 80 having a smaller surface area will reflect a small amount of light. Alternatively, paint or spray coatings may be selected to reduce the reflection, and may be applied in a specific pattern to the surface for accurate control of reflectivity.

[0049] In one embodiment, the amount of light received at each of detectors 30b via the in-glass route (shown in the figures as light beam 50) is greater than or equal to the amount of light received at each of detectors 30b via the above surface route (shown in the figures as light beam 90). In a preferred embodiment, the ratio of light received at each of detectors 30b via the in-glass route is ten times greater than the amount of light received at each of detectors 30b via the above surface route. This feature is advantageous as it allows the attenuation of the optical signal resulting from FTIR to be easily compared at the reconstruction phase to the attenuation of the optical

signal resulting from occlusion of the above surface light, even though the latter is usually significantly larger than the former.

[0050] In the embodiment shown in figure 3, reflector surface 80 is configured to reflect a portion of light beam 90 to travel along path 90a and a portion of light beam 90 to travel along path 90b, by reflecting off touch surface 20 and coupling out to the detector. This advantageously results in a larger portion of light beam 90 being detected by detectors 30b. Furthermore, the use of path 90b allows load tolerances of the touch-sensitive apparatus 100 to be improved. A heavy load on touch surface 20 may deform the panel and bring path 90a out of alignment. However, path 90b would likely be less affected by said deformation, allowing sufficient signal to continue to be received by detectors 30b.

[0051] In an embodiment of the invention shown in figure 8, transmissive panel 10 is curved to form a concave surface. In this embodiment, reflector surface 80 is configured to cause a portion of light beam 90 to reflect a plurality of times off touch surface 20 to follow a path 90c shown in figure 8. Similarly to the above embodiment, this feature allows a further enhancement of the signal to noise ratio, even for a curved panel.

[0052] In an embodiment of the invention shown in figure 9, edge reflector 70 is set further back from the periphery of touch surface 20 than in the previous embodiments. The positioning of the edge reflector 70 further back from the periphery of touch surface 20 provides a longer distance from emitters 30a to reflector surface 80, allowing the above surface detection lines to be broader. Furthermore, the extra distance that the edge reflector 70 is set back provides larger overlap between wide detection lines 96 in the peripheral regions of touch surface 20 resulting in improved accuracy in areas. This is especially advantageous where narrow detection lines 95 provide limited coverage. In a preferred embodiment, the edge reflector 70 is positioned so that reflector surface 80 is set 10 mm back from in-coupling point 45.

[0053] Figure 10 shows an embodiment of the invention featuring dust shield 110. A known problem with above-surface touch systems is the accumulation of dust and contamination around the sensor area or the area in which the light signal is emitted to travel across the touch panel. Dust or other contamination accumulating at this point will block the light signal and seriously degrade the ability of the touch system to determine a touch. For a system such as the embodiment presented in figure 3, the accumulation of contamination may be increased where reflector surface 80 is angled to form an overhang. This overhang forms a natural shelter for accumulating contamination, resulting in further touch signal degradation. A solution presented in figure 10 is that of a dust shield 110 forming a physical barrier preventing the dust from reaching reflector surface 80 and comprising transparent window 115 through which the light signal may pass.

unhindered. Preferably, dust shield 110 forms a sloping edge, sloping from the inside edge in contact with touch surface 20 outwardly to the top surface of edge reflector 70. This allows dust shield 110 to be effectively wiped clean.

[0054] In a preferred embodiment, transparent window 115 comprises a material of coating configured to allow only IR or Near-IR light to pass through. This feature provides improved ambient light noise reduction as light from artificial lighting or sun light is filtered before reaching detectors 30b.

[0055] In a preferred embodiment, dust shield 110 is configured with a longer dimension extending from edge reflector 70 towards touch surface 20 and with an internal top surface providing a light baffle effect so as to provide an angular filter for light entering through transparent window 115. This is advantageous for reducing ambient noise as light entering at the wrong angle is absorbed into the roof of the dust shield 110. Furthermore, when combined with the embodiment from figure 8, the angle of light paths travelling above the panel may be limited so that that detection lines very high above the glass 90a may be suppressed.

[0056] Figure 11 shows an alternative embodiment to the embodiment shown in figure 3. In figure 11, apparatus 100 is configured to transmit light from a first set of emitters 31a to a first set of detectors 31b inside a transmissive panel 10 so as to illuminate a touch surface 20 from within the transmissive panel 10. Apparatus 100 is also configured to transmit light from a second set of emitters 32a to a second set of detectors 32b such that the light is emitted by emitters 32a, exits transmissive panel 10 through touch surface 20 and is reflected by reflector surface 80 of edge reflector 70 to travel along path 90a 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 32b. Significant advantages may be obtained from using two separate emitting and detecting systems rather than a single set of emitters and detectors for both the above-surface and FTIR light paths. A significant problem with trying to differentiate between the attenuation of the light travelling along a path above the touch surface from the attenuation of light travelling along a path within the panel via FTIR is that a typical finger touch is likely to produce an attenuation of the light above the panel is greater than the attenuation of the light travelling within the panel via FTIR by as much as a factor of 50. This results in an attenuation signal of the light travelling in the panel which is difficult to differentiate from noise relative to the attenuation signal of the light travelling above the panel. For objects such as stylus tips, this relative difference in signal strength can be even greater. Therefore, the use of separate emitting and detecting systems for light paths above (above-surface system) and within the panel via FTIR (FTIR system) allows

each system to be configured appropriately for the respective signal-to-noise ratios. The separate resulting signals can then be combined to provide a system that provides the following features:

- [0057] - Oil or water contamination on the touch surface may appear to the FTIR system as an attenuation surface area and generate a false touch. However, in the above embodiment, the touch output of the FTIR system may be compared to the touch output of the above-surface system to identify touches of the FTIR system which do not appear in the touch output of the above-surface system. This would indicate that the identified touches do not correspond to actual objects above the touch surface but mere contamination on the surface. The output of the identified touches can then be suppressed.
- [0058] - Similarly to the above, when a user raises their finger from the touch surface, a previously identified touch should be removed from the touch output. However, on occasion, finger grease from the skin is left on the touch surface and an FTIR system continues to detect and report a touch. In the above embodiment, the output of the above-surface system may be used to identify touches of the FTIR system where the touching object has now been removed. The output of the identified touches can then be suppressed.
- [0059] - Certain object types produce very little attenuation of the FTIR light when in contact with the touch surface e.g. Hard objects such as stylus tips. Where the above-surface system registers an object but the FTIR system does not, it can be determined that the object is likely to be a 'hard object' as opposed to a normal touch from a finger. Differentiation between hard and soft surfaced objects may allow differentiation between e.g. a pen and a finger. A touch system configured to differentiate between a stylus and a fingertip may generate a different UI output in dependence on the identified object touching the touch surface.
- [0060] - One problem with above-surface systems is that the object touching the touch surface may completely occlude one or more light paths of the above-surface system. Where a large number of touches are simultaneously applied to the touch surface, portions of the touch surface may become significantly shielded from the light paths of the above-surface system, resulting in little or no touch signal in the shielded portion. In the above embodiment, the FTIR may continue to provide a touch signal within the occluded areas, as the attenuation of the FTIR light paths resulting from a touch is relatively small and non-occluding.
- [0061] In the embodiment of figure 11, a first wavelength of light emitted by first set of emitters 31a and detected by first set of detectors 31b may be different to a second wavelength of light emitted by second set of emitters 32a and detected by second set of detectors 32b. This allows light to be emitted from one of the first set of emitters 31a and one of the second set of emitters 32a

simultaneously and detected by the first set of detectors 31b and second set of detectors 32b without co-interference. This may also allow improved ambient light noise reduction in environments where ambient light comprises more light with a first wavelength than light with a second wavelength or vice versa. E.g. Wherein the first and second wavelengths are both near IR wavelengths.

[0062] In the embodiment of figure 11, the timing sequence used to activate emitters of the first and second set of emitters may be chosen to ensure that activation of the emitters of the first set of emitters does not chronologically overlap with activation of emitters of the second set of emitters. This allows potential co-interference to be minimized.

[0063] Figure 12 shows a top plan view of the Figure 11. In this embodiment, emitters 31a are spatially interlaced with emitters 32a around the peripheral edge of transmissive panel 10 so that emitters of first set 31a are positioned between adjacent emitters of second set 32a. Similarly, detectors 31b are spatially interlaced with detectors 32b around the peripheral edge of transmissive panel 10 so that detectors of first set 31b are positioned between adjacent emitters of second set 32b. This has the advantage of improving coverage of the touch surface where detection paths of the above-surface system cover gaps between detection paths of the FTIR system and vice versa.

[0064] In one embodiment, emitters 31a and detectors 31b are only positioned along sub-portions of the periphery of the touch surface. In this embodiment, the portion of the periphery of the touch surface along which emitters 31a and detectors 31b are positioned is smaller than the portion of the periphery of the touch surface along which emitters 31a and detectors 31b are positioned. In one example, emitters 31a and detectors 31b are only located along two opposing edges of a rectangular touch surface. In an alternative embodiment, emitters 31a are placed along one edge of the rectangular touch surface and detectors 31b are positioned along an opposing edge of the touch surface. Alternatively, emitters 31a and detectors 31b may be positioned along L-shaped portions of the periphery of the rectangular touch surface at the corners. In one embodiment, the number of emitters 31a and detectors 31b are fewer than the number of emitters 32a and detectors 32b respectively. This may result in an FTIR system with a lower resolution than the above-surface system. Alternatively, for all of the above arrangements, emitters 31a and detectors 31b may be swapped for emitters 32a and detectors 32b so that the FTIR system has a higher resolution and/or coverage than the above-surface system. These arrangements allow the advantages of a complete above-surface system or FTIR system to be supplemented with the advantages of a limited FTIR system or limited above-surface system respectively without the need for a complete version of both systems. This would allow a significant reduction

in manufacturing cost, power usage, and even physical size of the touch frame. E.g. Where high accuracy pressure detection needed to be added to an above-surface system, a limited FTIR type system configured to detect pressure (as is known in the art) may be added to the above-surface system with only as many emitters and detectors needed to accurately detect pressure. In one example, the limited system comprises only 25% of the number of emitters and detectors of the complete system.

[0065] In one embodiment, a low-power mode is provided wherein only the above-surface system is powered. When a touch is detected by the above-surface system, a full-power mode is activated and power is provided to the FTIR system. This has the advantage of preserving energy during periods that the above-surface system detects no touches whilst enabling the features of the FTIR system once it is required. Alternatively, an embodiment is provided wherein only the FTIR system is powered in a low-power mode and the above-surface system is only powered on when required. This may include a system wherein the above-surface system is only activated periodically or in response to a determination that a touch detected by the FTIR system is possibly a false touch caused by contamination.

[0066] Figure 13 shows a variation of figure 11 wherein emitters 31a are configured to simultaneously project light above and into transmissive panel 10 but wherein separate detectors 31b and 32b are used to provide separate above-surface and FTIR type touch signals. This advantageously allows simultaneous emission of both signals using a single emitter, allowing low energy consumption and cheaper manufacturing costs, whilst the above features.

[0067] Figure 14 shows an alternative to figure 13 wherein the detectors 31b are configured to simultaneously receive light from above and from within transmissive panel 10 but wherein separate emitters 31a and 32a are used to provide separate above-surface and FTIR type touch signals. This configuration advantageously allows separate control of the light intensity of the light emitted from emitters 31a and 32a to account for environmental light noise or other situations in which light levels need to be separately altered, whilst also allowing low energy consumption and cheaper manufacturing costs.

[0068] For all of the above embodiments, alternative in-coupling and out-coupling solutions used for coupling the light into and out of transmissive panel 10 may be employed according to techniques known in the prior art. E.g. Coupling the light into the edge of the panel rather than from below.

[0069] Furthermore, alternative waveguide, lens, and reflective surface configurations to convey light from emitters 32a to a plane parallel with touch surface 20 and back to detectors 32b may be employed according to

techniques known in the prior art. E.g. Configurations for conveying the light around the edge of the panel rather than through it.

Reference signs list

- A. touch-sensitive apparatus 100
- B. transmissive panel 10
- C. touch surface 20
- D. bottom surface 25
- E. emitters 30a
- F. detectors 30b
- G. coupling element 40
- H. in-coupling point 45
- I. light beam 50
- J. touching object 60
- K. edge reflector 70
- L. reflector surface 80
- M. reflector surface focal point 80a
- N. light beam 90
- O. path 90a
- P. path 90b
- Q. path 90c
- R. detection lines 95
- S. detection lines 96
- T. dust shield 110
- U. transparent window 115
- V. light paths D
- W. controller 120
- X. signal processor 130
- Y. processing unit 140
- Z. signal profile 150
- AA. signal profile 160

CLAIMS

1. A touch sensing apparatus, comprising:
 - a light transmissive element that defines a touch surface;
 - a first set of emitters arranged around a first portion of the periphery of the touch surface to emit first beams of light into the light transmissive element, wherein the first beams of light propagate inside the light transmissive element while illuminating the touch surface,
 - a second set of emitters arranged around a second portion of the periphery of the touch surface to emit second beams of light, wherein the second beams of light are reflected to travel above the touch surface,
 - a first set of light detectors arranged around a third portion of the periphery of the touch surface to receive light from the first set of emitters from the transmissive element
 - a second set of light detectors arranged around a fourth portion of the periphery of the touch surface to receive light from the second set of emitters from above the touch surface,
 - 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 first and second set of light detectors, the position of an object on the touch surface.
2. The touch sensing apparatus of claim 1, wherein the first and second set of emitters comprise at least one common emitter.
3. The touch sensing apparatus of claim 1, wherein the first and second set of detectors comprise at least one common detector.
4. The touch sensing system of any preceding claim wherein the processing element is configured to perform a first touch determination based on signals of the first set of light detectors and a second touch determination based on signals of the second set of light detectors, and wherein the the position of an object on the touch surface is determined in dependence on the first touch determination and second touch determination.
5. The touch sensing system of claim 4, wherein the processing element is configured to determine that the object is not touching the touch surface when the first touch determination indicates the presence of the object but the second touch determination indicates the absence of the object.
6. The touch sensing system of claim 4, wherein the processing element is configured to determine that the object is of a first object type when the first touch

determination indicates the absence of the object but the second touch determination indicates the presence of the object.

7. The touch sensing system of claim 4, wherein the processing element is configured to determine the position of an object on the touch surface in dependence on just the first touch determination when the object is occluded from the second beams of light.

8. The touch sensing system of any preceding claim wherein the first set of emitters is configured to emit light at a first wavelength and the first set of emitters is configured to detect light at the first wavelength, and wherein the second set of emitters is configured to emit light at a second wavelength and the second set of emitters is configured to detect light at the second wavelength.

9. The touch sensing system of any preceding claim wherein the touch sensing system is configured to activate the first set of emitters and the second set of emitters at non-overlapping times.

10. The touch sensing apparatus of any preceding claim, wherein the touch sensing system is configured to operate in a low-power mode wherein just the second set of emitters are powered, and wherein when the processing element determines the presence of an object on the touch surface from the second set of light detectors, entering a higher-power mode wherein the first and second set of emitters are powered.

11. The touch sensing apparatus of claims 1-9, wherein the touch sensing system is configured to operate in a low-power mode wherein just the first set of emitters are powered, and wherein when the processing element determines the presence of an object on the touch surface from the first set of light detectors, entering a higher-power mode wherein the first set of emitters are powered and the second set of emitters are at least intermittently powered.

12. The touch sensing apparatus of any preceding claim, wherein the first and/or third portion is larger than the second and/or fourth portion.

13. The touch sensing apparatus of any preceding claim, wherein the number of the first set of emitters and/or first set of detectors is larger than the number of the second set of emitters and/or second set of detectors.

14. The touch sensing apparatus of claim 11, wherein the ratio of the first set of emitters and/or first set of detectors to the number of the second set of emitters and/or second set of detectors is 4:1 .

15. The touch sensing apparatus of any preceding claim, wherein the first and second set of emitters are spatially interleaved along the periphery of the touch surface.

DRAWINGS

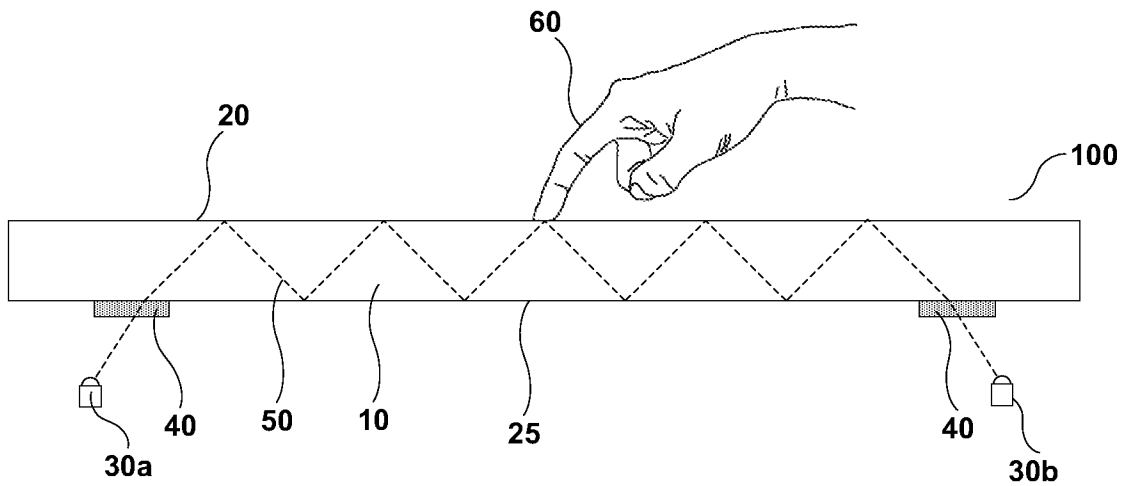


Figure 1

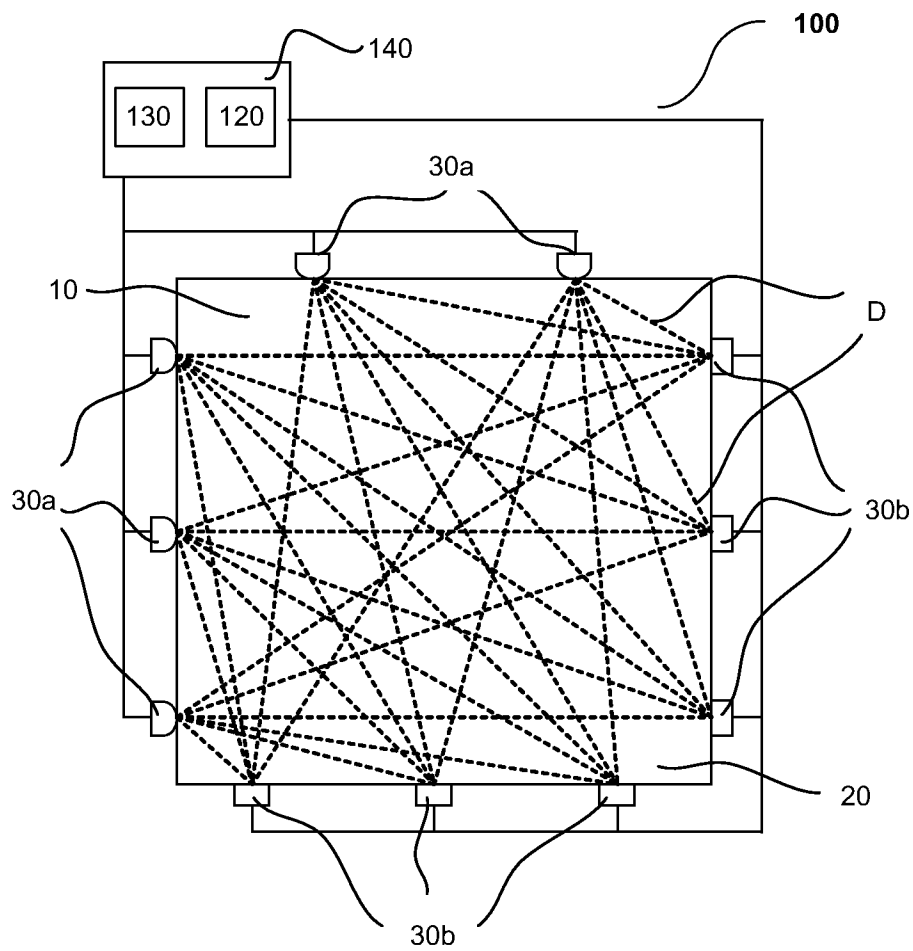


Figure 2

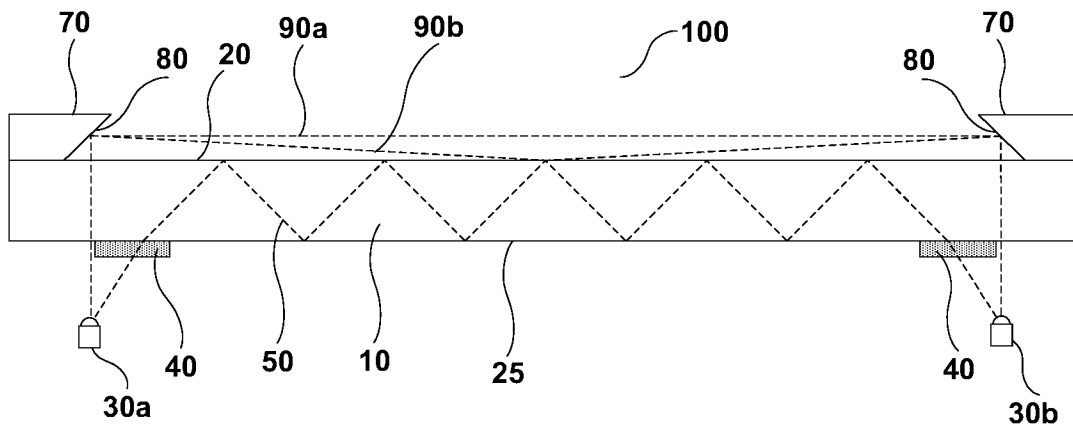


Figure 3

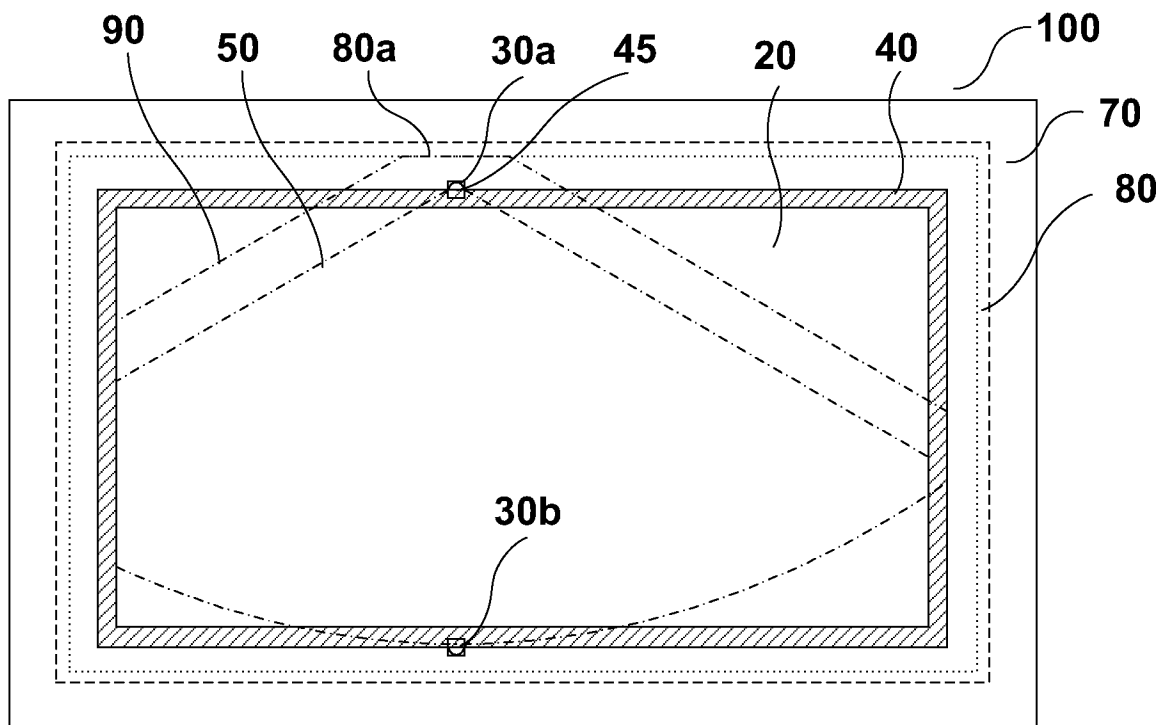


Figure 4

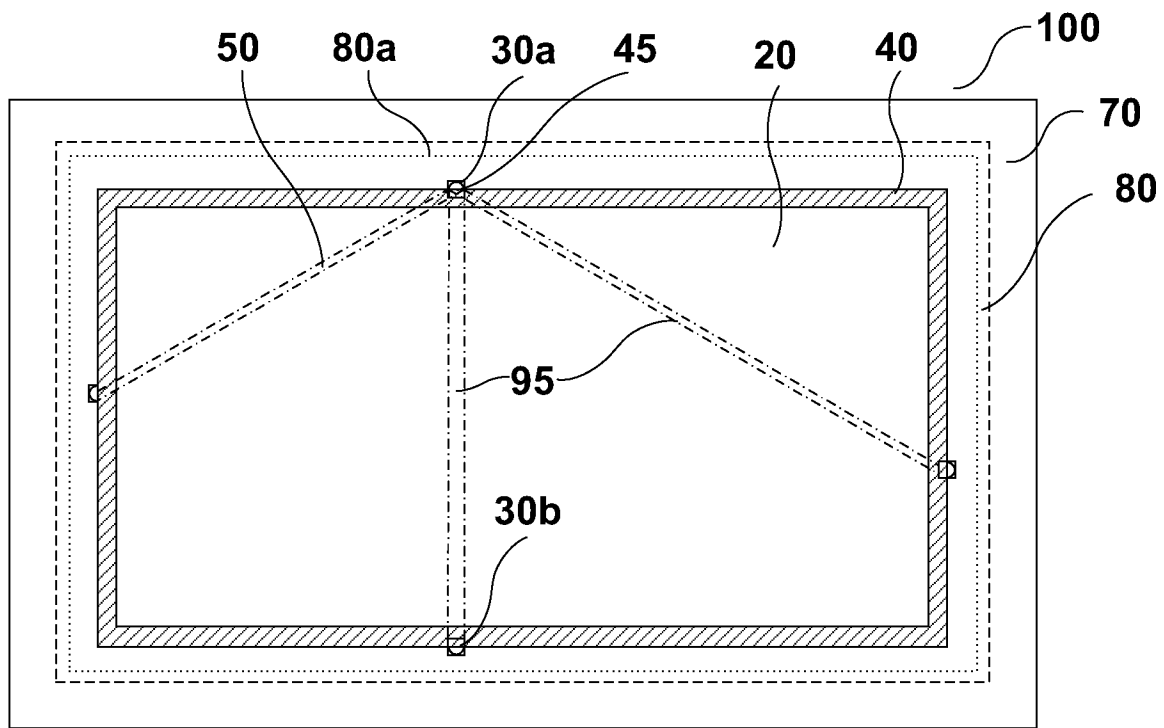


Figure 5

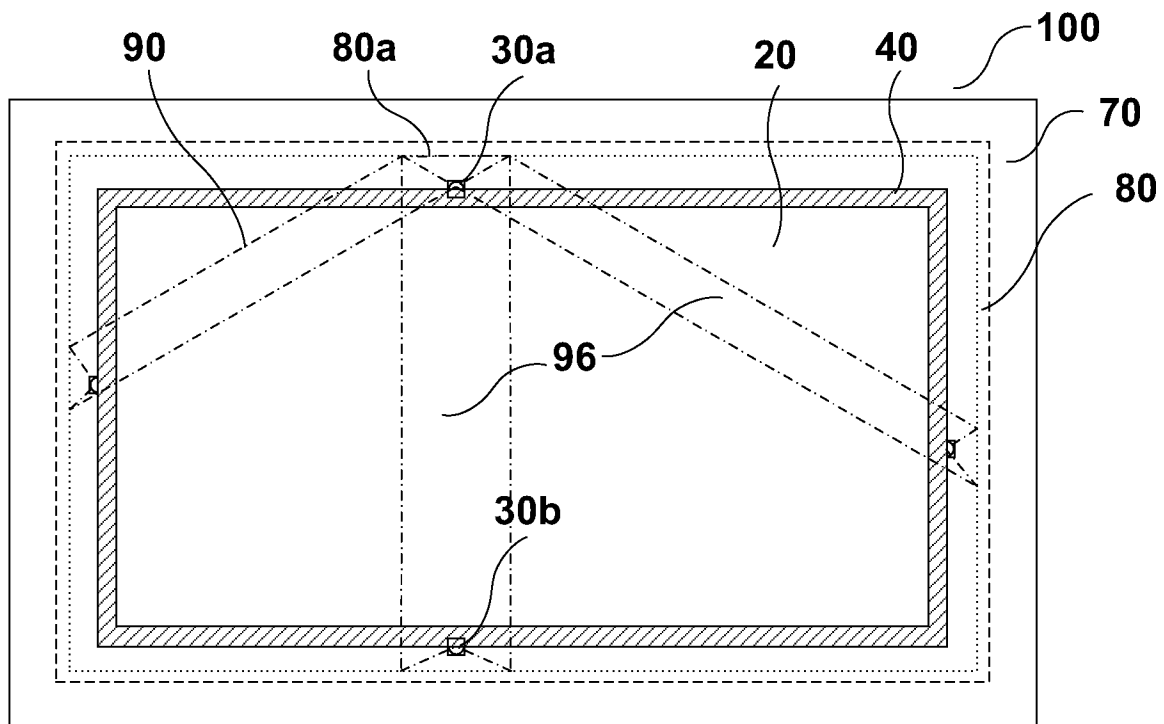


Figure 6

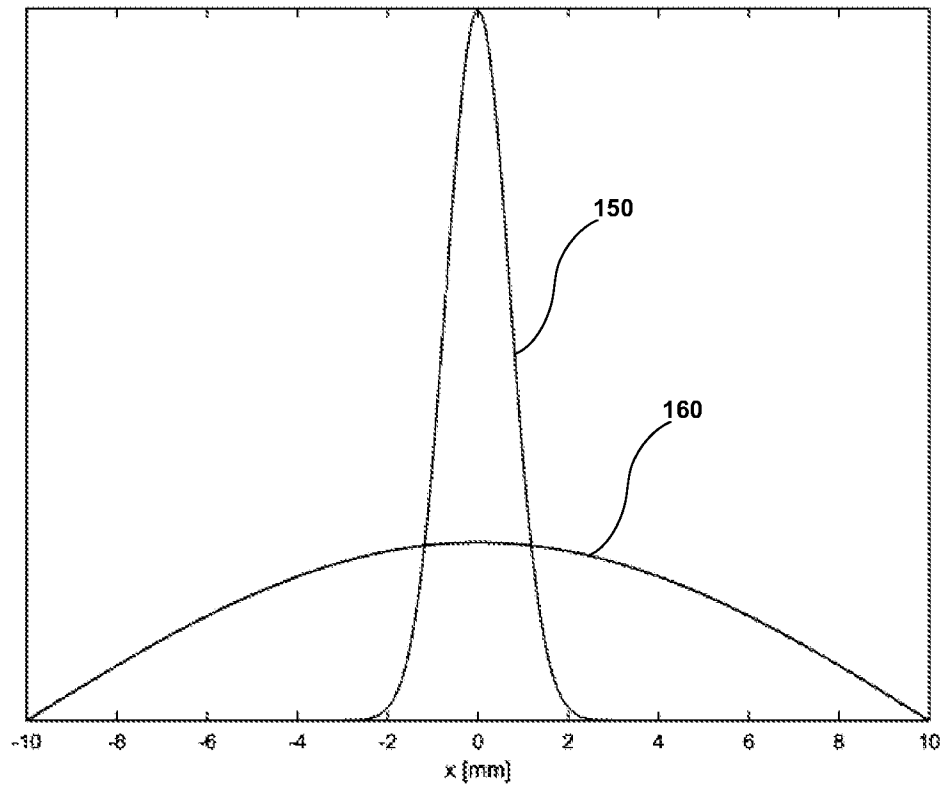


Figure 7

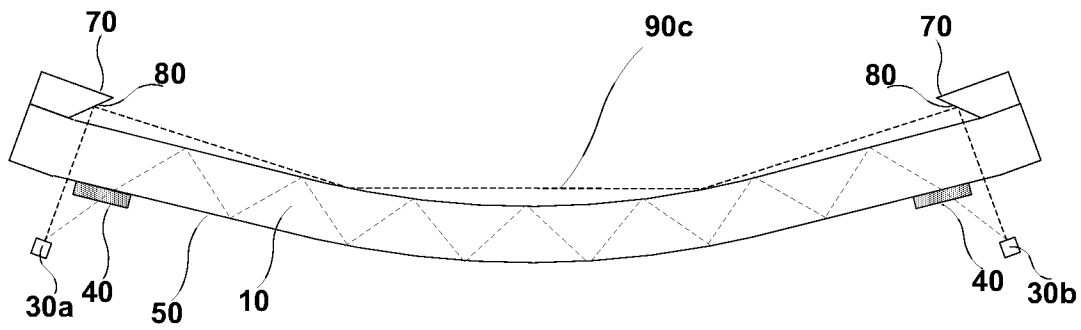


Figure 8

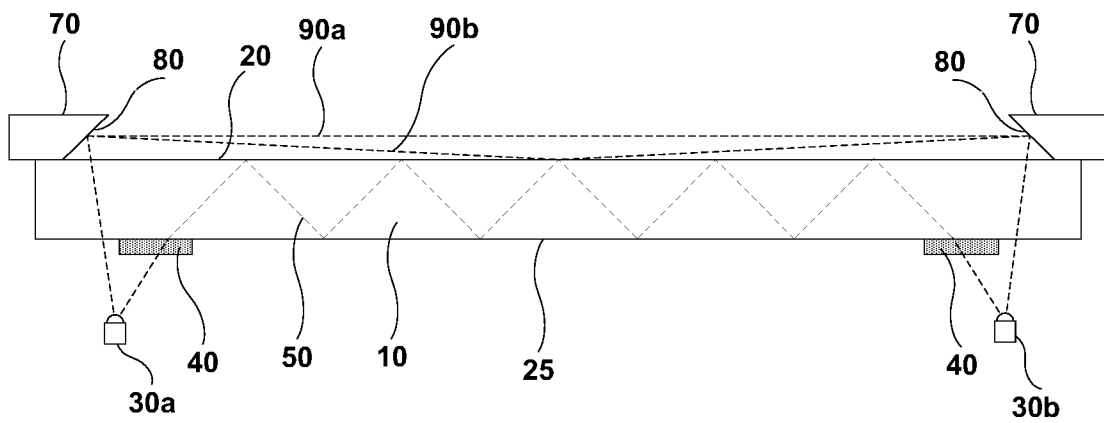


Figure 9

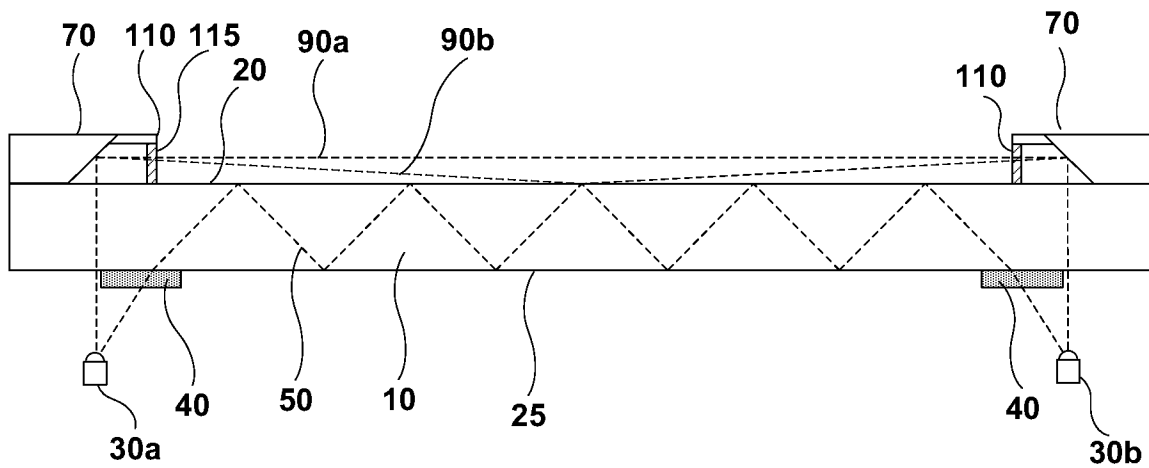


Figure 10

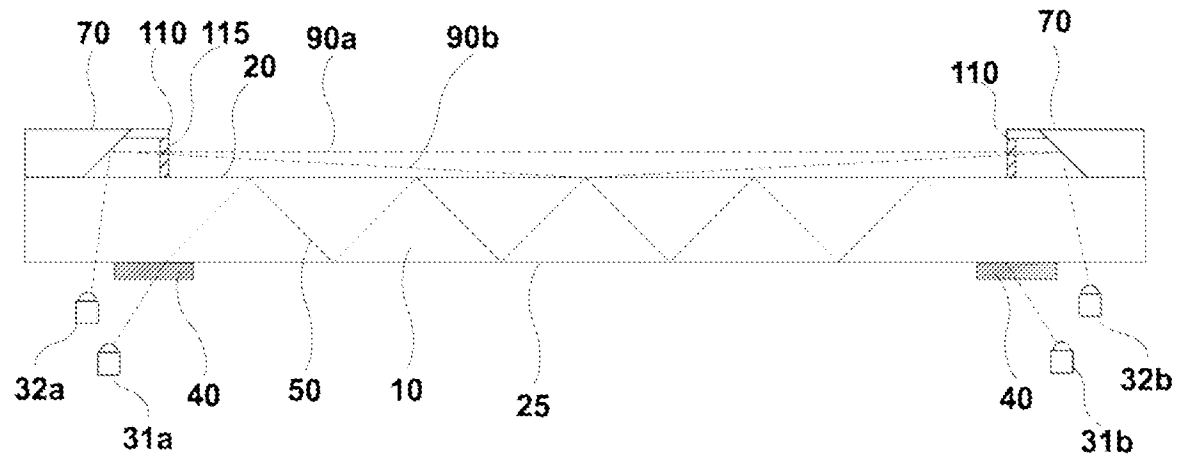
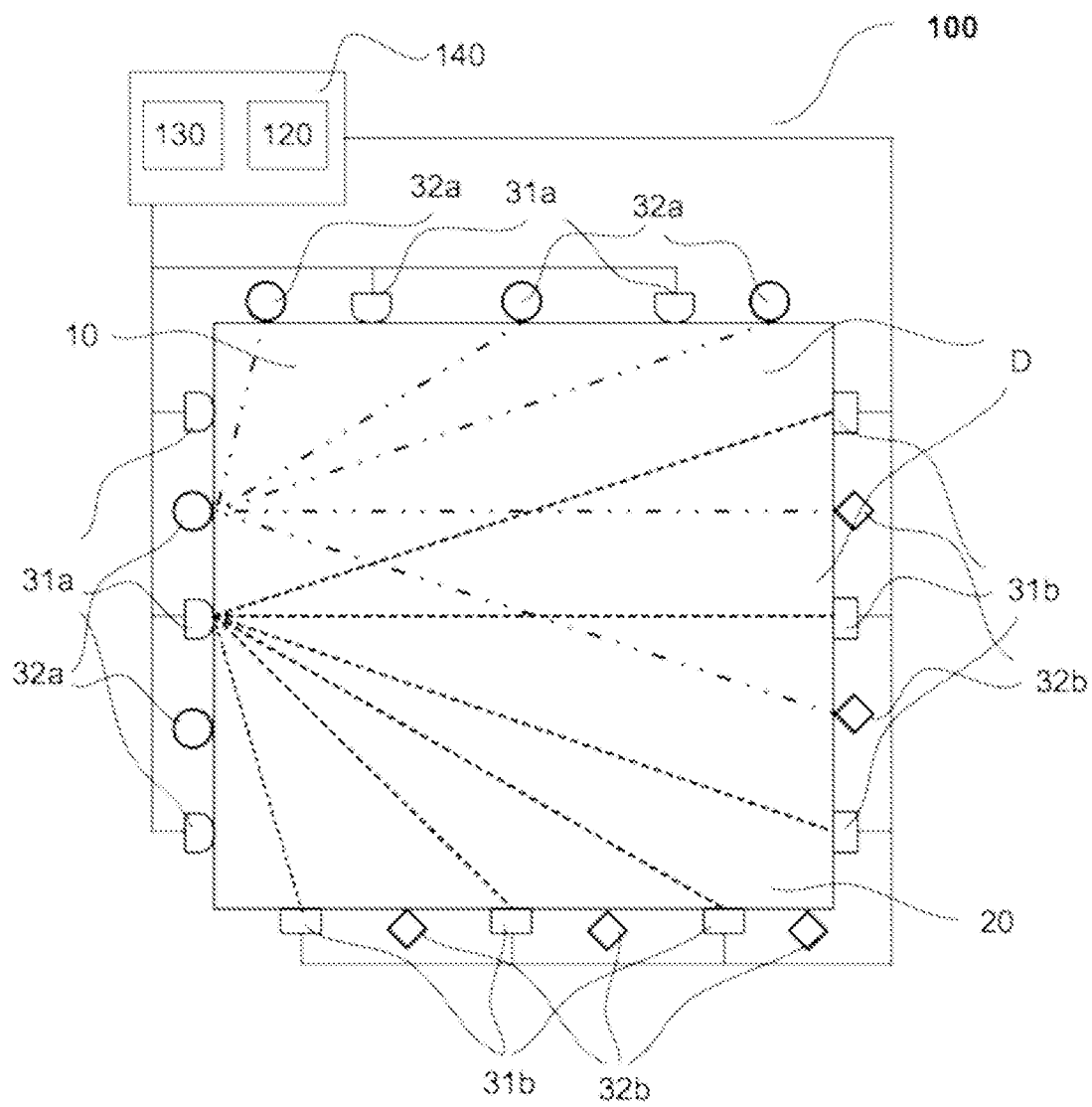


Figure 11

**Figure 12**

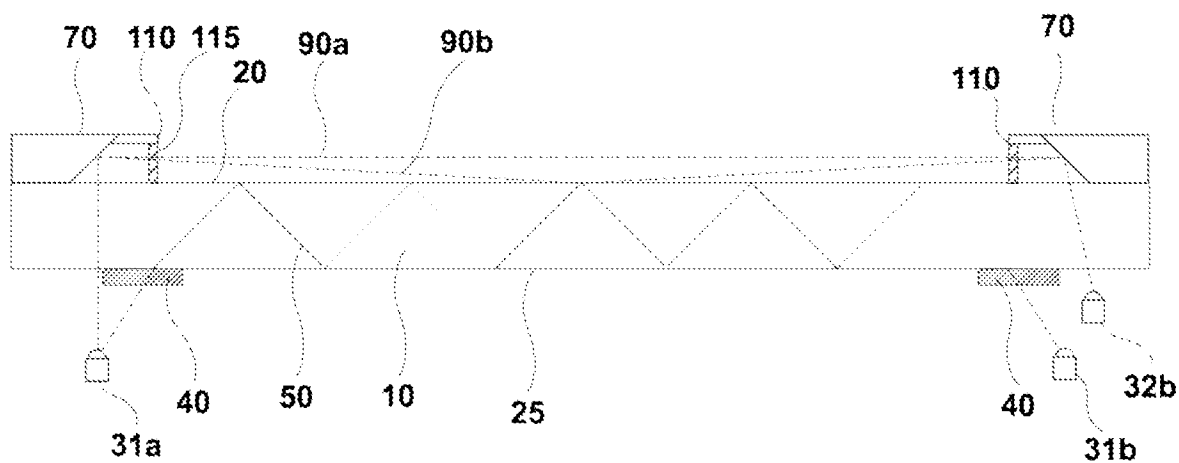


Figure 13

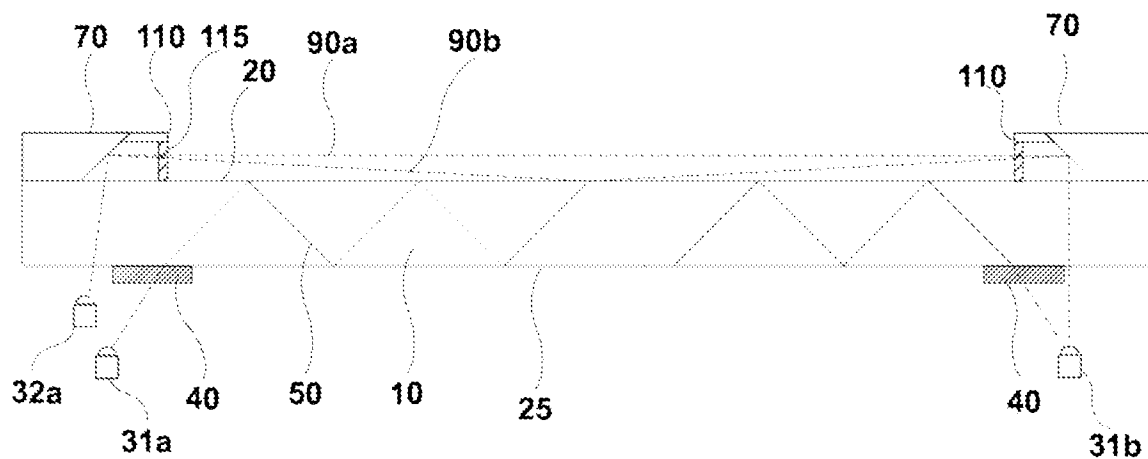


Figure 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 6/050098

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, 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 201 301 55027 A 1 (HOLMGREN STEFAN ET AL), 20 June 2013 (201 3-06-20); paragraphs [021 2], [0246], [031 1], [0374], [0388], [041 5]-[041 9]; figures 18,31 ,126 --	1-15
A	US 201 401 92023 A 1 (HOFFMAN DAVID), 10 July 201 4 (201 4-07-1 0); paragraphs [0008]-[001 1], [0026]-[0028], [0045]-[0048], [0050], [0057], [0070], [0072]; figure 1 --	1-15
A	US 201 10221 705 A 1 (YI KWON JU ET AL), 15 January 201 4 (2014-01 -15); paragraphs [0008]-[0009], [001 2], [001 8]-[001 9], [0037]-[0038], [0047], [0049], [0063]-[0069], [0078]-[0089]; figures 1,7-1 0 --	1-15



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

28-06-201 6

Date of mailing of the international search report

29-06-201 6

Name and mailing address of the ISA/SE

Patent- och registreringsverket

Box 5055

S-102 42 STOCKHOLM

Authorized officer

Alexander Lakic

Chemtronics v. FlatFrog

Chemtronics Exhibit 1013 Page 199

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 6/050098

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 201 10 122075 A 1 (SEO YOUNG-KWANG ET AL), 26 May 201 1 (201 1-05-26); paragraphs [0065], [0069]; figures 3,5 --	1-15
A	YOUNGSEOK AHN et al. "A slim and wide multi-touch tabletop interface and its applications", 2014 International Conference on Big Data and Smart Computing (BIGCOMP), 2014-01 -15, IEEE, p. 276-281 , ISSN: 2375-933X; whole document -- -----	1-15

Continuation of: second sheet

International Patent Classification (IPC)

G06F 3/042 (2006.01)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE201 6/050098

US	201301 55027 A 1	20/06/201 3	US	20140071 094 A 1	13/03/2014
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			EP	2365423 A2	14/09/201 1
			KR	201 10103140 A	20/09/201 1
u s	201 10 122075 A 1	26/05/201 1	EP	2325735 A2	25/05/201 1
			KR	201 10056892 A	31/05/201 1

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Application Number:	16706438
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Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Jenny Kim
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
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Filing Date:	06-DEC-2019
Time Stamp:	17:58:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		FFOG053C4_IDS.pdf	46051	yes	2
			d5a38400a726787bafa683c9f5c3026fc04e50ab		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Transmittal Letter	1	1
	Information Disclosure Statement (IDS) Form (SB08)	2	2

Warnings:

Information:

2	Foreign Reference	EP_2325735.pdf	295875	no	16
			da8ffa43ed759f63ae5c37de928200f438139ef4		

Warnings:

Information:

3	Foreign Reference	WO_2016130074.pdf	745074	no	29
			371fb4f6e9c3438939feda510e26496ace7f0404		

Warnings:

Information:

4	Non Patent Literature	SuppESR_EP16873465_06-25-2019.pdf	1584654	no	9
			24e75515b6455e55d281041eeb730632ff17f1ce6		

Warnings:

Information:

Total Files Size (in bytes):			2671654
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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

First Inventor : Aleksander Kocovski

App. No. : 16/706438

Filed : December 6, 2019

For : TOUCH DEVICE

Examiner : Lam, Vinh Tang

Art Unit : 2628

Conf. No. : 3081

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.

Timing of Disclosure

This Information Disclosure Statement is being filed after the mailing date of a final action or after the mailing date of a Notice of Allowance. Please place these references in the file in accordance with 37 CFR 1.97(i).

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: June 15, 2020

By: /Harnik Shukla/ _____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	06/15/2020	EXAMINER	
KNOBBE MARTENS OLSON & BEAR LLP			LAM, VINH TANG	
2040 MAIN STREET			ART UNIT	PAPER NUMBER
FOURTEENTH FLOOR			2628	
IRVINE, CA 92614			NOTIFICATION DATE	DELIVERY MODE
			06/15/2020	ELECTRONIC

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efiling@knobbe.com

jayna.cartee@knobbe.com

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 2	Attorney Docket No.	FFOG.053C4

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number <i>Number - Kind Code (if known)</i> Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	2015/0373864 A1	12-24-2015	Jung	
	2	2013/0321740 A1	12-5-2013	An et al.	
	3	2016/0154533 A1	06-02-2016	Eriksson et al.	
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	8	2013/0234991 A1	09-12-2013	Sparf	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document <i>Country Code-Number-Kind Code</i> Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T ¹
	9	WO 2014/065601	05-01-2014	LG Electronics Inc.		
	10	WO 2018/106176	06-14-2018	FlatFrog Laboratories AB		
	11	EP 3535640 A1	09-11-2019	FlatFrog Laboratories AB		
	12	EP 2765622 A2	08-13-2014	LG Electronics Inc.		
	13	WO 2013/159472	10-31-2013	Shenzhen Timelink Technology Co., LTD.		X

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
	14	Report on the Filing or Determination of an Action Regarding a Patent or Trademark. For U.S. Patent No. 10,282,035, U.S. District of Delaware, dated December 10, 2019, in 1 page.	
	15	Civil Cover Sheet FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., dated December 10, 2019, in 1 page.	
	16	Complaint for Patent Infringement, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019, in 83 pages.	
	17	Executed Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	18	Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 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.	

T¹ - Place a check mark in this area when an English language Translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 2 OF 2	Attorney Docket No.	FFOG.053C4

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
	19	Summons in a Civil Action to Promethean Ltd., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	20	Defendants' Answer to Second Amended Complaint and Defendant Promethean Inc.'s Counterclaims Against FlatFrog Laboratories AB., C.A. No. 19-2246, dated May 22, 2020, in 29 pages.	

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INFORMATION DISCLOSURE STATEMENT

First Inventor	: Aleksander Kocovski
App. No.	: 16/706438
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Examiner	: Lam, Vinh Tang
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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 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 the mailing date of a final action or after the mailing date of a Notice of Allowance. Please place these references in the file in accordance with 37 CFR 1.97(i).

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: May 29, 2020

By: /Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404

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First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	Civil_Cover_Sheet_12-10-2019.pdf	896949 773f4e80c82a3acd50457340569800fb342d485b	no	1

Warnings:

Information:					
2	Non Patent Literature	Complaint_Patent_Infringement_12-10-2019.pdf	8421510	no	83
			a0c527c04d82abffb1ba621897ceb3798db89309		
Warnings:					
Information:					
3	Non Patent Literature	Defendant_Answer_to_Second_Amended_Complaint.pdf	243662	no	29
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Warnings:					
Information:					
5	Foreign Reference	EP_3535640A1_eq_WO2018_106176.pdf	4694401	no	97
			4157792d205fd2563da4135d45bf2db141dfbc5e4		
Warnings:					
Information:					
6	Non Patent Literature	Executed_Summons_Civil_Action_12-10-2019.pdf	196209	no	2
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Information:					
7	Non Patent Literature	Rpt_on_Filing_Pat_10282035_12-10-2019.pdf	449958	no	1
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Warnings:					
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8	Non Patent Literature	Summons_Civil_Action_Promethean_Inc_12-10-2019.pdf	455675	no	2
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Warnings:					
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9	Non Patent Literature	Summons_Civil_Action_Promethean_Ltd_12-10-2019.pdf	448784	no	2
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Warnings:					
Information:					
10	Foreign Reference	WO_2013159472.pdf	836659	no	22
			b691b0072236ffdc06d1413e7e7367c80cc9ad8c		
Warnings:					
Information:					
11	Foreign Reference	WO_2014065601A1.pdf	10530514	no	54
			73e7b21a891c3b227398c3dd1ae75e4aca4a7d83		
Warnings:					
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12	Foreign Reference	WO_2018106176.pdf	4662685	no	96
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Information:					
13		053C4.pdf	58370	yes	4
			74486e1b9ba0f44cf328e931d899cdd7297825d0		
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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.



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- **Ryu, Hyunjong**
137-724 Seoul (KR)
- **Sung, Jaehyun**
137-724 Seoul (KR)
- **Park, Sangdon**
137-724 Seoul (KR)

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(71) Applicant: **LG Electronics, Inc.**
Seoul, 150-721 (KR)

(74) Representative: **Beyer, Andreas**
Wuesthoff & Wuesthoff
Patent- und Rechtsanwälte
Schweigerstrasse 2
81541 München (DE)

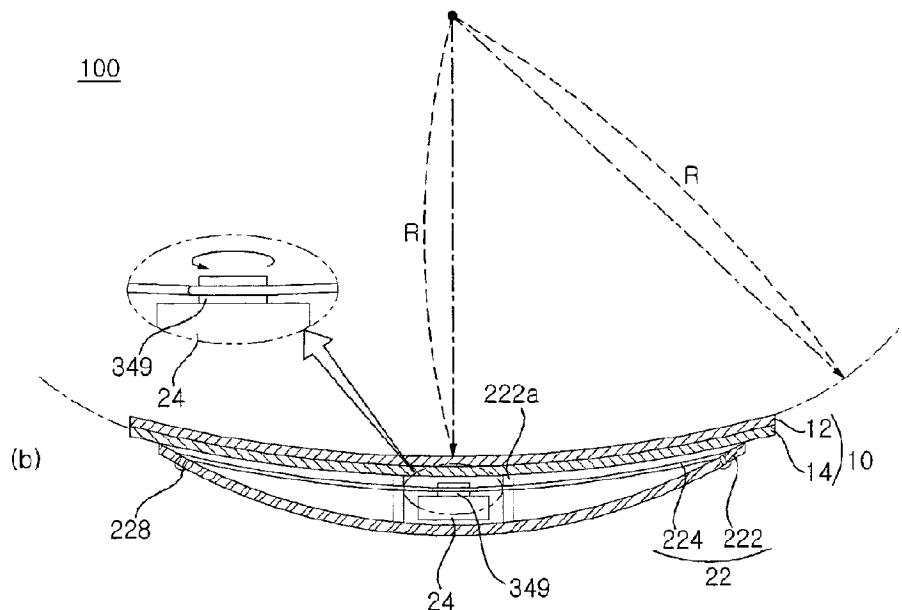
(72) Inventors:
• **Kang, Kitae**
137-724 Seoul (KR)

(54) **Display apparatus**

(57) A display apparatus includes a display module including a flexible display panel for displaying an image, and a variable member for varying a shape of the flexible display panel. The variable member includes a variable section capable of bending in shape. The variable mem-

ber also includes a driver for supplying mechanical energy to bend the shape of the variable section, where the flexible display panel is varied in shape by the bending in shape of the variable section.

FIG. 5



DescriptionCROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of Korean Patent Application No. 10-2013-0014478 filed on February 8, 2013 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field of the disclosure

[0002] The present disclosure relates to a display apparatus, and more particularly to a display apparatus with an improved structure.

2. Description of the Related Art

[0003] Various types of display apparatuses are used to display images. For example, there are various displays such as a liquid crystal display panel, a plasma display panel, and an organic light emitting diode display panel.

[0004] In accordance with recent expansion of application fields of display apparatuses, diverse characteristics of display apparatuses are now required in the application fields. In particular, such requirements have been increased in association with characteristics related not only to simple display of images, but also to display of images taking into consideration three-dimensional effects and sensory immersion. In order to meet such various requirements, research is being conducted to provide various display apparatuses having improved structures.

SUMMARY

[0005] Therefore, one object is to provide a display apparatus having an improved structure capable of achieving an enhancement in sensory immersion of a user.

[0006] In accordance with one aspect, the above and other objects may be accomplished by the provision of a display apparatus including a display module including a flexible display panel for displaying an image, and a variable member for varying a shape of the flexible display panel, wherein the variable member includes at least one variable section capable of varying in shape, and at least one driver for supplying mechanical energy to bend the shape of the variable section, where the flexible display panel is varied in shape by the bending in shape of the variable section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The above and other objects, features and other advantages will be more clearly understood from the fol-

lowing detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a front perspective view of a display apparatus according to an exemplary embodiment of the present invention;

FIG. 2 is an exploded rear perspective view of the display apparatus according to an exemplary embodiment of the present invention;

FIG. 3 is a perspective view illustrating a driver of the display apparatus according to an exemplary embodiment of the present invention;

FIG. 4 is a cross-sectional perspective view of the driver corresponding to FIG. 3;

FIGS. 5(a) and 5(b) are views explaining shape variation of the display apparatus according to an exemplary embodiment of the present invention; and

FIG. 6 is an exploded perspective view of a display apparatus according to another exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] Reference will now be made in detail to preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. These embodiments are not intended to limit the present invention. Other embodiments may also be provided.

[0009] Constituent elements other than elements constituting essential features of the present invention may be omitted from the drawings, for clarity of description. Like reference numerals refer to like elements throughout. In the drawings, the widths, thicknesses, and etc., of constituent elements may be exaggerated or reduced for clarity and convenience of illustration. The present invention is not limited to the illustrated thicknesses, widths, and etc.

[0010] It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. In addition, in the description of the embodiments, it will be understood that when a layer (or film), a region, a pad, a pattern or a structure is referred to as being disposed 'on/above/over' another layer, region, pad, pattern or structure, it can be directly in contact with another layer, region, pad, pattern or structure, or one or more intervening layers, regions, pads, patterns or structures may also be present. In addition, it will also be understood that when a layer (or

film), a region, a pad, a pattern or a structure are referred to as being disposed 'between' two layers, two regions, two pads, two patterns or two structures, it can be the only layer, region, pad, pattern or structure between the two layers, the two regions, the two pads, the two patterns and the two structures or one or more intervening layers, regions, pads, patterns or structures may also be present.

[0011] Hereinafter, a display apparatus according to an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0012] FIG. 1 is a front perspective view of a display apparatus according to an exemplary embodiment of the present invention. FIG. 2 is an exploded rear perspective view of the display apparatus according to an exemplary embodiment of the present invention.

[0013] Referring to FIGS. 1 and 2, the display apparatus of the illustrated embodiment, which is designated by reference numeral "100", includes a display module 10 for displaying an image, and a variable member 20 for varying the shape of the display module 10. The display apparatus 100 also includes a rear cover 30 for covering a rear surface of the display module 10. This will be described in more detail.

[0014] The display module 10 may include a display panel 12 for displaying an image, a support member 14 disposed at a rear surface of the display panel 12, to support the display panel 12, and a panel driver (not shown) fixed to the support member 14, to provide signals for driving of the display panel 12. Although not shown, the display module 10 may further include frames for enclosing edges of the display panel 12 and support member 14.

[0015] In an exemplary embodiment, the display panel 12 may be a panel not only having various structures and types capable of displaying an image, but also having flexibility, to be varied in shape by the variable member 20.

[0016] For example, the display panel 12 may be an organic light emitting display panel using organic light emitting diodes (OLEDs). Such an organic light emitting display panel is a self-luminous display panel in which electrons and holes are combined in a fluorescent or phosphorescent organic thin film when current flows through the organic thin film, thereby generating light. The organic light emitting display panel has various advantages such as excellent picture quality capable of providing bright and crisp images, no restriction as to viewing angle, and low power consumption. In particular, the organic light emitting display panel exhibits excellent flexibility in that it can be manufactured through lamination of organic thin films. Of course, the present invention is not limited to such a display panel. For the display panel 12, various display panels having various structures and types may be employed.

[0017] The support member 14, which is disposed at the rear surface of the display panel 12, supports the

display panel 12. The panel driver and variable member 20 may be fixed to a rear surface of the support member 14. As described above, the panel driver drives the display panel 12. To this end, the support member 14 not only has strength to firmly support the display panel 12, panel driver and variable member 20, but also has flexibility and elasticity to be varied in shape in accordance with variation in the shape of the display panel 12. In order to avoid thermal stress, the support member 14 may have a coefficient of thermal expansion similar to that of the display panel 12.

[0018] For example, in an exemplary embodiment, the support member 14 may include a composite material such as reinforced plastic. Here, the composite material is a material obtained by artificially combining two or more kinds of materials, to exhibit excellent characteristics. For example, the support member 14 may include carbon fiber reinforced plastic (CFRP), glass fiber reinforced plastic (GFRP) or the like. In this case, the support member 14 may exhibit not only characteristics of lightness and flexibility by virtue of the plastic, but also high strength, high elasticity and excellent wear resistance by virtue of the fiber type reinforcing material. The support member 14 may be constituted by a single composite material layer or may be constituted by a plurality composite material layers, to exhibit excellent strength.

[0019] The support member 14 may be fixed to the rear surface of the display panel 12 by an adhesive (for example, a double-sided tape). Of course, the present invention is not limited to such a fixing method. The display panel 12 and support member 14 may be fixed to each other, using various fixing methods.

[0020] The panel driver fixed to the rear surface of the support member 14 includes a circuit board (not shown) including various wirings and elements to provide signals for driving the display panel 12. The panel driver may be fixed to the support member 14 by a bracket (not shown) or the like. For example, the bracket may be fixed to the support member 14 at a middle portion thereof in order to minimize force required to vary the shape of the display panel 12. Of course, the present invention is not limited to such a structure, and various alternatives may be employed. For example, the panel driver may be partially or completely disposed at the outside of the display module 10. In an exemplary embodiment, the panel driver may include wirings, elements, and etc., for driving the variable member 20.

[0021] In addition, frames may be provided to protect the edges of the display panel 12 and support member 14. Such frames not only protect the display panel 12 and support member 14, but also support the rear cover 30. That is, the rear cover 30 may be fastened to the frames by fastening members (not shown). The frames may have various shapes, and various fastening structures and methods may be employed to fasten the rear cover to the frames and, as such, no detailed description thereof will be given.

[0022] The variable member 20 is disposed at the dis-

play module 10 (in this embodiment, the variable member 20 is disposed at the rear surface of the support member 14), to vary the shape of the display panel 12. The variable member 20 may include a variable section 22, and a driver 24 for supplying mechanical energy to vary the shape of the variable section 22. For example, the driver 24 varies the shape of the variable section 22 by bending in shape the variable section 22.

[0023] In an exemplary embodiment, the variable section 22 may be elongated in one direction (for example, a lateral direction of the display apparatus 100). Upon receiving mechanical energy from the driver 24, the variable section 22 may be varied in shape such that opposite end portions thereof protrude forward with respect to the middle portion (comment: since the middle portion is fixed to the display panel, see Figs. 2 and 5, it does not appear to retract rearward). As a result, the display module 10 may be bent throughout the entirety thereof, to have a predetermined radius of curvature (for example, "R" in FIG. 5(b)) in a lateral direction of the display module 10. In this state in FIG. 5(b), there is no difference in the distance from the eyes of the user to the display panel 12 between the middle and lateral end portions of the display panel 12. Even if there is a distance difference, such difference may be minute. Thus, it is possible to achieve an enhancement in sensory immersion of the user. Of course, the present invention is not limited to the above-described embodiment. For example, the varied shape of the variable section 22 may be different from the above-described shape and, as such, the varied shape of the display module 10 may also be different from the above-described shape.

[0024] In the illustrated embodiment, two variable sections 22 are provided such that one variable section 22 is disposed at an upper portion of the display module 10, and the other variable section 22 is disposed at a lower portion of the display module 10. While two or more variable section 22 are preferred, a single variable section 22 may be disposed at an intermediate portion of the display module 10, although insufficient shape variation may occur at lateral edge portions of the display module 10. Taking into such consideration, in this embodiment, two variable sections 22 are implemented. When a plurality of variable sections 22 are provided, it is possible to achieve uniform shape variation throughout the entirety of the display module 10. Of course, the present invention is not limited to the two variable sections 22, and various alternatives may be employed. For example, only one variable section 22 is provided for cost reduction and structure simplification.

[0025] Each variable section 22 may include a first portion 222 fixed to the support member 14 of the display module 10, and a second portion 224 disposed between the support member 14 and the first portion 222. The second portion 224 is fixed, at opposite ends thereof, to opposite ends of the first portion 222, respectively.

[0026] The second portion 224 is fixed, at a certain region thereof, for example, a central region, to the driver

24 and, as such, the second portion 224 has a connection length (that is, a rectilinear length between the opposite ends of the first portion 222 connected with the second portion 224) variable by mechanical energy supplied from the driver 24. When the connection length of the second portion 224 varies, the shape of the first portion 222 is varied. This will be described in more detail later with reference to FIGS. 5(a) and 5(b). When the shape of the first portion 222 varies, the first portion 222 applies force to the display module 10, thereby causing the shape of the display module 10 to be correspondingly varied.

[0027] Thus, the first portion 222 is a portion which is varied in shape by force received from the second portion 224, thereby varying the shape of the display module 10. In this regard, the first portion 222 may include a material having flexibility and excellent strength. In addition, the material of the first portion 222 may be light in weight in order to reduce the weight of the display apparatus 100.

[0028] For example, the first portion 222 may include a single layer structure or a multilayer structure, which includes a composite material, for example, reinforced plastic (CFRP, GFRP or the like). Of course, the present invention is not limited to such materials, and the first portion 222 may be made of various materials. The first portion 222 may have an elongated band shape having a certain width W. Accordingly, it is possible to more effectively apply force to the display module 10. Of course, the present invention is not limited to such a shape, and the first portion 222 may have various shapes.

[0029] The first portion 222 is fixed, at a central region thereof, to the display module 10 (in this embodiment, the support member 14) such that it cannot move at the central region. In this case, the first portion 222 is movable at opposite end regions thereof. Since the first portion 222 is movable (in this case, forward and rearward) at the opposite end regions thereof while being fixed at the central region thereof, the shape of the first portion 222 is variable.

[0030] The first portion 222 is fixed at the central region thereof by fixing members 222a such that it cannot move. The distance between the central region of the first portion 222 and the support member 14 may be greater than the distance between each end region of the first portion 222 and the support member 14. For example, the first portion 222 may be disposed on the support member 14 such that the central region of the first portion 222 is further protruded rearward from the display module 10, as compared to other regions of the first portion 222 and, as such, the first portion 222 has a curved structure. Then, as an example in accordance with FIG. 5(b), when the display module 10 is varied in shape to have a predetermined radius of curvature R throughout the entirety thereof in accordance with variation in the length of the second portion 224 by the driver 24, the shape variation can be more easily achieved. Each fixing member 222a may be constituted by a fastener such as a PEM nut or a screw. Using a PEM nut or a screw, it is possible to achieve simple and easy fastening. Of course, the

present invention is not limited to the above-described structures, and various fixing methods and structures may be employed for fixing of the first portion 222 to the support member 14.

[0031] The opposite end regions of the first portion 222 may be movably held by guide members 226 fixed to the support member 14, respectively. Accordingly, it is possible to movably hold the first portion 222 while preventing the first portion 222 from being downwardly bent at the opposite end regions thereof.

[0032] Each guide member 226 includes an upper portion 226a spaced from the support member 14, to form a predetermined space therebetween, and side portions 226b bent from the upper portion 226a, to be disposed adjacent to the support member 14. The side portions 226b are fixed to the support member 14 by fastening members 226c. For example, fixing of each guide member 226 to the support member 14 may be achieved by mounting PEM nuts 142 to the support member 14, and fastening the fastening members 226c, which may be screws, to the PEM nuts 142 through fastening holes formed at the side portions 226b. Using the PEM nuts and screws as described above, it is possible to easily and simply achieve fastening. Of course, the present invention is not limited to the above-described structures, and various fixing methods and structures may be employed for fixing of the side portions 226b to the support member 14.

[0033] The second portion 224 may have a wire structure, and may be fixed, at opposite ends thereof, to the opposite ends of the first portion 222, respectively. The second portion 224 is coupled to a rotating shaft 349 of the driver 24, and a portion of the second portion 224 can be wound on or unwound from the rotating shaft 349, to vary the connection length of the second portion 224. This will be described in more detail later.

[0034] Each end of the second portion 224 may be fixed to the first portion 222 by a fixing member 228 such as an adhesive or a seal after extending through a hole 222b formed at the corresponding end of the first portion 222. Of course, the present invention is not limited to the above-described method, and various fixing methods may be employed for fixing of the second portion 224 to the first portion 222.

[0035] The second portion 224 may be made of a material exhibiting little or no stretchability even under diverse conditions while having high yield strength. When the second portion 224 is stretchable, it is difficult to accurately vary the connection length of the second portion 224. In addition, it may be necessary to provide increased mechanical energy. For example, the second portion 224 may include a metal steel wire (for example, a stainless wire), an aramid fiber, a carbon steel wire or the like. The second portion 224 may have a diameter of 0.5 to 10mm. When the diameter of the second portion 224 is less than 0.5mm, there may be a problem in that the second portion 224 may snap or deform upon receiving energy from the driver 24. On the other hand, when the diameter of the

second portion 224 exceeds 10mm, there may be problems of increased costs and complicated configurations because mechanical energy required to vary the connection length of the second portion 224 should be increased.

Of course, the present invention is not limited to the above-described embodiment, and the second portion 224 may include various materials and may have various diameters. Although only one second portion 224 is provided in association with the first portion 222 in the illustrated embodiment, a plurality of second portions 224 may be provided. That is, various alternatives may be employed.

[0036] The driver 24 which supplies mechanical energy may have various configurations capable of varying the shape of the variable section 22. Since the driver 24 varies the shape of the variable section 22, using mechanical energy, it is possible to easily vary the shape of the variable section 22 while accurately controlling the variation degree and variation time of the variable section 22. The driver 24 will be described in more detail with reference to FIGS. 3 and 4.

[0037] FIG. 3 is a perspective view illustrating a configuration of the driver of the display apparatus according to an exemplary embodiment of the present invention. FIG. 4 is a cross-sectional perspective view of the driver corresponding to FIG. 3.

[0038] In the illustrated embodiment, the driver 24 may include a motor 242 for supplying rotational energy. As the motor 242, an ultrasonic motor may be employed. The ultrasonic motor is a motor in which frictional force generated between a vibration body vibrating using ultrasonic vibration and a mover is converted into rotational force. This motor is also called a "piezoelectric motor" in that it utilizes piezoelectric effects of piezoelectric ceramics.

[0039] The ultrasonic motor may generate great force while exhibiting a rapid response rate that is 10 times or more than that of existing electromagnetic motors. The ultrasonic motor does not generate noise during operation because it employs ultrasonic waves within an inaudible range. In addition, the ultrasonic motor may have a small size because the structure thereof is simple. The ultrasonic motor has no adverse influence on the display module 10 during operation of the display apparatus 100 because it does not include a magnet. The holding torque of the ultrasonic motor, namely, the torque to stop the ultrasonic motor, is great and, as such, no reverse rotation is generated even when no voltage is applied. Accordingly, it is possible to maintain the display module 10 in a shape-varied state without supplying separate electric power or the like. Thus, it is possible to achieve an enhancement in stability during shape variation of the display module 10. In addition, it is possible to achieve a simplified configuration because it is unnecessary to provide a separate configuration for maintaining the shape-varied state.

[0040] The driver 24 may further include a reducer 244 for reducing the speed of the motor 242, for example,

using reduction ratios, thereby increasing rotational energy supplied by the motor 242. Using the reducer 244, it is also possible to greatly reduce the size of the motor 242. The reduction ratios may be performed using gears. The reduction ratio of the reducer 244 may be 1:2 to 1:300. This range is a range within which the motor 242 can supply mechanical energy capable of sufficiently varying the shape of the variable section 22 while having a minimum size. Of course, the reduction ratio of the reducer 244 may be varied in accordance with the kind of the motor 242, the structure and system of the variable section 22, or the like.

[0041] In the illustrated embodiment, the motor 242 and reducer 244 are disposed within a housing 246.

[0042] When the housing 246 is employed, it is possible to simplify the structure of the driver 24. Fixing of the driver 24 can be easily achieved by coupling fastening members 246b into fastening holes 246a of the housing 246, thereby fastening the housing 246 to the support member 14. In this case, PEM nuts (not shown), to which the fastening members 246b will be fastened, may be provided at the support member 14. In the illustrated case, the housing 246 includes a first housing section 247, in which the motor 242 is disposed, and a second housing section 248, in which the reducer 244 is disposed. Accordingly, the motor 242 and reducer 244 are prevented from interfering with each other. Of course, the present invention is not limited to the illustrated embodiment, and various alternatives may be employed. For example, both the motor 242 and the reducer 244 may be accommodated within a single housing section.

[0043] It is possible to reduce the thickness of the driver 24 by arranging the motor 242 and reducer 244 in parallel in the housing 246. In this case, accordingly, it is possible to install the driver 24 without increasing the thickness of the display apparatus 100. For example, in an exemplary embodiment, a part of the housing 246, in particular, the housing section accommodating the reducer 244, may be interposed between the display module 10 and the first portion 222 of the corresponding variable section 22. In this case, the second portion 224 of the variable section 22 is coupled to the rotating shaft 349 of the reducer 244 and, as such, it is possible to adjust the connection length of the second portion 224 by winding or unwinding a portion of the second portion 224 on or from the rotating shaft 349. In this arrangement, there is also an advantage in terms of space. Of course, the present invention is not limited to such an arrangement. For example, the driver 24 may be spaced from the variable section 22. This will be described in more detail later.

[0044] The motor 242 includes a motor gear 341. The reducer 246 includes a ring gear 343 engaged with the motor gear 341, a plurality of planetary gears 345 engaged with the ring gear 343 within the ring gear 343, and a sun gear 347 engaged with the planetary gears 345. The rotating shaft 349, which is also included in the reducer 246, is coupled to the sun gear 347. The rotating shaft 349 includes a fixing portion 349a to which the sec-

ond portion 224 is fixed. When the motor gear 341 of the motor 24 rotates, the ring gear 343 engaged with the motor gear 341 rotates, thereby rotating the planetary gears 345 and sun gear 347. Accordingly, the rotating shaft 349 is rotated. The planetary gears 345 may be arranged in multi-layers so as to achieve an increase in reduction ratio.

[0045] The rotating shaft 349 is protruded outwards of the housing 246 toward the display module 10. A recessed fixing portion 349a is formed at a protruded end of the rotating shaft 349. The second portion 224 is engaged, at a central region thereof, in the recessed fixing portion 349a. Accordingly, the second portion 224 is coupled to the rotating shaft 349. Thus, it is possible to easily couple the second portion 224 to the rotating shaft 349 without a separate configuration by forming the recessed fixing portion 349a at the rotating shaft 349. Of course, the present invention is not limited to the above-described embodiment, and various alternatives may be employed. For example, the fixing portion 349a may have various structures. The fixing portion 349a may also be provided separately from the rotating shaft 349.

[0046] Although not shown, a guide path to guide winding of the second portion 224 may be formed on an outer surface of the rotating shaft 349. In this case, the second section 224 can be more stably wound on the rotating shaft 349 using the guide path.

[0047] Although one driver 24 is provided for each of the plural variable sections 22 in the illustrated embodiment, the present invention is not limited thereto. Alternatively, the plural variable sections 22 may be driven by one driver 24. This will be described in more detail later with reference to FIG. 6. Although a planetary gear reducer is employed as the reducer 244 in the illustrated embodiment, various structure and systems may be employed for the reducer 244.

[0048] The rear cover 30 is disposed in rear of the display module 10 and variable member 20. The rear cover 30 protects the display module 10, panel driver, and etc., from external impact while providing a space where the panel driver, and etc., are disposed. The rear cover 30 also covers the panel driver, and etc., to prevent an inner configuration of the display module 10 from being outwardly exposed, and thus to achieve an enhancement in appearance. For example, the rear cover 30 has a surface gently curved throughout the rear cover 30, to secure a sufficient space and to achieve an enhancement in appearance. In an exemplary embodiment, the rear cover 30 includes a material, a structure, or the like capable of coping with a variation in shape of the display module 10.

[0049] The above-described shape variation of the display apparatus 100 will be described in more detail with reference to FIGS. 5(a) and 5(b). FIGS. 5(a) and 5(b) are views explaining shape variation of the display apparatus 100 according to an exemplary embodiment of the present invention. For reference, FIGS. 5(a) and 5(b) are cross-sectional views taken along the line V-V of FIG. 2. For simplicity and convenience of description, illustra-

tion of the guide member 226 and rear cover 30 is omitted from FIGS. 5(a) and 5(b). For convenience of description, the following description will be given in conjunction with one variable section 22.

[0050] The display module 10 is kept in a flat state, as shown in FIG. 5(a), when there is no force applied to the display module 10.

[0051] The first portion 222 of the variable section 22 is fixed at the central region thereof by the fixing members 222a such that it cannot move. The first portion 222 is also disposed such that the central region of the first portion 222 is further protruded rearward from the display module 10, as compared to other regions of the first portion 222. In accordance with this structure, shape variation of the display module 10 can be more easily achieved. The opposite end regions of the first portion 222 are movably held by the guide members ("226" in FIG. 2), respectively. The second portion 224 is fixed to the fixing portion ("349a" in FIG. 2) of the rotating shaft 349 in the driver 24.

[0052] When the user inputs a command to vary the shape of the display apparatus 100, the driver 24 is driven by an element, for example, included in the panel driver to drive the driver 24. For example, the motor 242 rotates to rotate the rotating shaft 349 of the reducer 244. Accordingly, the second portion 224 fixed to the rotating shaft 349 is rotated together with the rotating shaft 349 and, as such, a portion of the second portion 224 is wound on the rotating shaft 349. As a result, the connection length of the second portion 224 is reduced, thereby reducing the rectilinear distance between the opposite ends of the first portion 222. Thus, the first portion 222 is bent throughout the entirety thereof such that the opposite end regions thereof protrude forward and, as such, the shape of the display module 10 is also varied. For example, the display module 10 is varied into a curved structure having a uniform radius of curvature R in the lateral direction of the display module 10, as shown in FIG. 5(b). Thus, the display module 10 provides an enhancement in sensory immersion of the user.

[0053] When the user inputs a command again to revert the shape of the display module 10 back to its the original shape, the portion of the second portion 224 wound on the rotating shaft 349 is unwound. As such, the length of the second portion 224 is increased to its original length, and the display module 10 reverts to a flat state, as shown in FIG. 5(a). Accordingly, the variable section 22 is returned to an original state thereof.

[0054] Thus, in the illustrated embodiment, it is possible to vary the shape of the display module 10 in order to achieve an enhancement in sensory immersion of the user. Using the driver 24 which supplies mechanical energy for shape variation of the display module 10, it is possible to easily vary the shape of the variable section 22 while accurately controlling the shape variation degree and time of the variable section 22. In addition, since the motor 242 (in particular, the ultrasonic motor) and reducer 244 are employed for the driver 24, the driver 24

can have a small size. It is also possible to vary the shape of the display module 10 without generation of noise.

[0055] For reference, the command to vary the shape of the display apparatus 100 may be input to the display apparatus 100 by various methods. For example, the user may input the command by pushing or pressing a button of the display apparatus, by using a device for a remote control (for example, a remote controller of the display apparatus 100), by moving a body of the user (such as, moving eyes of the user or applauding), and so on.

[0056] Hereinafter, a display apparatus according to another exemplary embodiment of the present invention will be described with reference to FIG. 6. With regard to the following embodiment, no description will be given of matters identical or very similar to those of the above-described embodiments, and only the different matters will be described in detail.

[0057] FIG. 6 is an exploded perspective view of a display apparatus according to another exemplary embodiment of the present invention.

[0058] Referring to FIG. 6, in this embodiment, a plurality of variable sections 22 are provided, and one driver 24 drives the plural variable sections 22. For example, in this embodiment, the driver 24 is disposed to be spaced from the plural variable sections 22. A path change member 28 is disposed between each variable section 22 and the display module 10, to change a movement path of the second section 224 toward the driver 24. In the illustrated embodiment, the path change member 28 protrudes from the support member 14. The path change member 28 has a cylindrical shape, and does not rotate. The path change member 28 may be mounted to the support member 14, using a PEM nut, a screw or the like. Of course, the path change member 28 may be mounted to the support member 14 in accordance with various methods.

[0059] The path change member 28 may be formed with a first guide 282 to guide movement of one part of the second portion 224 extending between one end region of the first portion 222 and the driver 24, and a second guide 284 to guide movement of the other part of the second portion 224 extending between the other end region of the first portion 222 and the driver 24. Accordingly, the two parts of the second portion 224 do not interfere with each other during movement thereof. The first and second guides 282 and 284 may be grooves formed on an outer surface of the path change member 28, as shown in an enlarged circle of FIG. 6. Each second portions 224 of the variable sections 22 may be fixed to the rotating shaft ("349" in FIG. 2) of the driver 24 under the condition that they are connected together. Thus, the connection lengths of each second portions 224 are simultaneously reduced or increased in accordance with rotation of the rotating shaft 349. Of course, the present invention is not limited to the above-described arrangement. In another exemplary embodiment, the second portions 224 of a plurality of the variable sections 22 may be connected together. In this instance, the second por-

tions 224 connected together may be connected to the driver 24 under the condition that only the movement paths thereof are guided by the path change members 28. Alternatively, each path change member 28 may be rotatably mounted to the support member 14. Of course, various alternatives may be employed.

[0060] When a plurality of variable sections 22 are driven by one driver 24, as described above, it is possible to easily vary the shape of the display module 10 while achieving structure simplification.

[0061] As apparent from the above description, in the display apparatus according to the above-described embodiment, it is possible to vary the shape of the display module so as to achieve an enhancement in sensory immersion of the user. Using the driver which supplies mechanical energy for shape variation of the display module, it is possible to easily vary the shape of the variable section while accurately controlling the shape variation degree and time of the variable section. In addition, since the motor (in particular, the ultrasonic motor) and reducer are employed for the driver, the driver can have a small size. It is also possible to vary the shape of the display module without generation of noise.

[0062] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. A display apparatus comprising:

a display module including a flexible display panel to display an image; and
a variable member to vary a shape of the flexible display panel,
wherein the variable member comprises
at least one variable section capable of bending in shape, and
at least one driver to supply mechanical energy to bend the shape of the variable section,
wherein, the flexible display panel is varied in shape by the bending in shape of the variable section.

2. The display apparatus according to claim 1, wherein the flexible display panel is varied by the variable member to correspond to the shape of the variable section.

3. The display apparatus according to claim 1, wherein the variable section comprises a first portion located at the display module, and a second portion located at the first portion, the second portion having a connection length variable by the driver to thereby

bend a shape of the first portion.

4. The display apparatus according to claim 3, wherein:

the first portion has a band shape;
the second portion has a wire shape; and
the second portion is fixed, at opposite ends thereof, to opposite ends of the first portion, respectively.

5. The display apparatus according to claim 3, wherein:

the first portion comprises a composite material; and
the second portion comprises one of a metal wire, a non-metal wire, or a composite wire.

6. The display apparatus according to claim 1, wherein:

the variable section is elongated in one direction; and
the variable section is fixed, at a central region thereof, at the display module such that the variable section does not move at the central region.

7. The display apparatus according to claim 6, wherein the variable section is movably fixed, at end regions thereof, by guide members fixed at the display module, respectively.

8. The display apparatus according to claim 1, wherein the driver comprises a motor.

9. The display apparatus according to claim 8, wherein the motor comprises an ultrasonic motor.

10. The display apparatus according to claim 8, wherein:

the variable section comprises a first portion located at the display module, and a second portion located at the first portion;
the driver comprises a rotating shaft rotatable by a rotating force from the motor;
the second portion is fixed on the rotating shaft, and has a connection length variable in accordance with winding or unwinding of a portion of the second portion on or from the rotating shaft.

11. The display apparatus according to claim 10, wherein:

the rotating shaft is formed with a fixing portion at an end of the rotating shaft disposed toward the display module; and
the second portion is fixed on the fixing portion.

12. The display apparatus according to claim 8,

wherein the driver further comprises a reducer connected to the motor.

13. The display apparatus according to claim 12,
wherein the motor and the reducer are disposed in parallel at the display module. 5

14. The display apparatus according to claim 1, wherein:

the at least one variable section comprises a plurality of variable sections and the at least one driver comprises a plurality of drivers respectively corresponding to the plurality of variable sections, and/or
wherein: 10 15

the at least one variable section comprises a plurality of variable sections, and the at least one driver comprises a driver to drive the plurality of variable sections. 20

15. The display apparatus according to claim 1, wherein:

the at least one variable section comprises a plurality of variable sections;
the at least one driver comprises a driver to drive the plurality of variable sections;
the at least one variable section comprises a first portion fixed on the display module, and a second portion disposed between the display module and the first portion, and fixed on the first portion;
the driver is spaced from the variable section;
and
a path change member is disposed between the at least one variable section and the display module, to change a movement path of the second portion toward the driver. 25 30 35 40

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FIG. 1

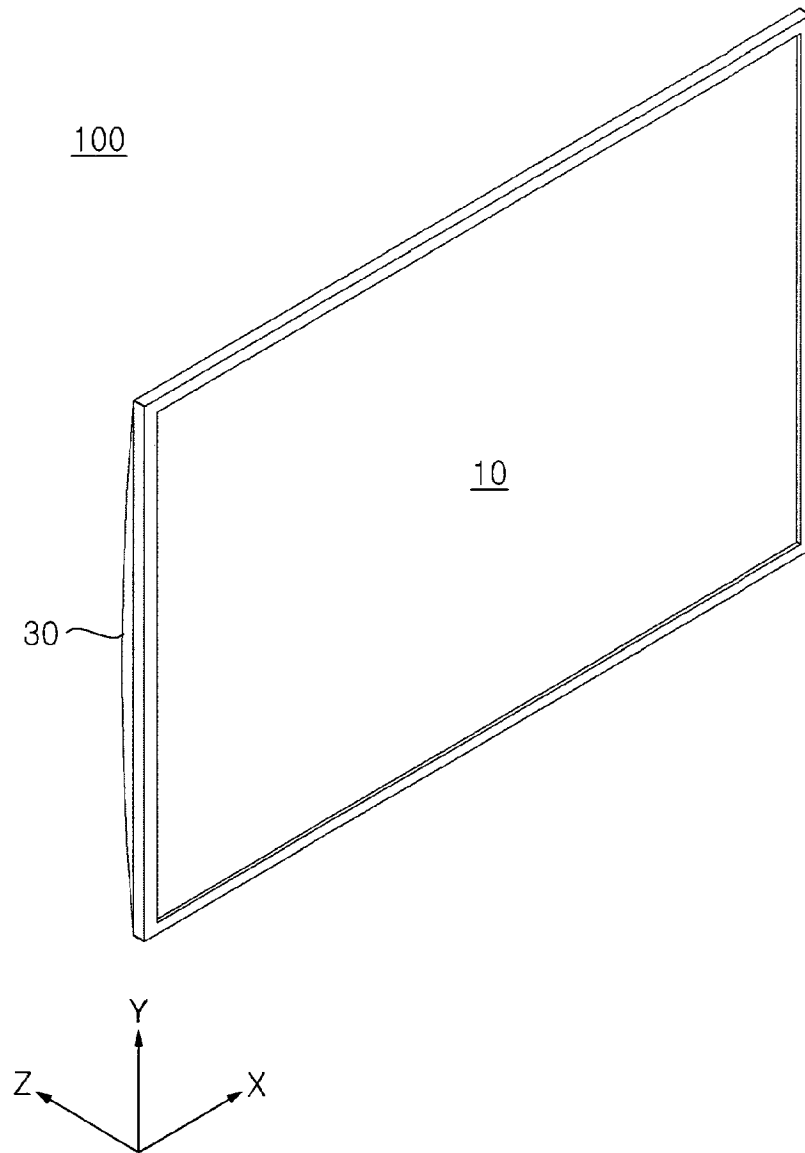


FIG. 2

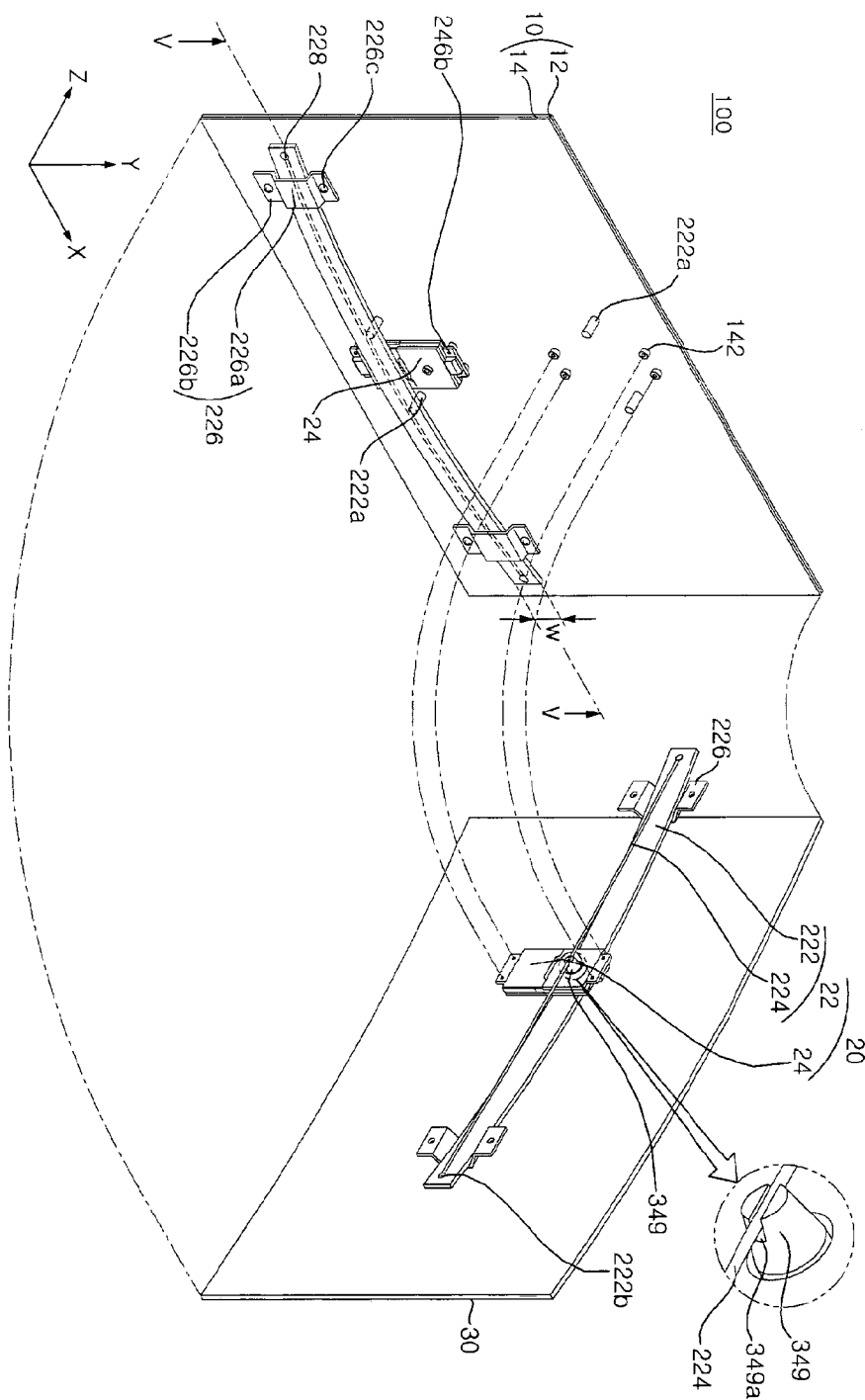


FIG. 3

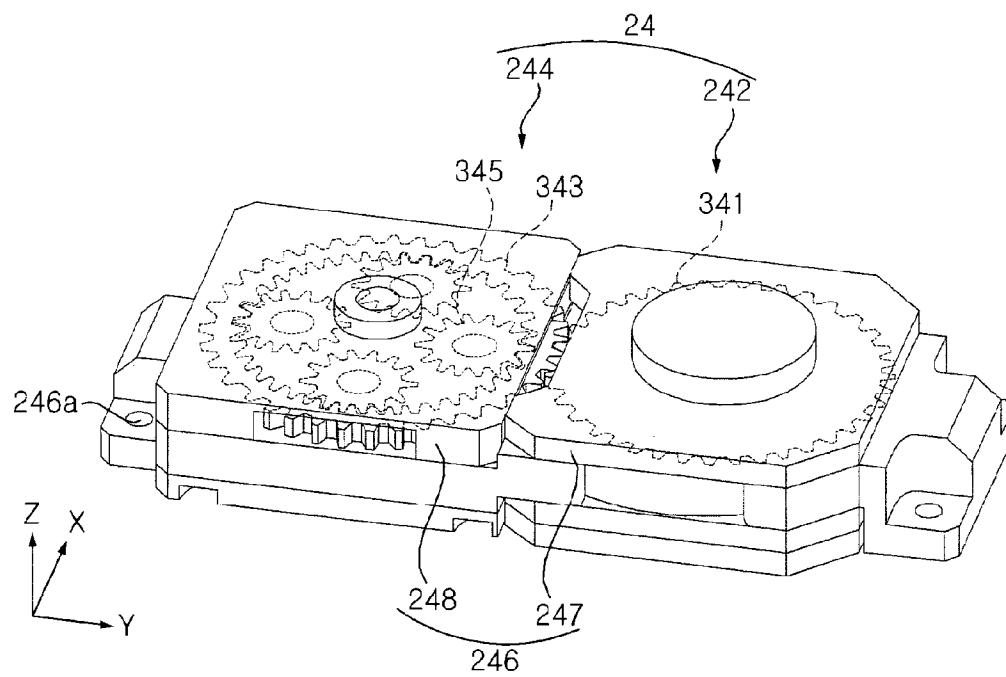


FIG. 4

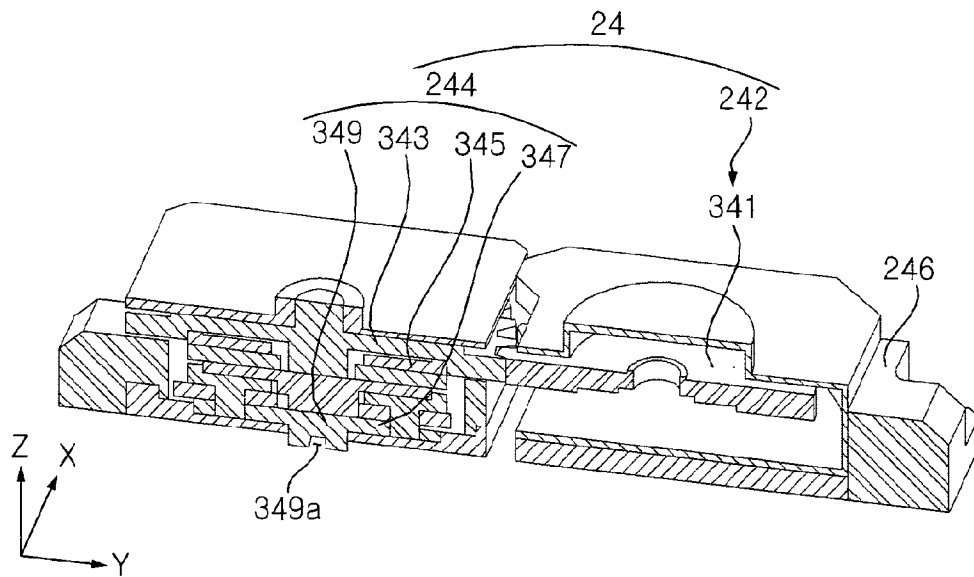


FIG. 5

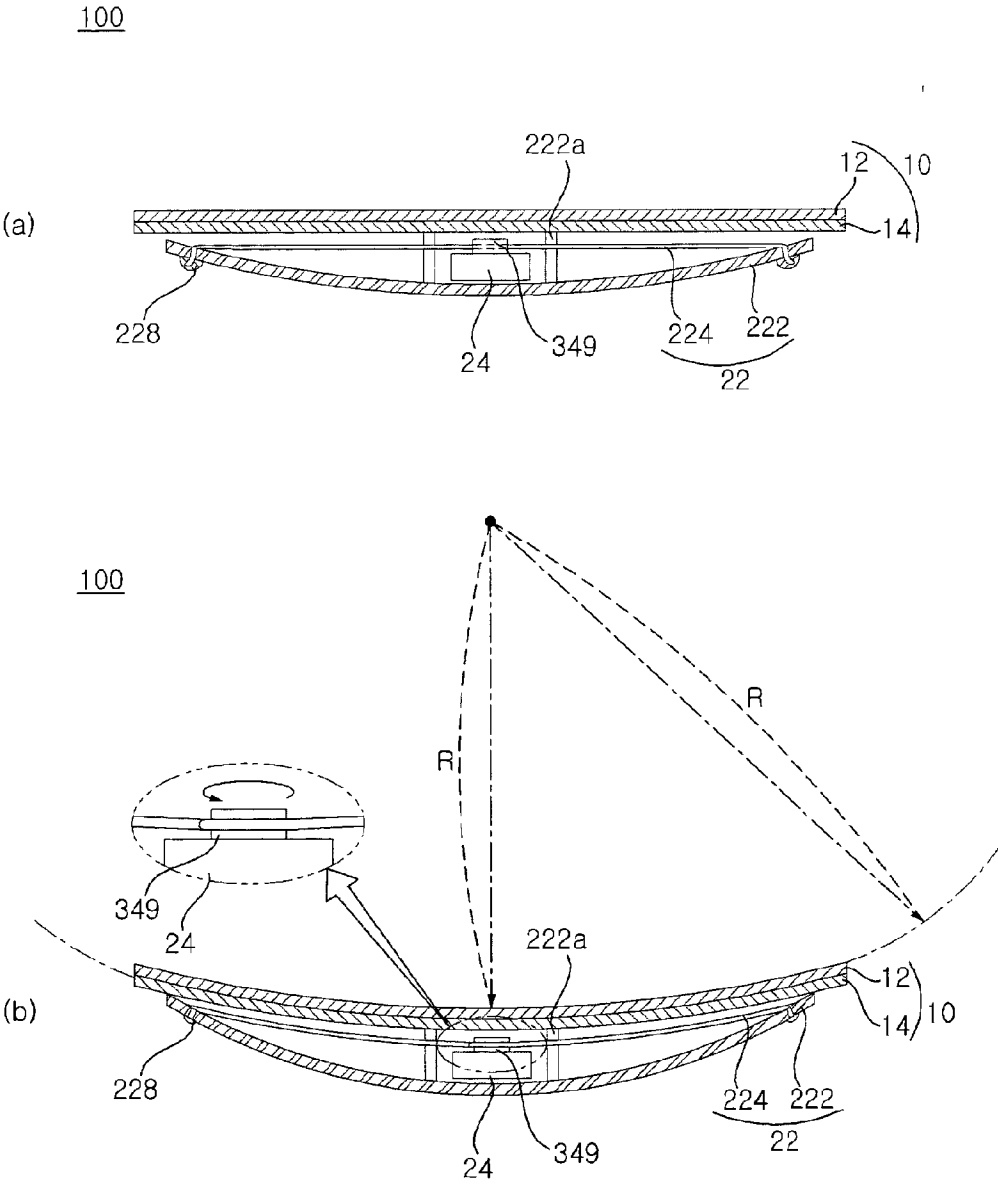
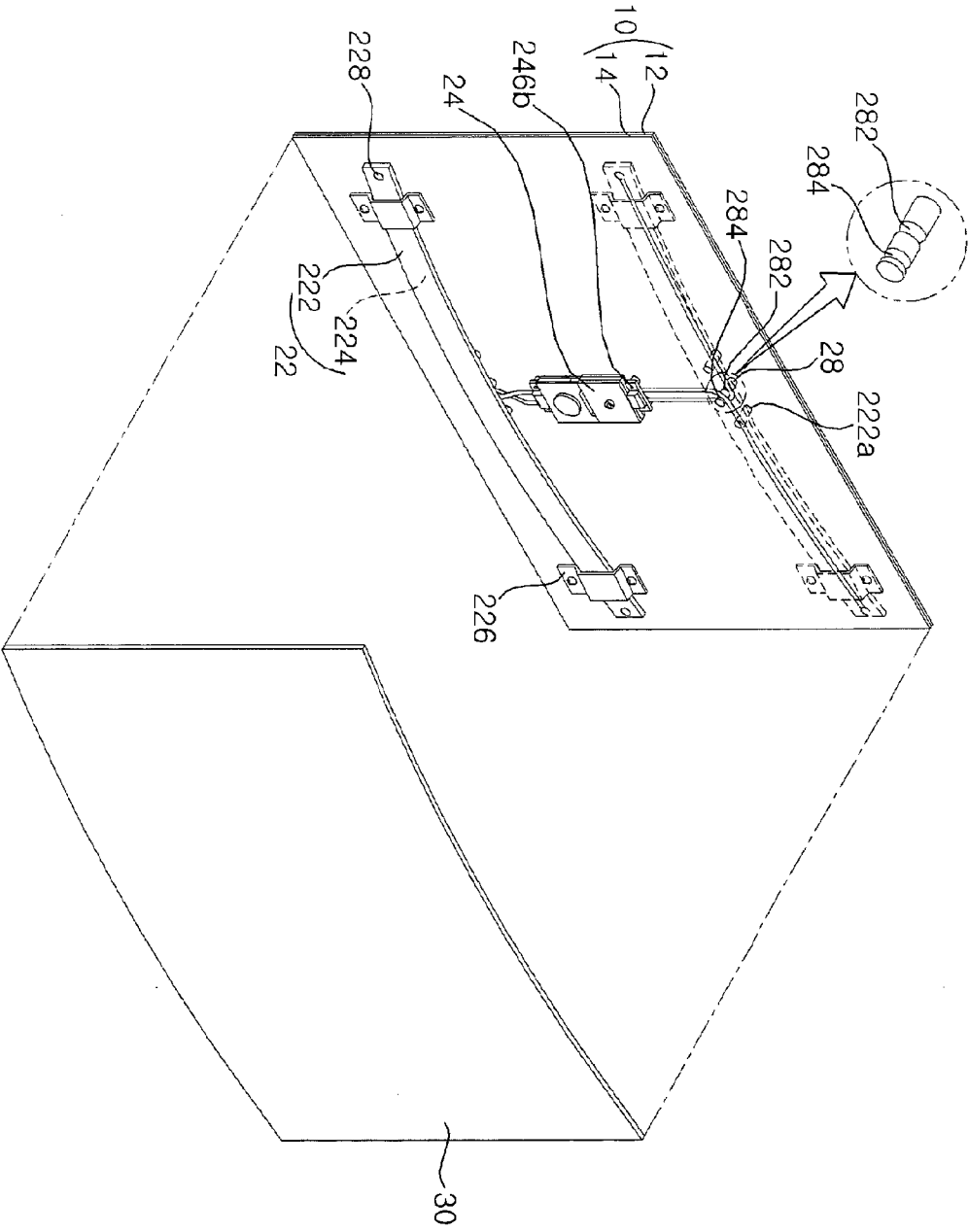


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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Åkerstorpsvägen 42, 247 95 Torna-Hällestad (SE).
THORVINGER, Jens; Kaprifolievägen 15, 227 38 Lund (SE).

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(74) Agent: **EVENT HORIZON IP**; Barometergatan 16B, 211 17 Malmö (SE).

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(71) Applicant: **FLATFROG LABORATORIES AB**
[SE/SE]; Scheelevägen 15 A, 223 63 Lund (SE).

(72) Inventors: **KOCOVSKI, Aleksander**; Kastellgatan 11, 211 48 Malmö (SE). **BERGSTRÖM, Håkan**;

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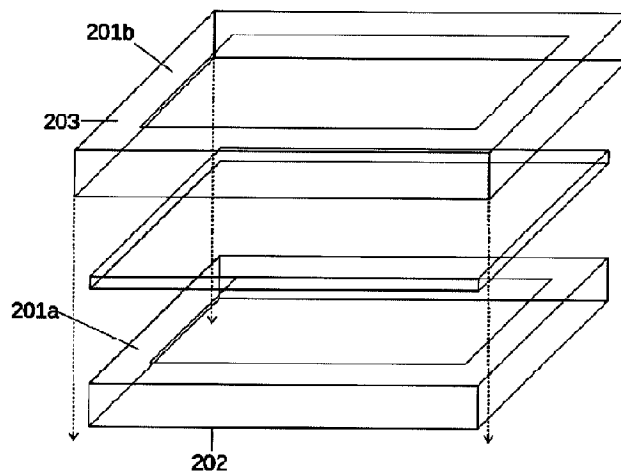


Figure 5b

(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 is 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.

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AN IMPROVED TOUCH DEVICE

Field of the Invention

This invention relates in general to the field of optical touch sensitive systems.
5 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.

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Background of the Invention

In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. US4459476, a plurality of optical emitters and optical receivers are arranged around the periphery of a touch surface to create a grid of
15 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
20 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
25 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
30 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 disproportionately large effect on
35 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
5 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
10 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.
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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
25 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
30 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
35 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 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 plate 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.

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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
10 drawings, in which:

Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

Figures 2a-2d are cross-sectional views of embodiments of assemblies;

Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1
15 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 1 of the assembly with the second frame element warped relative to the first frame
25 element and holding the plate in a curved plane that is concave;

Figure 4a is a perspective view of the first frame element;

Figure 4b 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;

Figure 4c is a side view showing screws 116a and 116b;

Figures 5a-5h are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

Figures 6 is a schematic cross section from a first direction of an embodiment of the assembly;

Figure 7 is a schematic side-view of another embodiment for providing curvature of plate 2;

Figure 8 shows an isometric view of a variation of the embodiment of figures 5a-5g;

Figure 9 is a diagram showing a top down view of an optical touch system and corresponding detection lines;

5 Figure 10a shows an isometric view of a flat touch surface of an optical touch system;

Figure 10b shows a section view of an optical touch system with a flat touch surface;

10 Figure 11a shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

Figure 11b 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;

Figure 11c 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;

15 Figure 11d shows an example of types of warpage that a touch panel may exhibit.

Figure 12a shows top view of a touch surface of an optical touch system;

Figure 12b 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;

20 Figure 12c 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;

Figure 12d 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;

25 Figure 13a 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;

Figure 13b 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;

30 Figure 14a 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;

Figure 14b 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;

Figure 15a 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;

5 Figure 15b 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;

Figure 16a 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;

10 Figure 16b 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;

Figure 17a 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;

Figure 17b 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;

20 Figure 18a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

Figure 18b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

Figure 19a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

25 Figure 19b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

Figure 20a shows top view of displacement contours for a touch surface according to an embodiment;

30 Figure 20b shows curvature of a touch surface along an x-axis according to the embodiment of figure 20a;

Figure 20c shows curvature of a touch surface along a y-axis according to the embodiment of figure 20a;

Figure 20d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 20a;

35 Figure 21a shows top view of displacement contours for a touch surface according to another embodiment;

Figure 21b shows curvature of a touch surface along an x-axis line according to the embodiment of figure 21a;

Figure 21c shows curvature of a touch surface along a y-axis line according to the embodiment of figure 21a;

5 Figure 21d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 21a.

Description of Embodiments

Specific embodiments of the invention will now be described with reference to
10 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
15 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
20 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
25 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
30 glass perimeter, and on how a VESA mount is attached.

Figure 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
35 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 figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. In the following, the embodiments of figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in figures 6a-6c.

Figures 2a-2d illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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 figures 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

In one embodiment, elements 102, 103 (shown in the figure as comprising elements 103a and 103b) are formed from a single piece.

The second frame element 103a, 103b may be attached to the first frame element 102.

In the embodiments of figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Therefore, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

The first frame element 102 may form a frame 109 (shown in figure 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 figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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 103a, 103b 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 101a, 101b and be configured to extend in the second plane opposite the frame 109. The first portion may extend
5 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

As is illustrated in figures 3a-3d, the first frame element 102 may be attached to
10 the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the
15 second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that it is substantially parallel with the panel 1 and/or controls the plate 2
20 to be in a flat plane, as is illustrated in figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in figure 3c and 3d. In the latter case, the plate 2 is given a slightly concave shape, i.e. in
25 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
30 101a, 101b 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.

Figures 2a-2d and 3a-3d illustrate embodiments of an attachment element 112
35 for attaching the first frame element 102 to the panel. A plurality of attachment elements 112 (e.g. as shown in triplicate as elements 112a, 112b, and 112c) may be arranged around

the frame 109, such as at each corner of the frame 109, which is illustrated as circles in figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c, 113a, 113b. 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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to displace the frame 109 away from panel 1, which is indicated with an arrow in figure 2d e.g. by having a thread in the frame 109 and pushing on the panel 1. At least one other of the screws 112b, 112c, 113b may be arranged to displace the frame 109 towards the panel 1, which is also indicated with an arrow in figure 2d. e.g. by having a thread in the panel and a hole in frame 109.

Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in figure 2a. In the illustrated embodiment, a first screw 112a is arranged between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 115a of the longitudinal axis of the first screw 113a passes through the support portion 101b when viewed in cross-section, such as through the center thereof, as is illustrated in figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101b, i.e. an imaginary extension 115b of the longitudinal axis of the first screw 113b passes outside the support portion 101b when viewed in cross-section, as is illustrated in figure 2b.

As shown in figure 2d, the first screw 112a is arranged to displace the frame 109 away from panel 1. This may be enabled by a threaded hole 112i in the frame 102 which the first screw engages while a head of the screw abuts the panel 1. The second screw 112b is arranged to displace the frame 109 towards the panel. This may be enabled by a threaded hole 112f in the panel 1, which the second screw 112b engages while the head of the second screw 112b abuts the surface of the frame. By using screw 112a and/or 112b, forces may be applied to frame 102 and/or panel 2 to control bending or rotation of the frame/panel.

Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of figure 2b, only two screws are required to control bending or rotation of the frame.

5 In figures 2a-2b, 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.

figure 2c illustrates that a combination the embodiment of figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Therefore, flexibility is provided for.

10 As is illustrated in figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Therefore, a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In the assembly illustrated in figure 3a, a net force is applied such that the
15 frame is substantially flat and parallel with the panel 1. In the assembly illustrated in figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b along the edge or perimeter of the plate 2.
20 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.

Figures 4a-4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a,
25 attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to figures 2a-2c and 3a-3d. 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 101a, 101b as described above. At least one spacing
30 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 103a, 103b such
35 that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled.

As is illustrated in figure 4b, 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.

5 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Therefore, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

10 When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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
15 at the opposing ends of the support 101a, 101b 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 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane
20 taken along the support portion 101a, 101b, such as at the free end or tip of the support portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b in the deflected or stressed state when assembled with
25 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,
30 element 116 may comprise a spacer component such as a washer, spacer, etc. In figure 3a and 3b and figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single-spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b may engage the frame 109, wherein the
35 frame 109 may be pulled towards the back cover 111. As a result, the frame 109 becomes concave. In some embodiments, the spacing element 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

5 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 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.

10 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
15 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 figure 5h, 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.

Figures 5a-5h illustrate embodiments of an assembly 200, which may be
20 combined with the first frame element 102 described above. The embodiments shown in figures 5a-5h are shown inverted relative to the embodiments shown previously, with the plate 2 at the top.

As shown in figures 5a and 5b, the frame assembly 200 may comprise a first frame element 202, and a second frame element 203. The first frame element 202 and the
25 second frame element 203 may be elongated members, each having a support portion 201a, 201b. 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
30 the support portion 201a, 201b, 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,
35 each support portion 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in figure 5g.

In some embodiments, such as illustrated in figures 5c-5d, a gasket 205 (e.g. gaskets 205a, 205b, 205c, 205d, 205e) 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 201a of the first frame element 202. Also, a sealing 204a may be arranged on the support portion 201b 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 figures 5f-5g. 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 1.5-2.0mm 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in figure 5e.

5 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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged
10 between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second
15 sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes 217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third
20 hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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
25 deflectable such that each hole 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Therefore, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c
30 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen, wherein the center holes 217c, 218c 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
35 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 figures 4a-4c, the frame side may replace the second frame element of the embodiments of figures 4a-4c. Therefore, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

As illustrated in figure 6, a component (e.g. a sealing component 204a) may be provided between the support portion 201a and the plate 2. Figure 6 illustrates the resulting forces and torque generated when a force 220 is applied to second frame element 203a. 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 figure 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 103A. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b 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 103A. 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 103A.

In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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.

Figure 9 illustrates a top plan view of an example of a touch-sensitive apparatus 99. Emitters 30a are distributed around the periphery of touch plate 10, to propagating light across touch surface 20. 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 propagate to a number of different detectors 30b 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 30a and detectors 30b. 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 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 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 fiber. 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.

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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b 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 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 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 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 10a 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 figure 10a. 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.

Figure 10b illustrates an example of a touch apparatus according to the prior art. Figure 10b 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 30a, 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 30b. 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.

Figure 11a illustrates an embodiment of touch plate 10 similar to that shown in figure 10a 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. Figure 11b shows a cross-section view along the x-axis of the touch plate 10 of figure 11a.

Figure 11c 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.

Figure 11d 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 figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$F(x) = 5.5 * 10^{-6} * x^2 - 2.0$$

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.

Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 O 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 O on the touch surface. Therefore, the curvature of the plate along this axis can be measured from the distance of the touch surface from the y-axis.

Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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:

$$z(x, y) = -a + b * x^2 + c * x^2 y^2 + d * y^2$$

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):

$$z(x, y) = -2 + 5.56e - 06 * x^2 - 4.74e - 11 * x^2 y^2 + 1.7e - 05 * y^2$$

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:

$$z(x, y) = -2.5 + 5.56e - 06 * x^2 - 2.37e - 11 * x^2 * y^2 + 1.28e - 05 * y^2$$

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Figure 13a 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 1310a 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, gracing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

Figure 13b 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 figure 13a. 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.

Figure 14a shows a section view of the embodiment of figure 13a. 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. Figure 14b shows the corresponding graph of figure 13b for the second point light source 1410.

Figure 15a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a third point light source 1510 are shown. Figure

15b shows the corresponding graph of figure 13b for the third point light source 1510. In this example, the detection signal boost is approximately 3.03.

Figure 16a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fourth point light source 1610 are shown.

5 Figure 16b shows the corresponding graph of figure 13b for the fourth point light source 1610. In this example, the detection signal boost is approximately 2.71.

Figure 17a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fifth point light source 1710 are shown. Figure 17b shows the corresponding graph of figure 13b for the fifth point light source 1710. In
10 this example, the detection signal boost is approximately 2.19.

Figures 13a-17b 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.

15 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.

Figure 18a shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of figure 18a, a curved touch
20 plate 10 has a width of 1900 mm along the x-axis and a height of 1070mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in figure 12a,4b). 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 10mm. The mathematically defined parabolic curve is defined as 1820. The
25 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 10b 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 $|\text{parabolic deviation}| < 0.5$ mm.

30 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.

Figure 18b shows a graph of the deviation between the mathematically defined
35 parabolic curve and a real-world parabolic touch surface of figure 18a.

