UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/02/2018	10087065	67846-006PUS1	3315

26096 7590 09/12/2018

CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

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):

Ricky Dean Shock, Victoria, TX;
Fuel Automation Station, LLC, Birmingham, MI;

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

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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)

26096 7590 05/31/2018
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

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

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

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1	3315

TITLE OF INVENTION: MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0	$0	$1000	08/31/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
ARNETT, NICOLAS ALLEN	3753	141-230000

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 03-02 or more recent) attached. **Use of a Customer Number is required.**

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

1 Carlson, Gaskey & Olds, P.C.
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 has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: FUEL AUTOMATION STATION, LLC

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Birmingham, MI

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

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 501482 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
  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.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
  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.
- ☐ Applicant changing to regular undiscounted fee 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 /Matthew L. Koziarz/ Date 2018-08-30

Typed or printed name Matthew L. Koziarz Registration No. 53154

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	15290304
Filing Date:	11-Oct-2016
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Filer:	Matthew L. Koziarz/Andrea DeHart
Attorney Docket Number:	67846-006PUS1

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:	33588274
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	30-AUG-2018
Filing Date:	11-OCT-2016
Time Stamp:	14:26:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1000
RAM confirmation Number	083118INTEFSW00000740501482
Deposit Account	501482
Authorized User	Andrea DeHart
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	IssueFee_Transmittal.pdf	95884 c068cd5e7b4124ada8d3639b6f4ab0ecc09f7428	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30672 b797186d0cc73c075b56f50046a2313930c0c54d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	126556		

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

26096 7590 05/31/2018

CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

EXAMINER
ARNETT, NICOLAS ALLEN

ART UNIT	PAPER NUMBER
3753	

DATE MAILED: 05/31/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1	3315

TITLE OF INVENTION: MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0	$0	$1000	08/31/2018

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.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

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26096 7590 05/31/2018
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SUITE 350
BIRMINGHAM, MI 48009

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1	3315

TITLE OF INVENTION: MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0	$0	$1000	08/31/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
ARNETT, NICOLAS ALLEN	3753	141-230000

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

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

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. 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. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29
  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.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27
  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.
- ❑ Applicant changing to regular undiscounted fee 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. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1	3315

26096 7590 05/31/2018

CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

EXAMINER	
ARNETT, NICOLAS ALLEN	
ART UNIT	**PAPER NUMBER**
3753	

DATE MAILED: 05/31/2018

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 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Examiner-Initiated Interview Summary	Application No.	Applicant(s)		
	15/290,304	SHOCK, RICKY DEAN		
	Examiner	Art Unit	AIA (First Inventor to File) Status	Page
	NICOLAS A. ARNETT	3753	Yes	1 of 1

All participants (applicant, applicant's representative, PTO personnel):

1. NICOLAS A. ARNETT (Primary Examiner); Telephonic
2. MATTHEW KOZIARZ (Attorney); Telephonic

Date of Interview: 15 May 2018

Claim(s) discussed: 18

Issues Discussed:

Item(s) under 35 U.S.C. 103:
The parties discussed an amendment to the claims to overcome the 103 rejection. The examiner explained that claim 18 would be rejected based on the cited references because the phrase "routed through" is broad enough to include the communication line running within the hose being fed through the reels. The parties agreed to incorporate the language of claim 6 to require that the communication line is routed through a respective spindle of the different reels to overcome the rejection of the claims. The agreed-upon changes will be entered via examiner's amendment.

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

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 applicant's responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04

Please further see:

MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Notice of Allowability	Application No. 15/290,304	Applicant(s) SHOCK, RICKY DEAN	
	Examiner NICOLAS A. ARNETT	Art Unit 3753	AIA (First Inventor to File) 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 *2/13/18*.
   ☐ 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 *2,3,5,7-10,13,14,16-19 and 21-25*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

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

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

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date no date required
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date *5/15/18* .
5. ☒ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

DETAILED ACTION

1. The amendment filed February 13, 2018 has been entered. Upon entry of the amendment, claims 2-3, 6-10, 13-14 and 16-25 remain pending.

Notice of Pre-AIA or AIA Status

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

Claim Interpretation

3. The following is a quotation of 35 U.S.C. 112(f):

> (f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

4. Use of the word “means” (or “step for”) in a claim with functional language creates a rebuttable presumption that the claim element is to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is invoked is rebutted when the function is recited with sufficient structure, material, or acts within the claim itself to entirely perform the recited function.