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.

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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	6.00	0.0	2.00	0.1	0.5

Convexity b is shown in figure 18a. Parabolic deviation is shown in figure 18b.

Figure 19a shows another graph of a mathematically defined parabolic curve and a similar glass to that of figure 18a but wherein the glass of figure 19a is out of range and not recommended for touch system production. One reason for the large concavity shown in figure 19a may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacturing. 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.

Figure 19b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 19a. The real-world parabolic touch surface of figure 19a 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.

Figure 20a shows an embodiment in which the touch surface forms a paraboloid. In figure 20a, 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 figure 20b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 20a, the curved touch plate 10 has a width of 1900mm along the x-axis and a height of 1070 mm along the y-axis.

Figures 20b-20d show optional parabola configurations for the embodiment shown in figure 20a. Figure 20b 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. Figure 20c 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. Figure 20d 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 figure 20a-20d 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.

Figure 21a shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in figure 20a. As with figure 20a, figure 21a 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 figure 21b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 21a, 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 embodiments where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect parabolas. 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.

Figure 21b 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. Figure 21c 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. Figure 21d 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.

CLAIMS

1. An assembly for holding and controlling curvature of a plate (2) for an optical touch sensitive system, comprising
- 5 a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);
- at least one second frame element (103a, 103b; 203) extending in a second plane and forming a support portion (101a, 101b; 201b) for the plate (2), and
- at least one spacing element positioned at least partially between the support
- 10 portion (101a, 101b; 201b) and the first frame element (102; 202), the spacing element being configured to control a curvature of the first frame element (102; 202), and
- wherein the at least one second frame element (103a, 103b; 203) is configured to engage the plate at the support portion (101a, 101b; 201b), is attached to the first frame element (102; 202), and wherein the shape and/or position of the second frame element is
- 15 controlled by the curvature of the first frame element (102, 202) with said spacing element, to control a curvature of the plate.
2. The assembly of claim 1, wherein the second frame element (103a, 103b; 203) is deflectable from a relaxed state to a deflected state, in which the second plane forms a
- 20 parabolic concave curve along at least a portion of the length of the support portion (101a, 101b; 201b), and wherein a screw arrangement (112a, 112b, 112c, 113a, 113b; 219a, 219b, 219c) of the assembly holds the second frame element (103a, 103b; 203) in the deflected state when assembled with the first frame element (102; 202).
- 25 3. The assembly of any of claims 1 or 2, wherein a frame (109) of the first frame element (102) comprises a plurality of spacing elements arranged spaced apart from corners of the frame (209) of the first frame element (102), wherein the spacing elements are configured to generate a force to the frame (109) away from the support portion (101a, 101b).
- 30 4. The assembly of claim 3, wherein each spacing element comprises a screw (116, 116a, 116b) arranged in a hole of the frame (109).
- 35 5. The assembly of claim 4, wherein each spacing element (112, 112a, 112b) comprises a screw with a predefined length, and a spacer arranged between a head of the screw and the frame (109).

6. The assembly of any of the previous claims, wherein assembly comprises a plurality of attachment elements (112) arranged around the frame (109) for attaching the first frame element (102) to said panel (1).

5 7. The assembly of claim 6, wherein each attachment element (112) comprises a plurality of screws (112a, 112b, 112c, 113a, 113b) arranged in holes of the frame (109), wherein at least one of said screws (112a, 113b) is arranged to apply a first force to the frame (109) towards the support portion (101a, 101b), and at least one other of said screws (112b, 112c, 113b) is arranged to apply a second force to the frame (109) away
10 from the support portion (101a, 101b).

8. The assembly of claim 7, wherein each attachment element (112) comprises at least two screws (113a, 113b), wherein a first screw (113a) of said two screws is arranged opposing the support portion (101a, 101b) and to apply said first force to the frame (109)
15 towards the support portion (101a, 101b), and a second screw (113b) of said two screws is arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b) and to apply said second force to the frame (109) away from the support portion (101a, 101b).

20 9. The assembly of claim 7, wherein each attachment element (112) comprises at least three screws (112a, 112b, 112c), wherein all three screws are arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b), and wherein a first screw (112a) of said three screws is arranged to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw
25 (112b) and a third screw (112c) of said three screws are arranged to apply said second force to the frame (109) away from the support portion (101a, 101b), the first screw (112a) being arranged between the second screw (112b) and the third screw (112c).

10. The assembly of any of the previous claims, wherein a gasket (205) is arranged
30 on another support portion (201a) of the second frame element (202), wherein the gasket (205) has a varying thickness along its length.

11. The assembly of claim 10, wherein the gasket (205) has opposing ends, and is thinner between the opposing ends than at said ends.

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12. The assembly of claim 11, wherein a first section (205a) of the gasket (205) at one of said ends and a second section (205b) of the gasket (205) at the other of said ends has a first thickness, and at least a third section (205c) of the gasket between the first section (205a) and the second section (205b) has a second thickness, wherein the first
5 thickness is thicker than the second thickness.

13. The frame assembly of any of claims 10-12, wherein the second frame element (203) comprises a frame side and the third frame element comprises an edge cover, and wherein the edge cover comprises another support portion for said panel (1),
10 wherein a distance between the support portion of the frame side and the support portion of the edge cover is discontinuous in an assembled state.

14. The frame assembly of claim 13, wherein the frame side comprises a first hole (217a) and a second hole (217b) arranged at opposing ends of the frame side and in a first plane, and a third hole (217c) arranged between the first hole (217a) and the second hole
15 (217c) and in a plane that is different from the first plane, and

the edge cover comprises a first hole (218a) and a second hole (218b) arranged at opposing ends of the edge cover, and a third hole (218c) arranged between the first hole (218a) and the second hole (218c) of the edge cover, wherein the first hole (218a), the
20 second hole (218b), and the third hole (218c) of the edge cover are generally arranged in the same plane when the edge cover is disconnected from the frame side, and

wherein the edge cover is less stiff than the frame side and deflectable such that the holes (218a, 218b, 218c) of the edge cover are aligned with the holes (217a, 217b, 217c) of the frame side and such that the support portion of the edge cover extends in a
25 plane, which is curved.

15. A method for assembling a panel and a plate for an optical touch sensitive system, comprising:

providing a first frame element (102; 202) extending in a first plane and
30 configured to extend at least partially around a panel (1);

providing at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2);

supporting the plate (2) by the support portion (101a, 101b, 201b);

attaching the second frame element to the first frame element (102; 202) such
35 that

the support portion (101a, 101b; 201b) extends at least partially in a second plane generally opposite at least a portion of the first frame element (102; 202) and is spaced apart from the first plane; and

controlling a curvature of the first frame element (102; 102) with a spacing
5 element attached to the first frame element (102; 202) and thereby tilting the support portion (101a, 101b, 201b) to control a curvature of the plate (2).

16. A touch sensing apparatus, comprising:
a touch surface;
10 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
15 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.

20 17. The touch sensing apparatus of claim 16, wherein the touch surface is curved in a second axis according to a second parabola.

18. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

25 19. The touch sensing apparatus of claim 18, wherein the first parabolic curve paraboloid is an elliptical paraboloid.

20. The touch sensing apparatus of claim 16, wherein each point of the first axis of
30 the touch surface is within 0.5mm of a mathematical parabola.

21. The touch sensing apparatus of claim 16, wherein the mathematical parabola is defined according to $z(x, y) = a + bx^2 + cx^2y^2 + dy^2$, where z is depth, and x and y are co-ordinates in the plane of the glass.

35

22. The touch sensing apparatus of claim 16, wherein the touch surface comprises a portion of a surface of a plate.

5 23. The touch sensing apparatus of claim 22, wherein the plate comprises a glass or plastic sheet.

24. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

10

AMENDED CLAIMS

received by the International Bureau on 09.Apr.2018 (09.04.2018)

- [Claim 1] An assembly (100) for holding and controlling curvature of a plate (2) for an optical touch sensitive system, comprising
a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);
at least one second frame element (103a, 103b; 203) extending in a second plane and forming a support portion (101a, 101b; 201b) for the plate (2), and
at least one spacing element (116) positioned at least partially between the support portion (101a, 101b; 201b) and the first frame element (102; 202), the spacing element (116) being configured to control a curvature of the first frame element (102; 202), and
wherein the at least one second frame element (103a, 103b; 203) is configured to engage the plate at the support portion (101a, 101b; 201b), is attached to the first frame element (102; 202), and wherein the shape and/or position of the second frame element is controlled by the curvature of the first frame element (102, 202) with said spacing element (116), to control a curvature of the plate.
- [Claim 2] The assembly (100) of claim 1, wherein the second frame element (103a, 103b; 203) is deflectable from a relaxed state to a deflected state, in which the second plane forms a parabolic concave curve along at least a portion of the length of the support portion (101a, 101b; 201b), and wherein a screw arrangement (112a, 112b, 112c, 113a, 113b; 219a, 219b, 219c) of the assembly (100) holds the second frame element (103a, 103b; 203) in the deflected state when assembled with the first frame element (102; 202).
- [Claim 3] 3. The assembly (100) of any of claims 1 or 2, wherein a frame (109) of the first frame element (102) comprises a plurality of spacing elements (116) arranged spaced apart from corners of the frame (209) of the first frame element (102), wherein the spacing elements are configured to generate a force to the frame (109) away from the support portion (101a, 101b).
- [Claim 4] The assembly (100) of claim 3, wherein each spacing element (116) comprises a screw (116, 116a, 116b) arranged in a hole of the frame (109).
- [Claim 5] The assembly (100) of claim 4, wherein each spacing element (116) comprises a screw with a predefined length, and a spacer arranged

between a head of the screw and the frame (109).

[Claim 6] 6. The assembly (100) of any of the previous claims, wherein assembly (100) comprises a plurality of attachment elements (112) arranged around the frame (109) for attaching the first frame element (102) to said panel (1).

[Claim 7] The assembly (100) of claim 6, wherein each attachment element (112) comprises a plurality of screws (112a, 112b, 112c, 113a, 113b) arranged in holes of the frame (109), wherein at least one of said screws (112a, 113b) is arranged to apply a first force to the frame (109) towards the support portion (101a, 101b), and at least one other of said screws (112b, 112c, 113b) is arranged to apply a second force to the frame (109) away from the support portion (101a, 101b).

[Claim 8] 8. The assembly (100) of claim 7, wherein each attachment element (112) comprises at least two screws (113a, 113b), wherein a first screw (113a) of said two screws is arranged opposing the support portion (101a, 101b) and to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (113b) of said two screws is arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b) and to apply said second force to the frame (109) away from the support portion (101a, 101b).

[Claim 9] The assembly (100) of claim 7, wherein each attachment element (112) comprises at least three screws (112a, 112b, 112c), wherein all three screws are arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b), and wherein a first screw (112a) of said three screws is arranged to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (112b) and a third screw (112c) of said three screws are arranged to apply said second force to the frame (109) away from the support portion (101a, 101b), the first screw (112a) being arranged between the second screw (112b) and the third screw (112c).

[Claim 10] 10. The assembly (100) of any of the previous claims, wherein a gasket (205) is arranged on another support portion (201a) of the second frame element (202), wherein the gasket (205) has a varying thickness along its length.

[Claim 11] The assembly (100) of claim 10, wherein the gasket (205) has opposing ends, and is thinner between the opposing ends than at said ends.

[Claim 12] The assembly (100) of claim 11, wherein a first section (205a) of the

gasket (205) at one of said ends and a second section (205b) of the gasket (205) at the other of said ends has a first thickness, and at least a third section (205c) of the gasket between the first section (205a) and the second section (205b) has a second thickness, wherein the first thickness is thicker than the second thickness.

[Claim 13]

13. The assembly (100) of any of claims 10-12, wherein the second frame element (203) comprises a frame side and the third frame element comprises an edge cover, and wherein the edge cover comprises another support portion for said panel (1), wherein a distance between the support portion of the frame side and the support portion of the edge cover is discontinuous in an assembled state.

[Claim 14]

The assembly (100) of claim 13, wherein the frame side comprises a first hole (217a) and a second hole (217b) arranged at opposing ends of the frame side and in a first plane, and a third hole (217c) arranged between the first hole (217a) and the second hole (217c) and in a plane that is different from the first plane, and

the edge cover comprises a first hole (218a) and a second hole (218b) arranged at opposing ends of the edge cover, and a third hole (218c) arranged between the first hole (218a) and the second hole (218c) of the edge cover, wherein the first hole (218a), the second hole (218b), and the third hole (218c) of the edge cover are generally arranged in the same plane when the edge cover is disconnected from the frame side, and

wherein the edge cover is less stiff than the frame side and deflectable such that the holes (218a, 218b, 218c) of the edge cover are aligned with the holes (217a, 217b, 217c) of the frame side and such that the support portion of the edge cover extends in a plane, which is curved.

[Claim 15]

15. A method for assembling a panel and a plate for an optical touch sensitive system, comprising:

providing a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);

providing at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2);

supporting the plate (2) by the support portion (101a, 101b, 201b);

attaching the second frame element to the first frame element (102; 202) such that

the support portion (101a, 101b; 201b) extends at least partially in a second plane generally opposite at least a portion of the first frame

element (102; 202) and is spaced apart from the first plane; and controlling a curvature of the first frame element (102; 102) with a spacing element (116) attached to the first frame element (102; 202) and thereby tilting the support portion (101a, 101b, 201b) to control a curvature of the plate (2).

- [Claim 16] 16. 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.
- [Claim 17] 17. The touch sensing apparatus of claim 16, wherein the touch surface is curved in a second axis according to a second parabola.
- [Claim 18] 18. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.
- [Claim 19] 19. The touch sensing apparatus of claim 18, wherein the first parabolic curve paraboloid is an elliptical paraboloid.
- [Claim 20] 20. The touch sensing apparatus of claim 16, wherein each point of the first axis of the touch surface is within 0.5mm of a mathematical parabola.
- [Claim 21] 21. The touch sensing apparatus of claim 20, wherein the mathematical parabola is defined according to $z(x, y) = a + bx^2 + cx^2y^2 + dy^2$, where z is depth, and x and y are co-ordinates in the plane of the glass.
- [Claim 22] 22. The touch sensing apparatus of claim 16, wherein the touch surface comprises a portion of a surface of a plate.
- [Claim 23] 23. The touch sensing apparatus of claim 22, wherein the plate comprises a glass or plastic sheet.
- [Claim 24] 24. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

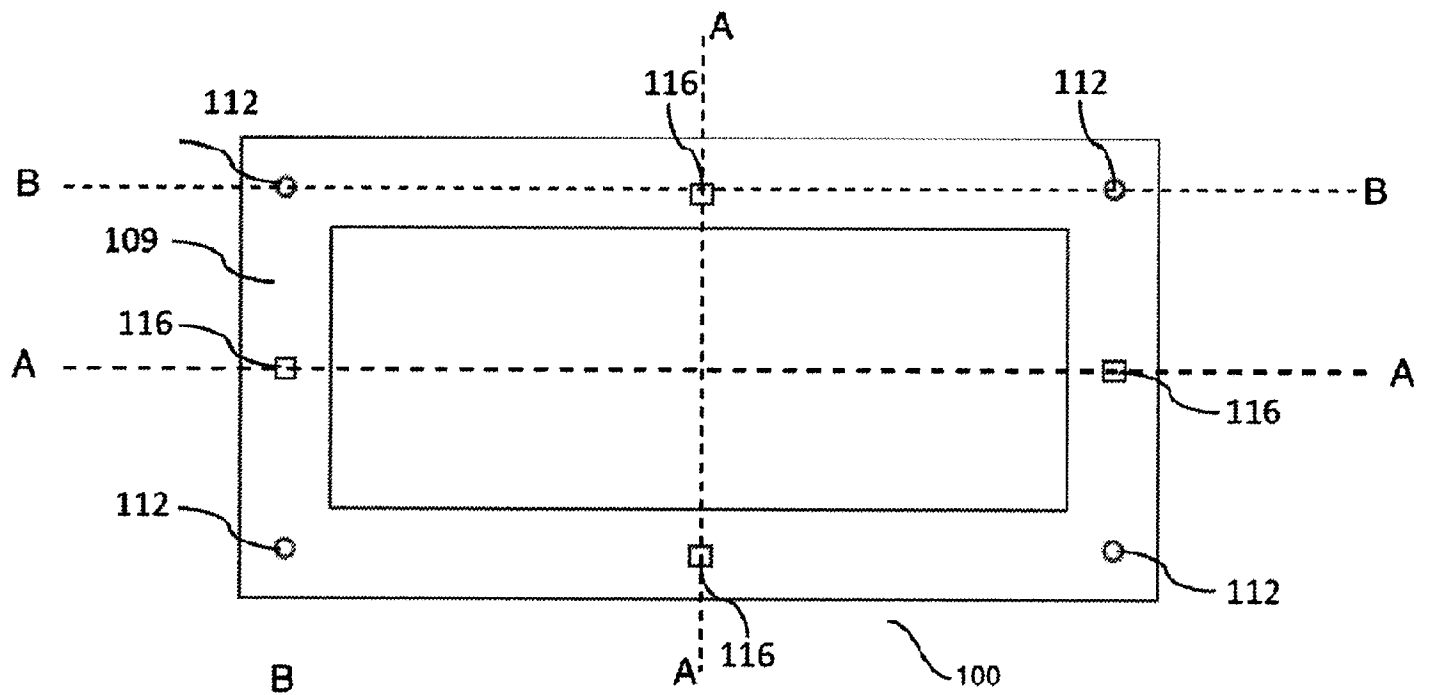


Figure 1

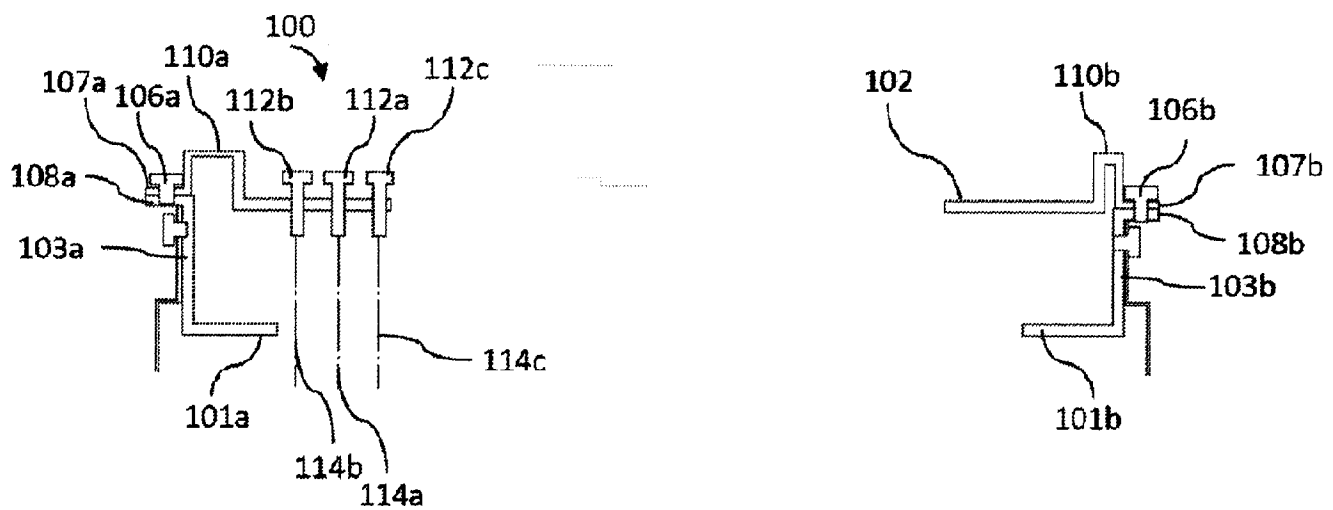


Figure 2a

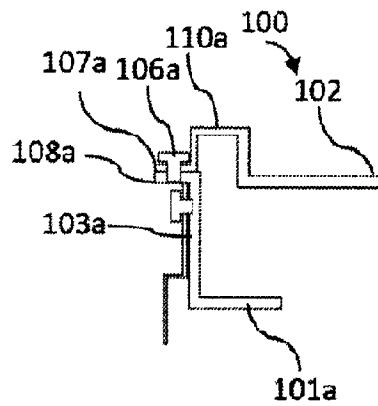
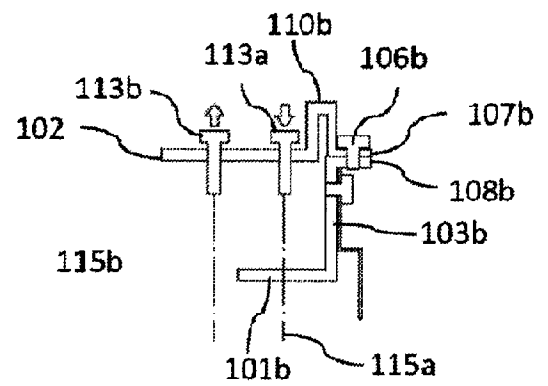


Figure 2b

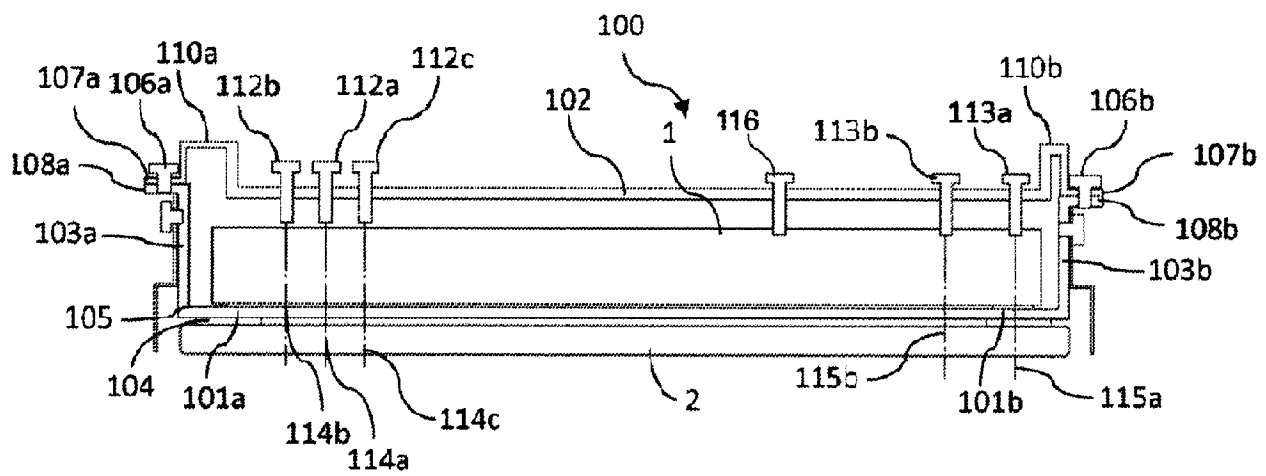


Figure 2c

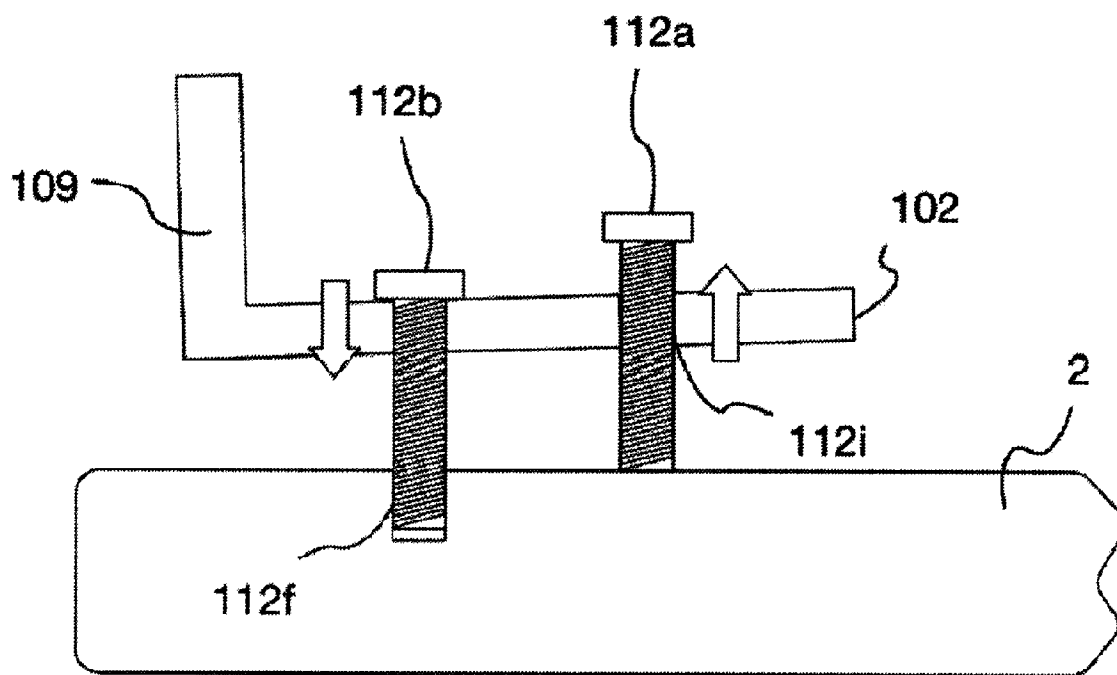


Figure 2d

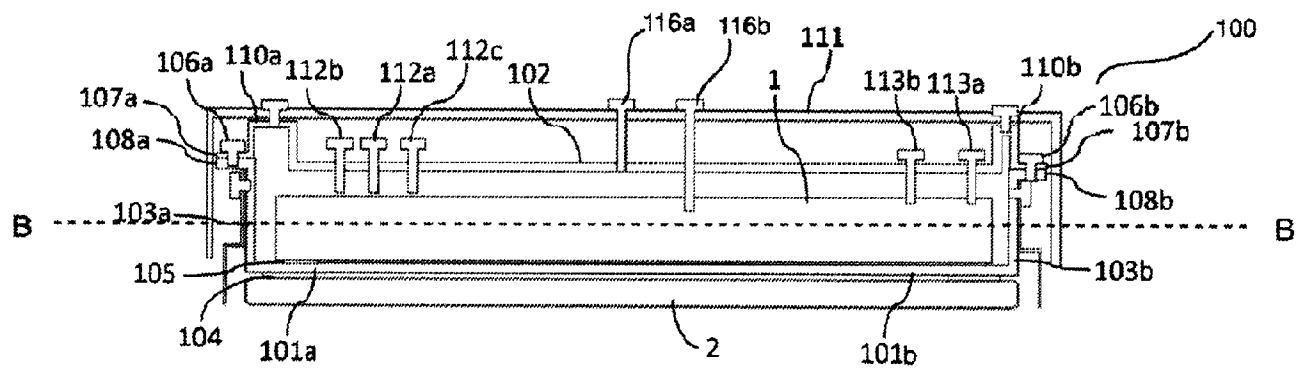


Figure 3a

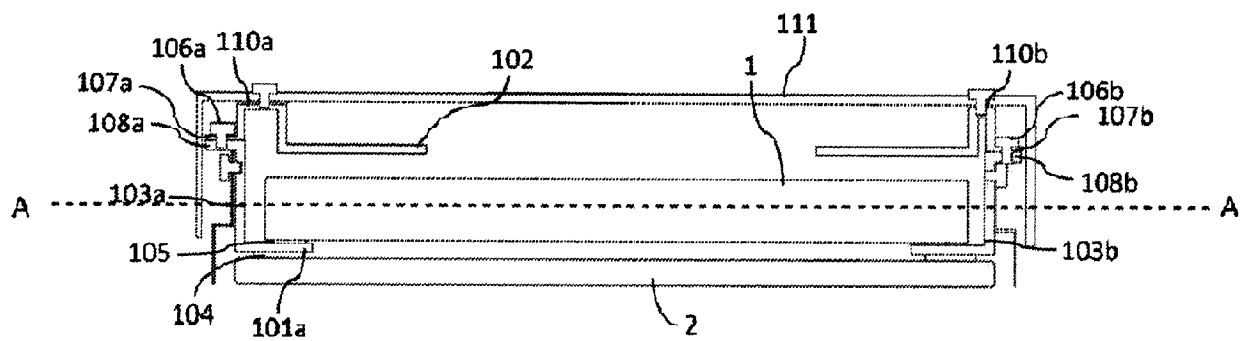


Figure 3b

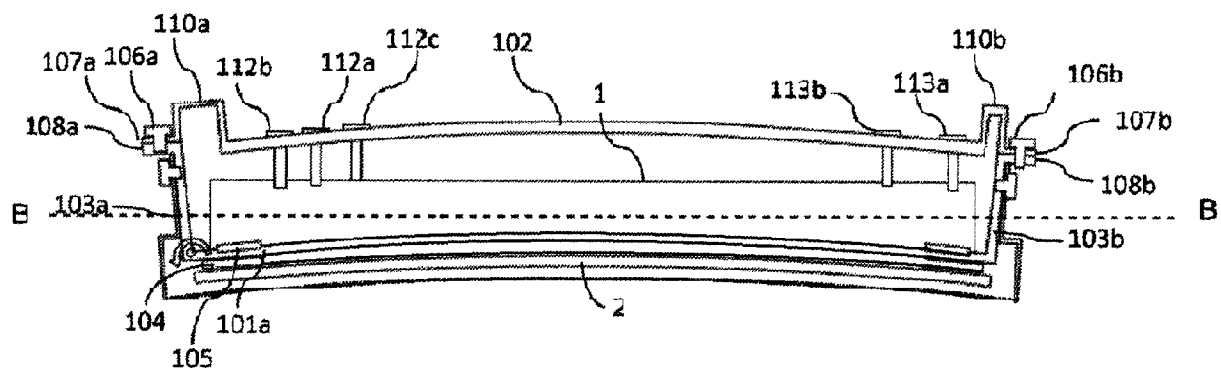


Figure 3c

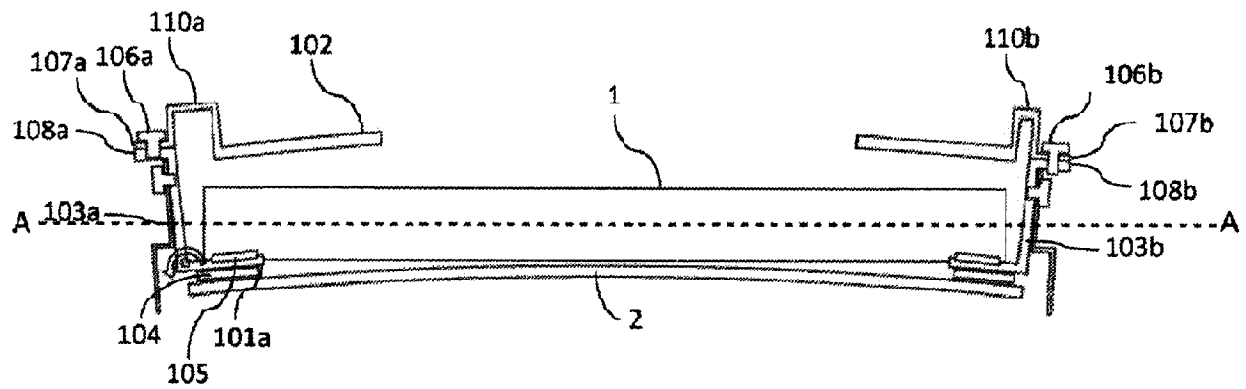


Figure 3d

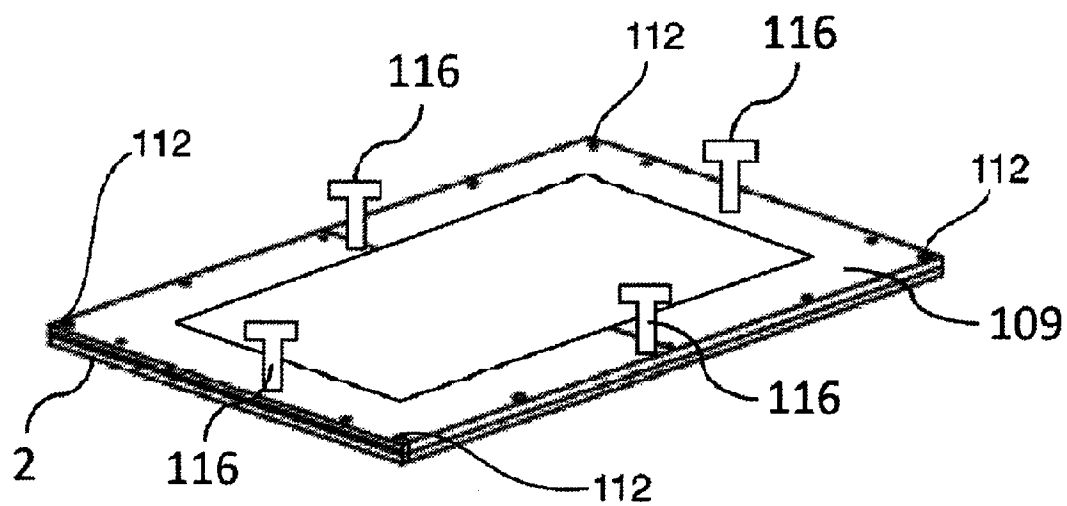


Figure 4a

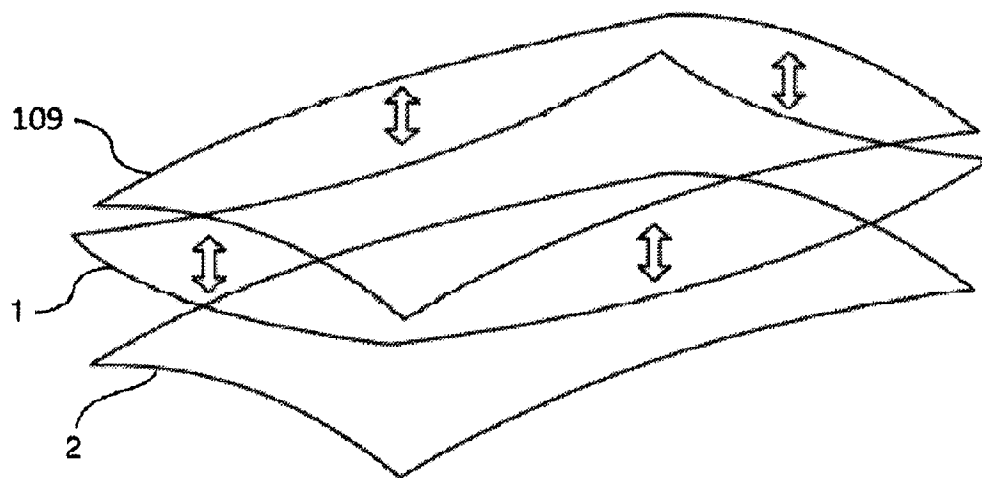


Figure 4b

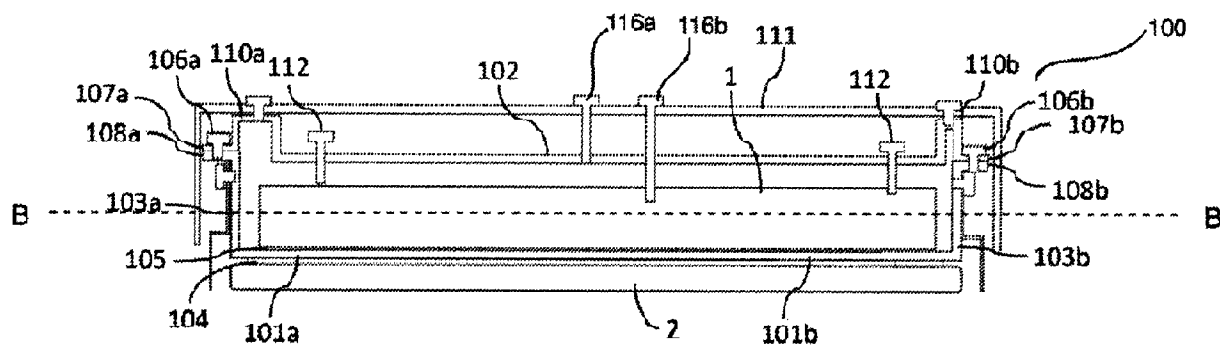


Figure 4c

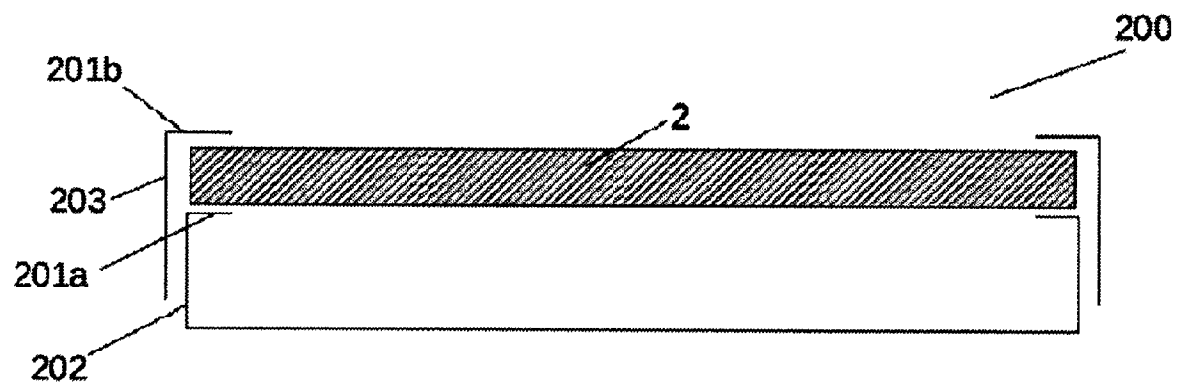


Figure 5a

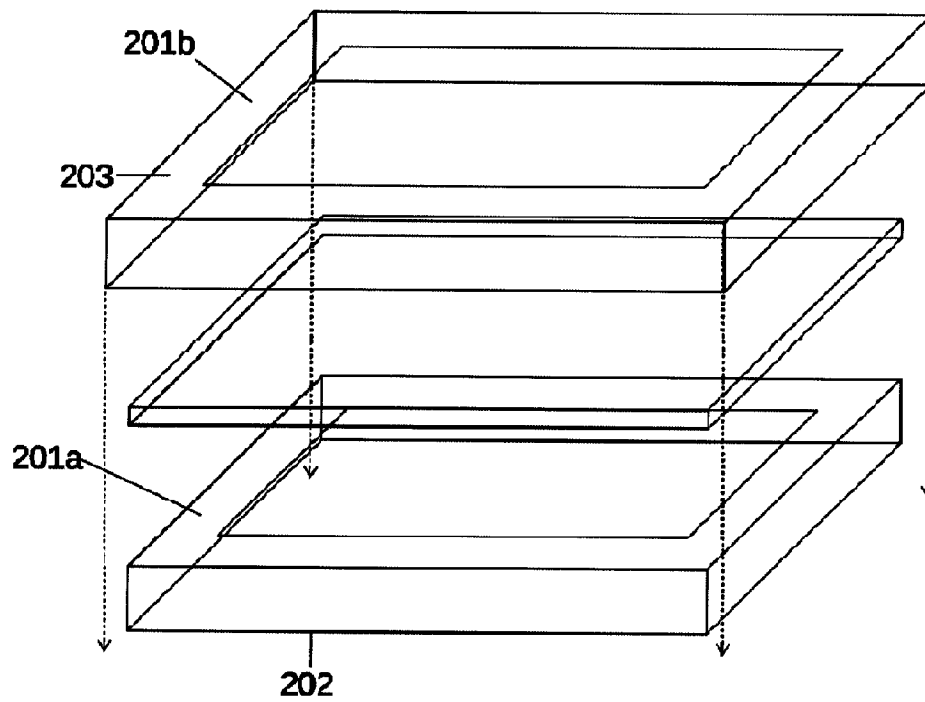


Figure 5b

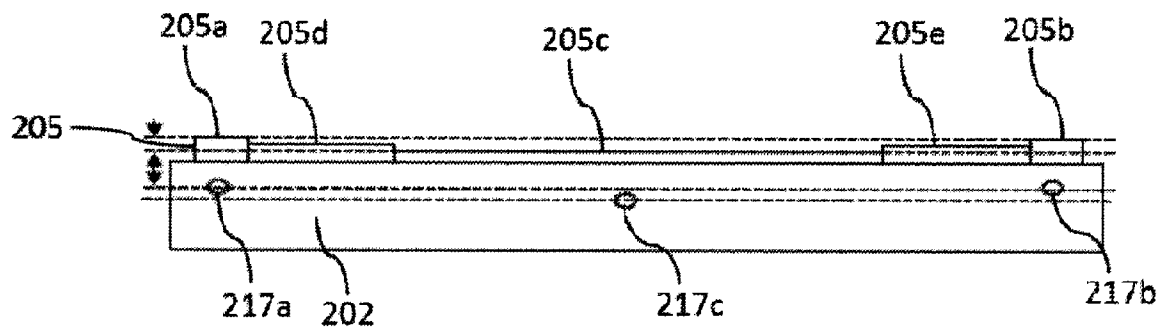


Figure 5c

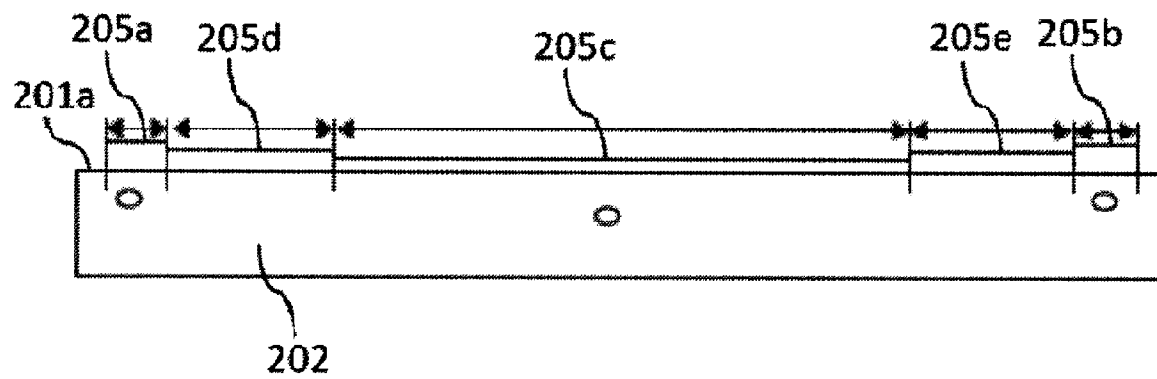


Figure 5d

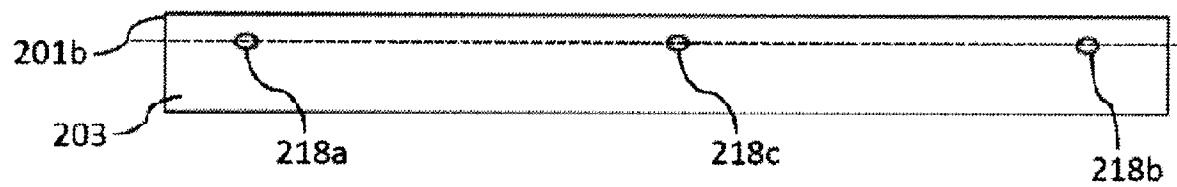


Figure 5e

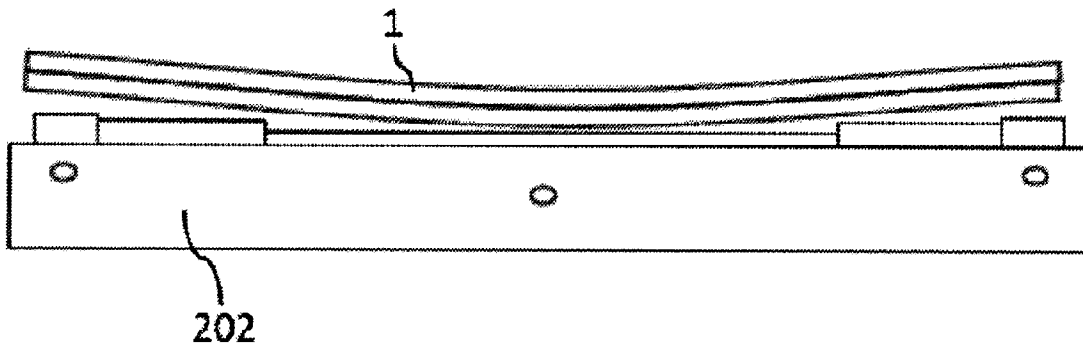


Figure 5f

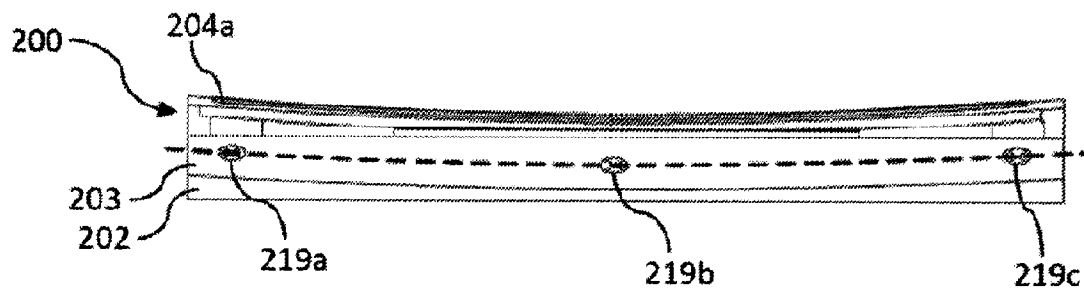


Figure 5g

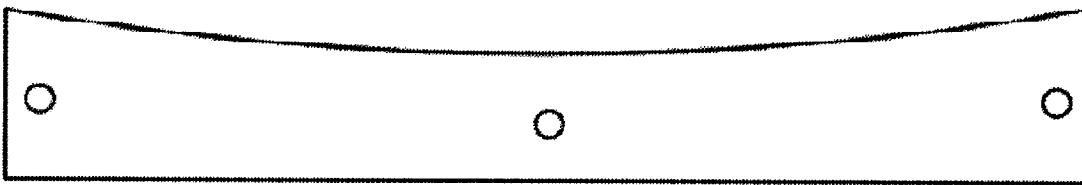


Figure 5h

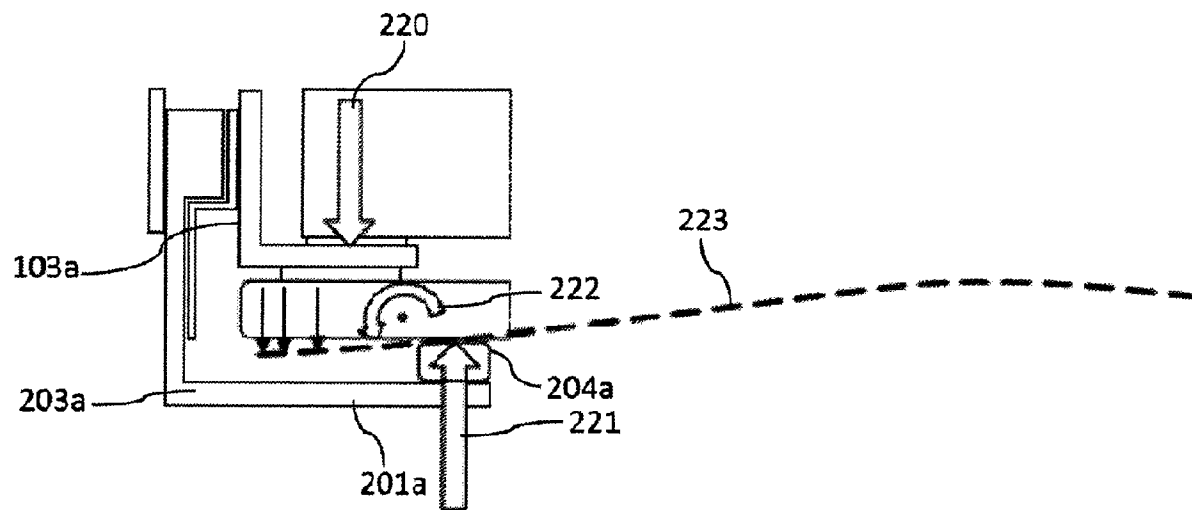


Figure 6

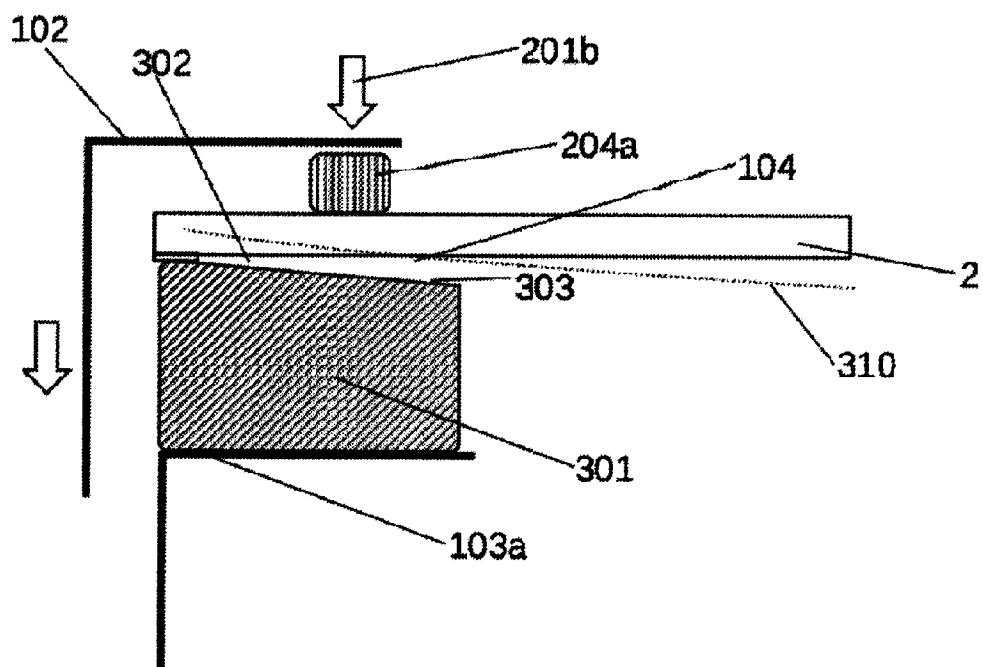


Figure 7

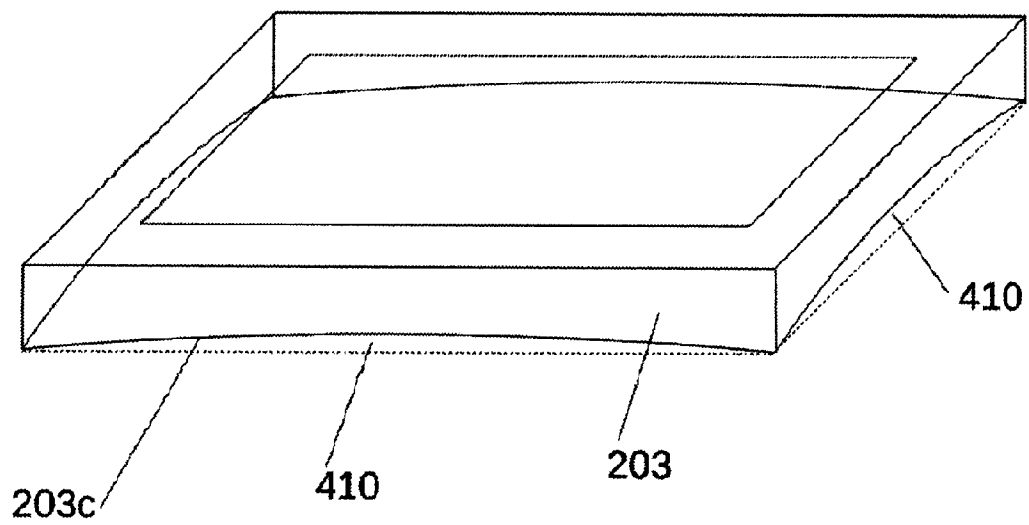


Figure 8

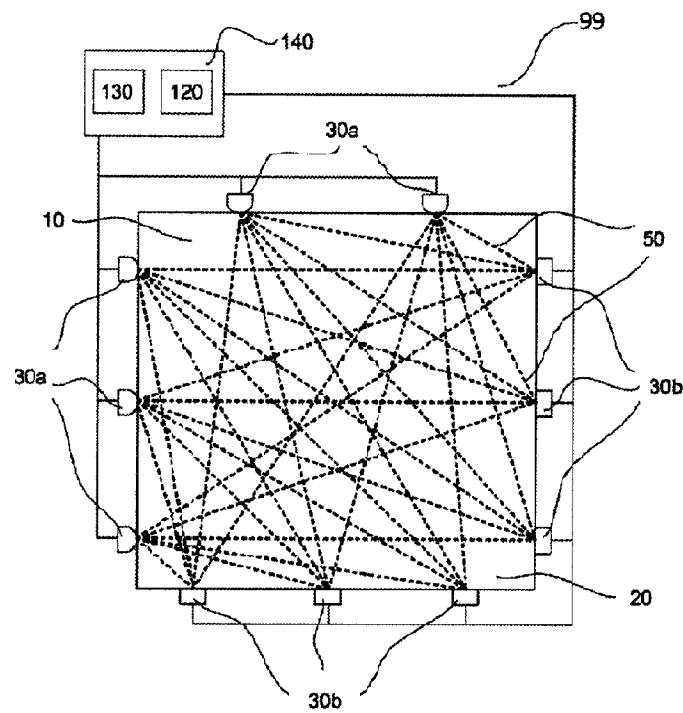


Figure 9

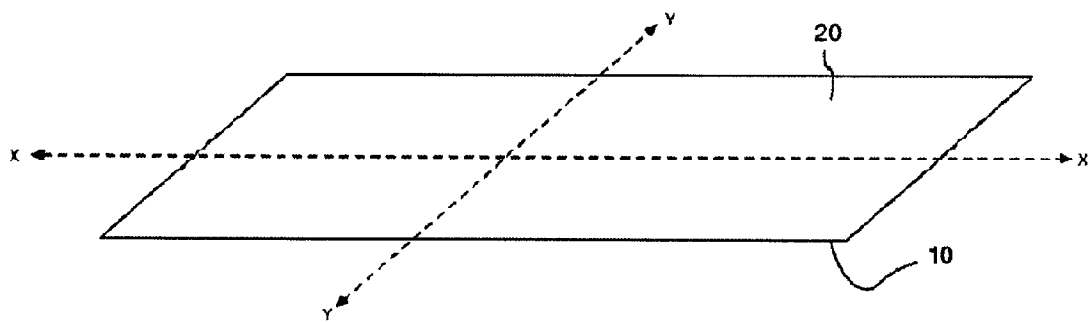


Figure 10a

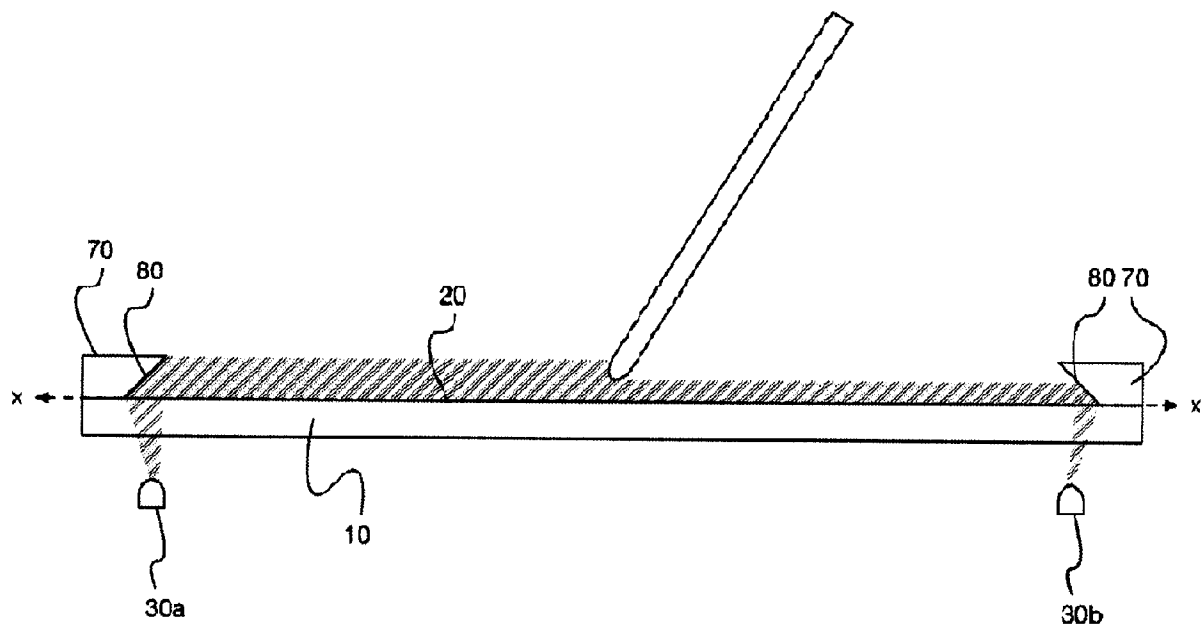


Figure 10b

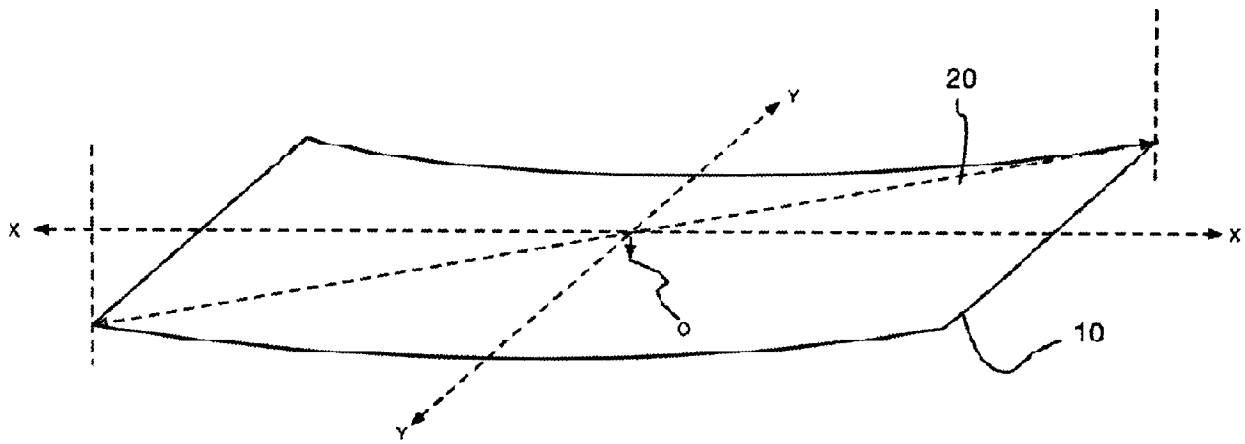


Figure 11a

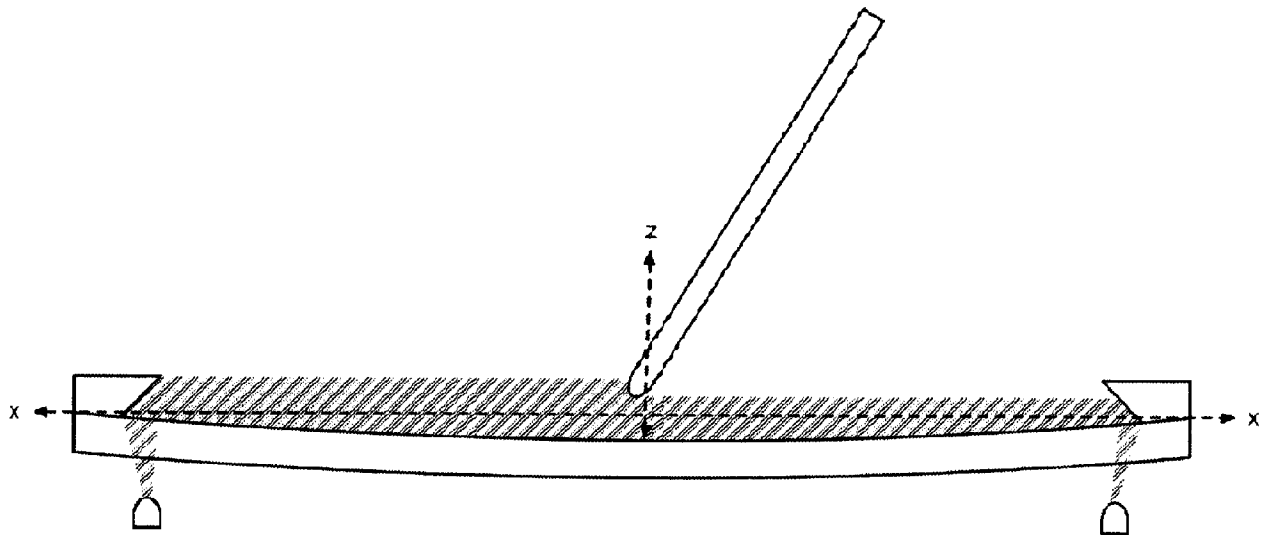


Figure 11b

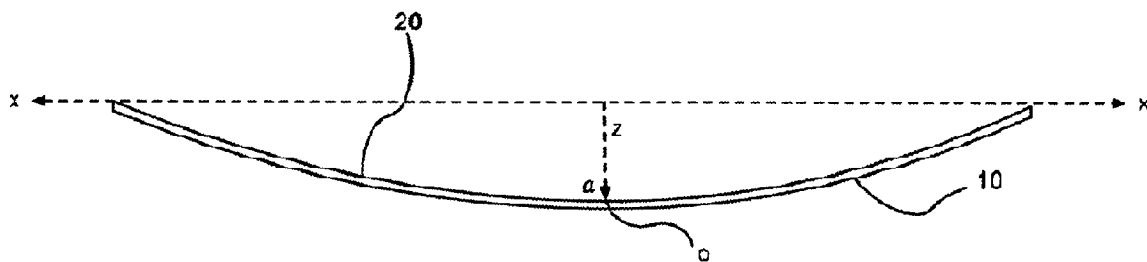


Figure 11c

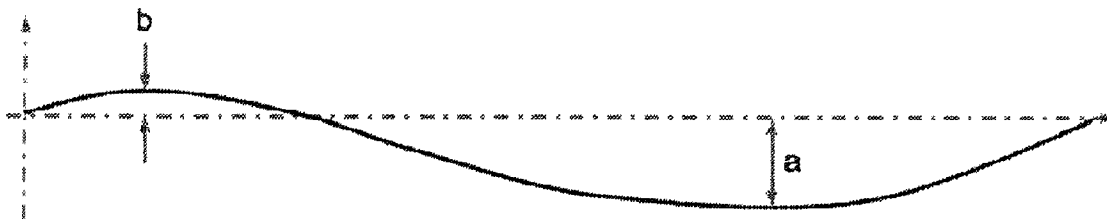


Figure 11d

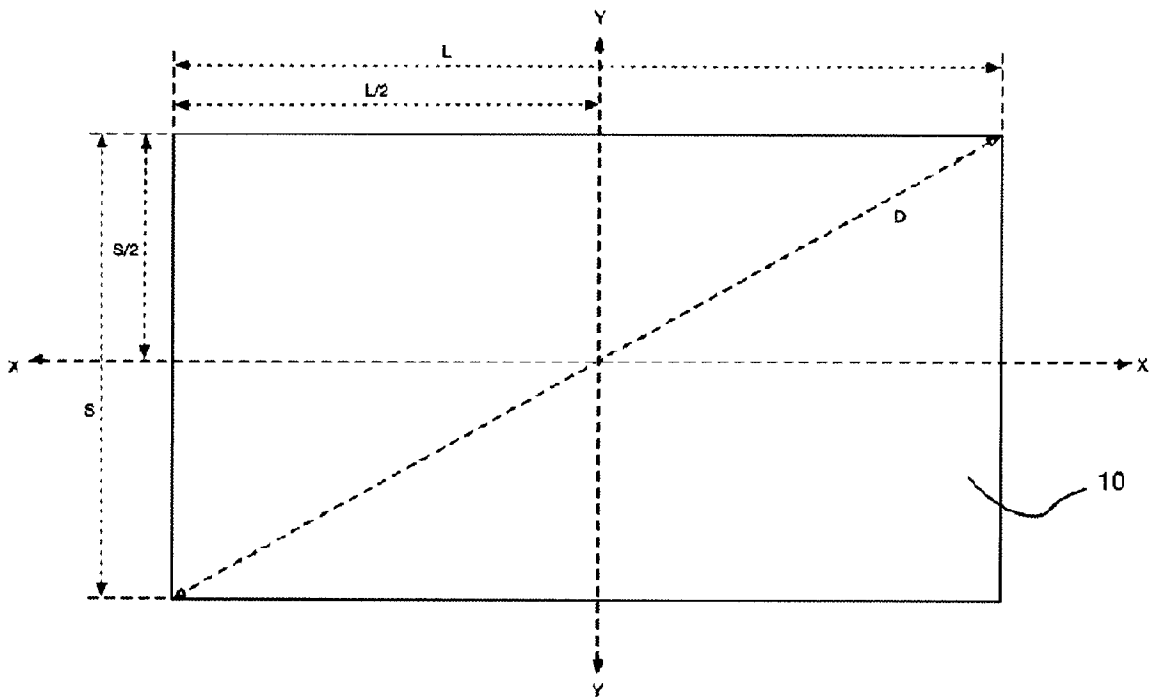


Figure 12a

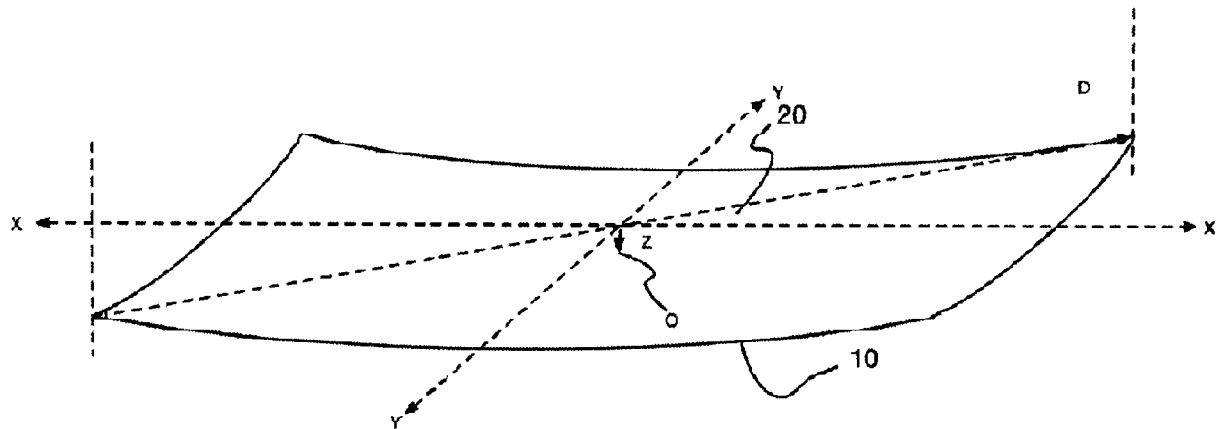


Figure 12b

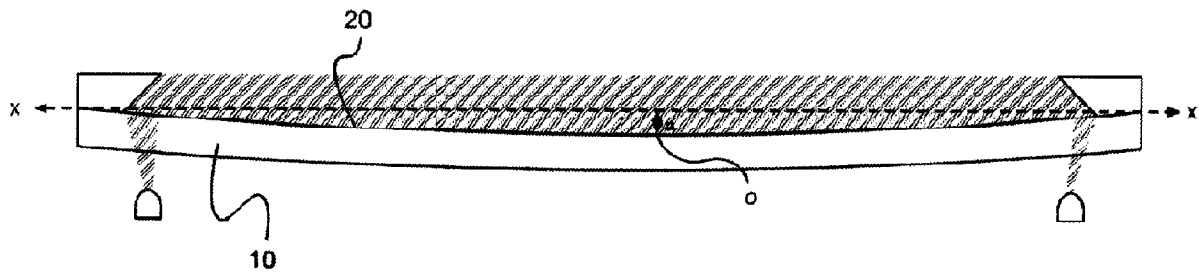


Figure 12c

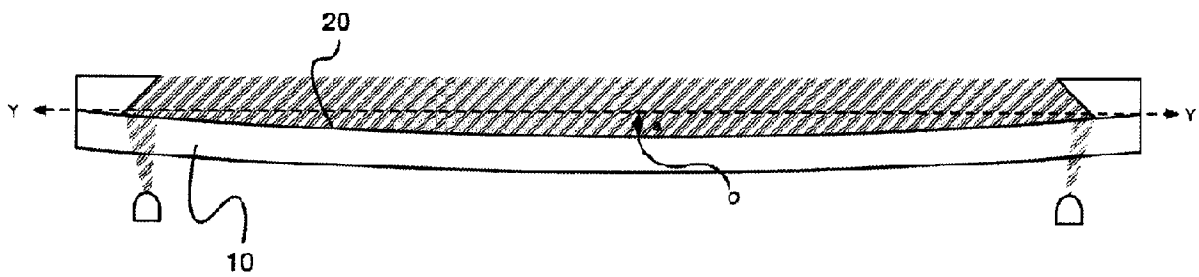


Figure 12d

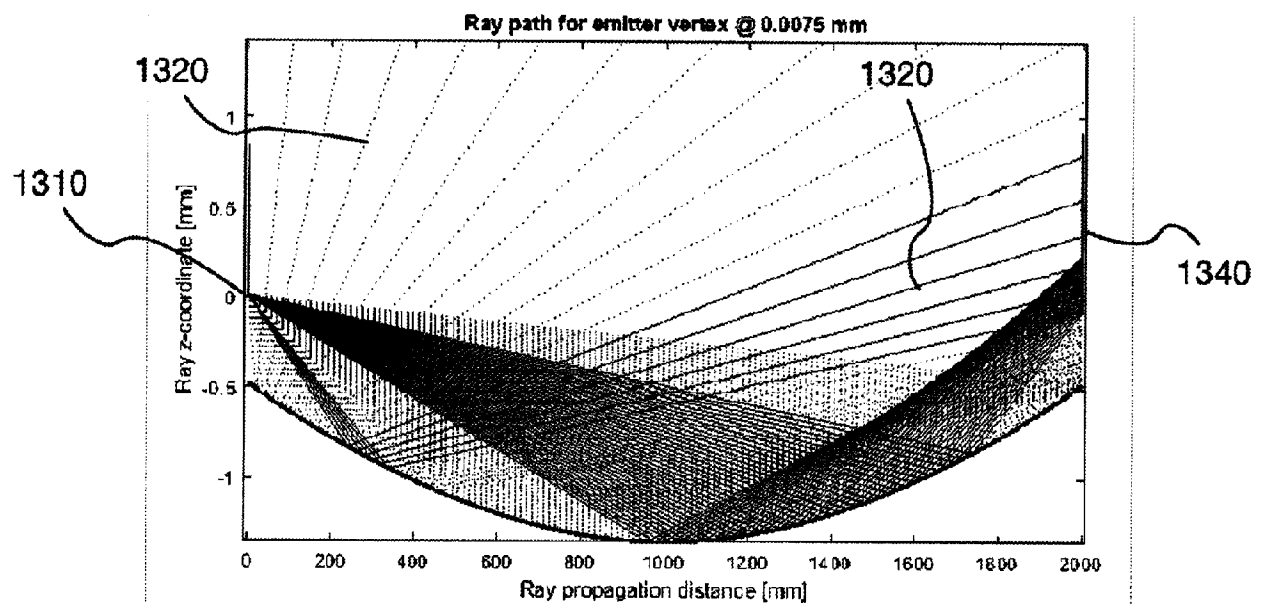


Figure 13a

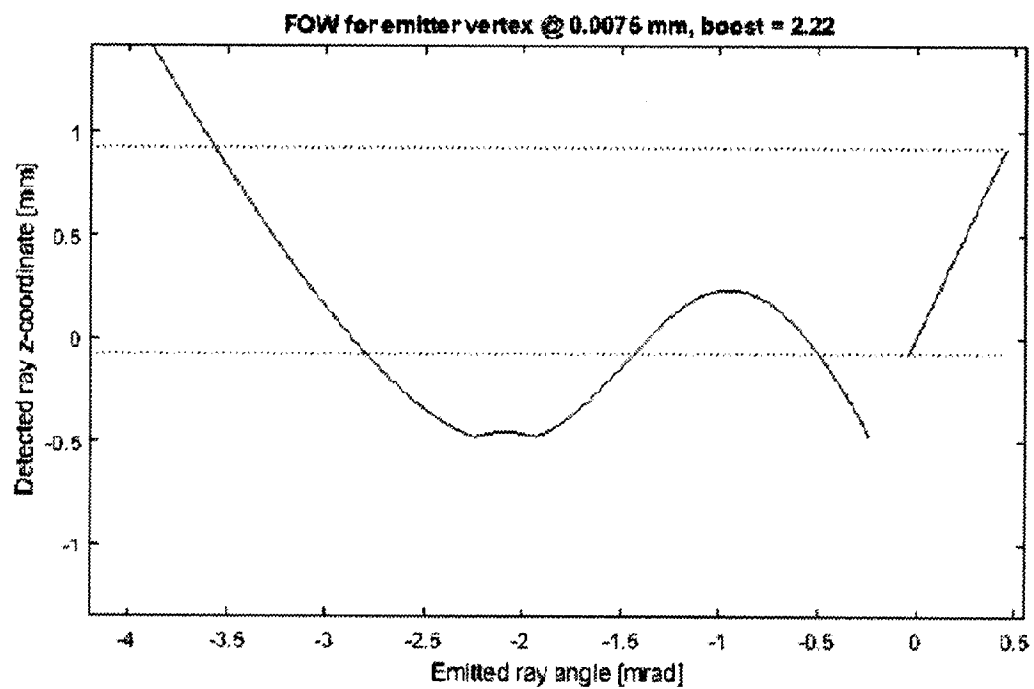


Figure 13b

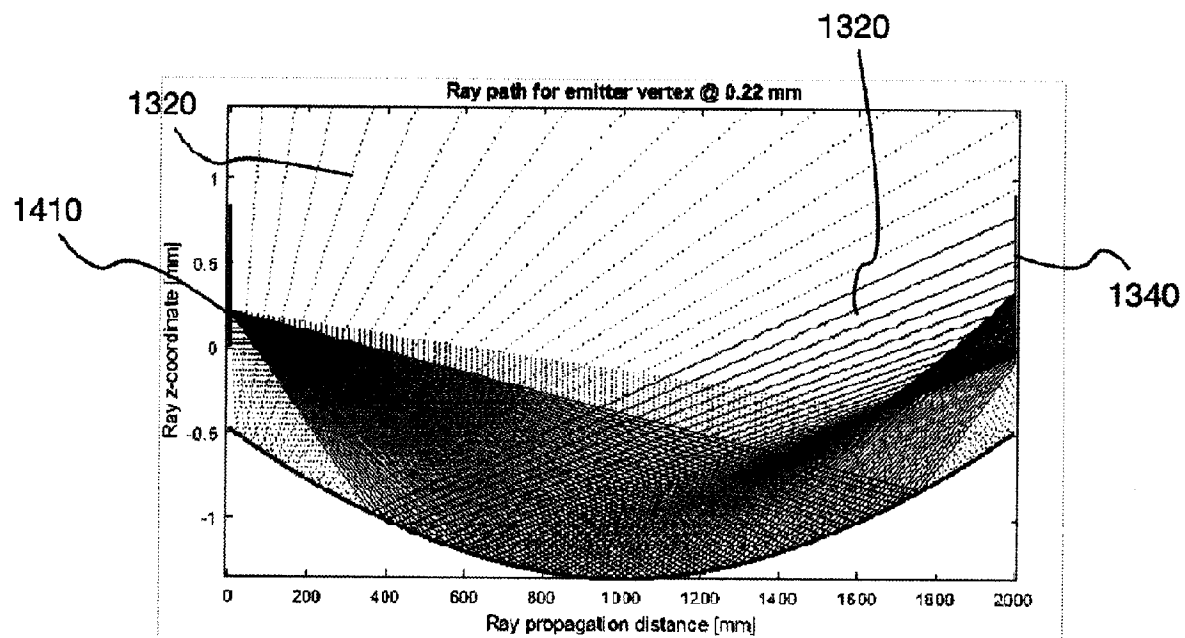


Figure 14a

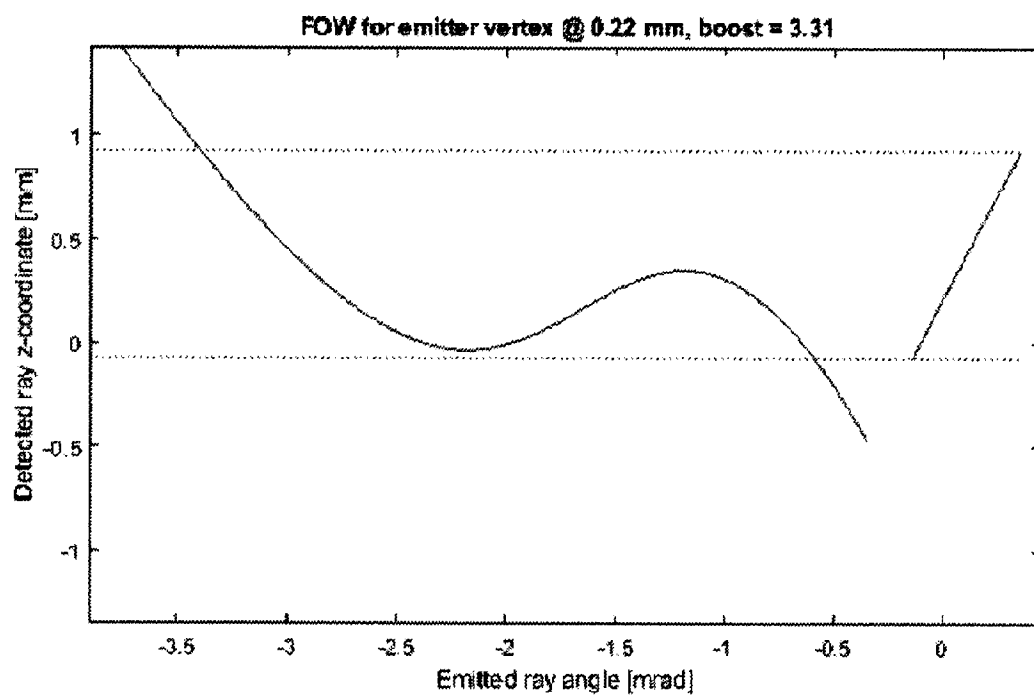


Figure 14b

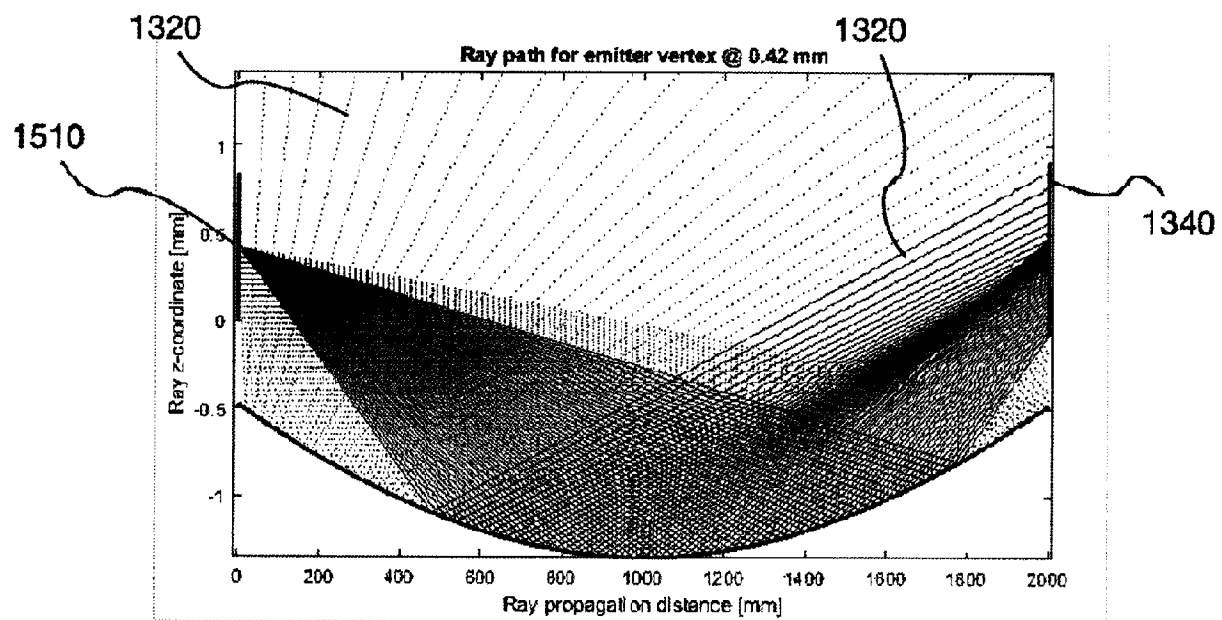


Figure 15a

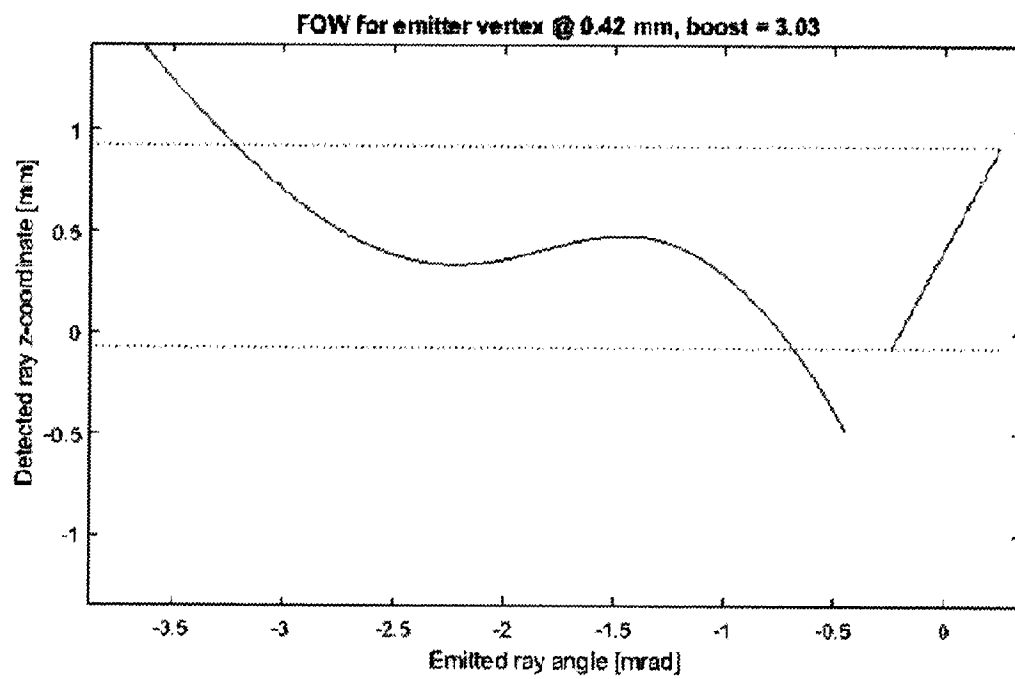


Figure 15b

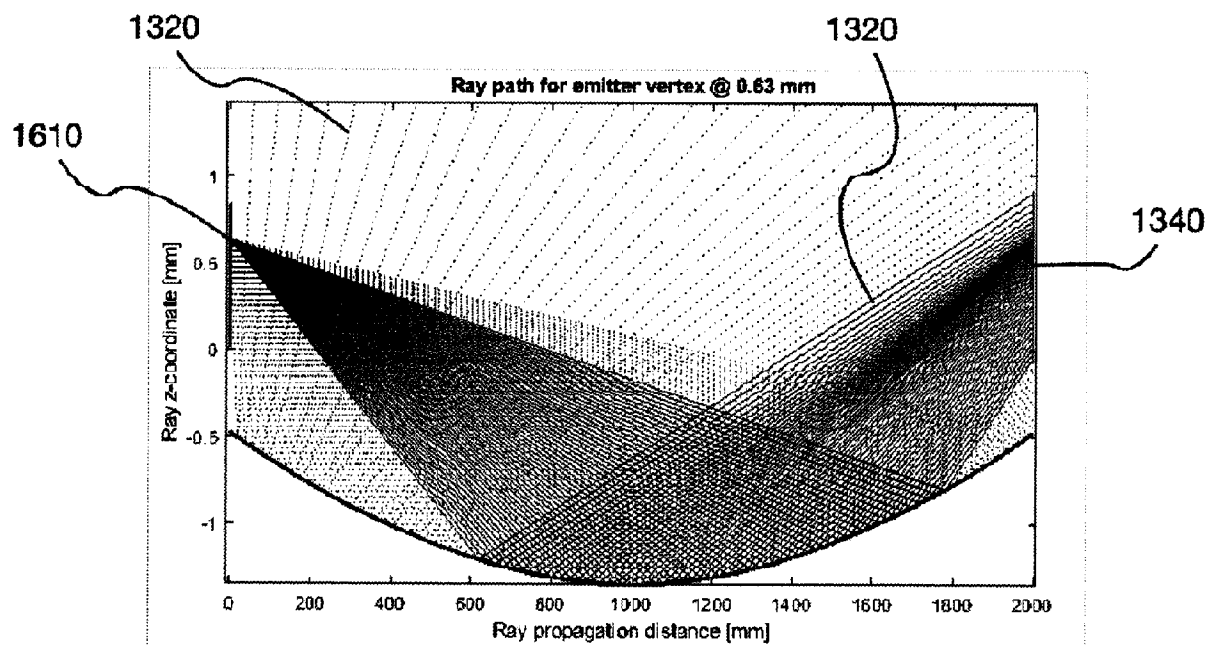


Figure 16a

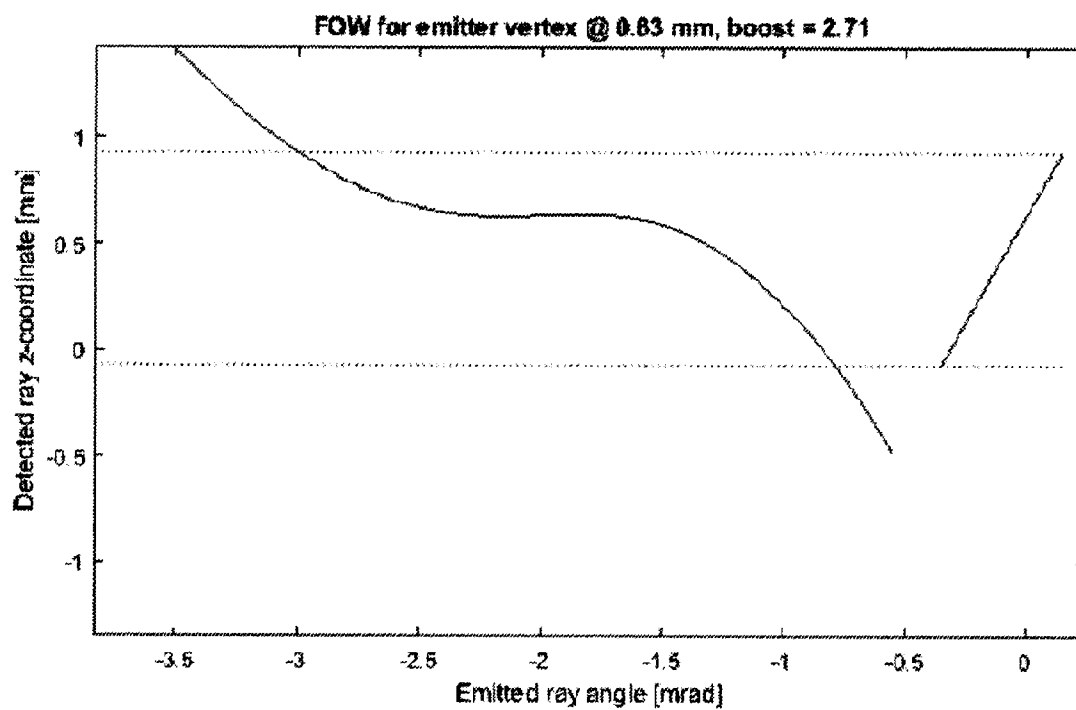


Figure 16b

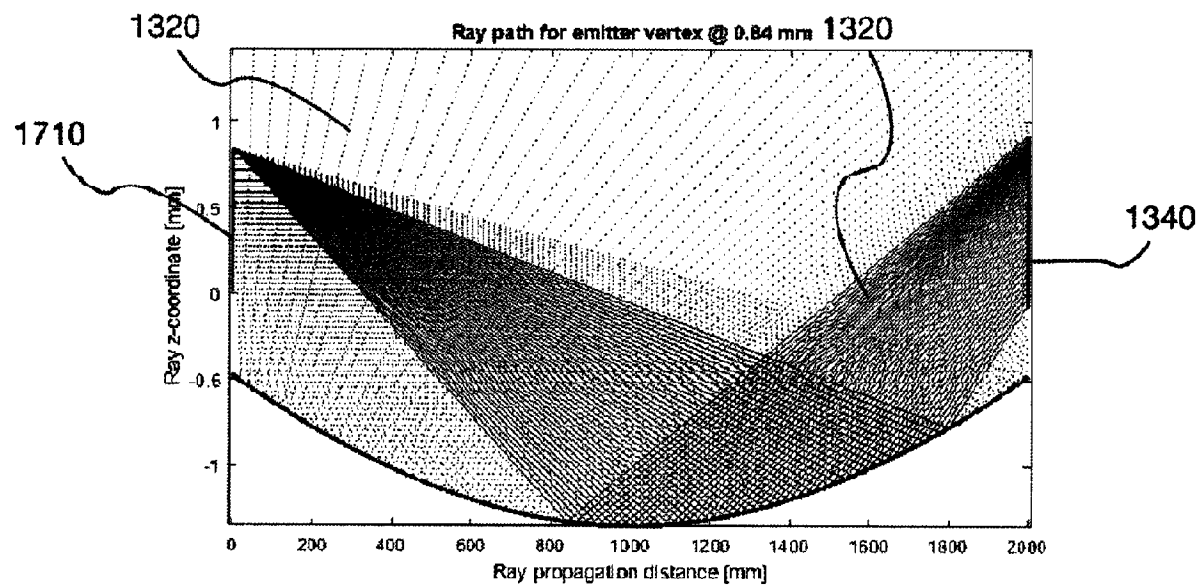


Figure 17a

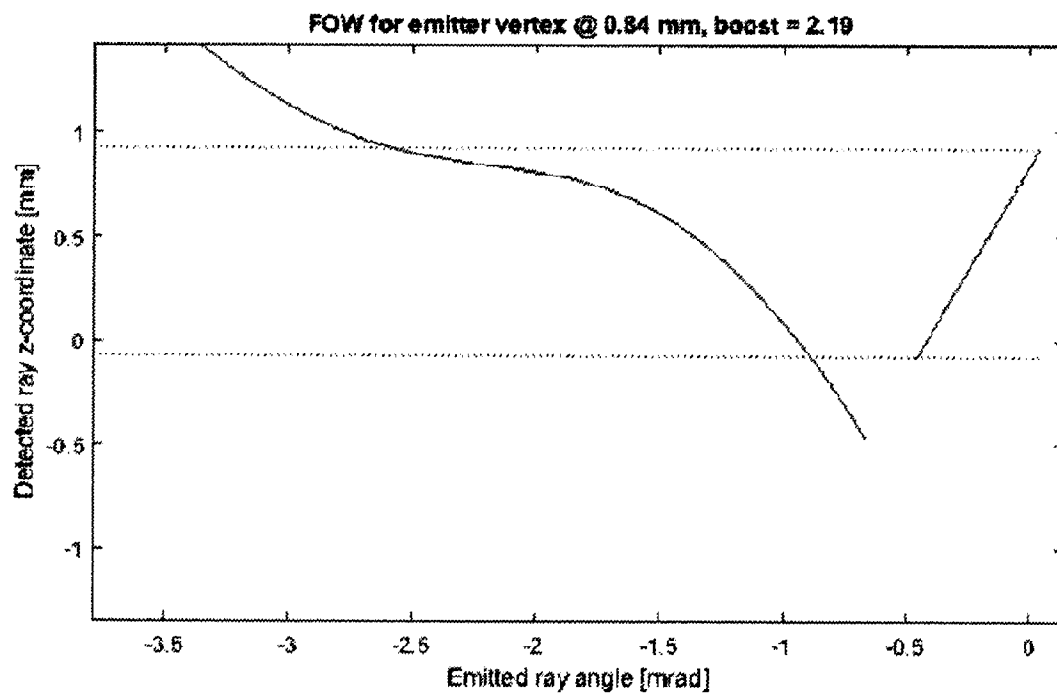


Figure 17b

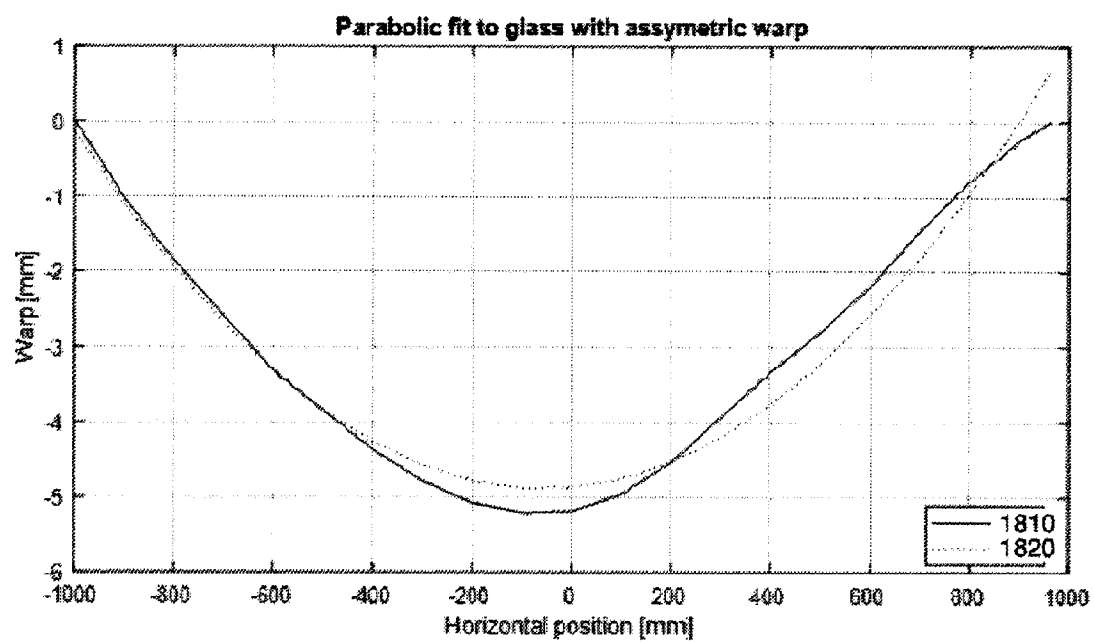


Figure 18a

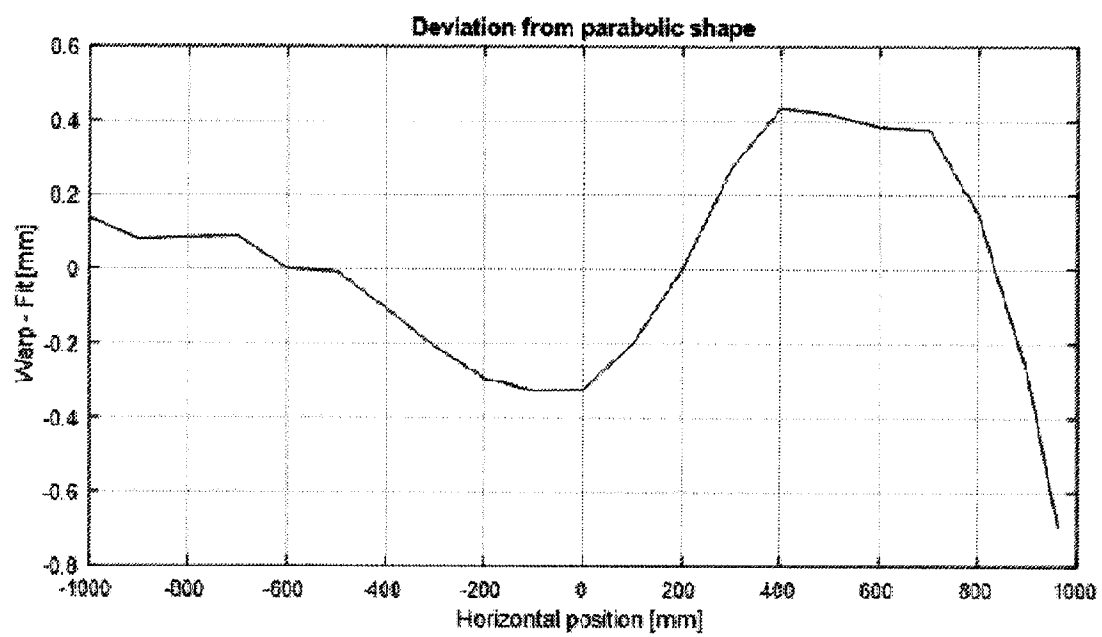


Figure 18b

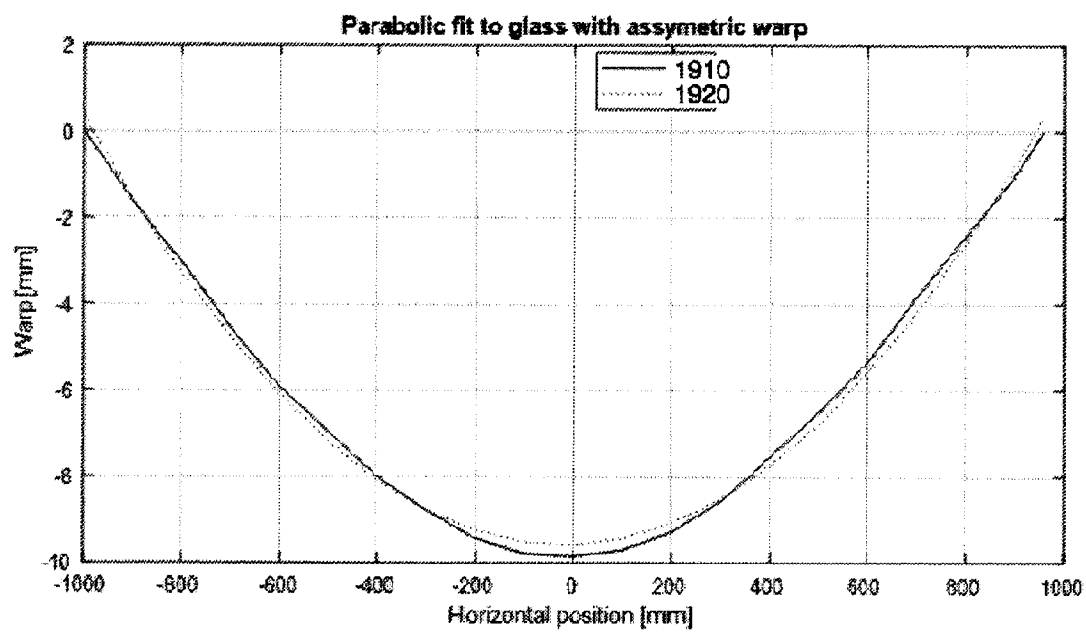


Figure 19a

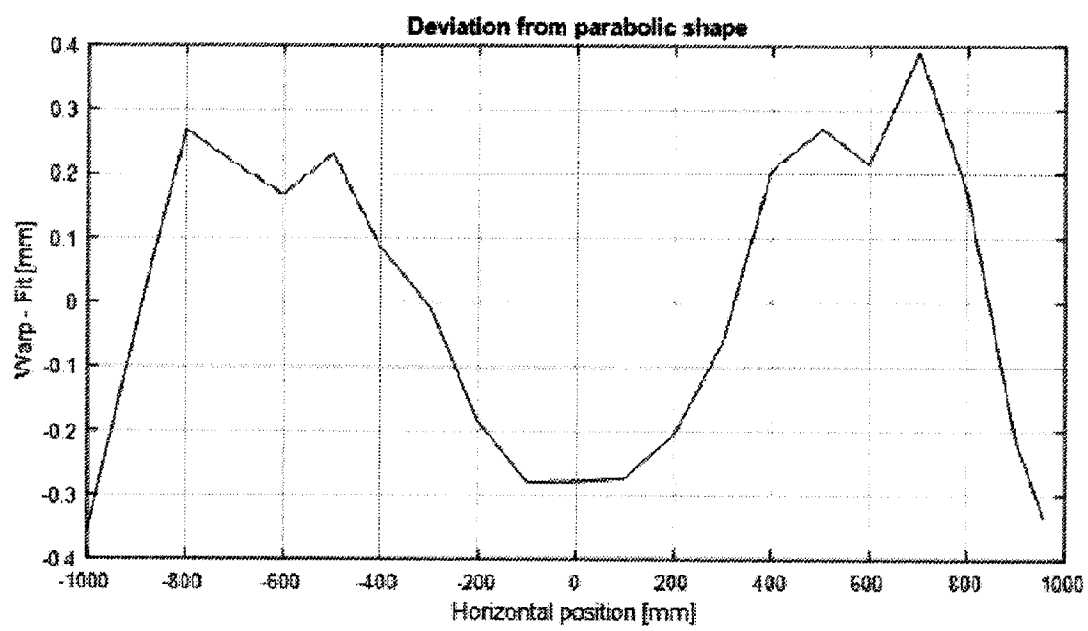


Figure 19b

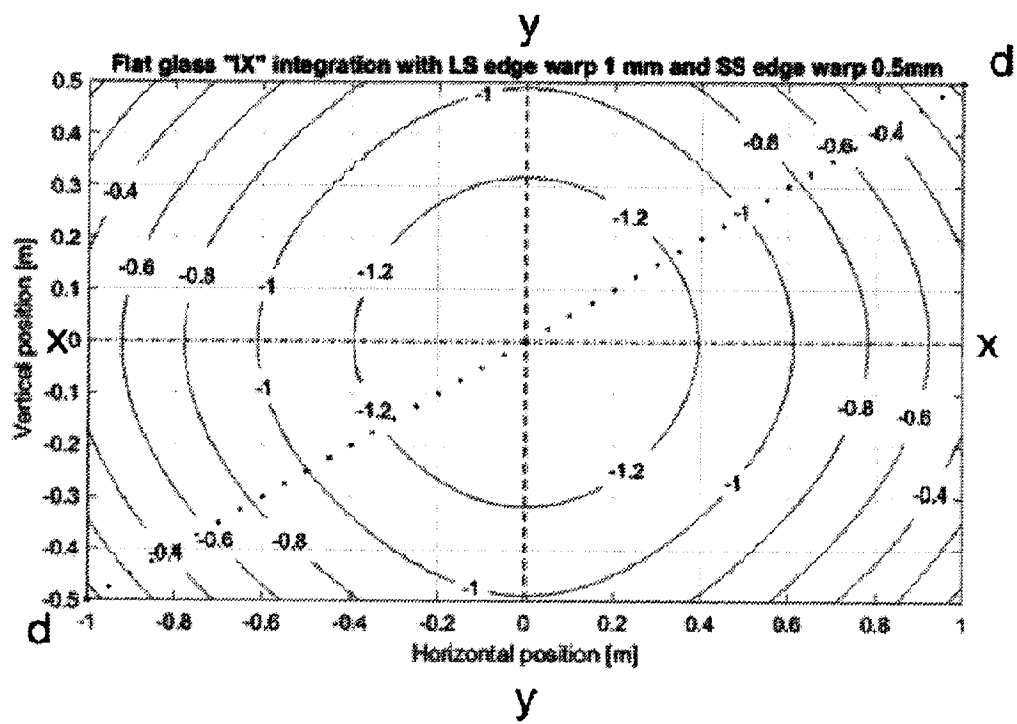


Figure 20a

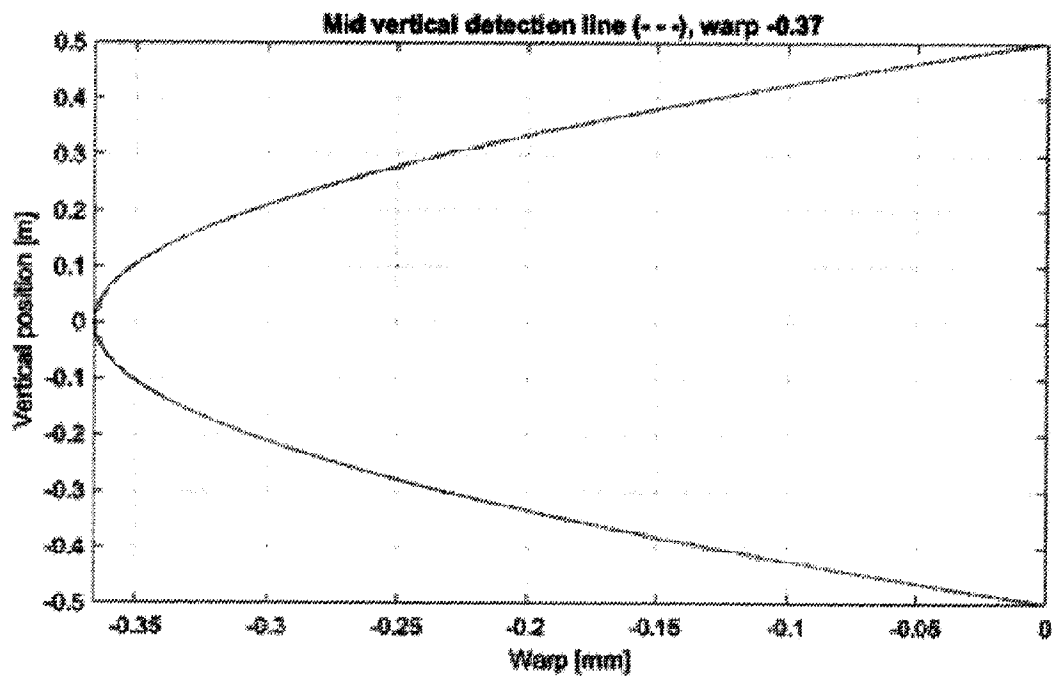


Figure 20b

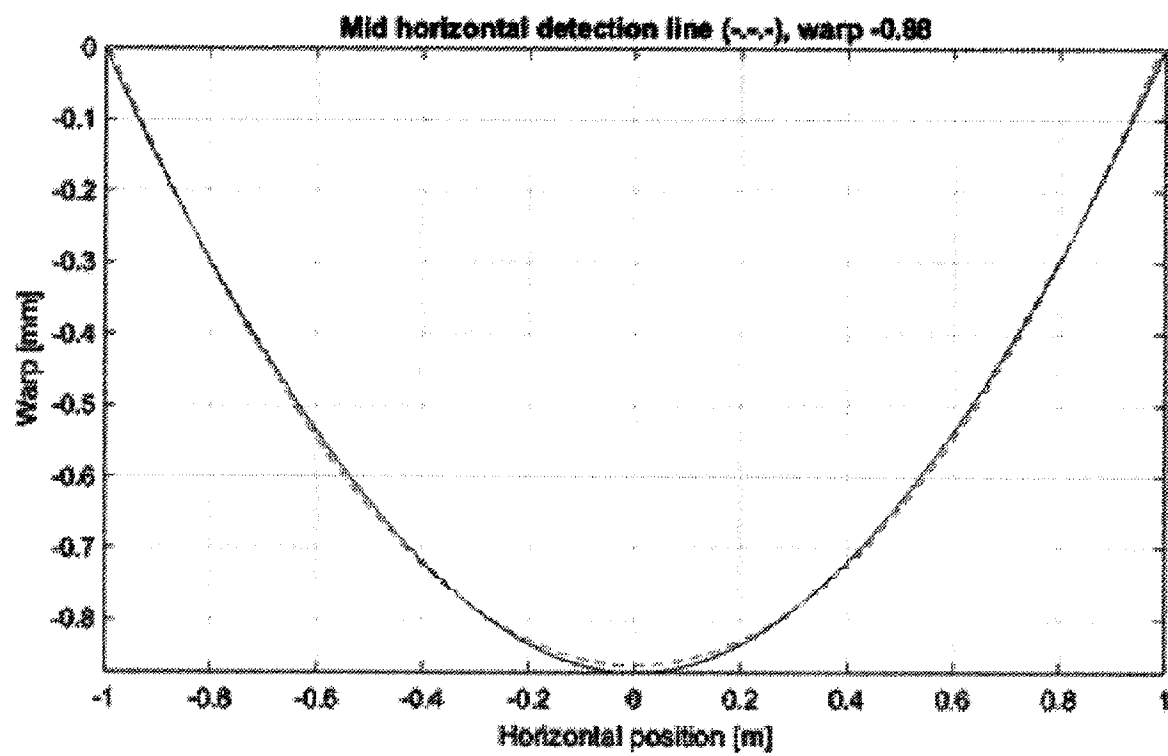


Figure 20c

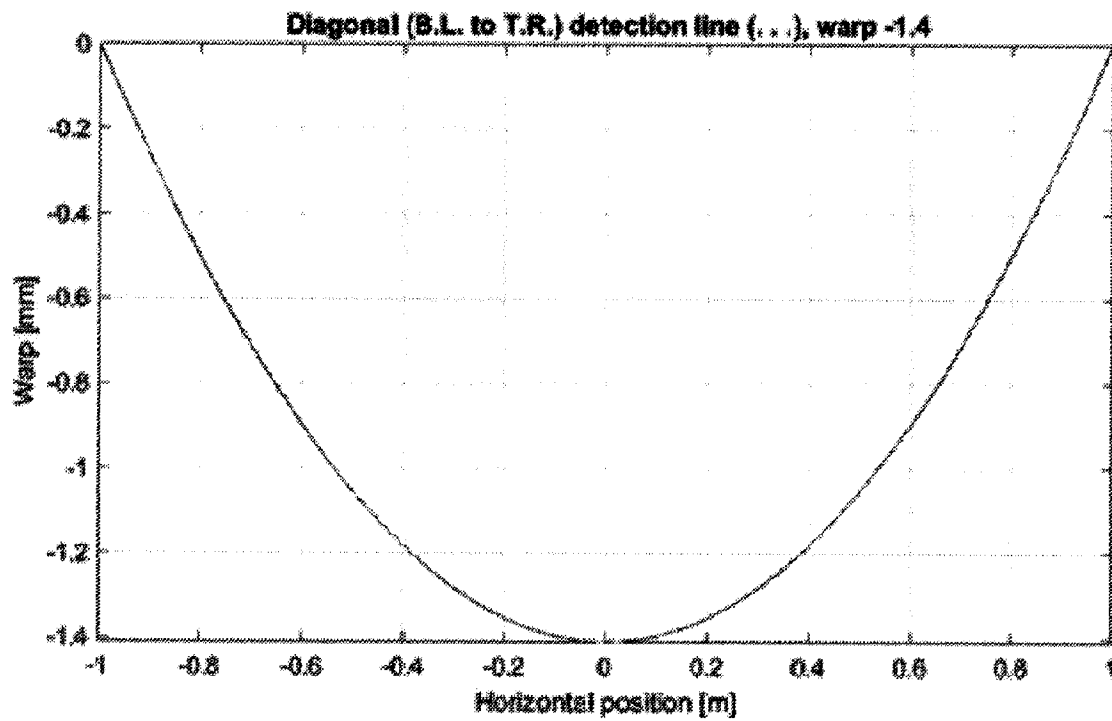
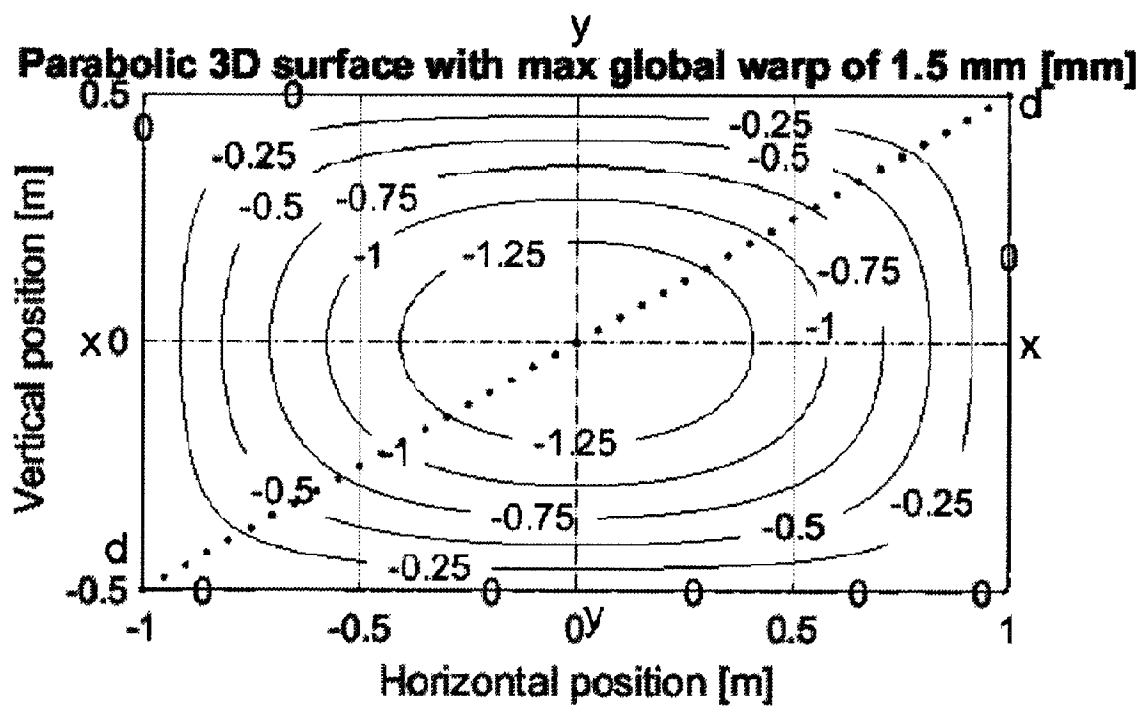


Figure 20d



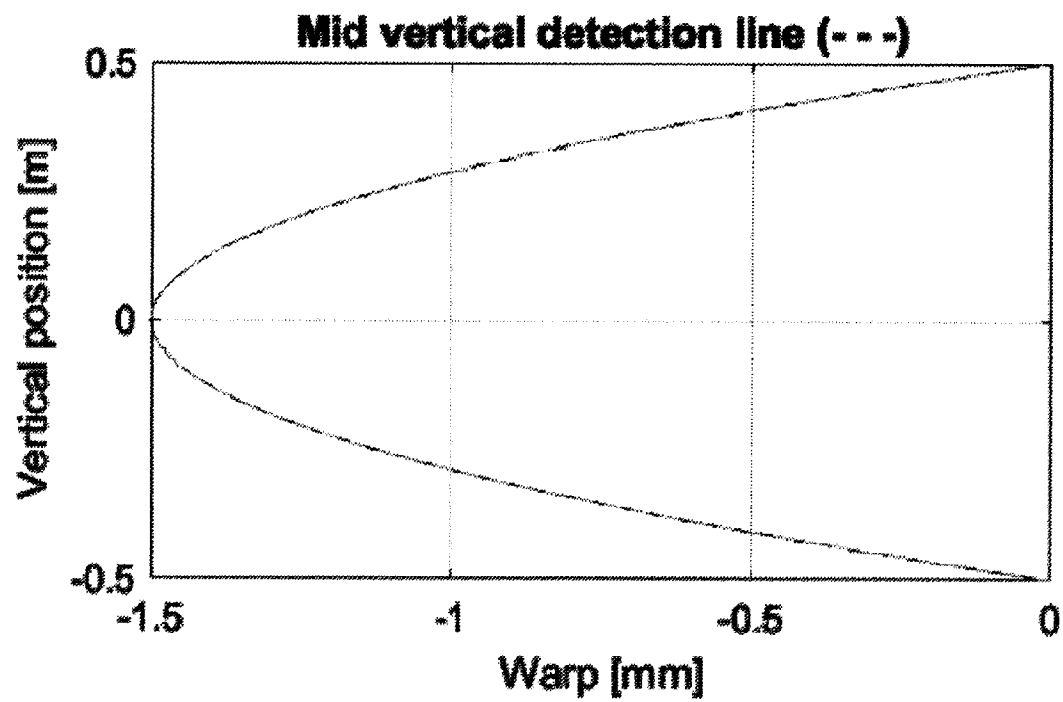


Figure 21b

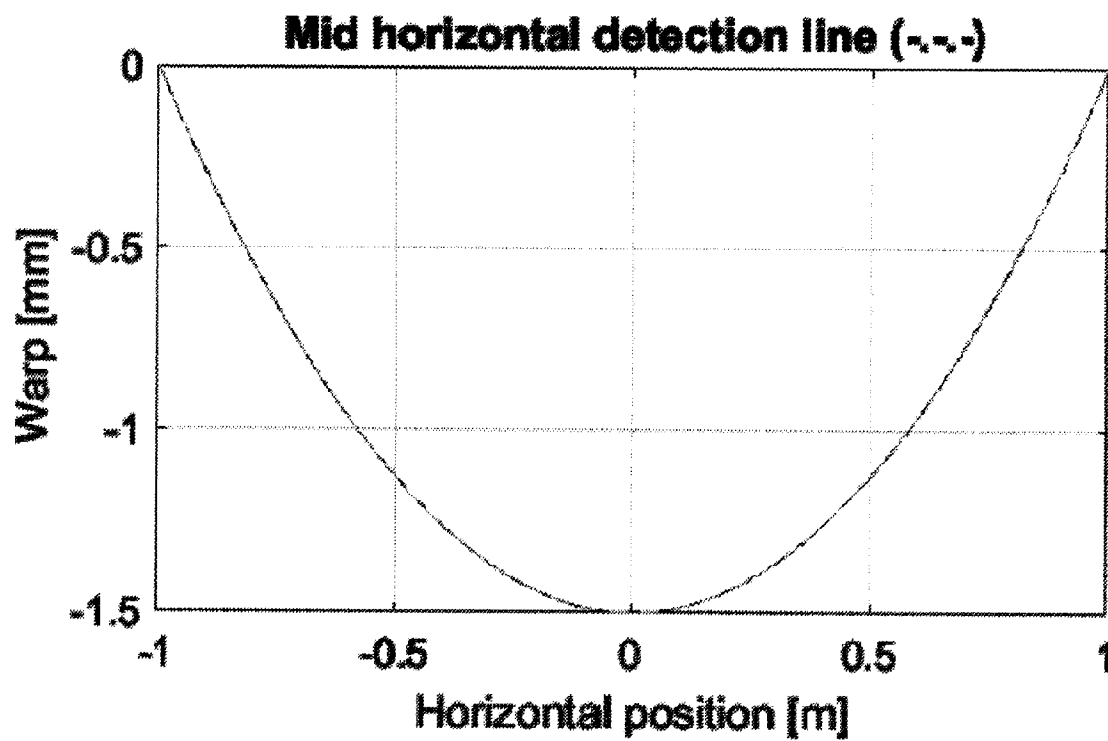


Figure 21c

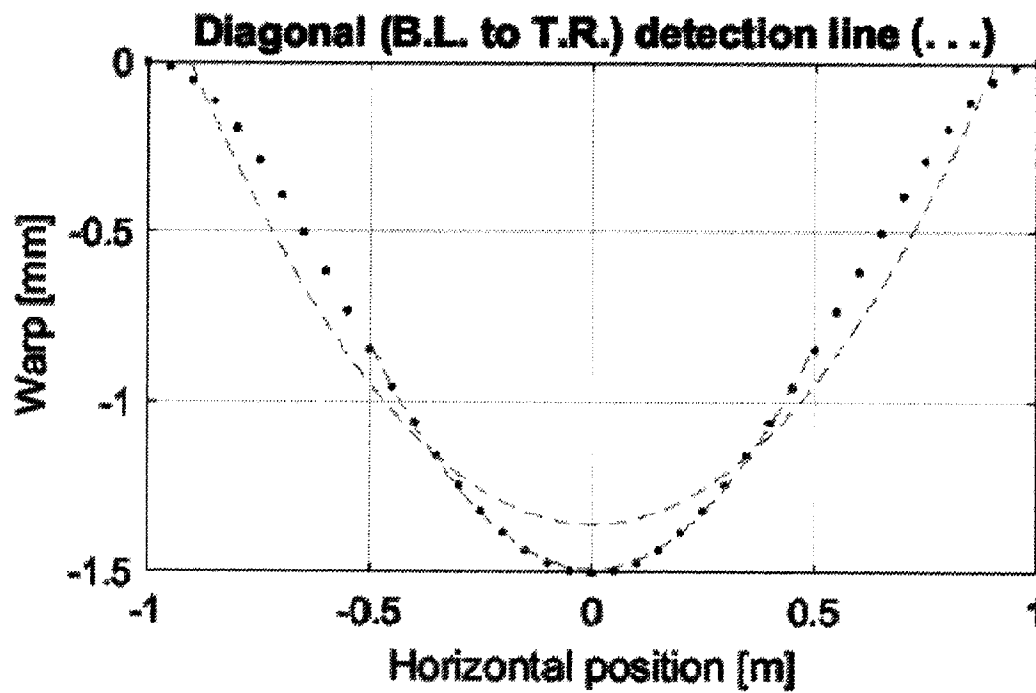


Figure 21d

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051233

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.
A	US 6031524 A1 (INTERMEC IP CORP), 29 February 2000 (2000-02-29); column 1, line 60 - column 2, line 20 --	1-24
A	US 20160295711 A1 (RYU HYUNJONG ET AL), 6 October 2016 (2016-10-06); whole document --	1-24
A	EP 3043242 A1 (DEXERIALS CORP), 13 July 2016 (2016-07-13); whole document --	1-24
A	WO 2016177592 A1 (AGC GLASS EUROPE), 10 November 2016 (2016-11-10); whole document --	1-24



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

12-03-2018

Date of mailing of the international search report

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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

Emil Bäcklund

Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051233

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 20120062492 A1 (KATOH SATOSHI), 15 March 2012 (2012-03-15); paragraphs [0006]-[0010] --	1-24
A	US 20120045170 A1 (SHIBATA NAOKI ET AL), 23 February 2012 (2012-02-23); whole document -- -----	1-24

Continuation of: second 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)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2017/051233

US	6031524 A1	29/02/2000	NONE		
US	20160295711 A1	06/10/2016	US	9839145 B2	05/12/2017
			WO	2015111890 A1	30/07/2015
EP	3043242 A1	13/07/2016	CN	105518592 A	20/04/2016
			JP	2015052916 A	19/03/2015
			JP	5848736 B2	27/01/2016
			KR	20160053923 A	13/05/2016
			TW	201523377 A	16/06/2015
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			WO	2015033569 A1	12/03/2015
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			KR	20180004141 A	10/01/2018
			TW	201704169 A	01/02/2017
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			WO	2010119882 A1	21/10/2010
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			JP	2012043136 A	01/03/2012
			KR	20120017403 A	28/02/2012
			TW	201219866 A	16/05/2012

[见续页]



一种触控显示设备，其包括平板显示部件、感应信号收发模块、控制模组以及外壳体，所述感应信号收发模块环设在所述平板显示部件的四周，所述平板显示部件、感应信号收发模块以及控制模组均封装在所述外壳体中，所述平板显示部件包括液晶显示器，所述感应信号收发模块包括若干感应信号收发对管以及印刷电路板，若干所述感应信号收发对管均电连接在所述印刷电路板上，感应信号收发对管包括感应信号发射管以及感应信号接收管，所述印刷电路板环设在所述液晶显示器的四周，且所述印刷电路板与所述液晶显示器面板垂直，电连接在所述印刷电路板上的感应信号收发对管设置在所述液晶显示器的显示面前侧。

一种触控显示设备

技术领域

[0001] 本发明涉及显示触控领域，特别是指一种采用触控式的显示设备。

背景技术

[0002] 为了操作上的方便，人们用触摸屏来代替鼠标或键盘工作时，我们必须首先用手指或其它物体触摸安装在显示器前端的触摸屏，然后系统根据手指触摸的图标或菜单位置来定位选择信息输入。触摸屏由触摸检测部件和触摸屏控制器组成；触摸检测部件安装在显示器屏幕前面，用于检测用户触摸位置，接受后送触摸屏控制器；而触摸屏控制器的主要作用是从触摸点检测装置上接收触摸信息，并将它转换成触点坐标，再送给 CPU，它同时能接收 CPU 发来的命令并加以执行。

[0003] 对于上述应用触摸屏技术的数码产品而言其优点主要是将控制键盘与显示屏的功能进行集合使显示屏同时具有键盘的功能，这种触摸屏的技术不但可以在有效的面积内尽可能的增大显示屏的面积，同时对于整体数码产品的外观效果也有比较大的提升。通过上述的触摸屏的技术可以在不增大数码产品整体体积的前提下尽可能的增大显示屏的尺寸，从而使通过装置有触摸屏的数码产品播放电视、动画类视频成为可能。而就目前市面上出现的触摸屏而言，红外式触摸屏占据一定的份额，如专利号 200720052423.3 以及专利号 200720051069.2 所公开的一种专利产品即为常见的红外触控显示装置，其主要包括平板显示部件（包括液晶显示屏）、围绕在平板显示部件四周的四块焊接有红外线发射管以及红外线接收管的印刷电路板、外框，其中，所述红外线发射管以及红外线接收管均设置在所述平板显示部件的显示面前侧，且所述红外线发射管与红外线接收管分别相对应的设置在平板显示部件四周的左右两侧以及上下两侧，从而使得平板显示部件的显示面前侧形成一个红外线光栅探测网。当使用者用手指或其它物体点触平板状显示部件的显示面上某一点时，便会挡住经过该位置的两条红外线，使红外线接收管不能收到与其相对应的红外线发射管所发射的红外线，该红外触控显示装置的控制系統便能即时计算出触点的位置，再根据触点位置对应的命令运行相应的程序，从而实现平板显示部件上的触控操作。

[0004] 如上所述的这种结构的红外触控显示装置中的印刷电路板按照与平板状显示部件相互平行的方式设置，其结构上存在着一系列的缺陷，具体叙述如下：

第一，由于用于连接红外线发射管以及红外线接收管的印刷电路板嵌设在所述平板显示部件的四周，且所述印刷电路板与平板显示部件成同一平面设置，在封装所述平板显示部件的外

框时，所述外框需要将所述印刷电路板封装起来，因此造成所述平板显示部件的外框尺寸也相应的更大，从而使红外触控显示装置显得非常厚重；

第二，为使红外线发射管以及红外线接收管所发射以及接收的红外光线与平板显示部件平行，红外线发射管以及红外线接收管需要进行弯脚工序后再焊接安装到印刷线路板上，或者是先焊接安装到印刷电路板上，再进行弯脚，如此不仅工序复杂，增加了制造成本，而且红外线发射管以及红外线接收管在弯脚后可能对其寿命及稳定性产生影响。

[0005] 随着社会的不断发展，目前液晶显示器都向超薄，超窄方向发展，按照传统的红外触摸屏采用边框，一般都需要二十几毫米宽，这主要受限于用于连接上述红外线发射管以及红外线接收管的印刷电路板的排列宽度。因而造成很多超薄、超窄的显示器上难以使用红外触控的技术。以上为传统红外触控显示装置在具体实施时所存在的主要技术缺陷，即为本发明所要研究解决的主要问题。

发明内容

[0006] 本发明的目的在于提供一种触控显示设备，其是一种与传统的触控显示装置同一性质的产品，其所要解决的主要技术问题在于：传统的触控显示装置受限于用于连接感应信号发射管以及感应信号接收管的印刷电路板的宽度，需要制作相应宽度的外框，从而使得外框一般都需要二十几毫米宽，因此造成很多超薄、超窄的显示器上难以通过采用感应信号收发方式实现触控的技术。以上为本发明所要解决的主要技术问题。

[0007] 为解决上述技术问题，本发明采用的技术方案是：本发明提供一种触控显示设备，其包括平板显示部件、感应信号收发模块、控制模组以及外壳体，其中，所述感应信号收发模块环设在所述平板显示部件的四周，所述平板显示部件、感应信号收发模块以及控制模组均封装在所述外壳体中，所述平板显示部件包括液晶显示器，所述感应信号收发模块包括若干感应信号收发对管以及印刷电路板，若干所述感应信号收发对管均电连接在所述印刷电路板上，感应信号收发对管包括感应信号发射管以及感应信号接收管，所述印刷电路板环设在所述液晶显示器的四周，且所述印刷电路板与所述液晶显示器面板垂直，其特征在于：电连接在所述印刷电路板上的感应信号收发对管设置在所述液晶显示器的显示面前侧，且所述感应信号发射管与所述感应信号接收管分别相对应的设置在所述液晶显示器的左右两侧以及上下两侧，若干所述感应信号发射管所发射的感应信号在所述液晶显示器的显示面前侧形成一个感应信号探测网。

[0008] 优选方式：所述印刷电路板包括四块或四块以上环设在所述液晶显示器四周的小电路板，各个小电路板之间首尾固定的电连接在一起，所述印刷电路板为硬性 PCB 或柔性

PCB 板。

[0009] 优选方式：所述控制模组与所述印刷电路板电连接，且所述控制模组固定在所述小电路板上对应所述液晶显示器的一侧或另一侧。

[0010] 优选方式：所述控制模组设置在所述底壳上，所述控制模组与所述印刷电路板之间连接有用于传输电源、数据的软排线。

[0011] 优选方式：所述印刷电路板包括四块或四块以上环设在所述液晶显示器四周的小电路板，各个小电路板之间首尾固定连接在一起，所述印刷电路板为硬性 PCB 或柔性 PCB 板，所述控制模组设置在所述底壳上，所述控制模组与构成所述印刷电路板的各个小电路板之间连接有用于传输电源、数据的软排线。

[0012] 优选方式：所述外壳体包括面壳以及底壳，所述平板显示部件以及感应信号收发模块均设置在所述底壳中，所述面壳为一与所述底壳大小匹配的四方形的框体，四方框形的所述面壳盖设在所述底壳上，所述液晶显示器的显示面对应在四方框体围绕成的方框内，所述感应信号收发模块收设在所述面壳与所述底壳之间，所述面壳与所述底壳上相对应的设置有卡槽，与所述液晶显示器垂直的所述印刷电路板卡设在所述卡槽中，借助所述卡槽对所述印刷电路板进行固定。

[0013] 优选方式：所述感应信号收发对管为红外收发对管，且所述红外收发对管包括红外线发射管以及红外线接收管，所述红外线发射管为贴片红外 LED。

[0014] 优选方式：所述面壳与所述液晶显示器的显示面之间预留有出光间隙，所述红外收发对管的红外线发射管以及红外线接收管相对应设置在所述出光间隙中。

[0015] 优选方式：所述面壳与所述液晶显示器之间的出光间隙中设置有滤光条，所述滤光条位于所述红外收发对管的红外线发射管以及红外线接收管前侧。

[0016] 优选方式：所述平板显示部件还包括触摸面板，所述触摸面板盖设在所述液晶显示器的显示面一侧，所述触摸面板采用透明的钢化玻璃板制成。

[0017] 与现有技术相比，本专利申请的技术效果是：本发明提供一种触控显示设备，其将所述平板显示部件以及感应信号收发模块封装在所述外壳体中时，由于所述印刷电路板与所述液晶显示器垂直，因此四方框形的所述面壳边框只需能够封盖所述感应信号收发对管以及板面与所述边框垂直的印刷电路板即可，从而能够很大程度的缩减所述面壳的宽度，进一步实现触控显示设备的边框超窄化，采用本发明的方案所述边框宽度可缩减至 3.6 毫米；而且由于所述印刷电路板与所述液晶显示器垂直，而所述感应信号收发对管与所述液晶显示器平行，因此，当所述感应信号收发对管的引脚焊接在所述印刷电路板上时，无须进行弯脚工

序，减少了制造工序，同样节约了制造成本，且所述感应信号收发对管的引脚未作折弯加工，其使用寿命更长，稳定性更好。

附图说明

[0018] 图 1 为本发明的一种较佳实施例的局部剖视示意图。

[0019] 图 2 为本发明的一种较佳实施例的局部剖视分解示意图。

[0020] 图 3 为本发明的另一种实施例的局部剖视示意图。

[0021] 图 4 为本发明的第二种较佳实施例的局部剖视示意图。

具体实施方式

[0022] 以下将结合附图 1 至 4 以及较佳实施例对本发明提出的一种触控显示设备作更为详细说明。

[0023] 如图 1 所示，本发明提供一种触控显示设备，其包括平板显示部件 10、感应信号收发模块 20、控制模组 30 以及外壳体 40，其中，所述感应信号收发模块 20 环设在所述平板显示部件 10 的四周，所述平板显示部件 10、感应信号收发模块 20 以及控制模组 30 均封装在所述外壳体 40 中；

所述平板显示部件 10 包括液晶显示器 11；

所述感应信号收发模块 20 包括若干感应信号收发对管 21 以及印刷电路板 22，若干所述感应信号收发对管 21 均电连接在所述印刷电路板 22 上，感应信号收发对管 21 包括感应信号发射管以及感应信号接收管；

所述印刷电路板 22 环设在所述液晶显示器 11 的四周，且所述印刷电路板 22 与所述液晶显示器 11 面板垂直；

电连接在所述印刷电路板 22 上的感应信号收发对管 21 设置在所述液晶显示器 11 的显示面前侧，且所述感应信号发射管与所述感应信号接收管分别相对应的设置在所述液晶显示器 11 的左右两侧以及上下两侧，若干所述感应信号发射管所发射的感应信号在所述液晶显示器 11 的显示面前侧形成一个感应信号探测网；

所述控制模组 30 与所述印刷电路板 22 电连接，所述控制模组 30 控制所述液晶显示器 11 以及所述感应信号收发对管 21 的工作；

所述外壳体 40 包括面壳 41 以及底壳 42，所述平板显示部件 10 以及感应信号收发模块 20 均设置在所述底壳 42 中，所述面壳 41 为一与所述底壳 42 大小匹配的四方形的框体，四方框形的所述面壳 41 盖设在所述底壳 42 上，所述液晶显示器 11 的显示面对应在四方框体围绕成的方框内，所述感应信号收发模块 20 收设在所述面壳 41 与所述底壳 42 之间。

[0024] 本发明在具体实施时，将所述平板显示部件 10 以及感应信号收发模块 20 封装在上述外壳体 40 中时，由于所述印刷电路板 22 与所述液晶显示器 11 垂直，四方框形的所述面壳 41 边框只需能够容纳所述感应信号收发对管 21 的长度以及与其垂直的印刷电路板 22 即可，从而能够很大程度的缩减所述面壳 41 的宽度，进一步实现触控显示设备的边框超窄化，采用本发明的方案所述边框宽度可缩减至 3.6 毫米，较小地占有现有显示设备表面边框的空间，较小地改变工艺结构，使触控与显示的整体性更强；而且由于所述印刷电路板 22 与所述液晶显示器 11 垂直，而所述感应信号收发对管 21 与所述液晶显示器 11 平行，因此，当所述感应信号收发对管 21 的引脚焊接在所述印刷电路板 22 上时，无须进行弯脚工序，减少了制造工序，同样节约了制造成本，且所述感应信号收发对管 21 的引脚未作折弯加工，其使用寿命更长，稳定性更好。

[0025] 较佳实施例：如图 1、2、3 所示，所述印刷电路板 22 为硬性 PCB 或柔性 PCB 板，所述印刷电路板 22 包括四块或四块以上环设在所述液晶显示器 11 四周的小电路板，各个小电路板之间首尾固定的电连接在一起，所述控制模组 30 固定连接在小电路板上，通过将所述控制模组 30 固定在小电路板上使本发明的内部结构更加的紧凑，所述控制模组 30 固定在所述小电路板上对应所述液晶显示器 11 的一侧或另一侧。

[0026] 较佳实施例：如图 4 所示，所述印刷电路板 22 包括四块或四块以上环设在所述液晶显示器 11 四周的小电路板，各个小电路板之间首尾固定的电连接在一起，所述控制模组 30 设置在所述底壳 42 上，所述控制模组 30 与所述印刷电路板 22 之间连接有助于传输电源、数据的软排线，通过使用软排线将所述控制模组 30 与所述感应信号收发模块 20 相连接，通过所述控制模组 30 控制所述感应信号收发模块 20 的正常工作，且通过软排线的连接方式可以方便所述控制模组 30 的拆装、换修。

[0027] 较佳实施例：如图 4 所示，所述印刷电路板 22 为硬性 PCB 或柔性 PCB 板，所述印刷电路板 22 包括四块或四块以上环设在所述液晶显示器 11 四周的小电路板，各个小电路板之间首尾固定连接在一起，所述控制模组 30 设置在所述底壳 42 上，所述控制模组 30 与构成所述印刷电路板 22 的各个小电路板之间连接有助于传输电源、数据的软排线，通过使用软排线将所述控制模组 30 与各个小电路板之间电连接，从而可以方便所述控制模组 30 以及各个小电路板的拆换、修理，防止因为极个别的感应信号收发对管 21 损坏而影响整个感应信号收发模块 20。

[0028] 较佳实施例：如图 2 所示，所述面壳 41 与所述底壳 42 上相对应的设置有卡槽 411，与所述液晶显示器 11 垂直的所述印刷电路板 22 卡设在所述卡槽 411 中，借助所述卡槽 411

对所述印刷电路板 22 进行固定。

[0029] 较佳实施例：所述感应信号收发对管 21 为红外收发对管，且所述红外收发对管包括红外线发射管以及红外线接收管，所述红外线发射管为贴片红外 LED。

[0030] 较佳实施例：如图 2 所示，所述面壳 41 与所述液晶显示器 11 的显示面之间预留有出光间隙 43，所述红外收发对管的红外线发射管以及红外线接收管相对应设置在所述出光间隙 43 中。

[0031] 较佳实施例：如图 1、2、3、4 所示，所述面壳 41 与所述液晶显示器 11 之间的出光间隙 43 中设置有滤光条 44，所述滤光条 44 位于所述红外收发对管的红外线发射管以及红外线接收管前侧，利用所述滤光条 44 来滤掉外界光线，使所述红外线发射管以及红外线接收管能够选择性的对外发出、接收光。

[0032] 较佳实施例：如图 1、2、3、4 所示，所述平板显示部件 10 还包括触摸面板 12，所述触摸面板 12 盖设在所述液晶显示器 11 的显示面一侧，所述触摸面板 12 采用透明的钢化玻璃板制成，借助采用透明钢化玻璃板制成的触摸面板 12 为位于所述显示窗口 411 处的所述液晶显示器 11 提供抗外力保护。

[0033] 综合上所述，本发明的技术方案可以充分有效的完成上述发明目的，且本发明的结构原理及功能原理都已经在实施例中得到充分的验证，而能达到预期的功效及目的，且本发明的实施例也可以根据这些原理进行变换，因此，本发明包括一切在专利申请范围中所提到范围内的所有替换内容。任何在本发明专利申请范围内所作的等效变化，皆属本案申请的专利范围之内。

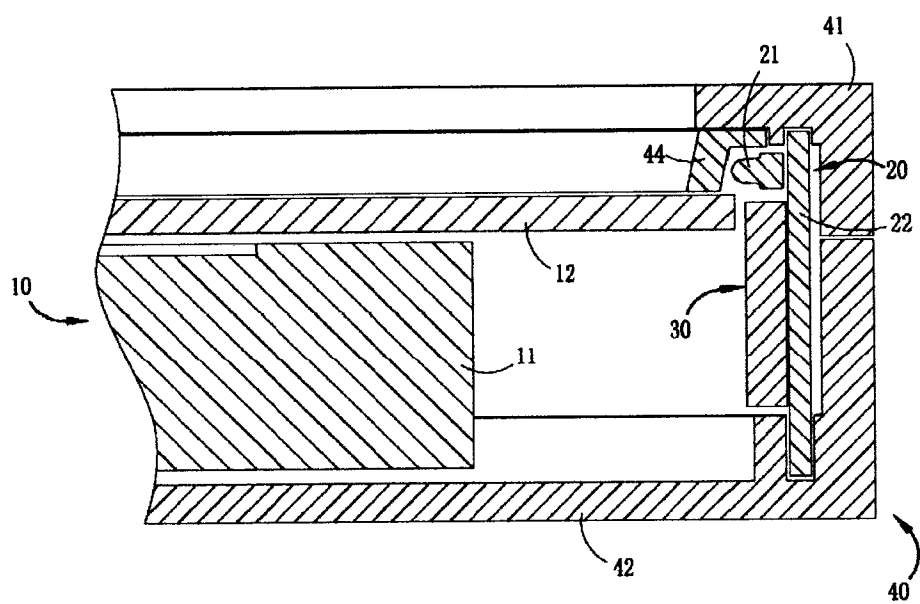
1. 一种触控显示设备，其包括平板显示部件、感应信号收发模块、控制模组以及外壳体，其中，所述感应信号收发模块环设在所述平板显示部件的四周，所述平板显示部件、感应信号收发模块以及控制模组均封装在所述外壳体中，所述平板显示部件包括液晶显示器，所述感应信号收发模块包括若干感应信号收发对管以及印刷电路板，若干所述感应信号收发对管均电连接在所述印刷电路板上，感应信号收发对管包括感应信号发射管以及感应信号接收管，其特征在于：所述印刷电路板环设在所述液晶显示器的四周，且所述印刷电路板与所述液晶显示器面板垂直，电连接在所述印刷电路板上的感应信号收发对管设置在所述液晶显示器的显示面前侧，且所述感应信号发射管与所述感应信号接收管分别相对应的设置在所述液晶显示器的左右两侧以及上下两侧，若干所述感应信号发射管所发射的感应信号在所述液晶显示器的显示面前侧形成一个感应信号探测网。
2. 如权利要求 1 所述的一种触控显示设备，其特征在于：所述印刷电路板包括四块或四块以上环设在所述液晶显示器四周的小电路板，各个小电路板之间首尾固定的电连接在一起，所述印刷电路板为硬性 PCB 或柔性 PCB 板。
3. 如权利要求 2 所述的一种触控显示设备，其特征在于：所述控制模组与所述印刷电路板电连接，且所述控制模组固定在所述小电路板上对应所述液晶显示器的一侧或另一侧。
4. 如权利要求 2 所述的一种触控显示设备，其特征在于：所述控制模组设置在所述底壳上，所述控制模组与所述印刷电路板之间连接有用于传输电源、数据的软排线。
5. 如权利要求 1 所述的一种触控显示设备，其特征在于：所述印刷电路板包括四块或四块以上环设在所述液晶显示器四周的小电路板，各个小电路板之间首尾固定连接在一起，所述印刷电路板为硬性 PCB 或柔性 PCB 板，所述控制模组设置在所述底壳上，所述控制模组与构成所述印刷电路板的各个小电路板之间连接有用用于传输电源、数据的软排线。
6. 如权利要求 2 或 3、4、5 中任意一项所述的一种触控显示设备，其特征在于：所述外壳体包括面壳以及底壳，所述平板显示部件以及感应信号收发模块均设置在所述底壳中，所述面壳为一与所述底壳大小匹配的四方形的框体，四方框形的所述面壳盖设在所述底壳上，所述液晶显示器的显示面对应在四方形框体围绕成的方框内，所述感应信号收发模块收设在所述面壳与所述底壳之间，所述面壳与所述底壳上相对应的设置有卡槽，与所述液晶显示器垂直的所述印刷电路板卡设在所述卡槽中，借助所述卡槽对所述印刷电路板进行固定。
7. 如权利要求 1 所述的一种触控显示设备，其特征在于：所述感应信号收发对管为红外收发对管，且所述红外收发对管包括红外线发射管以及红外线接收管，所述红外线发射管为贴片红外 LED。

8, 如权利要求 1 所述的一种触控显示设备, 其特征在于: 所述面壳与所述液晶显示器的显示面之间预留有出光间隙, 所述红外收发对管的红外线发射管以及红外线接收管相对应设置在所述出光间隙中。

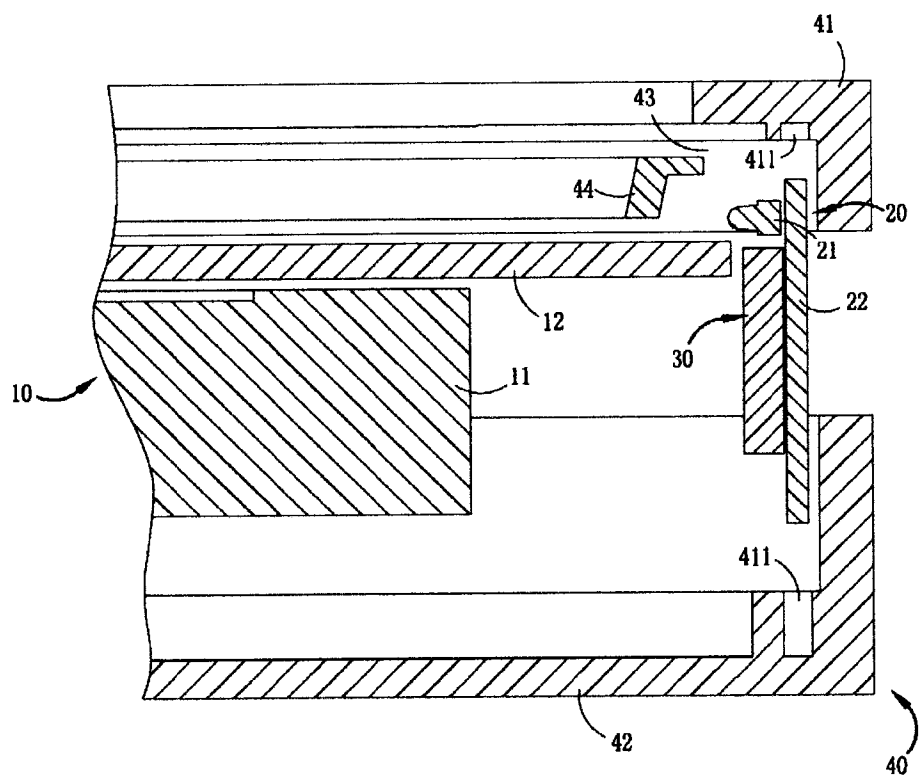
9, 如权利要求 8 所述的一种触控显示设备, 其特征在于: 所述面壳与所述液晶显示器之间的出光间隙中设置有滤光条, 所述滤光条位于所述红外收发对管的红外线发射管以及红外线接收管前侧。

10, 如权利要求 9 所述的一种触控显示设备, 其特征在于: 所述平板显示部件还包括触摸面板, 所述触摸面板盖设在所述液晶显示器的显示面一侧, 所述触摸面板采用透明的钢化玻璃板制成。

说明书附图

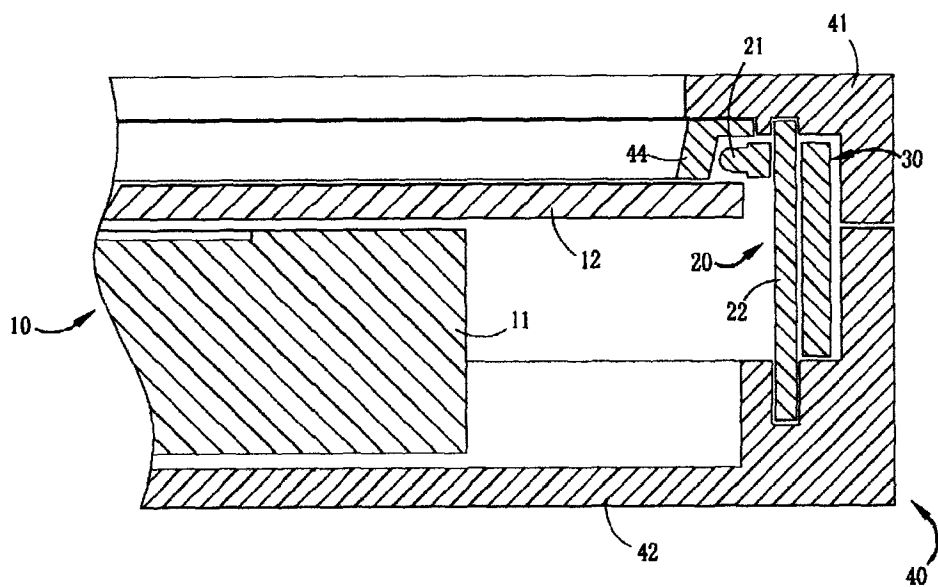


【图号】 图1

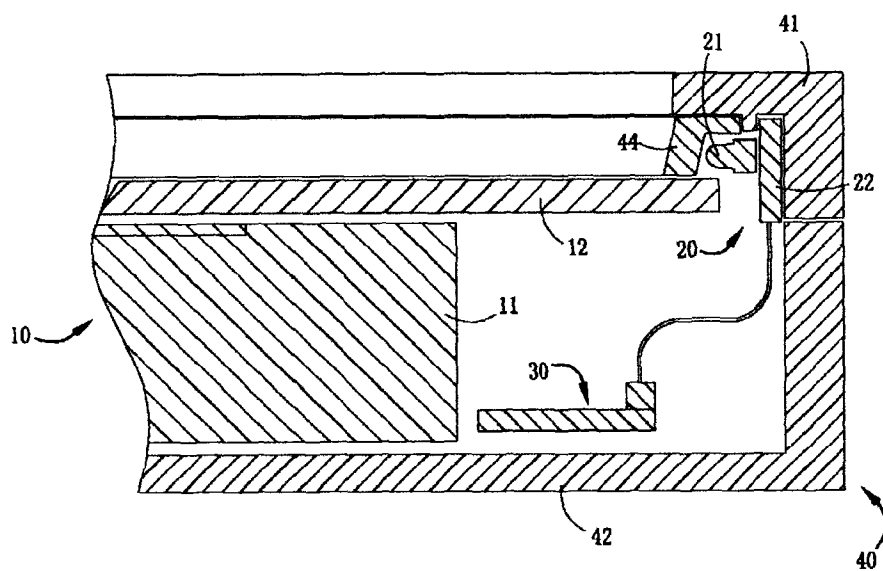


【图号】 图2

说明书附图



【图号】图3



【图号】图4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/080153

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/-

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)

CPRS, CNKI, WPI, EPODOC: up and down, left and right, display, shell, infrared, touch, receive, transmit, up, down, left, right, front, back, PCB, circuit board, right angle, perpendicular, vertical+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation 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), abstract, description, paragraphs 0029 and 0071-0073, and figure 1	1-10
A	CN 2731587 Y (IRTOUCH SYSTEMS CO., LTD.), 05 October 2005 (05.10.2005), the whole document	1-10
A	CN 2731588 Y (IRTOUCH SYSTEMS CO., LTD.), 05 October 2005 (05.10.2005), the whole document	1-10

II 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 25 January 2013 (25.01.2013)	Date of mailing of the international search report 07 February 2013 (07.02.2013)
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimengjiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer LIU, Qingquan Telephone No.: (86-10) 62411700

Chemtronics v. FlatFrog

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/080153

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 201917889 U	03.08.2011	None	
CN 2731587 Y	05.10.2005	None	
CN 2731588 Y	05.10.2005	None	

国际检索报告		国际申请号 PCT/CN2012/080153
A. 主题的分类		
G06F3/042 (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))		
CPRS,CNKI,WPI,EPODOC: 红外,触,收,发,上下,左右,显示,壳,电路板,垂直,infrared, touch, receive, transmit, up, down, left, right, front, back, PCB, circuit board, right angle, perpendicular, vertical+		
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	CN201917889U (浙江润智电子科技有限公司)03.8月2011(03.08.2011) 摘要,说明书0029、00714)073段,附图1	1-10
A	CN273 1587Y (北京汇冠新技术有限公司)05.10月2005(05.10.2005)全文	1-10
A	CN273 1588Y (北京汇冠新技术有限公司)05.10月2005(05.10.2005)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3/4或3/4后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 25.1月2013(25.01.2013)		国际检索报告邮寄日期 07.2月2013(07.02.2013)
ISACN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 刘清泉 Chemtronics v. FlatFrog Chemtronics Exhibit 1013 Page 343 电话号码:(86-10)62411760

国际检索报告

关于同族专利的信息

国际申请号

PCT/CN2012/080153

检索报告中引用的 专利文件	公布日期	同族专利	公布日期
CN201917889U	03.08.201 1	无	
CN273 1587Y	05. 10.2005	无	
CN273 1588Y	05. 10.2005	无	
Chemtronics v. FlatFrog Chemtronics Exhibit 1013 Page 344			



Touch control display device

Abstract

A touch control display device, comprising a panel display unit, an induction signal receiving and transmitting module, a control module, and a housing; the induction signal receiving and transmitting module is annularly disposed around the panel display unit; the panel display unit, the induction signal receiving and transmitting module, and the control module are all encapsulated in the housing; the panel display unit comprises a liquid crystal display; the induction signal receiving and transmitting module comprises a plurality of induction signal receiving and transmitting geminate transistors and a printed circuit board; the plurality of induction signal receiving and transmitting geminate transistors are all electrically connected to the printed circuit board; each induction signal receiving and transmitting geminate transistor comprises an induction signal transmitting transistor and an induction signal receiving transistor; the printed circuit board is annularly disposed around the liquid crystal display, and is perpendicular to the panel of the liquid crystal display, and the induction signal receiving and transmitting geminate transistors electrically connected to the printed circuit board are disposed on the front side of the display surface of the liquid crystal display.

Classifications

G06F3/045 Digitisers, e.g. for touch screens or touch pads, characterised by the transducing means by electromagnetic means

WO2013159472A1

WIPO (PCT)

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Other languages: French, Chinese

Inventor: 陈伟山

Worldwide applications

2012 [GN](#) [WO](#)

Application PCT/CN2012/080153 events

2012-04-27 Priority to CN20121012742B7A

2012-04-27 Priority to CN20121012742B7

2012-08-15 Application filed by 深圳市天时捷科技有限公司

2013-10-31 Publication of WO2013159472A1

Info: Patent citations (4), Cited by (6), Legal events, Similar documents, Priority and Related Applications

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Claims

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Claims

A touch display device includes a flat panel display component, a sensing signal transceiver module, a control module, and an outer casing, wherein the sensing signal transceiver module is disposed around the flat panel display component, and the flat panel display component The sensing signal transceiver module and the control module are all packaged in the outer casing, the flat panel display component comprises a liquid crystal display, and the sensing signal transceiver module comprises a plurality of sensing signal transceiver tubes and a printed circuit board, and the plurality of sensing signals The transceiver pair is electrically connected to the printed circuit board, and the sensing signal transceiver tube comprises an inductive signal transmitting tube and an inductive signal receiving tube, wherein: the printed circuit board ring is disposed around the liquid crystal display, Ji The printed circuit board is perpendicular to the liquid crystal display panel, and a sensing signal transceiver tube electrically connected to the printed circuit board is disposed on a front side of the display of the liquid crystal display, and the sensing signal transmitting tube and the sensing The signal receiving tubes are respectively disposed corresponding to the left and right sides of the liquid crystal display And upper and lower sides, one thousand if the sensing signal transmitted ray tube is formed in front side of the detection signal displaying the liquid crystal display of a sensing signal detection network.

2. The touch display device according to claim 1, wherein: the printed circuit board comprises four or more small circuit boards disposed around the liquid crystal display, and each small circuit board The first and last fixed electrical connections are made together, and the printed circuit board is a rigid PCB or a flexible PCB board.

3. The touch display device according to claim 2, wherein: the control module is electrically connected to the printed circuit board, and the control module is fixed on the small circuit board. One side or the other side of the liquid crystal display.

4. The touch display device according to claim 2, wherein: the control module is disposed on the bottom case, and the control module is connected to the printed circuit board $\frac{3}{4}$ in the transmission of power, data soft # line.

5. The touch display device according to claim 1, wherein: the printed circuit board comprises four or more small circuit boards disposed around the liquid crystal display, and each small circuit board The first and last ends are fixedly connected together, the printed circuit board is a rigid PCB or a flexible PCB board, the control module is disposed on the bottom case, and the control module and each small circuit board constituting the printed circuit board A soft cable for transmitting power and data is connected between them.

The touch display device according to any one of claims 2 to 3, wherein the outer casing comprises a surface shell and a bottom shell, and the flat panel display component and the sensing signal are transmitted and received. The module is disposed in the bottom case, wherein the face shell is a square frame matching the size of the bottom case, and the face plate of the four-box shape is disposed on the bottom case, the liquid crystal The display surface of the display corresponds to a square surrounded by a square frame, and the sensing signal transceiver module is disposed between the face shell and the bottom case, and the face shell and the bottom case are opposite Correspondingly, a card slot is disposed, and the printed circuit board perpendicular to the liquid crystal display is locked in the card slot, and the printed circuit board is fixed by the card slot.

7. The touch display device as claimed in claim 1, wherein: the sensing signal transceiver tube is an infrared transceiver tube, and the infrared transceiver tube comprises an infrared transmitting tube and an infrared receiving tube. The infrared emitting tube is a patch infrared LED.

Claims

8. The touch display device according to claim 1, wherein: a light gap is reserved between the face shell and a display surface of the liquid crystal display, and the infrared light is sent to and received from the tube. The launch tube and the red line receiving tube are correspondingly disposed in the light exit gap.

The touch display device of claim 8, wherein: a light filter strip is disposed in the light exit gap between the face shell and the liquid crystal display, and the filter strip is located in the infrared The infrared transmitting tube of the transmitting and receiving tube and the front side of the infrared receiving tube are provided.

The touch display device of claim 9, wherein the flat panel display component further comprises a touch panel, the touch panel is disposed on a side of the display surface of the liquid crystal display, and the touch The panels are made of transparent tempered glass panels.

Description

Touch display device

[0001] The present invention relates to the field of display touch, and more particularly to a touch display device.

Background technique

[0002] For the convenience of operation, when people use a touch screen instead of a mouse or a keyboard to work, we must first touch the touch screen mounted on the front end of the display with a finger or other object, and then the system locates the selection information according to the icon or menu position touched by the finger. The input touch screen is composed of a touch detection component and a touch screen controller; the touch detection component is installed in front of the display screen for detecting the touch position of the $\frac{1}{4}$ households, and accepting the touch screen controller; and the main function of the touch screen controller is $\frac{1}{4}$ is from the touch point The detecting device receives the touch information, converts it into contact coordinates, and sends it to the CPU, which can simultaneously receive and execute the command sent by the CPU.

[0003] For the digital products using the touch screen technology described above, the main advantage is that the functions of the control keyboard and the display screen are combined to make the display screen have the function of the keyboard at the same time. The technology of the touch screen can not only be as effective as possible within an effective area. The area of the display is increased, and the appearance effect of the overall digital product is greatly improved. Through the above-mentioned touch screen technology, it is possible to increase the size of the display screen as much as possible without increasing the overall volume of the digital product, and it is possible to play television and animated video through the digital product having the touch screen. In the current touch screens on the market, the infrared touch screen occupies a certain share. The two patent products disclosed in Patent No. 200720052423.3 and Patent No. 200720051069.2 are common infrared touch display devices, which mainly include a flat panel display, a component (including a liquid crystal display), four printed circuit boards and an outer frame around which the infrared emitting tube and the infrared receiving tube are welded around the flat display member, wherein the red and white emitting tubes and the infrared receiving tube are disposed On the front side of the display of the flat display unit, and the infrared emitting tube and the infrared receiving tube are respectively disposed on the left and right sides and the upper and lower sides of the flat display member, so that the front side of the display of the flat display member is formed. An infrared grating detection network. When the user touches a point on the display surface of the flat display member with a finger or other object, the two infrared rays passing through the position are blocked, so that the infrared receiving tube cannot receive the infrared emitting tube corresponding thereto. Infrared, the control system of the infrared touch display device can instantly calculate the position of the contact, and then run the corresponding program according to the command corresponding to the contact position, thereby realizing the touch operation on the flat display part.

[0004] The printed circuit board in the infrared touch display device of such a structure as described above is disposed in parallel with the flat display member, and has a series of defects in its structure, and is specifically described as T:

First, since a printed circuit board for connecting the infrared emitting tube and the infrared receiving tube is embedded around the flat display member, and the printed circuit board is disposed in the same plane as the flat display member, the flat panel is packaged Part of the When the frame is used, the outer frame needs to package the printed circuit board, so that the outer frame size of the flat display component is correspondingly larger, and the infrared touch display device is very thick;

Secondly, in order to make the infrared light emitted and received by the infrared emitting tube and the infrared receiving tube parallel to the flat display unit, the infrared emitting tube and the infrared receiving tube need to be bent and then soldered to the printed circuit board, or first Soldering is mounted on the printed circuit board and then bending the chest. This not only complicates the process, but also increases the manufacturing cost. The infrared emission tube and the infrared receiving tube may affect the life and stability of the infrared receiving tube after bending.

[0005] With the continuous development of the society, liquid crystal displays are currently developing in an ultra-thin and ultra-narrow direction. According to the conventional infrared touch screen, a frame is generally required to be twenty millimeters wide, which is mainly limited to the connection of the above infrared rays. The arrangement width of the printed circuit board of the transmitting tube and the infrared receiving tube. As a result, many ultra-thin, ultra-narrow displays make it difficult to make $\frac{1}{4}$ infrared touch technology. The above is the main technical defect of the conventional infrared touch display device in the specific implementation, which is the main problem to be solved by the present invention.

Summary of the invention

[0006] An object of the present invention is to provide a touch display device, which is a product of the same nature as a conventional touch display device, and the main technical problem to be solved is that the conventional touch display device is limited to The width of the printed circuit board used to connect the inductive signal transmitting tube and the inductive signal receiving tube requires the outer frame of the corresponding width, so that the outer frame generally needs to be twenty millimeters wide, thus causing many ultra-thin, ultra-narrow displays. It is difficult to implement touch technology by using an inductive signal transceiving method. The above is the main technical problem to be solved by the present invention.

[0007] In order to solve the above technical problem, the technical solution adopted by the present invention is: The present invention provides a touch display device, which includes a flat panel display component, a sensing signal transceiver module, a control module, and an outer casing, wherein the sensing The signal transceiver module is disposed around the flat panel display component, and the flat panel display component, the sensing signal transceiver module, and the control module are all encapsulated in the outer casing. The flat panel display component includes a liquid crystal display, and the sensing signal is The transceiver module includes a plurality of sensing signal transceiver tubes and a printed circuit board, and the plurality of sensing signal transceiver tubes are electrically connected to the printed circuit board, and the sensing signal transceiver tube includes an inductive signal transmitting tube and an inductive signal receiving tube. The printed circuit board is disposed around the liquid crystal display, and the printed circuit board is perpendicular to the liquid crystal display panel, wherein: the sensing signal transceiver tube electrically connected to the printed circuit board is disposed at Displaying the front side of the liquid crystal display, the sensing signal transmitting tube and The sensing signal receiving tubes are respectively disposed on the left and right sides and the upper and lower sides of the liquid crystal display, and if the sensing signal emitted by the sensing signal tube is formed on the front side of the liquid crystal display, an induction is formed. Signal detection network.

[0008] Preferably, the printed circuit board includes four or more small circuit boards disposed around the liquid crystal display, and each of the small circuit boards is electrically connected end to end, and the printed circuit board is electrically connected. Hard PCB or flexible PCB board.

[0009] Preferably, the control module is electrically connected to the printed circuit board, and the control module is fixed on one side or the other side of the small circuit board corresponding to the liquid crystal display.

[0010] Preferably, the control module is disposed on the bottom casing, and a soft cable for transmitting power and data is connected between the control module and the printed circuit board.

[0011] Preferably, the printed circuit board comprises four or more small circuit boards disposed around the liquid crystal display, and the small circuit boards are fixedly connected end to end, and the printed circuit board is rigid. The PCB or the flexible PCB board is disposed on the bottom case, and the control module and the small circuit boards constituting the printed circuit board are connected with a flexible cable for transmitting power and data.

[0012] Preferably, the outer casing includes a surface shell and a bottom shell, and the flat panel display component and the sensing signal transceiver module are disposed in the bottom casing, and the face shell is matched with the size of the bottom casing. a four-square frame, the four-square-shaped cover is disposed on the bottom case, and the display surface of the liquid crystal display corresponds to a square surrounded by a square frame, the sensing signal transceiver module Between the face shell and the bottom case, the face shell is provided with a card slot corresponding to the bottom case, and the printed circuit board perpendicular to the liquid crystal display is clamped in the In the card slot, the printed circuit board is fixed by the card slot.

[0013] Preferably, the sensing signal transceiver tube is an infrared transceiver tube, and the infrared transceiver tube includes an infrared line tube and an infrared receiving tube, and the infrared emitting tube is a patch infrared LED.

[0014] Preferably, a light exit gap is reserved between the face shell and the display surface of the liquid crystal display, and the infrared emitting tube and the infrared receiving tube of the infrared receiving tube are disposed in the light exiting gap.

[0015] Preferably, a light filter strip is disposed in the light exit gap between the surface shell and the liquid crystal display, and the filter strip is located on the front side of the infrared light emitting tube and the infrared receiving tube of the infrared transceiver tube.

[0016] Preferably, the flat panel display component further includes a touch panel, the touch panel is disposed on a display surface side of the liquid crystal display, and the touch panel is made of a transparent tempered glass panel.

[0017] Compared with the prior art, the technical effect of the application of the present invention is: The present invention provides a touch display device, which encapsulates the flat display component and the sensing signal transceiver module in the outer casing Because the printed circuit board is perpendicular to the liquid crystal display, the frame-shaped frame of the square frame only needs to be able to cover the sensing signal transceiver tube and the printed circuit board whose board surface is perpendicular to the frame. Therefore, the width of the face shell can be greatly reduced, and the frame of the touch display device can be further narrowed. The width of the frame can be reduced to 3.6 mm by using the solution of the invention; The circuit board is perpendicular to the liquid crystal display, and the sensing signal transceiver tube is parallel to the liquid crystal display. Therefore, when the sensing signal transceiver tube is soldered to the printed circuit board ff1, there is no need to bend Footwork In order to reduce the manufacturing process, the manufacturing cost is also saved, and the pins of the sensing signal transceiver are not bent, and the service life is longer and the stability is better.

DRAWINGS

- 1 is a partial cross-sectional view showing a preferred embodiment of the present invention.
- 2 is a partial cross-sectional exploded view of a preferred embodiment of the present invention.
- 3 is a partial cross-sectional view showing another embodiment of the present invention.
- 4 is a partial cross-sectional view showing a first preferred embodiment of the present invention.

detailed description

[0022] A touch display device according to the present invention will be described in more detail below with reference to FIGS. 1 to 4 and preferred embodiments.

As shown in FIG. 1, the present invention provides a touch display device, which includes a flat panel display component 10, a sensing signal transceiver module 20, a control module 30, and a housing 40, wherein the sensing signal is transmitted and received. The module 20 is disposed around the flat panel display unit 10, and the flat panel display component 10, the sensing signal transceiver module 20, and the control module 30 are all packaged in the outer casing 40;

The flat panel display unit 10 includes a liquid crystal display 11;

The sensing signal transceiver module 20 includes a plurality of sensing signal transceiver tubes 21 and a printed circuit board 22, and a plurality of the sensing signal transceiver tubes 21 are electrically connected to the printed circuit board 22, and the sensing signal transceiver tube 21 is including an inductive signal transmitting tube and an inductive signal receiving tube;

The printed circuit board 22 is disposed around the liquid crystal display 11, and the printed circuit board 22 is perpendicular to the panel of the liquid crystal display 11;

An inductive signal transceiving pair 21 electrically connected to the printed circuit board 22 is disposed on a front side of the display of the liquid crystal display 11, and the sensing signal transmitting tube and the sensing signal receiving tube respectively are disposed at a position The sensing signals emitted by the plurality of sensing signal tubes form an inductive signal detecting network on the display side of the liquid crystal display 11 on the left and right sides and the upper and lower sides of the liquid crystal display 11;

The control module 30 is electrically connected to the printed circuit board 22, and the control module 30 controls the operation of the liquid crystal display 11 and the sensing signal transceiver pair 21;

The outer casing 40 includes a face shell 41 and a bottom case 42. The flat panel display unit 10 and the inductive signal transceiver module 20 are disposed in the bottom case 42. The face shell 41 is a size of the bottom case 42. a matching square frame, the square frame 4 is covered on the bottom case 42, and the display surface of the liquid crystal display 11 corresponds to a square surrounded by a square frame. The sensing signal transceiver module 20 is disposed between the face shell 41 and the bottom case 42. [0024] in the specific implementation, when the flat panel display component 10 and the sensing signal transceiver module 20 are packaged in the outer casing 40, since the printed circuit board 22 is perpendicular to the liquid crystal display 11, four squares The frame 41 of the shape of the face can only accommodate the length of the sensing signal transmitting and receiving tube 21 and the printed circuit board 22 perpendicular thereto, and the width of the face 41 can be greatly reduced, further realizing The frame of the touch display device is ultra-narrow, and the width of the frame can be reduced to 3.6 mm by using the solution

of the invention, which occupies less space of the surface frame of the existing display device, and changes the process structure to make the touch and display smaller. The overall integrity is stronger; and Ji is perpendicular to the liquid crystal display 11 because the printed circuit board 22 is perpendicular to the liquid crystal display 11, and the sensing signal transceiver tube 21 is parallel to the liquid crystal display 11, so that when the sensing signal is transmitted and received to the tube. When the lead of 21 is soldered on the printed circuit board 22, the bending process is not required, the manufacturing process is reduced, and the manufacturing cost is also saved, and the sensing letter is saved. Transceiver 21 of pin header is not any bending that causes] % longer life, better stability.

[0025] Preferred embodiment: As shown in FIG. 1, 2, and 3, the printed circuit board 22 is a rigid PCB or a flexible PCB board, and the printed circuit board 22 includes four or more rings. A small circuit board around the liquid crystal display 11, each of the small circuit boards is electrically connected together end to end, and the control module 30 is fixedly connected to the small circuit board by fixing the control module 30 to the small circuit. The internal structure of the present invention is made more compact on the board, and the control module 30 is fixed on one side or the other side of the small circuit board corresponding to the liquid crystal display 11.

[0026] Preferred embodiment: As shown in FIG. 4, the printed circuit board 22 includes four or more small circuit boards disposed around the liquid crystal display 1, and each of the small circuit boards is fixed between the first and the last. The control module 30 is disposed on the bottom case 42. The control module 30 and the printed circuit board 22 are connected with a flexible cable for transmitting power and data. The control module 30 is connected to the sensing signal transceiver module 20, and the control module 30 controls the normal operation of the sensing signal transceiver module 20, and the connection mode of the flexible cable can be conveniently used. The disassembly and replacement of the control module 30 will be described.

[0027] Preferred embodiment: As shown in FIG. 4, the printed circuit board 22 is a rigid PCB or a flexible PCB board, and the printed circuit board 22 includes four or more rings disposed around the liquid crystal display 11. A small circuit board, each small circuit board is fixedly connected end to end, the control module 30 is disposed on the bottom case 42, and the control module 30 and each small circuit constituting the printed circuit board 22. A flexible cable for transmitting power and data is connected between the boards, and the control module 30 is electrically connected to the small circuit boards by means of a flexible cable, so that the control module 30 can be facilitated. The replacement and repair of each small circuit board prevents the entire sensing signal transceiver module 20 from being affected by the damage of the tube 21 due to the transmission of a very small number of sensing signals.

[0028] Preferred embodiment: As shown in FIG. 2, the face shell 41 is provided with a card slot 411 corresponding to the bottom case 42, and the printed circuit board 22 perpendicular to the liquid crystal display 11 a card is disposed in the card slot 411 by means of the card slot 411. The printed circuit board 22 is fixed.

[0029] The preferred embodiment: the sensing signal transceiver tube 21 is an infrared transceiver tube, and the red transceiver tube includes an infrared emitting tube and an infrared receiving tube, and the infrared emitting tube is a patch infrared LED.

[0030] Preferred embodiment: as shown in FIG. 2, a light-emitting gap 43 is reserved between the face shell 41 and the display surface of the liquid crystal display 11, and the infrared transmitting and receiving tube of the infrared transmitting and receiving tube and the infrared receiving tube is correspondingly disposed in the light exit gap 43.

[0031] Preferred embodiment: As shown in FIG. 1, 2, 3, and 4, a filter strip 44 is disposed in the light exit gap 43 between the face shell 41 and the liquid crystal display 11, and the filter strip is disposed. 44 is located on the front side of the infrared transmitting tube and the infrared receiving tube of the infrared transceiver tube, and uses the filter strip 44 to filter out external light, so that the infrared emitting tube and the infrared receiving tube can selectively send and receive externally Light.

[0032] Preferred embodiment: As shown in FIG. 1, 2, 3, and 4, the flat panel display unit 10 further includes a touch panel 12, and the touch panel 12 is disposed on a display surface side of the liquid crystal display 11. The touch panel 12 is made of a transparent tempered glass plate, and the touch panel 2 made of a transparent tempered glass plate provides protection against external force to the liquid crystal display 11 located at the display window 411.

[0033] In summary, the technical solution of the present invention can fully and effectively accomplish the above object, and the structural principle and functional principle of the present invention have been fully verified in the embodiment, and the expected effect and purpose can be achieved. The embodiments of the present invention can also be modified according to these principles, and therefore, the present invention includes all alternatives within the scope of the claims. Any equivalent changes made within the scope of the patent application of the present invention are within the scope of the patent application of the present application.

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CN2731588Y *	2004-06-25	2005-10-05	北京汇冠新技术有限公司	Novel infrared touch panel
CN201917889U *	2010-12-26	2011-08-03	浙江润智电子科技有限公司	Side frame structure member of infrared touch display device
Family To Family Citations				
CN202651975U *	2012-04-27	2013-01-09	深圳市天时捷科技有限公司	Touch control displaying device

* Cited by examiner, † Cited by third party

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Family To Family Citations				
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CN103123556A *	2013-03-01	2013-05-29	深圳市天时捷科技有限公司	Projection type touch-control electronic whiteboard and frame structure thereof
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CN104657005A *	2015-03-24	2015-05-27	北京瀚云科技有限公司	Infrared touch frame and infrared touch display screen
CN104867415A *	2015-05-30	2015-08-26	中山市晶艺光电科技有限公司	Shell with touch induction structure and LED digital display
CN108259676A *	2018-02-08	2018-07-06	上海摩轲通讯技术有限公司	Terminal device and photosensitive control method

* Cited by examiner, † Cited by third party, ‡ Family to family citation

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US10025411B2	2018-07-17	Touch screen and pressure touch detection method thereof
CN105278788B	2019-03-19	Touch input device
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JP5864741B2	2016-02-17	Touch sensitive display
US20160018922A1	2016-01-21	In-cell touch panel and display device
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CN102050376B	2013-09-11	Electrostatic capacitance-type input device, method of manufacturing electrostatic capacitance-type input device, and electro-optical apparatus provided with input function
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US20200065551A1	2020-02-27	Optical fingerprint recognition assembly, display device, and terminal
TW494819B	2015-08-01	Touch panel assembly and electronic device

Priority And Related Applications

Priority Applications (2)

Application	Priority date	Filing date	Title
CN2012101274207A	2012-04-27	2012-04-27	Touch display device
CN2012101274207		2012-04-27	

Legal Events

Date	Code	Title	Description
2013-12-25	121	Ep: the epo has been informed by wipo that ep was designated in this application	Ref document number: 12875319 Country of ref document: EP Kind code of ref document: A1
2014-10-27	NENP	Non-entry into the national phase in:	Ref country code: DE
2015-05-27	122	Ep: pct app. not ent. europ. phase	Ref document number: 12875319 Country of ref document: EP Kind code of ref document: A1
2015-10-21	32PN	Ep: public notification in the ep bulletin as address of the addressee cannot be established	Free format text: NOTING OF LOSS OF RIGHTS PURSUANT TO RULE 112(1) EPC (EPO FORM 1205N DATED 11/06/2015)
2015-10-28	122	Ep: pct app. not ent. europ. phase	Ref document number: 12875319 Country of ref document: EP Kind code of ref document: A1

Concepts

machine-extracted

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Name	Image	Sections	Count	Query match
liquid crystal related substances		claims,abstract,description	58	0
inductive effects		claims,abstract,description	23	0
shell materials		claims,description	21	0
corresponding		claims,description	9	0
toughened glasses		claims,description	4	0
Show all concepts from the description section				

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(71) Applicant: **LG ELECTRONICS INC.** [KR/KR]; 20
Yeouido-dong, Yeongdeungpo-gu, Seoul 150-721 (KR).

(72) Inventors: **SUNG, Jaehyun**; LG Electronics Inc. IP
Group, 16 Umyeon-dong, Seocho-gu, Seoul 137-724 (KR).
KIM, Jinsu; LG Electronics Inc. IP Group, 16 Umy-
eon-dong, Seocho-gu, Seoul 137-724 (KR). **LEE,**
Ahreum; LG Electronics Inc. IP Group, 16 Umyeon-dong,
Seocho-gu, Seoul 137-724 (KR). **SONG, Hyeoncheol**; LG

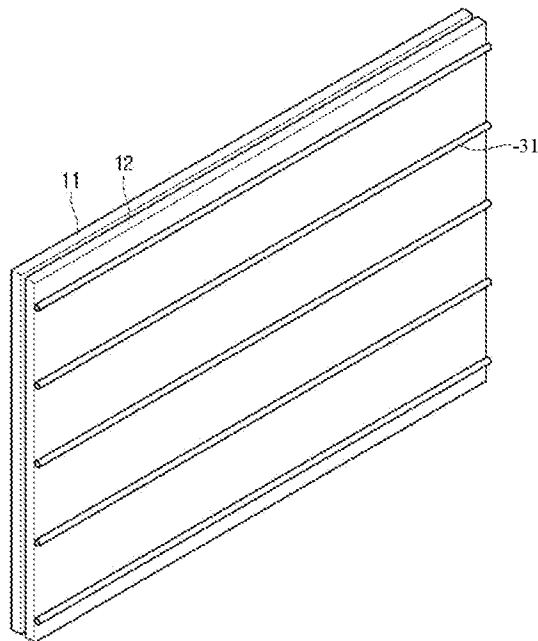
Electronics Inc. IP Group, 16 Umyeon-dong, Seocho-gu,
Seoul 137-724 (KR). **PARK, Sangdon**; LG Electronics
Inc. IP Group, 16 Umyeon-dong, Seocho-gu, Seoul 137-
724 (KR). **LEE, Moungyoub**; LG Electronics Inc. IP
Group, 16 Umyeon-dong, Seocho-gu, Seoul 137-724 (KR).
KWON, Heewon; LG Electronics Inc. IP Group, 16 Umy-
eon-dong, Seocho-gu, Seoul 137-724 (KR). **LEE, Deo-
gjin**; LG Electronics Inc. IP Group, 16 Umyeon-dong,
Seocho-gu, Seoul 137-724 (KR). **RYU, Inkeun**; LG Elec-
tronics Inc. IP Group, 16 Umyeon-dong, Seocho-gu, Seoul
137-724 (KR).

(74) Agent: **SEO, Kyo Jun**; 6th FL, Hyun Juk Bldg., 832-41
Yeoksam-dong, Gangnam-gu, Seoul 135-080 (KR).

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[Continued on nextpage]

(54) Title: DISPLAY DEVICE



(57) Abstract: A display device is provided. The display
device may include a display panel for displaying an image
and a back cover provided behind the display panel and
coupled to the display panel. A bending assembly may be
coupled to the back cover to bend the display panel. A con-
troller may be provided that is configured to control the
bending assembly to apply a physical force to the back cover
to bend the display panel a prescribed amount.

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Description

Title of Invention: DISPLAY DEVICE

Technical Field

- [I] Provided is a display device and a bending assembly configured to bend the display device.

Background Art

- [2] The present disclosure relates to a display device and method of changing a curvature of the display screen to improve user's immersion while viewing the display screen.
- [3] A display device may be a Liquid Crystal Display Device (LCD), a Plasma Display Panel (PDP), an Electro Luminescent Display (ELD), and a Vacuum Fluorescent Display (VFD). Display devices may also include 3-D imaging technology. With proliferation and advancement in digital technology, improvements in display technology to provide content to users is needed.

[4]

Disclosure of Invention

Technical Problem

- [5] Development of the display device to improve user's immersion while viewing the display screen is required.

Solution to Problem

- [6] Embodiments provide a display device having a structure capable of improving user's immersion.
- [7] In one embodiment, a display device includes: a display unit displaying an image; and a bending assembly bending the display unit.
- [8] The bending assembly may include a bending actuator applying force to the display unit and a bending control unit controlling an operation of the bending actuator.

Advantageous Effects of Invention

- [9] According to an embodiment of the present disclosure, user's immersion while viewing the display screen can be improved. In addition, bending amount of the display screen can be easily controlled.

[10]

Brief Description of Drawings

- [II] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:
- [12] Figure 1 is a view illustrating a shape of a display module according to an embodiment of the present disclosure;
- [13] Figure 2 is a view illustrating a shape of a display module and a back cover

according to an embodiment of the present disclosure;

[14] Figures 3A and 3B are views illustrating a portion of a display device according to an embodiment of the present disclosure;

[15] Figures 4 to 6 are cross-sectional views illustrating a portion of a display device according to an embodiment of the present disclosure;

[16] Fig 7 is a plan view illustrating a coupling structure of a back cover and a printed circuit board;

[17] Figures 8A and 8B are sectional views of a second fastener;

[18] Fig 9 is a sectional view of a third fastener;

[19] Fig 10 is a separate perspective view of a third fastener;

[20] Figures 11A and 11B are views illustrating a partial configuration of a display device according to another embodiment of the present disclosure;

[21] Figure 12 is a cross-sectional view illustrating a partial configuration of a display device according to another embodiment of the present disclosure;

[22] Figures 13 to 15B are views illustrating a partial configuration of a display device according to another embodiment of the present disclosure;

[23] Figures 16 to 17 are views illustrating a partial configuration of a display device according to another embodiment of the present disclosure;

[24] Figure 18 is a view when a sliding member is applied and Figure 19 is a view of an individual sliding member;

[25] Figures 20A and 20B are views illustrating a partial configuration of a display device according to another embodiment of the present disclosure;

[26] Figure 21A is a view illustrating a display module, a back cover, and a bending actuator according to an embodiment of the present disclosure;

[27] Figure 21B is a view when Figure 21A is bent;

[28] Figure 22 is a view illustrating a direction of force applied between parallel straight currents;

[29] Figure 23 is a view illustrating a display module, a back cover, and a bending actuator according to another embodiment of the present disclosure;

[30] Figure 24A is a view illustrating a flat cross section of Figure 23;

[31] Figure 24B is a view when Figure 24A is bent;

[32] Figure 25 is a view illustrating a display module, a back cover, and a bending actuator according to another embodiment of the present disclosure;

[33] Figure 26 is a view illustrating a flat cross section of Figure 25;

[34] Figure 27 is a view illustrating a display module, a back cover, and a bending actuator according to another embodiment of the present disclosure;

[35] Figure 28 is a sectional view of a bi-metal;

[36] Figure 29 is a plan view illustrating a back cover and a display module of Figure 27;

- [37] Figure 30 is a view illustrating a bending actuator according to another embodiment of the present disclosure;
- [38] Figure 31 is a view illustrating a bending actuator according to another embodiment of the present disclosure;
- [39] Figure 32 is a view illustrating a bending actuator according to another embodiment of the present disclosure;
- [40] Figure 33 is a view illustrating a plan view of Figure 32;
- [41] Figures 34 to 36 are views illustrating a bending actuator according to another embodiment of the present disclosure; and
- [42] Figure 37 is a sectional view illustrating a coupling structure of a first shaft and a second shaft.

[43]

Best Mode for Carrying out the Invention

- [44] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.
- [45] Hereinafter a display device according to embodiments of the present disclosure will be described in more detail with reference to the drawings. Hereinafter, each of embodiments described herein may be modified in various forms, and the technical range of the present disclosure is not limited thereto. Moreover, the form and size of each of components shown in the drawings may be exaggerated for clarity of illustration.
- [46] Figure 1 is a view illustrating a bending shape of a display module according to the present disclosure. The display module 11 (also display panel) equipped in a display device may bend in a curved shape with a constant curvature R . For example, in relation to the curved shape of the display module 11, the curvature R may be set to allow the distances d_1 , d_2 , and d_3 between a user's viewing position P and the front side of a panel to have the same or similar value, and the display module 11 may have a shape that is bent depending on the set curvature R .
- [47] Accordingly, while viewing an image displayed on a display device, user's immersion in the displayed content may be improved, and especially, when viewing a 3D image, user's immersion may be drastically improved by the curved shape of the display module 11. Moreover, the display module 11 displaying an image may include a self light emitting panel such as an OLED panel, or may include a panel that is not a self light emitting panel such as an LCD panel or a PDP panel and a backlight unit emitting light to the panel.
- [48] Hereinafter, merely for ease in description, the display module 11 is depicted as a self light emitting Organic Light Emitting Device (OLED) panel that uses an OLED as

an example. The OLED has a structure in which an organic light emitting layer of a functional thin film form is inserted between an anode electrode and a cathode electrode. Holes are injected from the cathode electrode and electrons are injected from the anode electrode so that the electrons and holes are combined to form excitons in the organic light emitting layer and then, the excitons are recombined to emit light

[49] As a method of realizing a full color organic light emitting display, there are an independent light emitting method, a color filter method, and a color conversion method. The independent light emitting method realizes R, G, and B by thermally depositing a light emitting material of each of R, G, and B with a metal shadow mask having a detailed pattern. The color filter method realizes R, G, and B by forming a white light emitting layer and patterning an R, G, and B color filter. The color conversion method forms a blue light emitting layer and realizing R, G, and B by using a color conversion layer changing blue into green and red. However, it should be appreciated that a display module of the present disclosure is not limited to an OLED panel, and as mentioned above, various flat panel display modules such as an LCD module, a PDP module, an FED module, or another appropriate type of display may be applied to the present disclosure.

[50] The display module 11 may be a flat panel display module 11 having a curvature close to 0° , and the flat panel display module 11 may be bent by a back cover 12. Thus, the display module 11 may have a curved shape having the constant curvature R as shown in Figure 1.

[51] Figure 2 is a sectional view illustrating a configuration of a display device according to the present disclosure. As shown in Figure 2(a), the display module 11 may be the flat panel display module 11. As shown in Figure 2(b), the back cover 12 disposed at the rear of the display module 11 may be bent by applying a force to the display module 11. Therefore, as shown in Figure 2(c), the display module 11 and the back cover 12 may be bent together. While Figure 2 illustrates only the display module 11 and the back cover 12 among components of the display device according to an embodiment of the present disclosure, the display device may further include various components not illustrated.

[52] Here, the back cover 12 may be a single plate-shaped member coupled to the rear of the display module 11 and may be formed of a material having elasticity to be bent forward. For example, the back cover 12 may be formed of Carbon Fiber-reinforced Plastic (CFRP). The back cover 12 may be disposed at the rear of the display module 11 and may serve to protect the display module 11. The back cover 12 may also be used to bend the display module 11 by applying physical force to the display module 11. However, the back cover 12 is not necessarily formed of a single plate-shaped member, and thus, may be formed of a plurality of plate-shaped members or an

assembly in which another configuration is coupled to a plurality of plate-shaped members.

[53] Additionally, in the present disclosure, although the back cover 12 having the approximately same area as the display module 11 is shown in the drawing, this illustrates just a conceptual shape to describe the bending shape of the back cover 12 and the display module 11. The actual back cover 12 may have a vertical or horizontal width that is shorter or longer than that of the display module 11. That is, the shape and size of the back cover 12 is not limited to the drawing.

[54] Moreover, the center of the back cover 12 in the lateral direction and the display module 11 may be fixed, and other parts other than the center may be installed not to restrain movement forward or backward. Therefore, when the back cover 12 and the display module 11 are bent, the left and right edges may move front to back.

[55] However, the back cover 12 and the display module 11 may be installed so that the front to back movements of both lateral ends are restrained and the center of the display in the lateral direction may move front to back. In this case, the back cover 12 and the display module 11 may be bent.

[56] Moreover, a display device according to an embodiment of the present disclosure may include a bending assembly that bends a display unit 10 by applying physical force to the display unit 10. The bending assembly may include a bending actuator and a bending control unit that controls the bending actuator. Here, the display unit 10 may include the above-mentioned display module 11 and back cover 12. Moreover, the display unit 10 may further include a middle cover 13 between the display module 11 and the back cover 12.

[57] In addition, the bending actuator as used herein may also refer to a device that produces mechanical force through use of various types of energy sources such as electricity or hydraulic pressure. The bending actuator may be provided in various shapes as described with various embodiments below.

[58] The bending control unit may control operations of the bending actuator. For example, when the bending actuator is an elastic member, for example being formed of a shape memory alloy, the bending control unit adjusts the amount of current applied to the shape memory alloy to adjust a temperature change of the shape memory alloy, so that a length change of the shape memory alloy may be controlled. Moreover, when the bending actuator is a sensitive heat tube surrounded by conductive wire, electromagnet, bimetal, piezoelectric element, or heat wire, operations of the bending actuator may be controlled. This will be described later in each embodiment.

[59] Hereinafter, with reference to Figures 3A to 37, specific embodiments of a display device including the combined above-mentioned configurations according to the present disclosure will be described in more detail.

- [60] Hereinafter, a configuration of a display device according to one embodiment of the present disclosure will be described with reference to Figures 3A to 10. Figures 3A to 10 schematically illustrate only a configuration relating to the bending of the display module 11 merely for ease of description of a structure and principle for bending a display device. However, it should be appreciated that the display device may include various other configurations besides the shown configuration.
- [61] First, referring to Figures 3A, 3B, and 4, the display device may include the display module 11, the back cover 12 coupled to the rear of the display module 11, and the bending assembly bending the back cover 12. Here, the bending assembly includes a elastic members. The elastic member may be formed of, for example, a shape memory alloy (SMA).
- [62] SMA is an alloy using shape memory and superplastic properties appearing in a metal transformed from austenite to martensite. When a specific shape is memorized in austenite of a high temperature state and then cooled to low temperature, martensite transformation occurs, and residual stress is formed in the tissue. Therefore, the specific shape is transformed. Then, when being heated again at an austenite temperature, the transformed specific shape is restored to its original shape.
- [63] Accordingly, when current flows in an SMA set to be restored to an original shape at a predetermined temperature, the SMA serves as resistance and temperature increases. Therefore, the SMA returns to its original shape and size according to temperature increase. At this point, the SMA may be set to increase or decrease its length at an increased predetermined temperature.
- [64] Moreover, the bending assembly may include a bending actuator that applies physical force to the back cover 12 and a bending controller (also bending control unit) that controls operations of the bending actuator. Here, the bending actuator may include an SMA 31 and the bending control unit may control a length change of the SMA 31.
- [65] The SMA 31 may be provided in a rod shape extending in the left and right directions, and may be attached to the backside of the back cover 12. For reference, the front side of the back cover 12 is a side facing the display module 11 and its backside is the opposite side. The rod shape may have various cross-sections, such as a round or rectangular cross-section. For example, the SMA 31 may have a cylindrical or wire shape.
- [66] The SMA 31 may be provided in plurality, horizontally in parallel to each other. The SMA 31 may be provided to maintain a predetermined length at a room temperature and when the temperature rises more than a set temperature, its length extends.
- [67] At this point, the rise in the temperature may be achieved by power supply that is controlled by the bending control unit. Accordingly, once power is supplied by the

bending control unit, a resistance of the SMA 31 causes the temperature to rise. As the temperature rises, the length of the SMA 31 extends laterally, in the left and right directions.

[68] When the length of the SMA 31 increases, the back cover 12 may bend and both the left and right ends of the display module 11 may protrude toward the front relative to the center of the display module 11, and its center may have a concave shape. At this point, an angle at which the back cover 12 bends may be adjusted by controlling an amount of current through the SMA 31.

[69] When the back cover 12 is bent, the both left and right ends of the back cover 12 applies pressures to the left and right edge of the backside of the display module 11, and the display module 11 is concavely bent toward the front. Therefore, user's immersion in the viewed image or perception may be enhanced.

[70] Moreover, as shown in Figure 5, a recess may be formed to receive the SMA 31. For example, a groove-shaped receiving unit for receiving the SMA 31 may be formed concave from the backside toward the front at the rear of the back cover 12 and the SMA 31 may be received therein.

[71] Additionally, as shown in Figure 6, the SMA 31 may be buried in or encapsulated in the back cover 12. The depth of the SMA 31 in the back cover 12 may be provided such that it is positioned toward the rear side of the back cover 12 relative to a center depth of the back cover 12, as illustrated. In this case, the SMA receiving unit may be a space where the SMA 31 in the back cover 12 is disposed. The SMA may be insert-molded together with the back cover 31.

[72] A printed circuit board (PCB) may be coupled to the rear of the display module 11 and the back cover 12 having the above configuration. Referring to Figure 7, the back cover 12 may be coupled to the PCB 15 by using a bracket 17.

[73] The plate-shaped bracket 17 may be disposed at the rear of the back cover 12 and the PCB 15 may be disposed at the rear of the bracket 17. At this point, the back cover 12 and the bracket 17 may be coupled by a first fastener 41 at the central part and the bracket 17 and the PCB 15 may be coupled by a second fastener 43 at the left and right direction edges.

[74] Accordingly, the first fastener 41 may be coupled to the backside of the back cover 12 at the center in the lateral direction and the front side of the bracket 17 at the center in the lateral direction, and the second fastener 43 may be coupled to the backside of the bracket 17 near the left and right side edge and the front of the PCB 15 near the left and right side edge.

[75] Figures 8A to 8B are sectional views illustrating a structure of the second fastener 43. The fastener 43 may include a front support part 43a of a roughly cylindrical shape coupled to the rear of the bracket 17, a spring 43c having the rear end supported by the

front support part 43a, and a head part 43b coupled to the rear end of the spring 43c.

[76] The front support unit 43a may be a pern nut whose portion protrudes toward the rear and the head part 43b may be a member of a roughly cylindrical shape. The head part 43b may be coupled to the PCB 15. Here, the spring 43c may be a coil spring. The second fastener 43 maintains a state as show in Figure 8A usually but when external force is applied to the bracket 17 or the PCB 15, as shown in Figure 8B, the spring 42c is compressed so that impact between two members is absorbed.

[77] Moreover, the left and right edges of the back cover 12 and the left and right edges of the bracket 17 may be coupled to each other by a third fastener 45. Figures 9 and 10 illustrate the third fastener 45 in more detail.

[78] The third fastener 45 provides a fastening structure that absorbs the bending of the back cover 12 between the back cover 12 and the bracket 17. The third fastener 45 may include a first member 45a coupled to the backside of the back cover 12 and a second member 45c coupled to the front side of the bracket 17. The backside of the first member 45a may have a rounded shape whose center protrudes convexly, and an opening part 45b extending in the lateral direction may be formed at the center of the rear.

[79] The second member 45c may extend from front to back relative to the display module 11 and may be insertable into the opening part 45b. A long hole 45d may be formed long in the lateral direction in the second member 45c. The long hole 45d may have a rounded shape as may progressively approach the left and right edge. Moreover, a head 45e may be coupled to the rear of the second member 45c.

[80] Accordingly, when the second member 45c is inserted into the opening part 45b of the first member 45a, a coupling protrusion may be inserted into the long hole 45d. Therefore, the second member 45c may be rotatable based on the coupling protrusion and may be movable by the length of the long hole 45d. Accordingly, the back cover 12 in a flat sate or a bending state may be continuously coupled to the back cover 12 and the bracket 17.

[81] Hereinafter, a configuration of a display device according to one embodiment of the present disclosure will be described with reference to Figures 11A and 11B. Figures 11A and 11B schematically illustrate only a configuration relating to the bending of the display module 11 merely for ease of description of a structure and principle for bending a display device. However, it should be appreciated that the display device may include various other configurations besides the shown configuration.

[82] The display device includes a display unit bending toward the front and a bending assembly bending the display unit. The display unit includes a display module 11 and a back cover 12 coupled to the rear of the display module 11. The bending assembly bends the back cover 12 so as to bend a display panel.

- [83] Moreover, the bending assembly includes a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator.
- [84] In the embodiment of Figure 3, the SMA 31 configuring the bending actuator extends from the left end part of the back cover 12 to the right end part. However, in this embodiment, a fixing unit 32 (also support bracket) is provided at the rear center of the back cover 12. Accordingly, the bending actuator according to this embodiment includes the SMA 31 and the fixing unit 32 where the SMA 31 is fixed. The bending control unit controls operations of the bending actuator.
- [85] The SMA 31 has a rod shape (e.g., cylindrical or wire shape) and extends in the left and right directions. A plurality of SMAs 31 may be attached to the rear of the back cover 12 and extend horizontally, parallel to each other. There may be a group of SMAs 31 that form a left column at the left side of the fixing unit 32 and there may be a group of SMAs 31 that form a right column at the right side of the fixing unit 32. Accordingly, the right end part of the left column and the left end part of the right column may be fixed at the fixing unit 32.
- [86] Due to the above configuration, when power is applied to the SMA 31, the wires extend in the left and right directions and the back cover 12 is bent toward the front with a centrally concaved shape. At this point, the control unit may supply power to the left column to allow only a portion where the left column is attached to be bent and on the contrary, may supply power to the right column to allow only a portion where the right column is attached to be bent. Moreover, by differently supplying the amount of current applied to the left column or the right column, the degree of bending may differ.
- [87] When the back cover 12 is bent, the both left and right end parts of the back cover 12 forwardly applies pressures around the left and right edges of the display module 11, so that the display module 11 is bent simultaneously. Moreover, when power is cut off by the bending control unit, and thus a temperature of the SMA 31 drops, the length of the SMA 31 is reduced and the display module 11 and the back cover 12 return to their original flat states by the elastic restoring force of the material.
- [88] While the SMA 31 is described herein as including only the two columns such as the left column and the right column, the SMA 31 may have other configurations, for example, to have three columns or more.
- [89] Furthermore, as shown in Figures 11A and 11B, the SMA 31 may be attached to the backside of the back cover 12, or like Figures 5 and 6, the SMA 31 may be received in the SMA receiving unit on the inner side of the back cover 12. Like the embodiment of Figures 5, the SMA receiving unit may have a groove shape concave toward the inner side (the front) at the backside of the back cover 12, and when the SMA 31 is buried

inside the back cover 12, the space in which it is buried may be the SMA receiving unit.

[90] Moreover, when the SMA 31 is buried inside the back cover 12, it may be disposed toward the rear of the back cover 12 with respect a depth of the back cover 12. The reason is that the length of the SMA 31 increases at a predetermined temperature in this embodiment. Additionally, when the SMA 31 is received in the SMA receiving unit, a portion of the fixing unit 32 may be buried at the rear of the back cover 12.

[91] Moreover, in the display device according to the present disclosure, the bracket 17, the first fastener 41, and the second fastener 43 shown in Figure 7 to 8B may be applicable for the coupling of the PCB 15. Additionally, as shown in Figures 9 and 10, the third fastener 45 may be applicable.

[92] Hereinafter, a configuration of a display device will be described with reference to Figure 12. Figure 12 schematically illustrates only a configuration relating to the bending of the display module 11 merely to facilitate description of a structure and principle for bending a display device. However, the display may include various other configurations besides the shown configuration.

[93] The SMA 31 may be disposed at position symmetric to the position of Figure 6 toward the front of the back cover 12 toward the display, as illustrated in Figure 12. The display device may include a display unit for displaying an image and a bending assembly for bending the display unit. The display unit may include a display module 11 displaying an image and a back cover 12 coupled to the rear of the display module 11.

[94] Moreover, the bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator. Here, the bending actuator may include the SMA 31 and the bending control unit that controls a length change of the SMA 31.

[95] The SMA 31 may be provided in a rod shape (e.g., cylindrical or wire shape) and extending in the left and right directions, and may be attached to the front of the back cover 12. The SMA 31 maintains a predetermined length at a room temperature and when the temperature rises more than a set temperature, its length is reduced. Here, because the SA 31 is provided toward the front surface of the back cover 12, the length of the SMA 31 is reduced to bend the display forward. At this point, the rise in the temperature may be achieved by power supply that is controlled by the bending control unit.

[96] Accordingly, once power is supplied by the bending control unit, current flows though the SMA and the resistance of the SMA 31 generates heat, thereby raising its temperature. As the temperature rises, the length of the SMA 31 is reduced laterally, i.e., in the left and right directions.

- [97] When the length of the SMA 31 is reduced, the back cover 12 becomes bent and both the left and right ends may protrude toward the front relative to its center, and the center may have a concave shape. At this point, an angle at which the back cover 12 bends may be adjusted by controlling the amount of current to the SMA 31. When the back cover 12 is bent, the display module 11 at the front of the back cover 12 is concavely bent toward the front. Due to this, user's immersion or perception while viewing the display may be enhanced.
- [98] Moreover, when the SMA 31 is disposed at the front of the back cover 12, like the above embodiment (refer to Figures 11A and 11B), the SMA 31 may be grouped to form a left column and the right column, or other configurations, for example, three columns or more. Furthermore, the length of each column may be differently controlled. For example, the length of the SMA 31 in the left column may be controlled to have a first prescribed length, and the SMA 31 in the right column may be controlled to have a second prescribed length, such that the curvature of the display may be controlled more precisely.
- [99] Moreover, in the display device according to this embodiment, the bracket 17, the first fastener 41, and the second fastener 43 shown in Figure 7 to 8B may be applicable for coupling the PCB 15. Additionally, as shown in Figures 9 and 10, the third fastener 45 may be applicable.
- [100] Hereinafter, a configuration of a display device according to another embodiment of the present disclosure will be described with reference to Figures 13 to 15B. Figures 13 to 17 schematically illustrate only a configuration relating to the bending of the display module 11 merely to facilitate description of a structure and principle for bending a display device. However, the display device according to the present embodiment may include various other configurations besides the shown configuration.
- [101] Figure 13 is a perspective view illustrating the back cover 12 and the bending assembly of the display device, and Figure 14 is a view illustrating the front side of the back cover 12. Moreover, Figures 15A and 15B are plan views of the display device. The display device may include a display unit and a bending assembly that bends the display unit. The display unit may include a display module 11, a thin plate-shaped middle cover 13 attached to the backside of the display module 11 (or display panel) through a double-sided tape 14 or another appropriate method of connection, and a back cover 12 coupled to the rear of the middle cover 13. The bending assembly may apply force to bend the back cover 12, so that the entire display unit may be bent.
- [102] Here, the bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit that controls operations of the bending actuator. The bending actuator may include an SMA 31 and a fixing unit 33 (or support bracket) fixing the SMA 31 to the front of the back cover 12. Also, the bending

actuator may control a length change of the SMA 31.

- [103] The fixing unit 33 may include four extension units 38a that extend front to back and protruding toward the front around each edge of the back cover 12. The fixing unit 33 may have a roughly rectangular shape and a vertical extension unit 33b that vertically connects two extension units 38a may be provided around the left and right sides of the back cover 12. The vertical extension unit 33b may be provided to be in one or more pairs. As illustrated, the vertical portions may be provided a prescribed distance from the back cover toward the display panel.
- [104] The SMA 31 extends across two vertical extension units 33b. The SMA 31 may be provided to have a rod shape that extends in the left and right directions, and may be provided in plurality to extend horizontally, parallel to each other. The rod shape may have various cross-sections, such as a round shape, square shape or the like. For example, the SMA 31 may have a wire shape.
- [105] Accordingly, the SMA 31 may be coupled to a position that is spaced toward the front from the front side of the back cover 12, and extends parallel to the front side of the back cover 12. That is, the left end part of the SMA 31 may be coupled to the vertical extension unit 33b at the left side and the right end part of the SMA 31 may be coupled to the vertical extension unit 33b at the right side. Moreover, the fixing unit 33 and the SMA 31 may be formed as one module. When a module including the fixing unit 33 and the SMA 31 is manufactured separately and is coupled to the front side of the back cover 12, manufacturing efficiency may be improved.
- [106] In this embodiment, the SMA 31 may maintain a predetermined length at a room temperature and when the temperature rises more than a set temperature, its length is reduced. At this point, the rise in the temperature may be achieved by a power supply that is controlled by the bending control unit.
- [107] Accordingly, once current is supplied to the SMA 31, the resistance of the SMA 31 may produce a prescribed amount of heat causing its temperature to increase. As the temperature increases, the length of the SMA 31 is reduced in the lateral, e.g., left and right, directions.
- [108] When the length of the SMA 31 is reduced from Figure 15A to Figure 15B, the back cover 12 becomes bent and the both left and right end parts protrude toward the front relatively, and its center has a concavely retreated shape. At this point, an angle at which the back cover 12 bends may be adjusted by controlling the amount of current through the SMA 31.
- [109] When the back cover 12 is bent, pressure is forwardly applied on the both left and right ends of the middle cover 13 from the front of the back cover 12, and due to this, the display module 11 is also concavely bent toward the front. Therefore, user's immersion may be increased. Moreover, when power is cut off by the bending control

unit, and thus a temperature of the SMA 31 drops, the length of the SMA 31 is increased again and the display module 11 and the back cover 12 return to their original flat states by the elastic restoring force of the material.

[110] Moreover, the bracket 17, the first fastener 41, and the second fastener 42 shown in Figures 7 to 8B may be applicable to the display device according to this embodiment. Additionally, as shown in Figures 9 and 10, the third fastener 43 may be also applicable.

[III] Hereinafter, a partial configuration of a display device will be described with reference to Figures 16 to 19. Figures 16 to 19 schematically illustrate only a partial configuration relating to the bending of the display module 11 merely to facilitate description for a structure and principle for bending a display device. However, the display device according to the present embodiment may include various other configurations besides the shown configuration.

[112] Figure 16 illustrates the middle portion of the display module 11, the back cover 12, and the middle cover 13 in the display device. Figure 17 illustrates a portion horizontally deviated from the center of the display module 11, the back cover 12, and the middle cover 13 in the display device. The display device may include a display unit and a bending assembly that bends the display unit. The display unit may include a display module 11, a middle cover 13 located at the rear of the display module 11, and a back cover 12 located at the rear of the middle cover 13. The bending assembly applies physical force to the back cover 12, so that the entire display unit may be bent.

[113] The middle cover 13 may be attached to the backside of the display module 11 by using a double-sided tape 14 or another appropriate method of connection. The back cover 12 may have a shape in which the left and right ends protrude toward the front relative to the center, and the center is curved toward the rear. Accordingly, the central part of the back cover 12 is spaced from the middle cover 13 toward the rear and the left and right end parts of the back cover 12 contact the left and right edge backside of the middle cover 13. At this point, the back cover 12 and the middle cover 13 may contact directly, or may contact through a sliding member 37 as described in more detail hereinafter. Additionally, when the sliding member 37 is provided, the left and right end parts of the back cover 12 and the middle cover 13 may not contact each other, and thus may be spaced apart from each other.

[114] Moreover, the bending assembly may include a bending actuator that applies physical force to the back cover 12 and a bending control unit that controls operations of the bending actuator. The bending actuator may include an SMA 31 (or elastic member) and fixing units 35a and 35b (or support bracket) fixing the SMA 31 to the rear of the back cover 12. The bending control unit may control a length change of the SMA 31.

- [115] The fixing units 35a and 35b may include a central fixing unit 35a (or center support) protruding toward the front from the front side at the left and right direction center of the back cover 12 and a side fixing unit 35b (or lateral support) protruding from the front side toward the front around the left and right both end parts of the back cover 12.
- [116] The front end of the central fixing unit 35a is coupled to the rear of the left and right direction center of the middle cover 13, and the rear end is coupled to the left and right direction center of the back cover 12. At this point, the central fixing unit 35a may function as a spacer to maintain a predetermined interval between the back cover 12 and the middle cover 13.
- [117] The SMA 31 may be attached to the both left and right sides of the central fixing unit 35a, or the central fixing unit 35a may serve as a supporter to allow one SMA 31 to pass through. An end part of the SMA 31 may be fixed at the side fixing unit 35. The SMA 31 may be provided in a wire shape extending in the left and right directions, and is forwardly spaced a predetermined distance apart from the back cover 12.
- [118] The SMA 31 may maintain a predetermined length at a room temperature and when the temperature rises more than a set temperature, its length may be reduced. At this point, the rise in the temperature is achieved by power supply that is controlled by the bending control unit. Accordingly, once power is supplied by the bending control unit, the resistance of the SMA 31 causes generation of heat and its temperature rises. As the temperature rises, the length of the SMA 31 is reduced in the lateral, e.g., left and right, directions.
- [119] When the length of the SMA 31 is reduced, the both end parts (or lateral sides) of the back cover 12 are pulled toward the center, and as the distance between the both end parts of the back cover 12 becomes narrower, both end parts of the back cover 12 are moved toward the front relative to the center. Then, the both end parts of the back cover 12 forwardly apply pressure to a point horizontally deviated from the center of the mid cover 13, so that the display module 11 becomes bent.
- [120] At this point, the back cover 12 may have a curved shape whose center in the lateral direction is curved toward the rear relatively and both lateral ends protrude toward the front relatively. In this case, when the distance between the both end parts of the back cover 12 becomes narrower, the back cover 12 becomes bent with a greater curvature than the original, which then forwardly applies pressure to a point horizontally deviated from the center of the mid cover 13 so that the display module 11 becomes bent. At this point, an angle at which the back cover 12 bends may be adjusted by controlling current flow through the SMA 31.
- [121] Since the central fixing unit 35a maintains a predetermined interval laterally between the center of the back cover 12 and the center of the display module 11, when the back cover 12 is bent, forward pressure is applied by both the left and right ends of the back

cover 12 to both the left and right end parts of the display module 11 to simultaneously bend the display module 11. Therefore, user's immersion may be increased.

[122] Moreover, when power is cut off by the bending control unit and thus a temperature of the SMA 31 drops, the length of the SMA 31 is increased and the display module 11 and the back cover 12 return to their original flat states by the elastic restoring force of the material. Moreover, the sliding member 37 shown in Figures 18 and 19 may be additionally included in the above configuration.

[123] The sliding member 37 may be fixed at one of the back cover 12 or the middle cover 13 and may be slidable at the other. That is, the sliding member 37 may be coupled to the front side of the back cover 12 so that it may slide relative to the backside of the middle cover 13, or may be coupled to the rear of the middle cover 13 so that it may slide relative to the front of the back cover 12. Additionally, the sliding member 37 may be coupled to each of the back cover 12 and the middle cover 13, so that sliding may occur between a portion coupled to the back cover 12 and a portion coupled to the middle cover 13.

[124] Hereinafter, a configuration and function of the sliding member 37 according to this embodiment will be described with reference to Figures 18 and 19. The sliding member 37 slide relative to a body 37a fixed at the middle cover 13 and a moving member 37d fixed at the back cover 12 to be movable horizontally.

[125] The body 37a may have a plate-shaped member that extends horizontally, and its center slide relative to a sliding area 37b extending horizontally. Moreover, a fixing unit 37c protruding toward the front side may be provided at the front side of the body 37a. The fixing unit 37c may be fixed by directly contacting the backside of the middle cover 13, and the body 35a may be spaced by the length of the fixing unit 37c apart from the middle cover 13. The moving member 37d may be provided to allow reciprocating sliding in the sliding area 37b, and its flat backside may be coupled to the front side of the back cover 12. Since the sliding member 37 is provided, the back cover 12 and the middle cover 13 may have coherence at a portion horizontally deviated from the center in addition to the center.

[126] Moreover, when the sliding member 37 is provided between the back cover 12 and the middle cover 13, the left and right end parts of the back cover 12 protrude toward the front relatively by the bending assembly. When pressure is applied on the backside of the middle cover 13, the back cover 12 does not directly contact the middle cover 13 and contacts the middle cover 13 through the sliding member 37, allowing the display module 11 to be bent more efficiently. Additionally, when the sliding member 37 is provided, the left and right end parts of the back cover 12 may contact the middle cover 13 so that the back cover 12 applies pressure on the middle cover 13.

[127] Moreover, the bracket 17, the first fastener 41, and the second fastener 43 shown in

Figures 7 to 8B may be applicable to the display device according to this embodiment. Additionally, the third fastener 45 shown in Figures 9 and 10 may be also applicable.

- [128] Hereinafter, a configuration of a display device will be described with reference to Figures 20A and 20B. Figure 20A is a view of a flat state before a display unit of the display device is bent. Figure 20B is a view when the display unit is bent. Merely for convenience and to facilitate description, a configuration shown in Figures 20A and 20B does not include all of the features of the display device, and only a partial configuration relating to the bending of the display module 11 is shown while other configurations are omitted.
- [129] The display device may include a display unit, a bending assembly bending the display unit, and a lower frame 50 supporting the display unit from the lower part. The display unit may include a display module 11 (or display panel) and a back cover 12 at the rear of the display module 11. The lower frame 50 receives various parts therein such as a control module, and the display module 11 and the back cover 12 are coupled to the top of the lower frame 50. Additionally, a stopper 51 may be provided at the top of the lower frame 50 and may contact the backside of the back cover 12 at the rear of both the left and right ends of the back cover 12.
- [130] The bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator. The bending actuator includes an SMA 31, a fixing unit 39 fixing the SMA 31 to the rear of the back cover 12, and a motor 52 rotating the fixing unit 39. The bending control unit controls a length change of the SMA 31 and operations of the motor 52.
- [131] The fixing unit 39 (or support bracket) may be provide in a cylindrical shape extending in a vertical direction, and may be backwardly spaced apart from the center of the back cover 12. The SMA 31 (or elastic member) may be provided in a cylindrical or wire shape extending in a lateral direction. Its front end may be coupled to the center laterally at the backside of the back cover 2 and its rear end may be coupled to the fixing unit 39. A plurality of SMA 31 may be provided horizontally, parallel to each other.
- [132] The motor 52 may be coupled to the lower part of the fixing unit 39, and the fixing unit 39 may rotate by rotation of the motor 52. The bending control unit may be included in the control module provided at the inner side of the lower frame 50, and may control a current applied to the SMA 31 and rotation of the motor 52.
- [133] Accordingly, once current is supplied to the SMA 31 by the bending control unit, resistance of the SMA 31 may cause heat generation and its temperature rises. As the temperature rises, the length of the SMA 31 may be reduced in the lateral, e.g., left and right, directions.

- [134] When the length of the SMA 31 is reduced, the both left and right end regions of the back cover 12 are restrained from moving toward the rear, and only the center part is moved toward the rear, so that the back cover 12 has a bending shape that is centrally concaved relative to the front. At this point, an angle at which the back cover 12 is bent may be adjusted by controlling a current applied to the SMA 31.
- [135] Moreover, in this embodiment, auxiliary bending is possible by rotation of the motor 52. When the motor 52 rotates, the cylindrical fixing unit 37 rotates to wind the SMA 31 on its outer circumferential surface, so that the center part of the back cover 12 may be further pulled back. Accordingly, when the motor 52 is used sufficient bending effect may be achieved even when the reduced length of the SMA 31 is insufficient for the desired amount of bending.
- [136] Additionally, when the length reduction of the SMA 31 is not obtained properly, the bending of the back cover 12 and the display module 11 becomes possible. Also, as the fixing unit 37 rotates, it winds the outer circumference surface with the SMA 31, so that the center part of the back cover may be further retreated.
- [137] As mentioned above, when the back cover 12 is bent, the left and right direction center of the back cover 12 is retreated and thus, the left and right direction center part of the display module 11 is pulled toward the rear. Due to this, the display module 11 is bent simultaneously. Therefore, user's immersion may be increased by bending the display unit.
- [138] Moreover, when power is cut off by the bending control unit, and thus a temperature of the SMA 31 drops, the length of the SMA 31 is increased and the display module 11 and the back cover 12 return to their original flat states by the elastic restoring force of the material. In this case, if the wire-shaped SMA 31 is wound on a fixing unit by rotating a motor, the display module 121 returns to a flat state by reversely rotating the fixing unit to unwind the SMA 31.
- [139] Hereinafter, a display device will be described with reference to Figures 21A to 22. Figures 21A to 22 schematically illustrate only a configuration relating to the bending of the display module 11 merely to facilitate description of a structure and principle for bending a display device. However, the display device may include various other configurations besides the shown configuration.
- [140] The display device may include a display unit displaying an image and a bending assembly bending the display unit. The display unit may include a display module 11 displaying an image and a back cover 12 coupled to the rear of the display module 11.
- [141] The bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator. The bending actuator may be a leading wire 34 coupled to the rear of the back cover 12 to flow current.

- [142] Figure 2 1A is a view of a flat state when the display module 11 and the back cover 12 are not bent. Figure 2 1B is a view when the display unit 11 and the back cover 12 are bent. Figures 2 1A and 2 1B are views when a plurality of wires 34 coupled to the rear of the back cover 12 extend vertically. Additionally, Figure 22 is a view illustrating the direction of a current flowing in a wire and the direction of a force acting on between wires.
- [143] As shown in Figure 22(a), when the direction of a current flowing in one wire is the same as that in an adjacent wire, gravitation acts on between two wires. As shown in Figure 22(b), when the direction of a current flowing in one wire is different from that in an adjacent wire, repulsion acts on between two wires.
- [144] Referring to Figures 2 1A and 2 1B, the wire 34 may be provided in plurality vertically in parallel to each other. Each wire 34 extends in parallel to another adjacent wire 34. The wire 34 may be attached to the backside of the back cover 12, or may be built in the back cover 12. The wire 34 may be built in the back cover 12, it needs to be positioned at the rear on the basis of the back and forth direction center of the back cover 12.
- [145] Moreover, as shown in Figures 2 1A and 2 1B, a groove part 18 formed long vertically may be provided at the front of the back cover 12. The groove part 18 may have a roughly V-shaped shape whose left and right widths become narrower gradually as they approach the rear from the front, and a plurality of groove parts 18 are horizontally arranged in parallel to each other. Each groove part 18 may be disposed parallel to an adjacent groove part 18.
- [146] Moreover, the left and right direction central parts of the back cover 12 and the display module 11 may be fixed, and other parts other than the fixed central parts may be installed not to restrain the movement in the front and rear directions. Therefore, when the back cover 12 and the display module 11 are bent, the left and right direction edges may move back and forth.
- [147] However, the back cover 12 and the display module 11 may be installed so that the back and forth movements of both end parts are restrained and a central part of the left and right directions may move back and forth. In this case, the back cover 12 and the display module 11 may be bent.
- [148] Due to the above configuration, when current is applied to the wire 34 by the bending control unit, it generates a magnetic field. At this point, a current flowing into the wire 34 is controlled so that the direction of a current flowing in one wire 34 is opposite to that in an adjacent wire 34. Therefore, repulsion occurs between the one wire 34 and the adjacent wire 34.
- [149] When repulsion acts on between each wire 34, a force in the lateral direction is applied to the rear of the back cover 12 relative to its center. Accordingly, the back

cover 12 and the display module 11 change from a flat shape shown in Figure 2 1A into a shape whose both left and right ends protrude toward the front and the center is pushed back, as illustrated in Figure 2 1B. At this point, since a plurality of groove parts 18 are formed in the front side of the back cover 12, the groove part 18 becomes smaller to aid the bending of the back cover 12, so that the back cover 12 may be bent with a smaller amount of force.

- [150] Moreover, the amount of current flowing in the wire 34 may be controlled by the bending control unit and by adjusting the amount of current, the bending degree of the back cover 12 and the display module 11 may be adjusted. Furthermore, the wire 34 may be coupled to the front of the back cover 12. In this case, the wire 34 may be attached to the front side of the back cover 12, or may be built at the front inside the back cover 12 in the front to back direction relative to a thickness of the back cover 12.
- [151] When the wire 34 is coupled to the front of the back cover 12, the bending control unit may allow the direction of a current flowing in each wire 34 to be identical. Due to this, gravitation may act on between each wire 34. Once gravitation occurs between each wire 34, since a force to narrow the left and right widths is applied to the front on the basis of the back and forth direction center of the back cover 12, an interval between the groove parts 18 becomes narrower. Due to this, the back cover 12 and the display module 11 may be bent toward the front. In this case, the degree of bending of the back cover 12 and the display module 11 may be controlled when the bending control unit controls current flow through the wires 34.
- [152] Moreover, as mentioned above, as the wire 34 serves as a bending actuator, when a current flowing in the wire 34 is cut off the display module 11 and the back cover 12 return to their original flat states by elastic restoring force. If necessary, a current flowing in the wire 34 is applied in an opposite direction, so that this may aid to unbend the display module 11 and the back cover 12 to the original states.
- [153] Moreover, a bending actuator configuring a bending assembly may be an electromagnet as shown in Figures 23 to 26. When compared with the configuration of Figures 21A and 21B, all other configurations are the same except that the wire 34 is replaced with an electromagnet 38, and thus repeated description is omitted.
- [154] Figures 23 to 25B are views when the electromagnet 38 is coupled to the rear of the back cover 12, and Figures 25 and 26 are views when the electromagnet 38 is coupled to the front of the back cover 12. The electromagnet 38 may extend to have its polarities in the lateral directions. That is, the left end part is an S pole, the right end part is an N pole. When the left end part is an N pole, the right end part is an S pole.
- [155] In relation to the electromagnet 38, a plurality of electromagnets which are vertically arranged in parallel to each other may form one electromagnet column 38a. A plurality of columns of electromagnets may be provided horizontally across the back cover 12

and aligned with adjacent electromagnets.

- [156] The electromagnet 38 may generate different N and S poles depending on whether the electromagnet 38 is coupled to the front or rear of the back cover 12. Accordingly, as shown in Figure 23, when a plurality of electromagnet columns are coupled to the rear of the back cover 12, the bending control unit controls the current to create repulsion between one electromagnet column and another adjacent electromagnet column.
- [157] Once repulsion acts between each electromagnet column, a force to expand the rear in the lateral direction is applied to the back cover 12 as illustrated in Figures 24A and 24B. Due to this, the back cover 12 and the display panel 11 are bent, so that the left and right direction end parts protrude toward the front and the central part is moved toward the rear. The bending of the back cover 12 bends the display module 11 a prescribed amount. At this point, an angle at which the display module 11 and the back cover 12 bend may be adjusted by controlling the amount of current flowing in the electromagnet.
- [158] Moreover, as shown in Figures 25 and 26, when a plurality of electromagnet columns are coupled to the front of the back cover 12, the bending control unit controls current to generate gravitation to act between one electromagnet column and another adjacent electromagnet column. Figure 25 is a view when an electromagnet is coupled to the front of the back cover 12 and Figure 26 is a plan view thereof.
- [159] Once gravitation is applied to between each electromagnet column, the front of the back cover 12 becomes narrower in the lateral direction. Due to this, the back cover 12 and the display module 11 may be bent. In this case, the amount of current flowing in the electromagnet 38 is controlled by the bending control unit, so that the degree of bending of the display module 11 and the back cover 12 may be adjusted.
- [160] Moreover, as mentioned above, as the electromagnet 38 serves as a bending actuator, when a current flowing in the electromagnet 38 is cut off, the display module 11 and the back cover 12 return to their original flat states by elastic restoring force. If necessary, a current flowing in the electromagnet 38 is applied in an opposite direction, so that this may aid to unbend the display module 11 and the back cover 12 to the original states. Additionally, when the electromagnet 38 is used as the bending actuator, the groove part 18 may be provided at the front of the back cover 12.
- [161] Moreover, a bending actuator configuring a bending assembly may be a bi-metal or piezoelectric element as shown in Figures 27 to 31. When compared with the configuration of Figures 23 to 25, all other configurations are the same except that the wire 34 is replaced with a bi-metal 36 or a piezoelectric element 36a, and thus repeated description is omitted.
- [162] Figures 27 to 29 are views when the bi-metal 36 is attached to the back cover 12. Ac-

cordingly, the bending actuator becomes the bi-metal 36. The bi-metal 36 refers to an object including thin metal plates that have different thermal expansion coefficients and are joined together. When temperature rises, a metal plate having a greater thermal expansion coefficient expands longer so that it is bent toward a metal plate having a less thermal expansion coefficient.

- [163] Figure 27 is a view when the bi-metal 36 is attached to the front side of the back cover 12. Figure 28 is a sectional view of the bi-metal 36. Figure 29 is a view when the back cover 12 and the display module 11 are combined. First, referring to Figure 28, the bi-metal 36 includes a first metal 36a having a relatively greater thermal expansion coefficient and a second metal 35a coupled to the front of the first metal 36a. At this point, the first metal 36a may be a piezoelectric element. A voltage applied to the piezoelectric element 36a may be controlled by the bending control unit.
- [164] The piezoelectric element 36a is a device having piezoelectric effect (when mechanical pressure is applied, voltage occurs and when voltage is applied, mechanical deformation occurs). When external force is applied, electric polarization occurs to generate potential difference and on the contrary, when voltage is applied, deformation or stress occurs.
- [165] The display device according to this embodiment uses the property that when voltage is applied to the piezoelectric element 36a, it expands. The piezoelectric element 36a may be formed of BaTiO₃, PbZrO₃ or another appropriate type of material. One bi-metal 36 may have a band shape and extends in the lateral direction. Also, a plurality of the bi-metal 36 may be provided vertically, in parallel to each other.
- [166] Moreover, a plurality of groove parts 18 may be provided perpendicular to a direction in which the piezoelectric element 36a extends. A configuration and functions of the groove part 18 are the same as described above.
- [167] Due to the above configuration, when power is supplied to the piezoelectric element 36a by the bending control unit, the length of the piezoelectric element 36a is increased and the both end parts of the bi-metal are bent toward the front. As the bi-metal 36 is bent, the back cover 12 is bent with the same curvature radius. Due to this, the display module 11 is bent simultaneously.
- [168] Accordingly, the back cover 12 and the display module 11 may have a shape in which the lateral ends protrude toward the front, and the center part is moved toward the rear. That is, the display unit is bent in a shape concaved toward the front.
- [169] At this point, when the bending control unit may control a voltage applied to the piezoelectric element 36a, the amount of length change in the piezoelectric element 36a is adjusted so that the bending amount of the back cover 12 may be controlled. Moreover, when the bending control unit cuts off a voltage applied to the piezoelectric device 36a, the piezoelectric device 36a returns to its original length, and also the back

cover 12 and the display module 11 return to their original flat states.

- [170] Additionally, as shown in Figure 30, the bi-metal 36 may be coupled to the rear of the back cover 12. In this case, the configuration and operation principle of the bi-metal 36 are the same as those of Figures 9 to 11.
- [171] Moreover, the bending actuator may include only a piezoelectric element instead of the bi-metal 36. In Figure 31, only the piezoelectric element 36a is attached to the position where the bi-metal 36 of Figure 30 was attached before. Therefore, the piezoelectric element 36a extends in the left and right directions and is provided in plurality vertically in parallel to each other.
- [172] As mentioned above, since the length of the piezoelectric element 36a is increased by applying a predetermined voltage, after the piezoelectric element 36a is coupled to the rear of the back cover 12, when voltage is applied to the piezoelectric element 36a by the bending control unit, the length of the piezoelectric element 36a is increased so that the back cover 12 may be bent toward the front. When the piezoelectric element 36a is bent, the display module 11 is bent simultaneously, so that user's immersion may be improved.
- [173] Moreover, when the bending control unit cuts off a voltage applied to the piezoelectric element 36a, the piezoelectric element 36a returns to its original length, and also the back cover 12 and the display module 11 return to their original flat states by the restoring force of the piezoelectric element 36a and the elastic restoring force of the display panel 11 and the back cover 12.
- [174] Figures 32-33 illustrates another configuration of the bending actuator according to the present disclosure. The display device may include a display unit displaying an image and a bending assembly bending the display unit. The display unit may include a display module 11 displaying an image and a back cover 12 coupled to the rear of the display module 11. The bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator.
- [175] The bending actuator 47 shown in Figure 32 and 33 includes a sensitive heat tube 47a filled with refrigerant gas, a flow path 47b serving as a path through which the refrigerant gas of the sensitive heat tube 47a flows, a cylinder 47c coupled to the end part of the flow path 47b, and a heater 47d surrounding the external of the sensitive heat tube 47a. The heater 47d may be a heating wire.
- [176] The flow path 47b has a roughly T-shape as seen from the rear. The flow path 47b may extend from the sensitive heat tube 47a upward, is split into the left and right flow paths 47b at a predetermined position, and then extends at an angle toward the front left and right outer edges. Accordingly, the cylinder 47c coupled to a distal end of the flow path 47b also extends at an angle toward the front left and right outer edges.

- [177] Moreover, a stopping part 48 (or stopper) that protrudes toward the rear may be provided at both the left and right edges on the backside of the back cover 12. The stopping part 48 may include a pressing side 48a (or angled surface) toward a direction in which the cylinder 47c extends and the cylinder 47c contacts the pressing side 48a.
- [178] When voltage is applied to the heater 47d by the bending control unit and the heater 47d heats the refrigerant, the volume of the refrigerant gas expands and the cylinder 47c is pushed outward. The cylinder 47c applies pressure to the pressing side 48a of the stopping part 48 so that the lateral edges of the back cover 12 are pressed toward the front. Therefore, the back cover 12 is bent toward the front. When the back cover 12 is bent, the display module 11 at the front of the back cover 12 is concavely bent toward the front. Due to this, user's immersion may be increased.
- [179] Moreover, when the bending control unit cuts off the power applied to the heater 47d, the display module 11 and the back cover 12 return to their original flat states by the elastic restoring force thereof. Moreover, the bending actuator may have the structure shown in Figures 16 and 19.
- [180] Figures 34 to 47 illustrate another configuration of the bending actuator according to the present disclosure. The display device may include a display unit displaying an image and a bending assembly bending the display unit. The display unit may include a display module 11 displaying an image and a back cover 12 coupled to the rear of the display module 11.
- [181] The bending assembly may include a bending actuator applying physical force to the back cover 12 and a bending control unit controlling operations of the bending actuator. Here, the bending actuator may include a motor 49a, shafts 49b and 49c, and a speaker 49d.
- [182] Figure 34 is a plan view when the speaker 49d is hidden by the rear of the display module 11 and the back cover 12. Figure 35 is a plan view when the speaker 49d is visible at the left and right side of the display unit. Figure 36 is a view when the speaker 49d is further pressed to bend the back cover 12 and the display module 11. Additionally, Figure 47 is a sectional view illustrating a coupling structure of the first shaft 49b and the second shaft 49c.
- [183] In the bending assembly applied to the display device according to this embodiment, the bending actuator 49 may include the motor 49a and the shafts 49b and 49c. The shafts 49b and 49c may include a first shaft 49b having a screw gear on the outer circumference thereof and a hollow second shaft 49c having a gear corresponding to the first shaft 49b on the inner circumference thereof. Moreover, the speaker 49 is coupled to the end part of the second shaft 49c to be slidable.
- [184] The display module 11, the back cover 12, and the bending actuator 49 may all be provided on the lower frame 50. At this point, the center part of the display module 11

and the back cover 12 may be fixed at the lower frame 50, and both the left and right end parts are not fixed. Accordingly, when external force is applied from the rear to around the both left and right ends of the display module 11 and the back cover 12, the lateral ends may protrude toward the front when the display module is bent.