Absence of the word “means” (or “step for”) in a claim creates a rebuttable presumption that the claim element **is not** to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is not invoked is rebutted when the claim element recites function but fails to recite sufficiently definite structure, material or acts to perform that function.

Claim elements in this application that use the word “means” (or “step for”) are presumed to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action. Similarly, claim elements that do not use the word “means” (or “step for”) are presumed not to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action.

Double Patenting

5. The rejections of the claims under 35 U.S.C. 101 are withdrawn in view of the amendment.

Claim Rejections - 35 USC § 103

6. The rejections of the claims under 35 U.S.C. 103 are withdrawn in view of the amendment and in view of the examiner's amendment below.

EXAMINER’S AMENDMENT

7. An examiner’s amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided

by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Matthew Koziarz on May 15, 2018.

The application has been amended as follows:

Claims 6 and 20 have been **cancelled**.

In claim 18:

In line 14, "reels." has been **replaced** with - - reels; wherein each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles. - -

In each of claims 21 and 22:

In line 1, "20" has been **replaced** with - -19 - -.

Allowable Subject Matter

8. Claims 2-3, 5, 7-10, 13-14, 16-19 and 21-25 are allowed.

9. The following is an examiner's statement of reasons for allowance: the cited documents do not disclose a mobile distribution station comprising, in combination with the claimed invention as a whole, level sensors hard wired through the reels to the controller or each communication line being routed through a spindle of a respective

different one of the reels. Therefore, the cited documents do not disclose or render obvious applicant's claimed invention.

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

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NICOLAS A. ARNETT whose telephone number is (571)270-5062. The examiner can normally be reached on Monday - Thursday 7:00 AM to 4:00 PM EST; Friday 12:30 PM to 4:30 PM EST.

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, Mary E. McManmon can be reached on (571) 272-6007. 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 http://pair-direct.uspto.gov. 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.

/NICOLAS A ARNETT/
Primary Examiner, Art Unit 3753
May 18, 2018

Examiner-Initiated Interview Summary	Application No.	Applicant(s)		
	15/290,304	SHOCK, RICKY DEAN		
	Examiner	Art Unit	AIA (First Inventor to File) Status	Page
	NICOLAS A. ARNETT	3753	Yes	1 of 1

All participants (applicant, applicant's representative, PTO personnel):

1. NICOLAS A. ARNETT (Primary Examiner); Telephonic
2. MATTHEW KOZIARZ (Attorney); Telephonic

Date of Interview: 15 May 2018

Claim(s) discussed: 18

Issues Discussed:

Item(s) under 35 U.S.C. 103:
The parties discussed an amendment to the claims to overcome the 103 rejection. The examiner explained that claim 18 would be rejected based on the cited references because the phrase "routed through" is broad enough to include the communication line running within the hose being fed through the reels. The parties agreed to incorporate the language of claim 6 to require that the communication line is routed through a respective spindle of the different reels to overcome the rejection of the claims. The agreed-upon changes will be entered via examiner's amendment.

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

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 applicant's responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04

Please further see:

MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	Art Unit
	NICOLAS A ARNETT	3753

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

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

CLAIM		DATE								
Final	Original	09/08/2017	05/15/2018							
	1	✓	-							
6	2	✓	=							
7	3	✓	=							
	4	✓	-							
8	5	✓	=							
	6	✓	-							
9	7	✓	=							
10	8	✓	=							
11	9	✓	=							
12	10	✓	=							
	11	✓	-							
	12	✓	-							
1	13	✓	=							
2	14	✓	=							
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3	16	✓	=							
4	17	✓	=							
5	18		=							
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	20		-							
14	21		=							
15	22		=							
16	23		=							
17	24		=							
18	25		=							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	Art Unit
	NICOLAS A ARNETT	3753

CPC- SEARCHED		
Symbol	Date	Examiner
B67D 7/465, 40, 845, 04	9/8/2017	NAA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
141	94-95, 231	9/8/2017	NAA

* 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
Text search of the classifications indicated above	9/8/2017	NAA
Searched East: (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT)	9/8/2017	NAA
Inventor search Conducted, limited with text: (USPAT, USPGPUB)	9/8/2017	NAA
Applicant search Conducted, limited with text: (USPAT, USPGPUB)	9/8/2017	NAA
Google text search conducted	9/8/2017	NAA
Interference Search conducted East: (key words).clm.	5/15/2018	NAA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
B67D	7/465, 40, 845, 04	5/15/2018	NAA

	/NICOLAS A ARNETT/ Primary Examiner.Art Unit 3753

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	**Art Unit**
	NICOLAS A ARNETT	3753