- [185] Moreover, the guide part 53 for guiding the sliding of the speaker 49d may be provided at the lower frame 50. The guide unit 53 protrudes toward the top of the lower frame 40 and extends in a straight line shape, and thus the speaker 49d contacts the backside of the guide unit 53 and is guided. Additionally, the stopping part 48 shown in Figures 34 to 36 is provided at the left and right edges of the back cover 12.
- [186] Under the above structure, when the bending control unit rotates the motor 49a, the rotation of the motor 49a rotates the first shaft 49b. At this point, a power transmitting means such as a gear, a chain, and a belt may be provided between the rotational axis of the motor 49a and the first shaft 49b.
- [187] The second shaft 49c may be pushed toward the outer edge as the first shaft 49b rotates inside second shaft 49c. At this point, in order for the second shaft 49c to be pushed toward the outer edges a prescribed amount, the rotation of the second shaft 49b needs to be limited. Since the second shaft 49c is coupled to the speaker 49d and the speaker 49d contacts the guide unit 53, the second shaft 49c is pushed toward the outer edge and to the front.
- [188] When the second shaft 49c is pushed, and thus the speaker 49d is pressed at an angle toward the edges, the speaker 49d which was hidden from view protrudes at the outer edges of the display module 11 as shown in Figure 35. Accordingly, a user may control a display device to hide a speaker when not in use and show the speaker when in use.
- [189] Moreover, the speaker 49d is slid toward the outer edges and contacts the stopping part 48 as shown in Figure 35. During this state, when the motor 49a rotates, the speaker 49d presses against the stopping part 48. Due to this, the lateral edges of the back cover 12 may be pressed toward the front. Therefore, as shown in Figure 36, the lateral edges of the back cover 12 and the display module 11 may protrude toward the front to bend the display module 11 forward. Hence, the user's immersion may be improved. Furthermore, by reversing the rotation direction of the motor 49a, the bending control unit may return the bent display module 11 and back cover 12 to their original flat states.
- [190] Moreover, the bracket 17, the first fastener 41, and the second fastener 43 shown in Figures 7 to 8B may be applicable to the display device according to this embodiment. Additionally, the third fastener 45 shown in Figures 9 and 10 may be also applicable.
- [191] As broadly described and embodied herein, a display device is provided having a structure capable of improving user's immersion while viewing content. In one embodiment, a display device may include a display unit displaying an image, and a

bending assembly bending the display unit. The bending assembly may include a bending actuator applying force to the display unit and a bending control unit controlling an operation of the bending actuator. According to the present disclosure, since a display module of a display device is bent, user's immersion may be improved. Also, the bending degree of a display module may be easily adjusted.

- [192] In one embodiment, a display device may include a display panel for displaying an image, a back cover provided behind the display panel and coupled to the display panel, a bending assembly coupled to the back cover to bend the display panel, and a controller configured to control the bending assembly to apply a physical force to the back cover to bend the display panel a prescribed amount.
- [193] The bending assembly may include a plurality of elastic members formed of shape memory alloy that expands or contracts corresponding to a change in temperature of the shape memory alloy. The shape memory alloy may have a cylindrical shape having a prescribed length that changes based on an amount of current that flows through the shape memory alloy.
- [194] The elastic members may be provided on the back cover to extend laterally across on the back cover such that the shape memory alloy expands or contracts laterally with respect to the back cover. The elastic members may be provided on a front surface or a rear surface of the back cover. A recess may be formed in the back cover to accommodate the elastic members.
- [195] A support bracket may be coupled to the back cover to support the shape memory alloy. A middle cover may be attached to a rear surface of the display panel and provided between the display panel and the back cover, wherein the support bracket is provided on a front surface of the back cover between the back cover and the middle cover, the shape memory alloy extending laterally along the back cover and coupled to the support bracket. The support bracket may include a plurality of vertical portions spaced a prescribed distance from the back cover toward the display panel, the elastic members coupled to the vertical portions to extend laterally across the back cover. Moreover, the support bracket and the elastic members may be modularized for coupling to the back cover.
- [196] A support bracket may be coupled to the back cover and may include a center support that extends vertically along a center of the back cover and a plurality of lateral supports provided at lateral regions of the back cover, the support bracket coupling the center and lateral regions of the back cover to the display panel, and the back cover may have a prescribed curvature in a lateral direction and when the shape memory alloy provided laterally along the back cover contracts in length, a center of the display is pulled toward the back cover to bend the display panel. When the shape memory alloy contracts, the prescribed curvature of the back cover may be increased to bend

the display panel. The plurality of lateral supports may be slidable connectors that allow the middle cover to slide laterally relative to the back cover when the display panel is bent. The slidable connectors include a body fixed at one of the back cover or the middle cover and a moving member slidably coupled to the body and fixed to the other one of the back cover or the middle cover.

- [197] A support bracket may be provided a prescribed distance behind the back cover, the support bracket extending vertically and positioned to correspond to a center of the back cover, wherein the elastic members extend from the support bracket to the rear cover to pull the center of the rear cover toward the support bracket when the temperature of the shape memory alloy is increased above a prescribed level. A motor may be coupled to the support bracket to rotate the support bracket along a longitudinal axis of the support bracket, wherein the shape memory alloy is wound around an outer surface of the support bracket when the support bracket is rotated to bend the display panel.
- [198] The plurality of elastic members may be provided to extend parallel to each other to form a first column corresponding to a left side of the display panel and a second column corresponding to a right side of the display panel. The controller may control a length of the shape memory alloy in the left column to be different than in the right column. The controller may control an amount of current applied to the shape memory alloy to change a length of the shape memory alloy to bend the display panel.
- [199] The display device may also include a bracket coupled to a rear of the back cover, a printed circuit board coupled to a rear of the bracket, and a first fastener provided between the bracket and the back cover to couple the back cover to the bracket along a central vertical axis of the display panel. A second fastener may be provided between the bracket and the printed circuit board to couple the printed circuit board to the bracket along a lateral side of the printed circuit board. Another fastener may be provided between the bracket and the back cover to couple a lateral region of the back cover to the bracket, wherein this fastener includes a first portion coupled to the back cover and a second portion coupled to the bracket, the first portion being movably coupled to the second portion to allow lateral movement of the rear cover relative to the bracket.
- [200] The bending assembly may include a plurality of wires that extend vertically on the back cover and positioned a prescribed distance from each other in a lateral direction with respect to the display panel, the plurality of wires configured to apply a prescribed amount of force with respect to an adjacent wire to bend the display panel. The plurality of wires may be provided adjacent a front surface of the back cover that faces the display panel or adjacent a rear surface of the back cover opposite the front surface. Here, when the wires are provided adjacent the front surface of the back cover, the

controller controls a direction of current through each wire to be the same to apply a force that pulls each wire toward an adjacent wire. Moreover, when the wires are provided at the rear surface of the back cover, the controller controls the current through each adjacent wire to be opposite to apply a force that pushes each wire away from an adjacent wire.

- [201] The bending assembly may include a plurality of electromagnets arranged relative to each other to apply a lateral force to the back cover. The plurality of electromagnets may be provided adjacent a rear surface of the back cover that faces away from the display panel, and the controller controls a direction of current through each electromagnet such that an N pole of one electromagnet faces an N pole of an adjacent electromagnet. Moreover, the plurality of electromagnets may be provided adjacent a front surface of the back cover that faces the display panel, and the controller controls a direction of current through each electromagnet such that an N pole of one electromagnet faces an S pole of an adjacent electromagnet.
- [202] The bending assembly may include a bi-metal having a first metal provided at a front side that faces the display panel and a second metal provided at a rear side opposite the front side, the first metal having a thermal expansion coefficient that is relatively less than a thermal expansion coefficient of the second metal. The bending assembly may include a bi-metal having a first metal provided at a front side that faces the display panel and a second metal provided at a rear side opposite the front side, the second metal being a piezoelectric element. The bending assembly may also include a piezoelectric element that is coupled to the back cover, a length of the piezoelectric element configured to change in a lateral direction relative to the display panel.
- [203] The bending assembly may include a heat sensitive tube, refrigerant provided in the heat sensitive tube, a heater to heat the heat sensitive tube, and a cylinder connected to a distal end of the sensitive heat tube, wherein, when the heater heats the refrigerant, the heat sensitive tube expands to move the cylinder laterally to apply a lateral force to a side edge of the back cover. A stopper may be provided at a rear surface of the back cover that limits a range of movement of the cylinder, the stopper including an angled surface that abuts against the cylinder when the cylinder is moved laterally. The heater may be a heating wire that surrounds an outer surface of the heat sensitive tube.
- [204] The bending assembly may include a motor and a shaft provided behind the back cover and extending to a lateral region of the back cover, a length of the shaft being changed by driving the motor, wherein when the shaft is extended, a pressure is applied to a side edge of the back cover to bend the display panel. The shaft may include a first shaft that is rotated by the motor, and a second shaft coupled to the first shaft through a screw gear. Moreover, a speaker may be coupled to a distal end of the shaft. The speaker may be positioned behind the display panel when the length of the

shaft is at a first length. The speaker may be positioned adjacent the display panel when the length of the shaft is at a second length greater than the first length. Moreover, the speaker may be positioned adjacent the display panel and a rear lateral edge of the back cover to apply the pressure to the side edge of the back cover to bend the display panel when the length of the shaft is at a third length greater than the second length. In the various embodiments, the back cover may be formed of a Carbon Fiber-Reinforced Plastic.

[205] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[206] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

[207]

Claims

- [Claim 1] A display device comprising:
a display panel for displaying an image;
a back cover provided behind the display panel and coupled to the display panel;
a bending assembly coupled to the back cover to bend the display panel; and
a controller configured to control the bending assembly to apply a physical force to the back cover to bend the display panel a prescribed amount.
- [Claim 2] The display device according to claim 1, wherein the bending assembly includes a plurality of elastic members formed of shape memory alloy that expands or contracts corresponding to a change in temperature of the shape memory alloy.
- [Claim 3] The display device according to claim 2, wherein the shape memory alloy has a cylindrical shape having a prescribed length that changes based on an amount of current that flows through the shape memory alloy.
- [Claim 4] The display device according to claim 2, wherein the elastic members are provided on the back cover to extend laterally across on the back cover such that the shape memory alloy expands or contracts laterally with respect to the back cover.
- [Claim 5] The display device according to claim 4, wherein the elastic members are provided on a front surface or a rear surface of the back cover.
- [Claim 6] The display device according to claim 4, wherein a recess is formed in the back cover to accommodate the elastic members.
- [Claim 7] The display device according to claim 2, wherein a support bracket is coupled to the back cover to support the shape memory alloy.
- [Claim 8] The display device according to claim 7, further comprising a middle cover attached to a rear surface of the display panel and provided between the display panel and the back cover, wherein the support bracket is provided on a front surface of the back cover between the back cover and the middle cover, the shape memory alloy extending laterally along the back cover and coupled to the support bracket.
- [Claim 9] The display device according to claim 8, wherein the support bracket includes a plurality of vertical portions spaced a prescribed distance from the back cover toward the display panel, the elastic members

- coupled to the vertical portions to extend laterally across the back cover.
- [Claim 10] The display device according to claim 9, wherein the support bracket and the elastic members are modularized for coupling to the back cover.
- [Claim 11] The display device according to claim 2, wherein a support bracket is coupled to the back cover and includes a center support that extends vertically along a center of the back cover and a plurality of lateral supports provided at lateral regions of the back cover, the support bracket coupling the center and lateral regions of the back cover to the display panel, and the back cover has a prescribed curvature in a lateral direction and when the shape memory alloy provided laterally along the back cover contracts in length, a center of the display is pulled toward the back cover to bend the display panel.
- [Claim 12] The display device according to claim 11, wherein, when the shape memory alloy contracts, the prescribed curvature of the back cover is increased to bend the display panel.
- [Claim 13] The display device according to claim 12, wherein the plurality of lateral supports are slidable connectors that allow the middle cover to slide laterally relative to the back cover when the display panel is bent.
- [Claim 14] The display device according to claim 13, wherein the slidable connectors include a body fixed at one of the back cover or the middle cover and a moving member slidably coupled to the body and fixed to the other one of the back cover or the middle cover.
- [Claim 15] The display device according to claim 2, further comprising a support bracket provided a prescribed distance behind the back cover, the support bracket extending vertically and positioned to correspond to a center of the back cover, wherein the elastic members extend from the support bracket to the rear cover to pull the center of the rear cover toward the support bracket when the temperature of the shape memory alloy is increased above a prescribed level.
- [Claim 16] The display device according to claim 15, further comprising a motor coupled to the support bracket to rotate the support bracket along a longitudinal axis of the support bracket, wherein the shape memory alloy is wound around an outer surface of the support bracket when the support bracket is rotated to bend the display panel.
- [Claim 17] The display device according to claim 2, wherein the plurality of elastic

- members are provided to extend parallel to each other to form a first column corresponding to a left side of the display panel and a second column corresponding to a right side of the display panel.
- [Claim 18] The display device according to claim 17, wherein the controller controls a length of the shape memory alloy in the left column to be different than in the right column.
- [Claim 19] The display device according to claim 2, wherein the controller controls an amount of current applied to the shape memory alloy to change a length of the shape memory alloy to bend the display panel.
- [Claim 20] The display device according to claim 1, further comprising a bracket coupled to a rear of the back cover, a printed circuit board coupled to a rear of the bracket, and a first fastener provided between the bracket and the back cover to couple the back cover to the bracket along a central vertical axis of the display panel.
- [Claim 21] The display device according to claim 20, further comprising a second fastener provided between the bracket and the printed circuit board to couple the printed circuit board to the bracket along a lateral side of the printed circuit board.
- [Claim 22] The display device according to claim 20, further comprising a second fastener provided between the bracket and the back cover to couple a lateral region of the back cover to the bracket, wherein the second fastener includes a first portion coupled to the back cover and a second portion coupled to the bracket, the first portion being movably coupled to the second portion to allow lateral movement of the rear cover relative to the bracket.
- [Claim 23] The display device according to claim 1, wherein the bending assembly includes a plurality of wires that extend vertically on the back cover and positioned a prescribed distance from each other in a lateral direction with respect to the display panel, the plurality of wires configured to apply a prescribed amount of force with respect to an adjacent wire to bend the display panel.
- [Claim 24] The display device according to claim 23, wherein the plurality of wires are provided adjacent a front surface of the back cover that faces the display panel or adjacent a rear surface of the back cover opposite the front surface, wherein when the wires are provided adjacent the front surface of the back cover, the controller controls a direction of current through each wire to

be the same to apply a force that pulls each wire toward an adjacent wire, and
when the wires are provided at the rear surface of the back cover, the controller controls the current through each adjacent wire to be opposite to apply a force that pushes each wire away from an adjacent wire.

- [Claim 25] The display device according to claim 1, wherein the bending assembly includes a plurality of electromagnets arranged relative to each other to apply a lateral force to the back cover.
- [Claim 26] The display device according to claim 25, wherein the plurality of electromagnets are provided adjacent a rear surface of the back cover that faces away from the display panel, and the controller controls a direction of current through each electromagnet such that an N pole of one electromagnet faces an N pole of an adjacent electromagnet.
- [Claim 27] The display device according to claim 25, wherein the plurality of electromagnets are provided adjacent a front surface of the back cover that faces the display panel, and the controller controls a direction of current through each electromagnet such that an N pole of one electromagnet faces an S pole of an adjacent electromagnet.
- [Claim 28] The display device according to claim 1, wherein the bending assembly includes a bi-metal having a first metal provided at a front side that faces the display panel and a second metal provided at a rear side opposite the front side, the first metal having a thermal expansion coefficient that is relatively less than a thermal expansion coefficient of the second metal.
- [Claim 29] The display device according to claim 1, wherein the bending assembly includes a bi-metal having a first metal provided at a front side that faces the display panel and a second metal provided at a rear side opposite the front side, the second metal being a piezoelectric element.
- [Claim 30] The display device according to claim 1, wherein the bending assembly includes a piezoelectric element that is coupled to the back cover, a length of the piezoelectric element configured to change in a lateral direction relative to the display panel.
- [Claim 31] The display device according to claim 1, wherein the bending assembly includes
a heat sensitive tube,
refrigerant provided in the heat sensitive tube,
a heater to heat the heat sensitive tube, and

a cylinder connected to a distal end of the sensitive heat tube, wherein, when the heater heats the refrigerant, the heat sensitive tube expands to move the cylinder laterally to apply a lateral force to a side edge of the back cover.

[Claim 32] The display device according to claim 31, where a stopper is provided at a rear surface of the back cover that limits a range of movement of the cylinder, the stopper including an angled surface that abuts against the cylinder when the cylinder is moved laterally.

[Claim 33] The display device according to claim 32, wherein the heater is a heating wire that surrounds an outer surface of the heat sensitive tube.

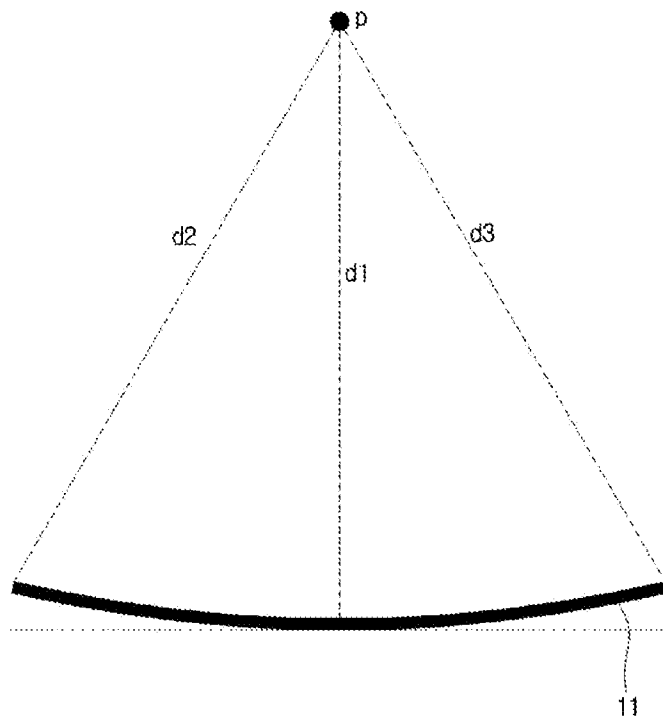
[Claim 34] The display device according to claim 1, wherein the bending assembly includes a motor and a shaft provided behind the back cover and extending to a lateral region of the back cover, a length of the shaft being changed by driving the motor, wherein when the shaft is extended, a pressure is applied to a side edge of the back cover to bend the display panel.

[Claim 35] The display device according to claim 34, wherein the shaft includes a first shaft that is rotated by the motor, and a second shaft coupled to the first shaft through a screw gear.

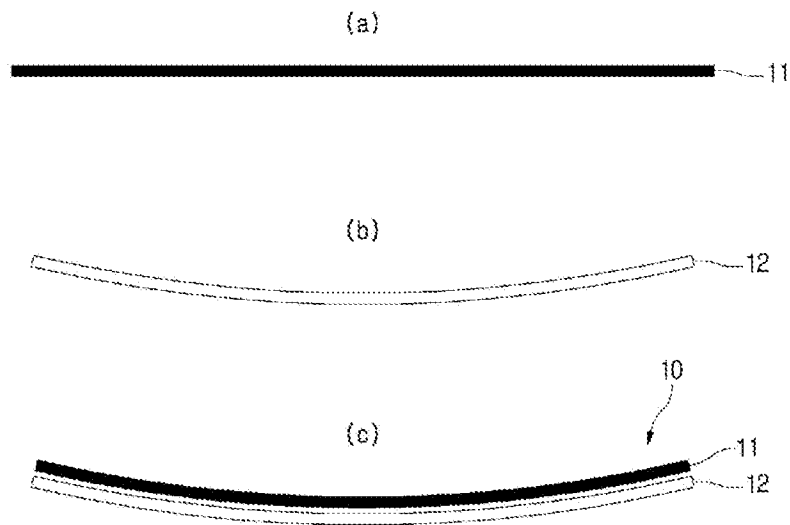
[Claim 36] The display device according to claim 34, wherein a speaker is coupled to a distal end of the shaft, wherein the speaker is positioned behind the display panel when the length of the shaft is at a first length, the speaker is positioned adjacent the display panel when the length of the shaft is at a second length greater than the first length, and the speaker is positioned adjacent the display panel and a rear lateral edge of the back cover to apply the pressure to the side edge of the back cover to bend the display panel when the length of the shaft is at a third length greater than the second length.

[Claim 37] The display device according to claim 1, wherein the back cover comprises Carbon Fiber-Reinforced Plastic.

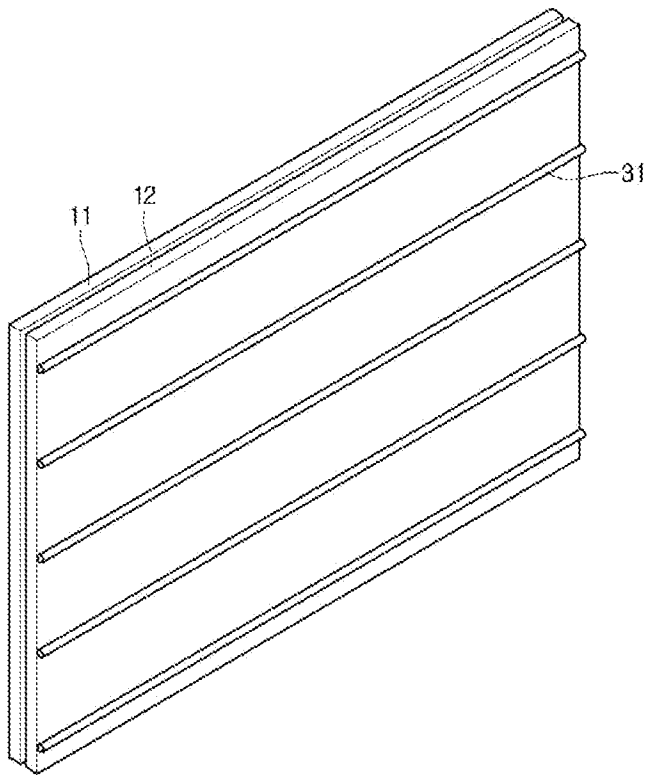
[Fig. 1]



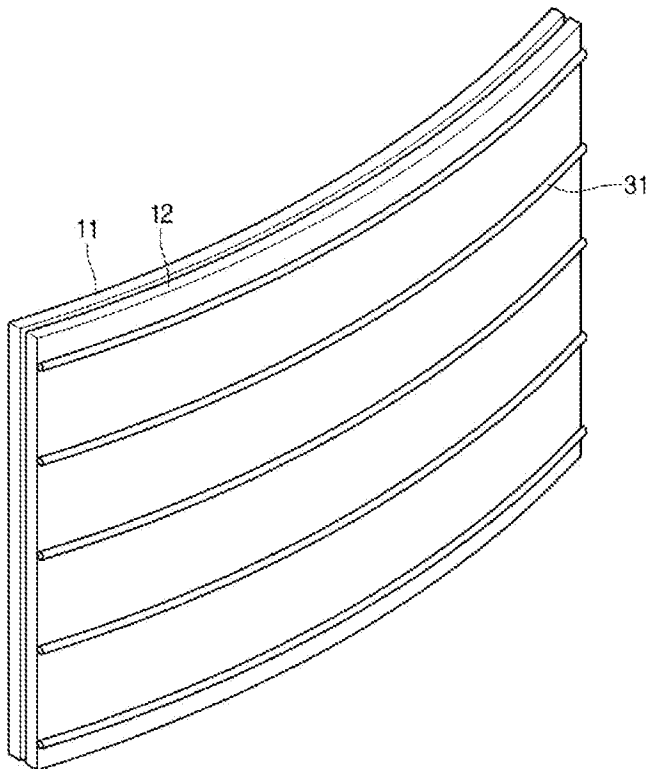
[Fig. 2]



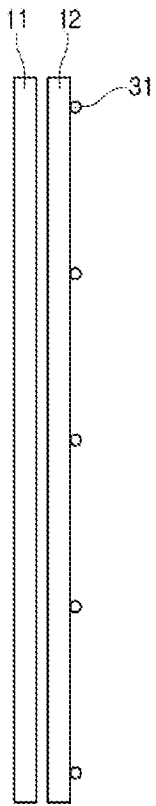
[Fig. 3A]



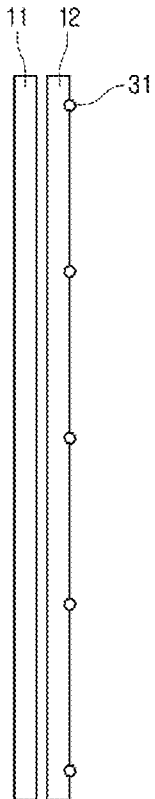
[Fig. 3B]



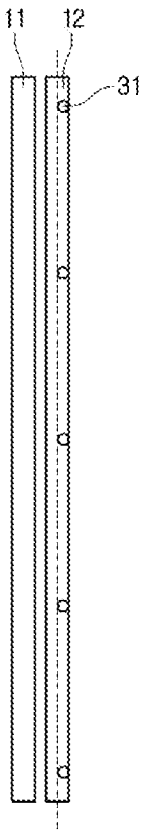
[Fig. 4]



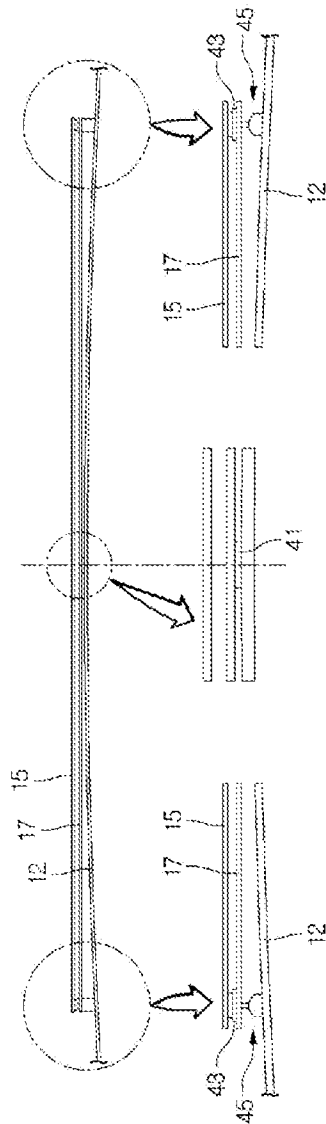
[Fig. 5]



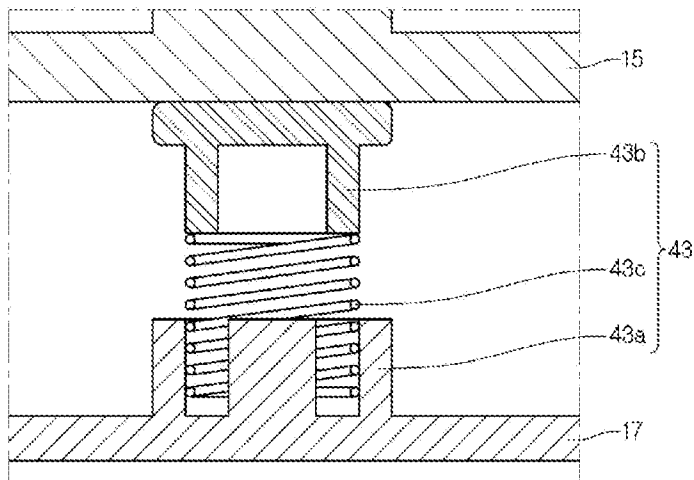
[Fig. 6]



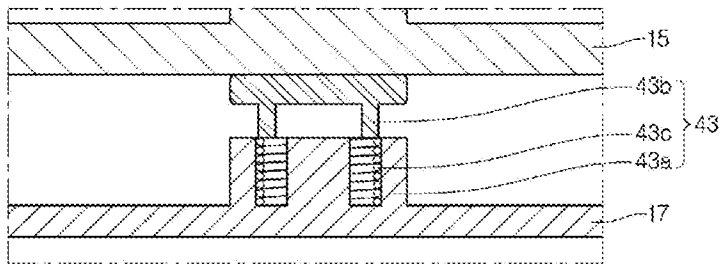
[Fig. 7]



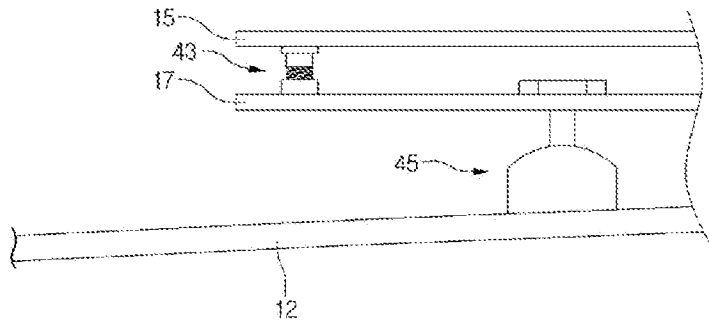
[Fig. 8A]



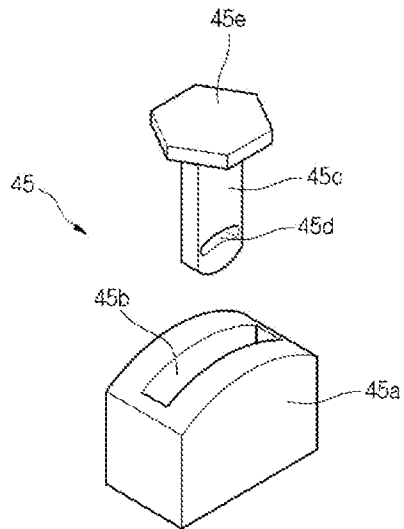
[Fig. 8B]



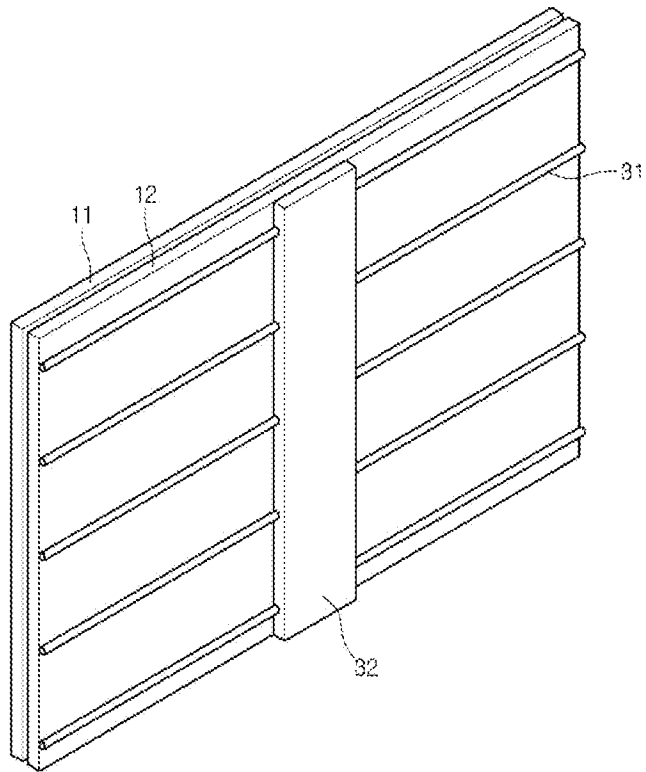
[Fig. 9]



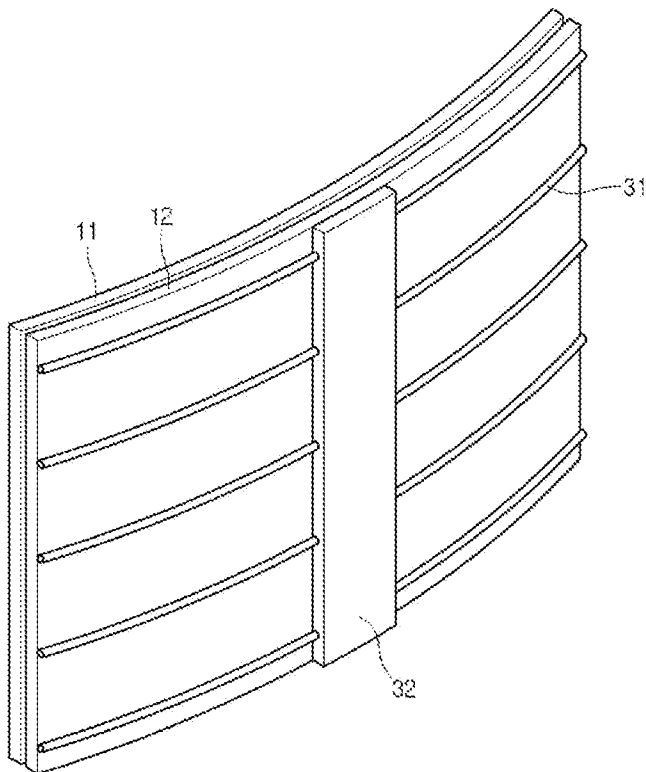
[Fig. 10]



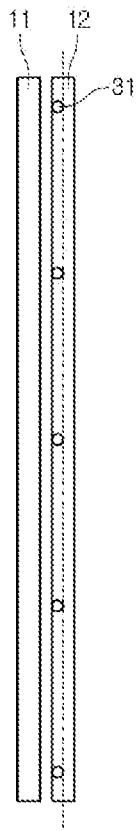
[Fig. 11A]



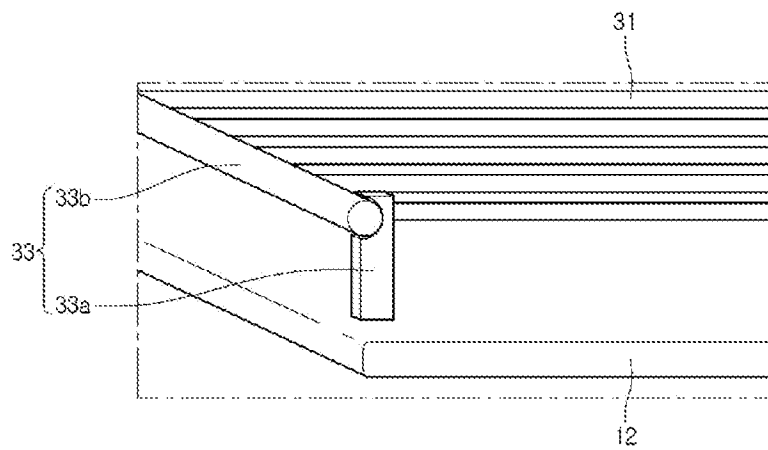
[Fig. 11B]



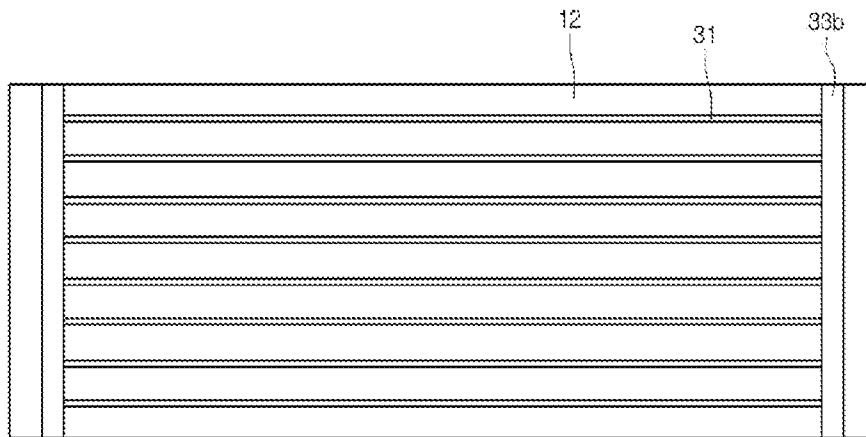
[Fig. 12]



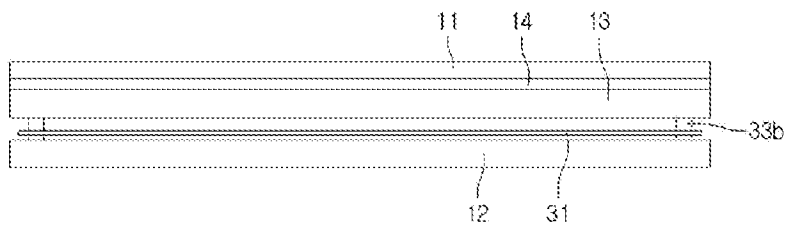
[Fig. 13]



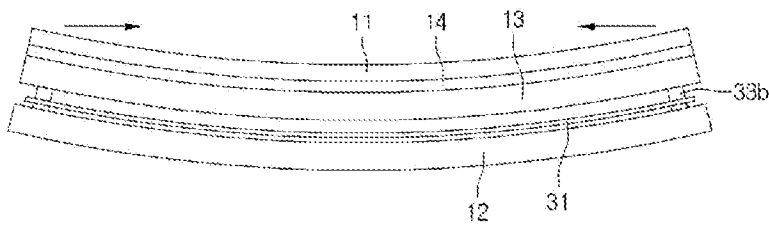
[Fig. 14]



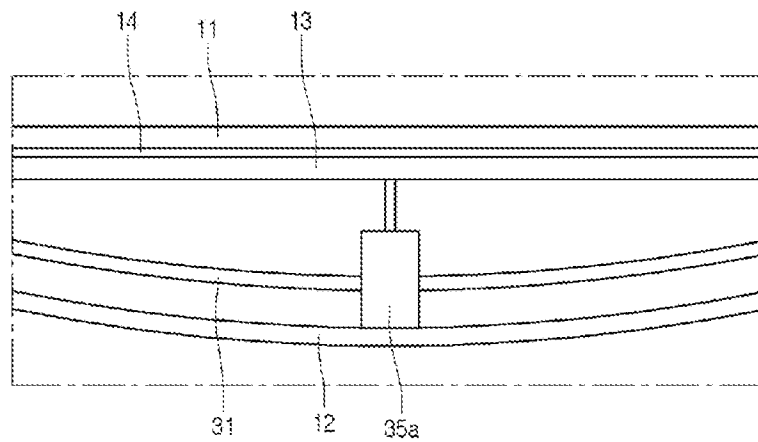
[Fig. 15A]



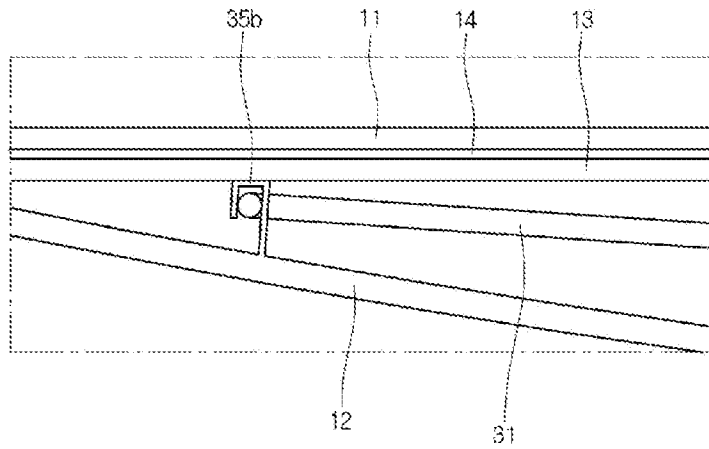
[Fig. 15B]



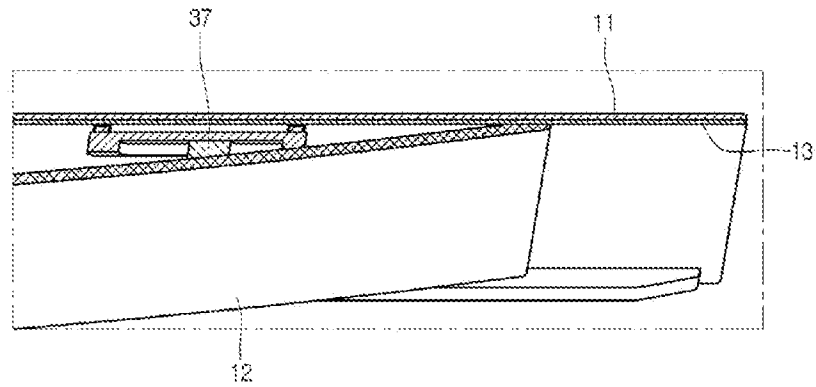
[Fig. 16]



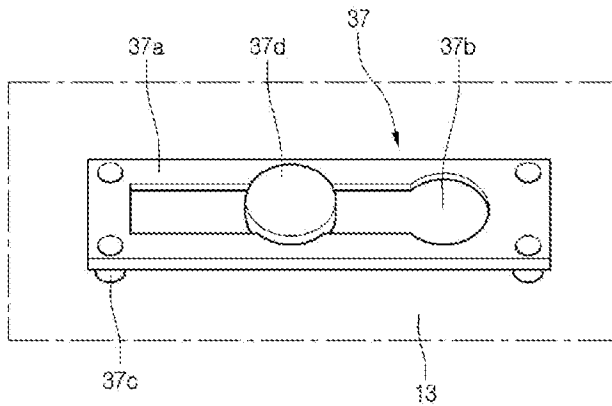
[Fig. 17]



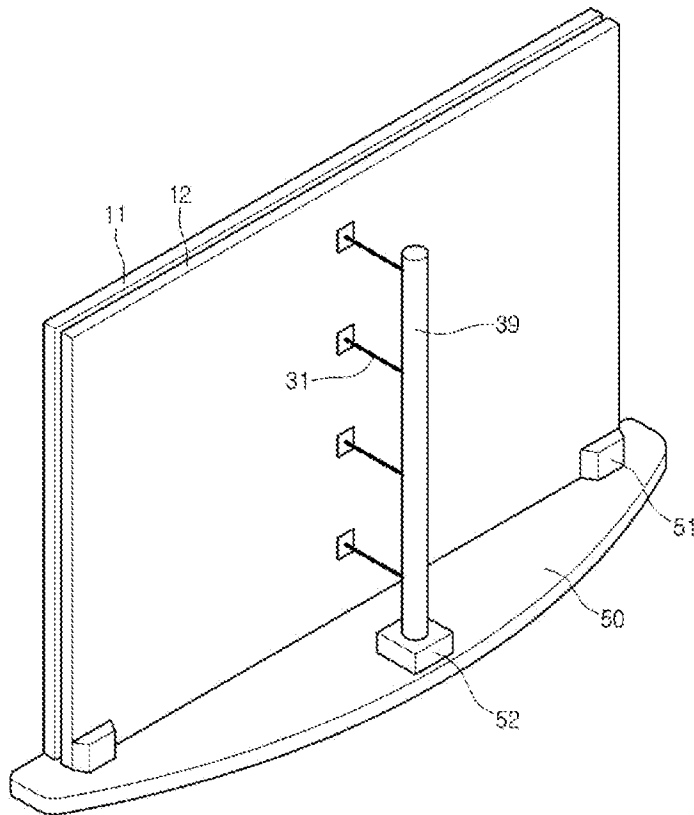
[Fig. 18]



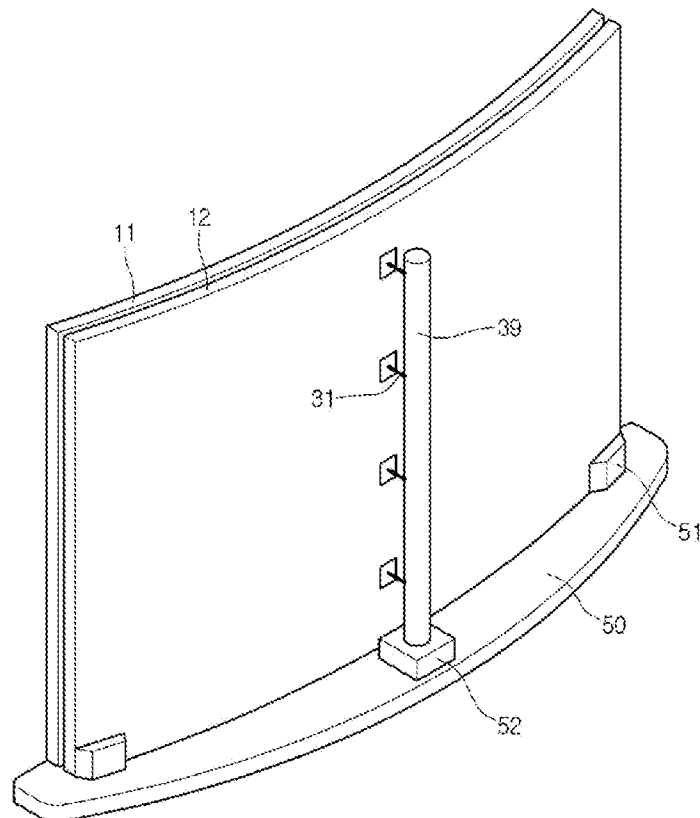
[Fig. 19]



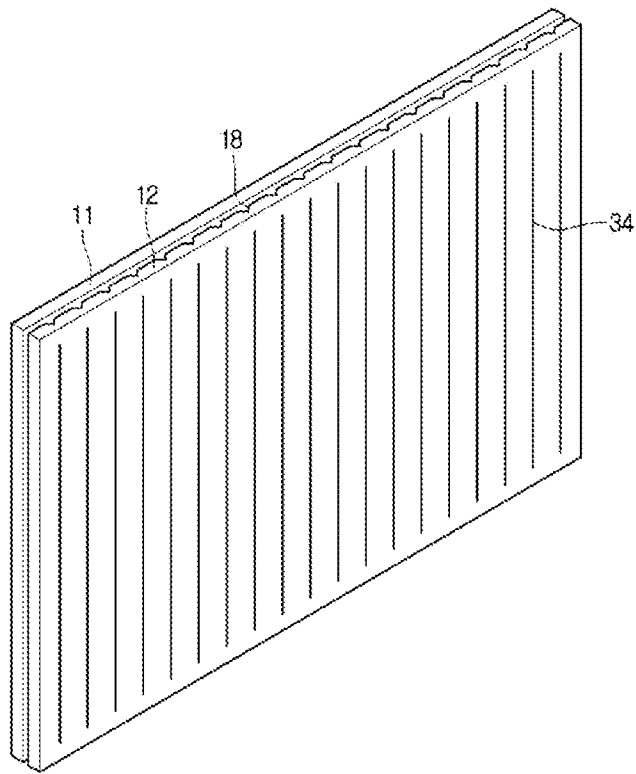
[Fig. 20A]



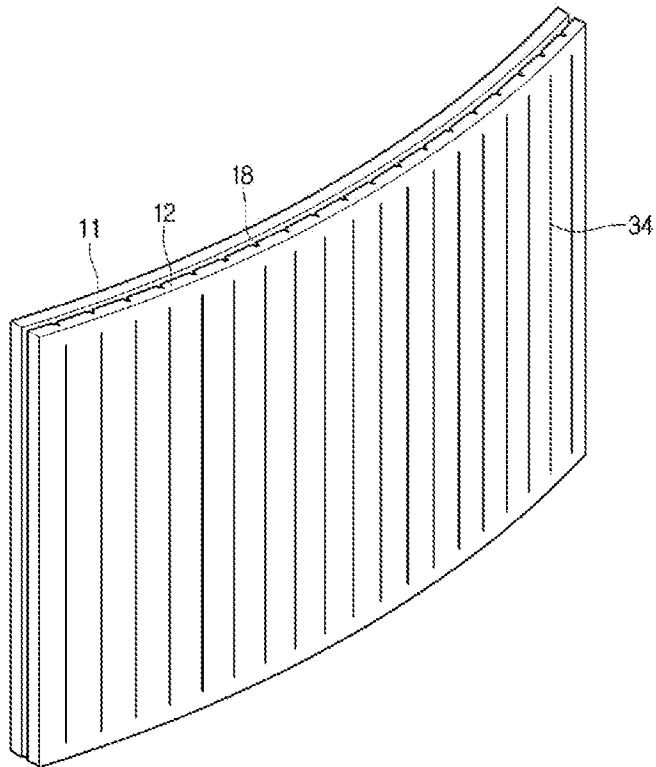
[Fig. 20B]



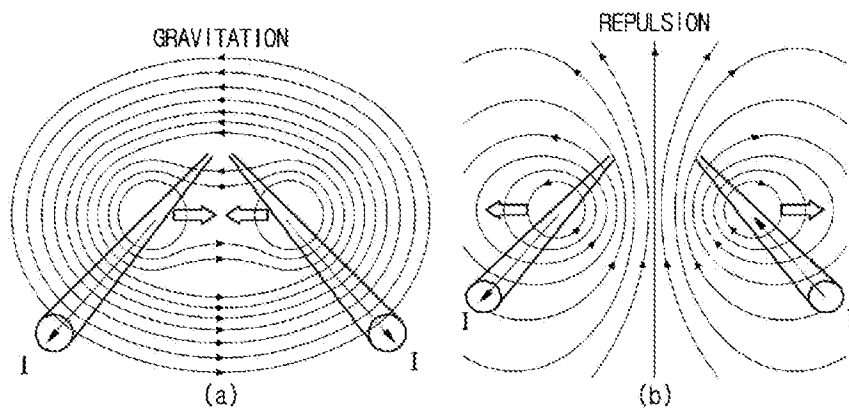
[Fig. 21A]



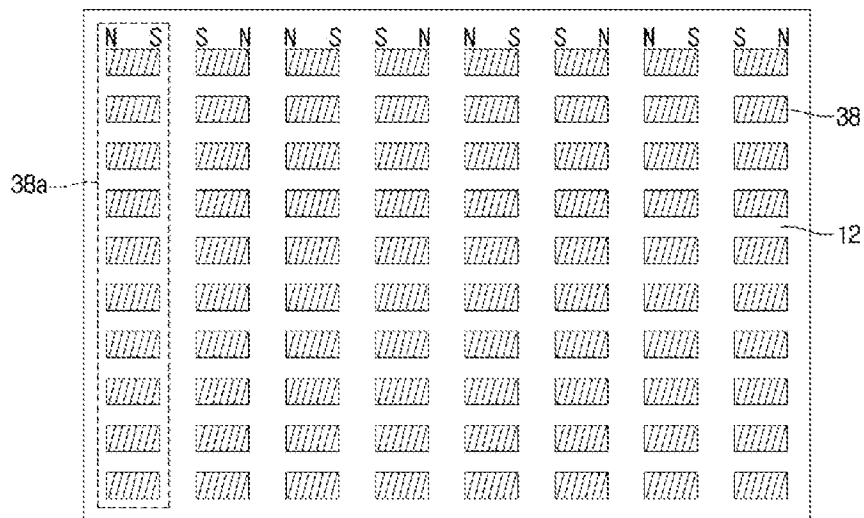
[Fig. 21B]



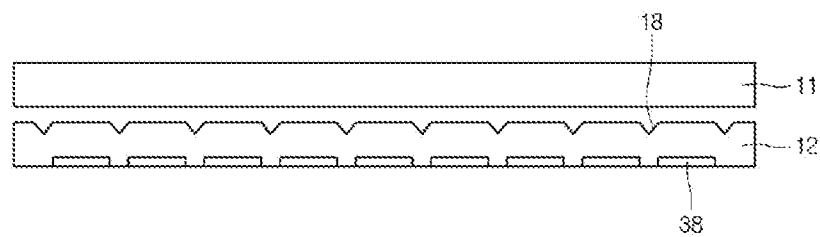
[Fig. 22]



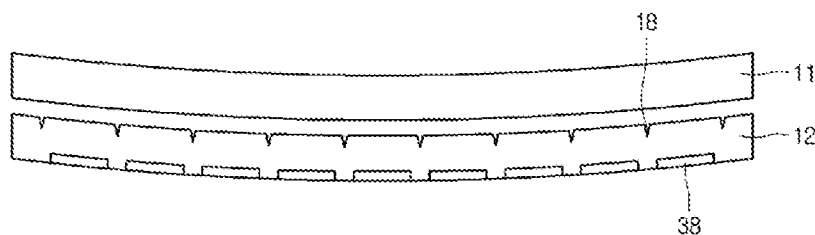
[Fig. 23]



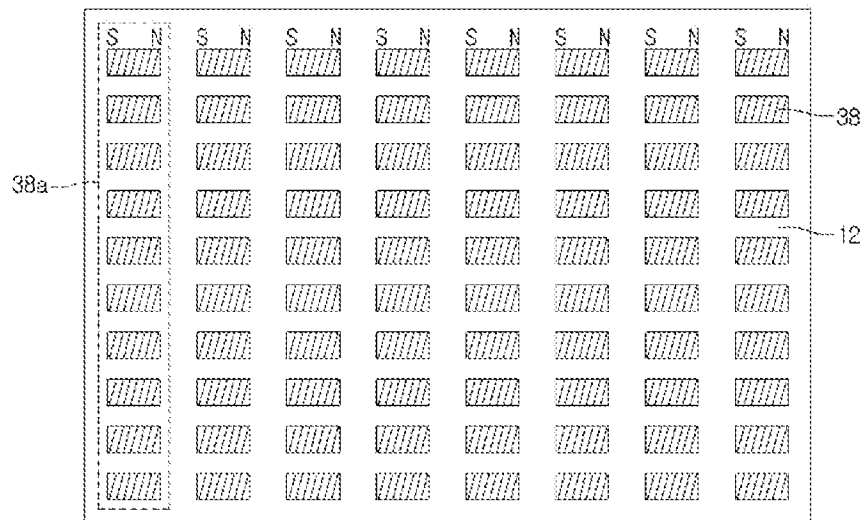
[Fig. 24A]



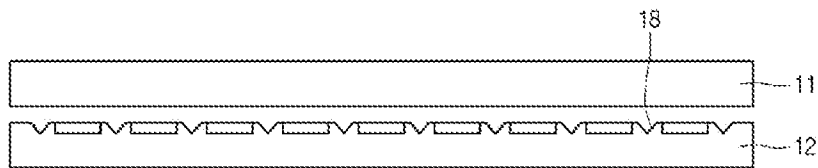
[Fig. 24B]



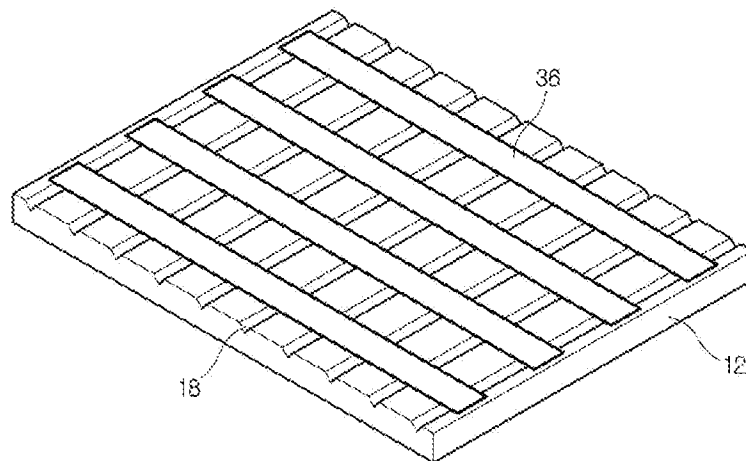
[Fig. 25]



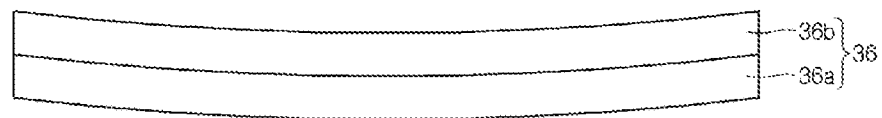
[Fig. 26]



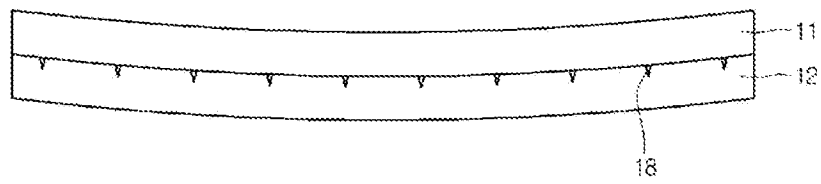
[Fig. 27]



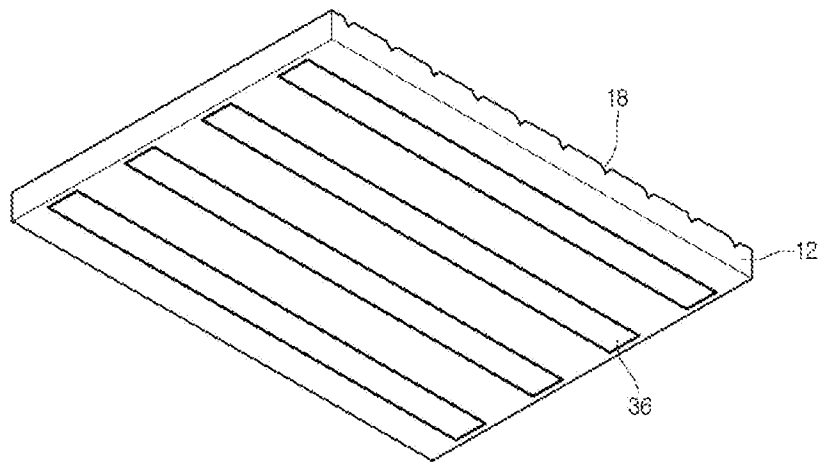
[Fig. 28]



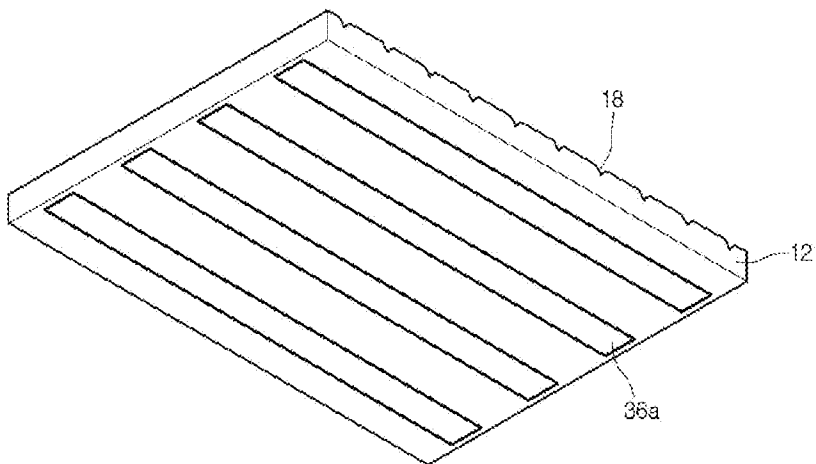
[Fig. 29]



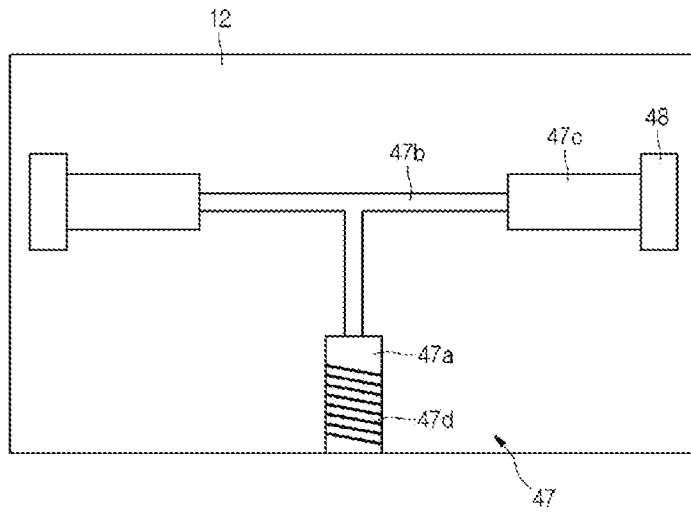
[Fig. 30]



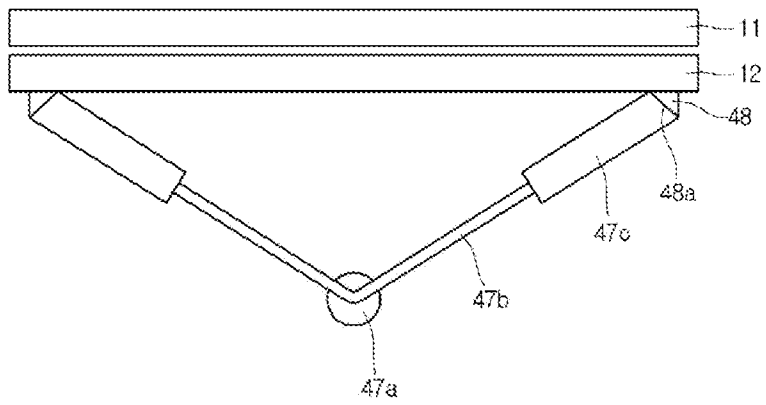
[Fig. 31]



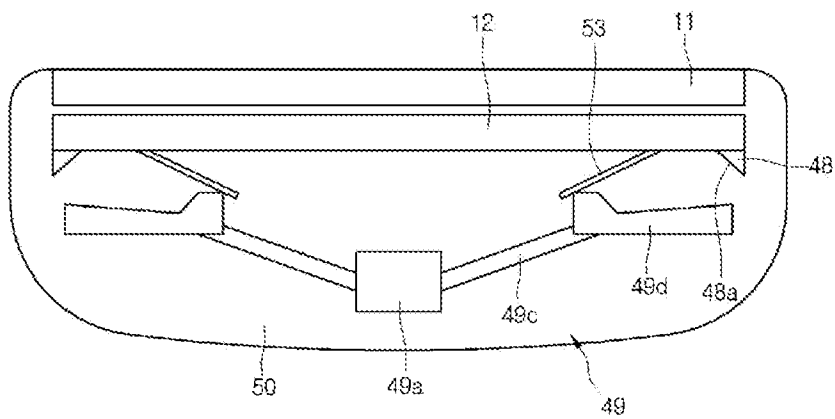
[Fig. 32]



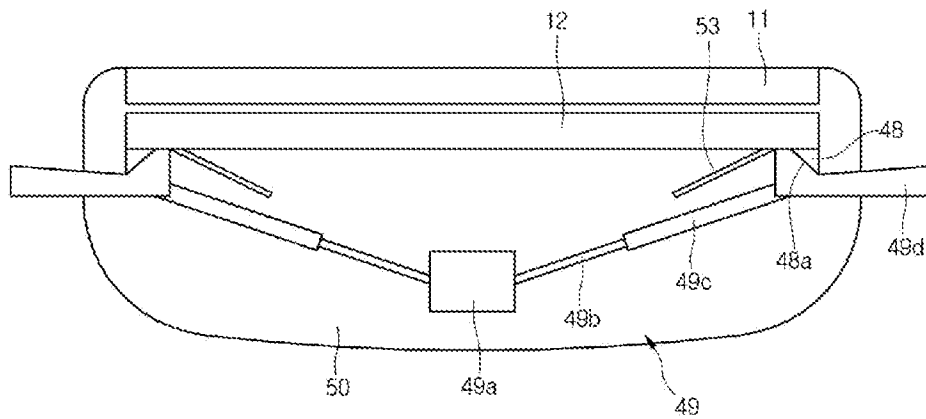
[Fig. 33]



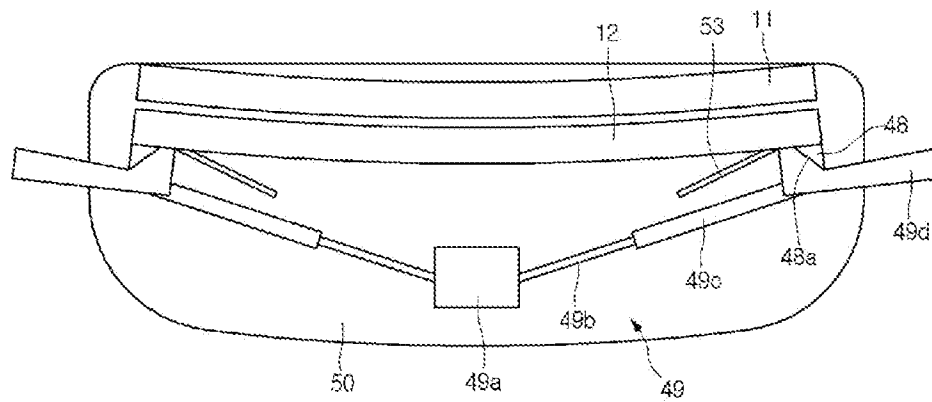
[Fig. 34]



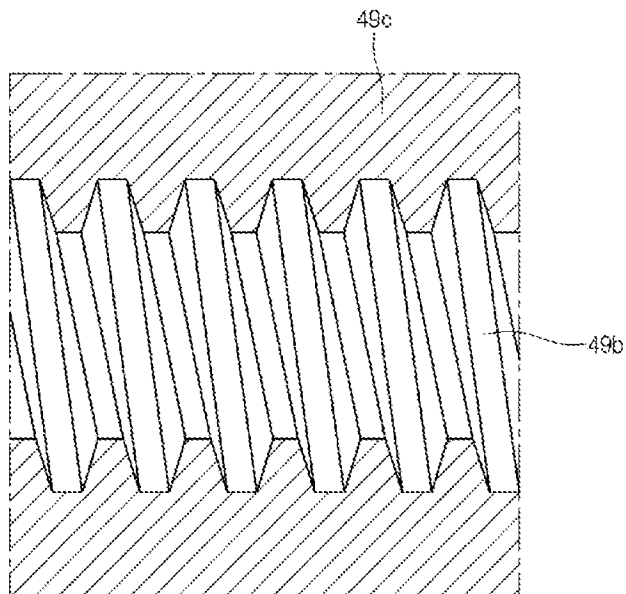
[Fig. 35]



[Fig. 36]



[Fig. 37]



A. CLASSIFICATION OF SUBJECT MATTER**G09F 9/00(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)

G09F 9/00; G02B 27/22; G09F 9/35; G02B 3/08; H05B 33/02; H04N 5/64; G02F 1/1333; G06F 3/041

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: display, control, bending, curvature

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2006-023676 A (PIONEER CORP.) 26 January 2006 See paragraphs [0015]- [0024] ; and figures 3.	1, 23, 24
Y		2-22, 25-37
Y	wo 2010-085575 AI (ARTIFICIAL MUSCLE, INC.) 29 July 2010 See paragraphs [0078] , [0141] ; and figures 1A, 1B.	2-19 , 25-30 , 37
Y	JP 2009-109812 A (NEC CORP.) 21 May 2009 See paragraphs [0015]- [0022] ; and figures 1, 3.	9-16
Y	JP 2009-063640 A (SONY CORP.) 26 March 2009 See paragraphs [0022]- [0050] ; and figures 2, 4.	13, 14, 20-22 , 31-33 , 36
Y	JP 10-026754 A (NIPPON DENKI IDO TSUSHIN KK.) 27 January 1998 See paragraphs [0011]- [0016] ; and figure 2.	16, 34-36

☐ 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

"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

06 March 2014 (06.03.2014)

Date of mailing of the international search report

07 March 2014 (07.03.2014)

Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

KIM, Do Weon

Telephone No. +82-42-481-5560



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2013/009503

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2006-023676 A	26/01/2006	None	
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Åkerstorpsvägen 42, 247 95 Torna-Hällestad (SE).
THORVINGER, Jens; Kaprifolievägen 15, 227 38 Lund (SE).

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(74) Agent: **EVENT HORIZON IP**; Barometergatan 16B, 211 17 Malmö (SE).

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(71) Applicant: **FLATFROG LABORATORIES AB**
[SE/SE]; Scheelevägen 15 A, 223 63 Lund (SE).

(72) Inventors: **KOCOVSKI, Aleksander**; Kastellgatan 11, 211 48 Malmö (SE). **BERGSTRÖM, Håkan**;

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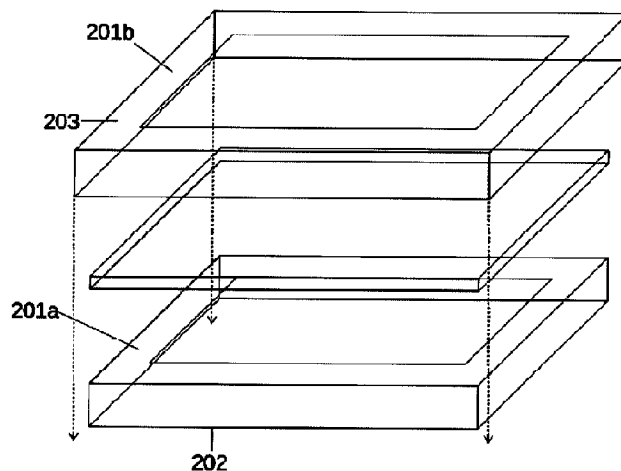


Figure 5b

(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 is 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.

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AN IMPROVED TOUCH DEVICE

Field of the Invention

This invention relates in general to the field of optical touch sensitive systems.
5 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.

10

Background of the Invention

In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. US4459476, a plurality of optical emitters and optical receivers are arranged around the periphery of a touch surface to create a grid of
15 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
20 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
25 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
30 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 disproportionately large effect on
35 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
5 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
10 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.
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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
25 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
30 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
35 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 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 plate 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.

5

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
10 drawings, in which:

Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

Figures 2a-2d are cross-sectional views of embodiments of assemblies;

Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1
15 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

20 Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 1 of the assembly with the second frame element warped relative to the first frame
25 element and holding the plate in a curved plane that is concave;

Figure 4a is a perspective view of the first frame element;

Figure 4b 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;

30 Figure 4c is a side view showing screws 116a and 116b;

Figures 5a-5h are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

Figures 6 is a schematic cross section from a first direction of an embodiment of the assembly;

35 Figure 7 is a schematic side-view of another embodiment for providing curvature of plate 2;

Figure 8 shows an isometric view of a variation of the embodiment of figures 5a-5g;

Figure 9 is a diagram showing a top down view of an optical touch system and corresponding detection lines;

5 Figure 10a shows an isometric view of a flat touch surface of an optical touch system;

Figure 10b shows a section view of an optical touch system with a flat touch surface;

10 Figure 11a shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

Figure 11b 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;

Figure 11c 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;

15 Figure 11d shows an example of types of warpage that a touch panel may exhibit.

Figure 12a shows top view of a touch surface of an optical touch system;

Figure 12b 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;

20 Figure 12c 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;

Figure 12d 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;

25 Figure 13a 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;

Figure 13b 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;

30 Figure 14a 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;

Figure 14b 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;

Figure 15a 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;

5 Figure 15b 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;

Figure 16a 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;

10 Figure 16b 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;

Figure 17a 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;

15 Figure 17b 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;

20 Figure 18a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

Figure 18b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

Figure 19a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

25 Figure 19b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

Figure 20a shows top view of displacement contours for a touch surface according to an embodiment;

30 Figure 20b shows curvature of a touch surface along an x-axis according to the embodiment of figure 20a;

Figure 20c shows curvature of a touch surface along a y-axis according to the embodiment of figure 20a;

Figure 20d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 20a;

35 Figure 21a shows top view of displacement contours for a touch surface according to another embodiment;

Figure 21b shows curvature of a touch surface along an x-axis line according to the embodiment of figure 21a;

Figure 21c shows curvature of a touch surface along a y-axis line according to the embodiment of figure 21a;

5 Figure 21d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 21a.

Description of Embodiments

Specific embodiments of the invention will now be described with reference to
10 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
15 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
20 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
25 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
30 glass perimeter, and on how a VESA mount is attached.

Figure 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
35 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 figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. In the following, the embodiments of figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in figures 6a-6c.

Figures 2a-2d illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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 figures 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

In one embodiment, elements 102, 103 (shown in the figure as comprising elements 103a and 103b) are formed from a single piece.

The second frame element 103a, 103b may be attached to the first frame element 102.

In the embodiments of figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Therefore, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

The first frame element 102 may form a frame 109 (shown in figure 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 figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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 103a, 103b 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 101a, 101b and be configured to extend in the second plane opposite the frame 109. The first portion may extend
5 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

As is illustrated in figures 3a-3d, the first frame element 102 may be attached to
10 the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the
15 second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that it is substantially parallel with the panel 1 and/or controls the plate 2
20 to be in a flat plane, as is illustrated in figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in figure 3c and 3d. In the latter case, the plate 2 is given a slightly concave shape, i.e. in
25 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
30 101a, 101b 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.

Figures 2a-2d and 3a-3d illustrate embodiments of an attachment element 112
35 for attaching the first frame element 102 to the panel. A plurality of attachment elements 112 (e.g. as shown in triplicate as elements 112a, 112b, and 112c) may be arranged around

the frame 109, such as at each corner of the frame 109, which is illustrated as circles in figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c, 113a, 113b. 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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to displace the frame 109 away from panel 1, which is indicated with an arrow in figure 2d e.g. by having a thread in the frame 109 and pushing on the panel 1. At least one other of the screws 112b, 112c, 113b may be arranged to displace the frame 109 towards the panel 1, which is also indicated with an arrow in figure 2d. e.g. by having a thread in the panel and a hole in frame 109.

Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in figure 2a. In the illustrated embodiment, a first screw 112a is arranged between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 115a of the longitudinal axis of the first screw 113a passes through the support portion 101b when viewed in cross-section, such as through the center thereof, as is illustrated in figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101b, i.e. an imaginary extension 115b of the longitudinal axis of the first screw 113b passes outside the support portion 101b when viewed in cross-section, as is illustrated in figure 2b.

As shown in figure 2d, the first screw 112a is arranged to displace the frame 109 away from panel 1. This may be enabled by a threaded hole 112i in the frame 102 which the first screw engages while a head of the screw abuts the panel 1. The second screw 112b is arranged to displace the frame 109 towards the panel. This may be enabled by a threaded hole 112f in the panel 1, which the second screw 112b engages while the head of the second screw 112b abuts the surface of the frame. By using screw 112a and/or 112b, forces may be applied to frame 102 and/or panel 2 to control bending or rotation of the frame/panel.

Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of figure 2b, only two screws are required to control bending or rotation of the frame.

5 In figures 2a-2b, 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.

figure 2c illustrates that a combination the embodiment of figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Therefore, flexibility is provided for.

10 As is illustrated in figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Therefore, a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In the assembly illustrated in figure 3a, a net force is applied such that the
15 frame is substantially flat and parallel with the panel 1. In the assembly illustrated in figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b along the edge or perimeter of the plate 2.
20 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.

Figures 4a-4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a,
25 attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to figures 2a-2c and 3a-3d. 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 101a, 101b as described above. At least one spacing
30 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 103a, 103b such
35 that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled.

As is illustrated in figure 4b, 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.

5 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Therefore, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

10 When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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
15 at the opposing ends of the support 101a, 101b 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 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane
20 taken along the support portion 101a, 101b, such as at the free end or tip of the support portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b in the deflected or stressed state when assembled with
25 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,
30 element 116 may comprise a spacer component such as a washer, spacer, etc. In figure 3a and 3b and figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single-spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b may engage the frame 109, wherein the
35 frame 109 may be pulled towards the back cover 111. As a result, the frame 109 becomes concave. In some embodiments, the spacing element 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

5 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 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.

10 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
15 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 figure 5h, 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.

Figures 5a-5h illustrate embodiments of an assembly 200, which may be
20 combined with the first frame element 102 described above. The embodiments shown in figures 5a-5h are shown inverted relative to the embodiments shown previously, with the plate 2 at the top.

As shown in figures 5a and 5b, the frame assembly 200 may comprise a first frame element 202, and a second frame element 203. The first frame element 202 and the
25 second frame element 203 may be elongated members, each having a support portion 201a, 201b. 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
30 the support portion 201a, 201b, 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,
35 each support portion 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in figure 5g.

In some embodiments, such as illustrated in figures 5c-5d, a gasket 205 (e.g. gaskets 205a, 205b, 205c, 205d, 205e) 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 201a of the first frame element 202. Also, a sealing 204a may be arranged on the support portion 201b 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 figures 5f-5g. 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 1.5-2.0mm 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in figure 5e.

5 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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged
10 between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second
15 sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes 217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third
20 hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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
25 deflectable such that each hole 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Therefore, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c
30 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen, wherein the center holes 217c, 218c 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
35 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 figures 4a-4c, the frame side may replace the second frame element of the embodiments of figures 4a-4c. Therefore, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

As illustrated in figure 6, a component (e.g. a sealing component 204a) may be provided between the support portion 201a and the plate 2. Figure 6 illustrates the resulting forces and torque generated when a force 220 is applied to second frame element 203a. 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 figure 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 103A. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b 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 103A. 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 103A.

In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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.

Figure 9 illustrates a top plan view of an example of a touch-sensitive apparatus 99. Emitters 30a are distributed around the periphery of touch plate 10, to propagating light across touch surface 20. 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 propagate to a number of different detectors 30b 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 30a and detectors 30b. 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 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 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 fiber. 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.

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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b 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 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 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 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 10a 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 figure 10a. 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.

Figure 10b illustrates an example of a touch apparatus according to the prior art. Figure 10b 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 30a, 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 30b. 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.

Figure 11a illustrates an embodiment of touch plate 10 similar to that shown in figure 10a 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. Figure 11b shows a cross-section view along the x-axis of the touch plate 10 of figure 11a.

Figure 11c 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.

Figure 11d 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 figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$F(x) = 5.5 * 10^{-6} * x^2 - 2.0$$

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.

Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 O 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 O on the touch surface. Therefore, the curvature of the plate along this axis can be measured from the distance of the touch surface from the y-axis.

Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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:

$$z(x, y) = -a + b * x^2 + c * x^2 y^2 + d * y^2$$

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):

$$z(x, y) = -2 + 5.56e - 06 * x^2 - 4.74e - 11 * x^2 y^2 + 1.7e - 05 * y^2$$

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:

$$z(x, y) = -2.5 + 5.56e - 06 * x^2 - 2.37e - 11 * x^2 * y^2 + 1.28e - 05 * y^2$$

5

Figure 13a 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 1310a 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, gracing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

Figure 13b 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 figure 13a. 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.

Figure 14a shows a section view of the embodiment of figure 13a. 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. Figure 14b shows the corresponding graph of figure 13b for the second point light source 1410.

Figure 15a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a third point light source 1510 are shown. Figure

15b shows the corresponding graph of figure 13b for the third point light source 1510. In this example, the detection signal boost is approximately 3.03.

Figure 16a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fourth point light source 1610 are shown.

5 Figure 16b shows the corresponding graph of figure 13b for the fourth point light source 1610. In this example, the detection signal boost is approximately 2.71.

Figure 17a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fifth point light source 1710 are shown. Figure 17b shows the corresponding graph of figure 13b for the fifth point light source 1710. In
10 this example, the detection signal boost is approximately 2.19.

Figures 13a-17b 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.

15 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.

Figure 18a shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of figure 18a, a curved touch
20 plate 10 has a width of 1900 mm along the x-axis and a height of 1070mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in figure 12a,4b). 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 10mm. The mathematically defined parabolic curve is defined as 1820. The
25 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 10b 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 $|\text{parabolic deviation}| < 0.5$ mm.

30 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.

Figure 18b shows a graph of the deviation between the mathematically defined
35 parabolic curve and a real-world parabolic touch surface of figure 18a.

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.

5

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	6.00	0.0	2.00	0.1	0.5

Convexity b is shown in figure 18a. Parabolic deviation is shown in figure 18b.

Figure 19a shows another graph of a mathematically defined parabolic curve and a similar glass to that of figure 18a but wherein the glass of figure 19a is out of range and not recommended for touch system production. One reason for the large concavity shown in figure 19a may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacturing. 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.

Figure 19b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 19a. The real-world parabolic touch surface of figure 19a 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.

Figure 20a shows an embodiment in which the touch surface forms a paraboloid. In figure 20a, 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 figure 20b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 20a, the curved touch plate 10 has a width of 1900mm along the x-axis and a height of 1070 mm along the y-axis.

Figures 20b-20d show optional parabola configurations for the embodiment shown in figure 20a. Figure 20b 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. Figure 20c 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. Figure 20d 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 figure 20a-20d 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.

Figure 21a shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in figure 20a. As with figure 20a, figure 21a 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 figure 21b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 21a, 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 embodiments where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect parabolas. 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.

Figure 21b 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. Figure 21c 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. Figure 21d 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.

CLAIMS

1. An assembly for holding and controlling curvature of a plate (2) for an optical touch sensitive system, comprising
- 5 a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);
- at least one second frame element (103a, 103b; 203) extending in a second plane and forming a support portion (101a, 101b; 201b) for the plate (2), and
- at least one spacing element positioned at least partially between the support
- 10 portion (101a, 101b; 201b) and the first frame element (102; 202), the spacing element being configured to control a curvature of the first frame element (102; 202), and
- wherein the at least one second frame element (103a, 103b; 203) is configured to engage the plate at the support portion (101a, 101b; 201b), is attached to the first frame element (102; 202), and wherein the shape and/or position of the second frame element is
- 15 controlled by the curvature of the first frame element (102, 202) with said spacing element, to control a curvature of the plate.
2. The assembly of claim 1, wherein the second frame element (103a, 103b; 203) is deflectable from a relaxed state to a deflected state, in which the second plane forms a
- 20 parabolic concave curve along at least a portion of the length of the support portion (101a, 101b; 201b), and wherein a screw arrangement (112a, 112b, 112c, 113a, 113b; 219a, 219b, 219c) of the assembly holds the second frame element (103a, 103b; 203) in the deflected state when assembled with the first frame element (102; 202).
- 25 3. The assembly of any of claims 1 or 2, wherein a frame (109) of the first frame element (102) comprises a plurality of spacing elements arranged spaced apart from corners of the frame (209) of the first frame element (102), wherein the spacing elements are configured to generate a force to the frame (109) away from the support portion (101a, 101b).
- 30 4. The assembly of claim 3, wherein each spacing element comprises a screw (116, 116a, 116b) arranged in a hole of the frame (109).
- 35 5. The assembly of claim 4, wherein each spacing element (112, 112a, 112b) comprises a screw with a predefined length, and a spacer arranged between a head of the screw and the frame (109).

6. The assembly of any of the previous claims, wherein assembly comprises a plurality of attachment elements (112) arranged around the frame (109) for attaching the first frame element (102) to said panel (1).

5 7. The assembly of claim 6, wherein each attachment element (112) comprises a plurality of screws (112a, 112b, 112c, 113a, 113b) arranged in holes of the frame (109), wherein at least one of said screws (112a, 113b) is arranged to apply a first force to the frame (109) towards the support portion (101a, 101b), and at least one other of said screws (112b, 112c, 113b) is arranged to apply a second force to the frame (109) away
10 from the support portion (101a, 101b).

8. The assembly of claim 7, wherein each attachment element (112) comprises at least two screws (113a, 113b), wherein a first screw (113a) of said two screws is arranged opposing the support portion (101a, 101b) and to apply said first force to the frame (109)
15 towards the support portion (101a, 101b), and a second screw (113b) of said two screws is arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b) and to apply said second force to the frame (109) away from the support portion (101a, 101b).

20 9. The assembly of claim 7, wherein each attachment element (112) comprises at least three screws (112a, 112b, 112c), wherein all three screws are arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b), and wherein a first screw (112a) of said three screws is arranged to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw
25 (112b) and a third screw (112c) of said three screws are arranged to apply said second force to the frame (109) away from the support portion (101a, 101b), the first screw (112a) being arranged between the second screw (112b) and the third screw (112c).

10. The assembly of any of the previous claims, wherein a gasket (205) is arranged
30 on another support portion (201a) of the second frame element (202), wherein the gasket (205) has a varying thickness along its length.

11. The assembly of claim 10, wherein the gasket (205) has opposing ends, and is thinner between the opposing ends than at said ends.

35

12. The assembly of claim 11, wherein a first section (205a) of the gasket (205) at one of said ends and a second section (205b) of the gasket (205) at the other of said ends has a first thickness, and at least a third section (205c) of the gasket between the first section (205a) and the second section (205b) has a second thickness, wherein the first
5 thickness is thicker than the second thickness.

13. The frame assembly of any of claims 10-12, wherein the second frame element (203) comprises a frame side and the third frame element comprises an edge cover, and wherein the edge cover comprises another support portion for said panel (1),
10 wherein a distance between the support portion of the frame side and the support portion of the edge cover is discontinuous in an assembled state.

14. The frame assembly of claim 13, wherein the frame side comprises a first hole (217a) and a second hole (217b) arranged at opposing ends of the frame side and in a first plane, and a third hole (217c) arranged between the first hole (217a) and the second hole
15 (217c) and in a plane that is different from the first plane, and

the edge cover comprises a first hole (218a) and a second hole (218b) arranged at opposing ends of the edge cover, and a third hole (218c) arranged between the first hole (218a) and the second hole (218c) of the edge cover, wherein the first hole (218a), the
20 second hole (218b), and the third hole (218c) of the edge cover are generally arranged in the same plane when the edge cover is disconnected from the frame side, and

wherein the edge cover is less stiff than the frame side and deflectable such that the holes (218a, 218b, 218c) of the edge cover are aligned with the holes (217a, 217b, 217c) of the frame side and such that the support portion of the edge cover extends in a
25 plane, which is curved.

15. A method for assembling a panel and a plate for an optical touch sensitive system, comprising:
providing a first frame element (102; 202) extending in a first plane and
30 configured to extend at least partially around a panel (1);
providing at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2);
supporting the plate (2) by the support portion (101a, 101b, 201b);
attaching the second frame element to the first frame element (102; 202) such
35 that

the support portion (101a, 101b; 201b) extends at least partially in a second plane generally opposite at least a portion of the first frame element (102; 202) and is spaced apart from the first plane; and

controlling a curvature of the first frame element (102; 202) with a spacing element attached to the first frame element (102; 202) and thereby tilting the support portion (101a, 101b, 201b) to control a curvature of the plate (2).

16. 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.

17. The touch sensing apparatus of claim 16, wherein the touch surface is curved in a second axis according to a second parabola.

18. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

19. The touch sensing apparatus of claim 18, wherein the first parabolic curve paraboloid is an elliptical paraboloid.

20. The touch sensing apparatus of claim 16, wherein each point of the first axis of the touch surface is within 0.5mm of a mathematical parabola.

21. The touch sensing apparatus of claim 16, wherein the mathematical parabola is defined according to $z(x, y) = a + bx^2 + cx^2y^2 + dy^2$, where z is depth, and x and y are co-ordinates in the plane of the glass.

22. The touch sensing apparatus of claim 16, wherein the touch surface comprises a portion of a surface of a plate.

5 23. The touch sensing apparatus of claim 22, wherein the plate comprises a glass or plastic sheet.

24. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

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AMENDED CLAIMS

received by the International Bureau on 09.Apr.2018 (09.04.2018)

- [Claim 1] An assembly (100) for holding and controlling curvature of a plate (2) for an optical touch sensitive system, comprising
a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);
at least one second frame element (103a, 103b; 203) extending in a second plane and forming a support portion (101a, 101b; 201b) for the plate (2), and
at least one spacing element (116) positioned at least partially between the support portion (101a, 101b; 201b) and the first frame element (102; 202), the spacing element (116) being configured to control a curvature of the first frame element (102; 202), and
wherein the at least one second frame element (103a, 103b; 203) is configured to engage the plate at the support portion (101a, 101b; 201b), is attached to the first frame element (102; 202), and wherein the shape and/or position of the second frame element is controlled by the curvature of the first frame element (102, 202) with said spacing element (116), to control a curvature of the plate.
- [Claim 2] The assembly (100) of claim 1, wherein the second frame element (103a, 103b; 203) is deflectable from a relaxed state to a deflected state, in which the second plane forms a parabolic concave curve along at least a portion of the length of the support portion (101a, 101b; 201b), and wherein a screw arrangement (112a, 112b, 112c, 113a, 113b; 219a, 219b, 219c) of the assembly (100) holds the second frame element (103a, 103b; 203) in the deflected state when assembled with the first frame element (102; 202).
- [Claim 3] 3. The assembly (100) of any of claims 1 or 2, wherein a frame (109) of the first frame element (102) comprises a plurality of spacing elements (116) arranged spaced apart from corners of the frame (209) of the first frame element (102), wherein the spacing elements are configured to generate a force to the frame (109) away from the support portion (101a, 101b).
- [Claim 4] The assembly (100) of claim 3, wherein each spacing element (116) comprises a screw (116, 116a, 116b) arranged in a hole of the frame (109).
- [Claim 5] The assembly (100) of claim 4, wherein each spacing element (116) comprises a screw with a predefined length, and a spacer arranged

between a head of the screw and the frame (109).

[Claim 6] 6. The assembly (100) of any of the previous claims, wherein assembly (100) comprises a plurality of attachment elements (112) arranged around the frame (109) for attaching the first frame element (102) to said panel (1).

[Claim 7] The assembly (100) of claim 6, wherein each attachment element (112) comprises a plurality of screws (112a, 112b, 112c, 113a, 113b) arranged in holes of the frame (109), wherein at least one of said screws (112a, 113b) is arranged to apply a first force to the frame (109) towards the support portion (101a, 101b), and at least one other of said screws (112b, 112c, 113b) is arranged to apply a second force to the frame (109) away from the support portion (101a, 101b).

[Claim 8] 8. The assembly (100) of claim 7, wherein each attachment element (112) comprises at least two screws (113a, 113b), wherein a first screw (113a) of said two screws is arranged opposing the support portion (101a, 101b) and to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (113b) of said two screws is arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b) and to apply said second force to the frame (109) away from the support portion (101a, 101b).

[Claim 9] The assembly (100) of claim 7, wherein each attachment element (112) comprises at least three screws (112a, 112b, 112c), wherein all three screws are arranged closer to a center of the first frame element (102) than a perimeter of the support portion (101a, 101b), and wherein a first screw (112a) of said three screws is arranged to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (112b) and a third screw (112c) of said three screws are arranged to apply said second force to the frame (109) away from the support portion (101a, 101b), the first screw (112a) being arranged between the second screw (112b) and the third screw (112c).

[Claim 10] 10. The assembly (100) of any of the previous claims, wherein a gasket (205) is arranged on another support portion (201a) of the second frame element (202), wherein the gasket (205) has a varying thickness along its length.

[Claim 11] The assembly (100) of claim 10, wherein the gasket (205) has opposing ends, and is thinner between the opposing ends than at said ends.

[Claim 12] The assembly (100) of claim 11, wherein a first section (205a) of the

gasket (205) at one of said ends and a second section (205b) of the gasket (205) at the other of said ends has a first thickness, and at least a third section (205c) of the gasket between the first section (205a) and the second section (205b) has a second thickness, wherein the first thickness is thicker than the second thickness.

[Claim 13]

13. The assembly (100) of any of claims 10-12, wherein the second frame element (203) comprises a frame side and the third frame element comprises an edge cover, and wherein the edge cover comprises another support portion for said panel (1), wherein a distance between the support portion of the frame side and the support portion of the edge cover is discontinuous in an assembled state.

[Claim 14]

The assembly (100) of claim 13, wherein the frame side comprises a first hole (217a) and a second hole (217b) arranged at opposing ends of the frame side and in a first plane, and a third hole (217c) arranged between the first hole (217a) and the second hole (217c) and in a plane that is different from the first plane, and

the edge cover comprises a first hole (218a) and a second hole (218b) arranged at opposing ends of the edge cover, and a third hole (218c) arranged between the first hole (218a) and the second hole (218c) of the edge cover, wherein the first hole (218a), the second hole (218b), and the third hole (218c) of the edge cover are generally arranged in the same plane when the edge cover is disconnected from the frame side, and

wherein the edge cover is less stiff than the frame side and deflectable such that the holes (218a, 218b, 218c) of the edge cover are aligned with the holes (217a, 217b, 217c) of the frame side and such that the support portion of the edge cover extends in a plane, which is curved.

[Claim 15]

15. A method for assembling a panel and a plate for an optical touch sensitive system, comprising:

providing a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);

providing at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2);

supporting the plate (2) by the support portion (101a, 101b, 201b);

attaching the second frame element to the first frame element (102; 202) such that

the support portion (101a, 101b; 201b) extends at least partially in a second plane generally opposite at least a portion of the first frame

element (102; 202) and is spaced apart from the first plane; and controlling a curvature of the first frame element (102; 102) with a spacing element (116) attached to the first frame element (102; 202) and thereby tilting the support portion (101a, 101b, 201b) to control a curvature of the plate (2).

- [Claim 16] 16. 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.
- [Claim 17] 17. The touch sensing apparatus of claim 16, wherein the touch surface is curved in a second axis according to a second parabola.
- [Claim 18] 18. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.
- [Claim 19] 19. The touch sensing apparatus of claim 18, wherein the first parabolic curve paraboloid is an elliptical paraboloid.
- [Claim 20] 20. The touch sensing apparatus of claim 16, wherein each point of the first axis of the touch surface is within 0.5mm of a mathematical parabola.
- [Claim 21] 21. The touch sensing apparatus of claim 20, wherein the mathematical parabola is defined according to $z(x, y) = a + bx^2 + cx^2y^2 + dy^2$, where z is depth, and x and y are co-ordinates in the plane of the glass.
- [Claim 22] 22. The touch sensing apparatus of claim 16, wherein the touch surface comprises a portion of a surface of a plate.
- [Claim 23] 23. The touch sensing apparatus of claim 22, wherein the plate comprises a glass or plastic sheet.
- [Claim 24] 24. The touch sensing apparatus of claim 16, wherein the touch surface forms a paraboloid.

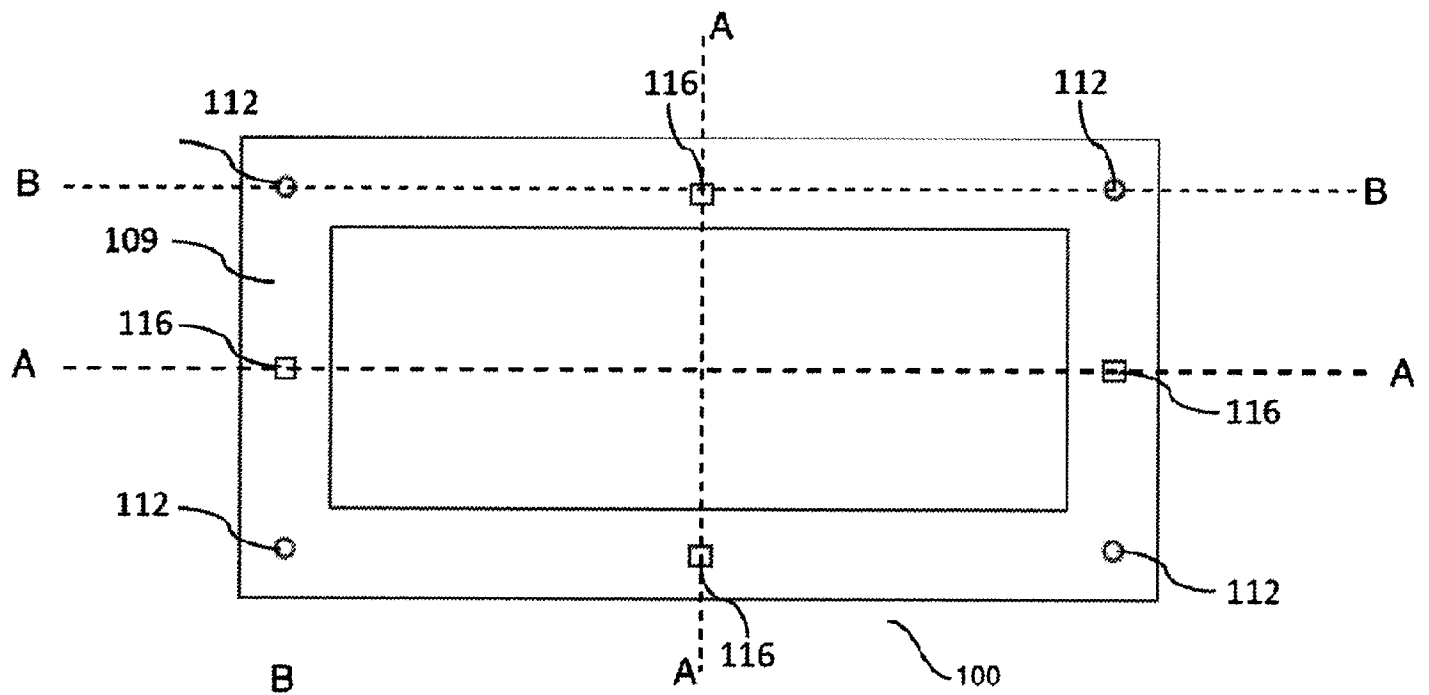


Figure 1

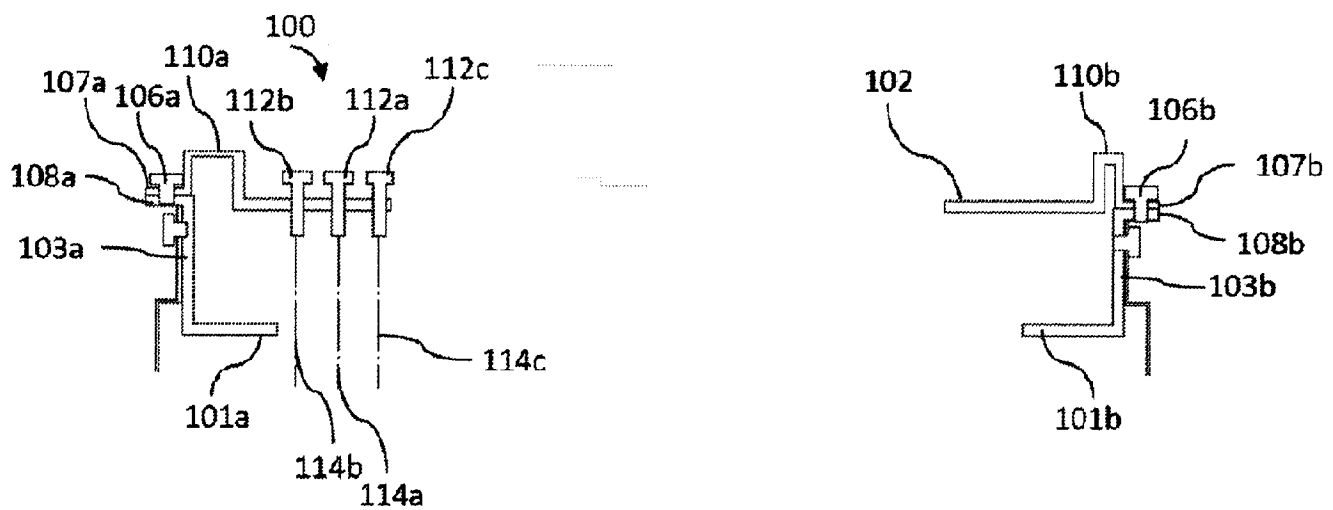


Figure 2a

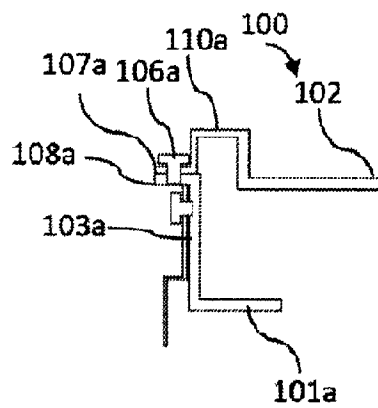
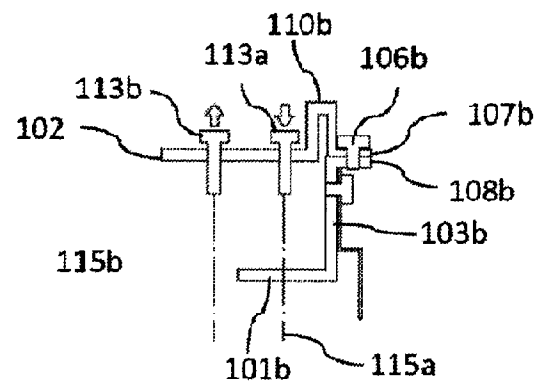