CPC						
Symbol					**Type**	**Version**
B67D		7	/	465	F	2013-01-01
B67D		7	/	04	I	2013-01-01
B67D		7	/	40	I	2013-01-01
B67D		7	/	845	I	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	18	
/NICOLAS A ARNETT/ Primary Examiner.Art Unit 3753	05/15/2018	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	Art Unit
	NICOLAS A ARNETT	3753

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		B	6	7	D	7 / 04 (2010.01.01)						
CROSS REFERENCE(S)												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 18	
/NICOLAS A ARNETT/ Primary Examiner.Art Unit 3753 (Primary Examiner)	05/15/2018 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	**Art Unit**
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☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	13	17	24												
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4	17														
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11	9														
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14	21														
15	22														
16	23														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 18	
/NICOLAS A ARNETT/ Primary Examiner.Art Unit 3753 (Primary Examiner)	05/15/2018 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

U.S. Patent and Trademark Office Part of Paper No. 20180515

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15290304
Filing Date	2017-02-23
First Named Inventor	Ricky Dean Shock
Art Unit	3753
Examiner Name	Arnett, Nicolas Allen
Attorney Docket Number	67846-006PUS1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2966921		1961-01-03	Whiteman	
	2	3605798		1971-09-20	Green et al.	
	3	3625399		1971-12-07	Heisler	
	4	3881509		1975-05-06	Newton	
	5	4591115		1986-05-27	DeCarlo	
	6	4728005		1988-03-01	Jacobs et al.	
	7	5660358		1997-08-26	Grafwallner et al.	
	8	5749339		1998-05-12	Graham et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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Attorney Docket Number	67846-006PUS1

	9	5927603		1999-07-27	McNabb	
	10	6779569		2004-08-24	Teer, Jr. et al.	
	11	2340070		1944-01-25	McCauley et al.	
	12	3677284		1972-07-18	Mendez	
	13	4284210		1981-08-18	Horak	
	14	4511311		1985-04-16	Olson	
	15	4651788		1987-03-24	Grosskreuz et al.	
	16	5465766		1995-11-14	Siegele et al.	
	17	5551309		1996-09-03	Goossens et al.	
	18	5651400		1997-07-29	Corts et al.	
	19	6098646		2000-08-08	Hennemann et al.	

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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	20	6601000		2003-07-29	Barlian et al.	
	21	7937215		2011-05-03	Humphrey	
	22	8448750		2013-05-28	Gaugush et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050109561		2005-05-26	Chopra	
	2	20010017815		2001-08-30	Ackermann et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1147397	DE		1963-04-18	WINDMUELLER & HOELSCHER	+ English Translation	
	2	10309307	DE		2004-09-16	BERTHOLD	+ English Translation	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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Attorney Docket Number	67846-006PUS1

	3	102006038652	DE		2008-02-21	SIG TECHNOLOGY AG	+ English Translation	
	4	0177006	WO		2001-10-18	BARTEC COMPONENTEN UND SYSTEME GMBH	+ English Translation	
	5	2007087849	WO		2007-08-09	BARTEC COMPONENTEN UND SYSTEME GMBH	+ English Translation	
	6	0161042	EP		1985-11-13	JET SPRAY CORP		
	7	949644	SU		1982-08-07	Naumenko, O.M., et al.	+ English Translation	
	8	28347	RU		2003-03-20	Yadrekhenskie V. N., et al.	+ English Translation	
	9	2452668	RU		2012-01-10	EHJRBAS OPEREHJSHNZ GMBKH	+ English Abstract	
	10	91135	RU		2010-01-27	Gidroresurs	+ English Abstract	
	11	20106400	DE		2001-10-18	Anetsberger, Alois	+ English Translation	
	12	102006025025	DE		2006-12-21	Dirmeier, Hans	+ English Abstract	
	13	0433041	EP		2001-06-19	Gilbarco Inc.		

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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	Art Unit	3753
	Examiner Name	Arnett, Nicolas Allen
	Attorney Docket Number	67846-006PUS1

	14	03029721	WO		2003-04-10	Honeyman Water LTD.		
	15	03093118	WO		2003-11-13	BOC EDWARDS		
	16	2006116572	WO		2006-11-02	Advanced Technology Materials, INC.		
	17	20090608065	WO		2009-06-04	Airbus Deutschland GMBH		

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NON-PATENT LITERATURE DOCUMENTS Remove

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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	SHIMAZAKI, H. (1986). Development of centralized fueling and management system of kerosene heating machine. Nisseki Technical Review, vol. 28(4). July 1986. pp. 184-188.	
	2	TECHNICAL DOCUMENT. Surface vehicle standard. SAE International. September 2014. pp. 1-5.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/NICOLAS A ARNETT/	Date Considered	05/15/2018

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

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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	Art Unit	3753
	Examiner Name	Arnett, Nicolas Allen
	Attorney Docket Number	67846-006PUS1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew L. Koziarz/	Date (YYYY-MM-DD)	2018-02-13
Name/Print	Matthew L. Koziarz	Registration Number	53154

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

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 record s.