Figure 2b

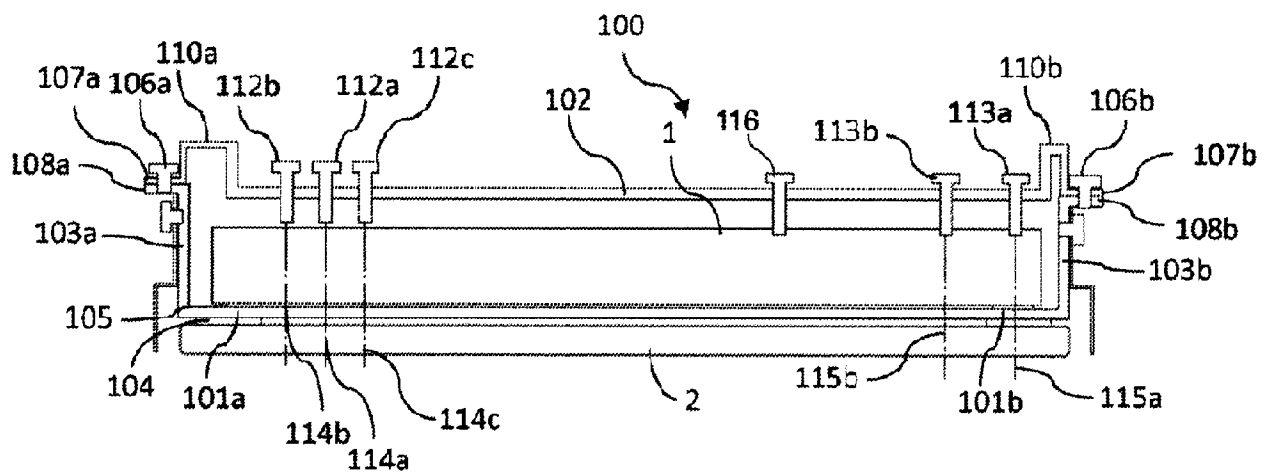


Figure 2c

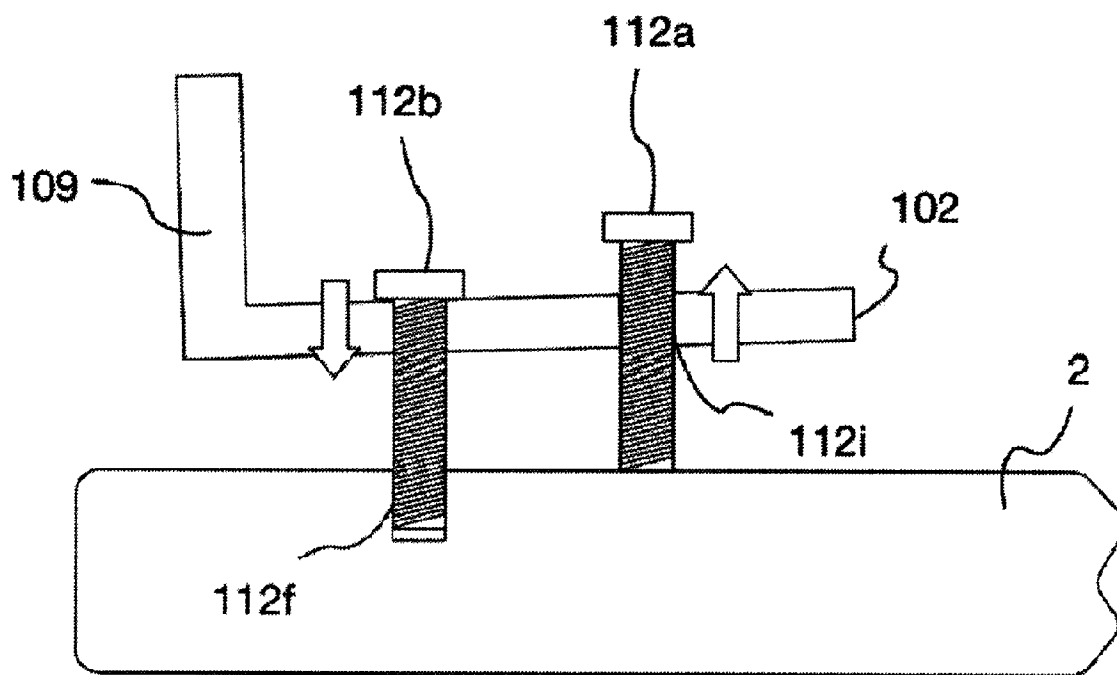


Figure 2d

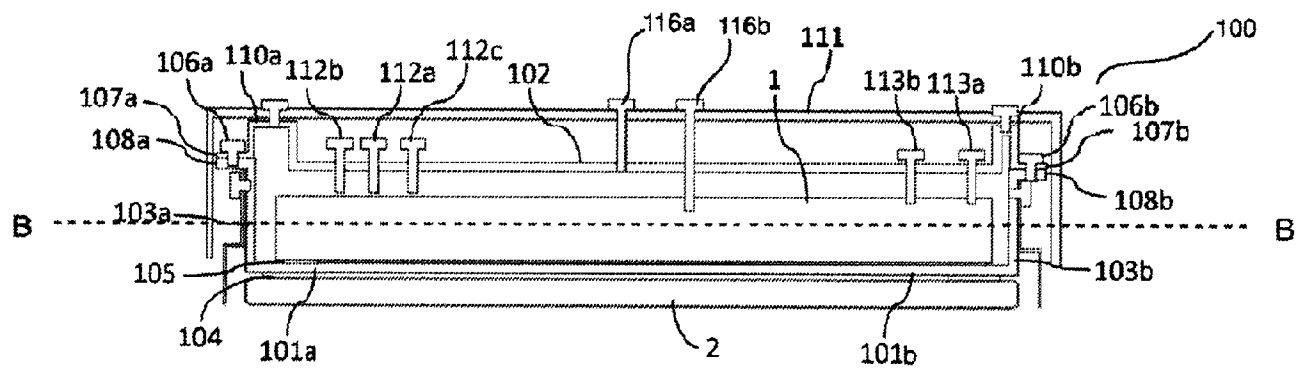


Figure 3a

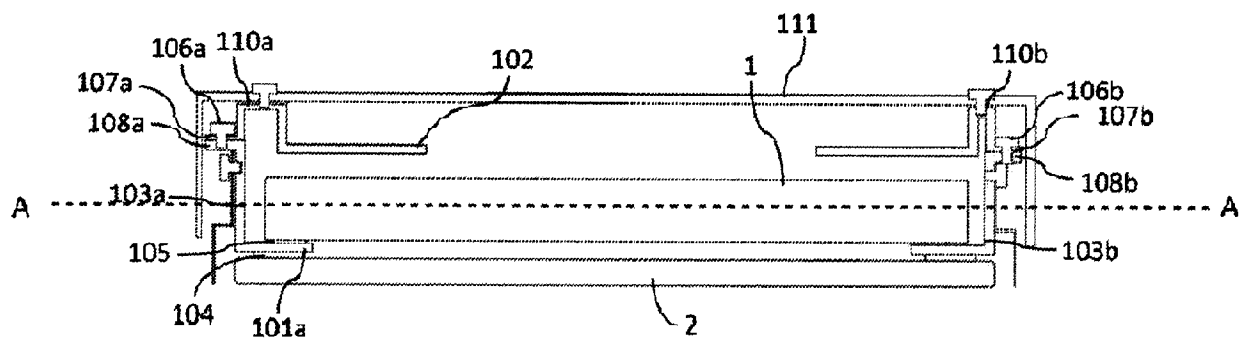


Figure 3b

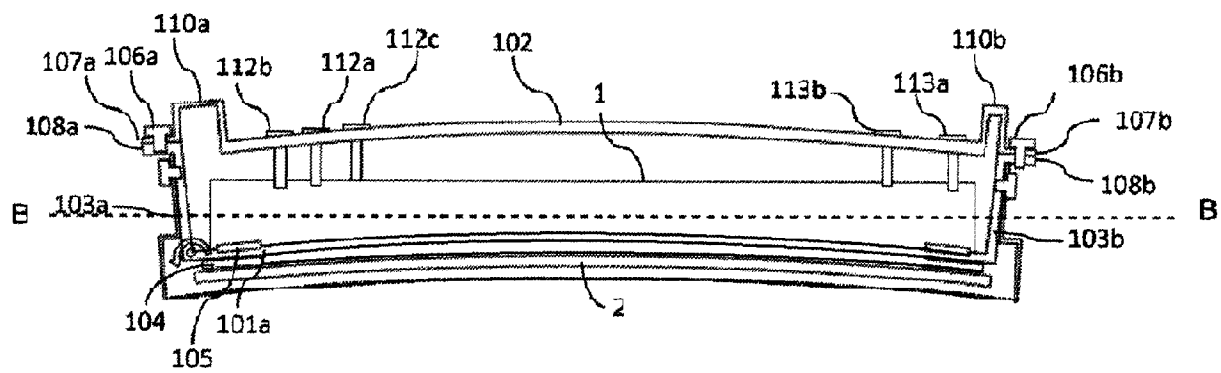


Figure 3c

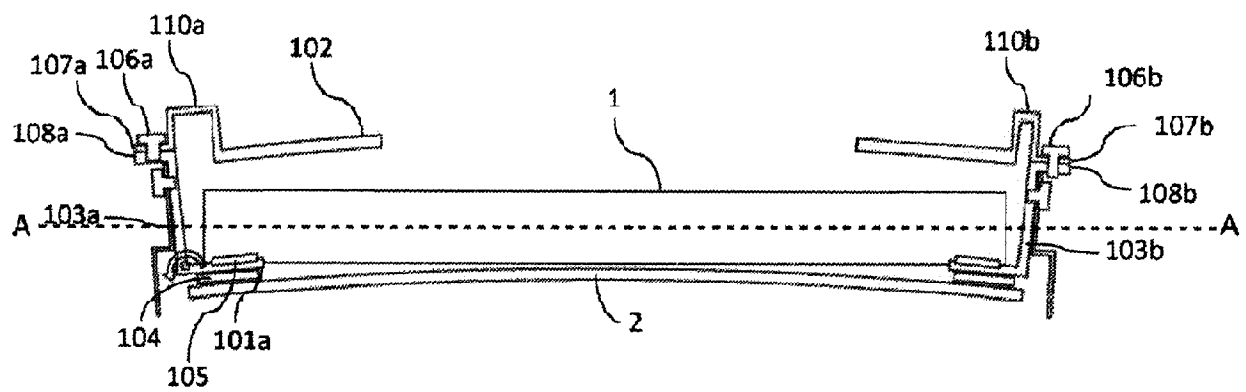


Figure 3d

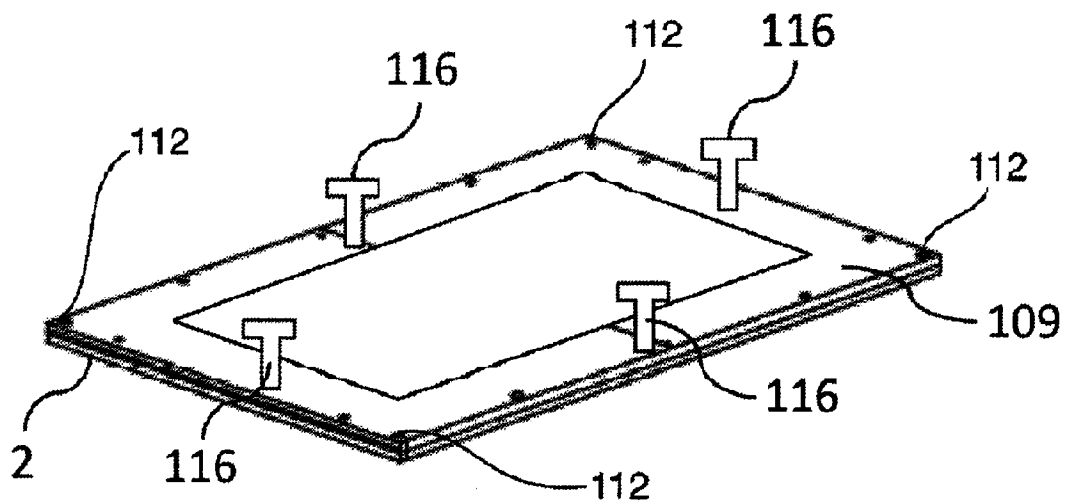


Figure 4a

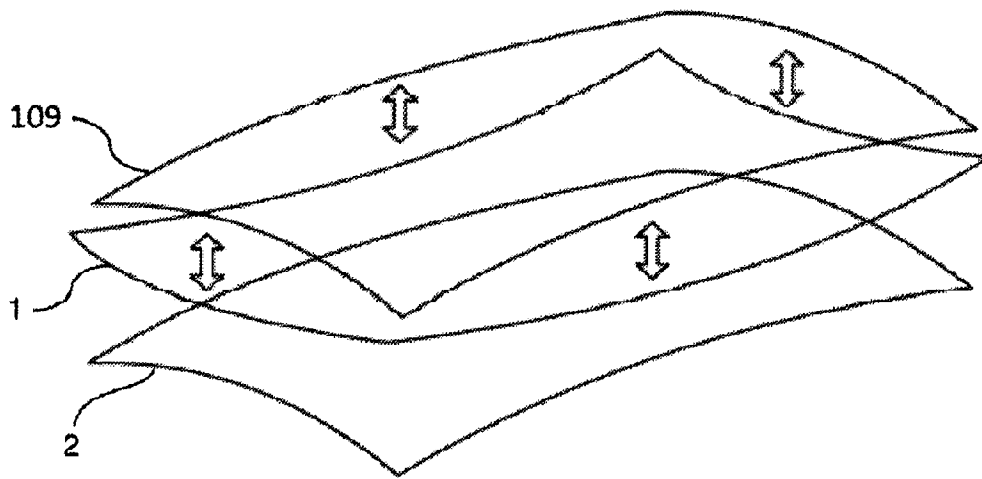


Figure 4b

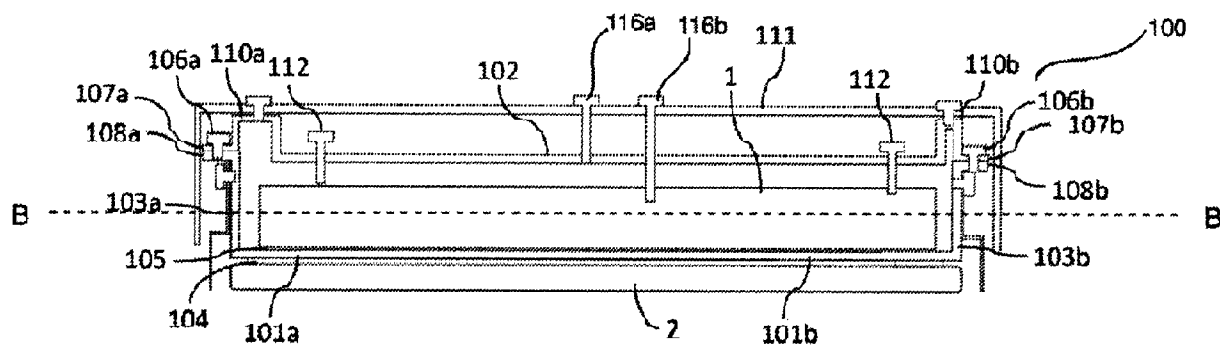


Figure 4c

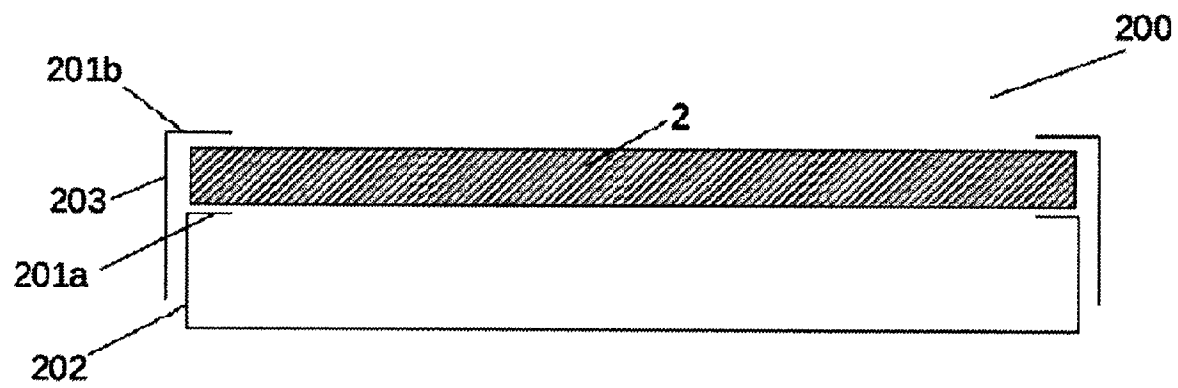


Figure 5a

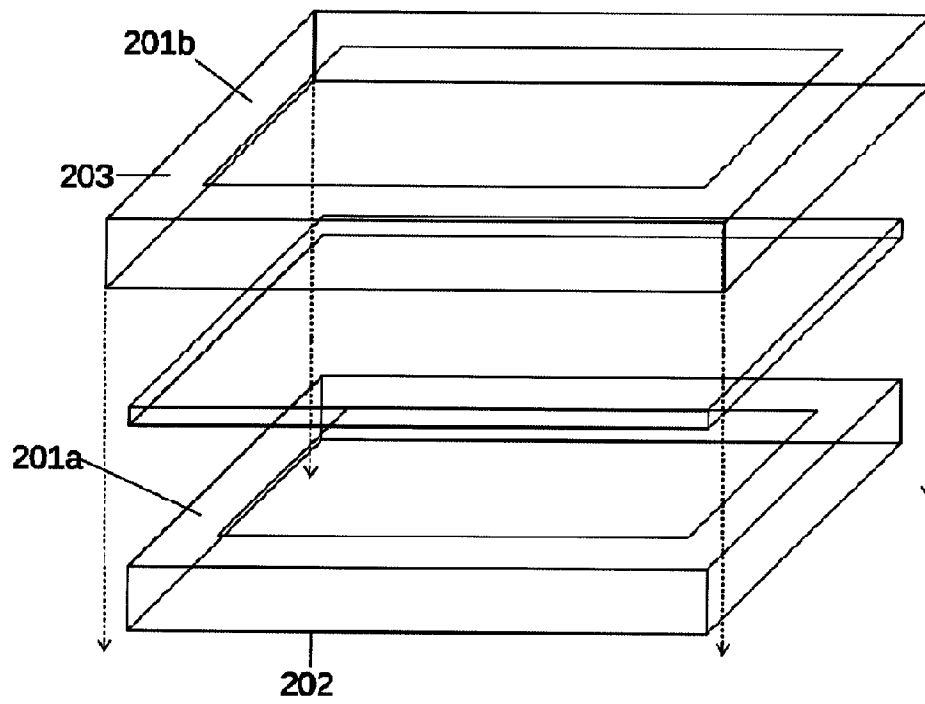


Figure 5b

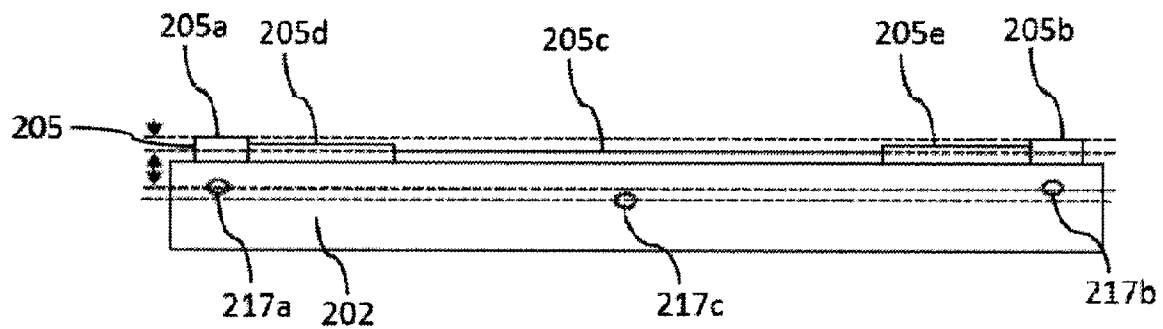


Figure 5c

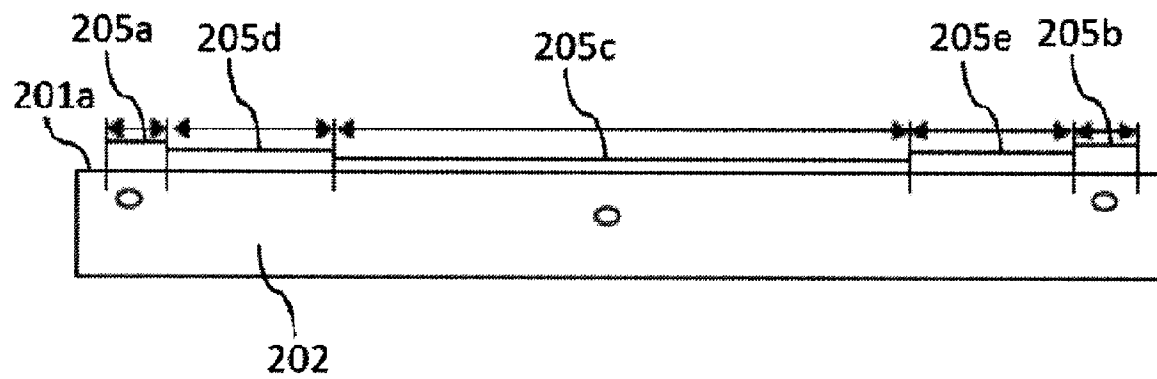


Figure 5d

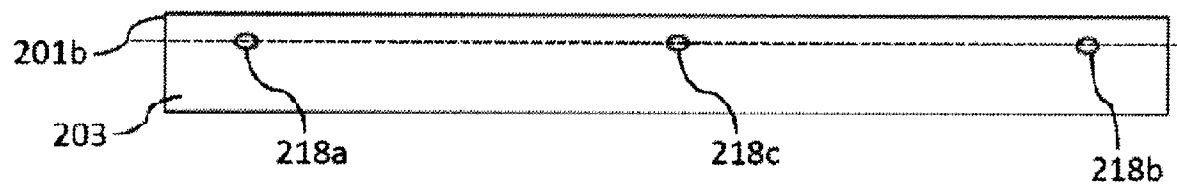


Figure 5e

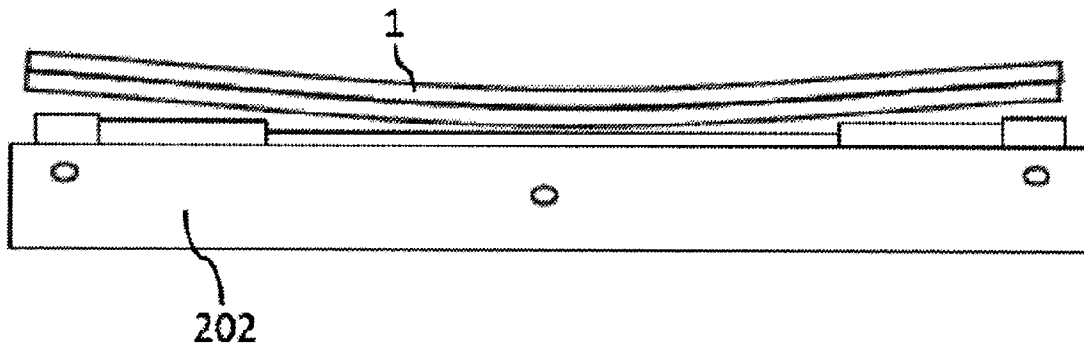


Figure 5f

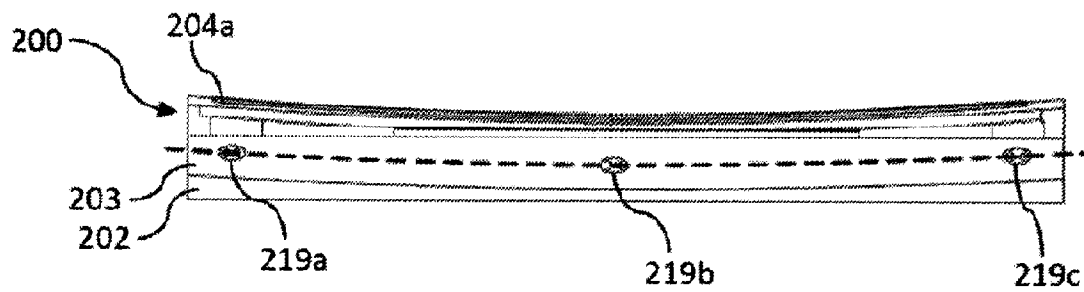


Figure 5g

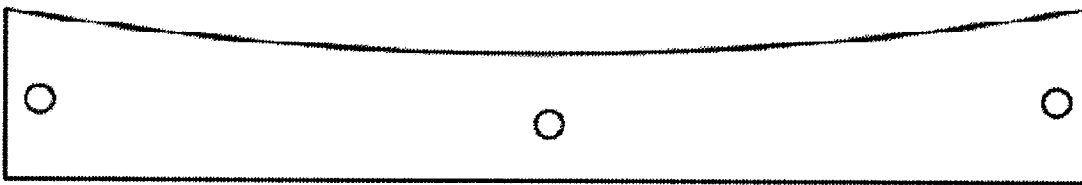


Figure 5h

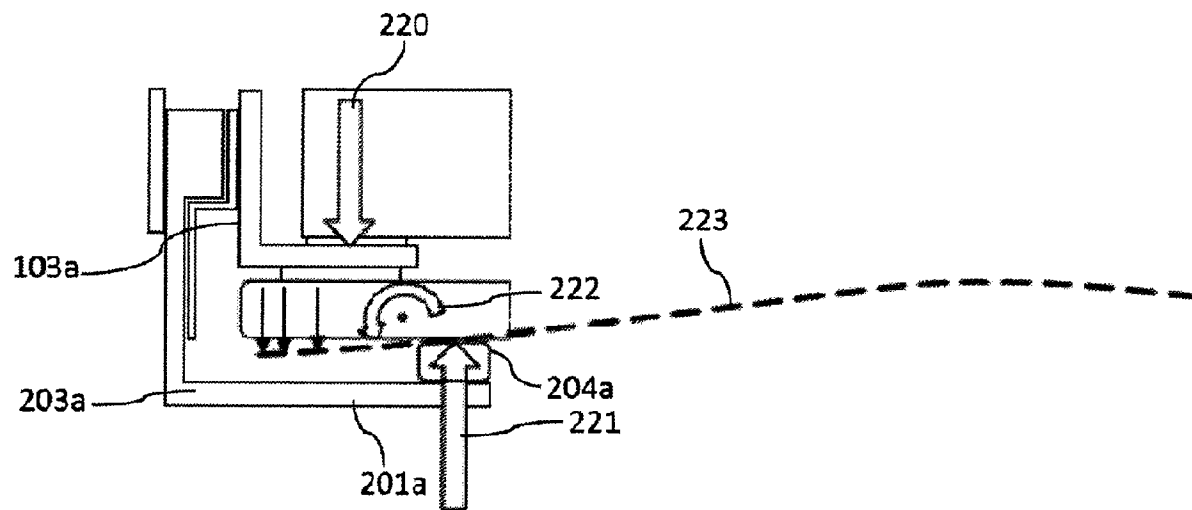


Figure 6

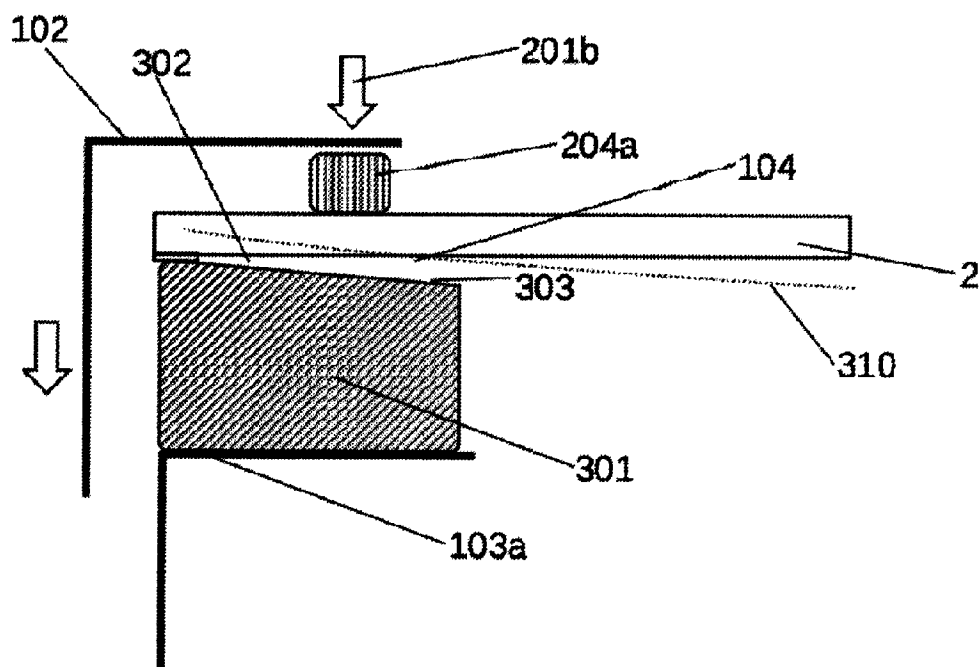


Figure 7

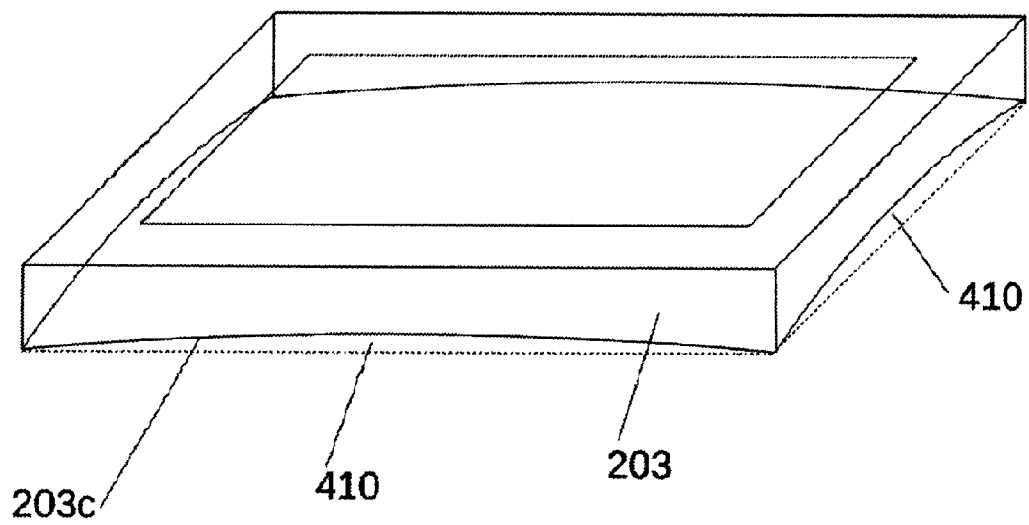


Figure 8

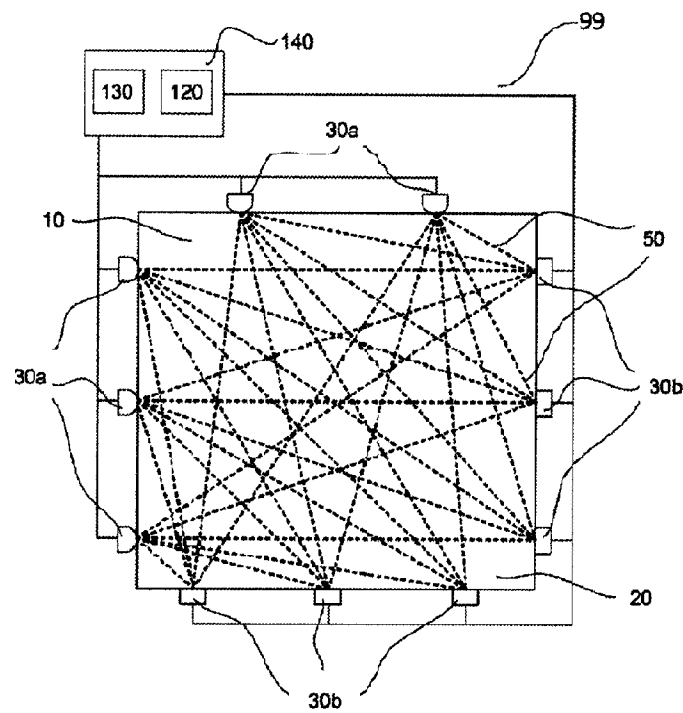


Figure 9

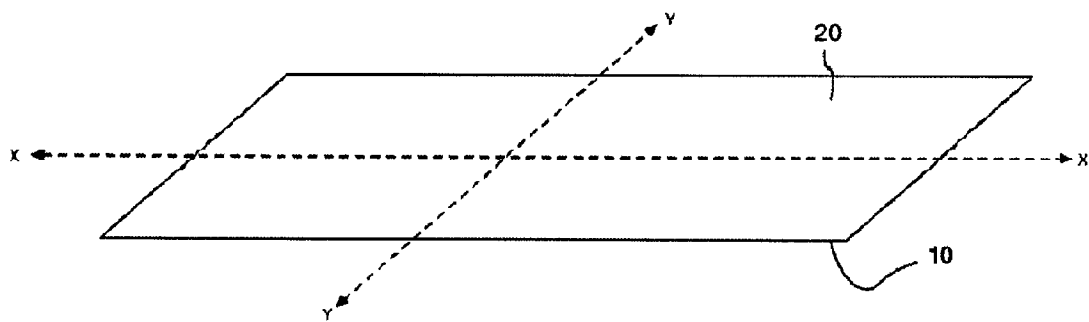


Figure 10a

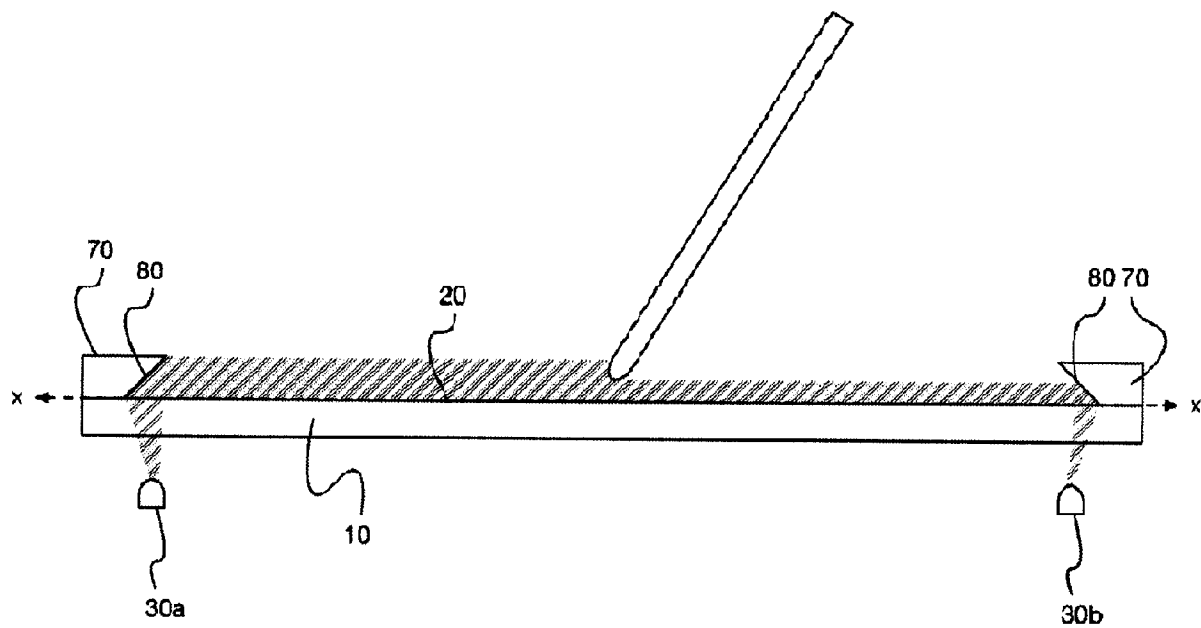


Figure 10b

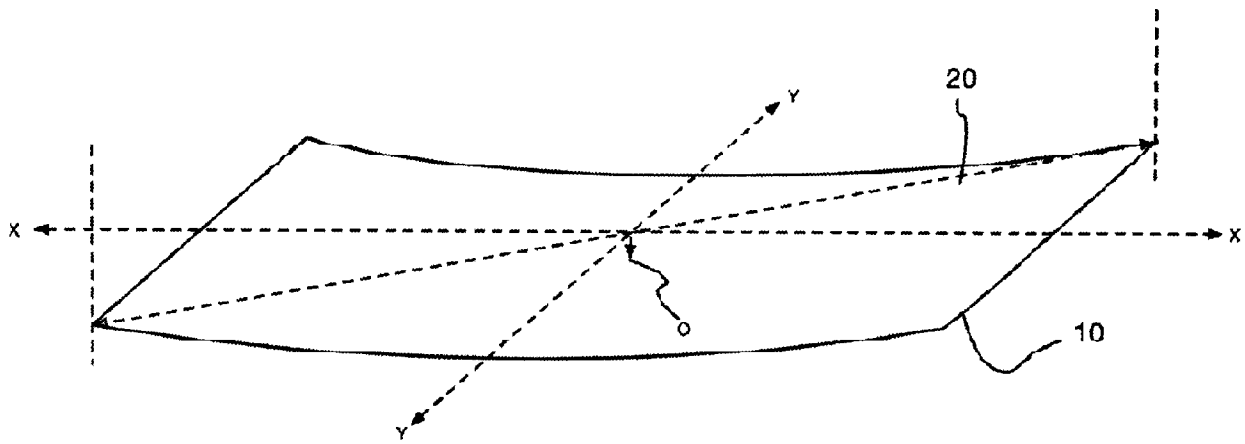


Figure 11a

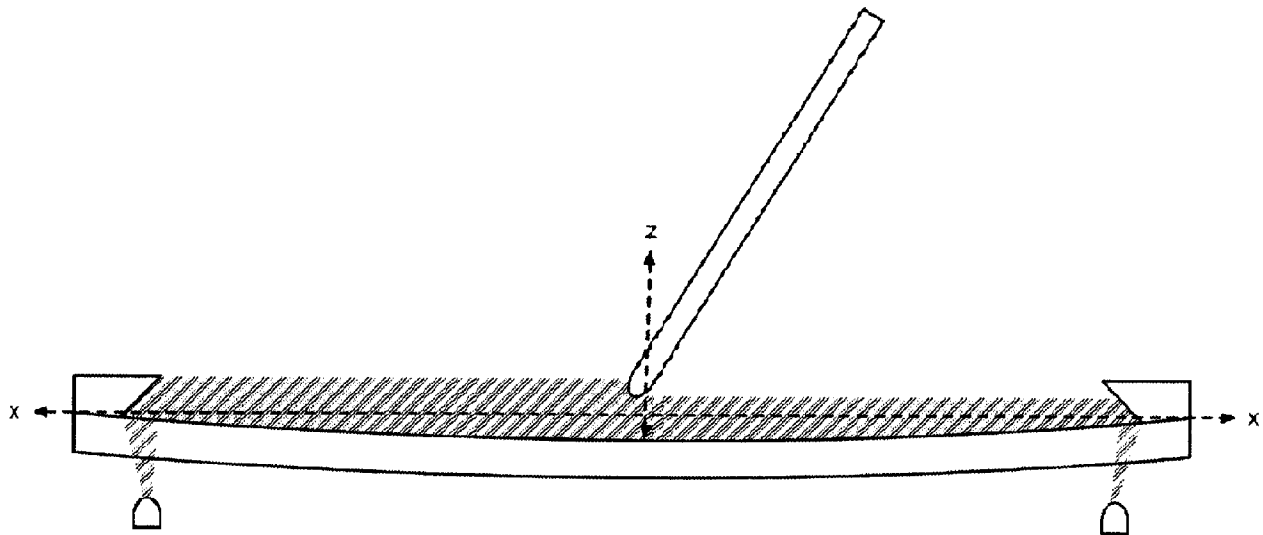


Figure 11b

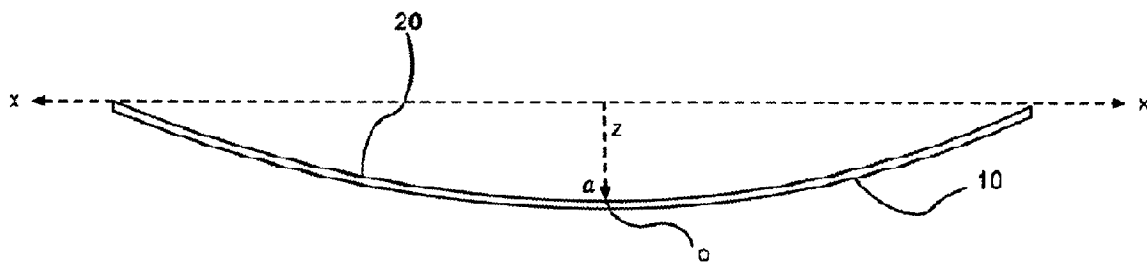


Figure 11c

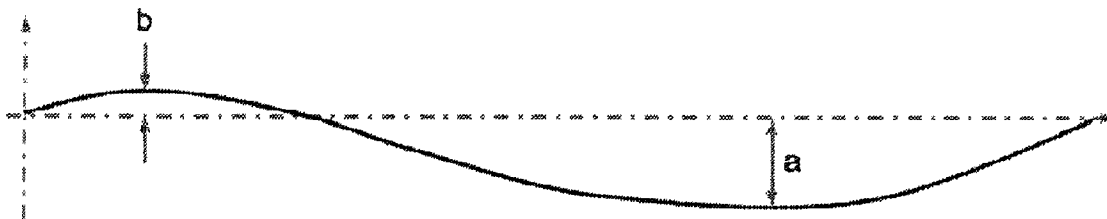


Figure 11d

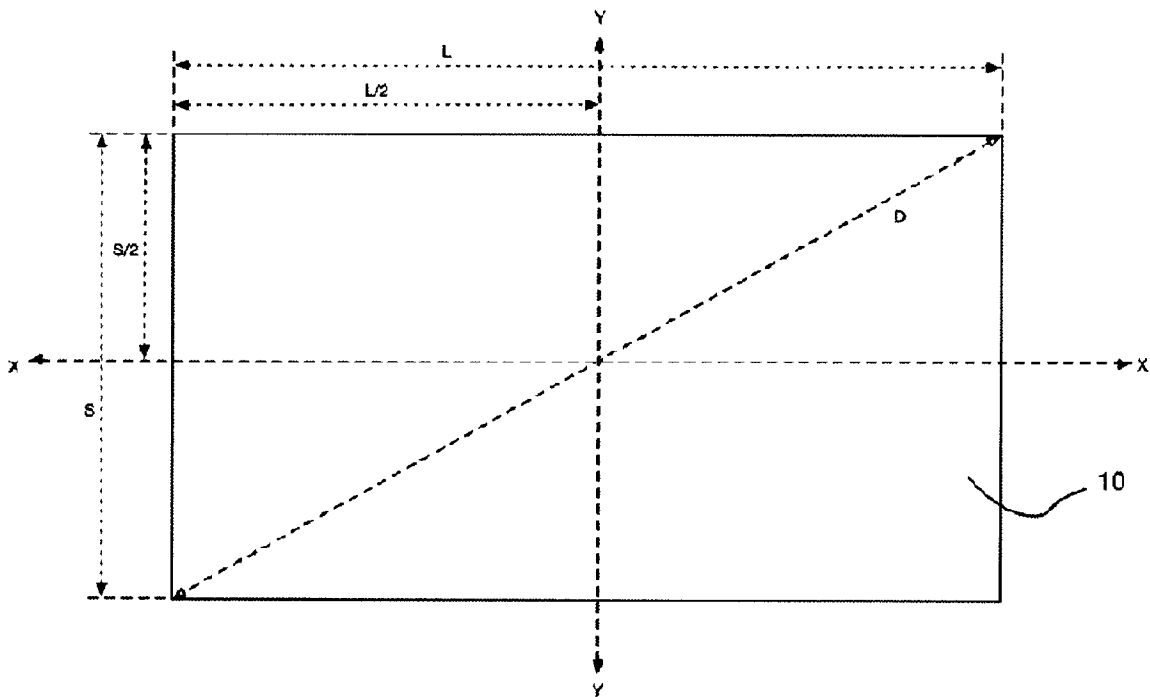


Figure 12a

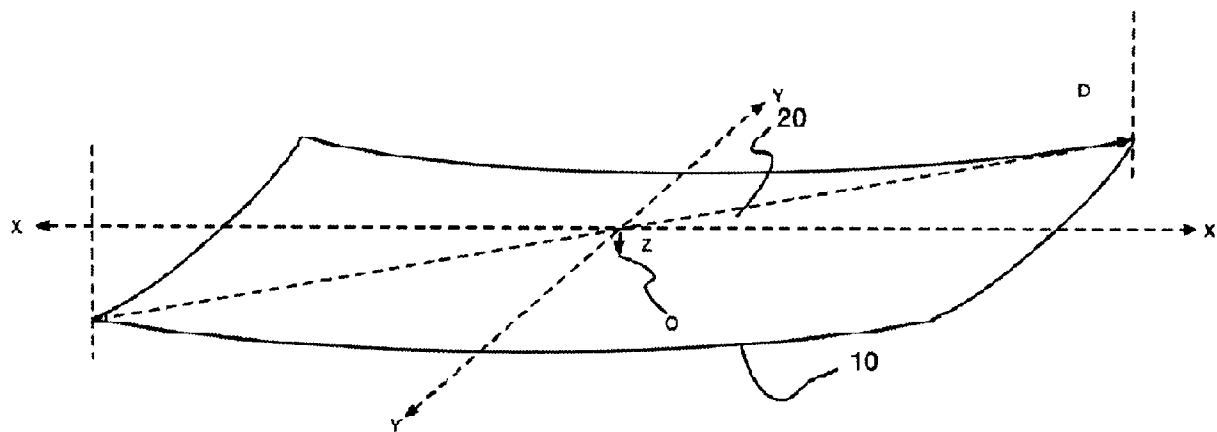


Figure 12b

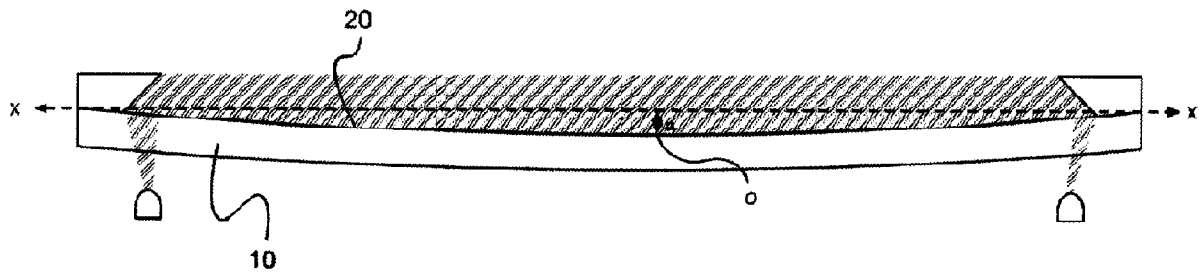


Figure 12c

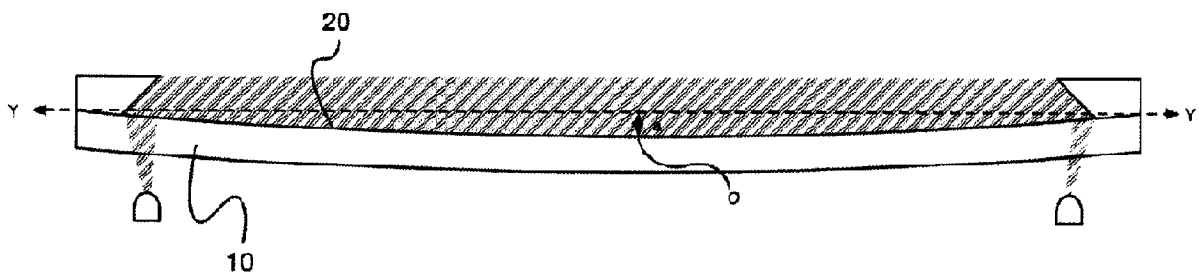


Figure 12d

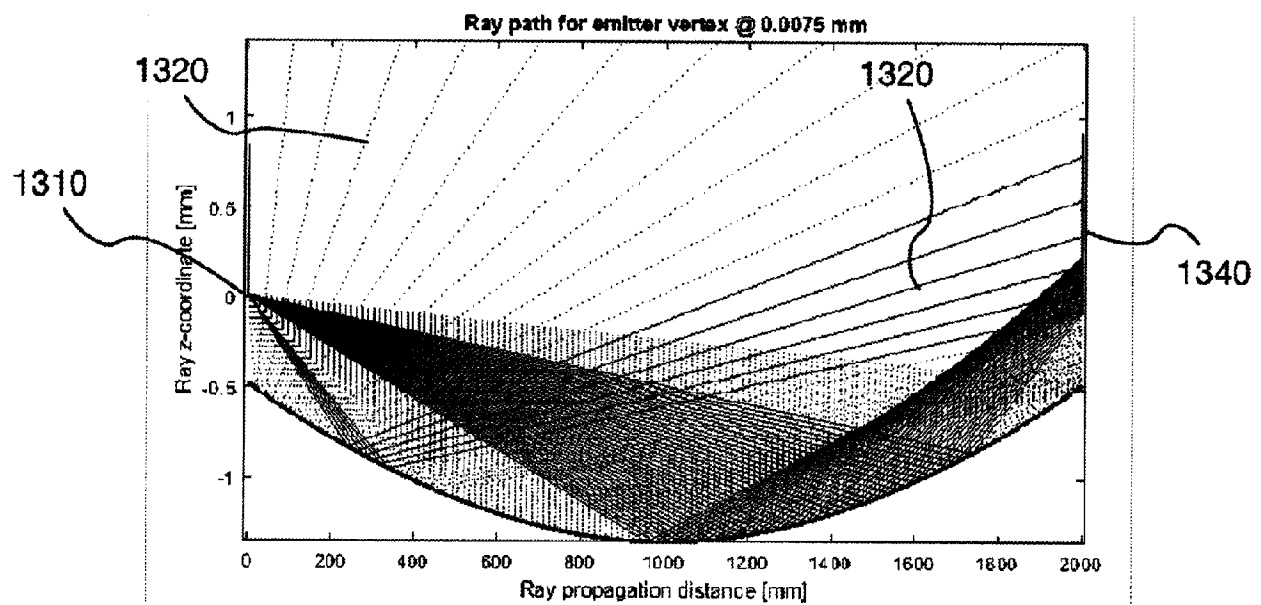


Figure 13a

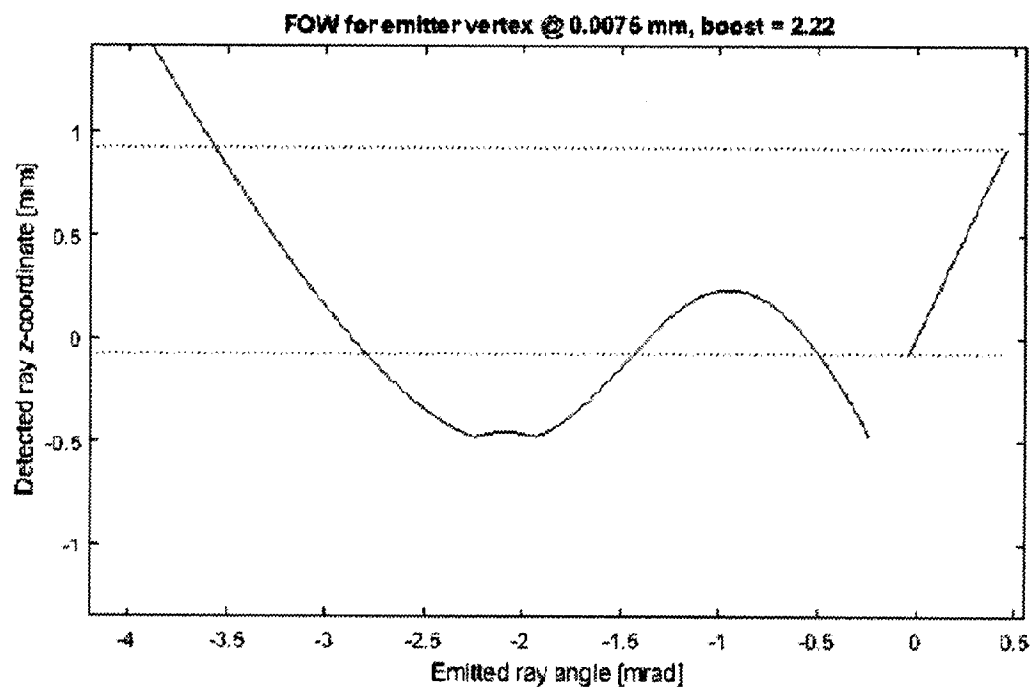


Figure 13b

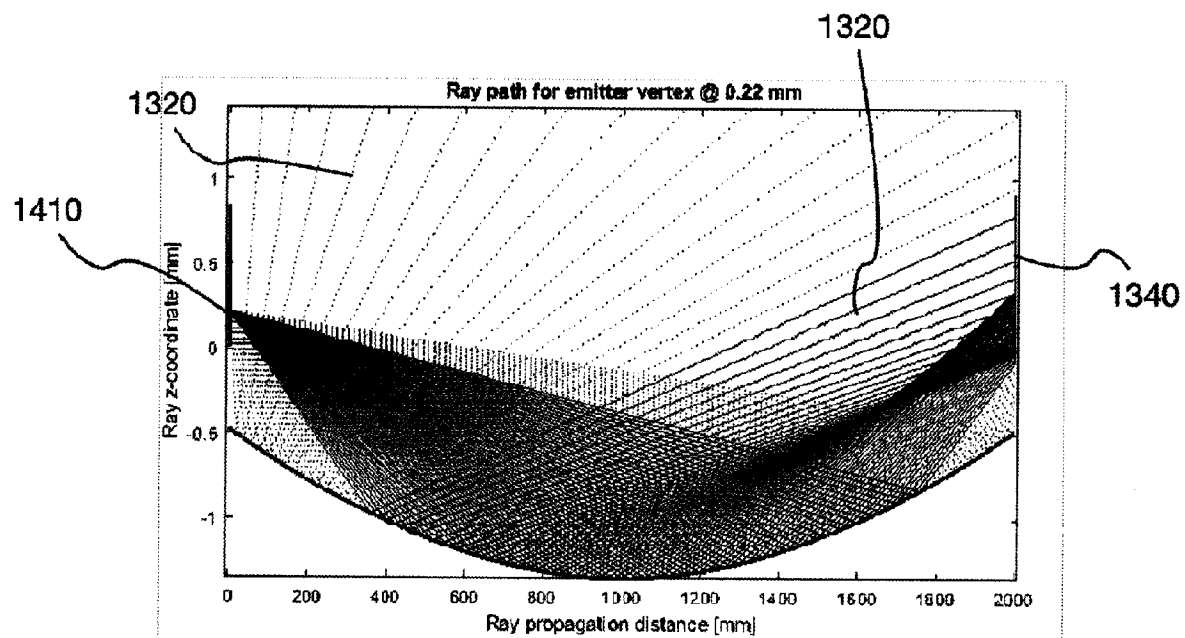


Figure 14a

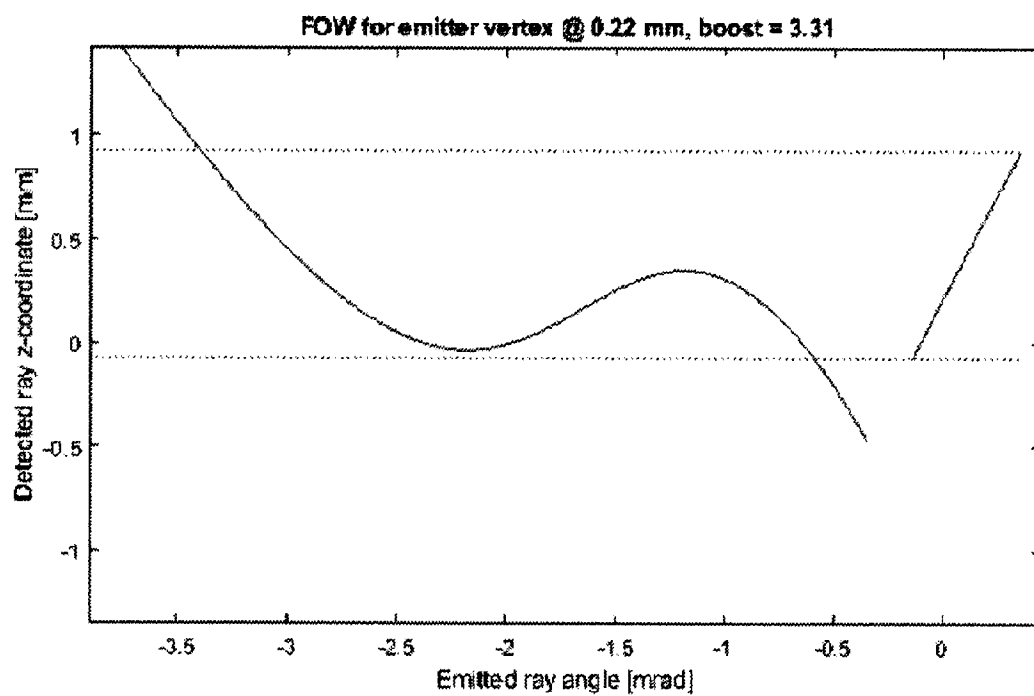


Figure 14b

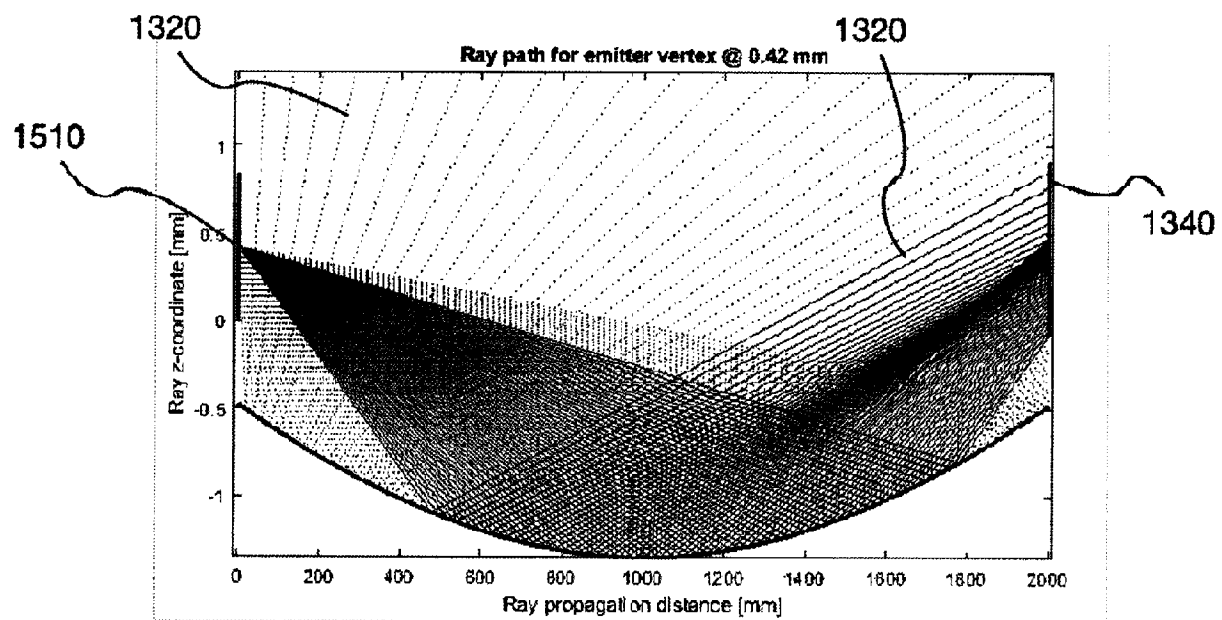


Figure 15a

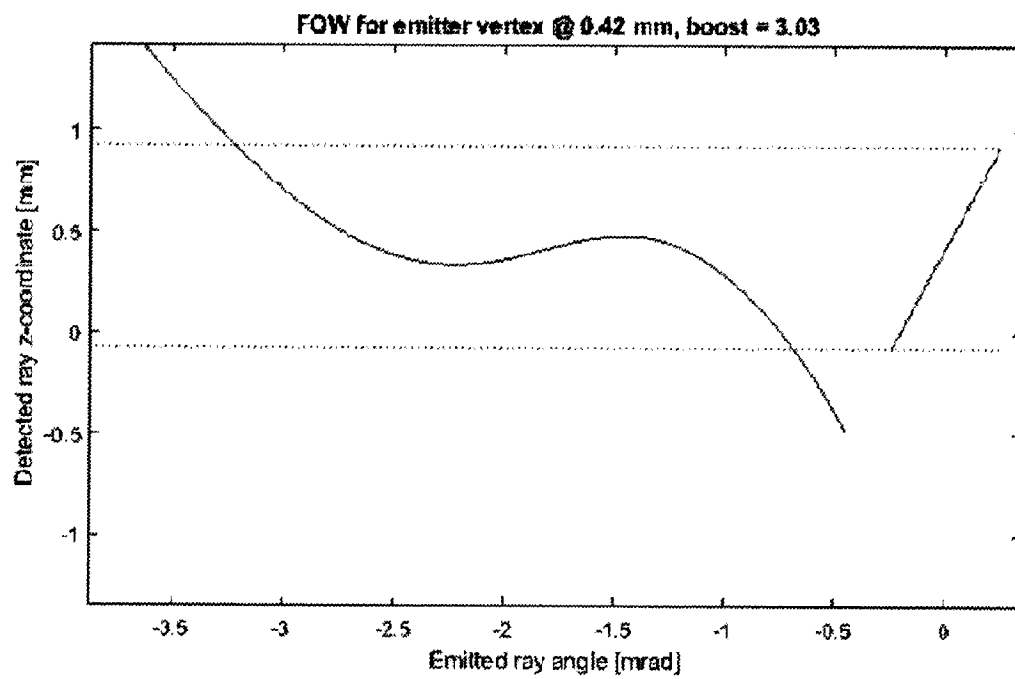


Figure 15b

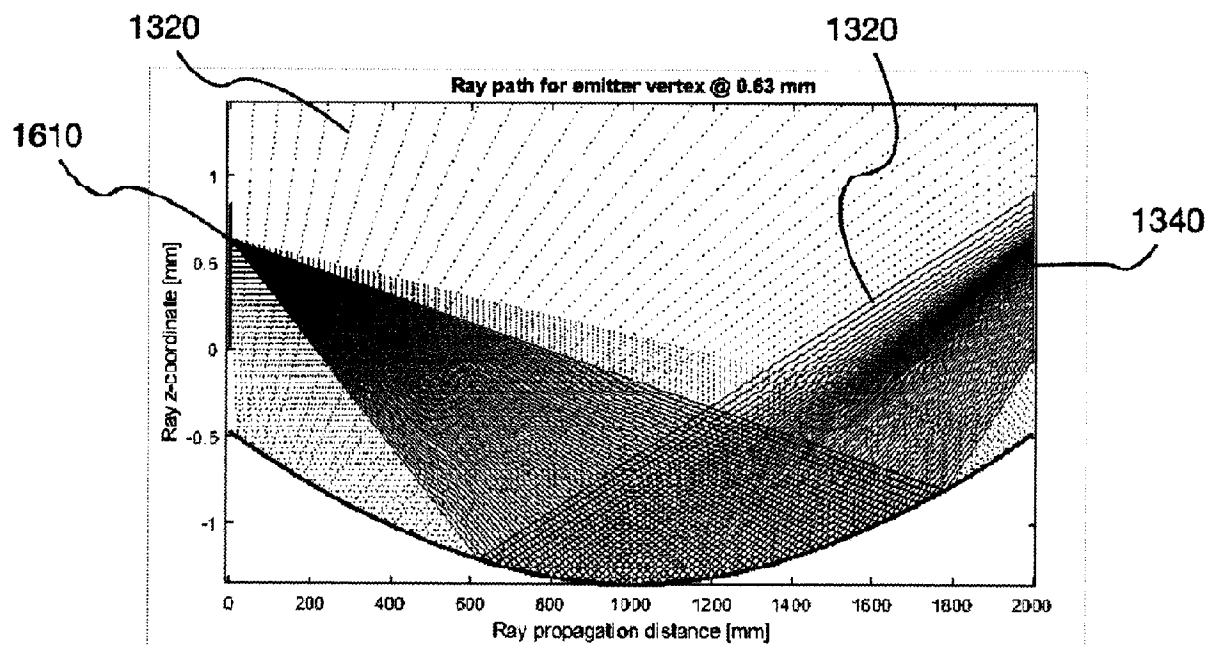


Figure 16a

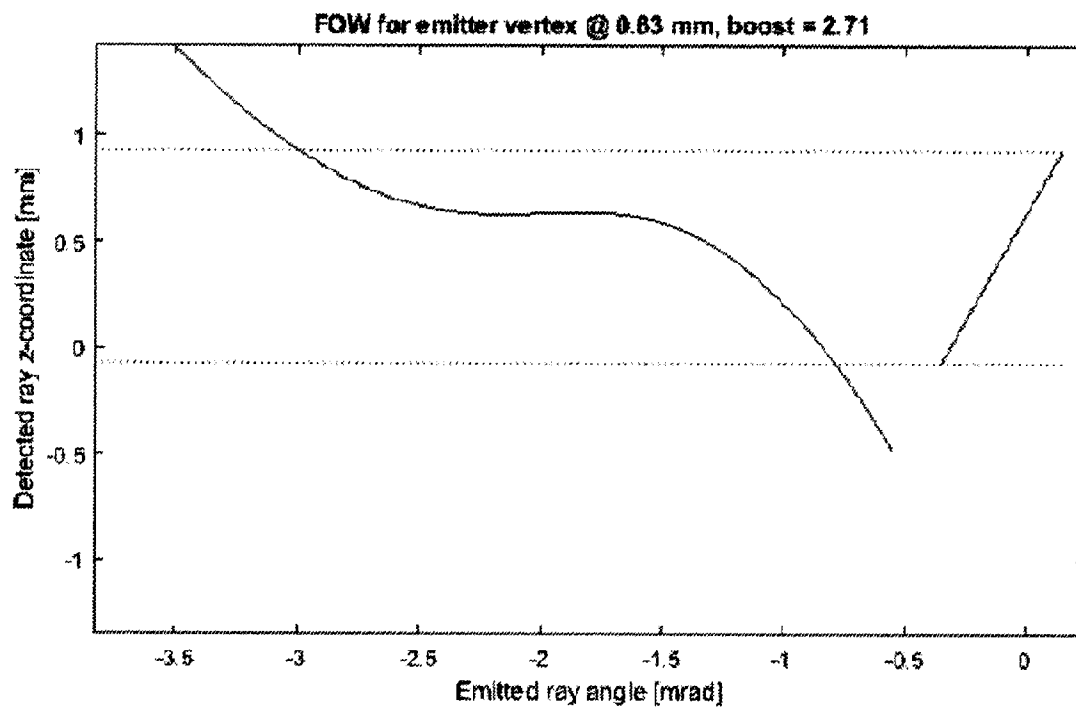


Figure 16b

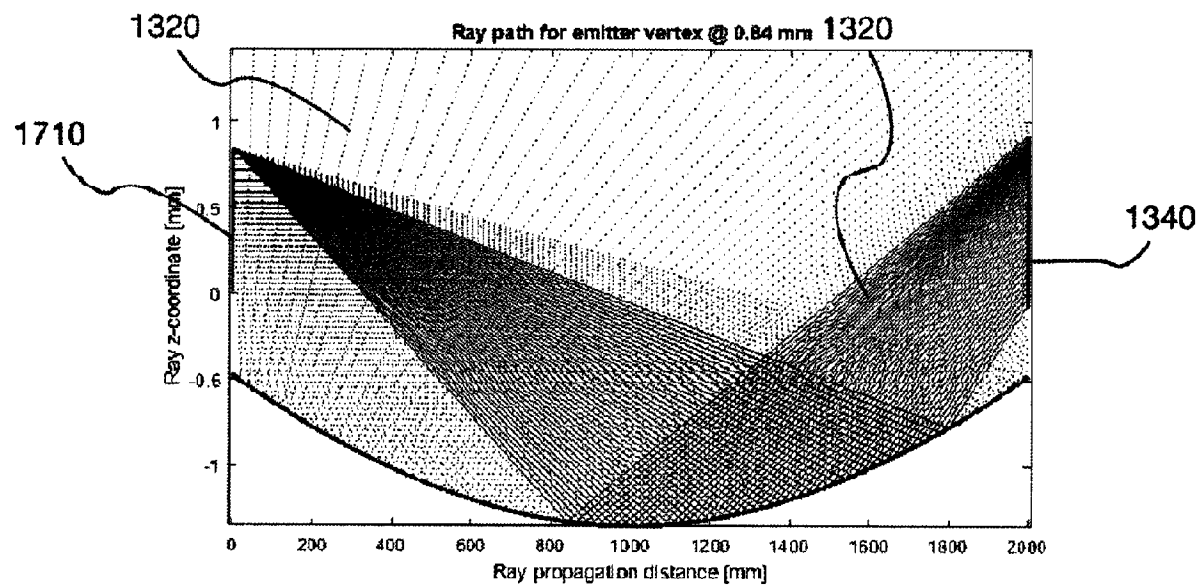


Figure 17a

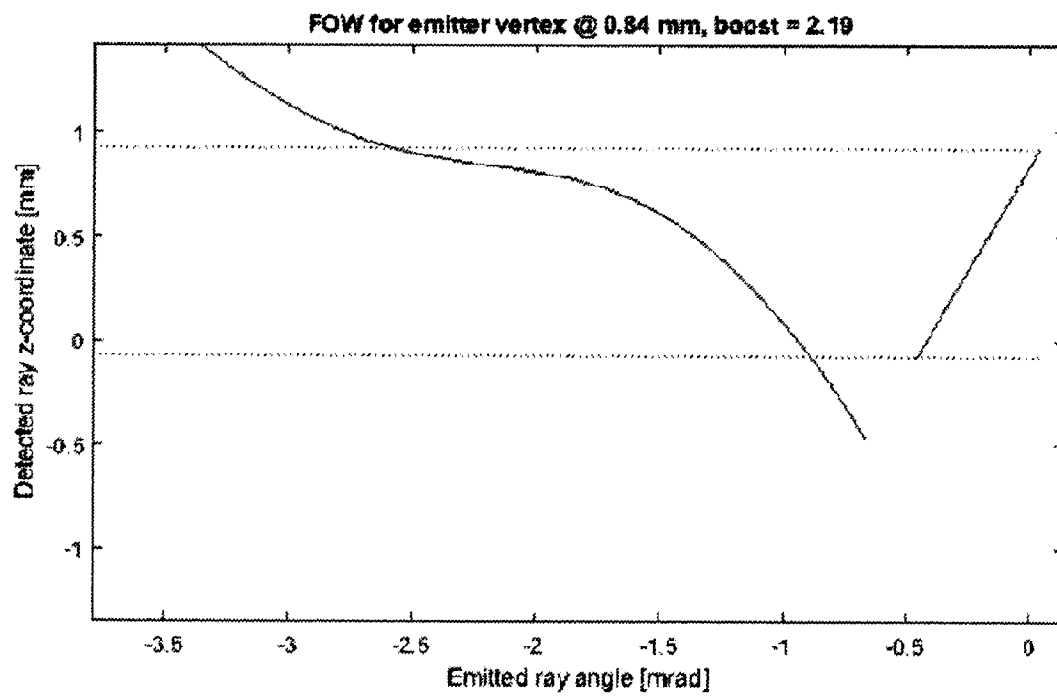


Figure 17b

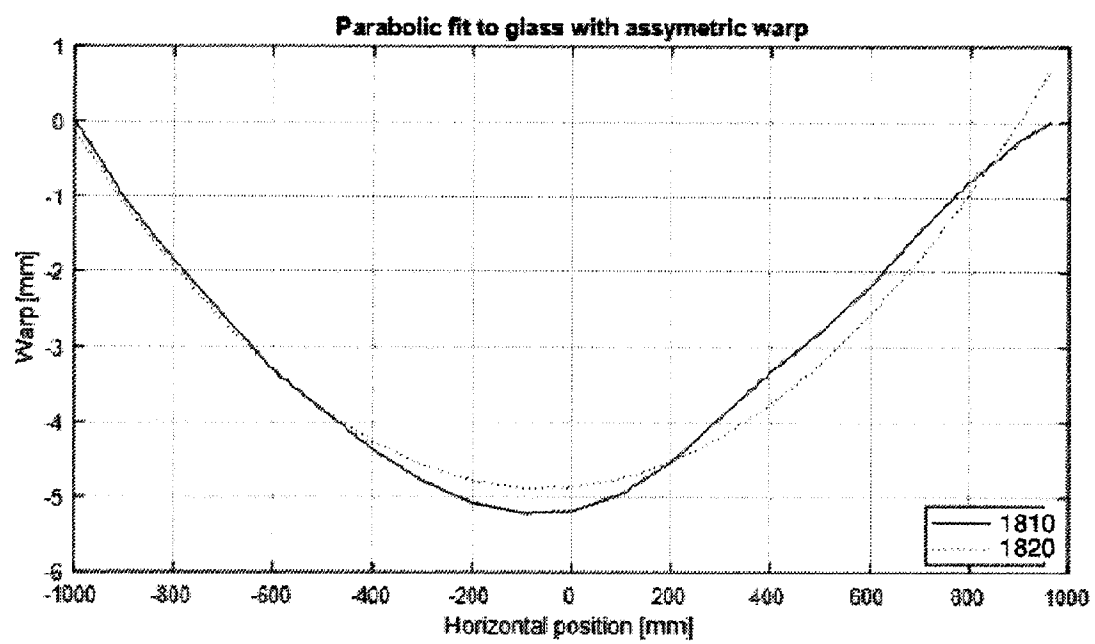


Figure 18a

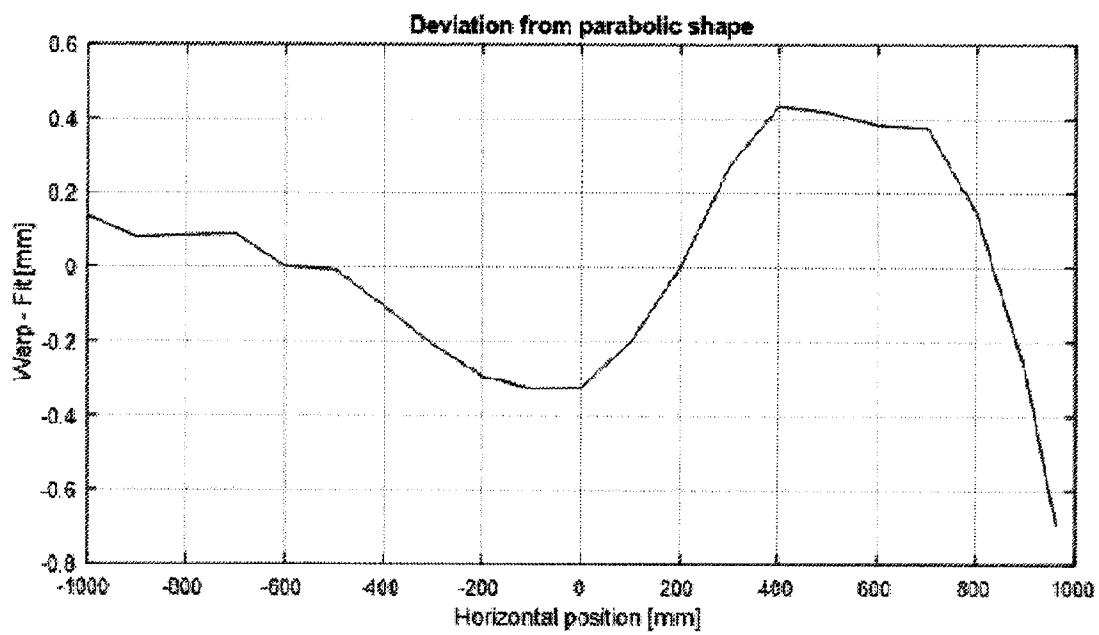


Figure 18b

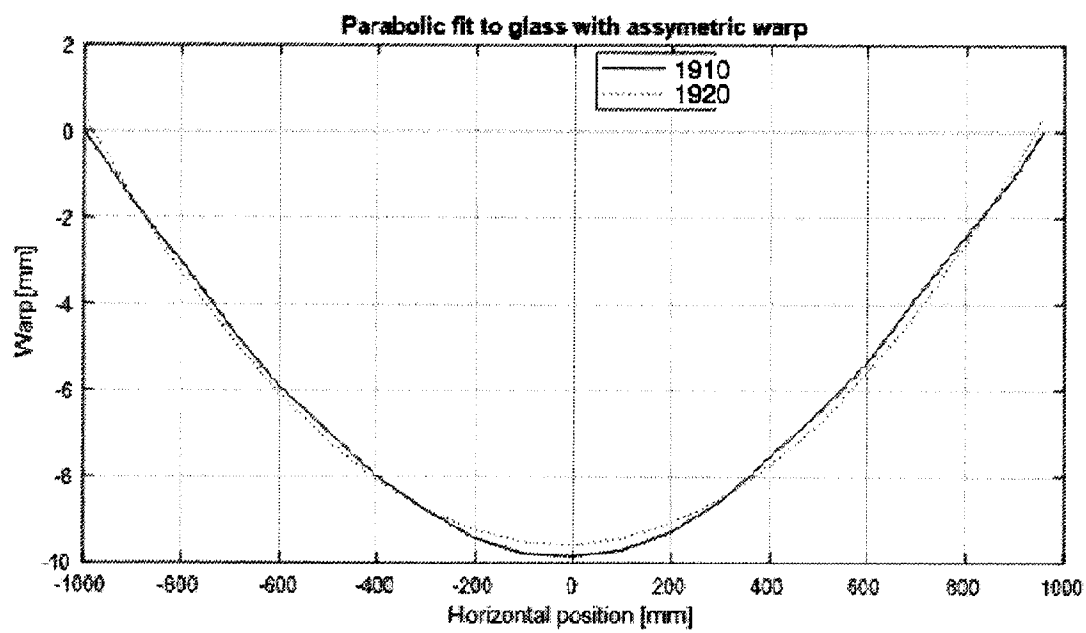


Figure 19a

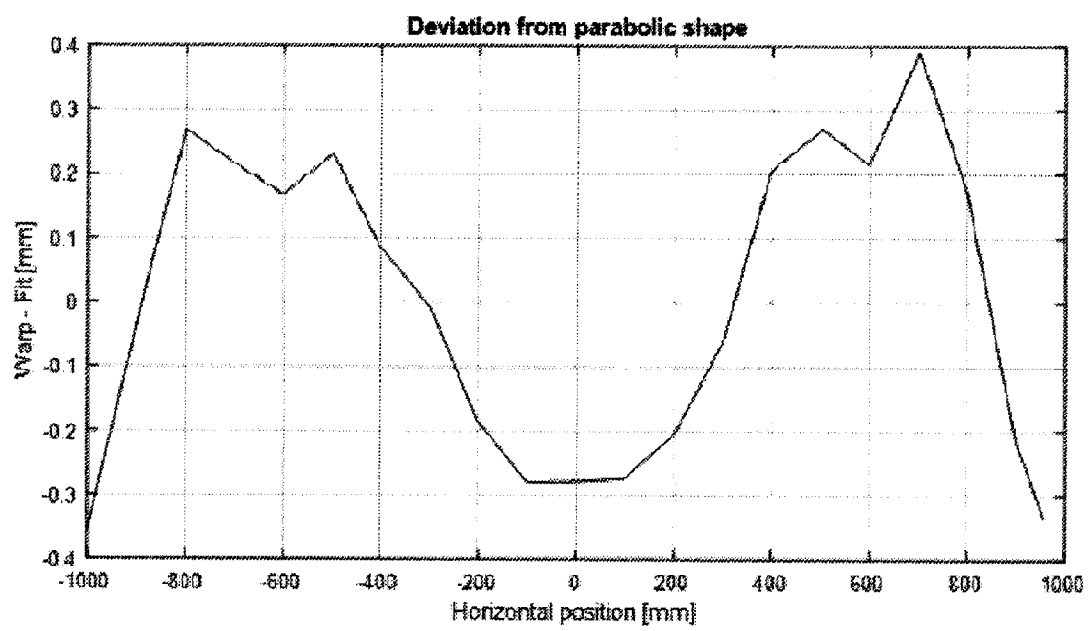
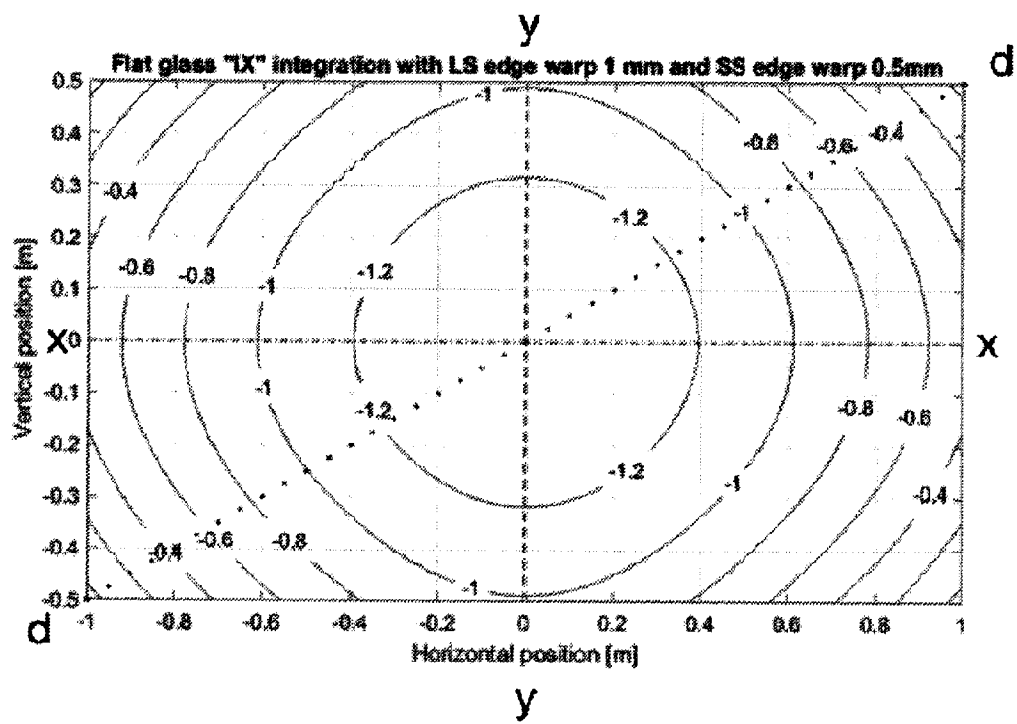


Figure 19b



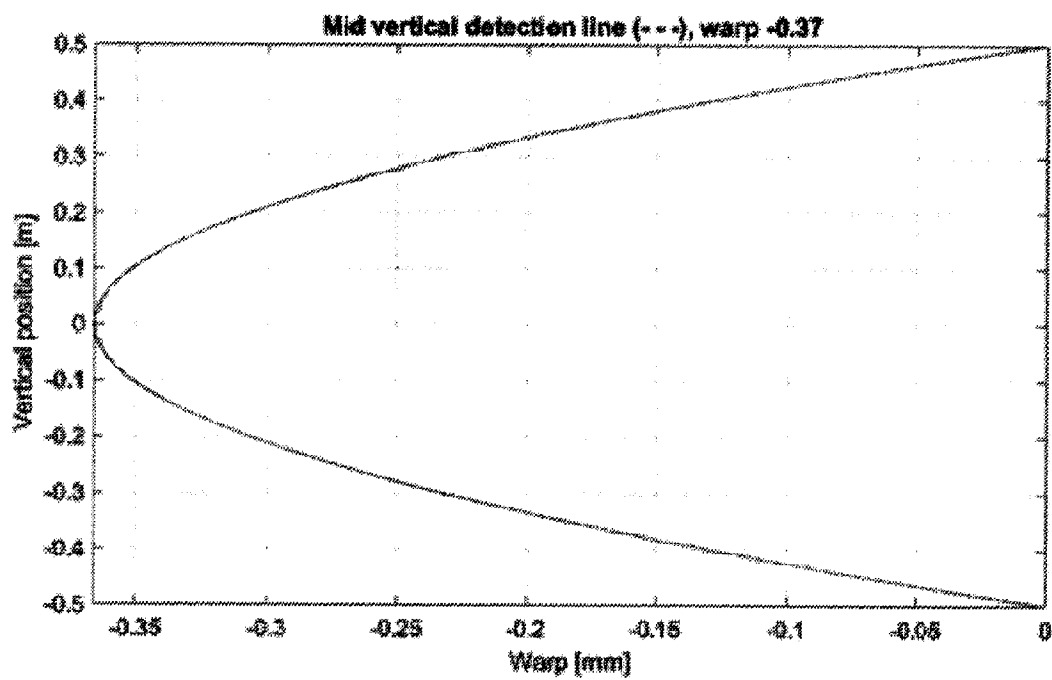


Figure 20b

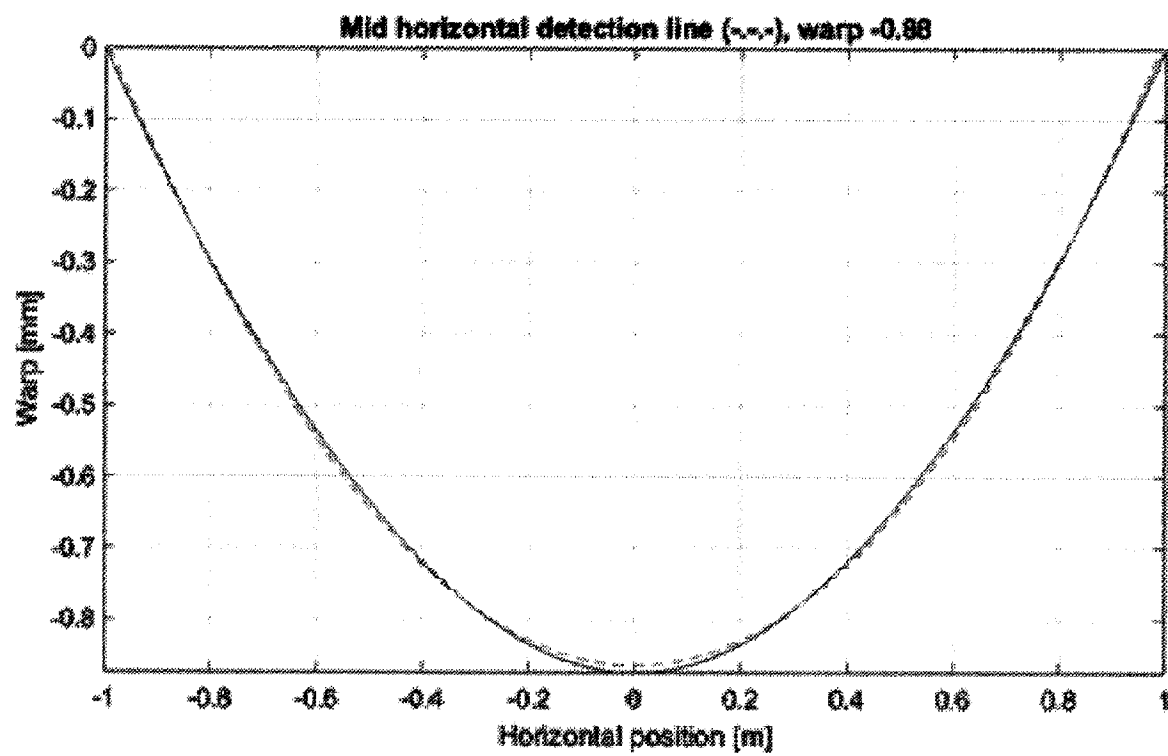


Figure 20c

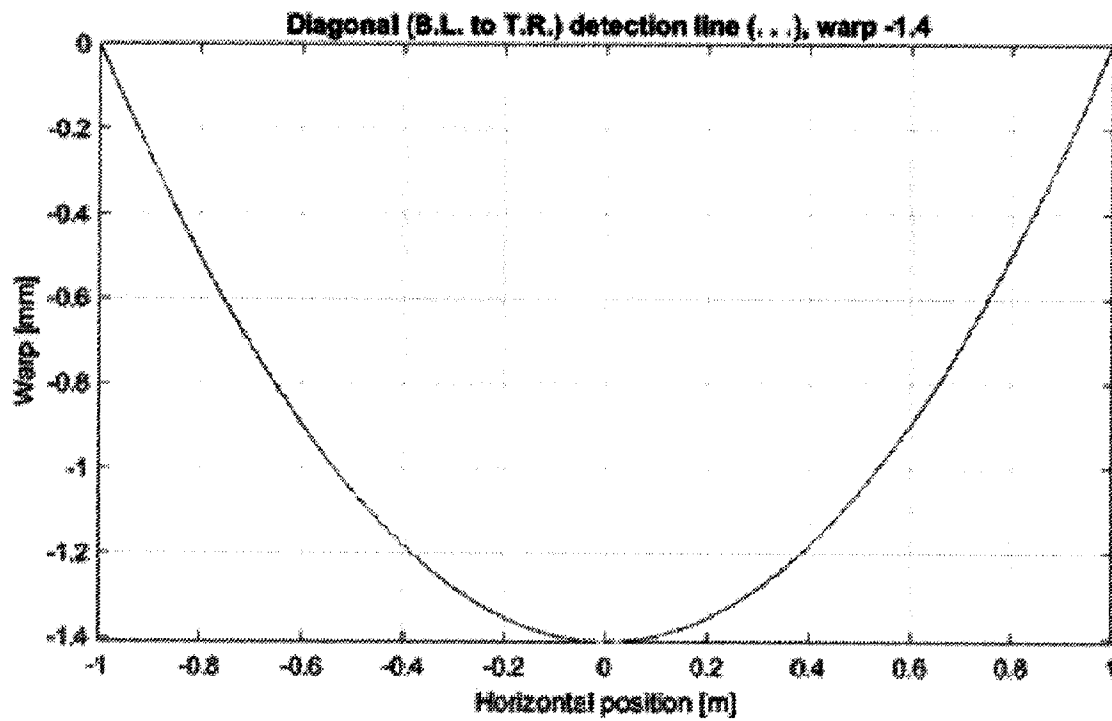
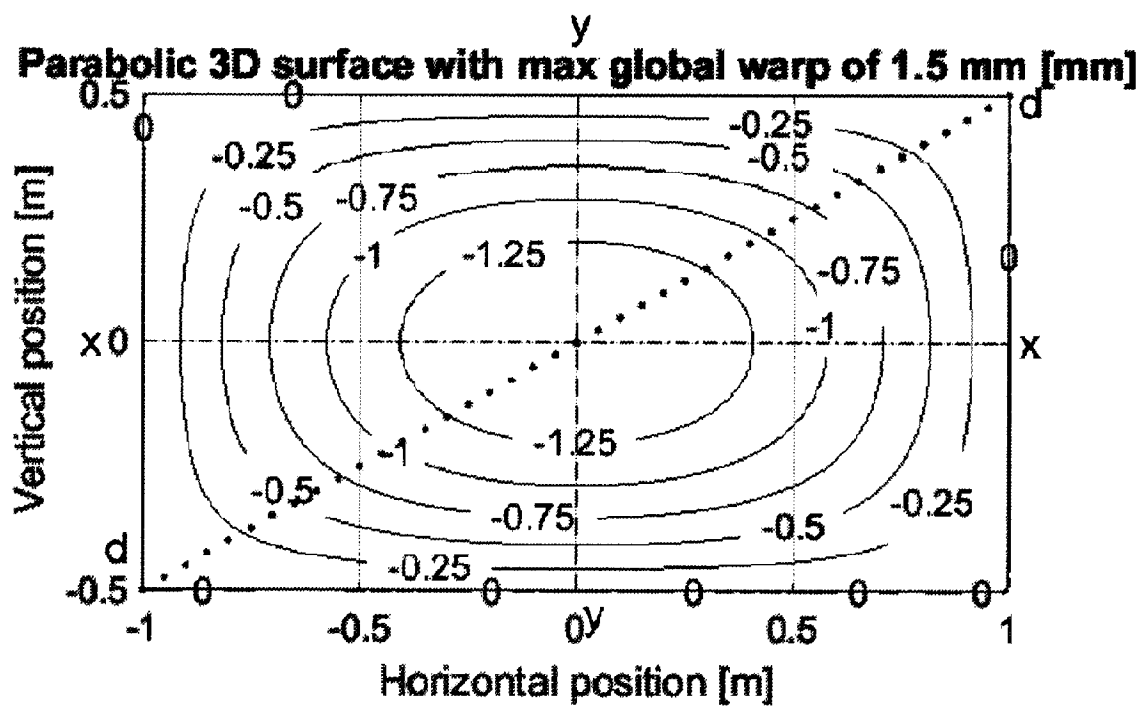


Figure 20d



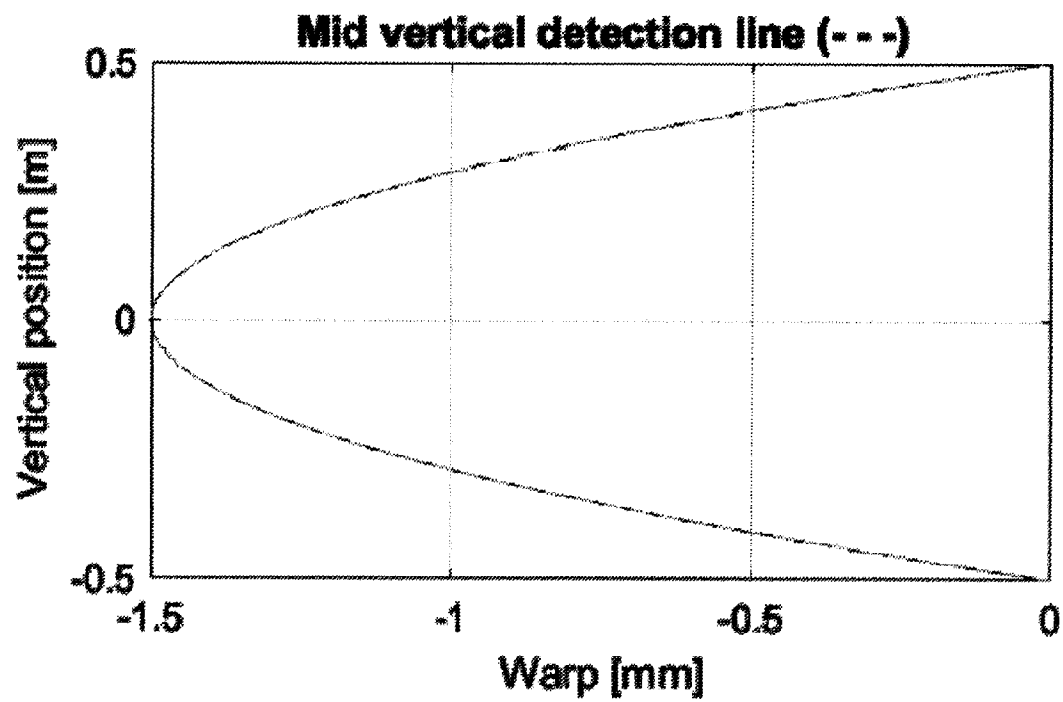


Figure 21b

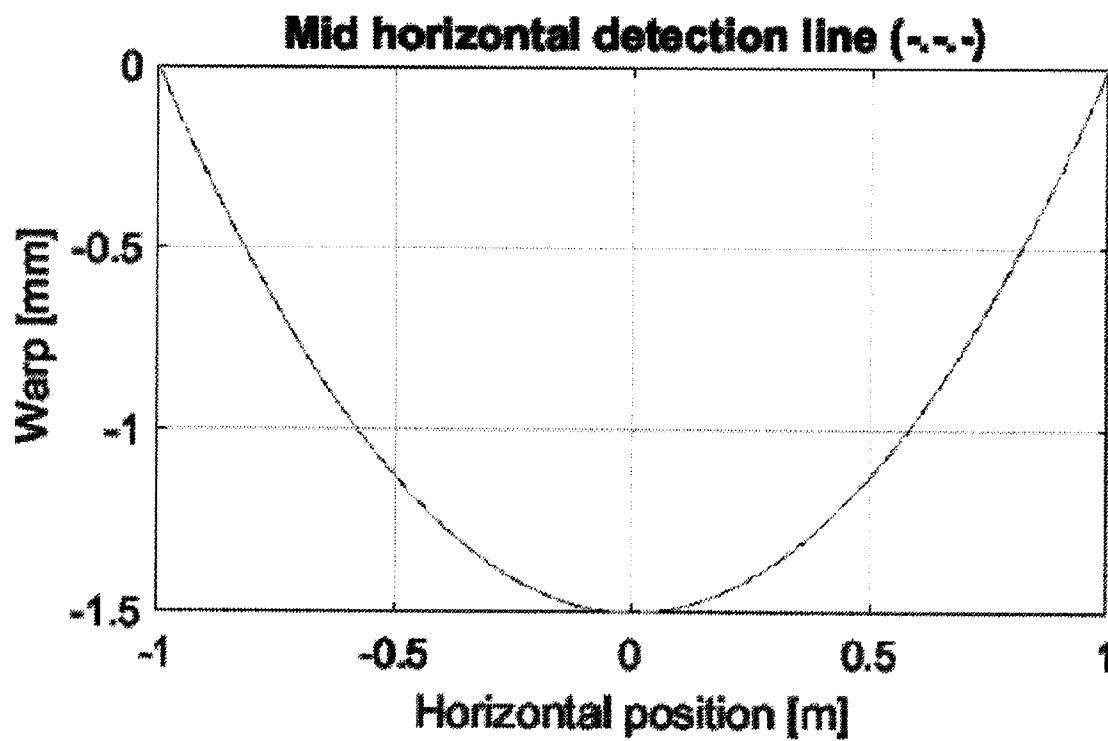


Figure 21c

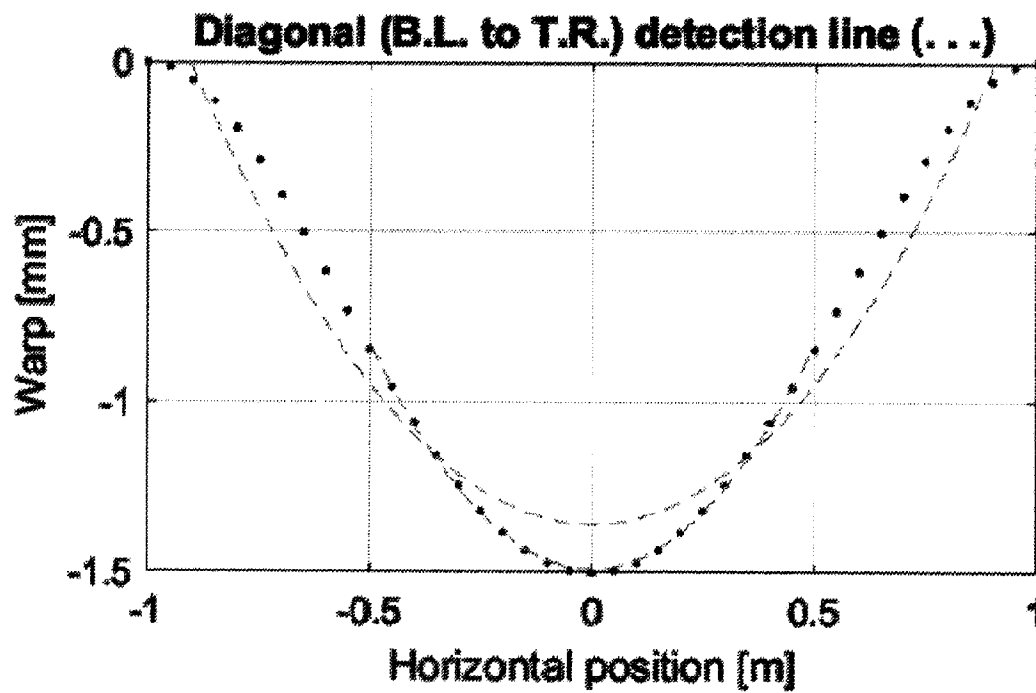


Figure 21d

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051233

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.
A	US 6031524 A1 (INTERMEC IP CORP), 29 February 2000 (2000-02-29); column 1, line 60 - column 2, line 20 --	1-24
A	US 20160295711 A1 (RYU HYUNJONG ET AL), 6 October 2016 (2016-10-06); whole document --	1-24
A	EP 3043242 A1 (DEXERIALS CORP), 13 July 2016 (2016-07-13); whole document --	1-24
A	WO 2016177592 A1 (AGC GLASS EUROPE), 10 November 2016 (2016-11-10); whole document --	1-24



Further documents are listed in the continuation of Box C.



See patent family annex.

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“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

12-03-2018

Date of mailing of the international search report

12-03-2018

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

Emil Bäcklund

Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/051233

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 20120062492 A1 (KATOH SATOSHI), 15 March 2012 (2012-03-15); paragraphs [0006]-[0010] --	1-24
A	US 20120045170 A1 (SHIBATA NAOKI ET AL), 23 February 2012 (2012-02-23); whole document -- -----	1-24

Continuation of: second 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)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2017/051233

US	6031524 A1	29/02/2000	NONE		
US	20160295711 A1	06/10/2016	US	9839145 B2	05/12/2017
			WO	2015111890 A1	30/07/2015
EP	3043242 A1	13/07/2016	CN	105518592 A	20/04/2016
			JP	2015052916 A	19/03/2015
			JP	5848736 B2	27/01/2016
			KR	20160053923 A	13/05/2016
			TW	201523377 A	16/06/2015
			US	20160202801 A1	14/07/2016
			WO	2015033569 A1	12/03/2015
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			KR	20180004141 A	10/01/2018
			TW	201704169 A	01/02/2017
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			JP	2012043136 A	01/03/2012
			KR	20120017403 A	28/02/2012
			TW	201219866 A	16/05/2012



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4

CONFIRMATION NO. 3081

PUBLICATION NOTICE



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2040 MAIN STREET
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IRVINE, CA 92614

Title: TOUCH DEVICE

Publication No. US-2020-0110508-A1

Publication Date: 04/09/2020

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	04/07/2020		
KNOBBE MARTENS OLSON & BEAR LLP			EXAMINER	
2040 MAIN STREET			LAM, VINH TANG	
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IRVINE, CA 92614				
			ART UNIT	PAPER NUMBER
			2628	
			NOTIFICATION DATE	DELIVERY MODE
			04/07/2020	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

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.

Priority

2. Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119 (a)-(d). The certified copy has been filed in parent Application No. **SE 16302945**, filed on **07 Dec 2016**.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claim(s) **1** and **4-5** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Kukulj (US Patent/PGPub. No. 20120223916)** in view of **Christiansson et al. (US Patent/PGPub. No. 20130044073)**.

Regarding Claim **1, (Currently Amended)** Kukulj teaches **a method for assembling** ([0009], FIG. 1-3, i.e. as **shown by the figure(s)**) **a touch sensing apparatus** ([0007], FIG. 3, i.e. **touch screen 31**), **the touch sensing apparatus** (i.e. please see above citation(s)) **comprising a display panel** ([0004], FIG. 3, i.e. **display screen**), **a plate** ([0006], FIG. 2, i.e. (VCLs) 30; [0007], FIG. 3, **light guide plate 34**) **including a touch surface** ([0006], FIG. 2, i.e. (VCLs) 30; [0007], FIG. 3, **light guide plate 34**), **and a frame assembly** ([0009], FIG. 3, i.e. **waveguide substrate 24**), **wherein the frame assembly** (i.e. please see above citation(s)) **includes:**

a first edge ([0007], FIG. 3, i.e. **right edge of light guide plate 34**);

a second edge ([0007], FIG. 3, i.e. **upper edge of light guide plate 34**) **perpendicular to** (FIG. 3, i.e. as **shown by the figure(s)**) **the first edge** (i.e. please see above citation(s)); **and**

a flat plane ([0007], FIG. 3, i.e. **plane** of light guide plate 34) **defined by**
(FIG. 3, i.e. as **shown** by the **figure(s)**) **the first edge and the second**
edge (i.e. please see above citation(s)); **and**

the method (i.e. please see above citation(s)) **comprising:**
configuring the frame assembly (i.e. please see above citation(s))
to support (FIG. 3, i.e. as **shown** by the **figure(s)**) **the display panel** (i.e.
please see above citation(s));

arranging a plurality of emitters ([0007], FIG. 3, i.e. **optical**
sources 4) adjacent to (FIG. 3, i.e. as **shown** by the **figure(s)**) **a periphery**
([0007], FIG. 3, **periphery** of light guide plate 34) **of the plate, said plurality**
of emitters (i.e. please see above citation(s)) **configured to emit light to**
propagate over ([0007], FIG. 3, **launched into**) **the touch surface** (i.e.
please see above citation(s));

arranging a plurality of detectors ([0005], FIG. 1, **photo-detectors**
10) arranged adjacent to (FIG. 1-3, i.e. as **shown** by the **figure(s)**) **the**
periphery of the plate (i.e. please see above citation(s)), **said plurality**
of detectors (i.e. please see above citation(s)) **configured to receive**

light ([0005], FIG. 1, beams of light 8 towards) from the set of emitters

(i.e. please see above citation(s)); and

configuring the frame assembly *(i.e. please see above citation(s))*

to support the plate *(i.e. please see above citation(s)).*

However, **Kukulj** does not explicitly teach

the touch surface includes a center point and

configuring the frame assembly to support the plate includes inducing a curvature in the touch surface such that the center point moves further away from the flat plane.

In the same field of endeavor, **Christiansson et al.** teach

the touch surface ([0072], FIG. 3A, top surface 5) includes a center point ([0072], FIG. 3A, center point of top surface 5) and

configuring the frame assembly ([0070], FIG. 3A, frame assembly of touch-sensitive apparatus 100) to support the plate ([0071], FIG. 3A, light transmissive panel 4) includes inducing a curvature ([0071], FIG. 3A, parallel surfaces 5, 6 and may be ... curved) in the touch surface such that the center point moves ([0071], FIG. 3A, center point of surface 5) further away from ([0071], FIG. 3A, since surfaces 5 and 6 may be curved, the center point of surface 5 would move further form surface 5) the flat plane ([0071], FIG. 3A, surface 5).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to combine **Kukulj** teaching method of assembling touch sensing apparatus comprising frame, plate, plurality of emitters and receivers with **Christiansson et al.** teaching of method of assembling touch sensing apparatus comprising curved at center of sensing surface *to effectively accommodate differences in design and manufacturing optical sensing surface by providing curved sensing surface (Christiansson et al.'s [0071])*.

Regarding Claim **4, (Currently Amended)** the method of **claim 1, wherein**

Kukulj teaches **the touch surface** (*i.e. please see above citation(s)*) **is concave** ([0007], FIG. 3, *i.e. right side of parabolic reflectors 38*).

Regarding Claim **5, (Original)** the method of **claim 1, wherein**

Kukulj teaches **the curvature** (*i.e. please see above citation(s)*) **is parabolic concave** ([0007], FIG. 3, *i.e. right side of parabolic reflectors 38*).

4. Claim(s) **6-11, 13, 15-20** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Kukulj (US Patent/PGPub. No. 20120223916)** in view of **Christiansson et al. (US Patent/PGPub. No. 20130044073)** and **RYU et al. (US Patent/PGPub. No. 20160295711)**.

Regarding Claim **6, (Original) Kukulj and Christiansson et al.** teach
the method of claim 1.

However, **Kukulj and Christiansson et al.** do not explicitly teach
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.

In the same field of endeavor, **RYU et al.** teach
the plate ([0072], FIG. 4(a) & 4(b), i.e. *plate of display unit 20*) **has a first
curvature** ([0071], FIG. 4(a), i.e. *flat*; please note that *flat* is a *curve* having *infinite
radius*) **when not configured in the frame assembly** ([0072], FIG.
4(a), i.e. *links 50 not pushed up in z-axis direction*), **and wherein the plate**
(i.e. please see above citation(s)) **has a second curvature** ([0072], FIG. 4(b),
i.e. *curvature in the second state*) **greater than** ([0061], FIG. 4(b), i.e. *curve more
than flat*) **the first curvature after the plate** (i.e. please see above
citation(s)) **is configured in** ([0072], FIG. 4(b), i.e. *links 50 are pushed up in z-
axis direction*) **the frame assembly** (i.e. please see above citation(s)).

It would have been obvious to a person having ordinary skill in the art at the time
the invention's effective date was filed to modify **Kukulj** teaching method of assembling

touch sensing apparatus comprising flat touch screen display with **RYU et al.** teaching of method of assembling touch sensing apparatus comprising curve touch screen display *to effectively enhance user's viewing experience by providing both flat and curve surfaces (RYU et al.'s [0005]).*

Regarding Claims **7** and **15, (Currently Amended)** the **touch sensing apparatus of claim [6 (Claim 7)] [10 (Claim 15)], wherein**

RYU et al. teach the first curvature and second curvature *(i.e. please see above citation(s))* **are [defined (Claim 7)] [measured (Claim 15)] along an edge** *([0072], FIG. 4(a) & 4(b), i.e. edge of display unit 20 in x-axis direction)* **of the plate** *(i.e. please see above citation(s)).*

Regarding Claims **8 (Original), and 16 (Currently Amended), the touch sensing apparatus of claim [6 (Claim 8)] [10 (Claim 16)], wherein**

RYU et al. teach the first curvature and second curvature *(i.e. please see above citation(s))* **are measured along an axis** *([0072], FIG. 4(a) & 4(b), i.e. z-axis direction)* **passing through a center point** *([0072], FIG. 4(a) & 4(b), i.e. point where R1, R2, and R3 meet)* **of the plate** *(i.e. please see above citation(s)).*

Regarding Claims **9, (Original)** and **17, (Currently**

Amended) the touch sensing apparatus of claim [6 (Claim 9)]

[10 (Claim 17)], wherein

RYU et al. teach the first curvature and second curvature (*i.e.*
please see above citation(s)) **are measured along a line** ([0072], FIG. 4(a) &
4(b), i.e. line parallel to x-axis on display unit 20) passing through a point
([0072], FIG. 4(a) & 4(b), *i.e. point on display unit 20*) **on the touch surface**
(*i.e. please see above citation(s)*).

Regarding Claim **10, (Currently Amended)** Kukulj teaches **a**
touch sensing apparatus ([0007], FIG. 3, *i.e. touch screen 31*)
comprising:

a display panel ([0004], FIG. 3, *i.e. display screen*);
a plate ([0006], FIG. 2, *i.e. (VCLs) 30*; [0007], FIG. 3, *light guide plate 34*)
having a width ([0006], FIG. 2, *i.e. horizontal width of (VCLs) 30*; [0007], FIG. 2,
horizontal width of light guide plate 34), **a length** ([0006], FIG. 2, *i.e. vertical*
length of (VCLs) 30; [0007], FIG. 3, *vertical length of light guide plate 34*) **and a**
periphery ([0006], FIG. 2, *i.e. periphery of (VCLs) 30*; [0007], FIG. 3, *periphery of*
light guide plate 34),

a flat plane ([0007], FIG. 3, i.e. *plane of light guide plate 34*) **defined by**
a first edge ([0007], FIG. 3, i.e. *right edge of light guide plate 34*) **of the**
touch surface (i.e. please see above citation(s)) **and a second edge**
([0007], FIG. 3, i.e. *upper edge of light guide plate 34*) **of the touch surface**
(i.e. please see above citation(s)) **perpendicular to** (FIG. 3, i.e. as *shown* by the
figure(s)) **the first edge** (i.e. please see above citation(s));

one or more emitters ([0006], FIG. 2, i.e. *transmit optical waveguide*
includes an in-plane lens 28) **arranged adjacent to** (FIG. 2-3, i.e. as *shown*
by the *figure(s)*) **the periphery of the plate** (i.e. please see above citation(s))
and configured to emit light across ([0006], FIG. 2, i.e. *transmit optical*)
the touch surface of the plate (i.e. please see above citation(s));

a set of detectors ([0006], FIG. 2, i.e. *receive optical waveguide*
includes an in-plane lens 29) **arranged adjacent to** (FIG. 2-3, i.e. as *shown*
by the *figure(s)*) **the periphery of the plate** (i.e. please see above citation(s))
and configured to receive light ([0006], FIG. 2, i.e. *receive optical*) **from**
the set of emitters (i.e. please see above citation(s)), **and a frame**
assembly ([0009], FIG. 3, i.e. *waveguide substrate 24*), **the frame**
assembly (i.e. please see above citation(s)) **comprising:**

a first frame element ([0009], FIG. 3, i.e. *horizontal portion of waveguide substrate 24*) **configured to support** (FIG. 2-3, i.e. as *shown by the figure(s)*) **the display panel** (i.e. please see above citation(s)); and

a second frame element ([0009], FIG. 3, i.e. *vertical portion of waveguide substrate 24 (receive optical waveguides 22)*) **arranged around at least a portion** ([0009], FIG. 3, i.e. *left portion of waveguide substrate 24*) **of the periphery of the plate, the second frame element** (i.e. please see above citation(s)) **having a first portion** ([0009], FIG. 3, i.e. *right portion of receive optical waveguides 22*) **extending along an edge** ([0009], FIG. 3, i.e. *left edge of light guide plate 34*) **of the plate** (i.e. please see above citation(s)) **and a second portion** ([0009], FIG. 3, i.e. *top portion of receive optical waveguides 22*) **opposed to** (FIG. 3, i.e. as *shown by the figure(s)*) **the touch surface** (i.e. please see above citation(s)); and

wherein the first curvature ([0007], FIG. 3, i.e. *right side of parabolic reflectors 38*) **is concave** ([0007], FIG. 3, i.e. *right side of parabolic reflectors 38*).

However, Kukulj does not explicitly teach

the plate further including a touch surface having a center point;

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 in the touch surface greater than the first curvature when the plate is installed in the frame assembly;

the frame assembly is arranged to induce the second curvature such that the center point of the touch surface causes the center point to move further away from the flat plane.

In the same field of endeavor, **Christiansson et al.** teach

the plate ([0071], FIG. 3A, *light transmissive panel 4*) **further including a touch surface** ([0072], FIG. 3A, *top surface 5*) **having a center point** ([0072], FIG. 3A, *center point of top surface 5*); **and the frame assembly** ([0070], FIG. 3A, *frame assembly of touch-sensitive apparatus 100*) **is arranged to induce the second curvature** ([0072], FIG. 3A, *top/bottom surface 5/6*) **such that the center point** ([0072], FIG. 3A, *center point of top surface 5*) **of the touch surface causes the center point** (*i.e. please see above citation(s)*) **to move further away from** ([0071], FIG. 3A, *since surfaces 5 and 6 may be curved, the center point of surface 5 would move further form surface 5*) **the flat plane** ([0071], FIG. 3A, *surface 5*).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to combine **Kukulj** teaching method of

assembling touch sensing apparatus comprising frame, plate, plurality of emitters and receivers with **Christiansson et al.** teaching of method of assembling touch sensing apparatus comprising curved at center of sensing surface *to effectively accommodate differences in design and manufacturing optical sensing surface by providing curved sensing surface (Christiansson et al.'s [0071])*.

However, **Kukulj and Christiansson et al.** do not explicitly teach
the plate has a first curvature in the touch surface when not installed in the frame assembly,

the plate has a second curvature in the touch surface greater than the first curvature when the plate is installed in the frame assembly.

In the same field of endeavor, **RYU et al.** teach
the plate ([0072], FIG. 4(a) & 4(b), i.e. *plate of display unit 20*) **has a first curvature** ([0071], FIG. 4(a), i.e. *flat*; please note that *flat* is a *curve* having *infinite radius*) **in the touch surface** (i.e. please see above citation(s)) **when not installed in the frame assembly** ([0072], FIG. 4(a), i.e. *links 50 not pushed up in z-axis direction*),

the plate (i.e. please see above citation(s)) **has a second curvature** ([0072], FIG. 4(b), i.e. *curvature in the second state*) **in the touch surface** (i.e. please see above citation(s)) **greater than** ([0061], FIG. 4(b), i.e. *curve more than flat*) **the first curvature when the plate** (i.e. please see above citation(s))

is installed in ([0072], FIG. 4(b), i.e. links 50 are **pushed up** in **z-axis** direction)
the frame assembly (i.e. please see above citation(s)).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to modify **Kukulj** and **Christiansson et al.** teaching apparatus of assembling touch sensing apparatus comprising flat touch screen display with **RYU et al.** teaching of apparatus of assembling touch sensing apparatus comprising curve touch screen display *to effectively enhance user's viewing experience by providing both flat and curve surfaces* (RYU et al.'s [0005]).

Regarding Claim **11, (Currently Amended)** the touch
sensing apparatus of claim 10, wherein

Kukulj teaches **the touch surface** (i.e. please see above citation(s)) **is**
parabolic concave ([0007], FIG. 3, i.e. *right side of parabolic reflectors 38*).

Regarding Claim **13, (Original)** the touch sensing
apparatus of claim 10,

Kukulj teaches **further comprising a processing element**
([0101], FIG. 5A & 5B, i.e. controller 60) configured to determine, based
on output signals ([0103], FIG. 6, i.e. *intensity*) **of the set of detectors**
(i.e. please see above citation(s)), a position of an object ([0103], FIG. 6, i.e.

touch object) proximate to the touch surface (i.e. please see above

citation(s)).

Regarding Claim **18, (Original) the touch sensing
apparatus of claim 10,**

Kukulj teaches **further comprising a gasket** ([0009], FIG. 3, i.e. **bezels**), **wherein the plate** (i.e. please see above *citation(s)*) **is supported by** ([0009], FIG. 3, i.e. **bezels** would be used to **support display**) **the gasket** (i.e. please see above *citation(s)*) **proximate to an edge** ([0009], FIG. 3, i.e. **bezels** would be positioned around edges of display) **of the plate** (i.e. please see above *citation(s)*).

Regarding Claim **19, (Original) the apparatus of claim 18,**
wherein

Kukulj teaches **the gasket** (i.e. please see above *citation(s)*) **is configured to have varying thickness to match** ([0009], FIG. 3, i.e. **`bezel width` on all four sides limits the available display size)** **a curvature** ([0009], FIG. 3, i.e. **parabolic reflectors 38**; please note that touch display area **34 proportional to curvature 38 as shown by the figure)** **of the plate along the edge** (i.e. please see above *citation(s)*).

Regarding Claim **20, (Original) Kukulj and Christiansson et al.**

teach **the apparatus of claim 10.**

However, **Kukulj and Christiansson et al.** do not explicitly teach
the second frame element is curved.

In the same field of endeavor, **RYU et al.** teach

the second frame element ([0072], FIG. 4(b), i.e. *sides* of the display
unit **20** in the *z-axis direction*) **is curved** ([0072], FIG. 4(b), i.e. *curvature*).

It would have been obvious to a person having ordinary skill in the art at the time
the invention's effective date was filed to modify **Kukulj and Christiansson et al.**
teaching apparatus of assembling touch sensing apparatus comprising flat touch screen
display with **RYU et al.** teaching of apparatus of assembling touch sensing apparatus
comprising curve touch screen display *to effectively enhance user's viewing experience
by providing both flat and curve surfaces* (RYU et al.'s [0005]).

Response to Arguments

5. Applicant's arguments with respect to claims **1** and **10** have been
considered but are moot because the arguments do not apply to the newly reference
being used in the current rejection.

6. All dependent claims are properly rejected or objected as shown above.

7. Applicants' Response to the Non-Final Office action, 01/28/2020, has been entered and made of record. Claim(s) **1, 4, 7, 10-11, and 15-17** is/are amended, and Claim(s) **2-3, 12, and 14** is/are cancelled. Thus, Claim(s) **1, 4-11, 13, and 15-20** is/are pending in this application.

8. Applicant's arguments, see P. 7, filed **03/17/2020**, with respect to **Claim Objections** have been fully considered and are persuasive. The **Claim Objections** has/have been withdrawn.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINH TANG LAM whose telephone number is (571) 270-3704. The examiner can normally be reached on Monday to Friday 8:00 AM to 5:00 PM.

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, Nitin K Patel can be reached on (571) 272-7677. 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.

/VINH T LAM/
Primary Examiner, Art Unit 2628

Notice of References Cited	Application/Control No. 16/706,438		Applicant(s)/Patent Under Reexamination Kocovski et al.	
	Examiner VINH T LAM		Art Unit 2628	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20150331546-A1	11-2015	CRAVEN-BARTLE; Thomas	G02B5/00	345/175
*	B	US-9063614-B2	06-2015	Pettersson; Robert	G06F3/0416	1/1
*	C	US-20120089348-A1	04-2012	Perlin; Kenneth	G06F3/044	702/41
*	D	US-20120223916-A1	09-2012	Kukulj; Dax	G06F3/0421	345/175
*	E	US-20160295711-A1	10-2016	RYU; Hyunjong	G09F9/301	1/1
*	F	US-20130044073-A1	02-2013	Christiansson; Tomas	G06F3/0421	345/173
	G					
	H					
	I					
	J					
	K					
	L					
	M					

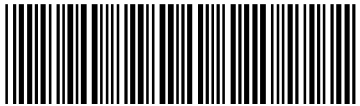
FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

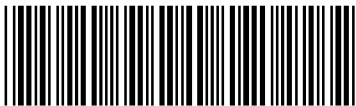
*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Index of Claims</i> 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	01/22/2020	03/27/2020							
	1	✓	✓							
	2	✓	-							
	3	✓	-							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
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	10	✓	✓							
	11	✓	✓							
	12	✓	-							
	13	✓	✓							
	14	✓	-							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							

Search Notes 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

CPC - Searched*		
Symbol	Date	Examiner
G06F3/0421 G06F2203/04103	03/27/2020	vl

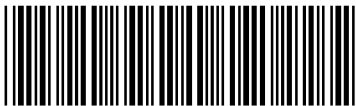
CPC Combination Sets - Searched*		
Symbol	Date	Examiner

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
Search inventor'(s)' name(s). No ODP.	01/22/2020	vl
Search technical terms and synonyms.	03/27/2020	vl
Search IDS.	03/27/2020	vl
Search Foreign Patent Literature(s) and NPL	03/27/2020	vl
Search CPC.	03/27/2020	vl
Search EAST.	03/27/2020	vl
Review amendment and argument.	03/27/2020	vl

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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<i>Search Notes</i> 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
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Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	0	16/190907.app.	US-PGPUB	OR	OFF	2019/01/31 16:20
S2	47226	((optic\$3 light\$3) same (sens\$3 detect\$3) same (warp\$3 twist\$3 curv\$3 bend\$3 bent distort\$3)).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:40
S3	41872	S2 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:41
S4	108	S3 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:43
S5	4	S4 and ((line\$1 plane\$1) same (parabol\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:45
S6	72	((("FLATFROG") near3 ("LABORATORIES") near3 ("AB"))).AS,AANM.	USPAT	OR	OFF	2019/01/31 16:46
S7	35	((("KOCOVSKI") near3 ("Aleksander")) OR ((("BERGSTROM") near3 ("Hakan")) OR ((("THORVINGER") near3 ("Jens")))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2019/01/31 16:47
S8	17	S7 and @pd<"20151207"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2019/01/31 16:48
S9	10	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (sens\$3 detect\$3) same (surface fac\$3)).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 17:58

EAST Search History (Prior Art)

S10	8	S9 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 17:59
S11	1	"20120112541".pn.	US-PGPUB	OR	OFF	2019/01/31 18:05
S12	58	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (sens\$3 detect\$3) same (surface fac\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 09:45
S13	43	S12 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 09:45
S14	5	S13 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 09:46
S15	284	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (surface fac\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:06
S16	208	S15 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:07
S17	29	S16 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:07

EAST Search History (Prior Art)

S19	128	("20160077625" "9524067" "4986662" "8350828" "20170351324" "20130147711" "20100259506" "20030210483" "8587562" "20110175852" "4467193" "20060188196" "7352940" "20090251811" "9128250" "20130156376" "5736688" "8847900" "7553035" "20120044206" "20050225885" "8730179" "9280237" "20050041018" "20100079387" "8692802" "20120223916" "20110169782" "8403203" "9195344" "20110167628" "20110043482" "8896575" "20110181552" "8049738" "6559835" "20060207806" "7825905" "5796368" "8902196" "9471170" "20110163998" "20150277663" "20110169780" "20100277436" "9075477" "9389730" "20110169781" "20140225874" "9052771" "20110210946" "20190025984" "5220409" "8760416" "20110080360" "9658705" "20140071070" "20130135255" "8390576" "20100053090" "20110080344" "20120327039" "20030231169" "7952567" "20060119587" "4387961" "8816991" "4878296" "20120218215" "7274358" "8704822" "20050146514" "20110080361" "20180067292" "20040175677" "10088952" "20180292945" "20120098794" "20180292946" "20100149182" "8842366" "20160188112" "7391410" "20050259074" "20130135359" "20080278460" "8665244" "9958996" "20170220146" "20120212451" "10126854" "20110032214" "20170031569" "2584697" "4880969" "20180040239" "20150029131" "4825212" "20120262580" "20100103140" "9411481" "20070247443" "20180136769" "8929697" "3365720" "5969823" "20150261339" "9063614" "5661561" "20120146957" "20140320459" "20020001091" "6177999" "20120275167" "8905592" "8810549" "20170038896" "20130027352" "6775012" "9678601" "7845827" "20080278946" "20130092154" "9335525" "20140225868" "20130222301" "9560293" "20160156857").pn.	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:33
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EAST Search History (Prior Art)

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EAST Search History (Prior Art)

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3/28/2020 3:04:49 PM C:\Users\vlam\Documents\Case 1 Workspaces\18706-198-1.wsp		Chemtronics v. FlatFrog Chemtronics Exhibit 1013 Page 532				

EAST Search History (Prior Art)

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EAST Search History (Prior Art)

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EAST Search History (Prior Art)

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EAST Search History (Prior Art)

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EAST Search History (Prior Art)

S41	74	(S38 S39 S40) and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/27 14:07
S42	1	13/695505.app.	US-PGPUB	OR	OFF	2020/03/27 14:16

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S32	193	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (surface fac\$3))	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:20
S33	181	S32 and @ad<"20161207"	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:21
S34	29	S33 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:22

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	Unassigned
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

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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
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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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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

Examiner Signature /VINH T LAM/	Date Considered 01/22/2020
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Chemtronics Exhibit 1013 Page 539

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 1 OF 30	Attorney Docket No.	FFOG.053C4

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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Examiner Signature	/VINH T LAM/	Date Considered	03/28/2020
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Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 540

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 2 OF 30	Attorney Docket No.	FFOG.053C4

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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Examiner Signature /VINH T LAM/	Date Considered 03/28/2020
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Chemtronics Exhibit 1013 Page 543

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	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 5 OF 30	Attorney Docket No.	FFOG.053C4

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
	117	7,199,932	04-03-2007	Sugiura	
	118	7,359,041	04-15-2008	Xie et al.	
	119	7,397,418	07-08-2008	Doerry et al.	
	120	7,432,893	10-07-2008	Ma et al.	
	121	7,435,940	10-14-2008	Eliasson et al.	
	122	7,436,443	10-14-2008	Hirunuma et al.	
	123	7,442,914	10-28-2008	Eliasson et al.	
	124	7,465,914	12-16-2008	Eliasson et al.	
	125	7,613,375	11-03-2009	Shimizu	
	126	7,629,968	12-08-2009	Miller et al.	
	127	7,646,833	01-12-2010	He et al.	
	128	7,653,883	01-26-2010	Hotelling et al.	
	129	7,655,901	02-02-2010	Idzik et al.	
	130	7,705,835	04-27-2010	Eikman	
	131	7,729,056	06-01-2010	Hwang et al.	
	132	7,847,789	12-07-2010	Kolmykov-Zotov et al.	
	133	7,855,716	12-21-2010	McCreary et al.	
	134	7,859,519	12-28-2010	Tulbert	
	135	7,924,272	04-12-2011	Boer et al.	
	136	7,932,899	04-26-2011	Newton et al.	
	137	7,969,410	06-28-2011	Kakarala	
	138	7,995,039	08-09-2011	Eliasson et al.	
	139	8,013,845	09-06-2011	Ostergaard et al.	
	140	8,031,186	10-04-2011	Ostergaard	
	141	8,077,147	12-13-2011	Krah et al.	
	142	8,093,545	01-10-2012	Leong et al.	
	143	8,094,136	01-10-2012	Eliasson et al.	
	144	8,094,910	01-10-2012	Xu	
	145	8,149,211	04-03-2012	Hayakawa et al.	

Examiner Signature /VINH T LAM/	Date Considered 03/28/2020
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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 6 OF 30	Attorney Docket No.	FFOG.053C4

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
	146	8,218,154	07-10-2012	Østergaard et al.	
	147	8,274,495	09-25-2012	Lee	
	148	8,325,158	12-04-2012	Yatsuda et al.	
	149	8,339,379	12-25-2012	Goertz et al.	
	150	8,350,827	01-08-2013	Chung et al.	
	151	8,384,010	02-26-2013	Hong et al.	
	152	8,407,606	03-26-2013	Davidson et al.	
	153	8,441,467	05-14-2013	Han	
	154	8,445,834	05-21-2013	Hong et al.	
	155	8,466,901	06-18-2013	Yen et al.	
	156	8,482,547	07-09-2013	Cobon et al.	
	157	8,542,217	09-24-2013	Wassvik et al.	
	158	8,567,257	10-29-2013	Van Steenberge et al.	
	159	8,581,884	11-12-2013	Fähræus et al.	
	160	8,624,858	01-07-2014	Fyke et al.	
	161	8,686,974	04-01-2014	Christiansson et al.	
	162	8,692,807	04-08-2014	Fähræus et al.	
	163	8,716,614	05-06-2014	Wassvik	
	164	8,727,581	05-20-2014	Saccomanno	
	165	8,745,514	06-03-2014	Davidson	
	166	8,780,066	07-15-2014	Christiansson et al.	
	167	8,830,181	09-09-2014	Clark et al.	
	168	8,860,696	10-14-2014	Wassvik et al.	
	169	8,872,098	10-28-2014	Bergström et al.	
	170	8,872,801	10-28-2014	Bergström et al.	
	171	8,884,900	11-11-2014	Wassvik	
	172	8,890,843	11-18-2014	Wassvik et al.	
	173	8,890,849	11-18-2014	Christiansson et al.	
	174	8,928,590	01-06-2015	El Dokor	

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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
	175	8,963,886	02-24-2015	Wassvik	
	176	8,982,084	03-17-2015	Christiansson et al.	
	177	9,024,916	05-05-2015	Christiansson	
	178	9,035,909	05-19-2015	Christiansson	
	179	9,063,614	06-23-2015	Petterson et al.	
	180	9,063,617	06-23-2015	Eliasson et al.	
	181	9,086,763	07-21-2015	Johansson et al.	
	182	9,134,854	09-15-2015	Wassvik et al.	
	183	9,158,401	10-13-2015	Christiansson	
	184	9,158,415	10-13-2015	Song et al.	
	185	9,201,520	10-03-2013	Benko et al.	
	186	9,213,445	12-15-2015	King et al.	
	187	9,274,645	03-01-2016	Christiansson et al.	
	188	9,280,237	03-08-2016	Kukulj	
	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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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	Blumel 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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	Filing Date	December 6, 2019
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	Art Unit	2628
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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
	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.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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SHEET 10 OF 30	Attorney Docket No.	FFOG.053C4

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.	

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	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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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.	

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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
	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	2009/0000831	01-01-2009	Miller et al.	
	326	2009/0002340	01-01-2009	Van Genechten	
	327	2009/0006292	01-01-2009	Block	
	328	2009/0040786	02-12-2009	Mori	
	329	2009/0066647	03-12-2009	Kerr et al.	
	330	2009/0067178	03-12-2009	Huang et al.	
	331	2009/0073142	03-19-2009	Yamashita et al.	
	332	2009/0077501	03-19-2009	Partridge et al.	
	333	2009/0085894	04-02-2009	Gandhi et al.	
	334	2009/0091554	04-09-2009	Keam	
	335	2009/0115919	05-07-2009	Tanaka et al.	
	336	2009/0122020	05-14-2009	Eliasson et al.	
	337	2009/0122027	05-14-2009	Newton	
	338	2009/0128508	05-21-2009	Sohn et al.	
	339	2009/0135162	05-28-2009	Van De Wijdeven et al.	
	340	2009/0143141	06-04-2009	Wells et al.	
	341	2009/0153519	06-18-2009	Suarez Rovere	
	342	2009/0161026	06-25-2009	Wu et al.	
	343	2009/0168459	07-02-2009	Holman et al.	
	344	2009/0187842	07-23-2009	Collins et al.	
	345	2009/0189857	07-30-2009	Benko et al.	
	346	2009/0189874	07-30-2009	Chene et al.	
	347	2009/0189878	07-30-2009	Goertz et al.	
	348	2009/0219256	09-03-2009	Newton	

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	349	2009/0229892	09-17-2009	Fisher et al.	
	350	2009/0251439	10-08-2009	Westerman et al.	
	351	2009/0256817	10-15-2009	Perlin et al.	
	352	2009/0259967	10-15-2009	Davidson et al.	
	353	2009/0267919	10-29-2009	Chao et al.	
	354	2009/0273794	11-05-2009	Østergaard et al.	
	355	2009/0278816	11-12-2009	Colson	
	356	2009/0297009	12-03-2009	Xu et al.	
	357	2010/0033444	02-11-2010	Kobayashi	
	358	2010/0045629	02-25-2010	Newton	
	359	2010/0060896	03-11-2010	Van De Wijdeven et al.	
	360	2010/0066016	03-18-2010	Van De Wijdeven et al.	
	361	2010/0066704	03-18-2010	Kasai	
	362	2010/0073318	03-25-2010	Hu et al.	
	363	2010/0078545	04-01-2010	Leong et al.	
	364	2010/0079407	04-01-2010	Suggs et al.	
	365	2010/0079408	04-01-2010	Leong et al.	
	366	2010/0097345	04-22-2010	Jang et al.	
	367	2010/0097348	04-22-2010	Park et al.	
	368	2010/0097353	04-22-2010	Newton	
	369	2010/0125438	05-20-2010	Audet	
	370	2010/0127975	05-27-2010	Jensen	
	371	2010/0134435	06-03-2010	Kimura et al.	
	372	2010/0142823	06-10-2010	Wang et al.	
	373	2010/0187422	07-29-2010	Kothari et al.	
	374	2010/0193259	08-05-2010	Wassvik	
	375	2010/0229091	09-09-2010	Homma et al.	
	376	2010/0238139	09-23-2010	Goertz et al.	
	377	2010/0245292	09-30-2010	Wu	

Examiner Signature /VINH T LAM/	Date Considered 03/28/2020
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T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 14 OF 30	Attorney Docket No.	FFOG.053C4

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	2010/0265170	10-21-2010	Norieda	
	379	2010/0277436	11-04-2010	Feng et al.	
	380	2010/0283785	11-11-2010	Satulovsky	
	381	2010/0284596	11-11-2010	Miao et al.	
	382	2010/0289754	11-18-2010	Sleeman et al.	
	383	2010/0295821	11-25-2010	Chang et al.	
	384	2010/0302196	12-02-2010	Han et al.	
	385	2010/0302209	12-02-2010	Large	
	386	2010/0302210	12-02-2010	Han et al.	
	387	2010/0302240	12-02-2010	Lettvin	
	388	2010/0315379	12-16-2010	Allard et al.	
	389	2010/0321328	12-23-2010	Chang et al.	
	390	2010/0322550	12-23-2010	Trott	
	391	2011/0043490	02-24-2011	Powell et al.	
	392	2011/0049388	03-03-2011	Delaney et al.	
	393	2011/0050649	03-03-2011	Newton et al.	
	394	2011/0051394	03-03-2011	Bailey	
	395	2011/0068256	03-24-2011	Hong et al.	
	396	2011/0069039	03-24-2011	Lee et al.	
	397	2011/0069807	03-24-2011	Dennerlein et al.	
	398	2011/0074725	03-31-2011	Westerman et al.	
	399	2011/0074734	03-31-2011	Wassvik et al.	
	400	2011/0074735	03-31-2011	Wassvik et al.	
	401	2011/0084939	04-14-2011	Gepner et al.	
	402	2011/0090176	04-21-2011	Christiansson et al.	
	403	2011/0102374	05-05-2011	Wassvik et al.	
	404	2011/0115748	05-19-2011	Xu	
	405	2011/0121323	05-26-2011	Wu et al.	
	406	2011/0122075	05-26-2011	Seo et al.	

Examiner Signature <u>/VINH T LAM/</u>	Date Considered <u>03/28/2020</u>
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T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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SHEET 15 OF 30	Attorney Docket No.	FFOG.053C4

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	2011/0122091	05-26-2011	King et al.	
	408	2011/0122094	05-26-2011	Tsang et al.	
	409	2011/0134079	06-09-2011	Stark	
	410	2011/0147569	06-23-2011	Drumm	
	411	2011/0157095	06-30-2011	Drumm	
	412	2011/0157096	06-30-2011	Drumm	
	413	2011/0163996	07-07-2011	Wassvik et al.	
	414	2011/0163997	07-07-2011	Kim	
	415	2011/0163998	07-07-2011	Goertz et al.	
	416	2011/0169780	07-14-2011	Goertz et al.	
	417	2011/0175852	07-21-2011	Goertz et al.	
	418	2011/0205186	08-25-2011	Newton et al.	
	419	2011/0216042	09-08-2011	Wassvik et al.	
	420	2011/0221705	09-15-2011	Yi et al.	
	421	2011/0221997	09-15-2011	Kim et al.	
	422	2011/0227036	09-22-2011	Vaufrey	
	423	2011/0227874	09-22-2011	Fähræus et al.	
	424	2011/0234537	09-29-2011	Kim et al.	
	425	2011/0254864	10-20-2011	Tsuchikawa et al.	
	426	2011/0261020	10-27-2011	Song et al.	
	427	2011/0267296	11-03-2011	Noguchi et al.	
	428	2011/0291989	12-01-2011	Lee	
	429	2011/0298743	12-08-2011	Machida et al.	
	430	2011/0309325	12-22-2011	Park et al.	
	431	2011/0310045	12-22-2011	Toda et al.	
	432	2012/0019448	01-26-2012	Pitkanen et al.	
	433	2012/0026408	02-02-2012	Lee et al.	
	434	2012/0038593	02-16-2012	Rönkä et al.	
	435	2012/0062474	03-15-2012	Weishaupt et al.	

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T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 16 OF 30	Attorney Docket No.	FFOG.053C4

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
	436	2012/0068973	03-22-2012	Christiansson et al.	
	437	2012/0086673	04-12-2012	Chien et al.	
	438	2012/0089348	04-12-2012	Perlin et al.	
	439	2012/0110447	05-03-2012	Chen	
	440	2012/0131490	05-24-2012	Lin et al.	
	441	2012/0141001	06-07-2012	Zhang et al.	
	442	2012/0146930	06-14-2012	Lee	
	443	2012/0153134	06-21-2012	Bergström et al.	
	444	2012/0154338	06-21-2012	Bergström et al.	
	445	2012/0162142	06-28-2012	Christiansson et al.	
	446	2012/0162144	06-28-2012	Fåhræus et al.	
	447	2012/0169672	07-05-2012	Christiansson	
	448	2012/0181419	07-19-2012	Momtahan	
	449	2012/0182266	07-19-2012	Han	
	450	2012/0188206	07-26-2012	Sparf et al.	
	451	2012/0191993	07-26-2012	Drader et al.	
	452	2012/0200532	08-09-2012	Powell et al.	
	453	2012/0200538	08-09-2012	Christiansson et al.	
	454	2012/0212441	08-23-2012	Christiansson et al.	
	455	2012/0217882	08-30-2012	Wong et al.	
	456	2012/0218229	08-30-2012	Drumm	
	457	2012/0249478	10-04-2012	Chang et al.	
	458	2012/0256882	10-11-2012	Christiansson et al.	
	459	2012/0268403	10-25-2012	Christiansson	
	460	2012/0268427	10-25-2012	Slobodin	
	461	2012/0274559	11-01-2012	Mathai et al.	
	462	2012/0305755	12-06-2012	Hong et al.	
	463	2012/0313865	12-13-2012	Pearce	
	464	2013/0021300	01-24-2013	Wassvik	

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	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 17 OF 30	Attorney Docket No.	FFOG.053C4

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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
	465	2013/0021302	01-24-2013	Drumm	
	466	2013/0027404	01-31-2013	Sarnoff	
	467	2013/0044073	02-21-2013	Christiansson et al.	
	468	2013/0055080	02-28-2013	Komer et al.	
	469	2013/0076697	03-28-2013	Goertz et al.	
	470	2013/0082980	04-04-2013	Gruhlke et al.	
	471	2013/0106709	05-02-2013	Simmons	
	472	2013/0107569	05-02-2013	Suganuma	
	473	2013/0113715	05-09-2013	Grant et al.	
	474	2013/0120320	05-16-2013	Liu et al.	
	475	2013/0125016	05-16-2013	Pallakoff et al.	
	476	2013/0127790	05-23-2013	Wassvik	
	477	2013/0135258	05-30-2013	King et al.	
	478	2013/0135259	05-30-2013	King et al.	
	479	2013/0141388	06-06-2013	Ludwig et al.	
	480	2013/0141395	06-06-2013	Holmgren et al.	
	481	2013/0154983	06-20-2013	Christiansson et al.	
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	485	2013/0181953	07-18-2013	Hinckley et al.	
	486	2013/0187891	07-25-2013	Eriksson et al.	
	487	2013/0201142	08-08-2013	Suarez Rovere	
	488	2013/0222346	08-29-2013	Chen et al.	
	489	2013/0241887	09-19-2013	Sharma	
	490	2013/0249833	09-26-2013	Christiansson et al.	
	491	2013/0269867	10-17-2013	Trott	
	492	2013/0275082	10-17-2013	Follmer et al.	
	493	2013/0285920	10-31-2013	Colley	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 18 OF 30	Attorney Docket No.	FFOG.053C4

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
	494	2013/0285968	10-31-2013	Christiansson et al.	
	495	2013/0300716	11-14-2013	Craven-Bartle et al.	
	496	2013/0307795	11-21-2013	Suarez Rovere	
	497	2013/0342490	12-26-2013	Wallander et al.	
	498	2014/0002400	01-02-2014	Christiansson et al.	
	499	2014/0028575	01-30-2014	Parivar et al.	
	500	2014/0028604	01-30-2014	Morinaga et al.	
	501	2014/0028629	01-30-2014	Drumm et al.	
	502	2014/0036203	02-06-2014	Guillou et al.	
	503	2014/0055421	02-27-2014	Christiansson et al.	
	504	2014/0063853	03-06-2014	Nichol et al.	
	505	2014/0071653	03-13-2014	Thompson et al.	
	506	2014/0085241	03-27-2014	Christiansson et al.	
	507	2014/0092052	04-03-2014	Grunthaner et al.	
	508	2014/0098032	04-10-2014	Ng et al.	
	509	2014/0098058	04-10-2014	Baharav et al.	
	510	2014/0109219	04-17-2014	Rohrweck et al.	
	511	2014/0125633	05-08-2014	Fähræus et al.	
	512	2014/0139467	05-22-2014	Ghosh et al.	
	513	2014/0160762	06-12-2014	Dudik et al.	
	514	2014/0192023	07-10-2014	Hoffman	
	515	2014/0232669	08-21-2014	Ohlsson et al.	
	516	2014/0237401	08-21-2014	Krus et al.	
	517	2014/0237408	08-21-2014	Ohlsson et al.	
	518	2014/0237422	08-21-2014	Ohlsson et al.	
	519	2014/0253520	09-11-2014	Cueto et al.	
	520	2014/0253831	09-11-2014	Craven-Bartle	
	521	2014/0259029	09-11-2014	Choi et al.	
	522	2014/0267124	09-18-2014	Christiansson et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 19 OF 30	Attorney Docket No.	FFOG.053C4

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	2014/0292701	10-02-2014	Christiansson et al.	
	524	2014/0300572	10-09-2014	Ohlsson et al.	
	525	2014/0320460	10-30-2014	Johansson et al.	
	526	2014/0347325	11-27-2014	Wallander et al.	
	527	2014/0362046	12-11-2014	Yoshida	
	528	2014/0368471	12-18-2014	Christiansson et al.	
	529	2014/0375607	12-25-2014	Christiansson et al.	
	530	2015/0002386	01-01-2015	Mankowski et al.	
	531	2015/0009687	01-08-2015	Lin	
	532	2015/0015497	01-15-2015	Leigh	
	533	2015/0035774	02-05-2015	Christiansson et al.	
	534	2015/0035803	02-05-2015	Wassvik et al.	
	535	2015/0053850	02-26-2015	Uvnäs	
	536	2015/0054759	02-26-2015	Christiansson et al.	
	537	2015/0083891	03-26-2015	Wallander	
	538	2015/0103013	04-16-2015	Huang	
	539	2015/0121691	05-07-2015	Wang, Yun-Jun	
	540	2015/0130769	05-14-2015	Björklund	
	541	2015/0138105	05-21-2015	Christiansson et al.	
	542	2015/0138158	05-21-2015	Wallander et al.	
	543	2015/0138161	05-21-2015	Wassvik	
	544	2015/0205441	07-23-2015	Bergström et al.	
	545	2015/0215450	07-30-2015	Seo et al.	
	546	2015/0242055	08-27-2015	Wallander	
	547	2015/0271481	09-24-2015	Guthrie et al.	
	548	2015/0286698	10-08-2015	Gagnier et al.	
	549	2015/0317036	11-05-2015	Johansson et al.	
	550	2015/0324028	11-12-2015	Wassvik et al.	
	551	2015/0331544	11-19-2015	Bergström et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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SHEET 20 OF 30	Attorney Docket No.	FFOG.053C4

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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
	552	2015/0331545	11-19-2015	Wassvik et al.	
	553	2015/0331546	11-19-2015	Craven-Bartle et al.	
	554	2015/0331547	11-19-2015	Wassvik et al.	
	555	2015/0332655	11-19-2015	Krus et al.	
	556	2015/0346856	12-03-2015	Wassvik	
	557	2015/0346911	12-03-2015	Christiansson	
	558	2015/0363042	12-17-2015	Krus et al.	
	559	2016/0004898	01-07-2016	Holz	
	560	2016/0026337	01-28-2016	Wassvik et al.	
	561	2016/0034099	02-04-2016	Christiansson et al.	
	562	2016/0050746	02-18-2016	Wassvik et al.	
	563	2016/0070415	03-10-2016	Christiansson et al.	
	564	2016/0070416	03-10-2016	Wassvik	
	565	2016/0077616	06-17-2016	Durojaiye et al.	
	566	2016/0117019	04-28-2016	Michiaki	
	567	2016/0124546	05-05-2016	Chen et al.	
	568	2016/0124551	05-05-2016	Christiansson et al.	
	569	2016/0154531	06-02-2016	Wall	
	570	2016/0154532	06-02-2016	Campbell	
	571	2016/0202841	07-14-2016	Christiansson et al.	
	572	2016/0216844	07-28-2016	Bergström	
	573	2016/0224144	08-04-2016	Klinghult et al.	
	574	2016/0299583	10-13-2016	Watanabe	
	575	2016/0299593	10-13-2016	Christiansson et al.	
	576	2016/0328090	11-10-2016	Klinghult	
	577	2016/0328091	11-10-2016	Wassvik et al.	
	578	2016/0334942	11-17-2016	Wassvik	
	579	2016/0342282	11-24-2016	Wassvik	
	580	2016/0357348	12-08-2016	Wallander	

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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
	581	2017/0010688	01-12-2017	Fahraeus et al.	
	582	2017/0090090	03-30-2017	Craven-Bartle et al.	
	583	2017/0102827	04-13-2017	Christiansson et al.	
	584	2017/0115235	04-27-2017	Ohlsson et al.	
	585	2017/0115823	04-27-2017	Huang et al.	
	586	2017/0139541	05-18-2017	Christiansson et al.	
	587	2017/0177163	06-22-2017	Wallander et al.	
	588	2017/0185230	06-29-2017	Wallander et al.	
	589	2017/0293392	10-12-2017	Christiansson et al.	
	590	2017/0344185	11-30-2017	Ohlsson et al.	
	591	2018/0031753	02-01-2018	Craven-Bartle et al.	
	592	2018/0129354	05-10-2018	Christiansson et al.	
	593	2018/0210572	07-26-2018	Wallander et al.	
	594	2018/0225006	08-09-2018	Wall	
	595	2018/0253187	09-06-2018	Christiansson et al.	
	596	2018/0267672	09-20-2018	Wassvik et al.	
	597	2018/0275788	09-27-2018	Christiansson et al.	
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T¹ - Place a check mark in this area when an English language Translation is attached. Chemtronics v. FlatFrog
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 22 OF 30	Attorney Docket No.	FFOG.053C4

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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Examiner Signature /VINH T LAM/	Date Considered 03/28/2020
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 23 OF 30	Attorney Docket No.	FFOG.053C4

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 24 OF 30	Attorney Docket No.	FFOG.053C4

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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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 25 OF 30	Attorney Docket No.	FFOG.053C4

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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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 26 OF 30	Attorney Docket No.	FFOG.053C4

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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Examiner Signature /VINH T LAM/	Date Considered 03/28/2020
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 27 OF 30	Attorney Docket No.	FFOG.053C4

FOREIGN PATENT DOCUMENTS						
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	720	WO 2012/050510 A1	04-19-2012	FLATFROG LABORATORIES AB		
	721	WO 2012/082055 A1	06-21-2012	FLATFROG LABORATORIES AB		
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	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 28 OF 30	Attorney Docket No.	FFOG.053C4

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	740	WO 2014/098744 A1	06-26-2014	FLATFROG LABORATORIES AB		
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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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	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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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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	769	Complaint for Patent Infringement, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019, in 83 pages.	
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	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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SHEET 30 OF 30	Attorney Docket No.	FFOG.053C4

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
	771	Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	772	Summons in a Civil Action to Promethean Ltd., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	

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Chemtronics Exhibit 1013 Page 569

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

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	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
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SHEET 1 OF 30	Attorney Docket No.	FFOG.053C4

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	4,752,655	06-21-1988	Tajiri et al.	
	28	4,772,763	09-20-1988	Garwin et al.	
	29	4,782,328	11-01-1988	Denlinger	

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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	4,812,833	03-14-1989	Shimauchi	
	31	4,837,430	06-06-1989	Hasegawa	
	32	4,868,912	09-19-1989	Doering	
	33	4,891,829	01-02-1990	Deckman et al.	
	34	4,916,712	04-10-1990	Bender	
	35	4,933,544	06-12-1990	Tamaru	
	36	4,949,079	08-14-1990	Loebner	
	37	4,986,662	01-22-1991	Bures	
	38	4,988,983	01-29-1991	Wehrer	
	39	5,065,185	11-12-1991	Powers et al.	
	40	5,073,770	12-17-1991	Lowbner	
	41	5,105,186	04-14-1992	May	
	42	5,159,322	10-27-1992	Loebner	
	43	5,166,668	11-24-1992	Aoyagi	
	44	5,227,622	07-13-1993	Suzuki	
	45	5,248,856	09-28-1993	Mallicoat	
	46	5,254,407	10-19-1993	Sergerie et al.	
	47	5,345,490	09-06-1994	Finnigan et al.	
	48	5,383,022	01-17-1995	Kaser	
	49	5,483,261	01-09-1996	Yasutake	
	50	5,484,966	01-16-1996	Segen	
	51	5,499,098	03-12-1996	Ogawa	
	52	5,502,568	03-26-1996	Ogawa et al.	
	53	5,525,764	06-11-1996	Junkins et al.	
	54	5,526,422	06-11-1996	Keen	
	55	5,539,514	07-23-1996	Shishido et al.	
	56	5,570,181	10-29-1996	Yasuo et al.	
	57	5,572,251	11-05-1996	Ogawa	
	58	5,577,501	11-26-1996	Flohr et al.	

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	59	5,600,105	02-04-1997	Fukuzaki et al.	
	60	5,608,550	03-04-1997	Epstein et al.	
	61	5,672,852	09-30-1997	Fukuzaki et al.	
	62	5,679,930	10-21-1997	Katsurahira	
	63	5,686,942	11-11-1997	Ball	
	64	5,688,933	11-18-1997	Evans et al.	
	65	5,729,249	03-17-1998	Yasutake	
	66	5,736,686	04-07-1998	Perret, Jr. et al.	
	67	5,740,224	04-14-1998	Müller et al.	
	68	5,764,223	06-09-1998	Chang et al.	
	69	5,767,517	06-16-1998	Hawkins	
	70	5,775,792	07-07-1998	Wiese	
	71	5,945,980	08-31-1999	Moissev et al.	
	72	5,945,981	08-31-1999	Paull et al.	
	73	5,959,617	09-28-1999	Bird et al.	
	74	6,061,177	05-09-2000	Fujimoto	
	75	6,067,079	05-23-2000	Shieh	
	76	6,122,394	09-19-2000	Neukermans et al.	
	77	6,141,104	10-31-2000	Schulz et al.	
	78	6,172,667	01-09-2001	Sayag	
	79	6,175,999	01-23-2001	Sloan et al.	
	80	6,227,667	05-08-2001	Halldorsson et al.	
	81	6,229,529	05-08-2001	Yano et al.	
	82	6,333,735	12-25-2001	Anvekar	
	83	6,366,276	04-02-2002	Kunimatsu et al.	
	84	6,380,732	04-30-2002	Gilboa	
	85	6,380,740	04-30-2002	Laub	
	86	6,390,370	05-21-2002	Plesko	
	87	6,429,857	08-06-2002	Masters et al.	

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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
	88	6,452,996	09-17-2002	Hsieh	
	89	6,476,797	11-05-2002	Kurihara et al.	
	90	6,492,633	12-10-2002	Nakazawa et al.	
	91	6,495,832	12-17-2002	Kirby	
	92	6,504,143	01-07-2003	Koops et al.	
	93	6,529,327	03-04-2003	Graindorge	
	94	6,538,644	03-25-2003	Muraoka	
	95	6,587,099	07-01-2003	Takekawa	
	96	6,648,485	11-18-2003	Colgan et al.	
	97	6,660,964	12-09-2003	Benderly	
	98	6,664,498	12-16-2003	Forsman et al.	
	99	6,664,952	12-16-2003	Iwamoto et al.	
	100	6,690,363	02-10-2004	Newton	
	101	6,707,027	03-16-2004	Liess et al.	
	102	6,738,051	05-18-2004	Boyd et al.	
	103	6,748,098	06-08-2004	Rosenfeld	
	104	6,784,948	08-31-2004	Kawashima et al.	
	105	6,799,141	09-28-2004	Stoustrup et al.	
	106	6,806,871	10-19-2004	Yasue	
	107	6,927,384	08-09-2005	Reime et al.	
	108	6,940,286	09-06-2005	Wang et al.	
	109	6,965,836	11-15-2005	Richardson	
	110	6,972,753	12-06-2005	Kimura et al.	
	111	6,985,137	01-10-2006	Kaikuranta	
	112	7,042,444	05-09-2006	Cok	
	113	7,084,859	08-01-2006	Pryor	
	114	7,087,907	08-08-2006	Lalovic et al.	
	115	7,133,031	11-07-2006	Wang et al.	
	116	7,176,904	02-13-2007	Satoh	

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U.S. PATENT DOCUMENTS					
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	117	7,199,932	04-03-2007	Sugiura	
	118	7,359,041	04-15-2008	Xie et al.	
	119	7,397,418	07-08-2008	Doerry et al.	
	120	7,432,893	10-07-2008	Ma et al.	
	121	7,435,940	10-14-2008	Eliasson et al.	
	122	7,436,443	10-14-2008	Hirunuma et al.	
	123	7,442,914	10-28-2008	Eliasson et al.	
	124	7,465,914	12-16-2008	Eliasson et al.	
	125	7,613,375	11-03-2009	Shimizu	
	126	7,629,968	12-08-2009	Miller et al.	
	127	7,646,833	01-12-2010	He et al.	
	128	7,653,883	01-26-2010	Hotelling et al.	
	129	7,655,901	02-02-2010	Idzik et al.	
	130	7,705,835	04-27-2010	Eikman	
	131	7,729,056	06-01-2010	Hwang et al.	
	132	7,847,789	12-07-2010	Kolmykov-Zotov et al.	
	133	7,855,716	12-21-2010	McCreary et al.	
	134	7,859,519	12-28-2010	Tulbert	
	135	7,924,272	04-12-2011	Boer et al.	
	136	7,932,899	04-26-2011	Newton et al.	
	137	7,969,410	06-28-2011	Kakarala	
	138	7,995,039	08-09-2011	Eliasson et al.	
	139	8,013,845	09-06-2011	Ostergaard et al.	
	140	8,031,186	10-04-2011	Ostergaard	
	141	8,077,147	12-13-2011	Krah et al.	
	142	8,093,545	01-10-2012	Leong et al.	
	143	8,094,136	01-10-2012	Eliasson et al.	
	144	8,094,910	01-10-2012	Xu	
	145	8,149,211	04-03-2012	Hayakawa et al.	

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	146	8,218,154	07-10-2012	Østergaard et al.	
	147	8,274,495	09-25-2012	Lee	
	148	8,325,158	12-04-2012	Yatsuda et al.	
	149	8,339,379	12-25-2012	Goertz et al.	
	150	8,350,827	01-08-2013	Chung et al.	
	151	8,384,010	02-26-2013	Hong et al.	
	152	8,407,606	03-26-2013	Davidson et al.	
	153	8,441,467	05-14-2013	Han	
	154	8,445,834	05-21-2013	Hong et al.	
	155	8,466,901	06-18-2013	Yen et al.	
	156	8,482,547	07-09-2013	Cobon et al.	
	157	8,542,217	09-24-2013	Wassvik et al.	
	158	8,567,257	10-29-2013	Van Steenberge et al.	
	159	8,581,884	11-12-2013	Fåhraeus et al.	
	160	8,624,858	01-07-2014	Fyke et al.	
	161	8,686,974	04-01-2014	Christiansson et al.	
	162	8,692,807	04-08-2014	Fåhraeus et al.	
	163	8,716,614	05-06-2014	Wassvik	
	164	8,727,581	05-20-2014	Saccomanno	
	165	8,745,514	06-03-2014	Davidson	
	166	8,780,066	07-15-2014	Christiansson et al.	
	167	8,830,181	09-09-2014	Clark et al.	
	168	8,860,696	10-14-2014	Wassvik et al.	
	169	8,872,098	10-28-2014	Bergström et al.	
	170	8,872,801	10-28-2014	Bergström et al.	
	171	8,884,900	11-11-2014	Wassvik	
	172	8,890,843	11-18-2014	Wassvik et al.	
	173	8,890,849	11-18-2014	Christiansson et al.	
	174	8,928,590	01-06-2015	El Dokor	

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	175	8,963,886	02-24-2015	Wassvik	
	176	8,982,084	03-17-2015	Christiansson et al.	
	177	9,024,916	05-05-2015	Christiansson	
	178	9,035,909	05-19-2015	Christiansson	
	179	9,063,614	06-23-2015	Petterson et al.	
	180	9,063,617	06-23-2015	Eliasson et al.	
	181	9,086,763	07-21-2015	Johansson et al.	
	182	9,134,854	09-15-2015	Wassvik et al.	
	183	9,158,401	10-13-2015	Christiansson	
	184	9,158,415	10-13-2015	Song et al.	
	185	9,201,520	10-03-2013	Benko et al.	
	186	9,213,445	12-15-2015	King et al.	
	187	9,274,645	03-01-2016	Christiansson et al.	
	188	9,280,237	03-08-2016	Kukulj	
	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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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.	

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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	2009/0000831	01-01-2009	Miller et al.	
	326	2009/0002340	01-01-2009	Van Genechten	
	327	2009/0006292	01-01-2009	Block	
	328	2009/0040786	02-12-2009	Mori	
	329	2009/0066647	03-12-2009	Kerr et al.	
	330	2009/0067178	03-12-2009	Huang et al.	
	331	2009/0073142	03-19-2009	Yamashita et al.	
	332	2009/0077501	03-19-2009	Partridge et al.	
	333	2009/0085894	04-02-2009	Gandhi et al.	
	334	2009/0091554	04-09-2009	Keam	
	335	2009/0115919	05-07-2009	Tanaka et al.	
	336	2009/0122020	05-14-2009	Eliasson et al.	
	337	2009/0122027	05-14-2009	Newton	
	338	2009/0128508	05-21-2009	Sohn et al.	
	339	2009/0135162	05-28-2009	Van De Wijdeven et al.	
	340	2009/0143141	06-04-2009	Wells et al.	
	341	2009/0153519	06-18-2009	Suarez Rovere	
	342	2009/0161026	06-25-2009	Wu et al.	
	343	2009/0168459	07-02-2009	Holman et al.	
	344	2009/0187842	07-23-2009	Collins et al.	
	345	2009/0189857	07-30-2009	Benko et al.	
	346	2009/0189874	07-30-2009	Chene et al.	
	347	2009/0189878	07-30-2009	Goertz et al.	
	348	2009/0219256	09-03-2009	Newton	

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	349	2009/0229892	09-17-2009	Fisher et al.	
	350	2009/0251439	10-08-2009	Westerman et al.	
	351	2009/0256817	10-15-2009	Perlin et al.	
	352	2009/0259967	10-15-2009	Davidson et al.	
	353	2009/0267919	10-29-2009	Chao et al.	
	354	2009/0273794	11-05-2009	Østergaard et al.	
	355	2009/0278816	11-12-2009	Colson	
	356	2009/0297009	12-03-2009	Xu et al.	
	357	2010/0033444	02-11-2010	Kobayashi	
	358	2010/0045629	02-25-2010	Newton	
	359	2010/0060896	03-11-2010	Van De Wijdeven et al.	
	360	2010/0066016	03-18-2010	Van De Wijdeven et al.	
	361	2010/0066704	03-18-2010	Kasai	
	362	2010/0073318	03-25-2010	Hu et al.	
	363	2010/0078545	04-01-2010	Leong et al.	
	364	2010/0079407	04-01-2010	Suggs et al.	
	365	2010/0079408	04-01-2010	Leong et al.	
	366	2010/0097345	04-22-2010	Jang et al.	
	367	2010/0097348	04-22-2010	Park et al.	
	368	2010/0097353	04-22-2010	Newton	
	369	2010/0125438	05-20-2010	Audet	
	370	2010/0127975	05-27-2010	Jensen	
	371	2010/0134435	06-03-2010	Kimura et al.	
	372	2010/0142823	06-10-2010	Wang et al.	
	373	2010/0187422	07-29-2010	Kothari et al.	
	374	2010/0193259	08-05-2010	Wassvik	
	375	2010/0229091	09-09-2010	Homma et al.	
	376	2010/0238139	09-23-2010	Goertz et al.	
	377	2010/0245292	09-30-2010	Wu	

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	378	2010/0265170	10-21-2010	Norieda	
	379	2010/0277436	11-04-2010	Feng et al.	
	380	2010/0283785	11-11-2010	Satulovsky	
	381	2010/0284596	11-11-2010	Miao et al.	
	382	2010/0289754	11-18-2010	Sleeman et al.	
	383	2010/0295821	11-25-2010	Chang et al.	
	384	2010/0302196	12-02-2010	Han et al.	
	385	2010/0302209	12-02-2010	Large	
	386	2010/0302210	12-02-2010	Han et al.	
	387	2010/0302240	12-02-2010	Lettvin	
	388	2010/0315379	12-16-2010	Allard et al.	
	389	2010/0321328	12-23-2010	Chang et al.	
	390	2010/0322550	12-23-2010	Trott	
	391	2011/0043490	02-24-2011	Powell et al.	
	392	2011/0049388	03-03-2011	Delaney et al.	
	393	2011/0050649	03-03-2011	Newton et al.	
	394	2011/0051394	03-03-2011	Bailey	
	395	2011/0068256	03-24-2011	Hong et al.	
	396	2011/0069039	03-24-2011	Lee et al.	
	397	2011/0069807	03-24-2011	Dennerlein et al.	
	398	2011/0074725	03-31-2011	Westerman et al.	
	399	2011/0074734	03-31-2011	Wassvik et al.	
	400	2011/0074735	03-31-2011	Wassvik et al.	
	401	2011/0084939	04-14-2011	Gepner et al.	
	402	2011/0090176	04-21-2011	Christiansson et al.	
	403	2011/0102374	05-05-2011	Wassvik et al.	
	404	2011/0115748	05-19-2011	Xu	
	405	2011/0121323	05-26-2011	Wu et al.	
	406	2011/0122075	05-26-2011	Seo et al.	

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	407	2011/0122091	05-26-2011	King et al.	
	408	2011/0122094	05-26-2011	Tsang et al.	
	409	2011/0134079	06-09-2011	Stark	
	410	2011/0147569	06-23-2011	Drumm	
	411	2011/0157095	06-30-2011	Drumm	
	412	2011/0157096	06-30-2011	Drumm	
	413	2011/0163996	07-07-2011	Wassvik et al.	
	414	2011/0163997	07-07-2011	Kim	
	415	2011/0163998	07-07-2011	Goertz et al.	
	416	2011/0169780	07-14-2011	Goertz et al.	
	417	2011/0175852	07-21-2011	Goertz et al.	
	418	2011/0205186	08-25-2011	Newton et al.	
	419	2011/0216042	09-08-2011	Wassvik et al.	
	420	2011/0221705	09-15-2011	Yi et al.	
	421	2011/0221997	09-15-2011	Kim et al.	
	422	2011/0227036	09-22-2011	Vaufrey	
	423	2011/0227874	09-22-2011	Fähræus et al.	
	424	2011/0234537	09-29-2011	Kim et al.	
	425	2011/0254864	10-20-2011	Tsuchikawa et al.	
	426	2011/0261020	10-27-2011	Song et al.	
	427	2011/0267296	11-03-2011	Noguchi et al.	
	428	2011/0291989	12-01-2011	Lee	
	429	2011/0298743	12-08-2011	Machida et al.	
	430	2011/0309325	12-22-2011	Park et al.	
	431	2011/0310045	12-22-2011	Toda et al.	
	432	2012/0019448	01-26-2012	Pitkanen et al.	
	433	2012/0026408	02-02-2012	Lee et al.	
	434	2012/0038593	02-16-2012	Rönkä et al.	
	435	2012/0062474	03-15-2012	Weishaupt et al.	

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	436	2012/0068973	03-22-2012	Christiansson et al.	
	437	2012/0086673	04-12-2012	Chien et al.	
	438	2012/0089348	04-12-2012	Perlin et al.	
	439	2012/0110447	05-03-2012	Chen	
	440	2012/0131490	05-24-2012	Lin et al.	
	441	2012/0141001	06-07-2012	Zhang et al.	
	442	2012/0146930	06-14-2012	Lee	
	443	2012/0153134	06-21-2012	Bergström et al.	
	444	2012/0154338	06-21-2012	Bergström et al.	
	445	2012/0162142	06-28-2012	Christiansson et al.	
	446	2012/0162144	06-28-2012	Fåhræus et al.	
	447	2012/0169672	07-05-2012	Christiansson	
	448	2012/0181419	07-19-2012	Momtahan	
	449	2012/0182266	07-19-2012	Han	
	450	2012/0188206	07-26-2012	Sparf et al.	
	451	2012/0191993	07-26-2012	Drader et al.	
	452	2012/0200532	08-09-2012	Powell et al.	
	453	2012/0200538	08-09-2012	Christiansson et al.	
	454	2012/0212441	08-23-2012	Christiansson et al.	
	455	2012/0217882	08-30-2012	Wong et al.	
	456	2012/0218229	08-30-2012	Drumm	
	457	2012/0249478	10-04-2012	Chang et al.	
	458	2012/0256882	10-11-2012	Christiansson et al.	
	459	2012/0268403	10-25-2012	Christiansson	
	460	2012/0268427	10-25-2012	Slobodin	
	461	2012/0274559	11-01-2012	Mathai et al.	
	462	2012/0305755	12-06-2012	Hong et al.	
	463	2012/0313865	12-13-2012	Pearce	
	464	2013/0021300	01-24-2013	Wassvik	

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	465	2013/0021302	01-24-2013	Drumm	
	466	2013/0027404	01-31-2013	Sarnoff	
	467	2013/0044073	02-21-2013	Christiansson et al.	
	468	2013/0055080	02-28-2013	Komer et al.	
	469	2013/0076697	03-28-2013	Goertz et al.	
	470	2013/0082980	04-04-2013	Gruhlke et al.	
	471	2013/0106709	05-02-2013	Simmons	
	472	2013/0107569	05-02-2013	Suganuma	
	473	2013/0113715	05-09-2013	Grant et al.	
	474	2013/0120320	05-16-2013	Liu et al.	
	475	2013/0125016	05-16-2013	Pallakoff et al.	
	476	2013/0127790	05-23-2013	Wassvik	
	477	2013/0135258	05-30-2013	King et al.	
	478	2013/0135259	05-30-2013	King et al.	
	479	2013/0141388	06-06-2013	Ludwig et al.	
	480	2013/0141395	06-06-2013	Holmgren et al.	
	481	2013/0154983	06-20-2013	Christiansson et al.	
	482	2013/0155027	06-20-2013	Holmgren et al.	
	483	2013/0158504	06-20-2013	Ruchti et al.	
	484	2013/0181896	07-18-2013	Gruhlke et al.	
	485	2013/0181953	07-18-2013	Hinckley et al.	
	486	2013/0187891	07-25-2013	Eriksson et al.	
	487	2013/0201142	08-08-2013	Suarez Rovere	
	488	2013/0222346	08-29-2013	Chen et al.	
	489	2013/0241887	09-19-2013	Sharma	
	490	2013/0249833	09-26-2013	Christiansson et al.	
	491	2013/0269867	10-17-2013	Trott	
	492	2013/0275082	10-17-2013	Follmer et al.	
	493	2013/0285920	10-31-2013	Colley	

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	494	2013/0285968	10-31-2013	Christiansson et al.	
	495	2013/0300716	11-14-2013	Craven-Bartle et al.	
	496	2013/0307795	11-21-2013	Suarez Rovere	
	497	2013/0342490	12-26-2013	Wallander et al.	
	498	2014/0002400	01-02-2014	Christiansson et al.	
	499	2014/0028575	01-30-2014	Parivar et al.	
	500	2014/0028604	01-30-2014	Morinaga et al.	
	501	2014/0028629	01-30-2014	Drumm et al.	
	502	2014/0036203	02-06-2014	Guillou et al.	
	503	2014/0055421	02-27-2014	Christiansson et al.	
	504	2014/0063853	03-06-2014	Nichol et al.	
	505	2014/0071653	03-13-2014	Thompson et al.	
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	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
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(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
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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	2014/0292701	10-02-2014	Christiansson et al.	
	524	2014/0300572	10-09-2014	Ohlsson et al.	
	525	2014/0320460	10-30-2014	Johansson et al.	
	526	2014/0347325	11-27-2014	Wallander et al.	
	527	2014/0362046	12-11-2014	Yoshida	
	528	2014/0368471	12-18-2014	Christiansson et al.	
	529	2014/0375607	12-25-2014	Christiansson et al.	
	530	2015/0002386	01-01-2015	Mankowski et al.	
	531	2015/0009687	01-08-2015	Lin	
	532	2015/0015497	01-15-2015	Leigh	
	533	2015/0035774	02-05-2015	Christiansson et al.	
	534	2015/0035803	02-05-2015	Wassvik et al.	
	535	2015/0053850	02-26-2015	Uvnäs	
	536	2015/0054759	02-26-2015	Christiansson et al.	
	537	2015/0083891	03-26-2015	Wallander	
	538	2015/0103013	04-16-2015	Huang	
	539	2015/0121691	05-07-2015	Wang, Yun-Jun	
	540	2015/0130769	05-14-2015	Björklund	
	541	2015/0138105	05-21-2015	Christiansson et al.	
	542	2015/0138158	05-21-2015	Wallander 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
	552	2015/0331545	11-19-2015	Wassvik et al.	
	553	2015/0331546	11-19-2015	Craven-Bartle et al.	
	554	2015/0331547	11-19-2015	Wassvik et al.	
	555	2015/0332655	11-19-2015	Krus et al.	
	556	2015/0346856	12-03-2015	Wassvik	
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	558	2015/0363042	12-17-2015	Krus 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	2017/0010688	01-12-2017	Fahraeus et al.	
	582	2017/0090090	03-30-2017	Craven-Bartle et al.	
	583	2017/0102827	04-13-2017	Christiansson et al.	
	584	2017/0115235	04-27-2017	Ohlsson et al.	
	585	2017/0115823	04-27-2017	Huang et al.	
	586	2017/0139541	05-18-2017	Christiansson et al.	
	587	2017/0177163	06-22-2017	Wallander et al.	
	588	2017/0185230	06-29-2017	Wallander et al.	
	589	2017/0293392	10-12-2017	Christiansson et al.	
	590	2017/0344185	11-30-2017	Ohlsson et al.	
	591	2018/0031753	02-01-2018	Craven-Bartle et al.	
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(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
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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
	610	AU 2008 280 952 A1	03-19-2009	NEXT HOLDINGS INC		
	611	CN 101019071 B	06-13-2012	QUALCOMM MEMS TECHNOLOGIES INC		
	612	CN 101075168 B	04-02-2014	BEIJING IRTOUCH SYSTEMS CO LTD		
	613	CN 101206550B	06-20-2012	MITSUBISHI ELECTRIC CORP		
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	628	EP 0845812 B1	06-03-1998	CASIO COMPUTER CO 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
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FOREIGN PATENT DOCUMENTS						
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	676	WO 2005/029395 A2	03-31-2005	KONINKL PHILIPS ELECTRONICS NV		
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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
	699	WO 2010/006886 A2	01-21-2010	FLATFROG LABORATORIES AB		
	700	WO 2010/015408 A1	02-11-2010	DRUMM		
	701	WO 2010/046539 A1	04-29-2010	VALTION TEKNILLINEN TUTKIMUSKESKUS		
	702	WO 2010/056177 A1	05-20-2010	FLATFROG LABORATORIES AB		
	703	WO 2010/064983 A2	06-10-2010	FLATFROG LABORATORIES AB		
	704	WO 2010/081702 A2	07-22-2010	CITRON GMBH		
	705	WO 2010/112404 A1	10-07-2010	IBM		
	706	WO 2010/123809 A2	10-28-2010	3M INNOVATIVE PROPERTIES CO		
	707	WO 2010/134865 A1	11-25-2010	FLATFROG LABORATORIES AB		
	708	WO 2011/028169 A1	03-10-2011	FLATFROG LABORATORIES AB		
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	710	WO 2011/049511 A1	04-28-2011	FLATFROG LABORATORIES AB		
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	719	WO 2012/018176 A2	02-09-2012	LG Innotek CO LTD.		
	720	WO 2012/050510 A1	04-19-2012	FLATFROG LABORATORIES AB		
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	723	WO 2012/121652 A1	09-13-2012	FLATFROG LABORATORIES AB		
	724	WO 2012/158105 A2	11-22-2012	FLATFROG LABORATORIES AB		
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	726	WO 2012/176801 A1	12-27-2012	NTT DOCOMO INC		
	727	WO 2013/036192 A1	03-14-2013	FLATFROG LABORATORIES AB		
	728	WO 2013/048312 A2	04-04-2013	FLATFROG LABORATORIES AB		
	729	WO 2013/055282 A2	04-18-2013	FLATFROG LABORATORIES AB		
	730	WO 2013/062471 A2	05-02-2013	FLATFROG LABORATORIES AB		
	731	WO 2013/089622 A2	06-20-2013	FLATFROG LABORATORIES AB		
	732	WO 2013/115710 A2	08-08-2013	FLATFROG LABORATORIES AB		
	733	WO 2013/133756 A1	09-12-2013	FLATFROG LABORATORIES AB		
	734	WO 2013/133757 A2	09-12-2013	FLATFROG LABORATORIES AB		
	735	WO 2013/176613 A2	11-28-2013	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.	

T¹ - Place a check mark in this area when an English language Translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 28 OF 30	Attorney Docket No.	FFOG.053C4

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
	736	WO 2013/176614 A2	11-28-2013	FLATFROG LABORATORIES AB		
	737	WO 2013/176615 A2	11-28-2013	FLATFROG LABORATORIES AB		
	738	WO 2014/055809 A1	04-10-2014	CORNING INC		
	739	WO 2014/086084 A1	06-12-2014	GENERALTOUCH TECHNOLOGY CO LTD		
	740	WO 2014/098744 A1	06-26-2014	FLATFROG LABORATORIES AB		
	741	WO 2014/104967 A1	07-03-2014	FLATFROG LABORATORIES AB		
	742	WO 2015/175586 A1	11-19-2015	MICROSOFT TECHNOLOGY LICENSING LLC		
	743	WO 2018/096430 A1	05-31-2018	FLATFROG LABORATORIES AB		
	744	WO 2018/106172 A1	06-14-2018	FLATFROG LABORATORIES AB		

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
	745	AHN, Y., et al., "A slim and wide multi-touch tabletop interface and its applications," BigComp2014, IEEE, 2014, in 6 pages.	
	746	CHOU, N., et al., "Generalized pseudo-polar Fourier grids and applications in regfersting optical coherence tomography images," 43rd Asilomar Conference on Signals, Systems and Computers, Nov. 2009, in 5 pages.	
	747	FIHN, M., "Touch Panel - Special Edition," Veritas et Visus, Nov. 2011, in 1 page.	
	748	FOURMONT, K., "Non-Equispaced Fast Fourier Transforms with Applications to Tomography," Journal of Fourier Analysis and Applications, Vol. 9, Issue 5, 2003, in 20 pages.	
	749	IIZUKA, K., "Boundaries, Near-Field Optics, and Near-Field Imaging," Elements of Photonics, Vol. 1: In Free Space and Special Media, Wiley & Sons, 2002, in 57 pages.	
	750	International Search Report for International App. No. PCT/SE2017/050102, dated April 5, 2017, in 4 pages.	
	751	JOHNSON, M., "Enhanced Optical Touch Input Panel", IBM Technical Disclosure Bulletin, 1985, in 3 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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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 29 OF 30	Attorney Docket No.	FFOG.053C4

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
	752	KAK, et al., "Principles of Computerized Tomographic Imaging", Institute of Electrical Engineers, Inc., 1999, in 333 pages.	
	753	The Laser Wall, MIT, 1997, http://web.media.mit.edu/~joep/SpectrumWeb/captions/Laser.html .	
	754	LIU, J., et al. "Multiple touch points identifying method, involves starting touch screen, driving specific emission tube, and computing and transmitting coordinate of touch points to computer system by direct lines through interface of touch screen," 2007, in 25 pages.	
	755	NATTERER, F., "The Mathematics of Computerized Tomography", Society for Industrial and Applied Mathematics, 2001, in 240 pages.	
	756	NATTERER, F., et al. "Fourier Reconstruction," Mathematical Methods in Image Reconstruction, Society for Industrial and Applied Mathematics, 2001, in 12 pages.	
	757	PARADISO, J.A., "Several Sensor Approaches that Retrofit Large Surfaces for Interactivity," ACM Ubicomp 2002 Workshop on Collaboration with Interactive Walls and Tables, 2002, in 8 pages.	
	758	TEDALDI, M., et al. "Refractive index mapping of layered samples using optical coherence refractometry," Proceedings of SPIE, Vol. 7171, 2009, in 8 pages.	
	759	Supplementary European Search Report for European App. No. EP 16759213, dated October 4, 2018, in 9 pages.	
	760	Extended European Search Report for European App. No. 16743795.3, dated September 11, 2018, in 5 pages.	
	761	International Search Report for International App. No. PCT/SE2017/051224, dated February 23, 2018, in 5 pages.	
	762	International Search Report for International App. No. PCT/IB2017/057201, dated March 6, 2018, in 4 pages.	
	763	Extended European Search Report in European Application Number 19165019.1, dated July 18, 2019 in 8 pages.	
	764	International Preliminary Report on Patentability received in International Application No. PCT/SE2017/051233, dated June 11, 2019, in 6 pages.	
	765	International Search Report for International App. No. PCT/SE2018/050070, dated April 25, 2018, in 4 pages.	
	766	Extended European Search Report in European Application number 17750516.1, dated July 16, 2019 in 5 pages.	
	767	Report on the Filing or Determination of an Action Regarding a Patent or Trademark. For U.S. Patent No. 10,282,035, U.S. District of Delaware, dated December 10, 2019, in 1 page.	
	768	Civil Cover Sheet FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., dated December 10, 2019, in 1 page.	
	769	Complaint for Patent Infringement, FLATFROG LABORATORIES AB v. PROMETHEAN LTD. and PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019, in 83 pages.	
	770	Executed Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	

Examiner Signature	Date Considered
<p>*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.</p>	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	2628
(Multiple sheets used when necessary)	Examiner	Lam, Vinh Tang
SHEET 30 OF 30	Attorney Docket No.	FFOG.053C4

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
	771	Summons in a Civil Action to PROMETHEAN INC., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	
	772	Summons in a Civil Action to Promethean Ltd., C.A. No. 19-2246, dated December 10, 2019 in 2 pages.	

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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.	

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor : Aleksander Kocovski
App. No. : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Lam, Vinh Tang
Art Unit : 2628
Conf. No. : 3081

RESPONSE TO OFFICE ACTION DATED JANUARY 28, 2020**Mail Stop Amendment**

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

Dear Commissioner:

In response to the Office Action mailed January 28, 2020, the Applicant respectfully requests the above-identified application be amended as follows:

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. (Currently Amended) 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;

a second edge perpendicular to the first edge; and

a flat plane defined by the first edge and the second edge; and

wherein the touch surface includes a center 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 curvature in the touch surface such that the center point moves further away from the flat plane.

2. (CANCELLED)

3. (CANCELLED)

4. (Currently Amended) The method of Claim ~~[[3]]~~ 1, wherein the touch surface is concave ~~further comprising 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.~~

5. (Original) The method of claim 1, wherein the curvature is parabolic concave.

6. (Original) 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.

7. (Currently Amended) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are ~~measured~~ defined along an edge of the plate.

8. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

9. (Original) The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

10. (Currently Amended) 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 having a center point;
a flat plane defined by a first edge of the touch surface and a second edge of the touch surface perpendicular to the first edge;
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 in the touch surface greater than the first curvature when the plate is installed in the frame assembly;

wherein the frame assembly is arranged to induce the second curvature such that the center point of the touch surface causes the center point to move further away from the flat plane, and

wherein the first curvature is concave.

~~wherein the touch surface is parabolic concave.~~

11. (Currently Amended) The touch sensing apparatus of claim 10, wherein the touch surface is parabolic concave ~~the set of emitters is configured to emit light to propagate over the touch surface.~~

12. (CANCELLED)

13. (Original) The touch sensing apparatus of claim 10, 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.

14. (CANCELLED)

15. (Currently Amended) The touch sensing apparatus of claim ~~[[14]]~~ 10, wherein the first curvature and second curvature are measured along an edge of the plate.

16. (Currently Amended) The touch sensing apparatus of claim ~~[[14]]~~ 10, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

17. (Currently Amended) The touch sensing apparatus of claim ~~[[14]]~~ 10, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

18. (Original) The touch sensing apparatus of claim 10, further comprising a gasket, wherein the plate is supported by the gasket proximate to an edge of the plate.

19. (Original) The apparatus of claim 18, wherein the gasket is configured to have varying thickness to match a curvature of the plate along the edge.

20. (Original) The apparatus of claim 10, wherein the second frame element is curved.

SUMMARY OF INTERVIEW

Applicant's representative, Harnik Shukla, conducted a telephonic interview with Examiner Vinh T. Lam on March 4, 2020. The Applicant's representative proposed amendments to Claims 1 and 10 and discussed the claims in view of cited art, Kukulj. The Examiner indicated that the proposed amendments overcome the cited art and are likely allowable, but further search is warranted.

REMARKS

By way of summary, Claims 1 - 20 were pending in this application. In the present amendment, Applicant has canceled claims 2 – 3, 12, and 14 without prejudice or disclaimer, and amended the claims without prejudice or disclaimer to previously pending versions thereof as shown above. Accordingly, Claims 1, 4 -11, 13, and 15-20 remain pending.

Claim Objections

Applicant has amended the claims as requested by the Examiner to resolve minor informalities. Applicant respectfully requests reconsideration of the objections.

Rejections of Claims Under 35 U.S.C. § 102

The Office Action rejected independent Claims 1 and 10 under 35 U.S.C. § 102 as being anticipated by US 20120223916 to Kukulj ("Kukulj"). The Office Action rejected the dependent claims based at least on the above cited references. Applicant respectfully traverses these rejections, the characterizations of the pending claims and the cited references and each and every implicit and explicit potential for reliance on Official Notice. Solely, in the interest of expediting prosecution, Applicant has amended the independent claims as shown above. The dependent claims are addressed in the "Dependent Claims" section below.

Independent Claim 1

As indicated by the Examiner, the proposed amendments to Claim 1 during the Interview overcome the cited art. Applicant has amended Claim 1 according to the proposed amendments. Thus, at least based on the discussions during the Interview, Applicant respectfully submits that amended Claim 1 is not anticipated by Kukulj. In contrast to amended Claim 1, Kukulj is directed to using "parabolic reflectors." *Kukulj*, [0009]. Thus, Applicant respectfully requests withdrawal of the rejection and reconsideration of amended Claim 1.

Independent Claim 10

As indicated by the Examiner, the proposed amendments to Claim 10 during the Interview overcome the cited art. Applicant has amended Claim 10 very closely to the proposed amendments. Thus, at least based on the discussions during the Interview, Applicant respectfully submits that amended Claim 10 is not anticipated by Kukulj. In contrast to amended Claim 10, Kukulj is directed to using “parabolic reflectors.” Kukulj, [0009]. Thus, Applicant respectfully requests withdrawal of the rejection and reconsideration of amended Claim 10.

Dependent Claims

The dependent claims are patentable for the same reasons articulated above with respect to their independent claims. The dependent claims are also patentable because of the additional features recited therein.

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. Further, Applicant’s arguments in favor of one independent claim should not be imputed to any other independent claim.

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.

Application No.: 16/706438
Filing Date: December 6, 2019

Docket No.	Serial No.	Title	Filed
FFOG.053C2	16/191,050	TOUCH DEVICE	November 14, 2018
FFOG.053C3	16/403,283	TOUCH DEVICE	May 3, 2019

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: March 17, 2020

By:/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 721-5278

32410796

Electronic Patent Application Fee Transmittal

Application Number:	16706438			
Filing Date:	06-Dec-2019			
Title of Invention:	TOUCH DEVICE			
First Named Inventor/Applicant Name:	Aleksander Kocovski			
Filer:	Harnik Shukla/Jenny Kim			
Attorney Docket Number:	FFOG.053C4			
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	240	240
Total in USD (\$)				240

Electronic Acknowledgement Receipt

EFS ID:	38887269
Application Number:	16706438
International Application Number:	
Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Chelsea Veinot
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
Receipt Date:	17-MAR-2020
Filing Date:	06-DEC-2019
Time Stamp:	14:48:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$240
RAM confirmation Number	E20203GE48297949
Deposit Account	111410
Authorized User	Chelsea Veinot

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)

Chemtronics v. FlatFrog

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	FFOG053C4_Rpt_on_Filing_Pat_10282035_12-10-2019.pdf	449958	no	1
			c509b1714667a4ee63962c7e952dddab86e29410		
Warnings:					
Information:					
2	Non Patent Literature	FFOG053C4_Civil_Cover_Sheet_12-10-2019.pdf	896949	no	1
			773f4e80c82a3acd50457340569800fb342d485b		
Warnings:					
Information:					
3	Non Patent Literature	FFOG053C4_Complaint_Patent_Infringement_12-10-2019.pdf	8421510	no	83
			a0c527c04d82abffb1ba621897ceb3798db89309		
Warnings:					
Information:					
4	Non Patent Literature	FFOG053C4_Executed_Summons_Civil_Action_12-10-2019.pdf	196209	no	2
			7f4e1552c59e247fb6dd3dadfc0a4e16cbc0f863		
Warnings:					
Information:					
5	Non Patent Literature	FFOG053C4_Summons_Civil_Action_Promethean_Inc_12-10-2019.pdf	455675	no	2
			41c8359fcffe458b47baf286c8aab5834214dc48		
Warnings:					
Information:					
6	Non Patent Literature	FFOG053C4_Summons_Civil_Action_Promethean_Ltd_12-10-2019.pdf	448784	no	2
			49b0b8722386174655adb944f1b4f5e1fcd59fa7		
Warnings:					
Information:					

7		FFOG053C4_IDS_rev.pdf	258548	yes	32
			b02b48c97a79a96795702ab50e8774299ea78c73		
	Multipart Description/PDF files in .zip description				
	Document Description	Start	End		
	Transmittal Letter	1	2		
	Information Disclosure Statement (IDS) Form (SB08)	3	32		
Warnings:					
Information:					
8		FFOG053C4_OAR_rev.pdf	47062	yes	9
			d4941d748ebb4ebd3a8dbd7957a10c8563cecba4		
	Multipart Description/PDF files in .zip description				
	Document Description	Start	End		
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1		
	Claims	2	5		
	Applicant summary of interview with examiner	6	6		
	Applicant Arguments/Remarks Made in an Amendment	7	9		
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	30614	no	2
			fd860f228010cdd206f7a7d88b8b2a91c9934b55		
Warnings:					
Information:					
Total Files Size (in bytes):			11205309		

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

First Inventor	: Aleksander Kocovski
App. No.	: 16/706438
Filed	: December 6, 2019
For	: TOUCH DEVICE
Examiner	: Lam, Vinh Tang
Art Unit	: 2628
Conf. No.	: 3081

Mail Stop Amendment

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 1-766 are of record in U.S. patent application No. 16/403,283, filed May 3, 2019, which is relied upon for an earlier filing date under 35 USC 120. Accordingly, copies of references numbered 1-766 are not submitted pursuant to 37 CFR 1.98(d).

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.

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

Dated: March 17, 2020

By: /Harnik Shukla/ _____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404

32459441

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 16/706,438		Filing Date 12/06/2019		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
		(Column 1)	(Column 2)						
FOR		NUMBER FILED	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), (l), 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	03/17/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	x \$100 =		0	
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0	x \$460 =		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.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	03/10/2020		
KNOBBE MARTENS OLSON & BEAR LLP			EXAMINER	
2040 MAIN STREET			LAM, VINH TANG	
FOURTEENTH FLOOR				
IRVINE, CA 92614				
			ART UNIT	PAPER NUMBER
			2628	
			NOTIFICATION DATE	DELIVERY MODE
			03/10/2020	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

<i>Applicant-Initiated Interview Summary</i>	Application No. 16/706,438	Applicant(s) Kocovski et al.		
	Examiner VINH T LAM	Art Unit 2628	AIA (First Inventor to File) Status Yes	Page 1 of 2

All participants (applicant, applicants representative, PTO personnel):

1. VINH T LAM (Examiner); Telephonic
2. Hamik Shukla (Attorney of Record); Telephonic

Date of Interview: 04 March 2020

Claims Discussed: 1 and 10

Prior Art Discussed: Kukulj (US Patent/PGPub. No. 20120223916)

Amendment proposed: Claim 1 amended

"a first edge;
a second edge perpendicular to the first edge; and
a flat plane defined by the first edge and the second edge; and
wherein the touch surface includes a center point ...
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 ..."

Claim 10 amended

"touch surface having a center point;
a flat plane defined by a first edge of the touch surface and a second edge of the touch surface perpendicular to the first edge ...
wherein the frame assembly is arranged to induce a curvature in the touch surface such that the center point of the touch surface causes the center point to move further away from the flat plane, and
wherein the plate has a first curvature when not installed in the frame assembly, and wherein the plate has a second curvature greater than the first curvature when the plate is installed in the frame assembly."

Brief Description of the main topic(s) of discussion: Amended Claims.

Issues Discussed:

Item(s) under 35 U.S.C. 102:

As shown above.

/VINH T LAM/ Primary Examiner, Art Unit 2628	
<p>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</p> <p>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</p>	

U.S. Patent and Trademark Office
PTOL-413/413b (Rev. 01/01/2015)

Interview Summary

Paper No. 20200305

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the 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.



UNITED STATES PATENT AND TRADEMARK OFFICE

USPTO Automated Interview Request (AIR)

Feb 20 2020

This paper requesting to schedule and/or conduct an interview is appropriate because:

This submission is requested to be accepted as an authorization for this interview to communicate via the internet. Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned concerning scheduling of the interview via video conference, instant messaging, or electronic mail, and to conduct the interview in accordance with office practice including video conferencing.

Name(s) :

Harnik Shukla

S-signature:

/Harnik Shukla/

Registration Number:

73097

U.S. Application Number:

16706438

Confirmation Number:

3081

E-mail Address:

2hzs@knobbe.com

Phone Number:

+1 949-721-5278

Proposed Time of Interview:

2-28-2020 1:00 PM ET

Preferred Interview Type:

Telephonic

I am the applicant or applicant's representative for this application.

Topic for Discussion:



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	01/28/2020		
KNOBBE MARTENS OLSON & BEAR LLP			EXAMINER	
2040 MAIN STREET			LAM, VINH TANG	
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IRVINE, CA 92614				
			ART UNIT	PAPER NUMBER
			2628	
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			01/28/2020	ELECTRONIC

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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

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.

Priority

2. Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119 (a)-(d). The certified copy has been filed in parent Application No. **SE 16302945**, filed on **07 Dec 2016**.

Claim Objections

3. Claim **4** is objected to because of the following informalities: Typo error.

*"the **set** of emitters" should be "the plurality of emitters".*

4. Claim **2** is objected to because of the following informalities: Typo error.

*"**the** inducement" should be "an inducement"*

5. Claim **10** is objected to because of the following informalities: Typo error.

“frame assembly comprising:” should be *“frame assembly comprising:”* (i.e. **colon** not semi-colon).

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

6. Claim(s) **1, 3-5, 10-13, and 18-19** is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by **Kukulj (US Patent/PGPub. No. 20120223916)**.

Regarding Claim **1**, Kukulj teaches **a method for assembling** ([0009], FIG. 1-3, i.e. as **shown by the figure(s)**) **a touch sensing apparatus** ([0007], FIG. 3, i.e. **touch screen 31**), **the touch sensing apparatus** (i.e. please see above citation(s)) **comprising a display panel** ([0004], FIG. 3, i.e. **display screen**), **a plate** ([0006], FIG. 2, i.e. (VCLs) 30; [0007], FIG. 2, **light guide plate 34**) **including a touch surface** ([0007], FIG. 3, i.e. **surface** of touch

screen 31), **and a frame assembly** ([0009], FIG. 3, i.e. *waveguide substrate 24*), **comprising:**

configuring the frame assembly (i.e. *please see above citation(s)*)
to support ([0009], FIG. 1-3, i.e. *as shown by the figure(s)*) **the display panel** (i.e. *please see above citation(s)*); **and**

configuring the frame assembly (i.e. *please see above citation(s)*)
to support the plate (i.e. *please see above citation(s)*);

wherein configuring the frame assembly (i.e. *please see above citation(s)*) **to support the plate** (i.e. *please see above citation(s)*) **includes inducing a curvature** ([0009], FIG. 3, i.e. *parabolic reflectors 38*) **in the touch surface** (i.e. *please see above citation(s)*).

Regarding Claim **3**, Kukulj teaches **the method of claim 1**,
further comprising arranging a plurality of emitters ([0006], FIG. 2, i.e. *transmit optical waveguide includes an in-plane lens 28*) **adjacent to a periphery** ([0006], FIG. 2, i.e. *top horizontal periphery*) **of the plate** ([0006], FIG. 2, i.e. *top horizontal periphery*), **said plurality of emitters** (i.e. *please see above citation(s)*) **configured to emit light to propagate over**

([0006], FIG. 2, i.e. transmit optical) **the touch surface** *(i.e. please see above citation(s)).*

Regarding Claim **4**, Kukulj teaches **the method of claim 3, further comprising arranging a plurality of detectors** *([0006], FIG. 2, i.e. receive optical waveguide includes an in-plane lens 29)* **arranged adjacent to** *(FIG. 2, i.e. as shown by the figure(s))* **the periphery of the plate** *(i.e. please see above citation(s))*, **said plurality of detectors** *(i.e. please see above citation(s))* **configured to receive light** *([0006], FIG. 2, i.e. receive optical)* **from the set of emitters** *(i.e. please see above citation(s)).*

Regarding Claim **5**, Kukulj teaches **the method of claim 1, wherein the curvature** *(i.e. please see above citation(s))* **is parabolic concave** *([0009], FIG. 3, i.e. parabolic).*

Regarding Claim **10**, Kukulj teaches **a touch sensing apparatus** *([0007], FIG. 3, i.e. touch screen 31)* **comprising:**

- a display panel** *([0004], FIG. 3, i.e. display screen);*
- a plate** *([0006], FIG. 2, i.e. (VCLs) 30; [0007], FIG. 2, light guide plate 34)*

having a width *([0006], FIG. 2, i.e. horizontal width of (VCLs) 30; [0007], FIG. 2, horizontal width of light guide plate 34), a length* *([0006], FIG. 2, i.e. vertical*

length of (VCLs) 30; [0007], FIG. 2, vertical length of light guide plate 34) and a
periphery ([0006], FIG. 2, i.e. periphery of (VCLs) 30; [0007], FIG. 2, periphery of
light guide plate 34), the plate (i.e. please see above citation(s)) further
including a touch surface ([0007], FIG. 3, i.e. surface of touch screen 31);
one or more emitters ([0006], FIG. 2, i.e. transmit optical waveguide
includes an in-plane lens 28) arranged adjacent to (FIG. 2-3, i.e. as shown
by the figure(s)) the periphery of the plate (i.e. please see above citation(s))
and configured to emit light ([0006], FIG. 2, i.e. transmit optical) across
the touch surface of the plate (i.e. please see above citation(s));
a set of detectors ([0006], FIG. 2, i.e. receive optical waveguide
includes an in-plane lens 29) arranged adjacent to the periphery of
the plate (i.e. please see above citation(s)) and configured to receive
light ([0006], FIG. 2, i.e. receive optical) from the set of emitters (i.e.
please see above citation(s)), and
a frame assembly ([0009], FIG. 3, i.e. waveguide substrate 24), the
frame assembly (i.e. please see above citation(s)) comprising;

a first frame element ([0009], FIG. 3, i.e. **horizontal portion** of waveguide substrate 24) **configured to support** (FIG. 2-3, i.e. as **shown** by the **figure(s)**) **the display panel** (i.e. please see above citation(s)); and

a second frame element ([0009], FIG. 3, i.e. **vertical portion** of waveguide substrate 24 (receive optical waveguides 22)) **arranged around at least a portion** ([0009], FIG. 3, i.e. **left portion** of waveguide substrate 24) **of the periphery of the plate** (i.e. please see above citation(s)), **the second frame element** (i.e. please see above citation(s)) **having a first portion** ([0009], FIG. 3, i.e. **right portion** of receive optical waveguides 22) **extending along** (FIG. 3, i.e. as **shown** by the **figure(s)**) **an edge** ([0009], FIG. 3, i.e. **left edge** of light guide plate 34) **of the plate** (i.e. please see above citation(s)) **and a second portion** ([0009], FIG. 3, i.e. **top portion** of receive optical waveguides 22) **opposed to** (FIG. 3, i.e. as **shown** by the **figure(s)**) **the touch surface** (i.e. please see above citation(s));

wherein the touch surface (i.e. please see above citation(s)) **is parabolic concave** ([0007], FIG. 3, i.e. **parabolic** reflectors 38).

Regarding Claim **11**, Kukulj teaches **the touch sensing apparatus of claim 10**, wherein **the set of emitters** (i.e. please see

above citation(s)) **is configured to emit light** ([0006], FIG. 2, *i.e. transmit optical*) **to propagate over the touch surface** (*i.e. please see above citation(s)*).

Regarding Claim **12**, Kukulj teaches **the touch sensing apparatus of claim 10, wherein the set of emitters is configured to emit light through the plate** (*i.e. please see above citation(s)*) **by total internal reflection** ([0006], FIG. 2, *i.e. collimate or focus in-plane transmit and receive*).

Regarding Claim **13**, Kukulj teaches **the touch sensing apparatus of claim 10, further comprising a processing element** ([0101], FIG. 5A & 5B, *i.e. controller 60*) **configured to determine, based on output signals** ([0103], FIG. 6, *i.e. intensity*) **of the set of detectors** (*i.e. please see above citation(s)*), **a position of an object** ([0103], FIG. 6, *i.e. touch object*) **proximate to the touch surface** (*i.e. please see above citation(s)*).

Regarding Claim **18**, Kukulj teaches **the touch sensing apparatus of claim 10, further comprising a gasket** ([0009], FIG. 3, *i.e. bezels*), **wherein the plate is supported by** ([0009], FIG. 3, *i.e.*

bezels would be used to **support** display) **the gasket proximate to an edge** ([0009], FIG. 3, i.e. *bezels* would be positioned around edges of display) **of the plate** (i.e. please see above citation(s)).

Regarding Claim **19**, Kukulj teaches **the apparatus of claim 18, wherein the gasket** (i.e. please see above citation(s)) **is configured to have varying thickness to match** ([0009], FIG. 3, i.e. *`bezel width`* on all four sides **limits the available display size**) **a curvature** ([0009], FIG. 3, i.e. *parabolic reflectors 38*; please note that touch display area **34 proportional to curvature 38 as shown by the figure**) **of the plate along the edge** (i.e. please see above citation(s)).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claim(s) **2, 6-9, 14-17, and 20** is/are rejected under 35 U.S.C. 103 as being unpatentable over **Kukulj (US Patent/PGPub. No. 20120223916)** in view of **RYU et al. (US Patent/PGPub. No. 20160295711)**.

Regarding Claim **2**, **Kukulj** teaches **the method of claim 1, wherein the frame assembly** *(i.e. please see above citation(s))* **includes:**

a first edge *([0007], FIG. 3, i.e. horizontal edge of light guide plate 34);*

a second edge *([0007], FIG. 3, i.e. vertical edge of light guide plate 34)*

perpendicular to *(FIG. 3, i.e. as shown by the figure(s))* **the first edge** *(i.e. please see above citation(s)); and,*

a plane *([0007], FIG. 3, i.e. plane including vertical and horizontal edges of light guide plate 34)* **defined by the first edge and the second edge** *(i.e. please see above citation(s));*

wherein the touch surface *(i.e. please see above citation(s))* **includes a center point** *([0007], FIG. 3, i.e. center point of touch screen 31).*

However, **Kukulj** does not explicitly teach the inducement of the curvature in the touch surface causes the center point to move further away from the plane.

In the same field of endeavor, **RYU et al.** teach

the inducement of the curvature ([0061], FIG. 4(b), i.e. *curvature* of display unit 20 as **shown by the figure(s)** in the touch surface ([0303], FIG. 4(b) & 67, i.e. *touch sensor*) **causes the center point** ([0072], FIG. 4(b), i.e. *arrow point of curvature R1*) **to move further away** (FIG. 4(b), i.e. as **shown by the figure(s)**) **from the plane** ([0072], FIG. 4(b), i.e. *plane include right and left edges perpendicular to plane of figure as shown by the figure*).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to modify **Kukulj** teaching method of assembling touch sensing apparatus comprising flat touch screen display with **RYU et al.** teaching of method of assembling touch sensing apparatus comprising curve touch screen display to effectively enhance user's viewing experience by providing both flat and curve surfaces (RYU et al.'s [0005]).

Regarding Claims **6** and **14**, **Kukulj** teaches **the [method of claim 1 (Claim 6)] [touch sensing apparatus of claim 10 (Claim 14)]**.

However, **Kukulj** does not explicitly teach 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 (Claim 6)] [when (Claim 14)] the plate is [configured (Claim 6)] [installed (Claim 14)] in the frame assembly.

In the same field of endeavor, **RYU et al.** teach

the plate ([0072], FIG. 4(a) & 4(b), i.e. **plate** of display unit 20) **has a first curvature** ([0071], FIG. 4(a), i.e. **flat**; please note that **flat** is a **curve** having **infinite radius**) **when not configured in the frame assembly** ([0072], FIG. 4(a), i.e. links 50 **not** pushed up in **z-axis** direction), **and wherein the plate** (i.e. please see above citation(s)) **has a second curvature** ([0072], FIG. 4(b), i.e. **curvature** in the **second state**) **greater than** ([0061], FIG. 4(b), i.e. **curve** more than **flat**) **the first curvature [after** (Claim 6) **] [when** (Claim 14) **] the plate is [configured** (Claim 6) **] [installed** (Claim 14) **] in the frame assembly** (i.e. please see above citation(s)).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to modify **Kukulj** teaching method/apparatus of assembling touch sensing apparatus comprising flat touch screen display with **RYU et al.** teaching of method/apparatus of assembling touch sensing apparatus comprising curve touch screen display *to effectively enhance user's viewing experience by providing both flat and curve surfaces (RYU et al.'s [0005])*.

Regarding Claims **7** and **15**, **the touch sensing apparatus of claim [6** (Claim 7) **] [14** (Claim 15) **], wherein**

RYU et al. teach **the first curvature and second curvature** (i.e. please see above citation(s)) **are measured along an edge** ([0072], FIG.

4(a) & 4(b), i.e. edge of display unit 20 in x-axis direction) of the plate (i.e. please see above citation(s)).

Regarding Claims **8** and **16**, the touch sensing apparatus
of claim **[6 (Claim 8)] [14 (Claim 16)]**, wherein

RYU et al. teach the first curvature and second curvature (i.e. please see above citation(s)) **are measured along an axis** ([0072], FIG. **4(a) & 4(b), i.e. z-axis direction) passing through a center point** ([0072], FIG. **4(a) & 4(b), i.e. point where R1, R2, and R3 meet) of the plate** (i.e. please see above citation(s)).

Regarding Claims **9** and **17**, the touch sensing apparatus
of claim **[6 (Claim 9)] [14 (Claim 17)]**, wherein

RYU et al. teach the first curvature and second curvature (i.e. please see above citation(s)) **are measured along a line** ([0072], FIG. **4(a) & 4(b), i.e. line parallel to x-axis on display unit 20) passing through a point** ([0072], FIG. **4(a) & 4(b), i.e. point on display unit 20) on the touch surface** (i.e. please see above citation(s)).

Regarding Claim **20**, Kukulj teaches **the apparatus of claim**
10.

However, **Kukulj** does not explicitly teach the second frame element is curved.

In the same field of endeavor, **RYU et al.** teach

the second frame element ([0072], FIG. 4(b), i.e. *sides of the display unit 20 in the z-axis direction*) **is curved** ([0072], FIG. 4(b), i.e. *curvature*).

It would have been obvious to a person having ordinary skill in the art at the time the invention's effective date was filed to modify **Kukulj** teaching apparatus of assembling touch sensing apparatus comprising flat touch screen display with **RYU et al.** teaching of apparatus of assembling touch sensing apparatus comprising curve touch screen display *to effectively enhance user's viewing experience by providing both flat and curve surfaces (RYU et al.'s [0005])*.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to VINH TANG LAM whose telephone number is (571) 270-3704. The examiner can normally be reached on Monday to Friday 8:00 AM to 5:00 PM.

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, Nitin K Patel can be reached on (571) 272-7677. 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.

/VINH T LAM/
Primary Examiner, Art Unit 2628

<i>Notice of References Cited</i>	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.	
	Examiner VINH T LAM	Art Unit 2628	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20150331546-A1	11-2015	CRAVEN-BARTLE; Thomas	G02B5/00	345/175
*	B	US-9063614-B2	06-2015	Pettersson; Robert	G06F3/0416	1/1
*	C	US-20120089348-A1	04-2012	Perlin; Kenneth	G06F3/044	702/41
*	D	US-20120223916-A1	09-2012	Kukulj; Dax	G06F3/0421	345/175
*	E	US-20160295711-A1	10-2016	RYU; Hyunjong	G09F9/301	1/1
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

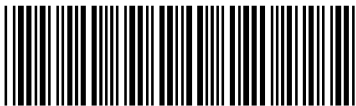
FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes 	Application/Control No. 16/706,438	Applicant(s)/Patent Under Reexamination Kocovski et al.
	Examiner VINH T LAM	Art Unit 2628

CPC - Searched*		
Symbol	Date	Examiner
G06F3/0421 G06F2203/04103	01/22/2020	vl

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
Search inventor'(s)' name(s). No ODP.	01/22/2020	vl
Search technical terms and synonyms.	01/22/2020	vl
Search IDS.	01/22/2020	vl
Search Foreign Patent Literature(s) and NPL	01/22/2020	vl
Search CPC.	01/22/2020	vl
Search EAST.	01/22/2020	vl

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/VINH T LAM/ Primary Examiner, Art Unit 2628	
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PTO/SB/08 Equivalent

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	Unassigned
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

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	10,282,035 B2	05-07-2019	Kocovski et al.	
	2	2016/0295711 A1	10/06/2016	Ryu et al.	
	3	2010/0103133 A1	04-29-2010	Park et al.	
	4	2012/0062492 A1	03-15-2012	Kato	
	5	2016/0026297 A1	01-28-2016	Shinkai et al.	
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	8	2016/0255713 A1	09-01-2016	Kim et al.	
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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

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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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.T.L/

Examiner Signature /VINH T LAM/	Date Considered 01/22/2020
*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.	

T¹ - Place a check mark in this area when an English language Translation is attached.Chemtronics v. FlatFrog
Chemtronics Exhibit 1013 Page 641

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L6	1	13/510155.app.	US-PGPUB	OR	OFF	2020/01/22 11:53
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S2	47226	((optic\$3 light\$3) same (sens\$3 detect\$3) same (warp\$3 twist\$3 curv\$3 bend\$3 bent distort\$3)).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:40
S3	41872	S2 and @ad<"20161207"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:41
S4	108	S3 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:43
S5	4	S4 and ((line\$1 plane\$1) same (parabol\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 16:45
S6	72	((("FLATFROG") near3 ("LABORATORIES") near3 ("AB"))).AS,AANM.	USPAT	OR	OFF	2019/01/31 16:46
S7	35	((("KOCOVSKI") near3 ("Aleksander")) OR ((("BERGSTROM") near3 ("Hakan")) OR ((("THORVINGER") near3 ("Jens")))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2019/01/31 16:47
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EAST Search History (Prior Art)

S9	10	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (sens\$3 detect\$3) same (surface fac\$3)).ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/01/31 17:58
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S11	1	"20120112541".pn.	US-PGPUB	OR	OFF	2019/01/31 18:05
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S14	5	S13 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 09:46
S15	284	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (surface fac\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:06
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EAST Search History (Prior Art)

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S20	120	S19 and @ad<"20161207"	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:34

EAST Search History (Prior Art)

S21	12	S20 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:34
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S25	390	("5471574" "4174533" "20160380583" "5023440" "2801363" "20150029092" "3553705" "5727108" "9855019" "9414155" "20060125713" "20100002237" "9698726" "20160109684" "20040233122" "20120086295" "4359041" "20110188138" "2657577" "20180173296" "9388961" "9405091" "6977624" "7245266" "9740336" "7084836" "20110037674" "9511290" "7233299" "9268069" "20020051303" "20040165821" "4506185" "20140331991" "20130235580" "20150370054" "6566853" "20130064468" "20120092775" "6985658" "6091825" "4059094" "8130120" "20030185506" "9806206" "7068880" "2821813" "9766040" "4530348" "20160259484" "20090193627" "20160202021" "20130083558" "7689054" "20150301267" "6832031" "20100019935" "20120320586" "4951180" "7770265" "2965899" "20170370618" "9110224" "20100006139" "20160322513" "5016995" "6023133" "20160337750" "8450597" "20010035747" "20170082322" "5939726" "20110265249" "9602917" "9390072" "5515255" "9039905" "20130276775" "20130192226" "8413266" "20140321151" "2368019" "4972127" "20130220312" "20130220307" "20160201947" "7086746" "9404675" "8978642" "20170284771" "2825063" "20050281017" "20100201977" "20150145869" "20130213929" "20130213387" "20090168446" "8632235" "20130000356" "3443086").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:48
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S28	200	("10013107" "10019113" "20010002694" "20010005004" "20010005308" "20010030642" "20020067348" "20020075243" "20020118177" "20020158823" "20020158853" "20020163505" "20030016450" "20030034439" "20030034935" "20030048257" "20030052257" "20030095399" "20030107748" "20030137494" "20030156100" "20030160155" "20030210537" "20030214486" "20040027339" "20040032401" "20040090432" "20040130338" "20040174541" "20040201579" "20040212603" "20040238627" "20040239702" "20040245438" "20040252091" "20040252867" "20050012714" "20050041013" "20050057903" "20050073508" "20050083293" "20050128190" "20050143923" "20050156914" "20050162398" "20050179977" "20050200613" "20050212774" "20050248540" "20050253834" "20050276053" "20060001650" "20060001653" "20060007185" "20060008164" "20060017706" "20060017709" "20060033725" "20060038698" "20060061861" "20060114237" "20060132454" "20060139340" "20060158437" "20060170658" "20060202974" "20060227120" "20060255248" "20060256092" "20060279558" "20060281543" "20060290684" "20070014486" "20070024598" "20070034783" "20070038691" "20070052684" "20070070056" "20070075648" "20070120833" "20070125937" "20070152985" "20070201042" "20070296688" "20080006766" "20080007540" "20080007541" "20080007542" "20080011944" "20080029691" "20080036743" "20080062150" "20080068691" "20080074401" "20080088603" "20080121442" "20080122792" "20080122803" "20080130979" "20080133265" "20080150846" "20080150848" "20080151126" "20080158176" "20080189046" "20080192025" "20080238433" "20080246388" "20080252619" "20080266266" "20080278460" "20080284925" "20080291668" "20080297482" "20090002340" "20090006292" "20090040786" "20090066647" "20090067178" "20090073142" "20090077501" "20090085894" "20090091554" "20090115919" "20090122020" "20090122027" "20090128508" "20090135162" "20090143141" "20090153519" "20090161026" "20090168459" "20090187842" "20090189857" "20090189874" "20090189878" "20090219256" "20090229892" "20090251439" "20090256817" "20090259967" "20090267919" "20090273794" "20090278816" "20090297009" "20100033444" "20100045629" "20100060896" "20100066016" "20100066704" "20100073318" "20100078545" "20100079407" "20100079408" "20100097345" "20100097348" "20100097353" "20100125438" "20100127975" "20100134435" "20100142823" "20100187422" "20100188258" "20100188259" "20100188260" "20100188261" "20100188262" "20100188263" "20100188264" "20100188265" "20100188266" "20100188267" "20100188268" "20100188269" "20100188270" "20100188271" "20100188272" "20100188273" "20100188274" "20100188275" "20100188276" "20100188277" "20100188278" "20100188279" "20100188280" "20100188281" "20100188282" "20100188283" "20100188284" "20100188285" "20100188286" "20100188287" "20100188288" "20100188289" "20100188290" "20100188291" "20100188292" "20100188293" "20100188294" "20100188295" "20100188296" "20100188297" "20100188298" "20100188299" "20100188300" "20100188301" "20100188302" "20100188303" "20100188304" "20100188305" "20100188306" "20100188307" "20100188308" "20100188309" "20100188310" "20100188311" "20100188312" "20100188313" "20100188314" "20100188315" "20100188316" "20100188317" "20100188318" "20100188319" "20100188320" "20100188321" "20100188322" "20100188323" "20100188324" "20100188325" "20100188326" "20100188327" "20100188328" "20100188329" "20100188330" "20100188331" "20100188332" "20100188333" "20100188334" "20100188335" "20100188336" "20100188337" "20100188338" "20100188339" "20100188340" "20100188341" "20100188342" "20100188343" "20100188344" "20100188345" "20100188346" "20100188347" "20100188348" "20100188349" "20100188350" "20100188351" "20100188352" "20100188353" "20100188354" "20100188355" "20100188356" "20100188357" "20100188358" "20100188359" "20100188360" "20100188361" "20100188362" "20100188363" "20100188364" "20100188365" "20100188366" "2010018
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EAST Search History (Prior Art)

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S31	50	(S28 S29 S30) and (parabol\$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/02/01 10:58

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S32	193	((parabol\$3) same (optic\$3 light\$3) same touch\$3 same (surface fac\$3))	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:20
S33	181	S32 and @ad<"20161207"	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:21
S34	29	S33 and (G06F3/0421 G06F2203/04103)	US-PGPUB; USPAT	OR	OFF	2019/02/01 10:22



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/706,438	12/06/2019	Aleksander Kocovski	FFOG.053C4	3081
20995	7590	01/13/2020	EXAMINER	
KNOBBE MARTENS OLSON & BEAR LLP 2040 MAIN STREET FOURTEENTH FLOOR IRVINE, CA 92614			ART UNIT	PAPER NUMBER
			2628	
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			01/13/2020	ELECTRONIC

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efiling@knobbe.com
jayna.cartee@knobbe.com

RESCISSION OF ANY PRIOR DISCLAIMERS AND REQUEST TO REVISIT ART

Inventor : Aleksander Kocovski
App. No. : 16/706438
Filed : December 6, 2019
For : TOUCH DEVICE
Examiner : Unassigned
Art Unit : 2628
Conf. No. : 3081

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: January 6, 2020

/Harnik Shukla/_____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
(949) 760-0404

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Electronic Acknowledgement Receipt

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Application Number:	16706438
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First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	FFOG053C4_HAKIM.pdf	15657	no	1
			a1bd0874e5e81fd7bf799642c4a2680de39bc510		

Warnings:

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<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>	



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efiling@knobbe.com
jayna.cartee@knobbe.com

<i>Decision Granting Request for Prioritized Examination (Track I)</i>	Application No. 16/706,438	Applicant(s) Kocovski et al.	
	Examiner BRIAN W BROWN	Art Unit OPET	AIA (FITF) Status Yes
<p>1. THE REQUEST FILED <u>06 December 2019</u> IS GRANTED .</p> <p>The above-identified application has met the requirements for prioritized examination</p> <p>A. ☒ for an original nonprovisional application (Track I).</p> <p>B. ☐ for an application undergoing continued examination (RCE).</p> <p>2. The above-identified application will undergo prioritized examination. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:</p> <p>A. filing a <u>petition for extension of time</u> to extend the time period for filing a reply;</p> <p>B. filing an <u>amendment to amend the application to contain more than four independent claims, more than thirty total claims</u>, or a multiple dependent claim;</p> <p>C. filing a <u>request for continued examination</u> ;</p> <p>D. filing a notice of appeal;</p> <p>E. filing a request for suspension of action;</p> <p>F. mailing of a notice of allowance;</p> <p>G. mailing of a final Office action;</p> <p>H. completion of examination as defined in 37 CFR 41.102; or</p> <p>I. abandonment of the application.</p> <p>Telephone inquiries with regard to this decision should be directed to BRIAN BROWN at (571)272-5338. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.</p>			
/BRIAN W BROWN/ Petitions Examiner, OPET			

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Date of issue of this certificate: 02 Jan 2020 (02.01.2020)



Prioritetsbevis Certificate of priority

Svensk patentansökan Swedish Patent Application

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen har ingivits till Patent- och registreringsverket i nedan nämnda ansökan.

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
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Emma Högberg

FRAME ASSEMBLY FOR HOLDING A PLATE OF AN OPTICAL TOUCH SENSITIVE SYSTEM

Field of the Invention

This invention pertains in general to the field of optical touch sensitive systems. More particularly, the invention relates to 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. Furthermore, the system relates to a kit of frame elements for assembling of the plate and the panel such that curvature of the plate 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. US4459476, 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 disproportionately 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.

Hence, 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.

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 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.

Further embodiments of the invention are defined in the dependent claims.

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 plate 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 lower 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.

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: Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

Figures 2a-2c are cross-sectional views of embodiments of assemblies;

Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

5 Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 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;

10 Figure 4a is a perspective view of the first frame element;

Figure 4b 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;

Figure 4c is a side view showing screws 116a and 116b;

15 Figures 5a-5g are side views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

Figures 6a is a schematic cross section from a first direction of an embodiment of the assembly;

Figure 6b is an enlarged view of a portion of the embodiment of Figure 6a illustrating a torque applied to the second frame element and the curvature of the plate; and

20 Figure 6c is a schematic side-view of the embodiment of Figure 6a, which is illustrated perpendicular to the direction in Figure 5a.

Description of Embodiments

25 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.

30 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

35 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 stiffest component of the assembly 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.

Embodiments presented herein provide 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.

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 Figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of Figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. However, the embodiments provide for avoiding convexity along the plate diagonals and may even induce concavity. In the following, the embodiments of Figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in Figures 6a-6c.

Figures 2a-2c illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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 Figures 1 and 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

In one embodiment, elements 102 and 103 are formed from a single piece.

The second frame element 103a, 103b may be attached to the first frame element 102. In the embodiments of Figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Hence, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

The first frame element 102 may form a frame 109 (shown in figure 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. Hence, the frame 109 may be rectangular, and made from a single piece of material.

As is illustrated in Figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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 103a, 103b 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 101a, 101b 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

As is illustrated in Figures 3a-3d, the first frame element 102 may be attached to the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in Figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b 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 Figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in Figure 3c and 3d. 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 101a, 101b 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.

Figures 2a-2c and 3a-3d illustrate embodiments of an attachment element 112 for attaching the first frame element 102 to the panel. A plurality of attachment elements 112 may be arranged around the frame 109, such as at each corner of the frame 109, which is illustrated as circles in Figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c,

113a, 113b. 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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to apply a first force to the frame 109 towards the support portion 101a, 101b, which is indicated with an arrow in Figures 2a-2c. At least one other of the screws 112b, 112c 113b may be arranged to apply a second force to the frame 109 away from the support portion 101a, 101b, which is also indicated with an arrow in Figures 2a-2c. Hence, since counter-forces may be induced to the frame, undesired twist of the frame 109 may be prevented. Twist induced by one of the screws may be counteracted by the other screw in the group of screws.

Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in Figure 2a. In the illustrated embodiment, a first screw 112a is arranged between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 114a of the longitudinal axis of the first screw 113a passes through the support portion 101a, 101b when viewed in cross-section, such as through the center thereof, as is illustrated in Figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. i.e. an imaginary extension 114b of the longitudinal axis of the first screw 113b passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in Figure 2b.

In each of the embodiments of Figures 2a and 2b, the first screw 112a, 113a is arranged to apply the force to the frame 109 towards the support portion 101a, 101b. This may be provided by a threaded hole in the panel 1 or directly engaging the material of the panel, which the first screw 112a, 113a engages while a head of the first screw 112a, 113a abuts the frame 109. The second screw 112b, 113b, and optionally the third screw 112c when provided, is arranged to apply the second force to the frame 109 away from the support portion 101a, 101b. This may be provided by a threaded hole in the frame 109, which the second screw 112b, 113b, and optionally the third screw 112c, engages while a tip of the second/third screw 112a, 112b, 113b abuts a surface of the panel 1. The further down the second/third screw will be inserted, the more the frame will be pushed away from the support portion 101a, 101b.

Since all three screws are arranged outside the extension of the support portion 101a, 101b in the embodiment of Figure 2a, the second screw 112b and the third screw 112c may provide a counter force on each side of the first screw 112a.

5 Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of Figure 2b, only two screws are required to prevent bend open or rotation of the frame.

In Figures 2a-2b, 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.

10 Figure 2c illustrates that a combination the embodiment of Figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Hence, flexibility is provided for.

As is illustrated in Figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Hence a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In the assembly illustrated in Figure 3a, a net force is applied such that the frame is substantially flat and parallel with the panel 1. In the assembly illustrated in Figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b along the edge or perimeter of the plate 2. Hence, controlling the curvature of the first frame element 109 may control curvature of the plate. The plate 2 may become be concave when viewed from the touch surface of the plate 2. When three screws are provided in each group of screws, the third screw 113b may provide a higher force away from the support portion 101a, 101b than the second screw 112b. This may be used to control the shape of the concavity of the frame 109 and thus also the level of tilt of the support portion 101a, 101b, and thereby the curvature of the plate 2 may be controlled.

Figures 4a—4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a, attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to Figures 2a-2c and 3a-3d. 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 101a, 101b 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 support 101a, 101b. Thereby, a

force applied by the spacing element 112 may be transferred to the second frame element 103a, 103b such that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled. Since the frame 109 is attached to the panel 109 at the corners, the first frame element 102 and the panel 1 does not need to be held together between the corners, but can rather be
5 pushed away from each other, creating a space between the panel 1 and the frame 109. Thereby the concavity of the frame 109, and thereby also the concavity of the plate 2, may be further controlled by the spacing element. As is illustrated in Figure 4b, 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.
10 Hence, 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Hence, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

15 When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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 101a, 101b where the attachment elements 112 are provided may be less than the level of tilt between the
20 ends where spacing element(s) 116 is/are provided. As consequence, the second frame element 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane taken along the support portion 101a, 101b, such as at the free end or tip of the support
25 portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b 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
30 frame 109 while its head engages a surface. Additionally, element 116 may comprise a spacer component such as a washer, spacer, etc. In Figure 3a and 3b and Figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b may engage the
35 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 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

5 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 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.

10 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
15 109.

Figures 5a-5g illustrate embodiments of an assembly 200, which can be combined with the first frame element 102 described above. However, the assembly 200 described with regard to Figures 5a-5g may also be used without the first frame element 102 described above.

20 As shown in figures 5a and 5b, 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 201a, 201b. 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 201a, 201b, and may be configured to extend
25 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. Hence, each support portion 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in Figure 5g.

30 In some embodiments, such as illustrated in Figures 5c-5d, a gasket 205 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 201a of the first frame element 202. Also, a sealing 204 may be arranged on the support portion 201b of the second frame element 203.

35 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 Figures 5f-5g. 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 1.5-2.0mm 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in Figure 5e.

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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes 217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Hence, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen, wherein the center holes 217c, 218c 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 Figures 4a-4c, the frame side may replace the second frame element of the embodiments of Figures 4a-4c. Hence, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

Figures 6a-6c illustrate a combination of the embodiments of Figure 3a-3b and Figures 5a-5g. Like elements are referenced with the same reference numerals as the embodiments described above, and these elements will not be further described with regard Figures 6a-6c. In this embodiment, a first frame element 102, and a second frame element 103 are provided as described above with regard to Figures 1-3d. The second frame element 102 in Figures 6a-6c may correspond to the first frame element 202 of the embodiment of Figures 5a-5g. The second frame element 203 of the embodiments of Figures 5a-5g provides a third frame element 203a in the embodiments of Figure 6a-6c, and may be configured as described above.

A sealing 204a may be provided between the support portion 201a of the third frame element 203a and the plate 2. The third frame element 203a may be attached to the second frame element at the second portion thereof, as described above.

Figure 6b is an enlarged view of the assembly illustrating the second frame element 103 and the third frame element 203a and the resulting forces and torque generated when a force is applied to the spacing member 116a, 116b such that the first frame element is curved. A first force 220 is applied directed towards and applied to the support portion of the second frame element 103. This force may be applied by the attachment member 112. A second force 221 applied by the spacing element 116a, 116b is transferred via the curved first frame element 102, to the support portion of the second frame element 103. Hence a net torque 222 is generated towards the first frame element 102, i.e. counter-clockwise in the illustrated arrangement. The plate 2 will assume a curved path, as is illustrated with dotted line 223.

Figure 6c schematically illustrates the assembly rotated 90 degrees relative to the illustration in Figure 6a. The first hole 217a the second hole and 217a of the second frame element 103 are illustrated aligned with the first hole 218a and the second hole 218b at the ends of each frame element 103, 203a. The third frame element 203a is illustrated in its relaxed or non-deformed state, wherein the third hole 217c of the second frame element 103 and the third hole 218c of the third frame element 203a are not aligned or only partially overlapping. A force, illustrated by arrow 224, may be applied at the support portion 201b, which deforms the third frame element 203 such that holes 217a-217c of the second frame element 103 are aligned with the holes 218a-218c of the third frame element 203a, which is illustrated with dotted line 225 that follows a curved path. The holes 218a-218c, and any additional holes that are included, may be arranged along such a curved path. Due to the deformation of the third frame element 203a along a curved plane, the support portion 201b applies a force to the plate 2 along a curved plane, which is illustrated with dotted line 226. Hence, force 224 is distributed along the length of the third frame element 203a, which is illustrated with smaller arrows along the length. This may contribute to the force 221 (Figure 6b) generated at the plate 2 towards the first frame element 103, wherein the control of curvature of the plate 2 may be further enhanced when combined with the spacing member 116a, 116b.

The second frame element 103 may provide a frame side, and the third frame element 203a may provide an edge cover. As can be seen in Figure 6b, the third frame element 203a engages the plate 2 further to the center of the plate 2 than the second frame element 103. This contributes to applying the torque at the plate 2, as discussed above. Furthermore, the third frame element 203a may cover any component, such as the second frame element 103, when viewed from the touch surface of the plate 2. For example, the third frame element 203a may extend about 1-2mm from the edge over the touch surface of the plate 2. The second frame element 103 may extend only about 1mm from the edge over the backside of the plate 2.

In an embodiment shown in figure 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 comprises a top surface, having a first surface portion 302 in a parallel plane to second frame element 103A and a second surface portion comprising a tapered edge 303 at an angle from first surface portion 302. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b causes plate 2 to follow the contour of the top surface of block 301. As tapered surface portion 303 is at an angle from first surface portion 302, the plate 2 is forced into a curving plane at an angle to the plane of second frame element 103A. The resulting path of plate 2 is shown by curvature path 310. Tapered surface portion 303 is preferably set between 0.5 degrees and 3 degrees from first surface portion 302 or second frame element 103A.

In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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.

A kit of frame elements comprising the first frame element and the second frame element that may be used for assembling the panel and the plate for the touch sensitive system. The kit may be provided separate from the plate and the panel.

Above, a curve, such as a concave curve, has been discussed. The concave curve may be a parabolic concave curve. When the plate 2 is given a concave curve, the amount of light that reaches the detector increases. This can be simulated by mapping where the light received by the detector would have gone if there was no glass - the detector has an effective larger surface area with curved glass. At least a 4-fold improvement of the field of view (i.e. how large angle that the detector can see the emitter within) may be provided with a curved plate. For example, the field of view may increase from 2.8 degrees to 20 degrees for bouncing rays, which will give a magnification = $(1+20/2.8)/(1+1) = 4$.

One implementation would be to look at a 2 meter long detection line with a spherical concavity of 2.5 mm ($R = -200$ m). Practically, however, the shape of the plate is typically parabolic. This would give a magnification of the field of view for a central emitter scattering facet (1 mm above the glass edge) of $M = 5.1$. Hence, the embodiments of the invention provide for substantially improvements in the improved field of view, provides for improved accuracy of the touch sensitive system and allows for lower light budget.

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.

CLAIMS

1. An assembly for holding and controlling curvature of a plate (2) for an optical touch sensitive system, comprising

5 a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);

at least one second frame element (103a, 103b; 203) extending in a second plane and forming a support portion (101a, 101b; 201b) for the plate (2), and

10 at least one spacing element positioned at least partially between the support portion (101a, 101b; 201b) and the first frame element (102; 202), the spacing element being configured to control a curvature of the first frame element (102; 202), and

15 wherein the at least one second frame element (103a, 103b; 203) is configured to engage the plate at the support portion (101a, 101b; 201b), is attached to the first frame element (102; 202), and wherein the shape and/or position of the second frame element is controlled by the curvature of the first frame element (102, 202) with said spacing element, to control a curvature of the plate.

2. The assembly of claim 1, wherein the second frame element (103a, 103b; 203) is deflectable from a relaxed state to a deflected state, in which the second plane forms a parabolic concave curve along at least a portion of the length of the support portion (101a, 101b; 201b), and
20 wherein a screw arrangement (112a, 112b, 112c, 113a, 113b; 219a, 219b, 219c) of the assembly holds the second frame element (103a, 103b; 203) in the deflected state when assembled with the first frame element (102; 202).

3. The assembly of any of claims 1 or 2, wherein a frame (109) of the first frame element
25 (102) comprises a plurality of spacing elements arranged spaced apart from corners of the frame (209) of the first frame element (102), wherein the spacing elements are configured to generate a force to the frame (109) away from the support portion (101a, 101b).

4. The assembly of claim 3, wherein each spacing element comprises a screw (116, 116a,
30 116b) arranged in a hole of the frame (109).

5. The assembly of claim 4, wherein each spacing element (112, 112a, 112b) comprises a screw with a predefined length, and a spacer arranged between a head of the screw and the frame (109).
35

6. The assembly of any of the previous claims, wherein assembly comprises a plurality of attachment elements (112) arranged around the frame (109) for attaching the first frame element (102) to said panel (1).

5 7. The assembly of claim 6, wherein each attachment element (112) comprises a plurality of screws (112a, 112b, 112c, 113a, 113b) arranged in holes of the frame (109), wherein at least one of said screws (112a, 113b) is arranged to apply a first force to the frame (109) towards the support portion (101a, 101b), and at least one other of said screws (112b, 112c, 113b) is arranged to apply a second force to the frame (109) away from the support portion (101a, 101b).

10 8. The assembly of claim 7, wherein each attachment element (112) comprises at least two screws (113a, 113b), wherein a first screw (113a) of said two screws is arranged opposing the support portion (101a, 101b) and to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (113b) of said two screws is arranged closer to a center of
15 the first frame element (102) than a perimeter of the support portion (101a, 101b) and to apply said second force to the frame (109) away from the support portion (101a, 101b).

 9. The assembly of claim 7, wherein each attachment element (112) comprises at least three screws (112a, 112b, 112c), wherein all three screws are arranged closer to a center of the first
20 frame element (102) than a perimeter of the support portion (101a, 101b), and wherein a first screw (112a) of said three screws is arranged to apply said first force to the frame (109) towards the support portion (101a, 101b), and a second screw (112b) and a third screw (112c) of said three screws are arranged to apply said second force to the frame (109) away from the support portion (101a, 101b), the first screw (112a) being arranged between the second screw (112b) and the third
25 screw (112c).

 10. The assembly of any of the previous claims, wherein a gasket (205) is arranged on another support portion (201a) of the second frame element (202), wherein the gasket (205) has a varying thickness along its length.

30 11. The assembly of claim 10, wherein the gasket (205) has opposing ends, and is thinner between the opposing ends than at said ends.

 12. The assembly of claim 11, wherein a first section (205a) of the gasket (205) at one of
35 said ends and a second section (205b) of the gasket (205) at the other of said ends has a first thickness, and at least a third section (205c) of the gasket between the first section (205a) and the

second section (205b) has a second thickness, wherein the first thickness is thicker than the second thickness.

5 13. The frame assembly of any of claims 10-12, wherein the second frame element (203) comprises a frame side and the third frame element comprises an edge cover, and wherein the edge cover comprises another support portion for said panel (1), wherein a distance between the support portion of the frame side and the support portion of the edge cover is discontinuous in an assembled state.

10 14. The frame assembly of claim 13, wherein the frame side comprises a first hole (217a) and a second hole (217b) arranged at opposing ends of the frame side and in a first plane, and a third hole (217c) arranged between the first hole (217a) and the second hole (217c) and in a plane that is different from the first plane, and
 15 the edge cover comprises a first hole (218a) and a second hole (218b) arranged at opposing ends of the edge cover, and a third hole (218c) arranged between the first hole (218a) and the second hole (218c) of the edge cover, wherein the first hole (218a), the second hole (218b), and the third hole (218c) of the edge cover are generally arranged in the same plane when the edge cover is disconnected from the frame side, and
 20 wherein the edge cover is less stiff than the frame side and deflectable such that the holes (218a, 218b, 218c) of the edge cover are aligned with the holes (217a, 217b, 217c) of the frame side and such that the support portion of the edge cover extends in a plane, which is curved.

15. A method for assembling a panel and a plate for an optical touch sensitive system, comprising:
 25 providing a first frame element (102; 202) extending in a first plane and configured to extend at least partially around a panel (1);
 providing at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2);
 supporting the plate (2) by the support portion (101a, 101b, 201b);
 30 attaching the second frame element to the first frame element (102; 202) such that the support portion (101a, 101b; 201b) extends at least partially in a second plane generally opposite at least a portion of the first frame element (102; 202) and is spaced apart from the first plane; and
 controlling a curvature of the first frame element (102; 102) with a spacing element attached to the first frame element (102; 202) and thereby tilting the support portion (101a, 101b, 35 201b) to control a curvature of the plate (2).

16. A kit of frame elements for assembling a panel and a plate for a touch sensitive system, comprising:

a first frame element (102; 202) extending in a first plane;

5 at least one second frame element (103a, 103b; 203) forming a support portion (101a, 101b; 201b) for the plate (2) and being attachable to the first frame element (102; 202), and

a spacing element adjustably attachable to the first frame element; wherein

at least a portion of the support portion (101a, 101b; 201b) is tiltable, by the spacing element, relative to the first frame element to extend in the second plane, which is curved.

10

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 is 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.

To be published together with Figure 5b.