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.

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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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A.A/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	39	("20070079891" | "20070164031" | "20070181212" | "20160076533" | "2516150" | "2769572" | "2777461" | "3028010" | "3136295" | "3547141" | "3618643" | "4139019" | "4591115" | "4930665" | "5406988" | "5454408" | "5503199" | "5538051" | "5708424" | "5884675" | "6206056" | "6564615" | "6651706" | "6697705" | "6755225" | "6761194" | "6786245" | "7063276" | "7106026" | "7353808" | "7415995" | "7458543" | "7568507" | "7602143" | "7628182" | "7938151" | "9346662" | "9371830" | "9371831").PN.	US-PGPUB; USPAT	ADJ	ON	2017/09/07 09:48
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S3	1	(("SHOCK") near3 ("Ricky")).INV.	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/09/07 09:49
S4	2962	(B67D7/465 or B67D7/40 or B67D7/845 or B67D7/04).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:50
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S6	1	(mobile with (station or trailer) with (fuel$3 or refuel$3)) same (manifold) same (valve) same (level with sens$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:54
S7	1523	(mobile with (station or trailer) with (fuel$3 or refuel$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:55
S8	80	S7 and (S4 or S5)	US-PGPUB;	ADJ	ON	2017/09/07 10:55

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT			
S9	0	S7 and (hose with (wir$3 or (communication near2 line)) with (level near3 sens$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:56
S10	0	(S4 or S5) and (hose with (wir$3 or (communication near2 line)) with (level near3 sens$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:57
S11	2	(fuel$3 or refuel$3) same (hose with (wir$3 or (communication near2 line)) with (level near3 sens$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 10:59
S12	2	S1 and S7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 11:00
S13	0	(S1) and (hose with (wir$3 or (communication near2 line)) with (level near3 sens$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	ADJ	ON	2017/09/07 11:03
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S15	1	("9346662").PN.	US-PGPUB; USPAT	OR	OFF	2017/09/07 11:24
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1

CONFIRMATION NO. 3315

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

PUBLICATION NOTICE

OC000000098742984

Title:MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

Publication No.US-2018-0099862-A1
Publication Date:04/12/2018

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.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/290,304	Filing Date 10/11/2016	☐ 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), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ 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)		
	02/13/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 20	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)		
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ 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.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

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PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	15290304
Filing Date	2017-02-23
First Named Inventor	Ricky Dean Shock
Art Unit	3753
Examiner Name	Arnett, Nicolas Allen
Attorney Docket Number	67846-006PUS1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2966921		1961-01-03	Whiteman	
	2	3605798		1971-09-20	Green et al.	
	3	3625399		1971-12-07	Heisler	
	4	3881509		1975-05-06	Newton	
	5	4591115		1986-05-27	DeCarlo	
	6	4728005		1988-03-01	Jacobs et al.	
	7	5660358		1997-08-26	Grafwallner et al.	
	8	5749339		1998-05-12	Graham et al.	

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	Attorney Docket Number	67846-006PUS1

	9	5927603		1999-07-27	McNabb	
	10	6779569		2004-08-24	Teer, Jr. et al.	
	11	2340070		1944-01-25	McCauley et al.	
	12	3677284		1972-07-18	Mendez	
	13	4284210		1981-08-18	Horak	
	14	4511311		1985-04-16	Olson	
	15	4651788		1987-03-24	Grosskreuz et al.	
	16	5465766		1995-11-14	Siegele et al.	
	17	5551309		1996-09-03	Goossens et al.	
	18	5651400		1997-07-29	Corts et al.	
	19	6098646		2000-08-08	Hennemann et al.	

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	20	6601000		2003-07-29	Barlian et al.	
	21	7937215		2011-05-03	Humphrey	
	22	8448750		2013-05-28	Gaugush et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050109561		2005-05-26	Chopra	
	2	20010017815		2001-08-30	Ackermann et al.	

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	1	1147397	DE		1963-04-18	WINDMUELLER & HOELSCHER	+ English Translation	
	2	10309307	DE		2004-09-16	BERTHOLD	+ English Translation	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15290304
	Filing Date	2017-02-23
	First Named Inventor	Ricky Dean Shock
	Art Unit	3753
	Examiner Name	Arnett, Nicolas Allen
	Attorney Docket Number	67846-006PUS1

	3	102006038652	DE		2008-02-21	SIG TECHNOLOGY AG	+ English Translation	
	4	0177006	WO		2001-10-18	BARTEC COMPONENTEN UND SYSTEME GMBH	+ English Translation	
	5	2007087849	WO		2007-08-09	BARTEC COMPONENTEN UND SYSTEME GMBH	+ English Translation	
	6	0161042	EP		1985-11-13	JET SPRAY CORP		
	7	949644	SU		1982-08-07	Naumenko, O.M., et al.	+ English Translation	
	8	28347	RU		2003-03-20	Yadrekhenskie V. N., et al.	+ English Translation	
	9	2452668	RU		2012-01-10	EHJRBAS OPEREHJSHNZ GMBKH	+ English Abstract	
	10	91135	RU		2010-01-27	Gidroresurs	+ English Abstract	
	11	20106400	DE		2001-10-18	Anetsberger, Alois	+ English Translation	
	12	102006025025	DE		2006-12-21	Dirmeier, Hans	+ English Abstract	
	13	0433041	EP		2001-06-19	Gilbarco Inc.		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15290304
	Filing Date	2017-02-23
	First Named Inventor	Ricky Dean Shock
	Art Unit	3753
	Examiner Name	Arnett, Nicolas Allen
	Attorney Docket Number	67846-006PUS1

	14	03029721	WO		2003-04-10	Honeyman Water LTD.			
	15	03093118	WO		2003-11-13	BOC EDWARDS			
	16	2006116572	WO		2006-11-02	Advanced Technology Materials, INC.			
	17	20090608065	WO		2009-06-04	Airbus Deutschland GMBH			

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NON-PATENT LITERATURE DOCUMENTS Remove

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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	SHIMAZAKI, H. (1986). Development of centralized fueling and management system of kerosene heating machine. Nisseki Technical Review, vol. 28(4). July 1986. pp. 184-188.	
	2	TECHNICAL DOCUMENT. Surface vehicle standard. SAE International. September 2014. pp. 1-5.	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2017-02-23
	First Named Inventor	Ricky Dean Shock
	Art Unit	3753
	Examiner Name	Arnett, Nicolas Allen
	Attorney Docket Number	67846-006PUS1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew L. Koziarz/	Date (YYYY-MM-DD)	2018-02-13
Name/Print	Matthew L. Koziarz	Registration Number	53154

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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.

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Mobile gas station translated from German

DE 20106400 U1

ABSTRACT available in

DESCRIPTION translated from German

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Publication number	DE20106400 U1
Publication type	Grant
Application number	DE2001206400
Publication date	Oct 18, 2001
Filing date	Apr 11, 2001
Priority date	Apr 11, 2001
Applicant	Anstsberger Alois
Export Citation	BiBTeX, EndNote, RefMan

Classifications (9), Legal Events (7)

External Links: DPMA, Espacenet

CLAIMS (17) translated from German

1. Mobile gas station **(2)** applied for water polluting liquids with at least one in a dispensing container **(3)** underweight dispensing device **(9),** as well as a Auffangeinrich tion **(4)** for collecting spilled **liquid, characterized** in that the collecting device as a static self-supporting and is intrinsically stable, drivable by at Betan kenden vehicle travel path element **(4)** with at least least an integrated drip pan **(15),** the liquid-tight manner to the power take-off container **(3)** is connected ver.

2. Mobile gas station according to claim 1, characterized in that the motorable road element **(4)** with a canopy **(23)** is provided.

3. Mobile filling station according to claim 1, characterized in that in the collecting trough **(15)** has a fluid warning probe **(6)** is provided which switches least the feed pump in the dispensing device **(9)** in the case of a triggering signal from min.

4. Mobile gas station according to claim 1, characterized in that the path element **(4)** two or more miteinan over the overflow openings **(60)** connected to the drip pans **(15)** are provided.

5. Mobile filling station according to claim 1, characterized in that the dispensing container **(3)** comprisss a separate liquid keitsdichte steel drip pan **(5),** in which a further fluid sensor **(6)** provided at the trip signal, the feed pump in the dispensing device **(9)** switches off.

6. Mobile gas station according to claim 1, characterized in that the path element **(4)** can be driven over ramps **(48).**

7. Mobile filling station according to claim 1, characterized in that the travel path element **(4)** has at least one said at least one collecting trough **(15)** connected to the drainage channel **(17)** and the road surface in the direction of from overflow channel **(17)** is inclined.