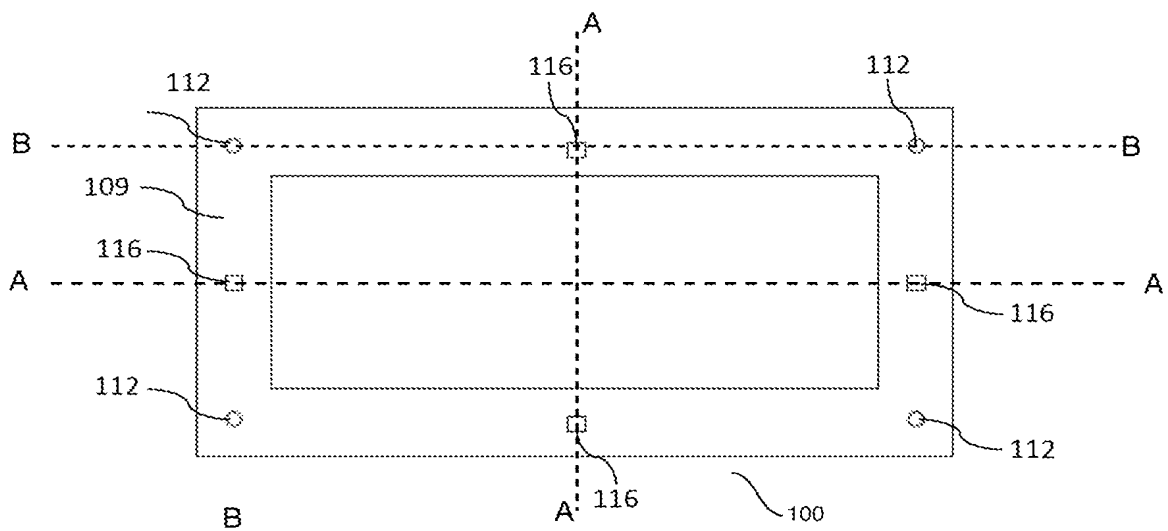


Figure 1

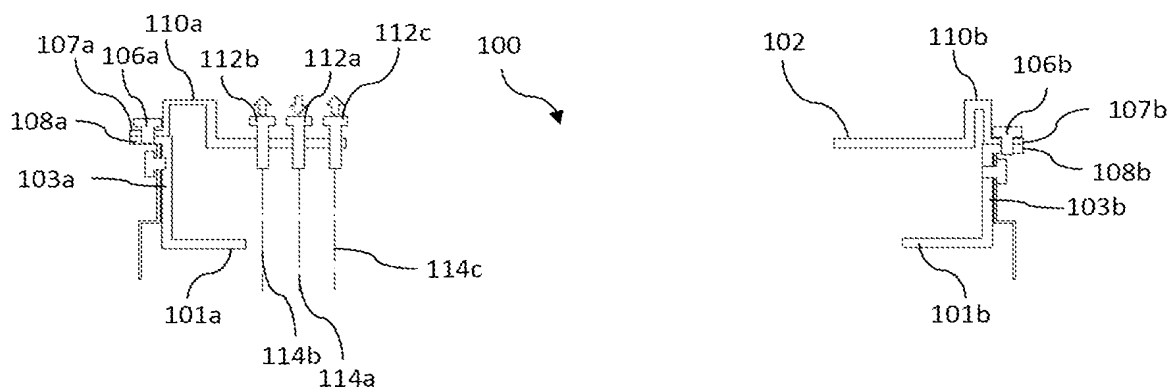


Figure 2a

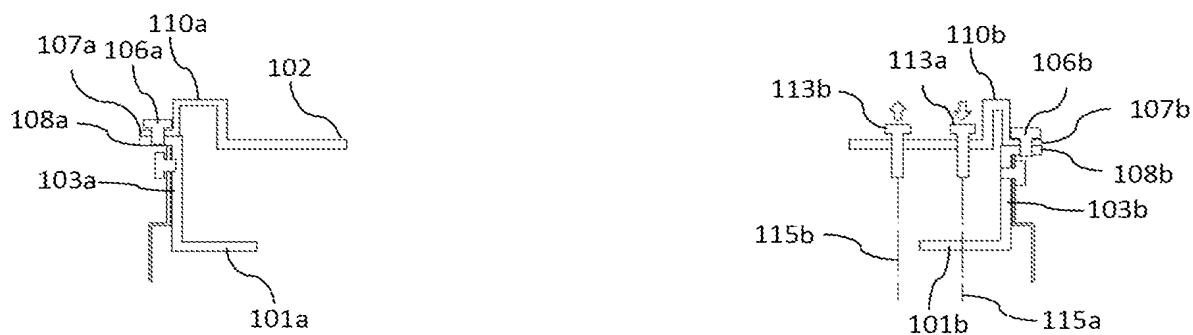


Figure 2b

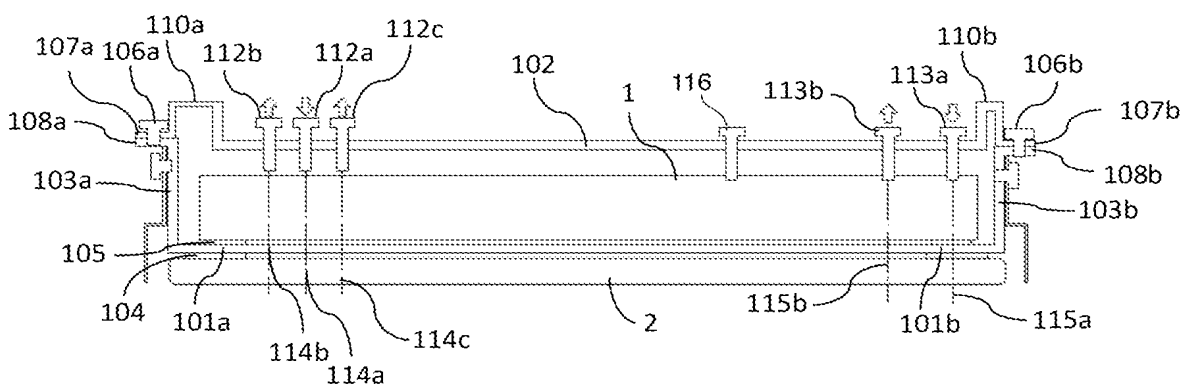


Figure 2c

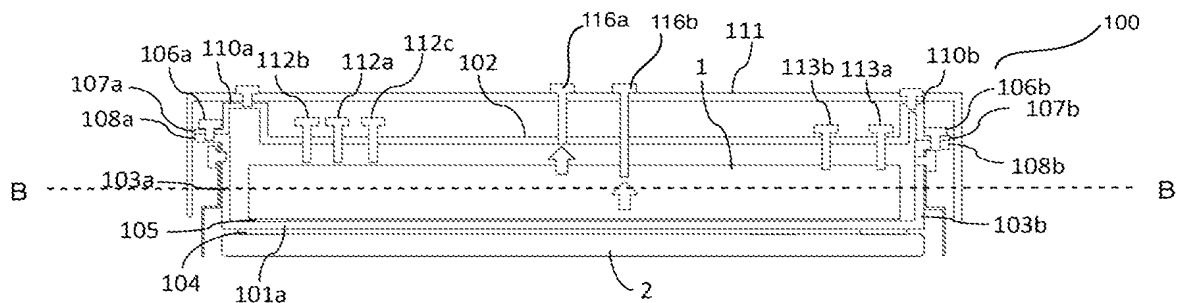


Figure 3a

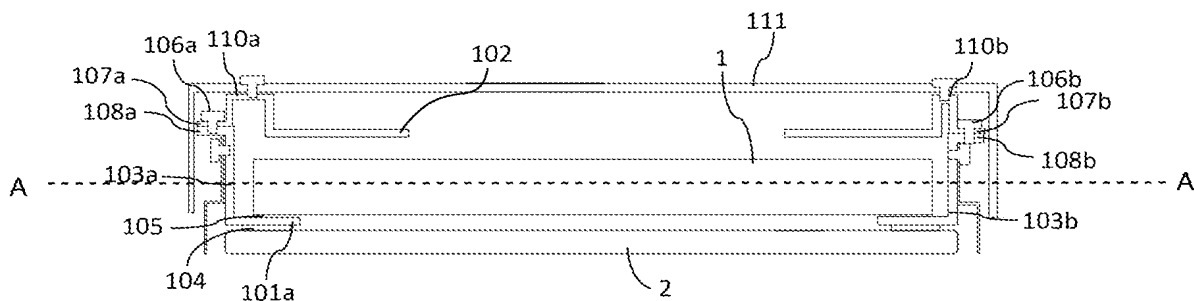


Figure 3b

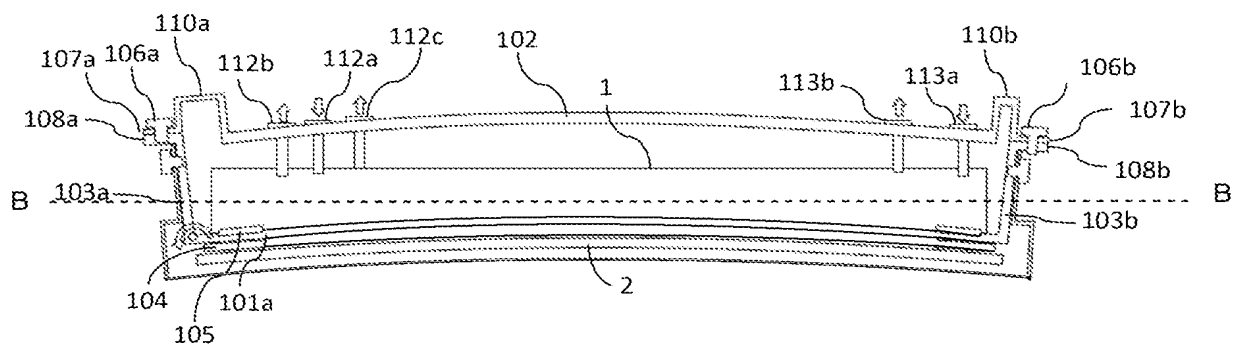


Figure 3c

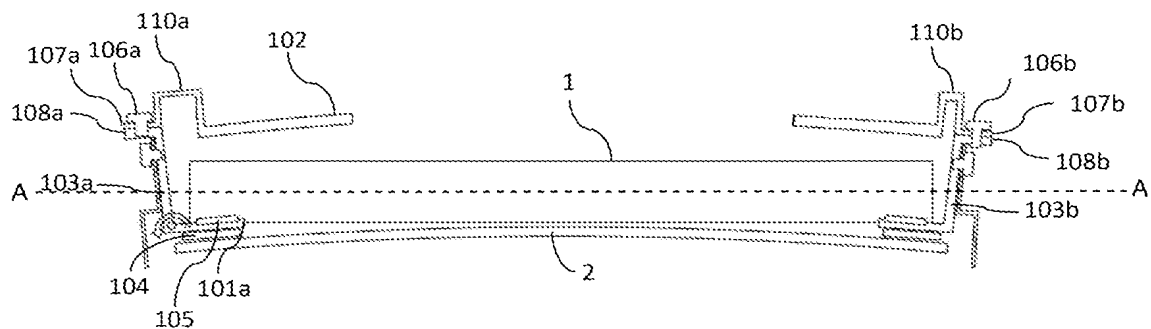


Figure 3d

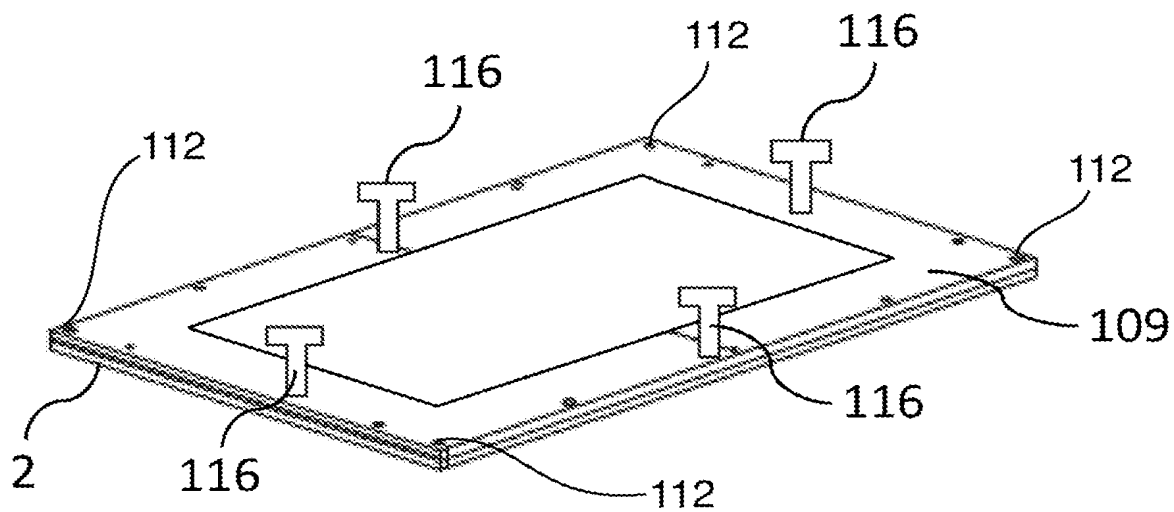


Figure 4a

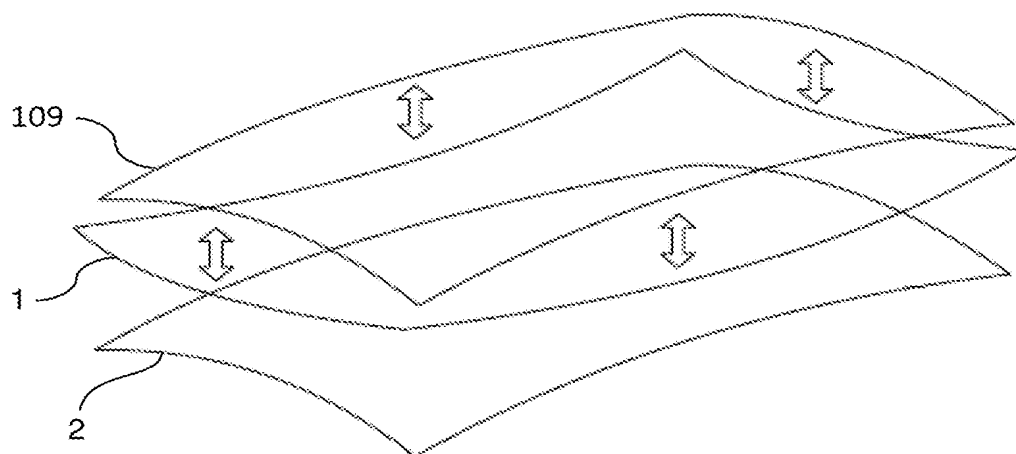


Figure 4b

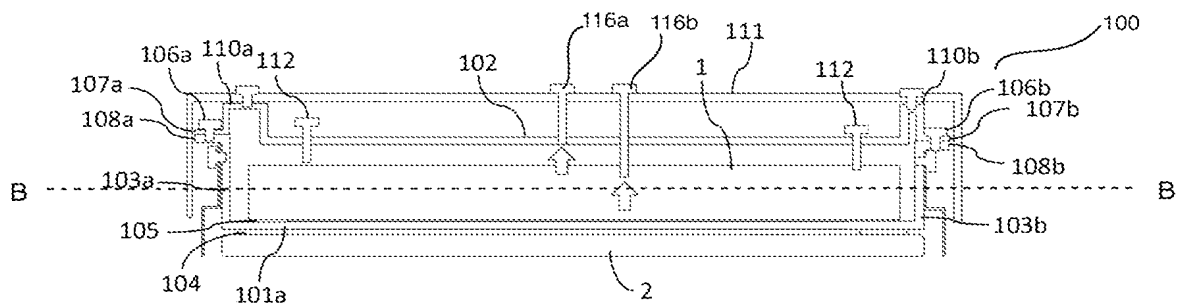


Figure 4c

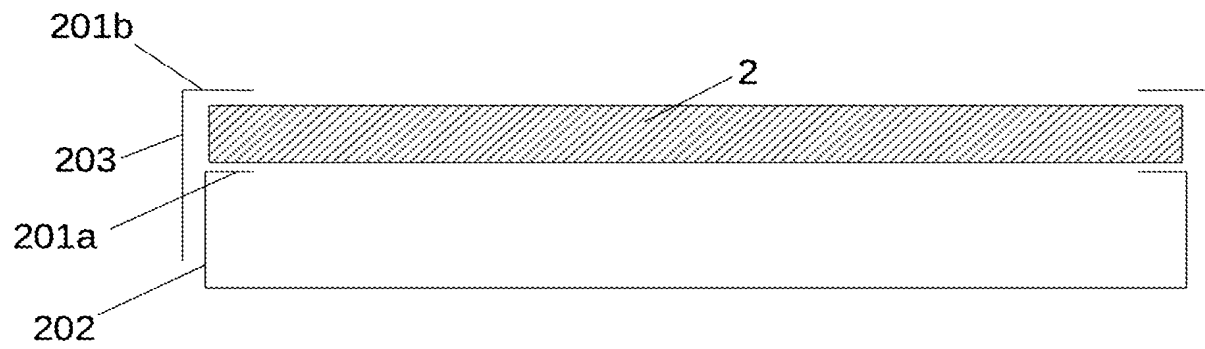


Figure 5a

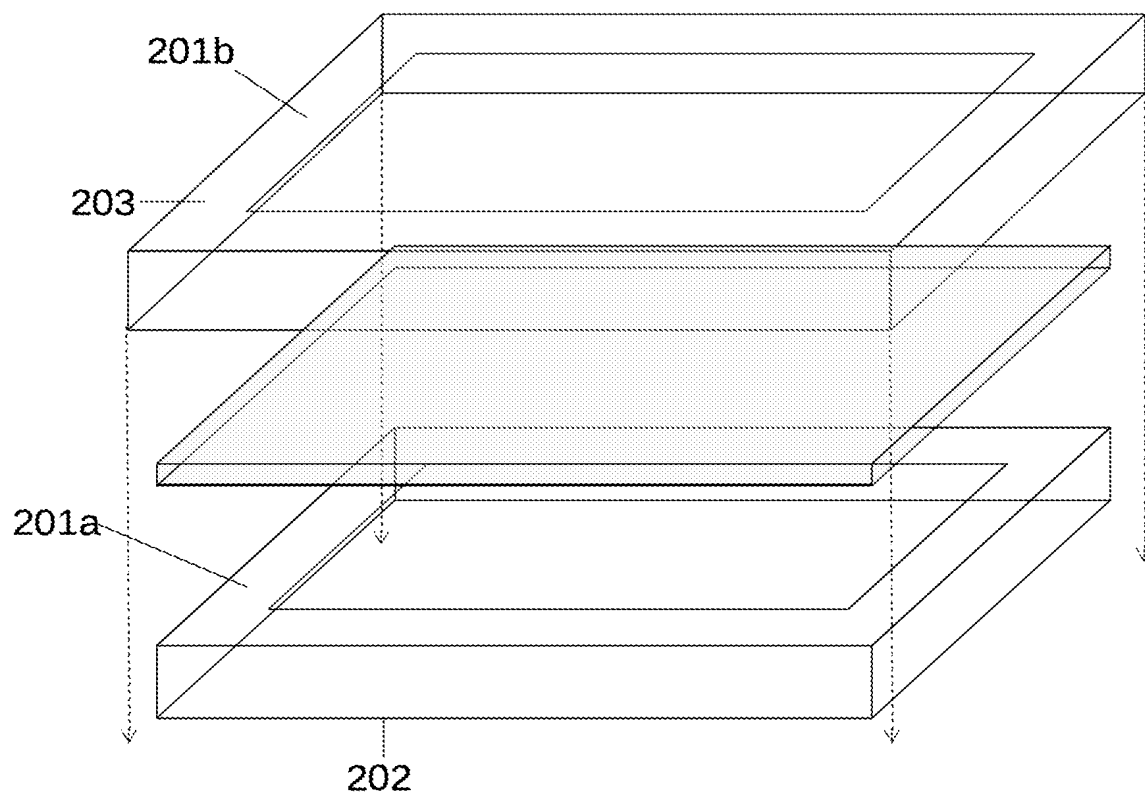


Figure 5b

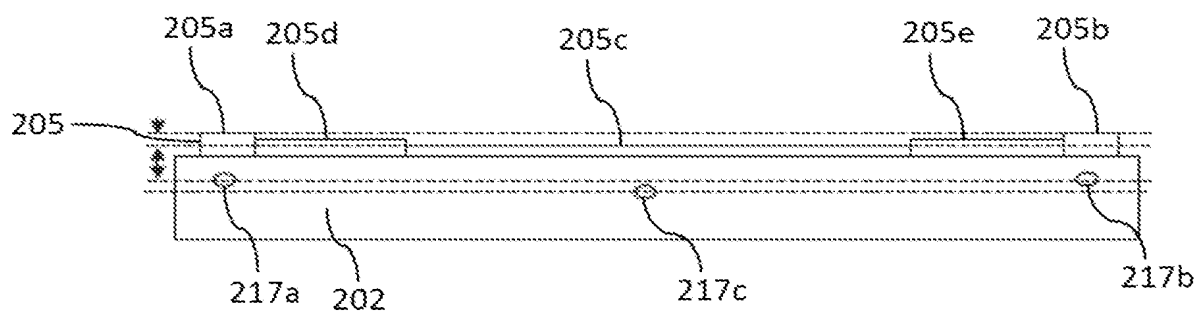


Figure 5c

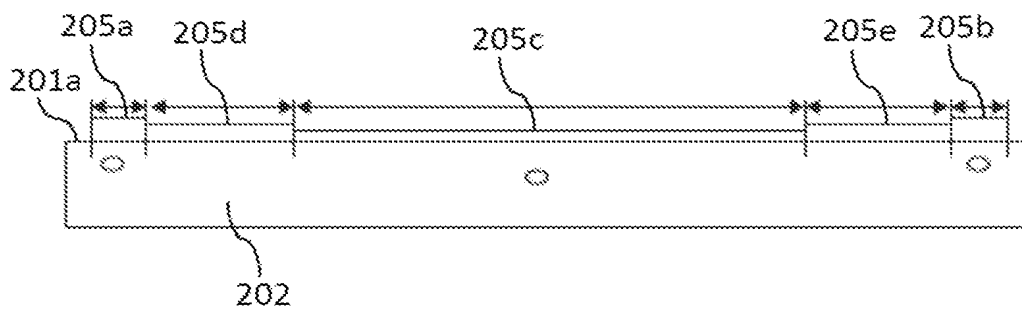


Figure 5d

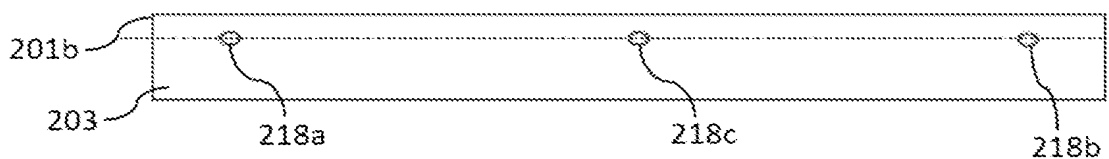


Figure 5e

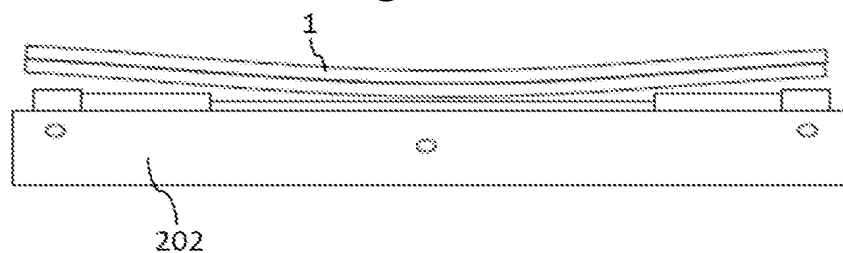


Figure 5f

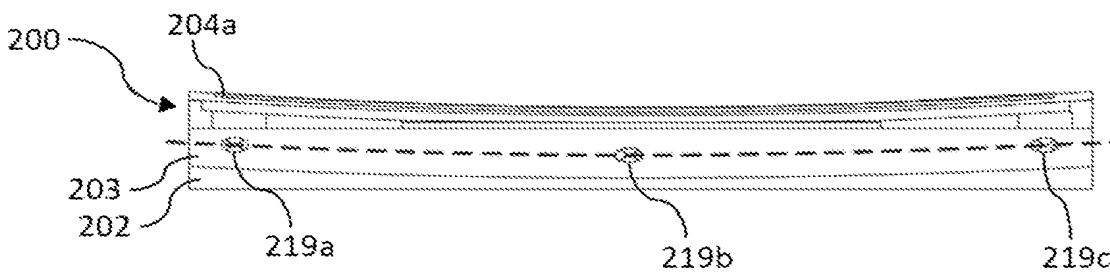


Figure 5g

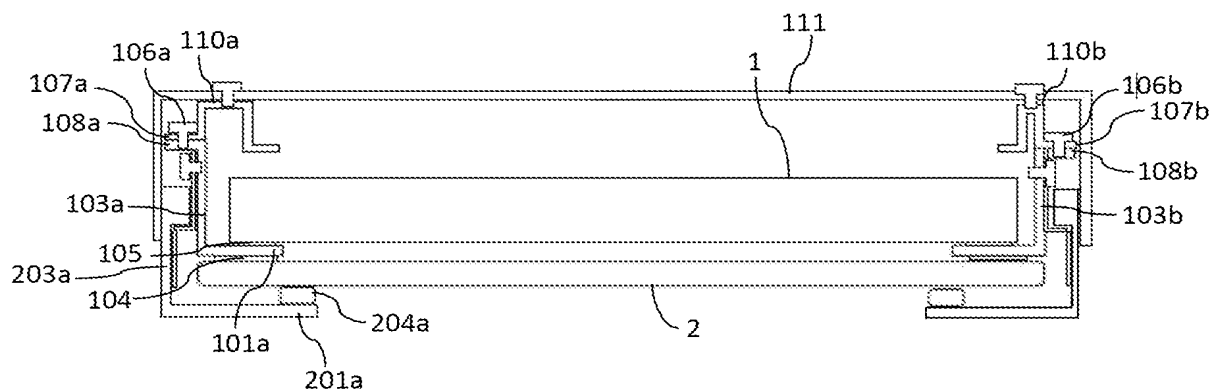


Figure 6a

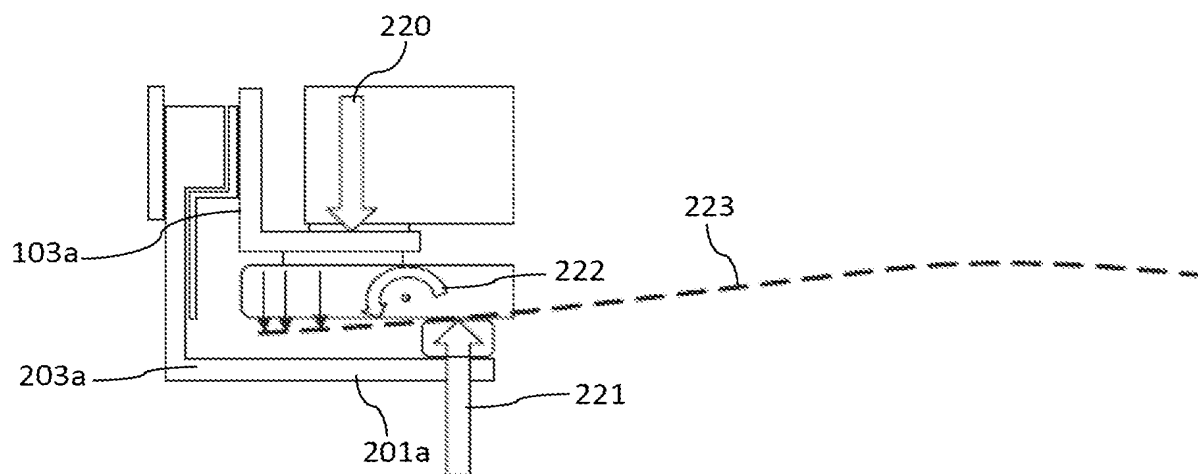


Figure 6b

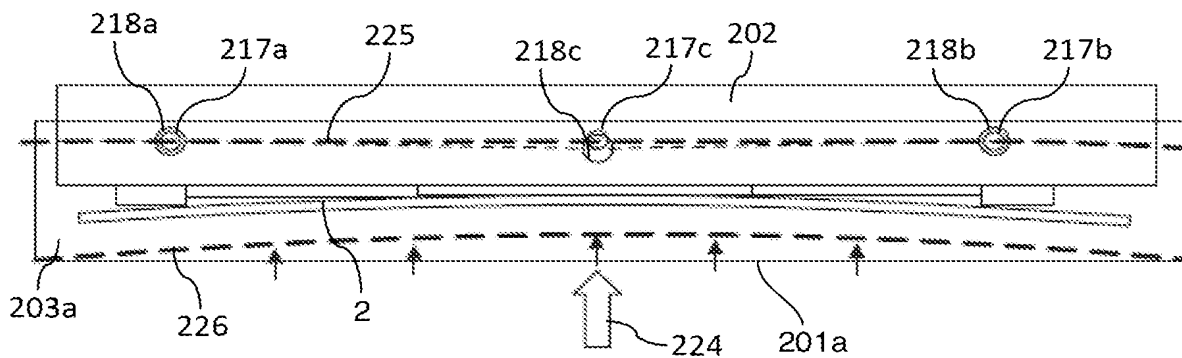


Figure 6c

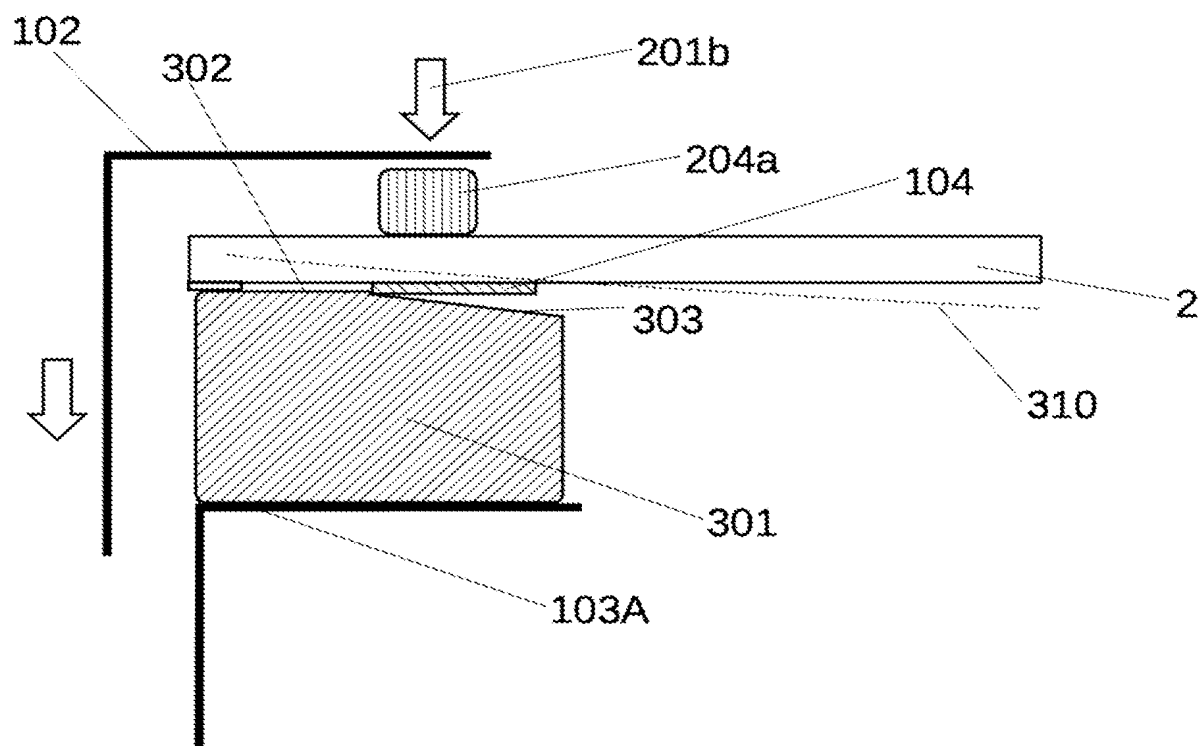


Figure 7

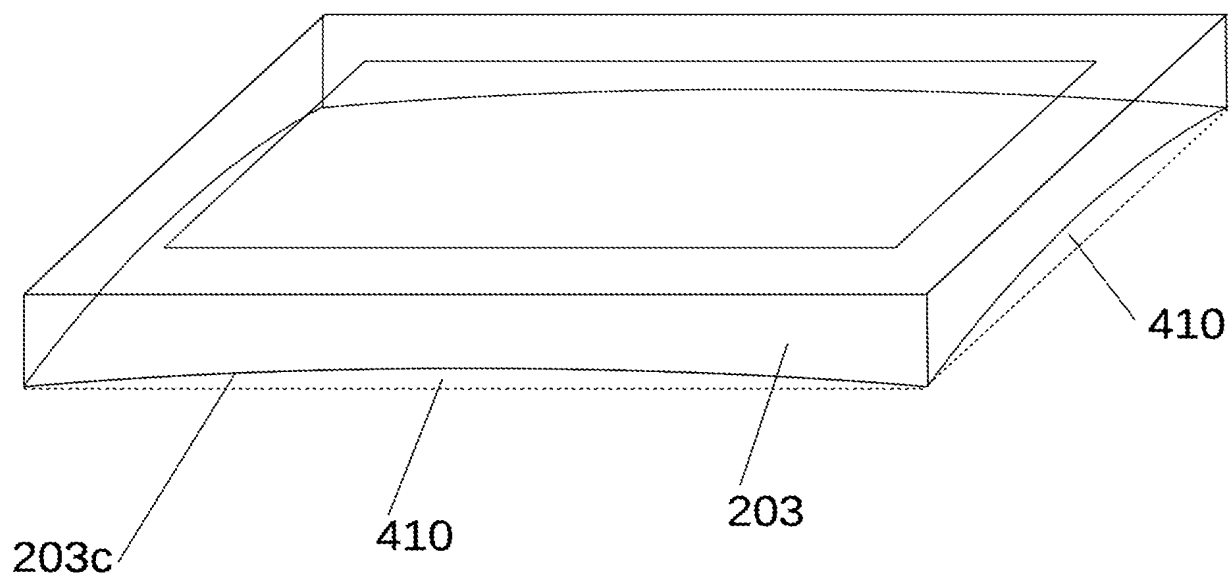


Figure 8



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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
16/706,438	12/06/2019		1720	FFOG.053C4	20	2

CONFIRMATION NO. 3081

FILING RECEIPT

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



0000000113603220

Date Mailed: 01/02/2020

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)

Aleksander Kocovski, Malmo, SWEDEN;
Hakan Bergstrom, Torna-Hallestad, SWEDEN;
Jens Thorvinger, Lund, 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 16/403,283 05/03/2019
which is a CON of 16/190,907 11/14/2018 PAT 10282035
which is a CON of PCT/SE2017/051233 12/07/2017

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 1630294-5 12/07/2016 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 16/706,438**

Projected Publication Date: 04/09/2020

Non-Publication Request: No

Early Publication Request: No
Title

TOUCH DEVICE

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/706,438	
APPLICATION AS FILED - PART I							
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A			N/A	300
SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A			N/A	660
EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	20	minus 20 = *			OR	x 100 =	0.00
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	2	minus 3 = *				x 460 =	0.00
APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	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 <small>(37 CFR 1.16(j))</small>							0.00
			TOTAL			TOTAL	1720
* If the difference in column 1 is less than zero, enter "0" in column 2.							
APPLICATION AS AMENDED - PART II							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus **	=	x =	OR	x =
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus ***	=	x =	OR	x =
	Application Size Fee <small>(37 CFR 1.16(s))</small>					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>					OR	
			TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus **	=	x =	OR	x =
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus ***	=	x =	OR	x =
	Application Size Fee <small>(37 CFR 1.16(s))</small>					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>					OR	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application No.	16/706438
	Filing Date	December 6, 2019
	First Named Inventor	Aleksander Kocovski
	Art Unit	Unassigned
(Multiple sheets used when necessary)	Examiner	Unassigned
SHEET 1 OF 1	Attorney Docket No.	FFOG.053C4

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No.	Document Number <i>Number - Kind Code (if known)</i> Example: 1,234,567 B1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear
	1	10,282,035 B2	05-07-2019	Kocovski et al.	
	2	2016/0295711 A1	10/06/2016	Ryu et al.	
	3	2010/0103133 A1	04-29-2010	Park et al.	
	4	2012/0062492 A1	03-15-2012	Katoh	
	5	2016/0026297 A1	01-28-2016	Shinkai et al.	
	6	2015/0373864 A1	12-24-2015	Jung	
	7	2016/0209886 A1	07-21-2016	Suh et al.	
	8	2016/0255713 A1	09-01-2016	Kim et al.	
	9	6,031,524 A	02-29-2000	Kunert	

FOREIGN PATENT DOCUMENTS						
Examiner Initials	Cite No.	Foreign Patent Document <i>Country Code-Number-Kind Code</i> Example: JP 1234567 A1	Publication Date MM-DD-YYYY	Name	Pages, Columns, Lines Where Relevant Passages or Relevant Figures Appear	T ¹

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

31889316

Examiner Signature	Date Considered
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EFS ID:	38129402
Application Number:	16706438
International Application Number:	
Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Jenny Kim
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
Receipt Date:	23-DEC-2019
Filing Date:	
Time Stamp:	18:58:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		FFOG053C4.pdf	44944	yes	3
			d418552245a549e9a5ffda0e4a0a1600565e17a1		

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	Transmittal Letter	1	2
	Information Disclosure Statement (IDS) Form (SB08)	3	3
Warnings:			
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INFORMATION DISCLOSURE STATEMENT

First Inventor	: Aleksander Kocovski
App. No.	: 16/706438
Filed	: December 6, 2019
For	: TOUCH DEVICE
Examiner	: Unassigned
Art Unit	: Unassigned
Conf. No.	: 3081

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.

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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.

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This Information Disclosure Statement is being filed within three months of the filing date or date of national phase entry, with an RCE or before receipt of a First Office Action after an RCE, and no fee is believed to be required.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Account No. 11-1410.

Application No.: 16/706438
Filing Date: December 6, 2019

Respectfully submitted,
KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 23, 2019

By: /Harnik Shukla/ _____
Harnik Shukla
Registration No. 73,097
Registered Practitioner
Customer No. 20995
(949) 760-0404

31889312

REQUEST FOR FIRST ACTION INTERVIEW (FULL PILOT PROGRAM)

Attorney Docket Number: FFOG.053C4	Application Number (if known):	Filing date: Herewith
First Named Inventor: Aleksander Kocovski	Title: TOUCH DEVICE	

APPLICANT HEREBY REQUESTS A FIRST ACTION INTERVIEW IN THE ABOVE-IDENTIFIED APPLICATION. See Instruction Sheet on page 2.

1. The application must contain three (3) or fewer independent claims and twenty (20) or fewer total claims.
2. The application must not contain any multiple dependent claims.
3. By filing this request:

Applicant is agreeing to make an election without traverse if the Office determines that the claims are not obviously directed to a single invention; and

Applicant is agreeing not to request for a refund of the search fee and any excess claims fee paid in the application after the mailing or notification of the pre-interview communication prepared by the examiner.

4. Other attachments: _____

Signature /Harnik Shukla/	Date December 6, 2019
Name (Print/Typed) Harnik Shukla	Registration Number 73,097
<p>Note: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.</p>	
<p>☐ *Total of <u>1</u> forms are submitted.</p>	

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 12 hours 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.

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.

Instruction Sheet for Request for First Action Interview (Full Pilot Program)

(Not to be Submitted to the USPTO)

A grantable request must meet the following conditions:

1. The application must be a new non-reissue utility application filed under 35 U.S.C. 111(a) or an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The application must contain three (3) or fewer independent claims and twenty (20) or fewer total claims. The application may not contain any multiple dependent claims.
3. The request must be filed electronically using the Office's electronic filing system, EFS-Web.
4. The claims must be directed to a single invention. If the Office determines that the claims are directed to multiple inventions (*e.g.*, in a restriction requirement), the applicant must make an election without traverse.
5. The request must be filed at least one day before a first Office action on the merits of the application appears in the Patent Application Information Retrieval (PAIR) system (*i.e.*, at least one day prior to the date when a first Office action on the merits, notice of allowability or allowance, or action under *Ex parte Quayle*, 1935 Dec. Comm'r Pat. 11 (1935) appears in the PAIR system). Applicant may check the status of the application using the PAIR system.
6. The request for a first action interview must include a statement that applicant agrees not to file a request for a refund of the search fee and any excess claims fees paid in the application after the mailing or notification of the Pre-Interview Communication. Any petition for express abandonment under 37 CFR 1.138(d), and request for a refund of the search fee and any excess claims fees, filed after the mailing or notification of the Pre-Interview Communication will not be granted.

For more information, see notice "Full First Action Interview Pilot Program" available on the USPTO web site at http://www.uspto.gov/patents/init_events/faipp_full.jsp

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.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		
<p>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.</p> <p>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.</p>			

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.)
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Inventor Information:

Inventor	1				<input type="button" value="Remove"/>
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Aleksander		Kocovski		
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		Kastellgatan 11			
Address 2					
City	Malmo		State/Province		
Postal Code	211 48		Country ⁱ	SE	
Inventor	2				<input type="button" value="Remove"/>
Legal Name					
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		Akerstorpsvagen 42			
Address 2					
City	Torna-Hallestad		State/Province		
Postal Code	247 95		Country ⁱ	SE	
Inventor	3				<input type="button" value="Remove"/>
Legal Name					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jens		Thorvinger	
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	Kaprifolievagen 15			
Address 2				
City	Lund	State/Province		
Postal Code	227 38	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 DEVICE		
Attorney Docket Number	FFOG.053C4	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	54	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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
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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	16/403283	2019-05-03		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/403283	Continuation of	16/190907	2018-11-14	10282035	2019-05-07
Prior Application Status	Expired	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
16/190907	Continuation of	PCT/SE2017/051233	2017-12-07		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					Add

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		

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).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)	Remove
1630294-5	SE	2016-12-07	CA59	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
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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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		

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
<p>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.</p> <p style="text-align: right;">Clear</p>		
☒ 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:		
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
If the Applicant is an Organization check here. ☒		
Organization Name	Flatfrog Laboratories AB	
Mailing Address Information For Applicant:		
Address 1	Scheelevagen 15 Alfa 2	
Address 2		
City	Lund	State/Province
Country	SE	Postal Code
Phone Number		Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. Add		

Assignee Information including Non-Applicant Assignee 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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		

Assignee	1			
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
				<input type="button" value="Remove"/>
If the Assignee or Non-Applicant Assignee is an Organization check here.				☐
Prefix	Given Name	Middle Name	Family Name	Suffix
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1		<input type="text"/>		
Address 2		<input type="text"/>		
City	<input type="text"/>	State/Province	<input type="text"/>	
Country ⁱ	<input type="text"/>	Postal Code	<input type="text"/>	
Phone Number	<input type="text"/>	Fax Number	<input type="text"/>	
Email Address	<input type="text"/>			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Harnik Shukla/		Date (YYYY-MM-DD)	2019-12-06
First Name	Harnik	Last Name	Shukla	Registration Number
				73,097
Additional Signature may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	FFOG.053C4
		Application Number	
Title of Invention	TOUCH DEVICE		

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

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 the Freedom of Information Act requires disclosure of these records.
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 inspections 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.

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	Aleksander Kocovski
Title	TOUCH DEVICE
Art Unit	Unknown
Examiner Name	Unknown
Attorney Docket Number	FFOG.053C4

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.**

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

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TOUCH DEVICE**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.

BACKGROUNDField of the Invention

[0002] 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

[0003] In one category of touch sensitive panels known as above surface optical touch systems and known from e.g. US4459476, 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.

[0004] 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.

[0005] These systems typically direct light to travel across the surface of the touch surface at a height of up to 5 mm.

[0006] 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.

[0007] 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 disproportionately 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.

[0008] 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.

[0009] 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.

[0010] 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

[0011] 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.

[0012] 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.

[0013] 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.

[0014] 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 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.

[0015] 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 plate 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.

[0016] 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.

[0017] 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

[0018] 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:

[0019] Figure 1 is a top view of the first frame element showing cross-sectional axes A-A and B-B;

[0020] Figures 2a-2d are cross-sectional views of embodiments of assemblies;

[0021] Figure 3a is a schematic illustration showing the cross-section axis B-B of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0022] Figure 3b is a schematic illustration showing the cross-section axis A-A of figure 1 of the assembly with the second frame element relative to the first frame element and holding the plate in a flat plane;

[0023] Figure 3c is a schematic view (cross section) showing the cross-section axis B-B of figure 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;

[0024] Figure 3d is a schematic view (cross section) showing the cross-section axis A-A of figure 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;

[0025] Figure 4a is a perspective view of the first frame element;

[0026] Figure 4b 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;

[0027] Figure 4c is a side view showing screws 116a and 116b;

[0028] Figures 5a-5h are side views and perspective views of an embodiment of the assembly comprising a screw arrangement for configuring frame shape; and

[0029] Figures 6 is a schematic cross section from a first direction of an embodiment of the assembly;

[0030] Figure 7 is a schematic side-view of another embodiment for providing curvature of plate 2;

[0031] Figure 8 shows an isometric view of a variation of the embodiment of figures 5a-5g;

[0032] Figure 9 is a diagram showing a top down view of an optical touch system and corresponding detection lines;

[0033] Figure 10a shows an isometric view of a flat touch surface of an optical touch system;

[0034] Figure 10b shows a section view of an optical touch system with a flat touch surface;

[0035] Figure 11a shows an isometric view of a touch surface of an optical touch system having a curved profile in the x-axis;

[0036] Figure 11b 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;

[0037] Figure 11c 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;

[0038] Figure 11d shows an example of types of warpage that a touch panel may exhibit.

[0039] Figure 12a shows top view of a touch surface of an optical touch system;

[0040] Figure 12b 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;

[0041] Figure 12c 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;

[0042] Figure 12d 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;

[0043] Figure 13a 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;

[0044] Figure 13b 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;

[0045] Figure 14a 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;

[0046] Figure 14b 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;

[0047] Figure 15a 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;

[0048] Figure 15b 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;

[0049] Figure 16a 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;

[0050] Figure 16b 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;

[0051] Figure 17a 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;

[0052] Figure 17b 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;

[0053] Figure 18a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0054] Figure 18b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0055] Figure 19a shows a curvature of a real touch surface vs a parabolic curved surface along an x-axis;

[0056] Figure 19b shows a deviation between a real touch surface vs a parabolic curved surface along an x-axis;

[0057] Figure 20a shows top view of displacement contours for a touch surface according to an embodiment;

[0058] Figure 20b shows curvature of a touch surface along an x-axis according to the embodiment of figure 20a;

[0059] Figure 20c shows curvature of a touch surface along a y-axis according to the embodiment of figure 20a;

[0060] Figure 20d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 20a;

[0061] Figure 21a shows top view of displacement contours for a touch surface according to another embodiment;

[0062] Figure 21b shows curvature of a touch surface along an x-axis line according to the embodiment of figure 21a;

[0063] Figure 21c shows curvature of a touch surface along a y-axis line according to the embodiment of figure 21a;

[0064] Figure 21d shows curvature of a touch surface along a diagonal line according to the embodiment of figure 21a.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0065] 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.

[0066] 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.

[0067] 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.

[0068] Figure 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.

[0069] 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 figures 2a-2c and 3a-3d, the force applies a torque to a support portion 101a, 101b for the plate 2. In the embodiments of figures 4a-4c, the force is substantially straight and perpendicular to the plate 2. In the following, the embodiments of figures 2a-2c, 3a-3d, 4a-4c, and 5a-5g will be described separately. However, these embodiments may be combined to provide further embodiments, such as the combination illustrated in figures 6a-6c.

[0070] Figures 2a-2d illustrate embodiments wherein the frame assembly 100 comprises a first frame element 102 and at least one second frame element 103a, 103b. 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 103a, 103b may form a holder or support bracket. Furthermore, second frame element 103a, 103b may extend along at least a portion of a perimeter of the plate 2 and/or the panel 1. Separate second frame elements 103a, 103b 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 103a, 103b may extend along opposing perimeters of the plate 2 and/or panel 1. Alternatively, four second frame elements 103a, 103b 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.

[0071] As is illustrated in figures 4a-4c, the panel 1 may be held between the first frame element 102 and the second frame element 103a, 103b. The plate 2 may be supported or held at a first side of a portion of the second frame element 103a, 103b forming the support portion 101a, 101b. The panel 1 may be held or supported by a second side of the support portion 101a, 101b, which forms a support portion for the panel 1. An adhesive 104, such as an adhesive tape, may be arranged between the support portion 101a, 101b and the plate 2. A gasket 105 may be arranged between the support portion 101a, 101b and the panel 1.

[0072] In one embodiment, elements 102, 103 (shown in the figure as comprising elements 103a and 103b) are formed from a single piece.

[0073] The second frame element 103a, 103b may be attached to the first frame element 102.

[0074] In the embodiments of figures 2a-2c and 3a-3d, the second frame element 103a, 103b, is attached to the first frame element 102 by at least one attachment member 106a, 106b, such as a screw, a weld, a rivet etc. Therefore, the second frame element 103a, 103b may be rigidly attached to the first frame element 102.

[0075] The first frame element 102 may comprise a flange 107a, 107b that extends at the perimeter of the first frame element 102. Similarly, the second frame element 103a, 103b may comprise a flange 108a, 108b. When assembled, the flange 107a, 107b of the first frame element 102 may be arranged in abutment with the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be held together with the flange 108a, 108b of the second frame element 103a, 103b by the attachment member 106a, 106b.

[0076] The first frame element 102 may form a frame 109 (shown in figure 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.

[0077] As is illustrated in figures 3a and 3b, the assembly 100 may comprise at least one support area 110a, 110b for supporting a back cover 111. The support area 110a, 110b may extend in a plane that is substantially parallel to the first plane, in which the frame 109 extends. The support area 110a, 110b may be located further away from the support portion 101a, 101b of the second frame element 103a, 103b than the frame 109, such that the frame 109 and the back cover 111 are spaced apart. In the illustrated embodiment, the support area 110a, 110b is provided between the flange 107a, 107b and the frame 109 of the first frame element 102. The back cover 111 may be attached to the support area 110a, 110b, e.g. by attachment elements, such as screws.

[0078] In other embodiments, the support area 110a, 110b is provided by the flange 108a, 108b of the second frame element 103a, 103b. The flange 107a, 107b of the first frame element 102 may be connected to the second frame element 103a, 103b between the flange 108a, 108b and the support portion 101a, 101b of the second frame element 103a, 103b.

[0079] The second frame element 103a, 103b may form the support portion 101a, 101b. For example, the second frame element 103a, 103b may form an elongated member that is at least partly L-shaped in cross-section. When assembled, the second frame element 103a, 103b may extend along the perimeter of the panel 1, and wrap around the perimeter of the panel such that the support portion 101a, 101b 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 103a, 103b 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.

[0080] In some embodiments, the second frame element 103a, 103b 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 101a, 101b 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 103a, 103b. The first portion may be substantially perpendicular to the second portion.

[0081] As is illustrated in figures 3a-3d, the first frame element 102 may be attached to the first portion of the second frame element 103a, 103b 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 101a, 101b is tilted towards the first frame element 102. Thus, a torque may control tilt of the second portion of the second frame element 103a, 103b, i.e. the support portion 101a, 101b that supports the plate 2, relative to the first frame element 102, which is illustrated with a curved arrow in figure 3c and 3d. In some embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be neutral, i.e. the angle of tilt of the support portion 101a, 101b 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 figures 3a and 3b. In other embodiments, the angle of tilt of the support portion 101a, 101b is controlled to be negative relative to the touch surface, i.e. the angle of tilt of the support portion 101a, 101b is controlled such that the free end of the support portion 101a, 101b is tilted towards the frame 109, as is illustrated in figure 3c and 3d. 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 101a, 101b 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.

[0082] Figures 2a-2d and 3a-3d 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 112a, 112b, and 112c) may be arranged around the frame 109, such as at each corner of the frame 109, which is illustrated as circles in figure 4a. Each attachment element may comprise a group of screws 112a, 112b, 112c, 113a, 113b.

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 112a, 112b, 112c, 113a, 113b. At least one of the screws 112a, 113a may be arranged to displace the frame 109 away from panel 1, which is indicated with an arrow in figure 2d e.g. by having a thread in the frame 109 and pushing on the panel 1. At least one other of the screws 112b, 112c, 113b may be arranged to displace the frame 109 towards the panel 1, which is also indicated with an arrow in figure 2d. e.g. by having a thread in the panel and a hole in frame 109.

[0083] Figure 2a illustrates an embodiment wherein each attachment element comprises at least three screws 112a, 112b, 112c. All three screws 112a, 112b, 112c are arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101a, 101b, i.e. an imaginary extension 114a, 114b, 114c of the longitudinal axis of each screw 112a, 112b, 112c passes outside the support portion 101a, 101b when viewed in cross-section, as is illustrated in figure 2a. In the illustrated embodiment, a first screw 112a is arranged between a second screw 112b and a third screw 112c. Figure 2a only illustrates one group of screws. However, a group of screws may be arranged at any location around the frame 109 to attach the first frame element 102 to the panel 1.

[0084] Figure 2b illustrates an embodiment wherein each group of screws consists of only two screws 113a, 113b. A first screw 113a is arranged opposing the support portion 101a, 101b, i.e. an imaginary extension 115a of the longitudinal axis of the first screw 113a passes through the support portion 101b when viewed in cross-section, such as through the center thereof, as is illustrated in figure 2b. A second screw 113b of the two screws is arranged closer to a center of the first frame element 102 than a perimeter of the support portion 101b, i.e. an imaginary extension 115b of the longitudinal axis of the first screw 113b passes outside the support portion 101b when viewed in cross-section, as is illustrated in figure 2b.

[0085] As shown in figure 2d, the first screw 112a is arranged to displace the frame 109 away from panel 1. This may be enabled by a threaded hole 112i in the frame 102 which the first screw engages while a head of the screw abuts the panel 1. The second screw 112b is arranged to displace the frame 109 towards the panel. This may be enabled by a threaded hole 112f in the panel 1, which the second screw 112b engages while the head of the second screw 112b abuts the surface of the frame. By using screw 112a and/or 112b,

forces may be applied to frame 102 and/or panel 2 to control bending or rotation of the frame/panel.

[0086] Since the first screw 113b is aligned over the support portion 101a, 101b in the embodiment of figure 2b, only two screws are required to control bending or rotation of the frame.

[0087] In figures 2a-2b, 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.

[0088] figure 2c illustrates that a combination the embodiment of figures 2a and 2b, i.e. groups of screws with two as well as three screws may be arranged around the frame 109. Therefore, flexibility is provided for.

[0089] As is illustrated in figures 2a-2c and 3c and 3d, each group of screws 112a, 112b, 112c, 113a, 113b may apply a force to the frame 109. Therefore, a torque may be applied at the second frame element 103a, 103b via controlling the curvature of the frame 109 such that tilt of the support portion 101a, 101b, and thereby curvature of the plate, is controlled. In the assembly illustrated in figure 3a, a net force is applied such that the frame is substantially flat and parallel with the panel 1. In the assembly illustrated in figure 3c and 3d, a net force away from the support portion 101a, 101b 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 103a, 103b, which will tilt the support portion 101a, 101b 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.

[0090] Figures 4a-4c, 5a-5g and 6a-6c illustrate embodiments wherein an alternative or additional control of the shape of the frame 109 may be introduced. As shown in figure 4a, attachment elements 112 may be arranged at the corners of the frame 109. The attachment elements 112 may comprise the group of screws 112a, 112b, 112c, 113a, 113b as described above with regard to figures 2a-2c and 3a-3d. 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 101a, 101b 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 103a, 103b such that the support 101a, 101b is tilted as described above, whereby curvature of the plate 2 is controlled.

[0091] As is illustrated in figure 4b, 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 101a, 101b, at least at the free end of the support portion 101a, 101b, may also follow a curved path. Therefore, at least a portion of the support portion 101a, 101b may extend in a plane that is curved.

[0092] When the second frame element 103a, 103b is disassembled or only attached to the first frame element 102, it may have a relaxed state. In the relaxed state, the support portion 101a, 101b extends in a plane that is substantially flat. The second frame element 103a, 103b 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 101a, 101b 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 103a, 103b may be deflected to the deflected or stressed state. In the deflected or stressed state, the support portion 101a, 101b extends, along its length, in a plane that is curved. A cross section of this plane taken along the support portion 101a, 101b, such as at the free end or tip of the support portion 101a, 101b may form a parabolic concave curve along at least a portion of the length of the support portion 101a, 101b. 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 103a, 103b in the deflected or stressed state when assembled with the first frame element 102.

[0093] 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 figure 3a and 3b and figure 6a, two spacing elements 116a, 116b are shown for illustrative purposes and may form separate embodiments. A single-spacing element 116a, 116b may be used in other embodiments. The head of the spacing element 116a, 116b may abut the back cover 111 while the spacing element 116a, 116b 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 116a 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 116b is sufficiently long such that a tip of the spacing element 116b abuts a surface of the panel 1. This adds further control of the shape of the plate 2.

[0094] 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 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.

[0095] 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 figure 5h, 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.

[0096] Figures 5a-5h illustrate embodiments of an assembly 200, which may be combined with the first frame element 102 described above. The embodiments shown in figures 5a-5h are shown inverted relative to the embodiments shown previously, with the plate 2 at the top.

[0097] As shown in figures 5a and 5b, 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 201a, 201b. 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 201a, 201b, 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 201a, 201b may support or engage opposing surfaces of the plate 2, such as is illustrated in figure 5g.

[0098] In some embodiments, such as illustrated in figures 5c-5d, a gasket 205 (e.g. gaskets 205a, 205b, 205c, 205d, 205e) 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 201a of the first frame element 202. Also, a sealing 204a may be arranged on the support portion 201b of the second frame element 203.

[0099] 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 figures 5f-5g. 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 1.5-2.0mm at the ends and about 1 mm thinner at the center.

[0100] 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 205a of the gasket is provided at one of its ends and a second section 205b of the gasket at the other of its ends. The first section 205a and the second section 205b may have a first thickness that may be equal at each section. At least a third section 205c of the gasket is arranged between the

first section 205a and the second section 205b. The third section 205c has a second thickness. The first thickness is thicker than the second thickness. For example, difference in thickness is about 0.5-2mm, preferably about 1.0mm. 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 205d, 205e may be provided between the first and second sections 205a, 205b and the third section 205c, respectively. The fourth and fifth sections 205d, 205e 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 205a, 205b 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 205d, 205e 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 205d, 205e is shorter than the length of the third section 205c, and the total length of the first and second sections 205a, 205a is shorter than total length of the fourth and fifth sections 205d, 205e. This provides for a parabolic concave curve along the length of the frame assembly 200.

[0101] A distance between the support portion 201a of the first frame element 202 and the support portion 201b of the second frame element 203 may be discontinuous in an assembled state, as can be seen in figure 5e.

[0102] 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 201a, 201b is maintained in the assembled state. The first frame element 202 has a first hole 217a and a second hole 217b 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 217a, 217b are arranged in a first plane. A third hole 217c is arranged between the first hole 217a and the second hole, such as centered between the first hole 217a and the second hole 217b. The third hole 217c 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 217a, 217b are arranged and the plane in which the third hole 217c is arranged may be substantially the same as the difference in thickness between the first and second sections 205a, 205b and the third section 205c, i.e. about 0.5-2mm. In some embodiments the first and second holes

217a, 217b are centered in each of the first and second sections 205a, 205b of the gasket 205 along the length of the first frame element 202.

[0103] Similarly, the second frame element 203 may comprise a first hole 218a and a second hole 218b arranged at opposing ends of the second frame element 203. A third hole 218c may be arranged between the first hole 218a and the second hole 218b of the second frame element 203. The first hole 218a, the second hole 218b, and the third hole 218c 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 218a, 218b, 218c of the second frame element 203 is aligned with the holes 217a, 217b, 217c of first frame element 202. Therefore, the support portion 201b of the second frame element 203 may be deflected such that it extends in plane, which is curved in the assembled state of the frame assembly 200. Screws 219a, 219b, 219c may be inserted through the aligned holes 217a, 217b, 217c; 218a, 218b, 218c 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 217a, 217b, 217c; 218a, 218b, 218c are foreseen, wherein the center holes 217c, 218c 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.

[0104] 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 figures 4a-4c, the frame side may replace the second frame element of the embodiments of figures 4a-4c. Therefore, the frame side comprises the support portion 201a with a support surface generally opposing the frame 109 and is configured to support the gasket 205.

[0105] As illustrated in figure 6, a component (e.g. a sealing component 204a) may be provided between the support portion 201a and the plate 2. Figure 6 illustrates the resulting forces and torque generated when a force 220 is applied to second frame element 203a. 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.

[0106] In an embodiment shown in figure 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 103A. Plate 2 is pressed against the top surface of support block 301 from pressure 201b from first frame element 102 and sealing 204a. Pressure 201b 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 103A. 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 103A.

[0107] In an embodiment shown in figure 8, a variation of the embodiment shown in figures 5a-5g is provided. In this embodiment, second frame element 203 has been modified, such that a portion 410 has been removed from the edge portion 203c 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%.

[0108] 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.

[0109] 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.

[0110] Figure 9 illustrates a top plan view of an example of a touch-sensitive apparatus 99. Emitters 30a are distributed around the periphery of touch plate 10, to propagating light across touch surface 20. 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 propagate to a number of different detectors 30b on a plurality of light paths 50.

[0111] 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 30a and detectors 30b. 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 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.

[0112] 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 fiber. 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.

[0113] 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 "projection signals", 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 projection signals. The projection signals represent the received energy, intensity or power of light received by the detectors 30b 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".

[0114] 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 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 determination are found in WO2009/077962, WO2011/049511, WO2011/139213, WO2012/050510, and WO2013/062471, all of which are incorporated herein by reference.

[0115] In the illustrated example, the apparatus 99 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.

[0116] Figure 10a 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 figure 10a. 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.

[0117] Figure 10b illustrates an example of a touch apparatus according to the prior art. Figure 10b 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 30a, 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 30b. 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.

[0118] Figure 11a illustrates an embodiment of touch plate 10 similar to that shown in figure 10a 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. Figure 11b shows a cross-section view along the x-axis of the touch plate 10 of figure 11a.

[0119] Figure 11c 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.

[0120] Figure 11d 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.

[0121] 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.

[0122] 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:

$$F(x) = -a + cx^2$$

[0123] In the present example embodiment, a maximum distance α between the 1900 mm long cross section of the touch surface in figure 11c and the x-axis is 2.0 mm. Therefore, an ideal parabolic curve for touch surface 20 may be:

$$F(x) = 5.5 * 10^{-5} * x^2 - 2.0$$

[0124] 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.

[0125] Figures 12a and 12b illustrates an embodiment of touch plate 10 similar to that shown in figure 11a but wherein the touch plate 10 is curved in two axes. Figure 12a shows a top plan view and figure 12b shows an isometric view of touch plate 10. In this embodiment, the plate is curved in a concave 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 figure 11a, 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 the y-axis.

[0126] Figure 12c and 12d shows respective section views along the x-axis and y-axis of the touch plate 10 of figure 12a and 12b. 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 α between the touch surface and the x-axis is at the center point O. The maximum distance α is a positive number

for a concave glass in the present examples. The curvature of the touch surface may therefore be modelled as:

$$z(x,y) = -a + b * x^2 + c * x^2 * y^2 + d * y^2$$

[0127] 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.

[0128] 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):

$$z(x,y) = -2 + 5.56e - 06 * x^2 - 1.71e - 11 * x^2 * y^2 + 1.7e - 05 * y^2$$

[0129] 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:

$$z(x,y) = -2.5 + 5.56e - 06 * x^2 - 2.37e - 11 * x^2 * y^2 + 1.28e - 05 * y^2$$

[0130] Figure 13a 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 1310a 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, gracing incidence, dirt or anti-glare coatings on the touch surface have no practical impact of the reflection, so it is practically a mirror.

[0131] Figure 13b 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 figure 13a. 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.

[0132] Figure 14a shows a section view of the embodiment of figure 13a. 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. Figure 14b shows the corresponding graph of figure 13b for the second point light source 1410.

[0133] Figure 15a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a third point light source 1510 are shown. Figure 15b shows the corresponding graph of figure 13b for the third point light source 1510. In this example, the detection signal boost is approximately 3.03.

[0134] Figure 16a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fourth point light source 1610 are shown. Figure 16b shows the corresponding graph of figure 13b for the fourth point light source 1610. In this example, the detection signal boost is approximately 2.71.

[0135] Figure 17a shows a section view of the embodiment of figure 13a. In the section view, the propagation paths of light from a fifth point light source 1710 are shown. Figure 17b shows the corresponding graph of figure 13b for the fifth point light source 1710. In this example, the detection signal boost is approximately 2.19.

[0136] Figures 13a-17b 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.

[0137] 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.

[0138] Figure 18a shows a graph of a mathematically defined parabolic curve and a real-world parabolic touch surface. In the example embodiment of figure 18a, a curved touch plate 10 has a width of 1900 mm along the x-axis and a height of 1070mm along the y-axis (wherein the x-axis and y-axis are defined as in the embodiment shown in figure 12a,4b). 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 α between the touch surface and the x-axis is 10mm. 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 10b 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 $|\text{parabolic deviation}| < 0.5$ mm.

[0139] 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.

[0140] Figure 18b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 18a.

[0141] 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	6.00	0.0	2.00	0.1	0.5

[0142] Convexity b is shown in figure 18a. Parabolic deviation is shown in figure 18b.

[0143] Figure 19a shows another graph of a mathematically defined parabolic curve and a similar glass to that of figure 18a but wherein the glass of figure 19a is out of range and not recommended for touch system production. One reason for the large concavity shown in figure 19a may be that the tempering process has been run with too large differences between bottom and top cooling parameters in a quenching process during manufacturing. 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.

[0144] Figure 19b shows a graph of the deviation between the mathematically defined parabolic curve and a real-world parabolic touch surface of figure 19a. The real-world parabolic touch surface of figure 19a 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.

[0145] Figure 20a shows an embodiment in which the touch surface forms a paraboloid. In figure 20a, 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

figure 20b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 20a, the curved touch plate 10 has a width of 1900mm along the x-axis and a height of 1070 mm along the y-axis.

[0146] Figures 20b-20d show optional parabola configurations for the embodiment shown in figure 20a. Figure 20b 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. Figure 20c 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. Figure 20d 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.

[0147] The embodiments shown in figure 20a-20d 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.

[0148] Figure 21a shows an embodiment in which the touch surface forms an alternative paraboloid to that of the embodiment shown in figure 20a. As with figure 20a, figure 21a 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 figure 21b, diagonal-axis d is shown running from the bottom left corner to the top right corner. In the example embodiment of figure 21a, 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 embodiments where the perimeter of the touch surface is flat or close to flat, the surface beneath some detection lines will not be perfect parabolas. 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.

[0149] Figure 21b 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. Figure 21c 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. Figure 21d 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.

[0150] 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.

[0151] 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.

[0152] 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, comprising:
 - configuring the frame assembly to support the display panel; and
 - configuring the frame assembly to support the plate;
 - wherein configuring the frame assembly to support the plate includes inducing a curvature in the touch surface.
2. The method of claim 1, wherein the frame assembly includes:
 - a first edge;
 - a second edge perpendicular to the first edge; and
 - a plane defined by the first edge and the second edge;
 - wherein the touch surface includes a center point; and
 - wherein the inducement of the curvature in the touch surface causes the center point to move further away from the plane.
3. The method of claim 1, further comprising 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.
4. The method of claim 3, further comprising 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.
5. The method of claim 1, wherein the curvature is parabolic concave.
6. 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.

7. The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along an edge of the plate.
8. The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.
9. The touch sensing apparatus of claim 6, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.
10. 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 touch surface is parabolic concave.
11. The touch sensing apparatus of claim 10, wherein the set of emitters is configured to emit light to propagate over the touch surface.
12. The touch sensing apparatus of claim 10, wherein the set of emitters is configured to emit light through the plate by total internal reflection.

13. The touch sensing apparatus of claim 10, 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.

14. The touch sensing apparatus of claim 10, wherein the plate has a first curvature when not installed in the frame assembly, and wherein the plate has a second curvature greater than the first curvature when the plate is installed in the frame assembly.

15. The touch sensing apparatus of claim 14, wherein the first curvature and second curvature are measured along an edge of the plate.

16. The touch sensing apparatus of claim 14, wherein the first curvature and second curvature are measured along an axis passing through a center point of the plate.

17. The touch sensing apparatus of claim 14, wherein the first curvature and second curvature are measured along a line passing through a point on the touch surface.

18. The touch sensing apparatus of claim 10, further comprising a gasket, wherein the plate is supported by the gasket proximate to an edge of the plate.

19. The apparatus of claim 18, wherein the gasket is configured to have varying thickness to match a curvature of the plate along the edge.

20. The apparatus of claim 10, wherein the second frame element is curved.

ABSTRACT OF THE DISCLOSURE

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 is 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.

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	TOUCH DEVICE			
First Named Inventor/Applicant Name:	Aleksander Kocovski			
Filer:	Harnik Shukla/Jenny Kim			
Attorney Docket Number:	FFOG.053C4			
Filed as Large Entity				
Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				5860

Electronic Acknowledgement Receipt

EFS ID:	37956576
Application Number:	16706438
International Application Number:	
Confirmation Number:	3081
Title of Invention:	TOUCH DEVICE
First Named Inventor/Applicant Name:	Aleksander Kocovski
Customer Number:	20995
Filer:	Harnik Shukla/Kealani Aguon
Filer Authorized By:	Harnik Shukla
Attorney Docket Number:	FFOG.053C4
Receipt Date:	06-DEC-2019
Filing Date:	
Time Stamp:	18:17:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$5860
RAM confirmation Number	E2019B6I19221440
Deposit Account	111410
Authorized User	Kealani Aguon

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)

Chemtronics v. FlatFrog

Chemtronics Exhibit 1013 Page 751

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	053C4_Track1.pdf	113806	no	2
			3a84d01963feabfaafd3162be47c63889c3845eb		
Warnings:					
Information:					
2	Drawings-only black and white line drawings	053C4_Figs.pdf	5393995	no	54
			4fb118ad699385e7bdc58a89fd2fe0ecdb4bc381		
Warnings:					
Information:					
3	Oath or Declaration filed	053C4_Decassign.pdf	151561	no	5
			e3ca4cf5dc24887e20a980b0e34a94a4f4441446		
Warnings:					
Information:					
4	First Action Interview - Enrollment Request	053C4_FAI.pdf	621216	no	3
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Warnings:					
Information:					
5	Application Data Sheet	053C4_ADS_rev.pdf	1256487	no	9
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Information:					
6	Power of Attorney	053C4_POA.pdf	1284228	no	2
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	Specification		1	32	
	Claims		33	35	
	Abstract		36	36	
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Warnings:					
Information:					
Total Files Size (in bytes):			9051142		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					

**CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION
UNDER 37 CFR 1.102(e) (Page 1 of 1)**

First Named Inventor:	Aleksander Kocovksi	Nonprovisional Application Number (if known):	
Title of Invention:	TOUCH DEVICE		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently \$0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.
2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.
3. The applicable box is checked below:

I. ☒ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

- i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.
---OR---
(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.
- ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, or the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

- i. A request for continued examination has been filed with, or prior to, this form.
- ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
- iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
- iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
- v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature <u>/Harnik Shukla/</u>	Date <u>12/6/2019</u>
Name (Print/Typed) <u>HARNIK SHUKLA</u>	Practitioner Registration Number <u>73,097</u>

Note: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.*

☒ *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.

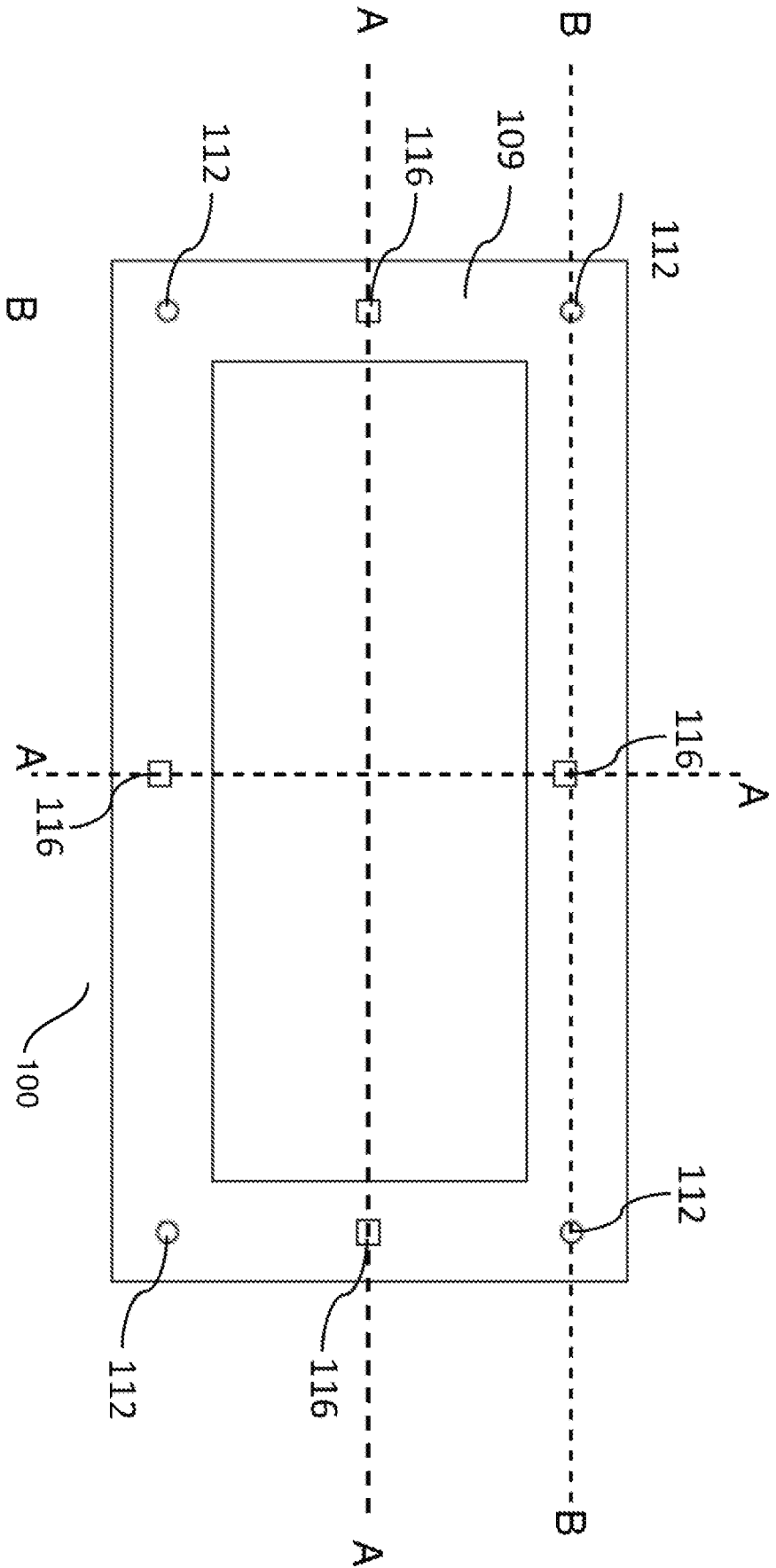


Figure 1

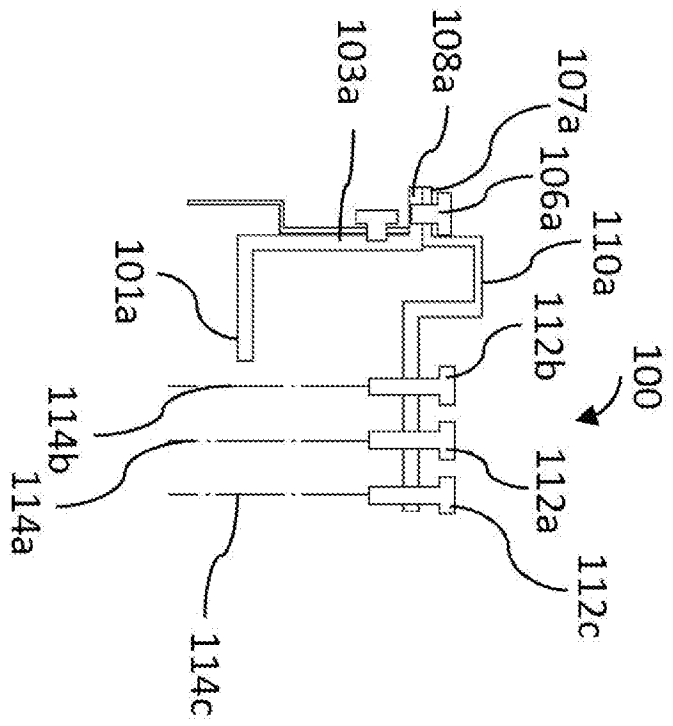
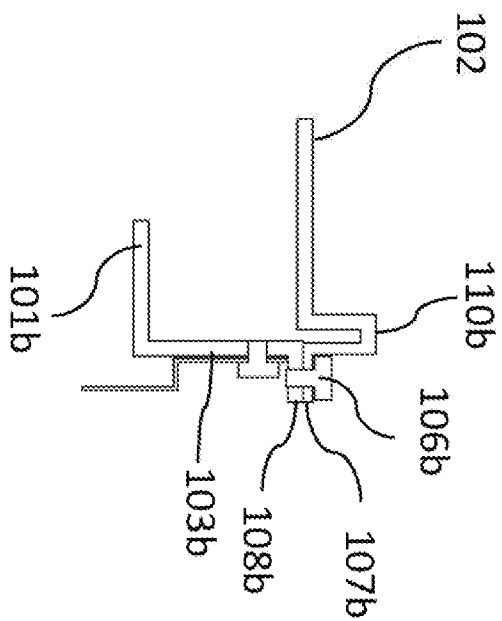


Figure 2a



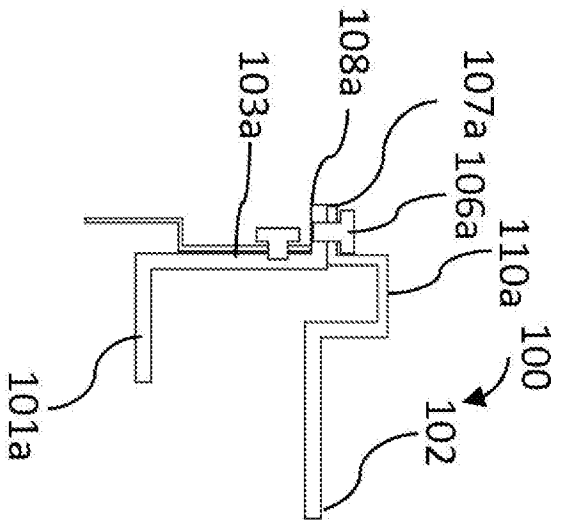
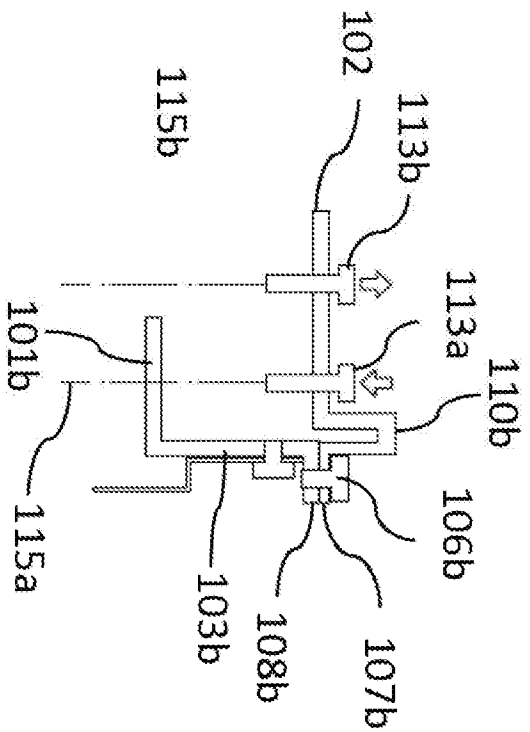