8. Mobile filling station according to claim 7, characterized in that above the drainage channel **(17),** a light grating **(21)** is arranged.

9. Mobile filling station according to claim 8, characterized in that the drainage channel **(17)** is connected via an opening **(62)** with the at least one collecting trough **(15),** where at this opening **(62)** opening at least about the Überlauföff **(60)** is such that below the overflow opening **(62)** a groove bottoms **(63)** is formed in which the in the drain gutter **(17)** is entering liquid first collects GE.

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10. Mobile filling station according to claim 1, characterized in that the at least one collecting trough (15) can be emptied by means of in each case one suction connection piece (50).

11. Mobile filling station according to claim 1, characterized in that between the lower region of the gutter (17) and the at least one collecting trough (15) Ver circuit valve (24) is arranged which opens when the decanting procedure is started and a time delay will be closed by the end of the tapping operation.

12. Mobile filling station according to claim 1, characterized in that the drainage channel (17) is connected via a closure valve (53) with an outlet (64), said Ver circuit valve (53) is closed when the Umfüllvor process is started and time delay after the order filling process is reopened.

13. Mobile filling station according to claim 1, characterized in that the travel path element (4) via a Anschlussele element (19) to the dispensing container (3).

14. Mobile filling station according to claim 1, characterized in that the travel path element (4) consists of a support grid.

15. Mobile gas station according to claim 14, characterized in that the support grid with the bottom plate (16 a) and the side walls (61) is firmly welded.

16. Mobile filling station according to claim 15, characterized in, that the floor panel are (16 a) and the side walls (61) are welded together so that they form a liquid-tight tray (15).

17. Mobile filling station according to claim 14, characterized in that the cover plate (16) of the roadway element (4) is screwed onto the supporting grid.

CLASSIFICATIONS

International Classification	B60S5/02, B67D7/04, B67D7/78
Cooperative Classification	B67D7/04, B60S5/02, B67D7/78
European Classification	B60S5/02, B67D7/04, B67D7/78

LEGAL EVENTS

Date	Code	Event	Description
Nov 22, 2001	R207	Utility model specification	**Effective date:** 20011122
Mar 17, 2005	R150	Term of protection extended to 6 years	**Effective date:** 20050111
Sep 27, 2007	R151	Term of protection extended to 8 years	**Effective date:** 20070723
Sep 10, 2009	R152	Term of protection extended to 10 years	**Effective date:** 20090703
May 2, 2011	R071	Expiry of right	
Feb 8, 2012	R082	Change of representative	**Representative=s name:** ROESLER SCHICK RASCH PATENTANWAELTE PARTNERSCH, DE **Representative=s name:** ROESLER SCHICK RASCH PATENTANWAELTE PARTNERSCHAFTS
Feb 22, 2012	R082	Change of representative	**Representative=s name:** ROESLER SCHICK RASCH PATENTANWAELTE PARTNERSCHAFTS **Representative=s name:** ROESLER SCHICK RASCH PATENTANWAELTE PARTNERSCH, DE

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(12) **Gebrauchsmusterschrift**

(10) **DE 201 06 400 U 1**

(51) Int. Cl.[7]:
B 67 D 5/04
E 04 H 5/02
B 65 D 90/24

(21) Aktenzeichen: 201 06 400.6
(22) Anmeldetag: 11. 4. 2001
(47) Eintragungstag: 18. 10. 2001
(43) Bekanntmachung im Patentblatt: 22. 11. 2001

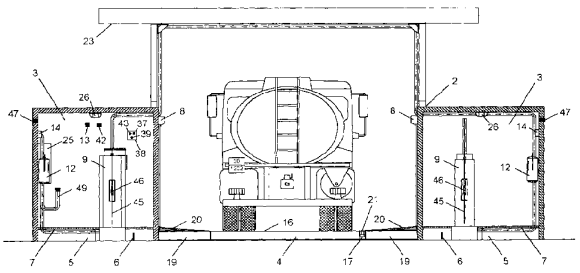
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(73) Inhaber:
Anetsberger, Alois, 83569 Vogtareuth, DE

(74) Vertreter:
Lewinsky & Partner GbR, Pat.- und Rechtsanwälte, 80689 München

(54) Mobile Tankstelle

(57) Mobile Tankstelle (2) für wassergefährdende Flüssigkeiten mit mindestens einer in einem Zapfcontainer (3) untergebrachten Zapfeinrichtung (9), sowie einer Auffangeinrichtung (4) zum Auffangen von verschütteter Flüssigkeit, dadurch gekennzeichnet, dass die Auffangeinrichtung als statisch selbsttragendes und eigenstabiles, vom zu betankenden Fahrzeug befahrbaren Fahrbahnelement (4) mit mindestens einer integrierten Auffangwanne (15) ausgeführt ist, die flüssigkeitsdicht mit dem Zapfcontainer (3) verbunden ist.



DE 201 06 400 U 1

Alois Anetsberger
33.316

11.04.01

Mobile Tankstelle

Die Erfindung betrifft eine mobile Tankstelle für wassergefährdende Flüssigkeiten mit mindestens einer in einem Zapfcontainer untergebrachten Zapfeinrichtung, sowie einer Auffangeinrichtung zum Auffangen von verschütteter Flüssigkeit. Eine derartige Systemtankstelle eignet sich insbesondere für das Betanken von Fahrzeugen und Arbeitsmaschinen sowie das Befüllen und Entleeren von Tankfahrzeugen dort, wo ungenügende bauliche Voraussetzungen, zum Beispiel Bodenabdichtung für die Anforderungen an Tankstellen und Abfüllplätze bestehen, die in Deutschland in bundes- und landesrechtlichen Vorschriften zum Schutz der Gewässer (WHG), in Landesverordnungen der Länder (VAwS) sowie in den technischen Regeln für brennbare Flüssigkeiten (TRbF) geregelt sind.

Nach dem Stand der Technik muss der Boden eines Abfüllplatzes so beschaffen sein, dass auslaufende wassergefährdende Flüssigkeiten erkannt und beseitigt werden können und nicht in ein oberirdisches Gewässer, in eine hierfür nicht geeignete Abwasseranlage oder in das Erdreich gelangen können. Die Bodenfläche muss ausreichend dicht und widerstandsfähig gegen die umzufüllenden wassergefährdenden Flüssigkeiten sowie gegen die zu erwartenden mechanischen Beanspruchungen sein.

Diese Anforderungen gelten beispielsweise als erfüllt, wenn der Abfüllplatz durch Gefällegrenzen, Einlaufrinnen oder Aufkantungen begrenzt ist und die Bodenflächen strengen Sicherheitsvorschriften hinsichtlich der Materialstärke, Materialqualität (z.B. Stahlbeton der Mindestgüte B 35 etc.) gerecht werden. Die Bodenflächen sind durch den Betreiber regelmässig auf sichtbare Schäden zu kontrollieren. Die Schäden sind umgehend auszubessern. Die Prüfung der Dichtheit und der elektrischen Leitfähigkeit der Bodenflächen ist in die Prüfung der Tankstelle durch den Sachverständigen einzubeziehen.

Die Flächen unterhalb von Abgabeeinrichtungen müssen so ausgebildet sein, dass Kraftstoffe nicht in den Untergrund ge-

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langen können. Dies kann zum Beispiel dadurch erreicht werden, dass Flüssigkeiten aus Leckagen über Ableitflächen auf die flüssigkeitsdichte Fläche des Abfüllplatzes gelangen und dort leicht erkannt und beseitigt werden können.

Offene Rohrenden oberhalb der Ableitflächen müssen flüssigkeitsundurchlässig abgedichtet werden. Durchführungen von Rohrleitungen oder Kabeln durch diese Ableitflächen müssen so ausgebildet werden, dass brennbare Flüssigkeiten nicht abfliessen können.

Durch geeignete Maßnahmen muss ferner verhindert werden, dass verunreinigtes Niederschlagswasser in den Boden oder in ein Gewässer gelangt. Dies ist z.B. erfüllt, wenn im Wirkbereich des Abfüllplatzes (außerhalb des Umfüllbereiches) die Abläufe mit Abscheider mit selbsttätigem Abschluss ausgerüstet sind.

Aus der DE 200 17 442 U1 ist eine Umfüllstation für wassergefährdende Flüssigkeiten bekannt, die ein Befüllen und Entleeren von Tankfahrzeugen sowie das Betanken von Betriebsfahrzeugen ermöglicht. Um eine Bodenverunreinigung beim Betankungsvorgang zu verhindern ist eine ausziehbare Auffangwanne vorgesehen, welche unter den Kraftstofftank des Fahrzeugs geschoben wird. Diese Wanne ist nicht befahrbar und für PKW nicht geeignet, da bei Pkws der Einfüllstutzen in der Regel über dem Hinterrad angeordnet ist und die Auffangwanne daher nicht unter den Einfüllstutzen geschoben werden kann.