Figure 2b

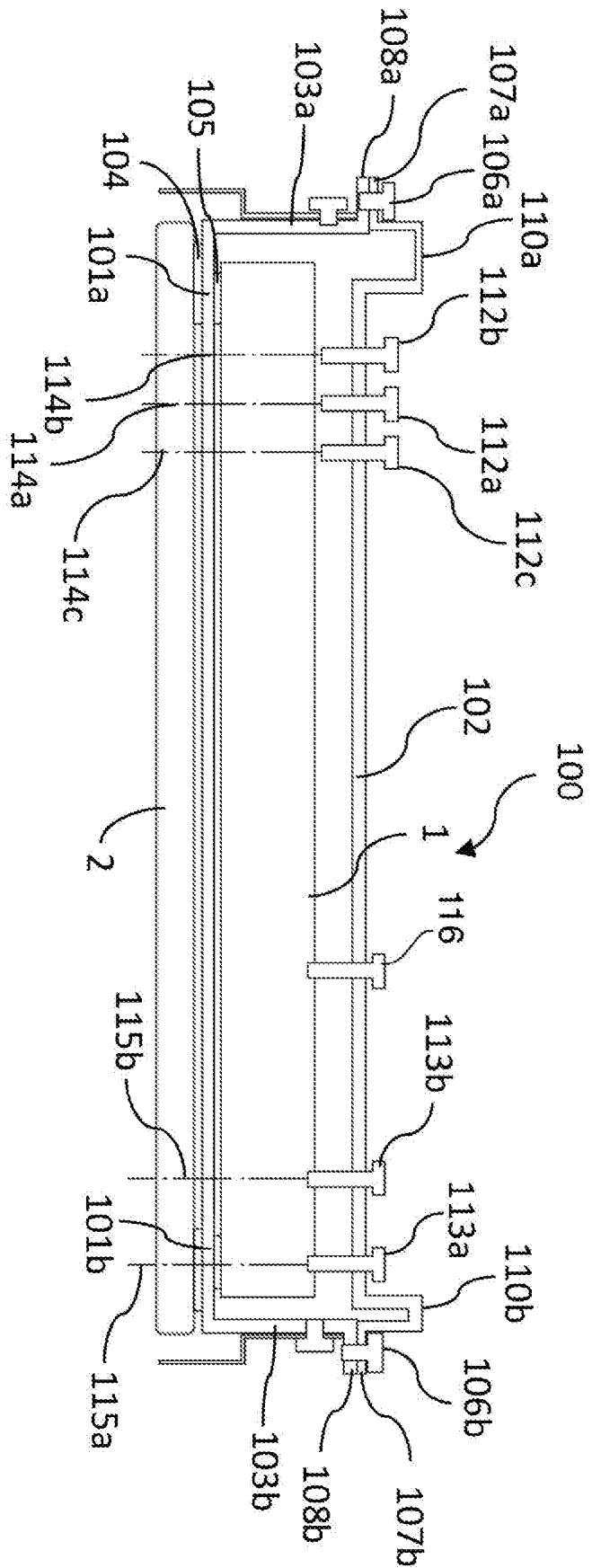


Figure 2c

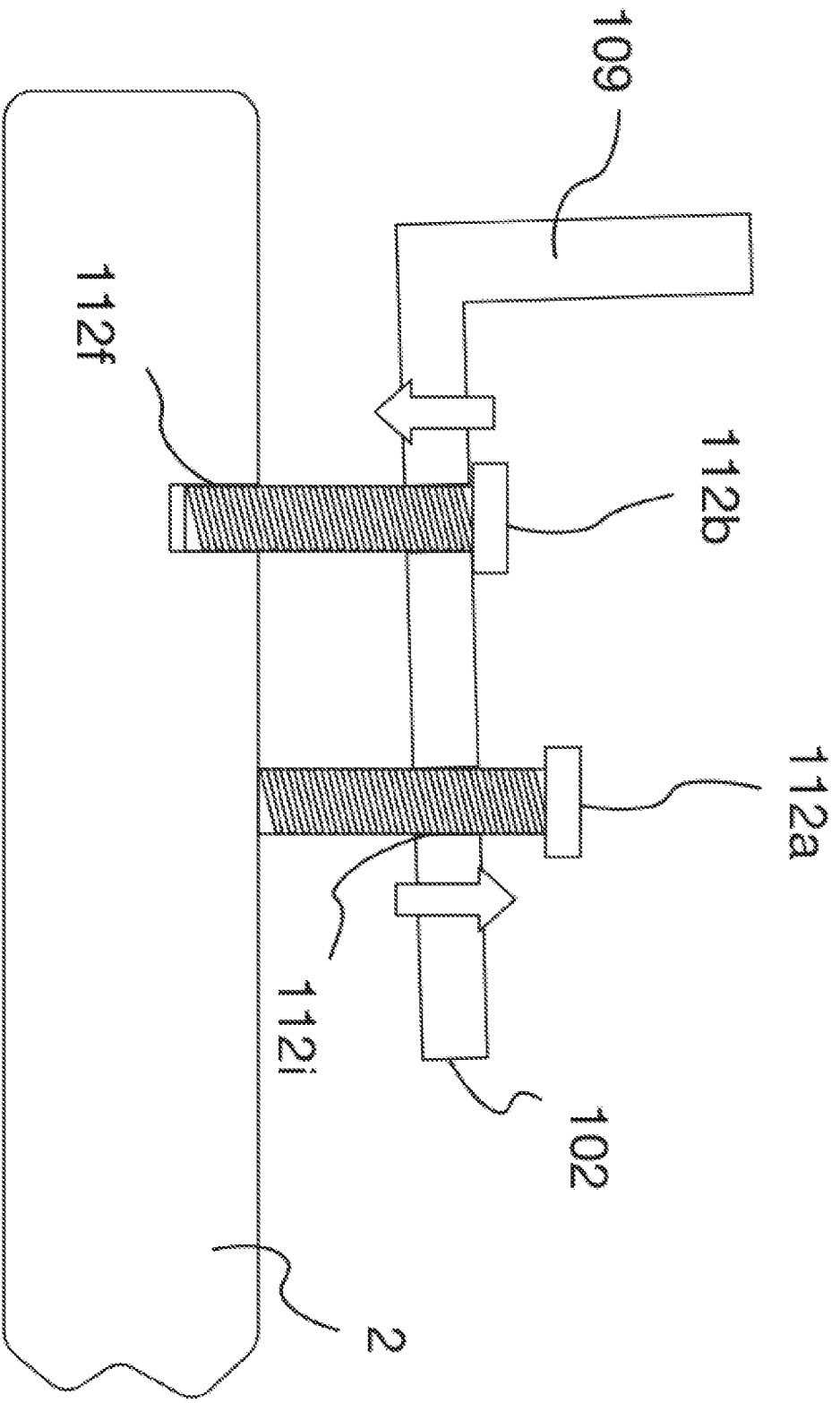


Figure 2d

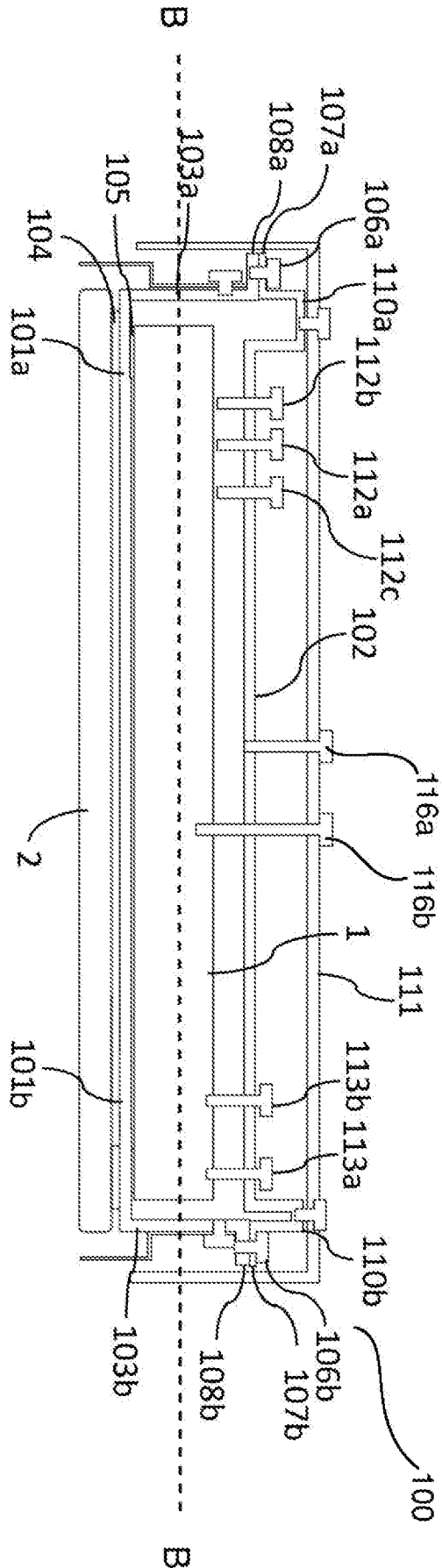


Figure 3a

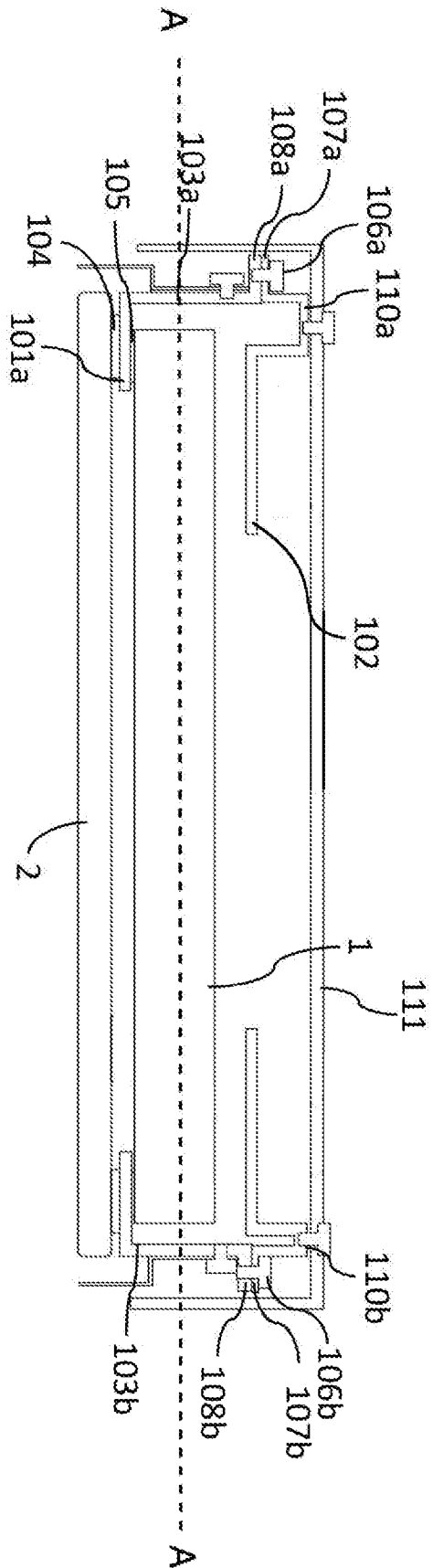


Figure 3b

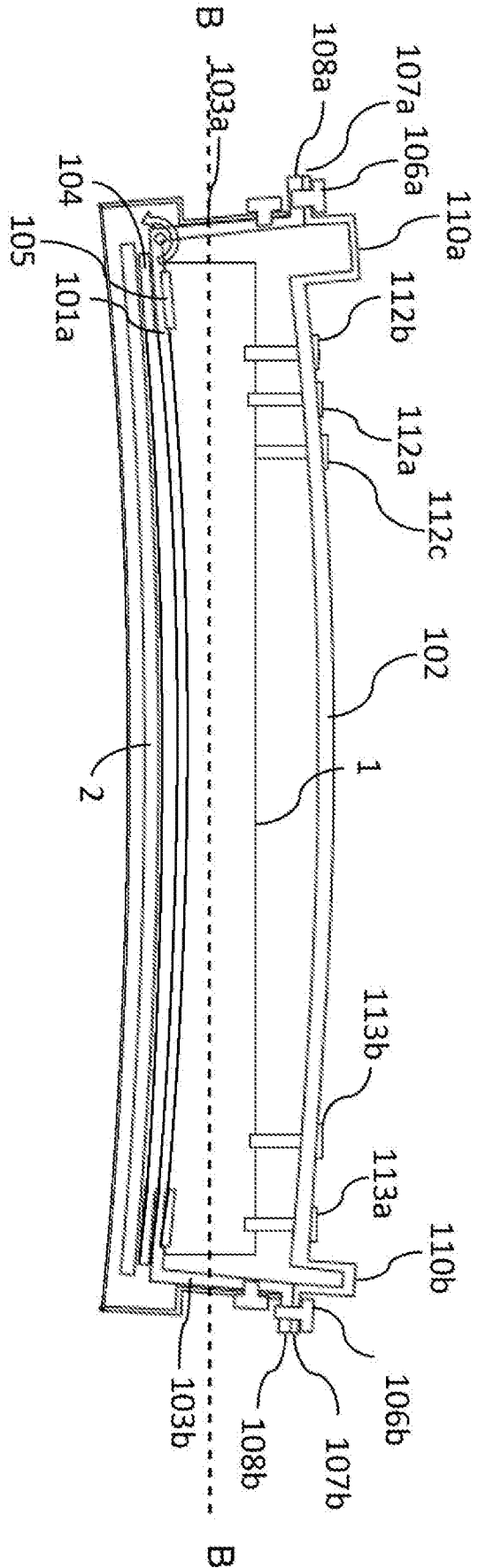


Figure 3c

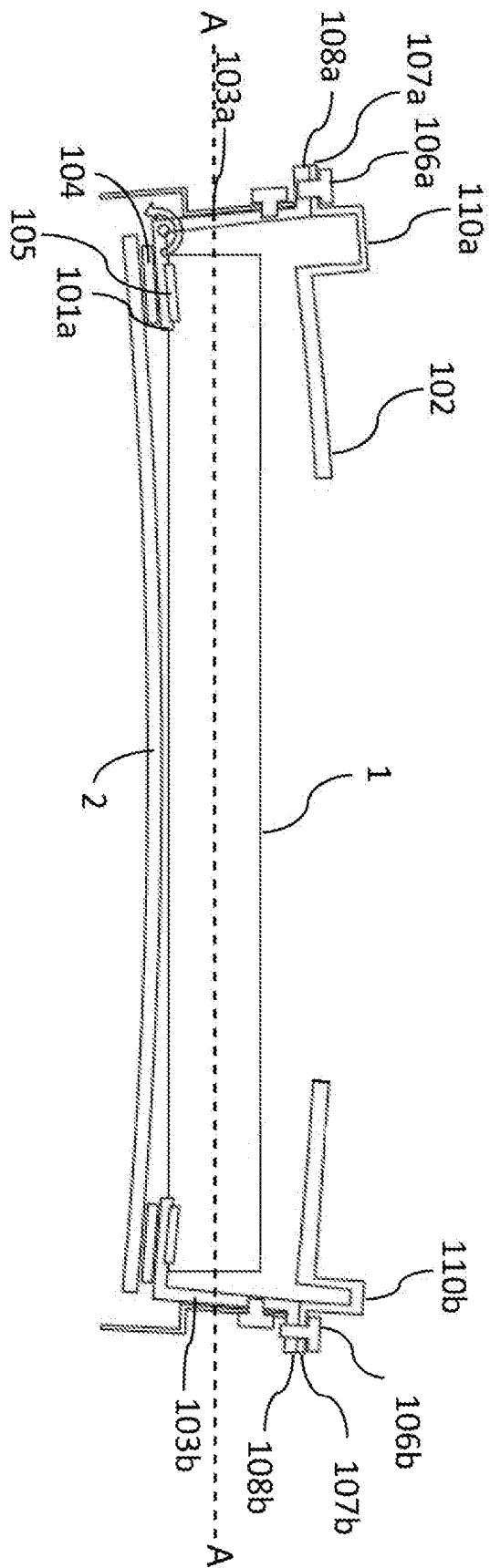


Figure 3d

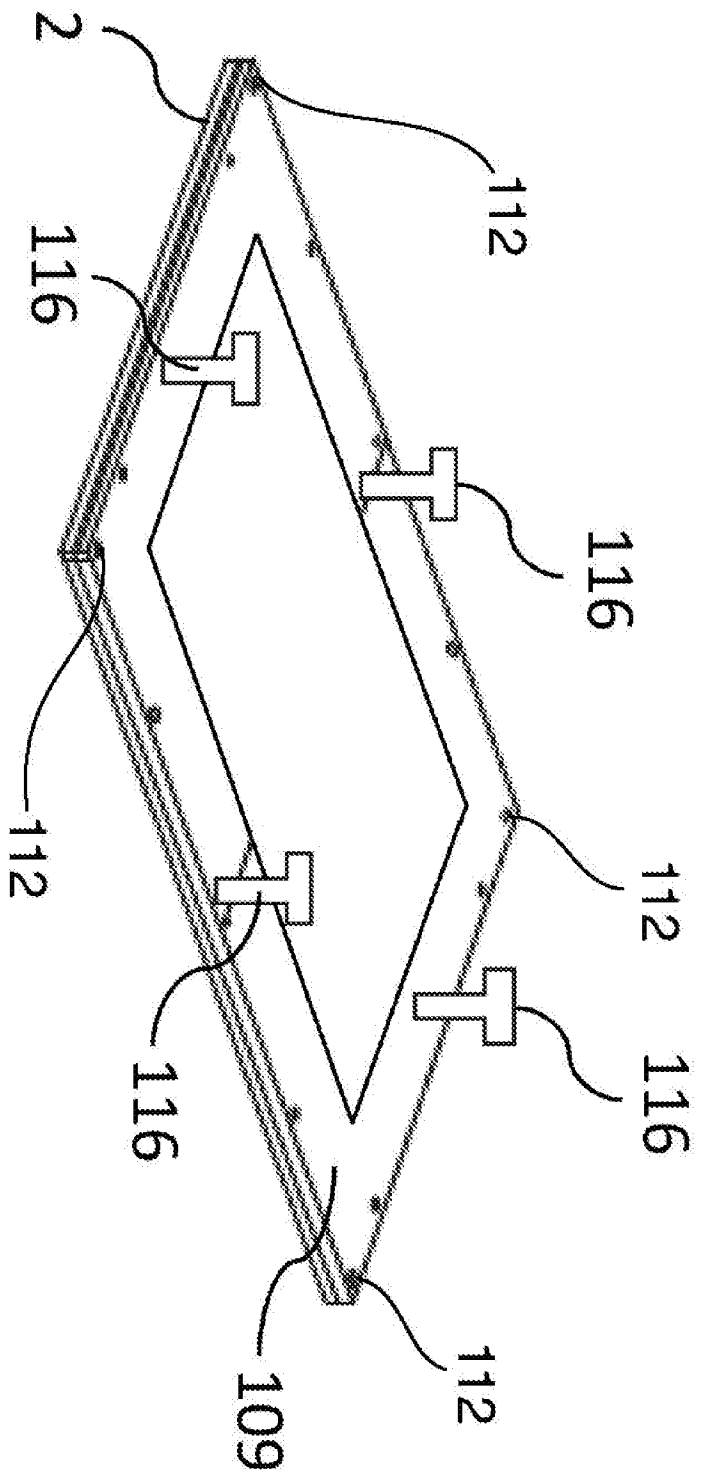


Figure 4a

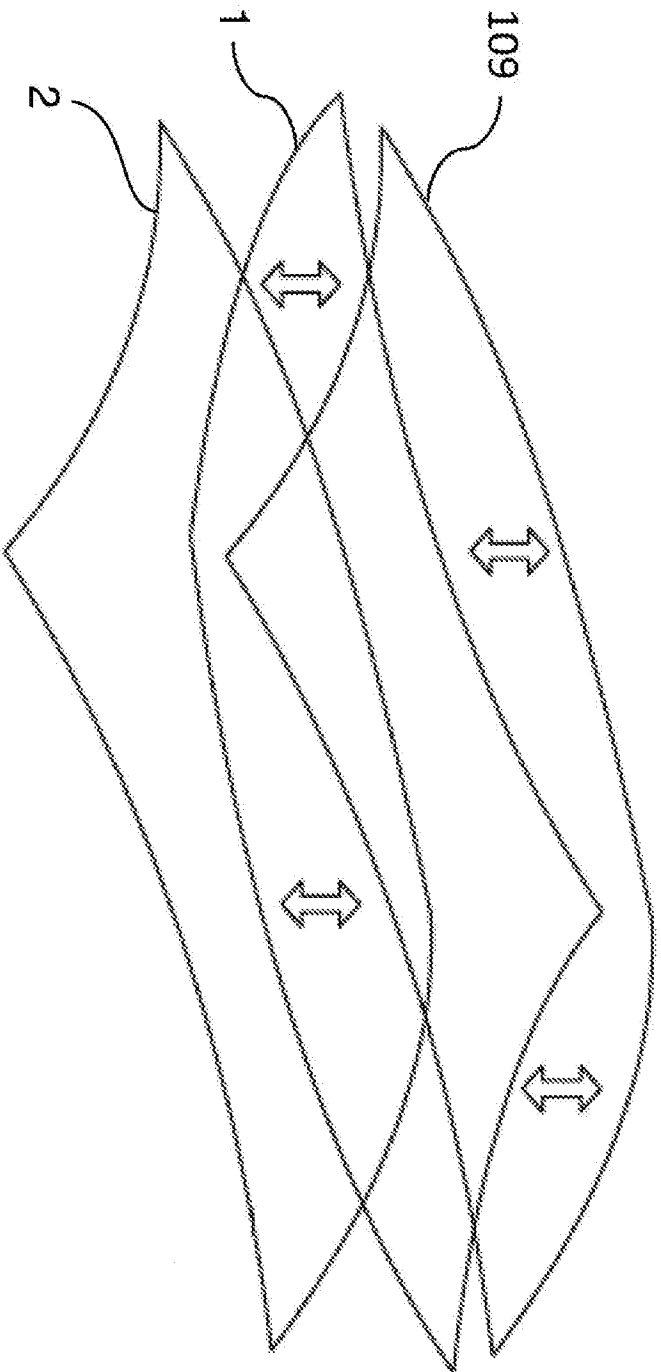


Figure 4b

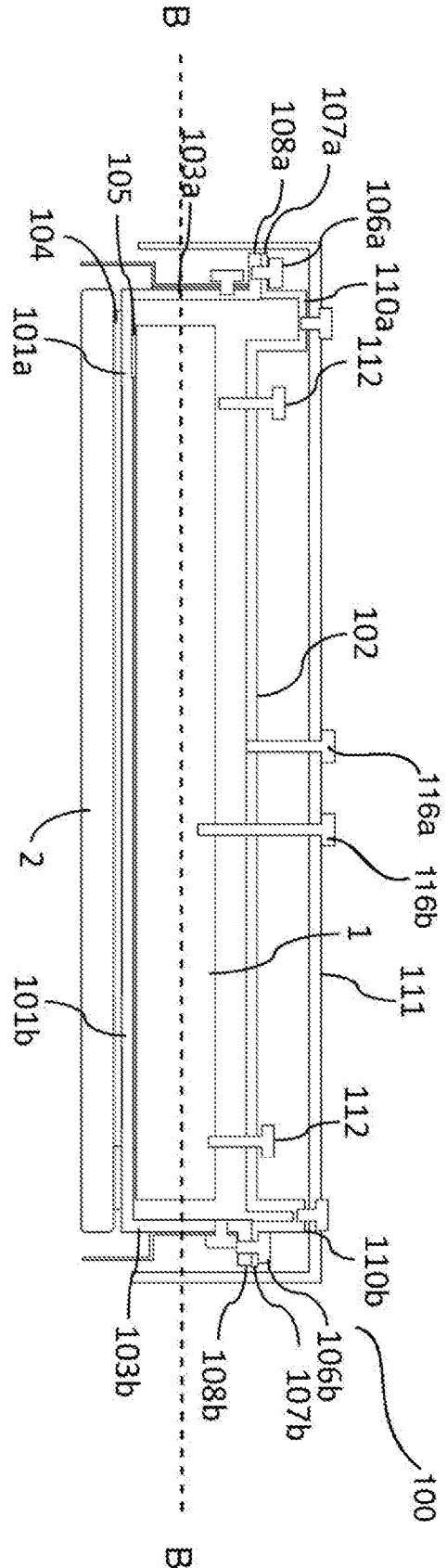


Figure 4c

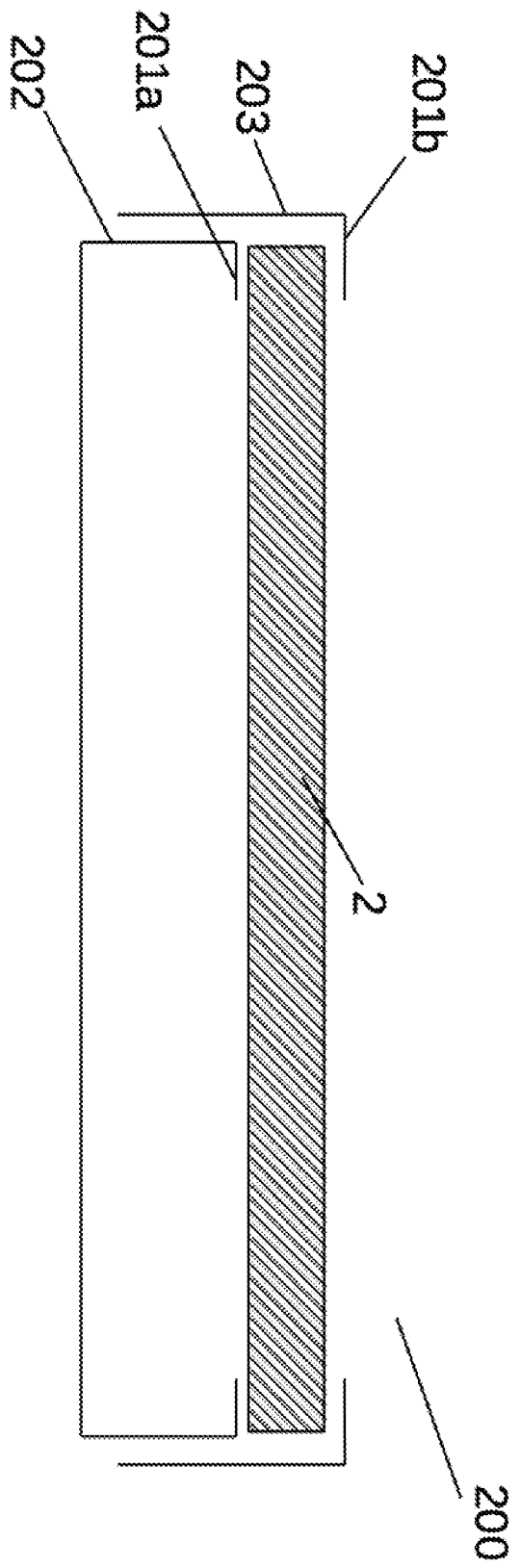


Figure 5a

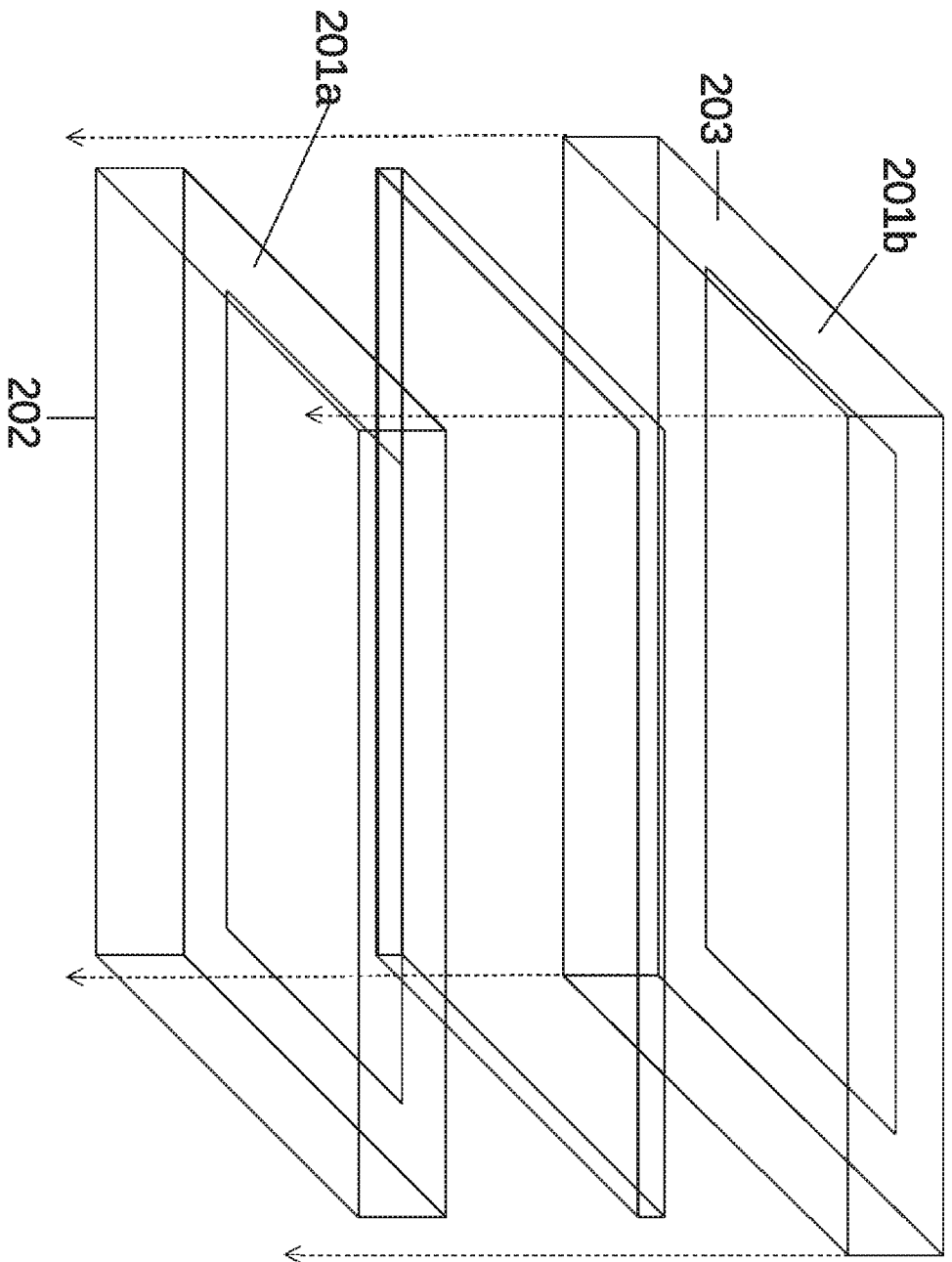


Figure 5b

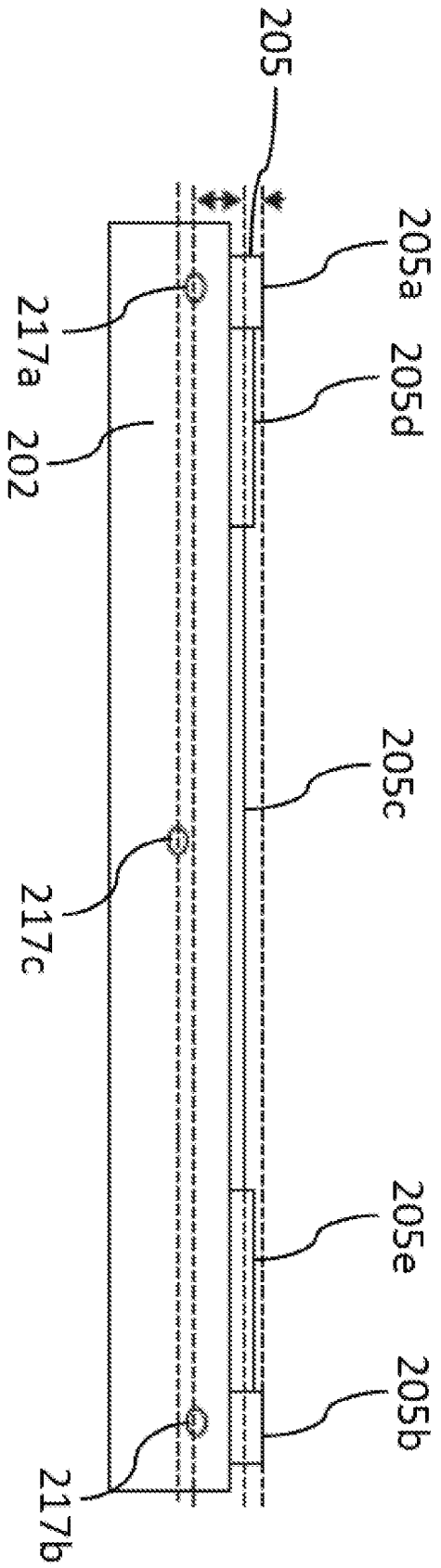


Figure 5c

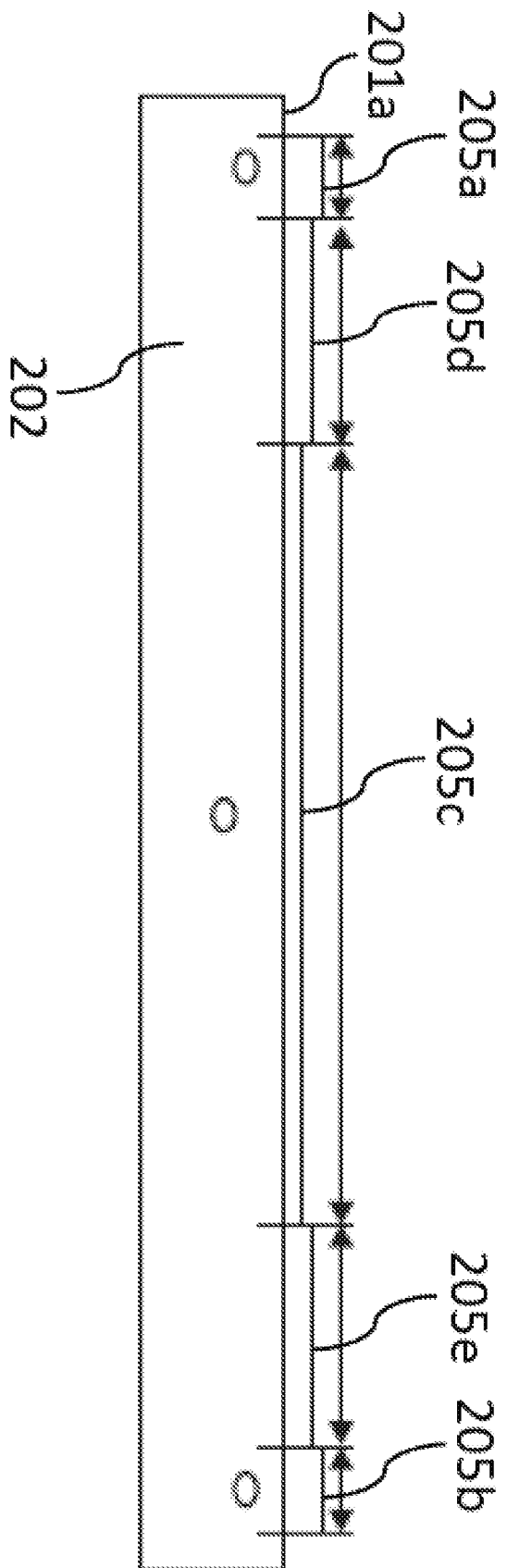


Figure 5d

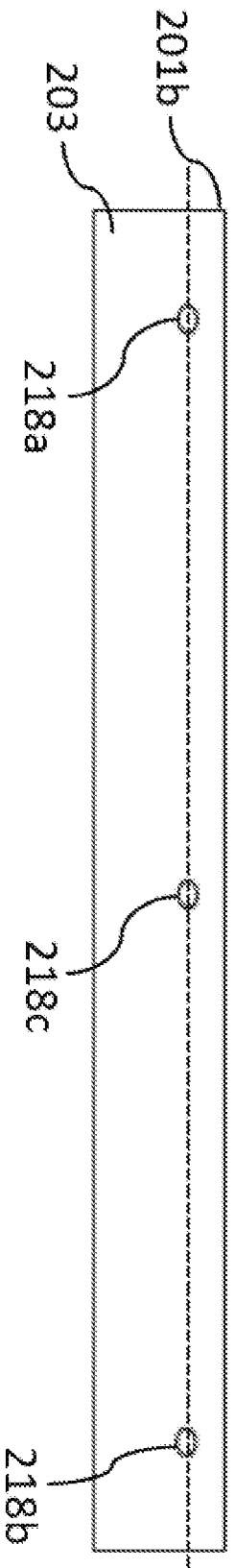


Figure 5e

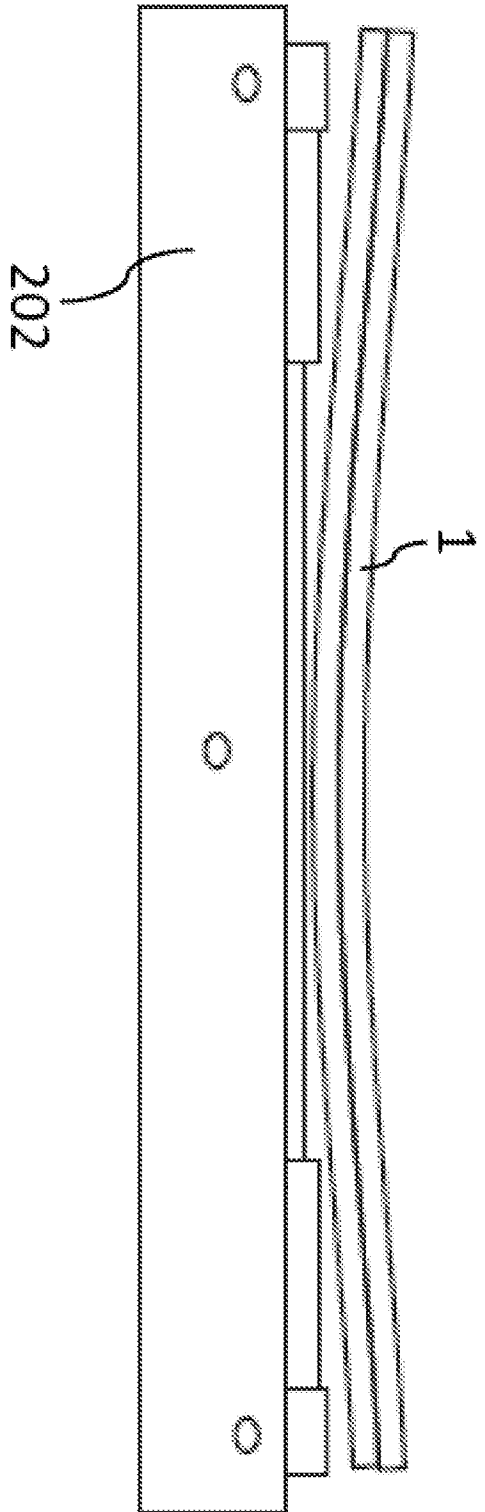


Figure 5f

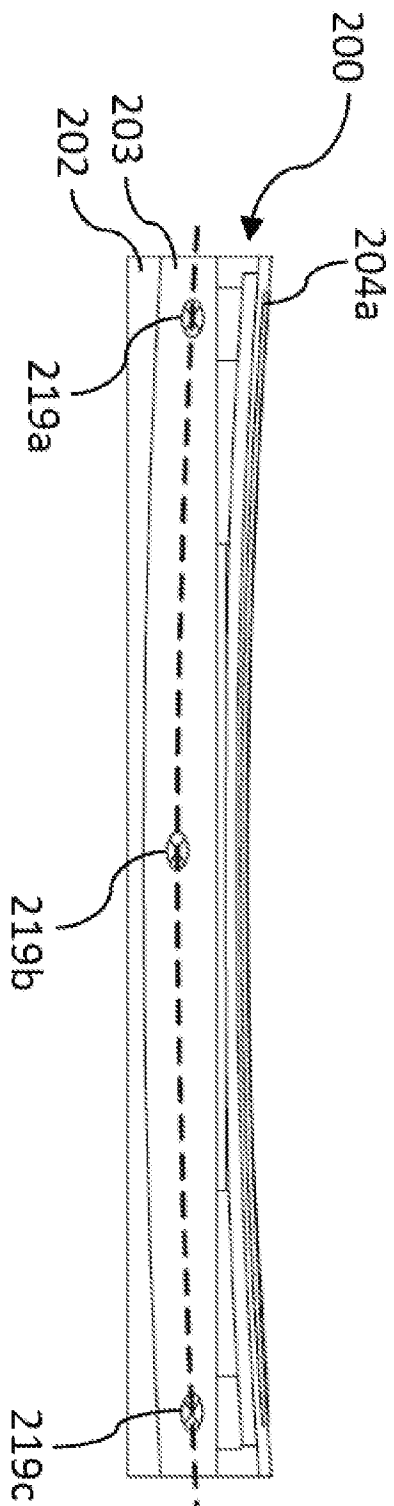


Figure 58

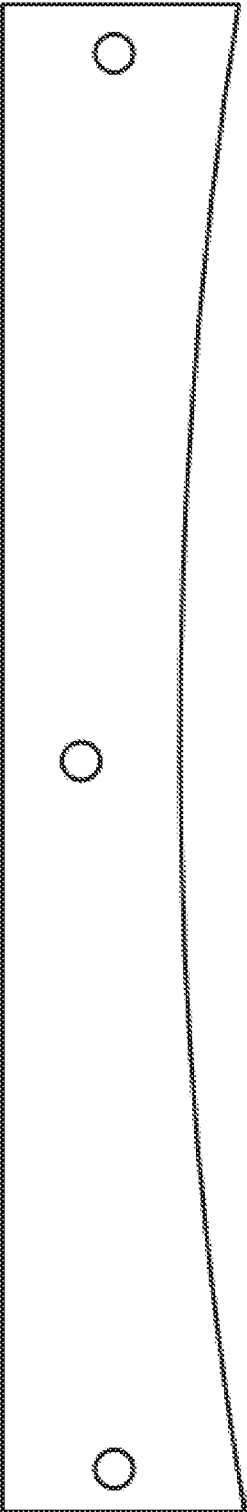


Figure 5h

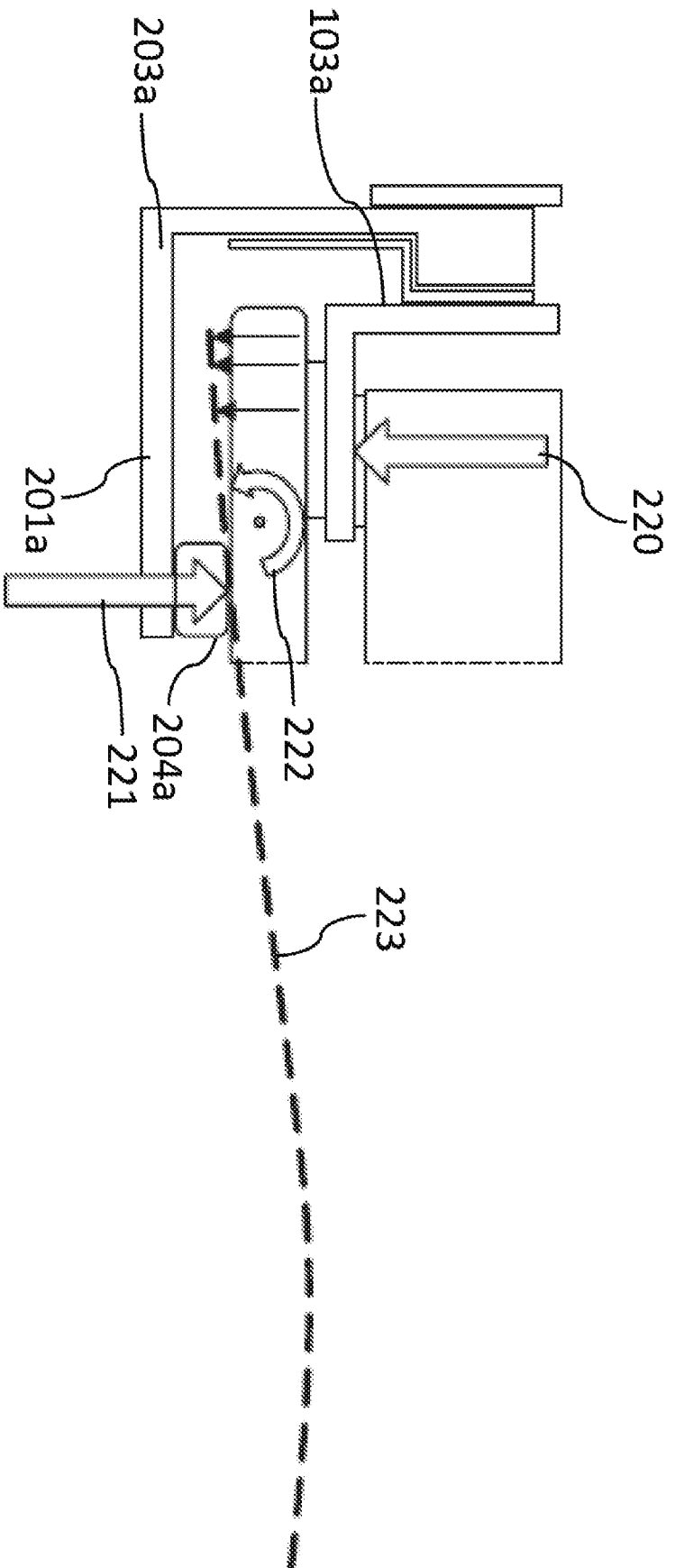


Figure 6

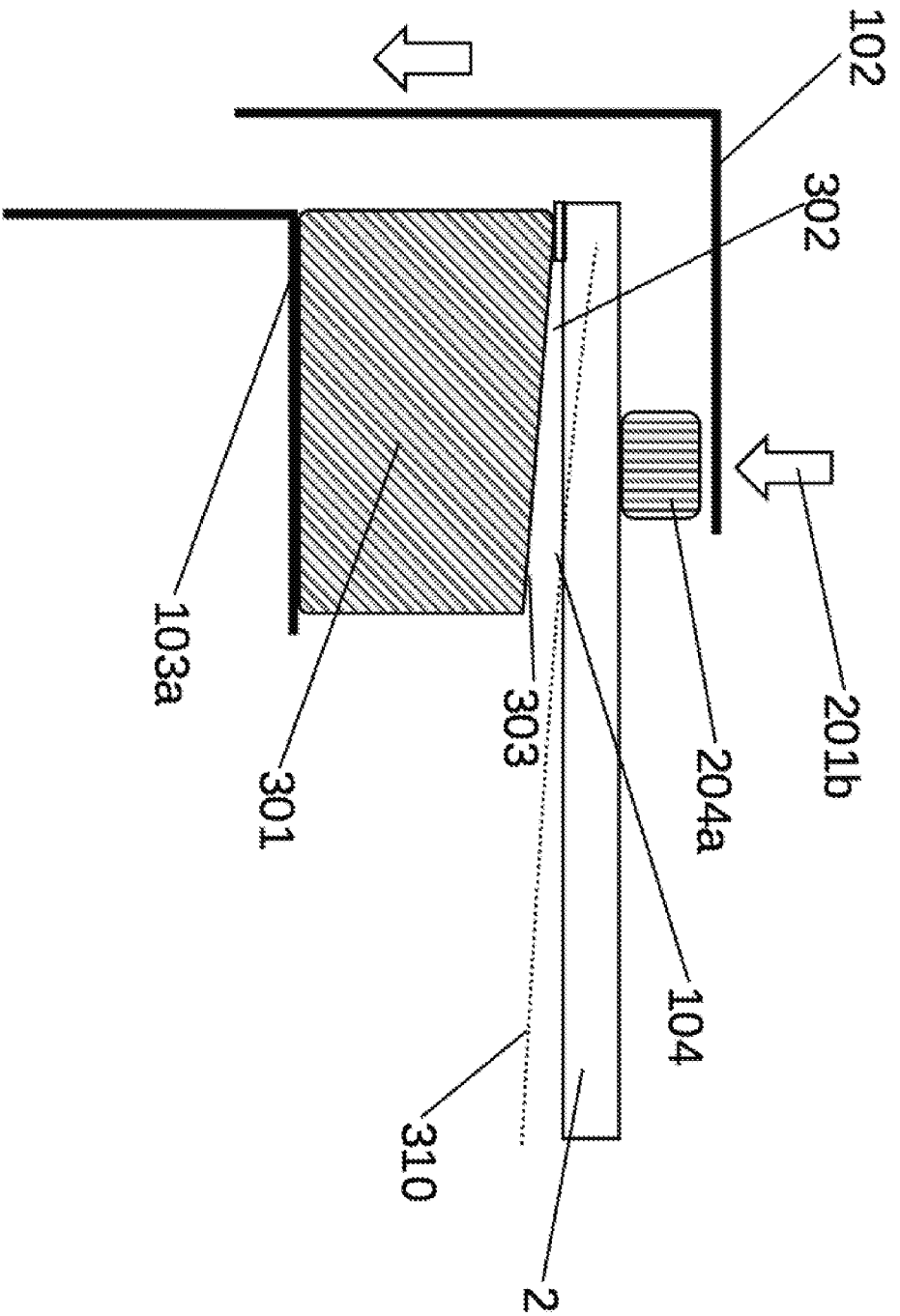


Figure 7

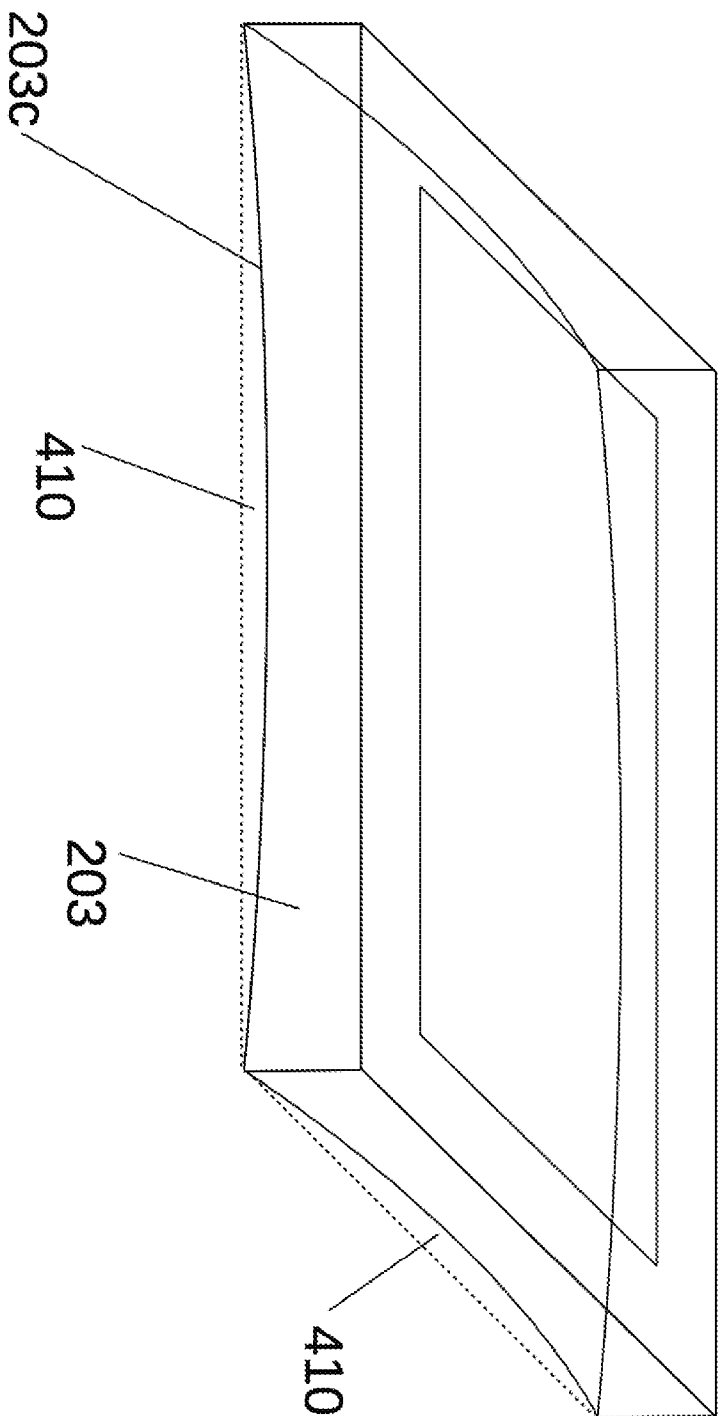


Figure 8

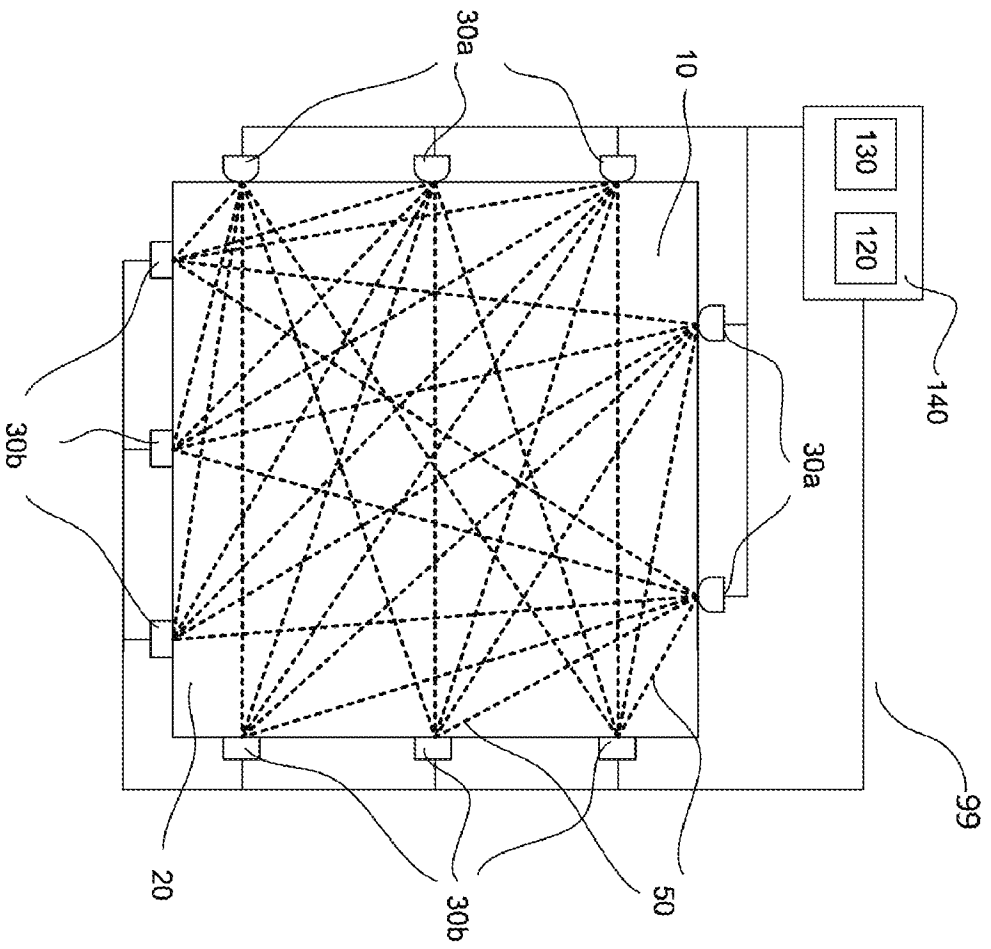


Figure 9

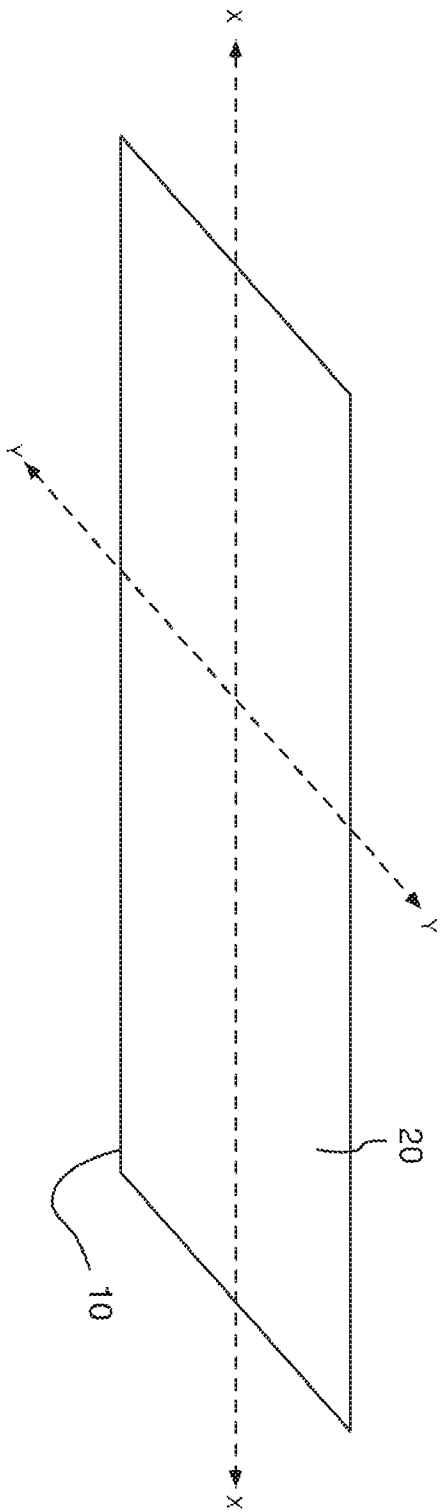


Figure 10a

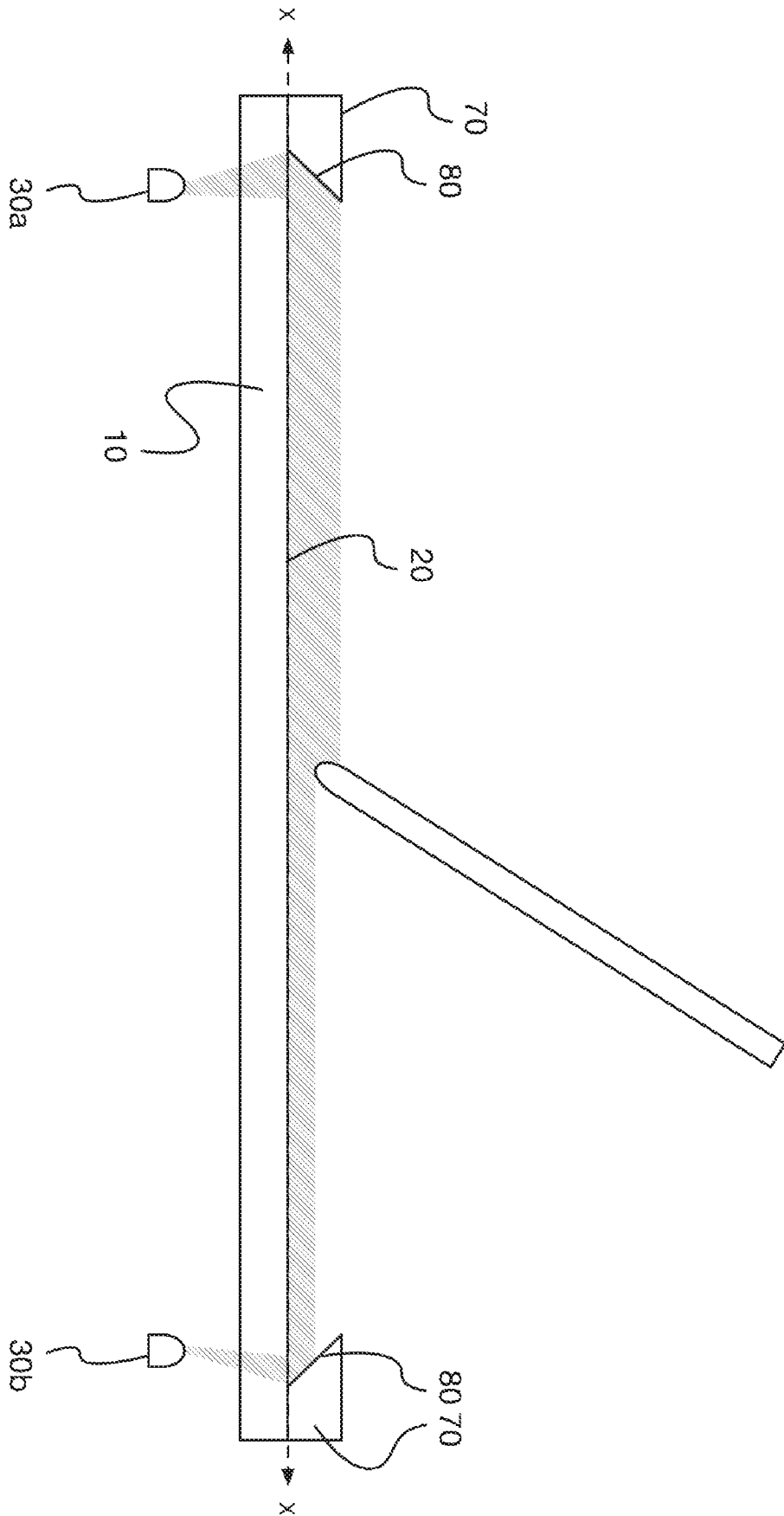


Figure 10b

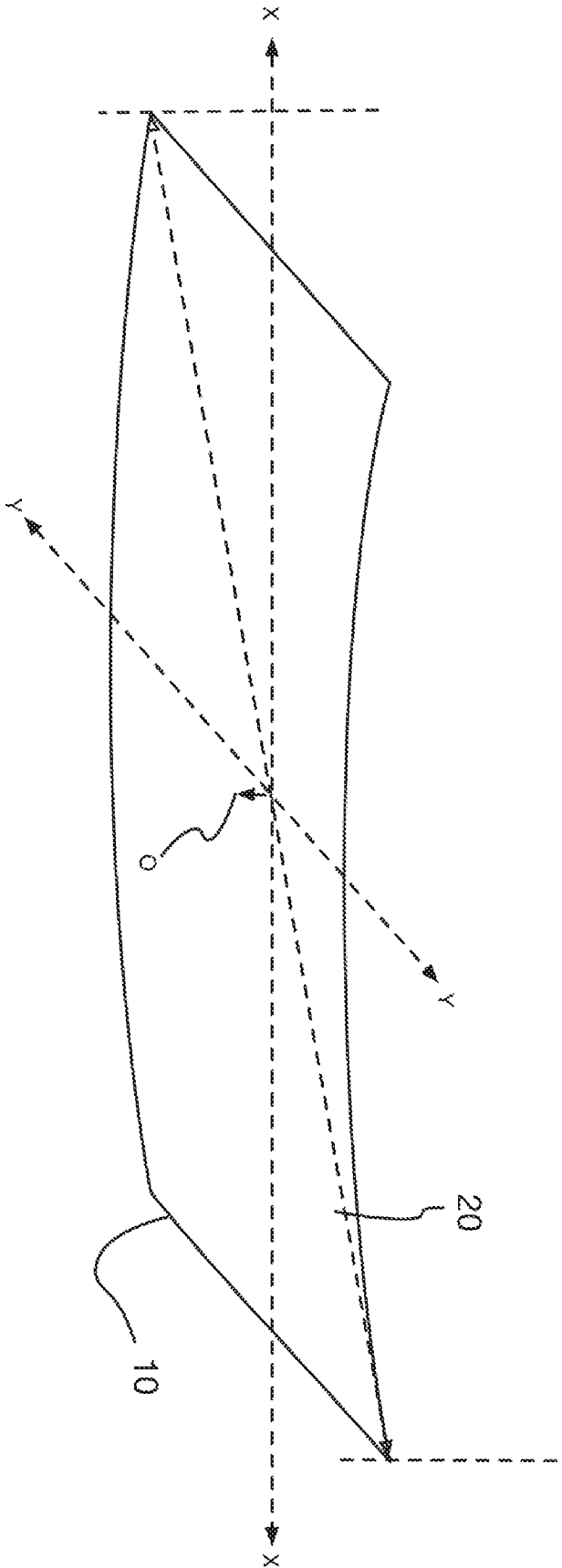


Figure 11a

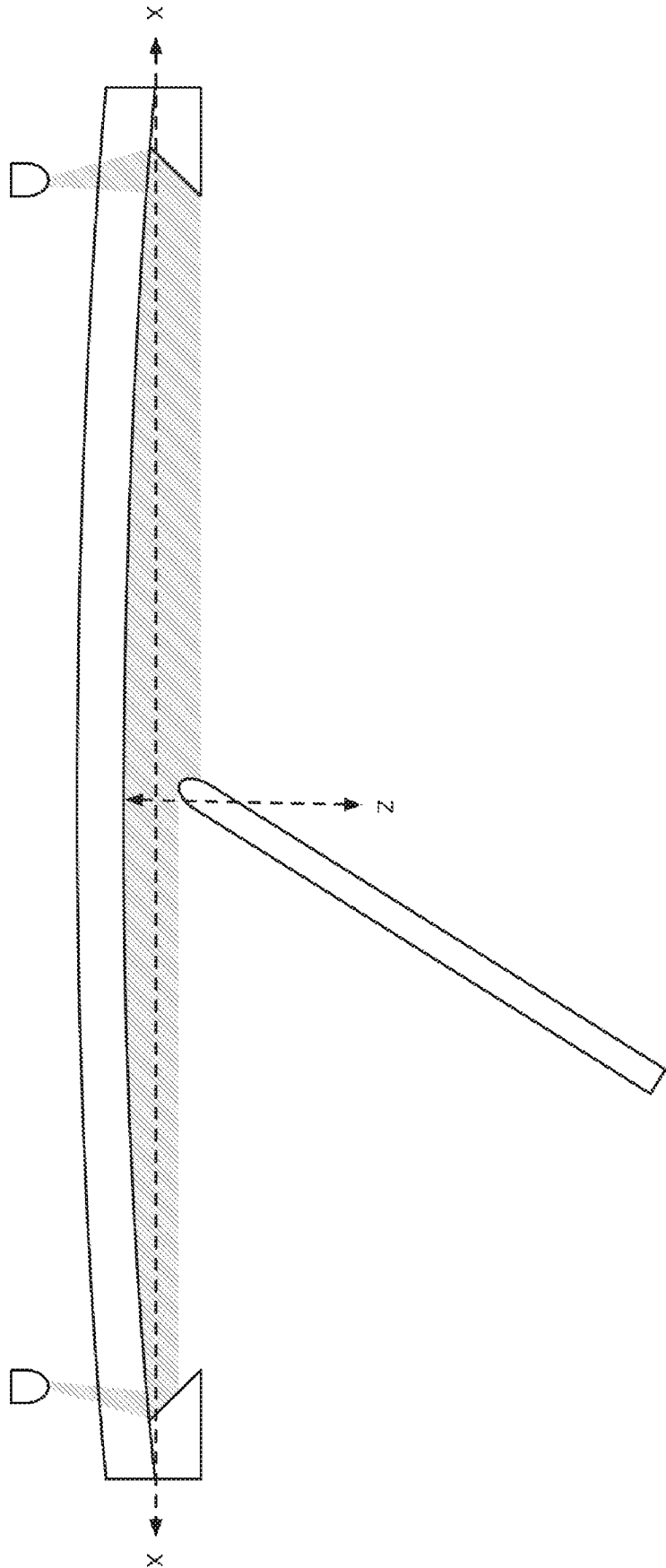


Figure 11b

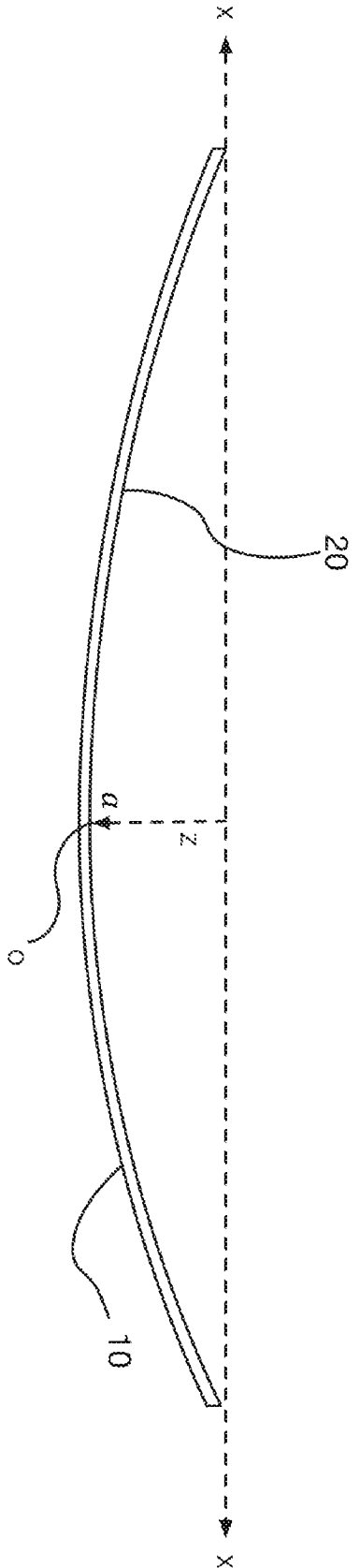


Figure 11c

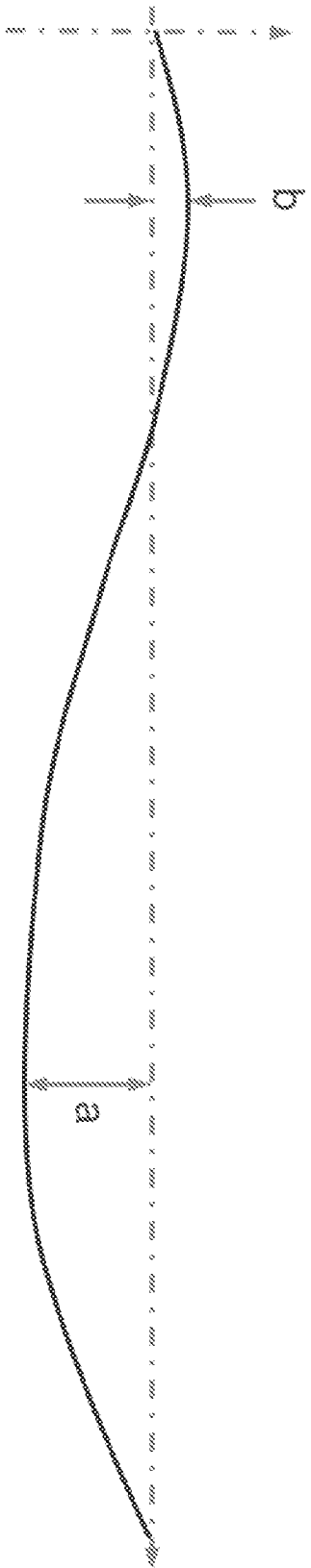


Figure 11d

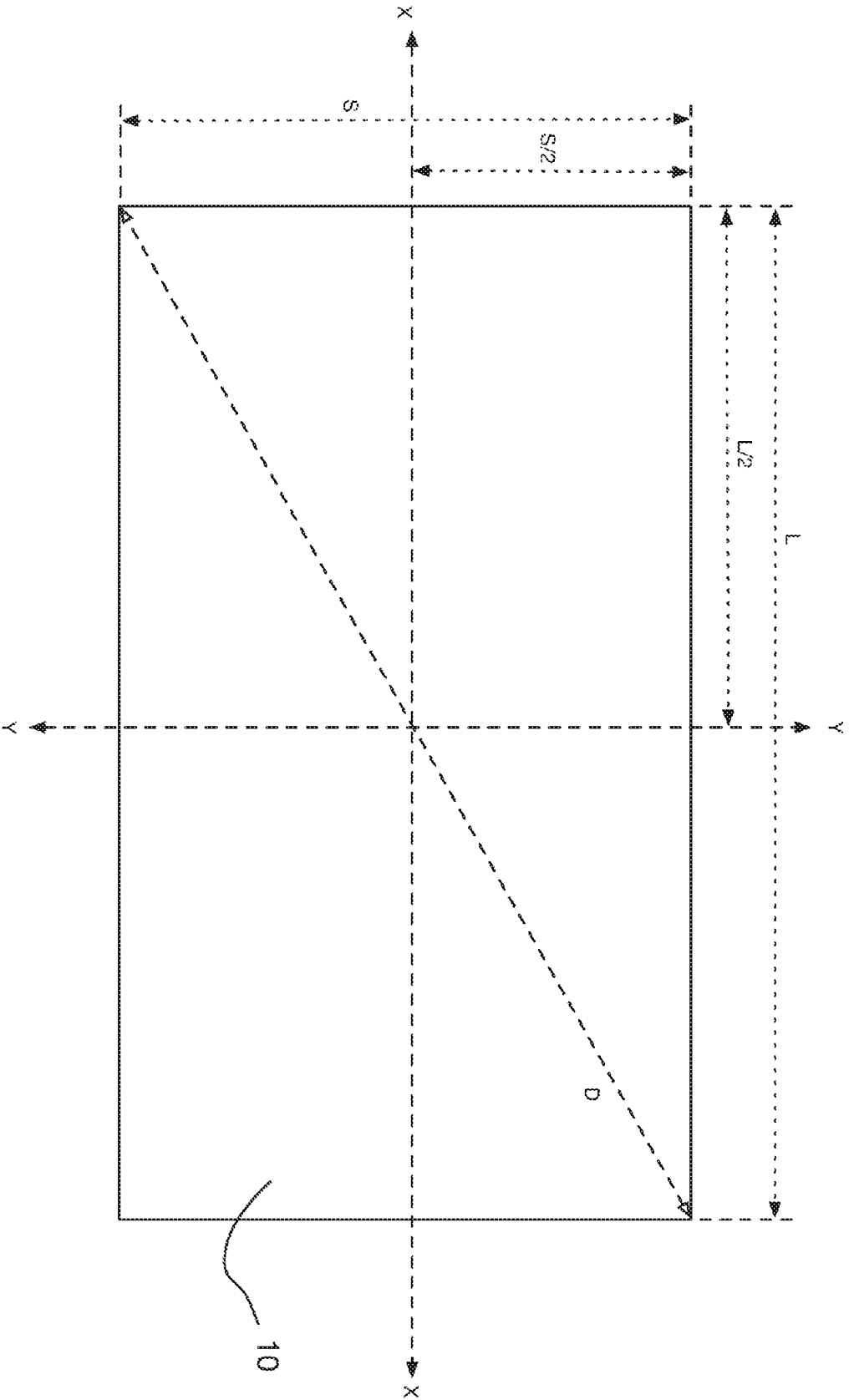


Figure 12a



Figure 12b

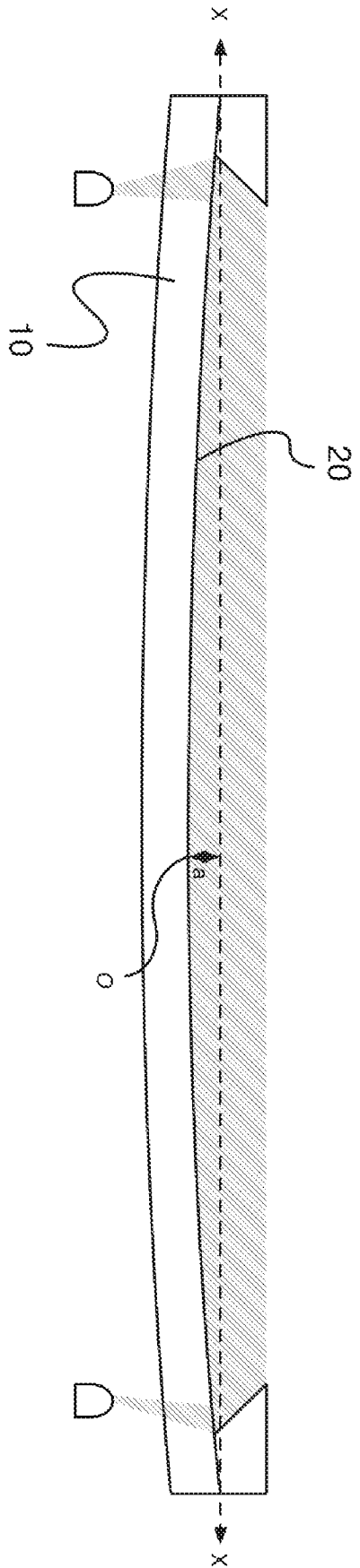


Figure 12c

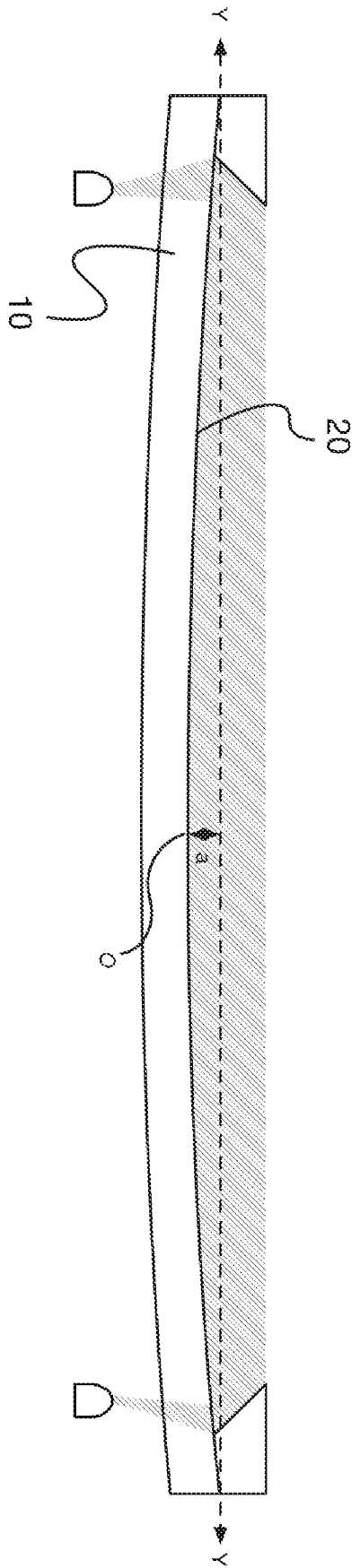


Figure 12d

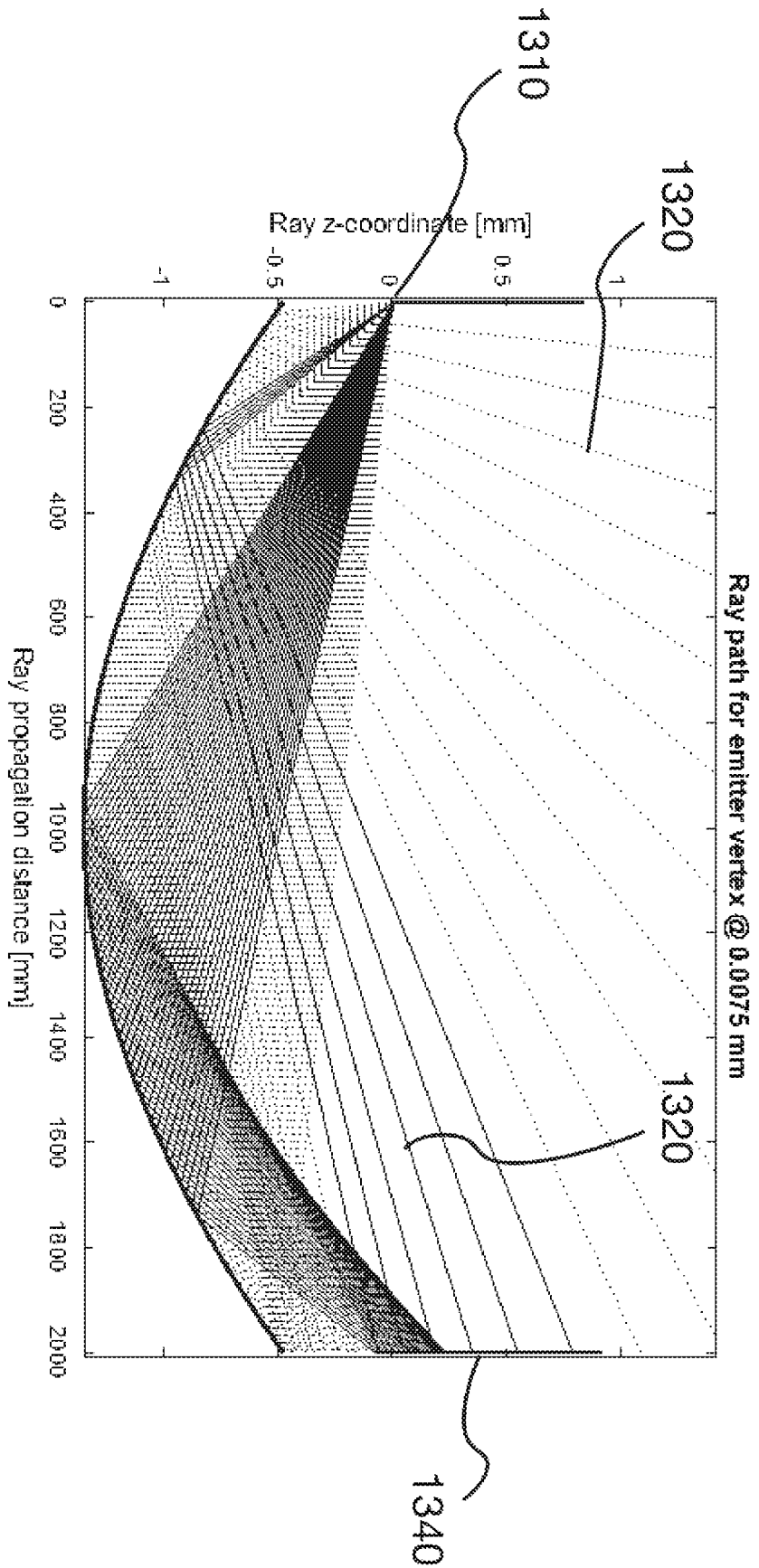


Figure 13a

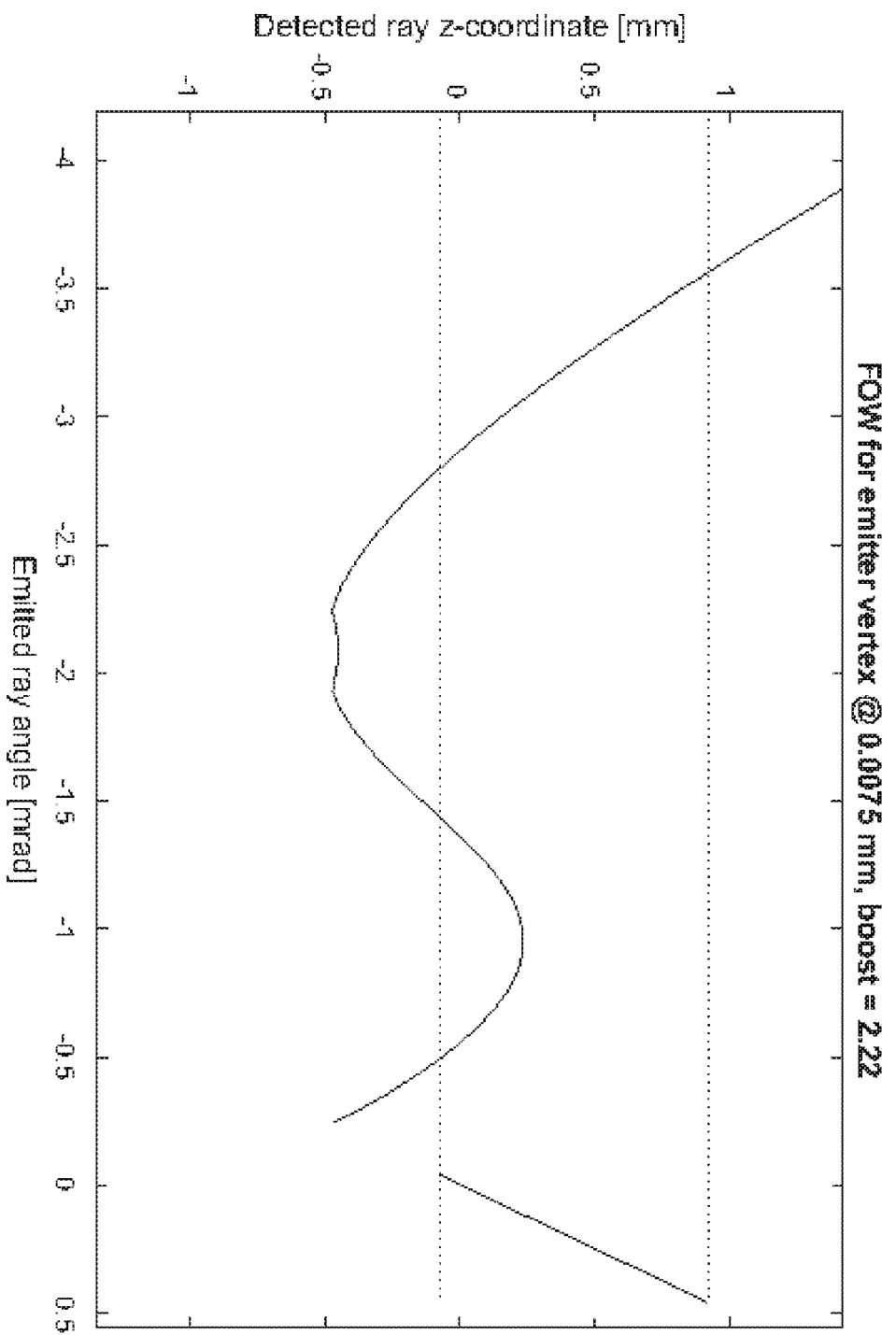


Figure 13b

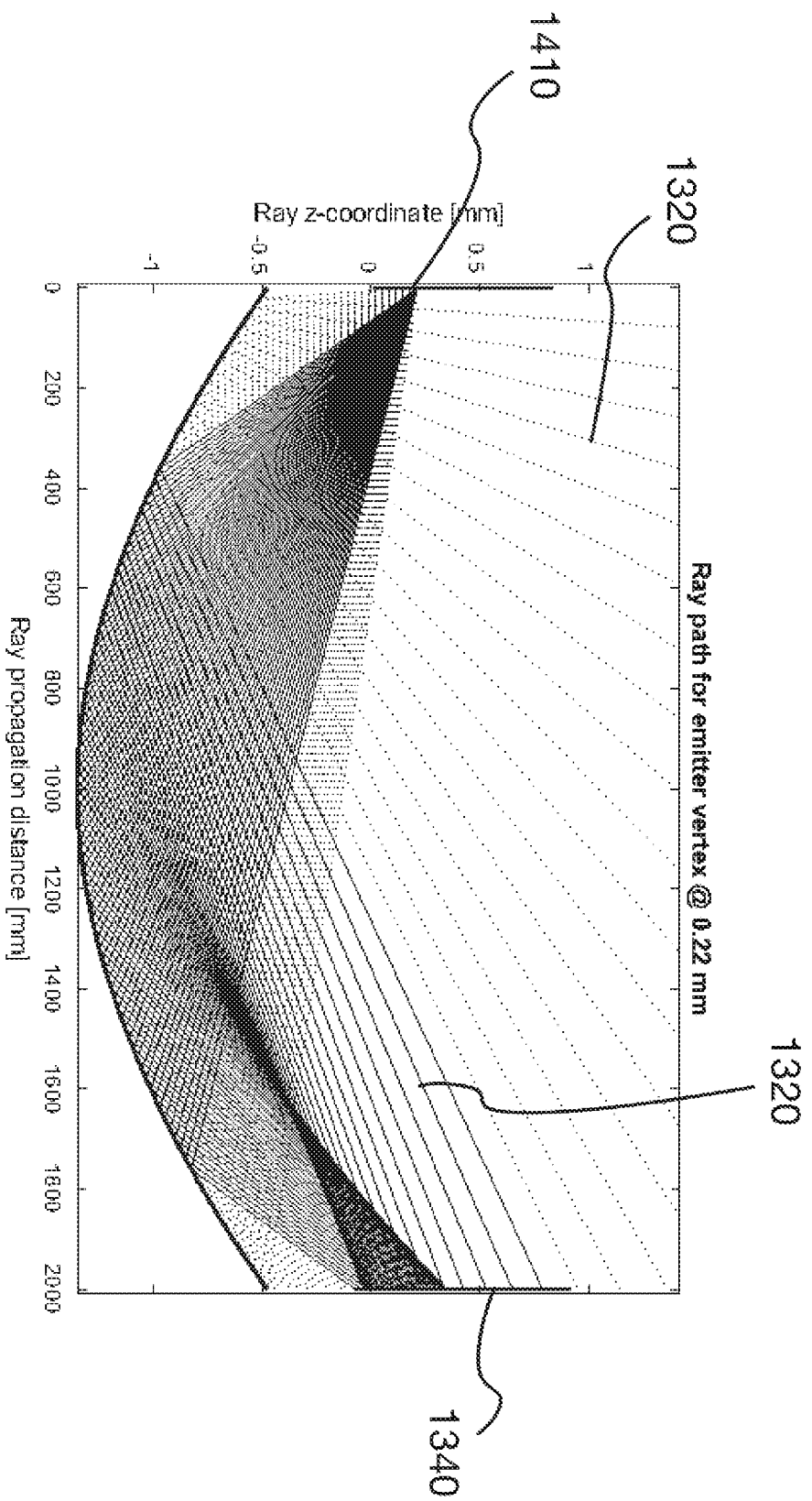


Figure 14a

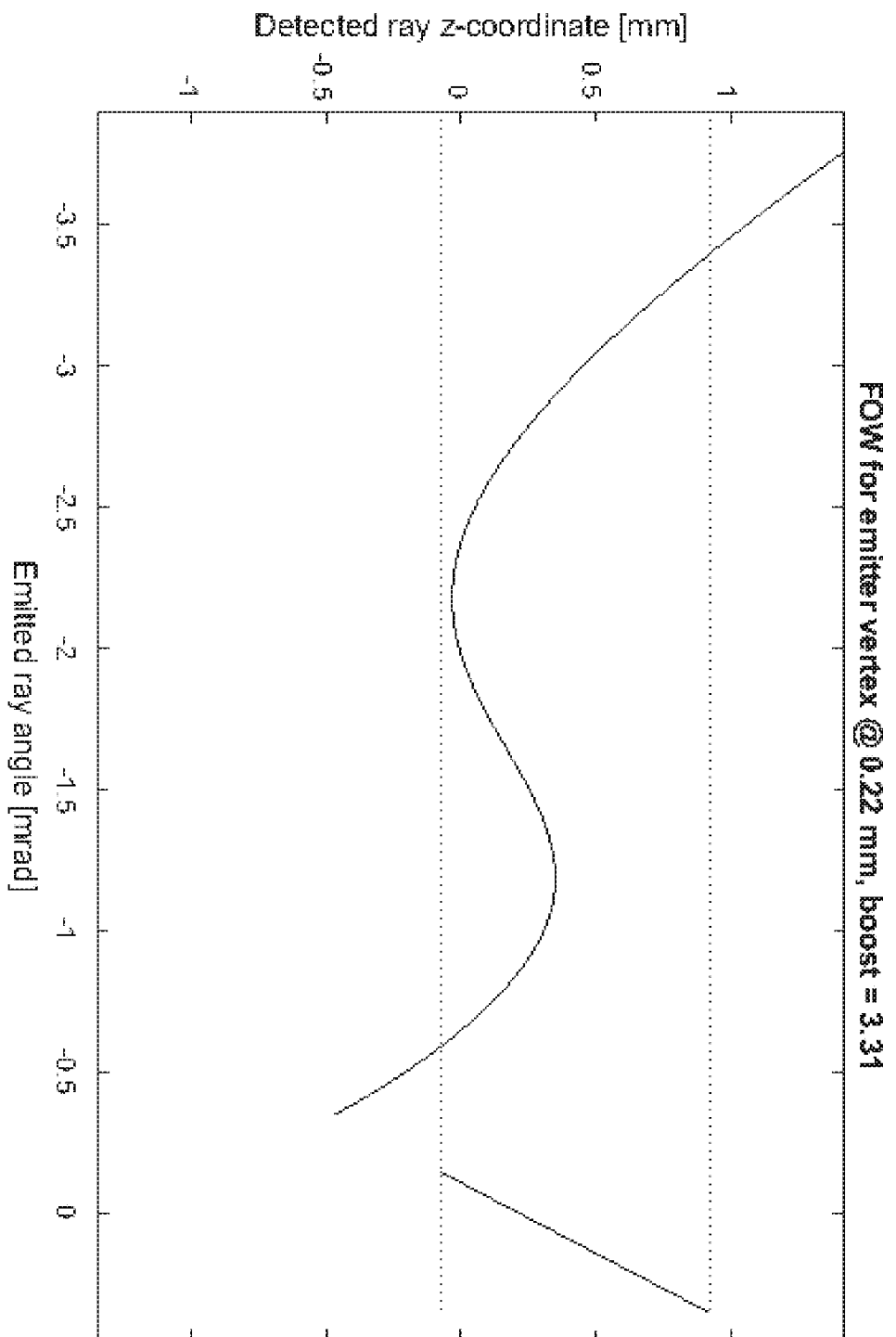


Figure 14b

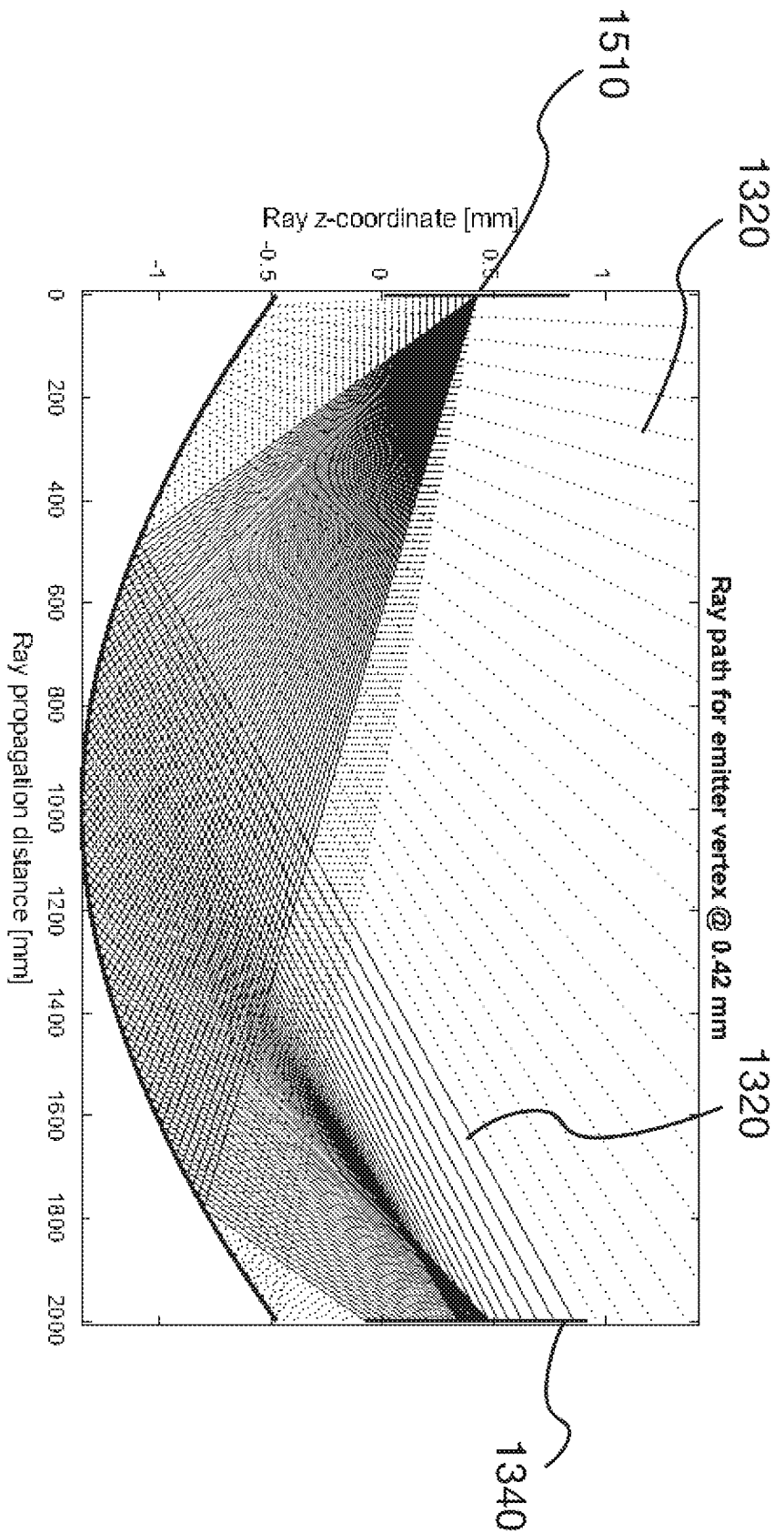


Figure 15a

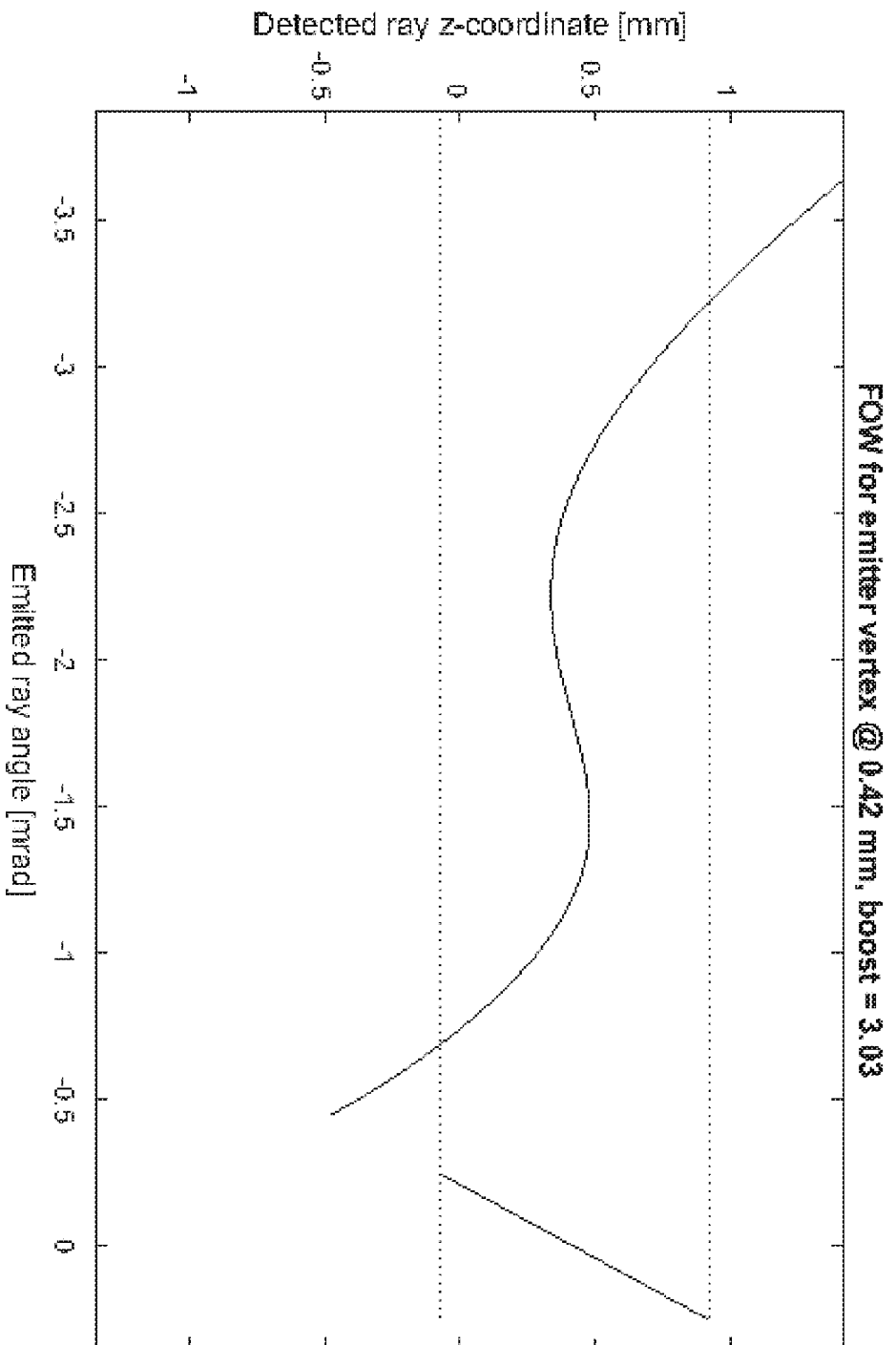


Figure 15b

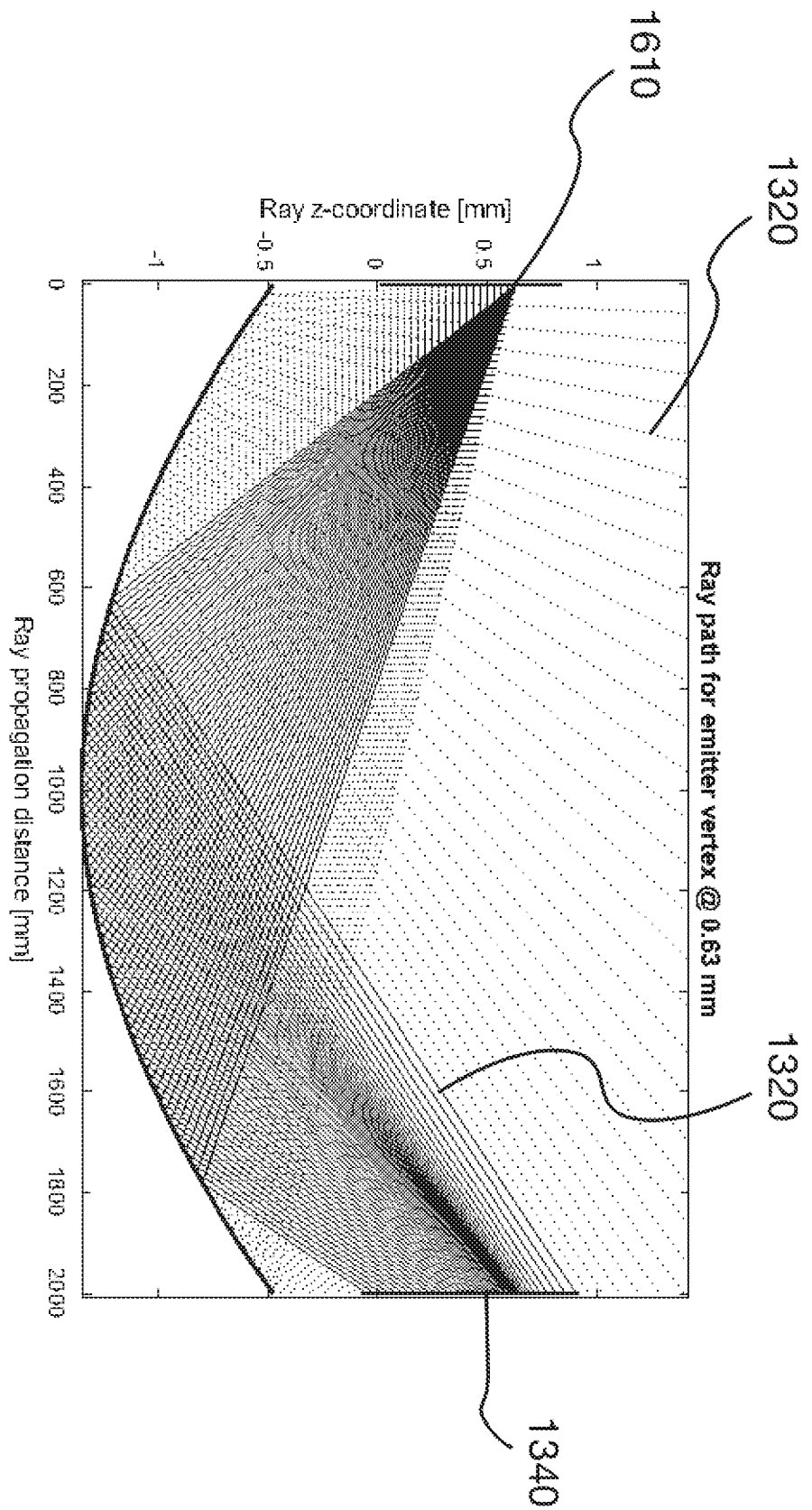


Figure 16a

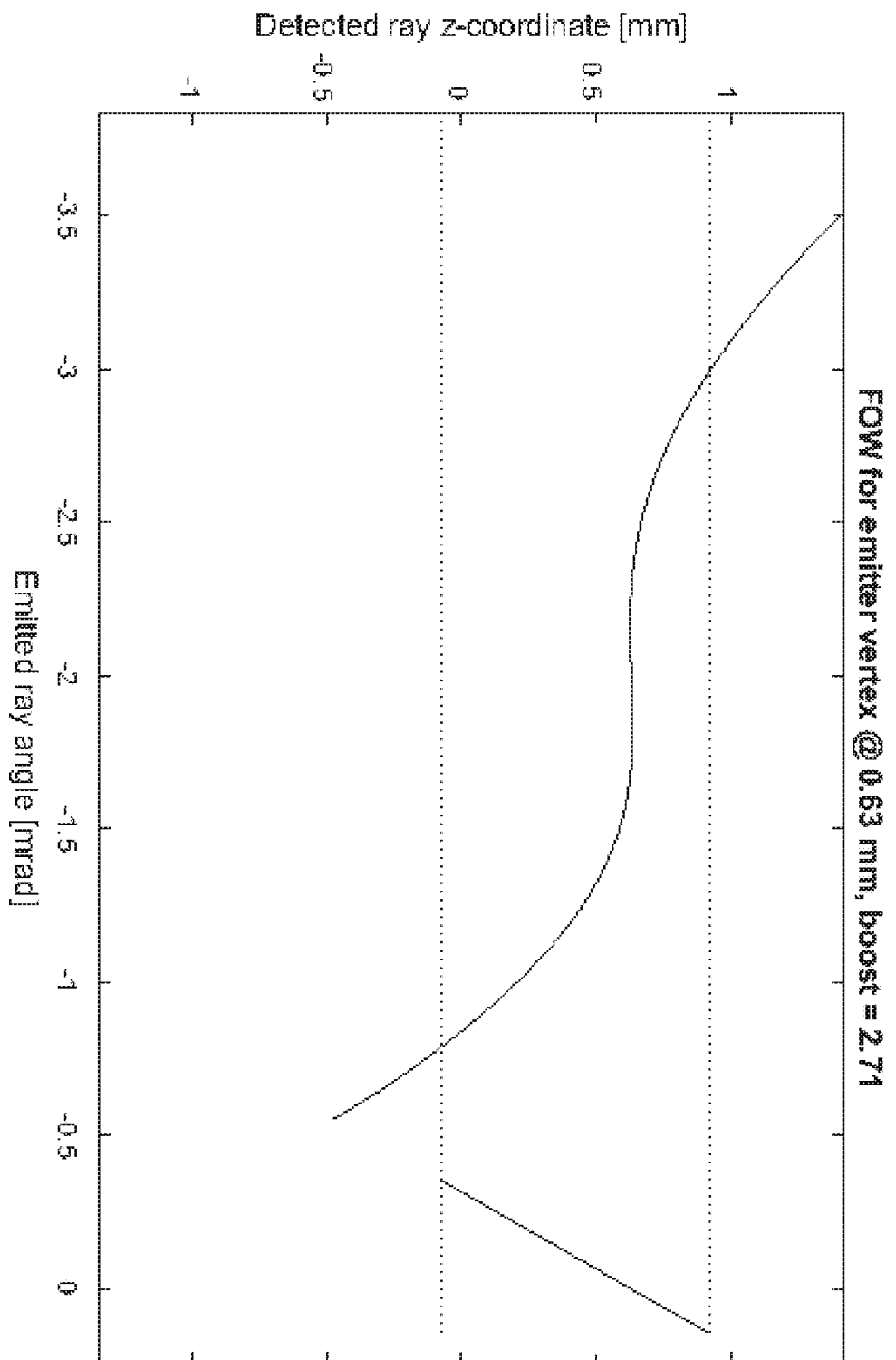
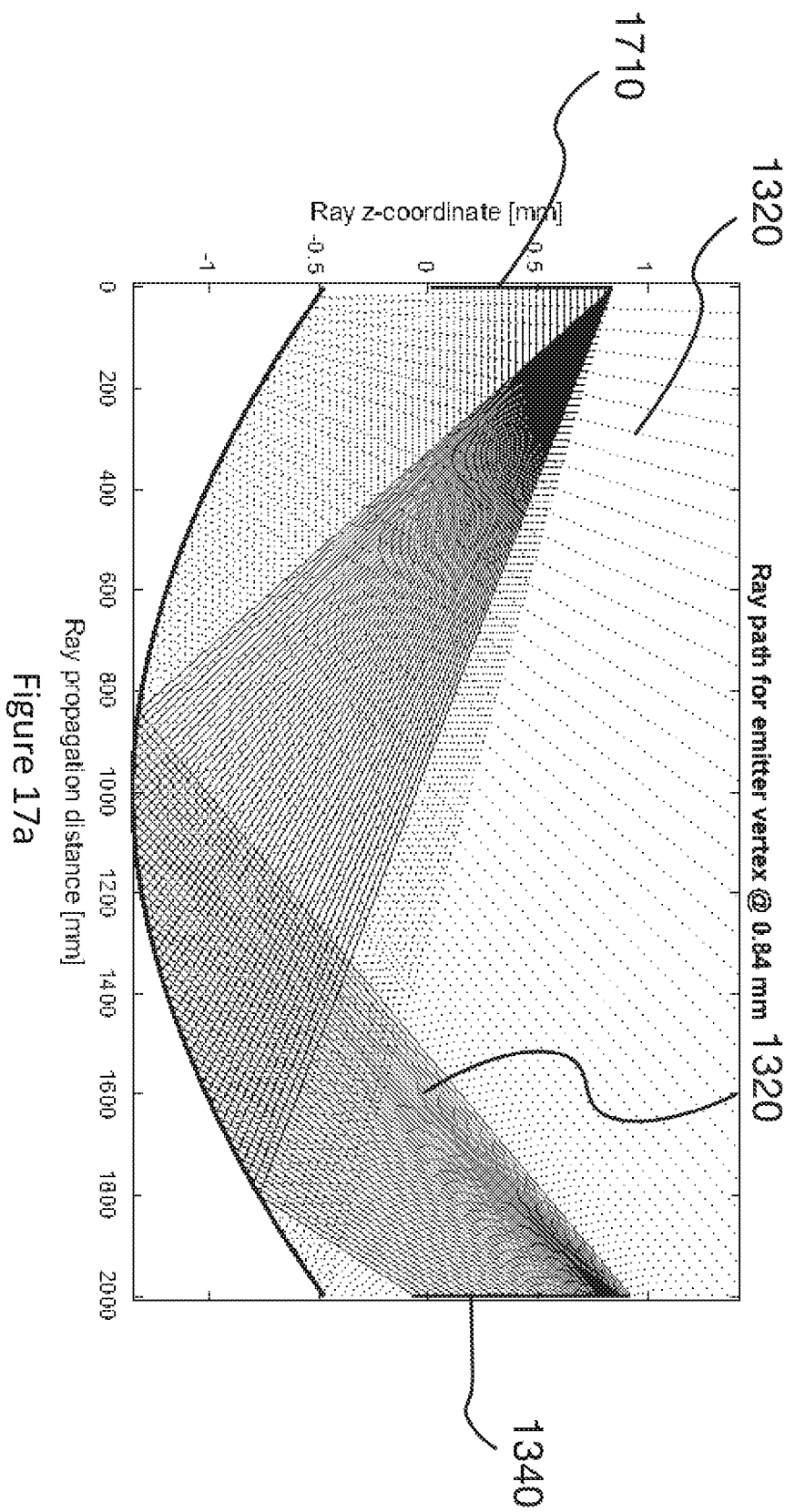
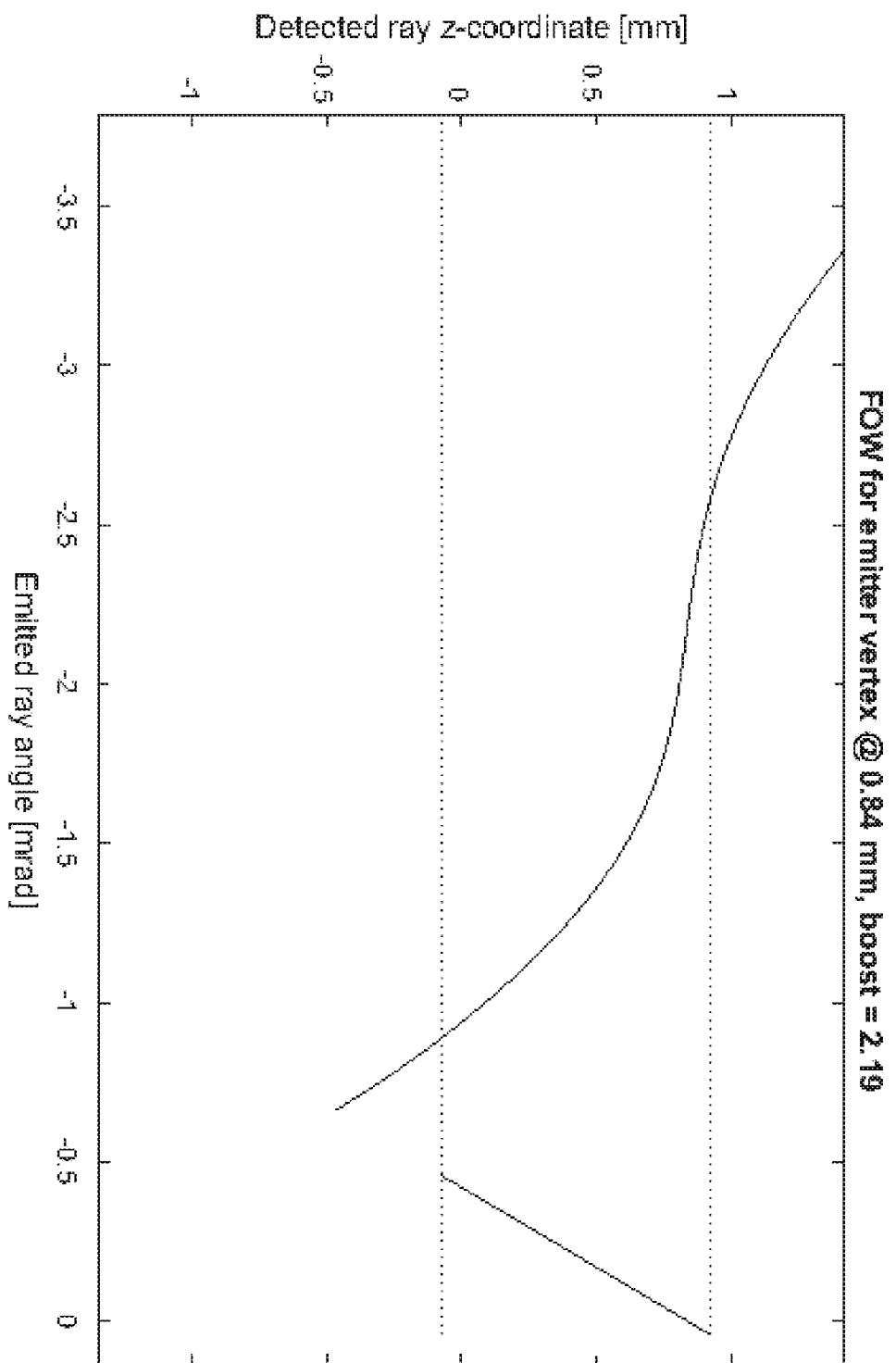


Figure 16b





Emitted ray angle [mrad]
Figure 17b

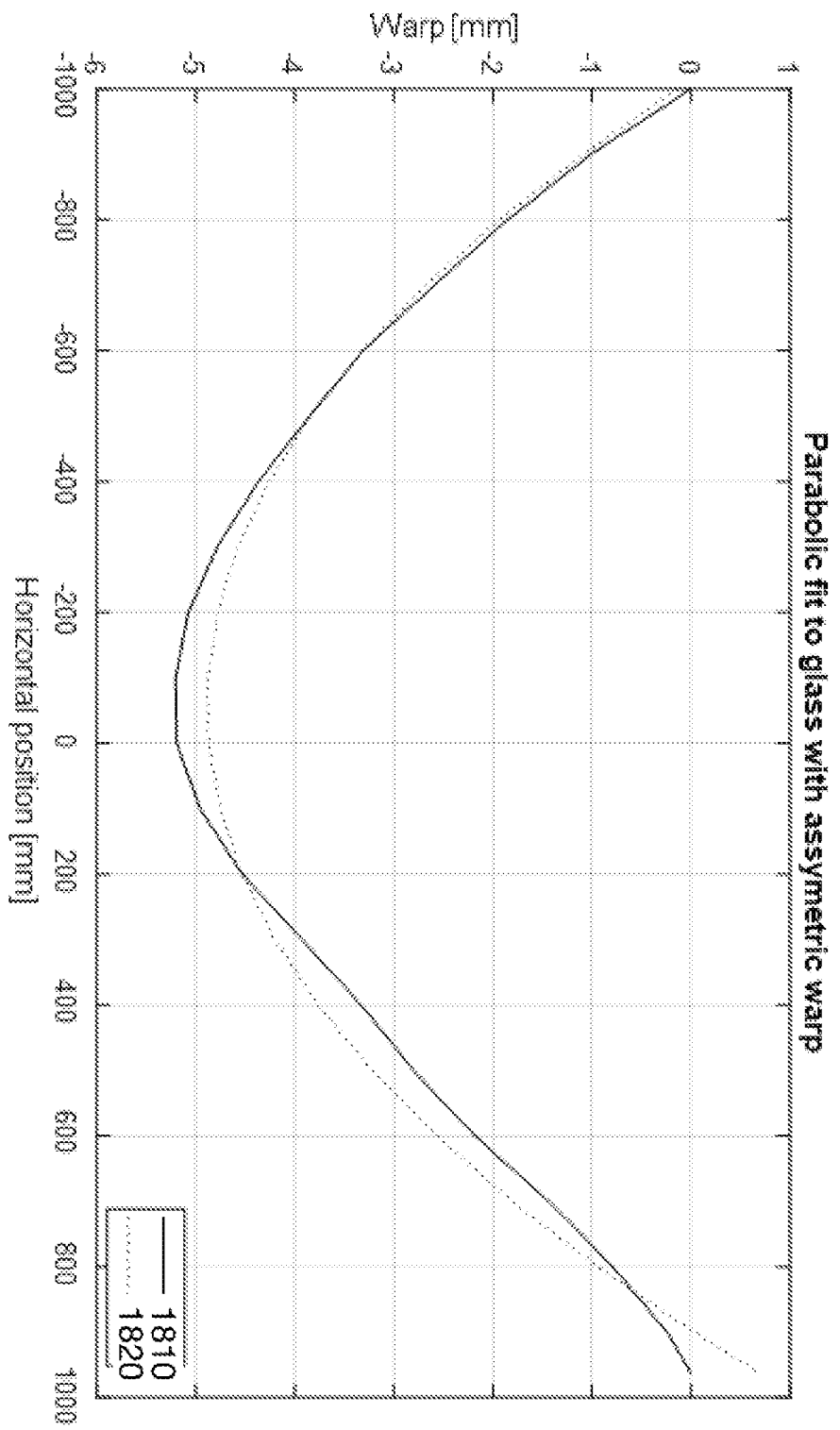


Figure 18a

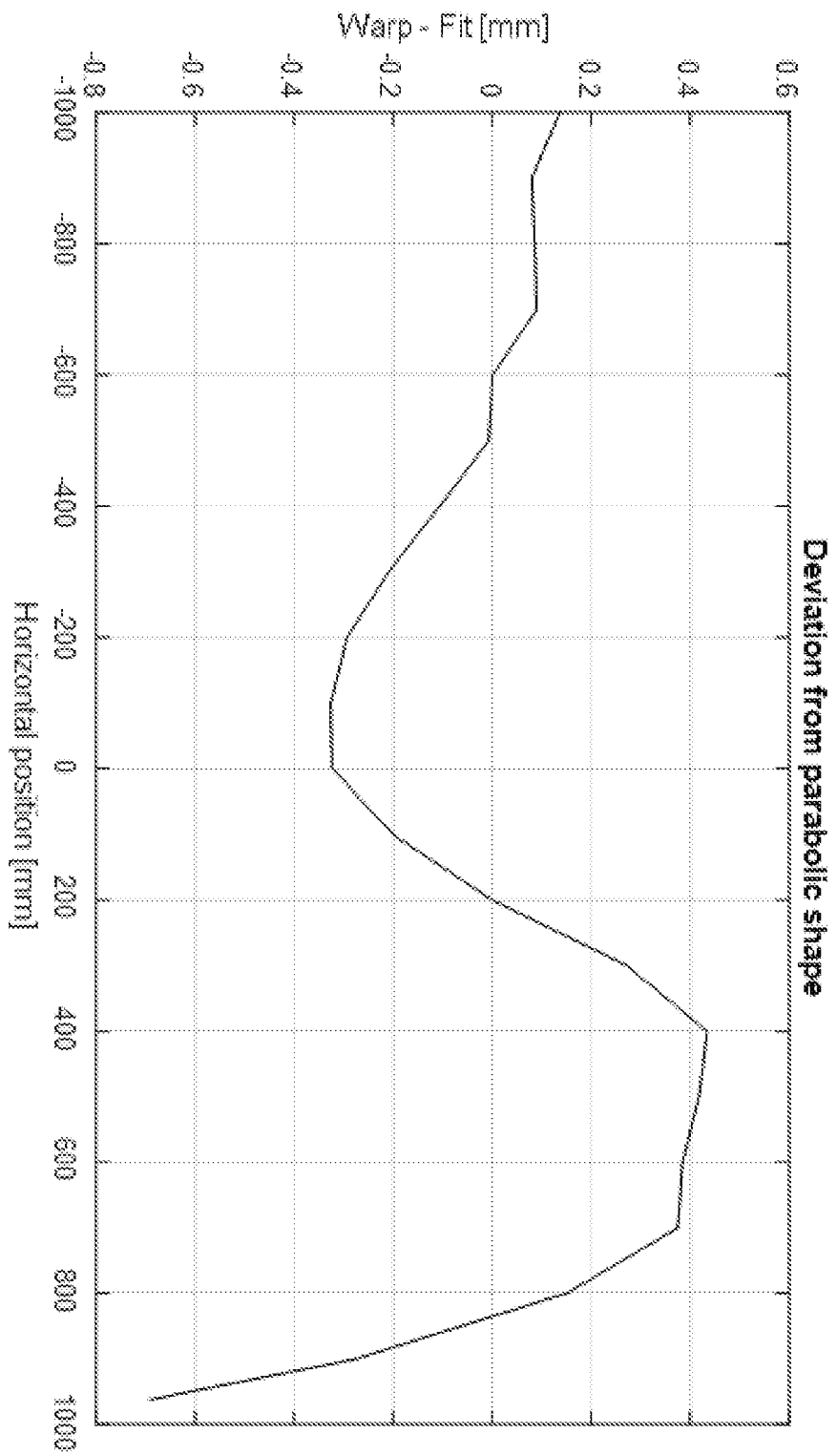


Figure 18b

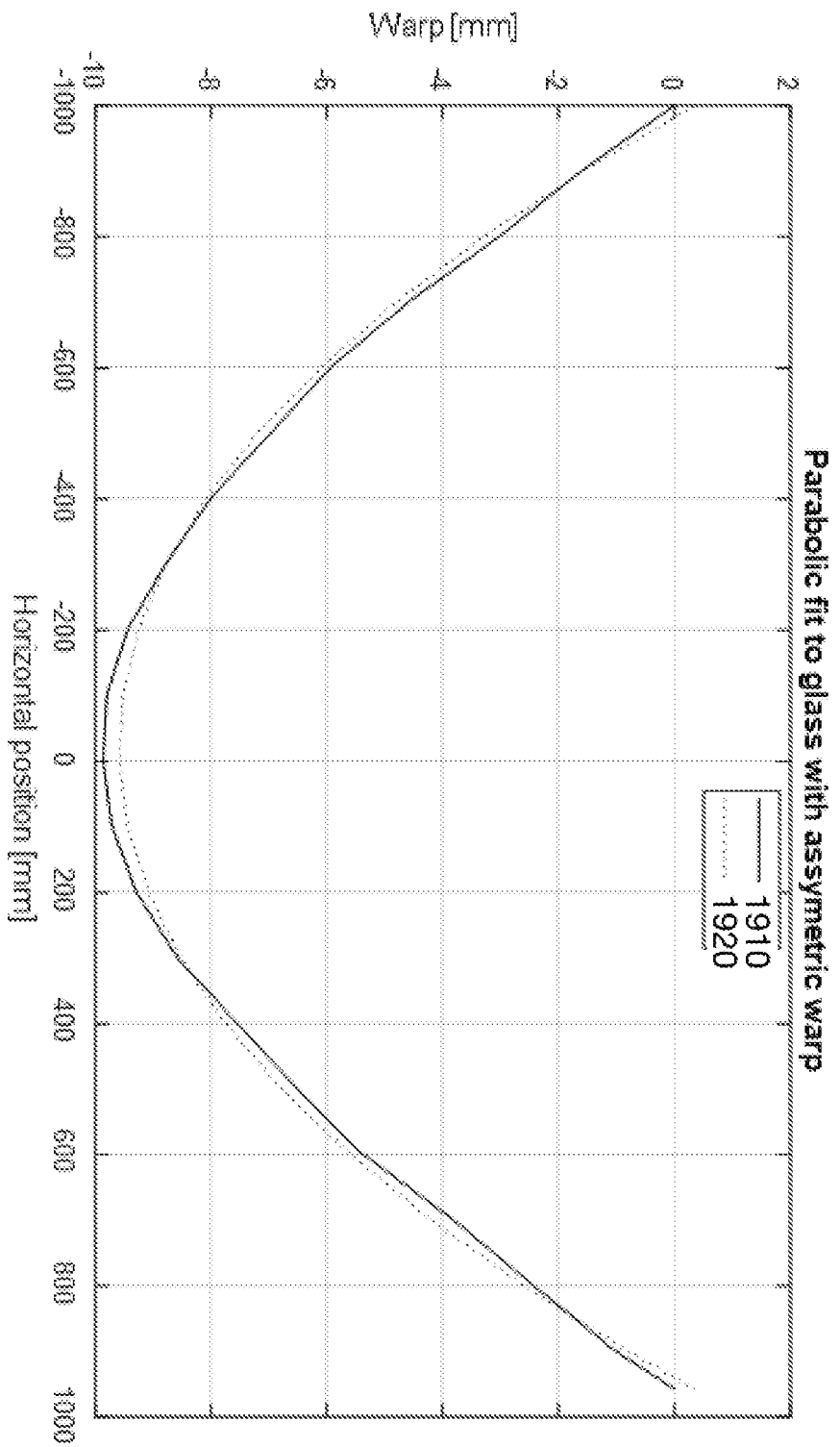


Figure 19a

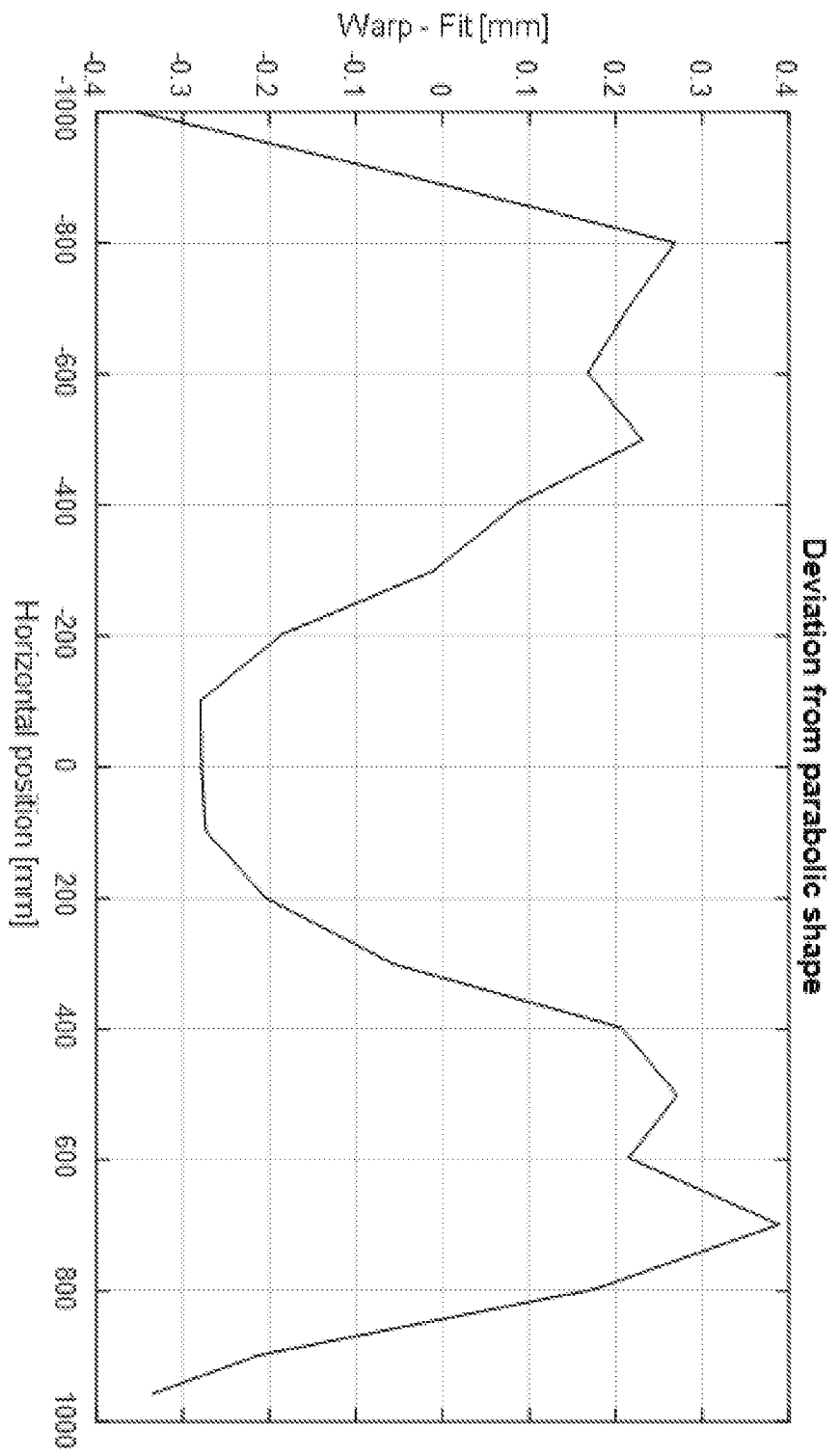


Figure 19b

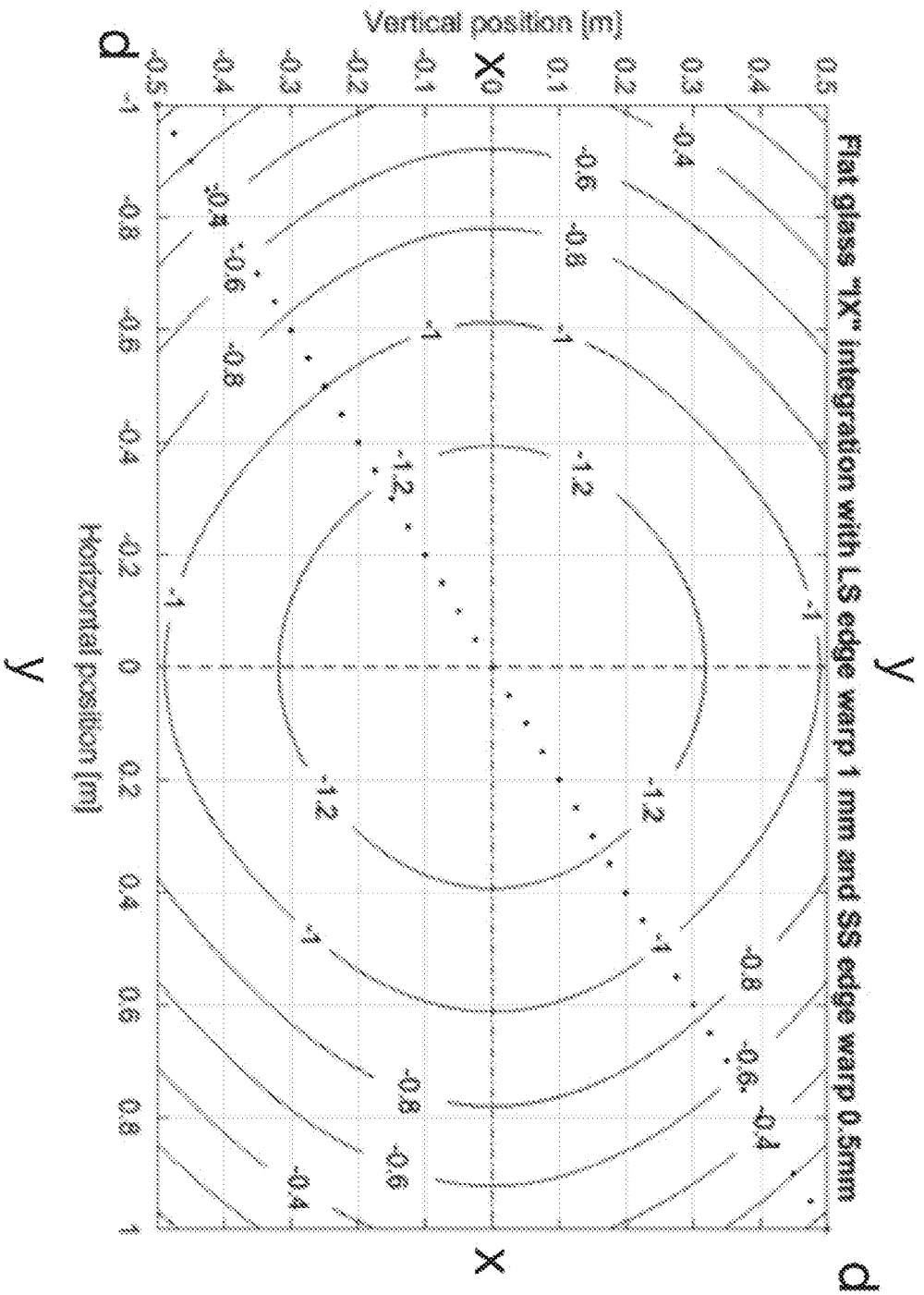


Figure 20a

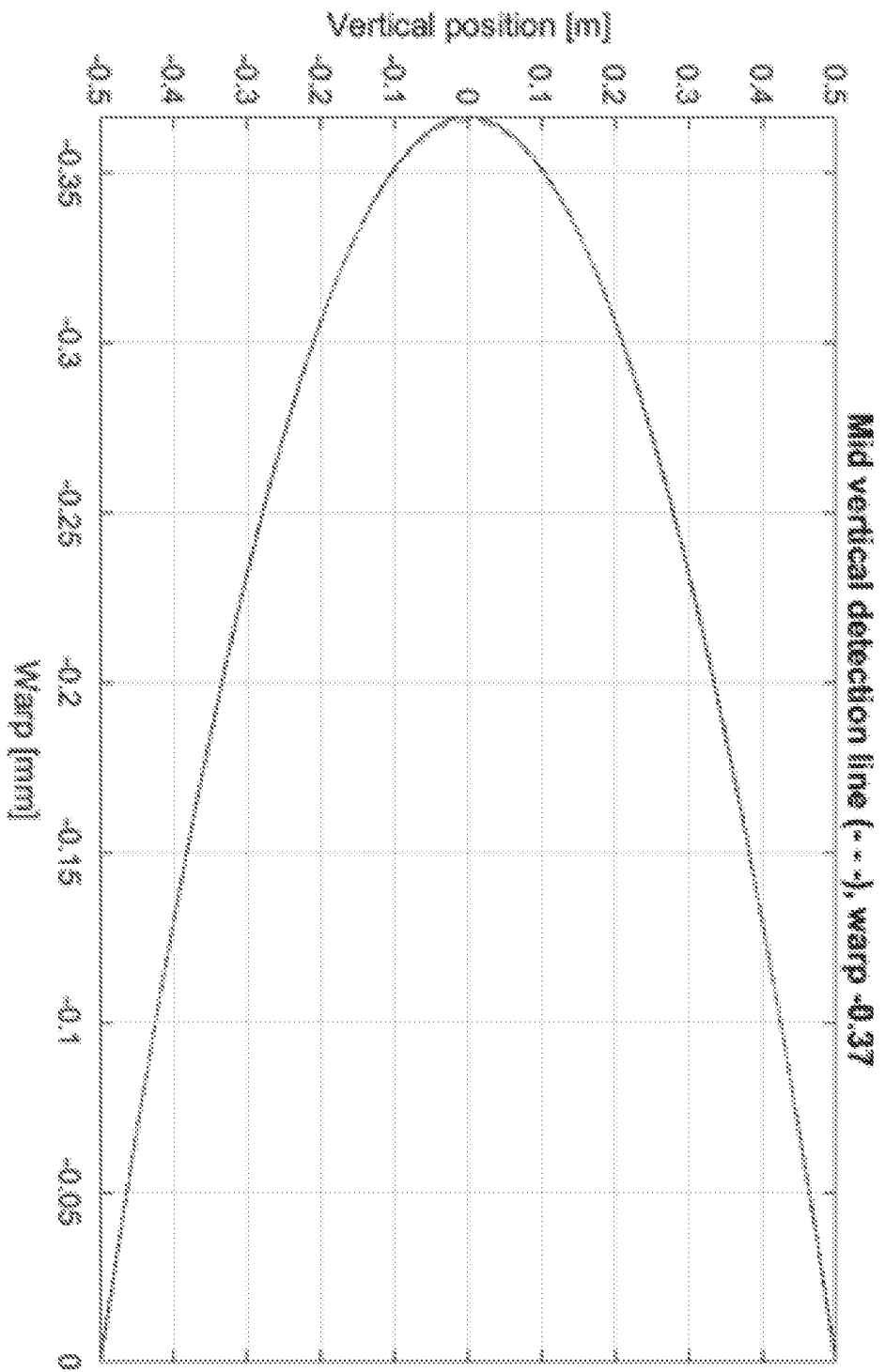


Figure 20b

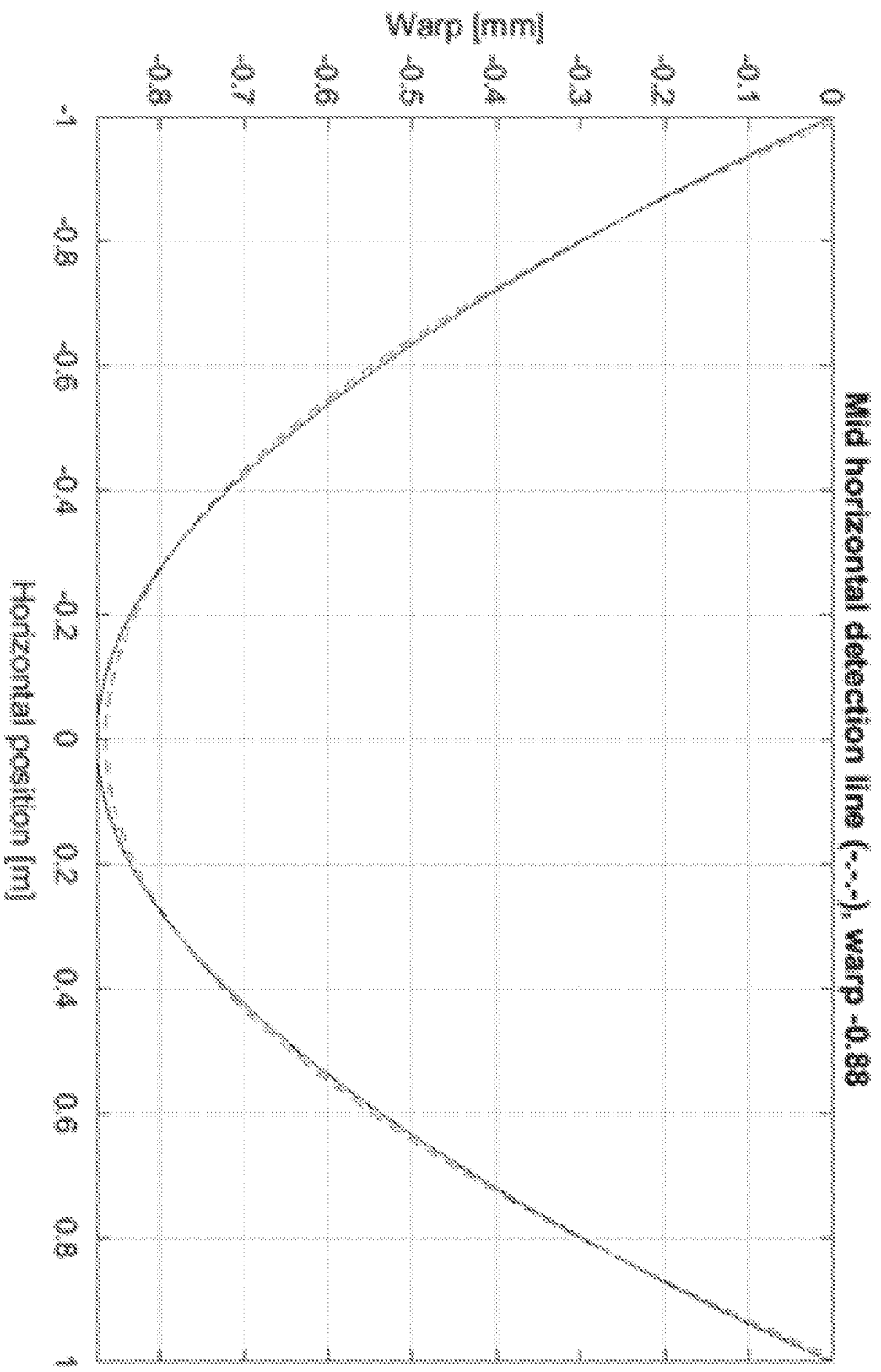


Figure 20c

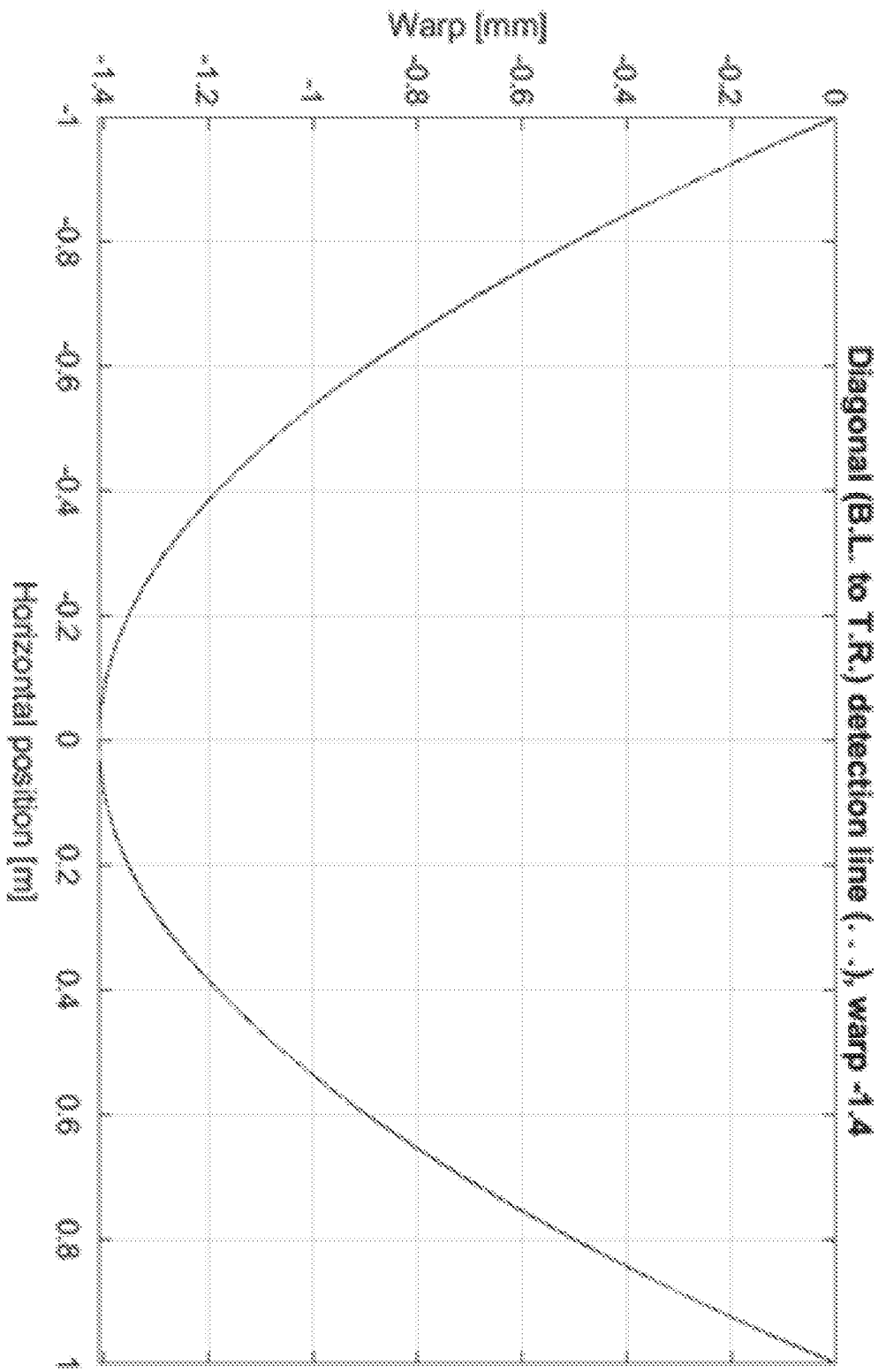


Figure 20d

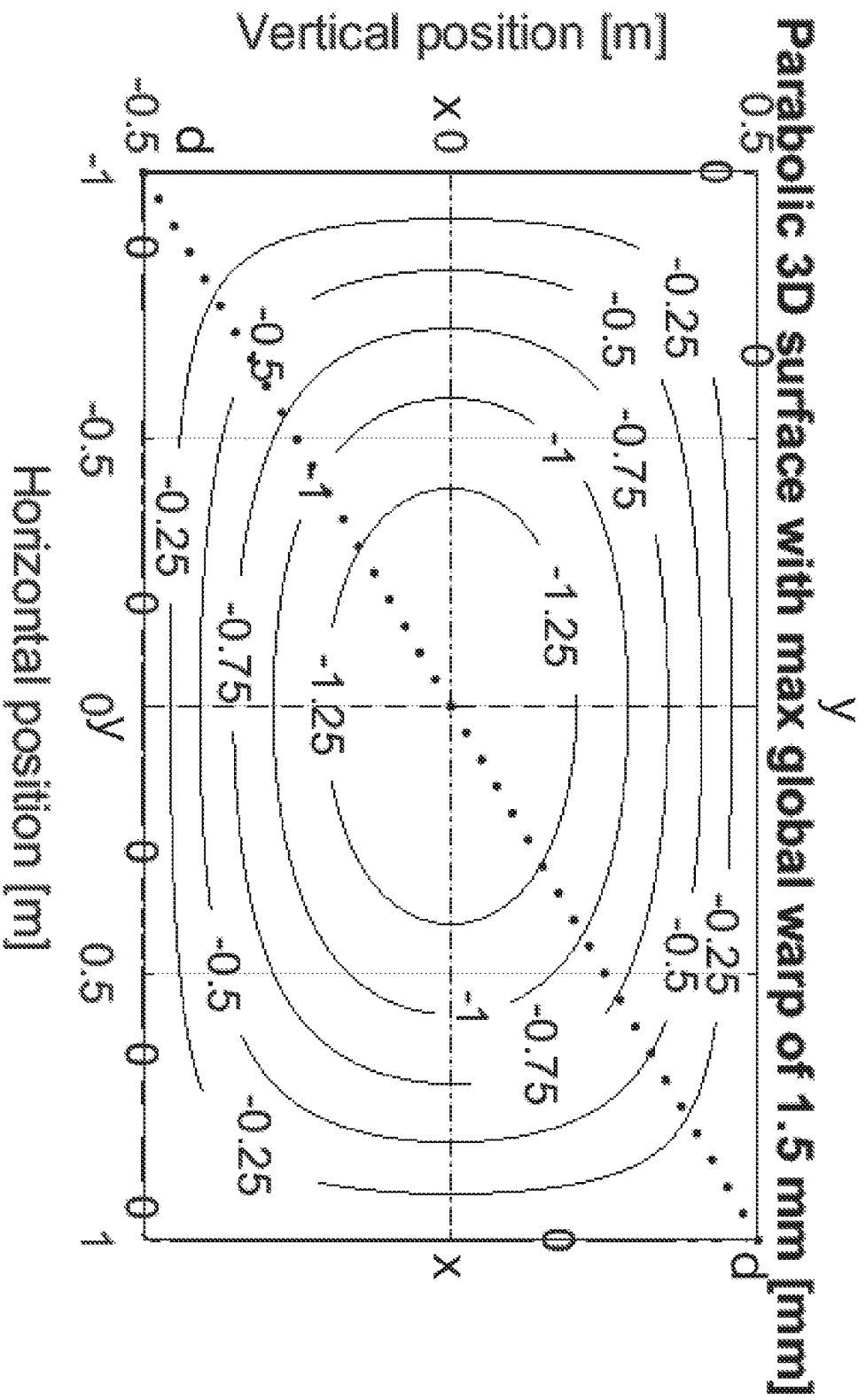


Figure 21a

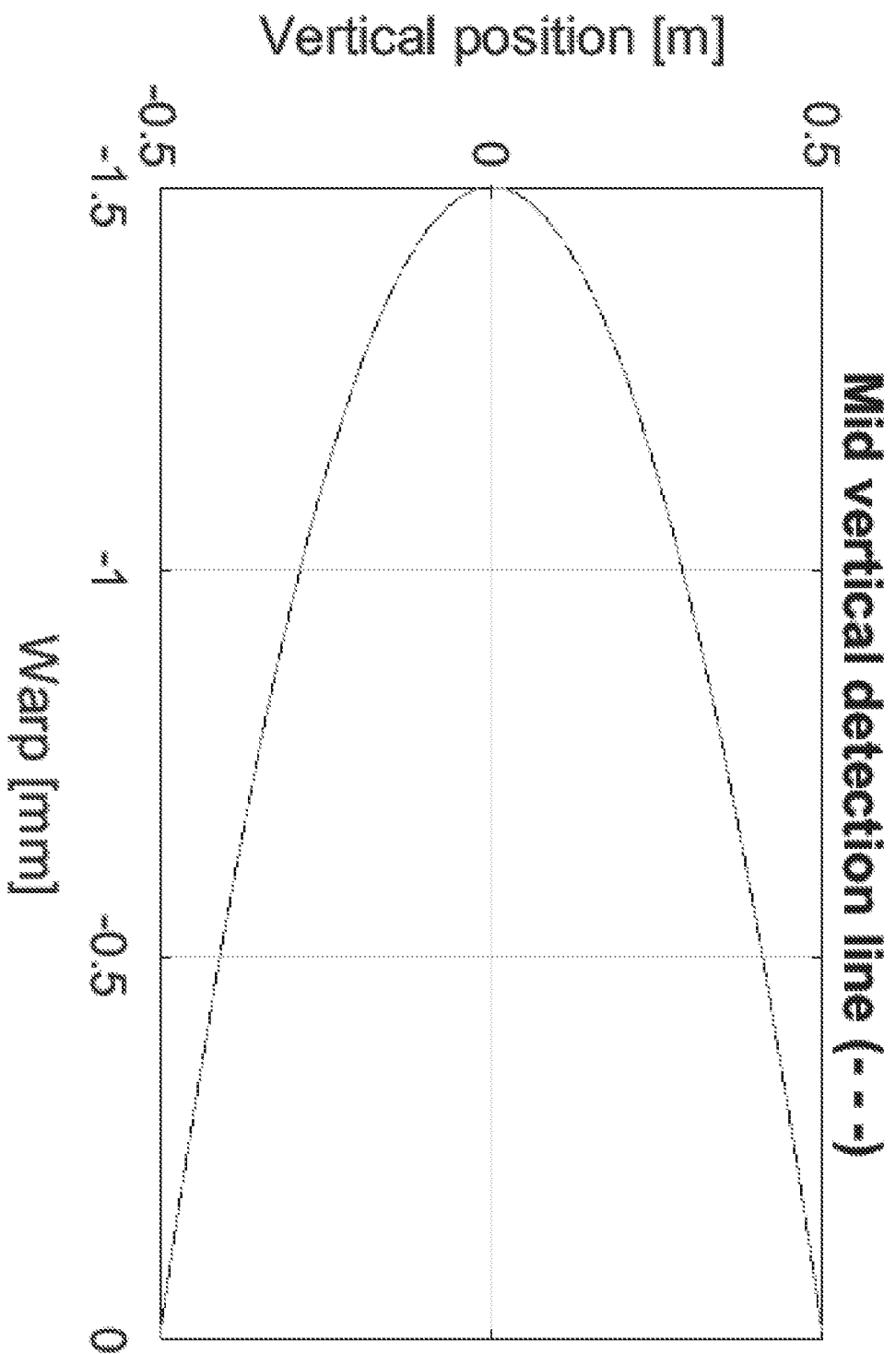


Figure 21b

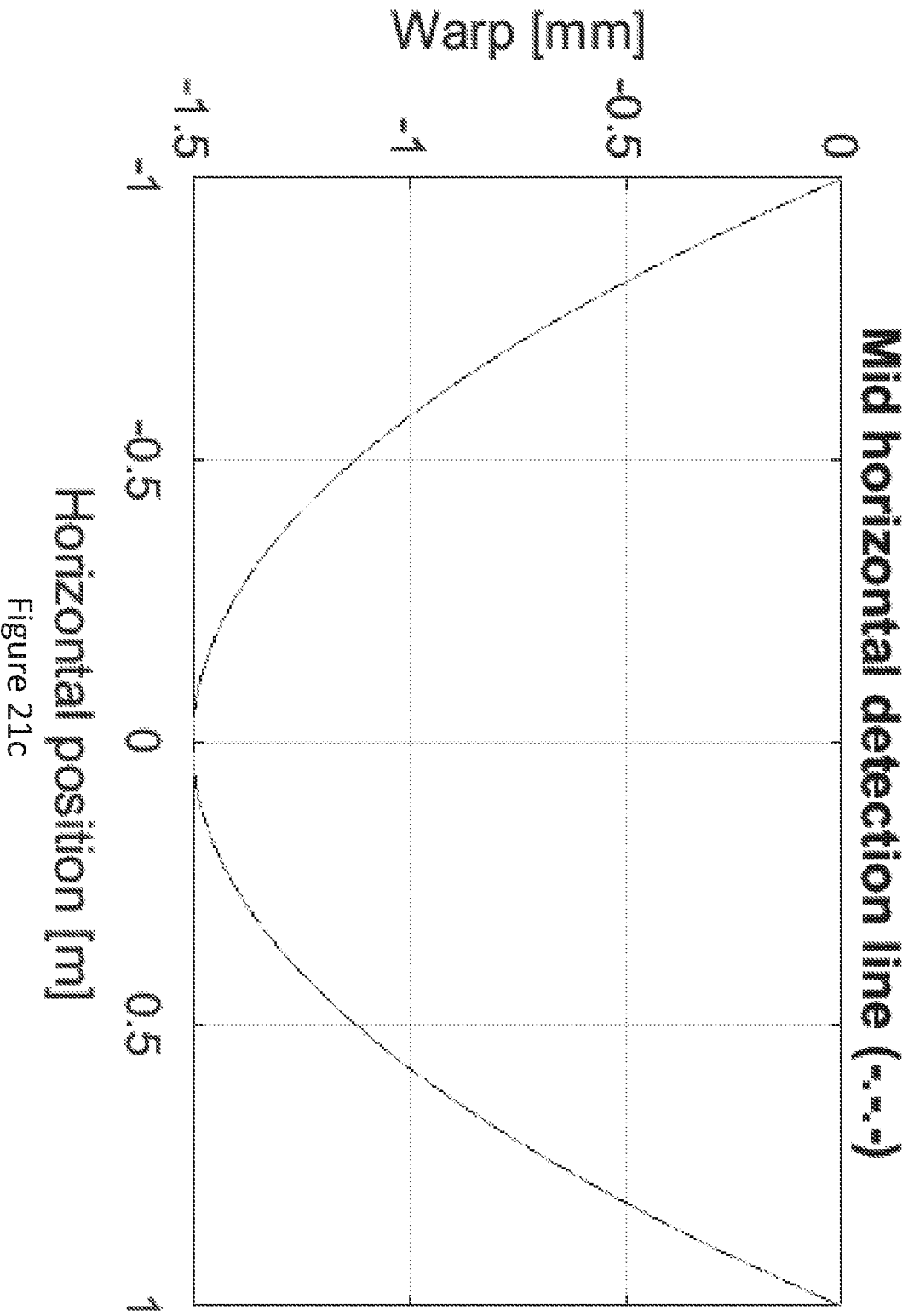


Figure 21c

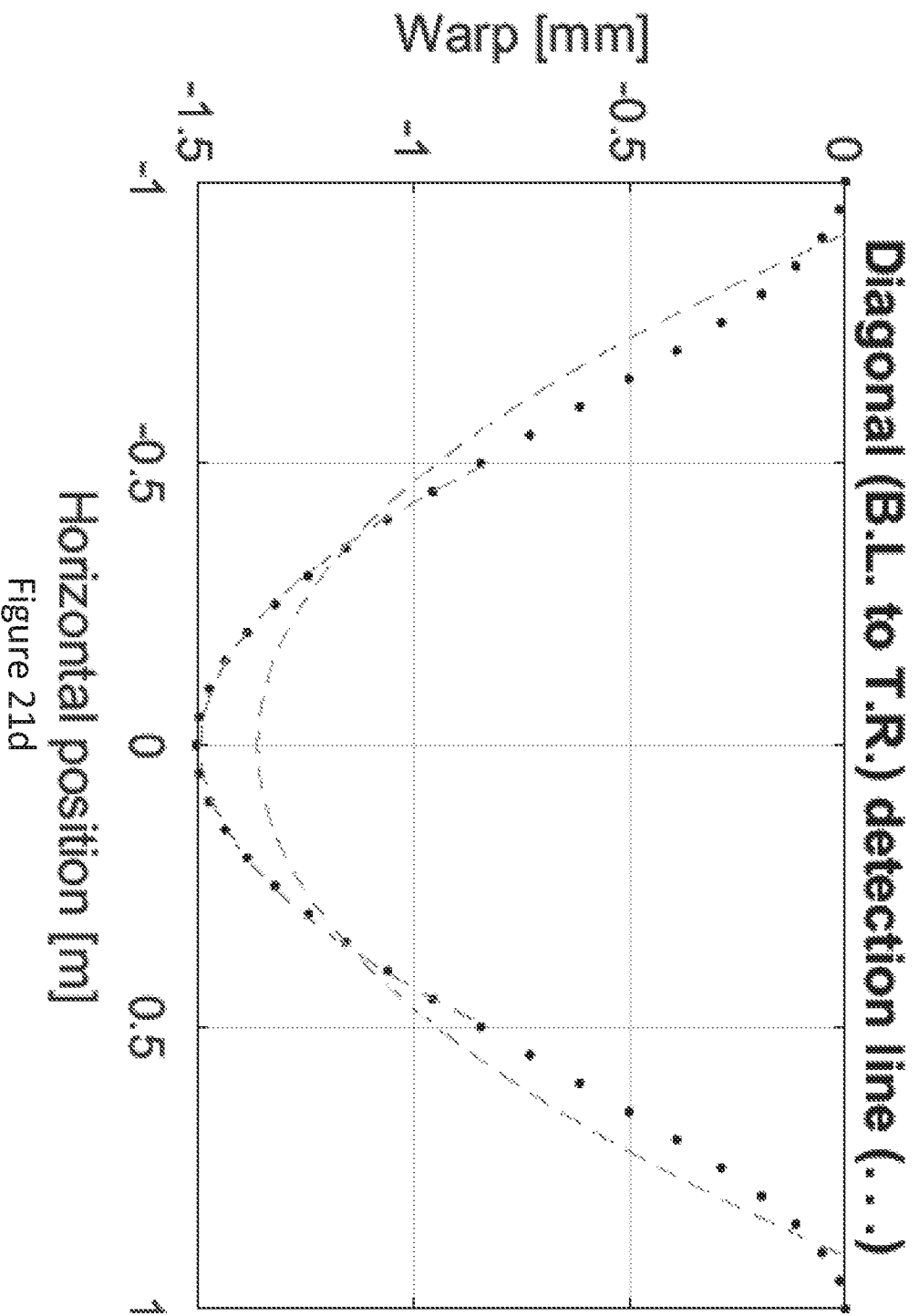


Figure 21d

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.053C1

Page 1 of 5

Title: TOUCH DEVICE

Inventors: Aleksander Kocovski, Hakan Bergstrom, Jens Thorvinger

Declaration

This Declaration is directed to U.S. or International Application No. **16/190907**, 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, and hereby assign or are under an obligation to assign to the below identified Assignee the above-titled application (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application").

AND WHEREAS, **FlatFrog Laboratories AB**, with its principal place of business at Scheelevagen 15, 223 63 Lund, Sweden (hereinafter the "ASSIGNEE"), desires to acquire 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 the Application and the Work, including all Patent Properties filed or issued upon the Application and the Work; where "Patent Properties" include, but are not limited to:

all provisional applications relating thereto (including but not limited to U.S. Provisional Application No(s)., filed (respectively if plural applications));

all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the present 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 acknowledges the ASSIGNEE as the Applicant for all aforementioned Patent Properties, and authorizes and requests the Commissioner of Patents of the United States, and any

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.053C1

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Title: TOUCH DEVICE

Inventors: Aleksander Kocovski, Hakan Bergstrom, Jens Thorvinger

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, in accordance with the terms of this instrument.

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, and 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 and 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.053C1

Page 3 of 5

Title: TOUCH DEVICE

Inventors: Aleksander Kocovski, Hakan Bergstrom, Jens Thorvinger

Legal Name of inventor: Aleksander Kocovski

Signature: Aleksander Kocovski
Aleksander Kocovski (Feb 21, 2019)

Date: Feb 21, 2019

Witnessed by: _____

Witness Name (printed): _____

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.053C1

Page 4 of 5

Title: TOUCH DEVICE

Inventors: Aleksander Kocovski, Hakan Bergstrom, Jens Thorvinger

Legal Name of inventor: Hakan Bergstrom

Signature: Håkan Bergström
Håkan Bergström (Feb 21, 2019)

Date: Feb 21, 2019

Witnessed by: _____

Witness Name (printed): _____

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: FFOG.053C1

Page 5 of 5

Title: TOUCH DEVICE

Inventors: Aleksander Kocovski, Hakan Bergstrom, Jens Thorvinger

Legal Name of inventor: Jens Thorvinger

Signature: Jens Thorvinger
Jens Thorvinger (Feb 25, 2019)

Date: Feb 25, 2019

Witnessed by: _____

Witness Name (printed): _____

29688161