Die DE 43 10 182 A1 offenbart eine montierbare Auffangwanneneinrichtung mit mehreren nebeneinander angeordneten separaten offenen Rinnen, zwischen denen Träger als Tragkonstruktion für befahrbare Gitter dienen. Die Rinnen sind mit einem gemeinsamen Sammelablauf verbunden. Diese Auffangwanneneinrichtung erfordert einen nicht unerheblichen Montageaufwand, da die einzelnen Bestandteile (Rinnen sowie die Träger) ausgerichtet und verbunden werden müssen. Darüber hinaus benötigt diese Vorrichtung eine Entwässerungseinrichtung mit Ölabscheidern.

Der Erfindung liegt somit das Problem zugrunde, eine mobile Tankstelle, insbesondere für das Betanken von Fahrzeugen und Arbeitsmaschinen sowie das Befüllen und Entleeren von Tankfahrzeugen in Verbindung mit Lagerbehältern für wassergefährdende Flüssigkeiten zu schaffen, ohne dass weitere aufwendige Bodenversiegelungen mit Entwässerungssystemen erforderlich werden.

Dieses Problem wird mit den im Schutzanspruch 1 aufgeführten Merkmalen gelöst. Vorteilhafte Weiterbildungen des Erfindungsgedankens ergeben sich aus den Unteransprüchen.

Der Einsatz der Erfindung gewährleistet eine hohe Flexibilität, außerdem fallen bei Standortwechseln keine Kosten für Rückbaumaßnahmen und Entsorgung an. Die Aufstellung und der Einsatz der mobilen Tankstelle erfolgt in kürzester Zeit, so dass die Stillstandszeit der Tankstelle bzw. des Tanklagers minimal gehalten wird.

Mit dem Einsatz der mobilen Tankstelle werden alle wasserrechtlichen Anforderungen der Länder (VAwS) zum Thema Tankstellen und Abfüllplatz erfüllt und es ist keine Baugenehmigung erforderlich.

Mit dieser Konstruktion ist sichergestellt, dass Belastungen des Bodens oder des Grundwassers durch unkontrolliertes Ablaufen von belastetem Oberflächenwasser aus dem Abfüllbereich nicht zu besorgen ist.

Die Erfindung ermöglicht ein Betanken von Fahrzeugen sowie das Befüllen und Entleeren von Tankfahrzeugen in Verbindung mit Lagerbehälter für wassergefährdende Flüssigkeiten. Der Abfüllbereich besteht aus einem Fahrbahnelement mit integrierten Auffangwannen und stellt eine wirksame Bodenabsicherung innerhalb des Wirkbereiches des Zapfschlauches dar. Das Fahrbahnelement mit integrierten Auffangwannen gewährleistet den Bodenschutz im Falle einer Leckage oder fehlerhaften Bedienhandlung, indem das geförderte Produkt über die Ablaufrinne in die Auffangwanne des Fahrbahnelementes gelei-

tet wird. Die Ablaufrinne ist vorzugsweise längsseitig im Fahrbahnelement angeordnet. Die hier vorgestellte Neuentwicklung ersetzt in Verbindung mit den Fahrbahnelementen die herkömmliche Bauweise zum Betanken von den oben genannten Fahrzeugen und Arbeitsmaschinen sowie die Befüllung und Entleerung von Tankfahrzeugen in Verbindung mit Lagerbehältern.

Ein Ausführungsbeispiel wird anhand der Abbildungen 1-10 erläutert. Dabei zeigt:

Abb. 1 : eine Vorderansicht der erfindungsgemäßen mobilen Tankstelle;

Abb. 2 : eine Seitenansicht der mobilen Tankstelle;

Abb. 3 : eine Draufsicht der mobilen Tankstelle;

Abb. 4 : eine Darstellung des Fahrbahnelementes;

Abb. 5 : eine Längsschnitt-Darstellung des Fahrbahnelementes;

Abb. 6 : eine Detail-Darstellung der Auffangwannen-Abtrennung im Fahrbahnelement;

Abb. 7 : eine Detail-Darstellung des Saug-Anschluss-Stutzens einer Auffangwanne im Fahrbahnelement für eine Erfindungsvariante mit Dach;

Abb. 8 : 3 Teilansichten der Verschlussventile für die Auffangwannen für eine Erfindungsvariante ohne Dach;

Abb. 9 : eine Darstellung des Adapters mit Schnellschlußventil für die Entleerung von Tankfahrzeugen;

Abb. 10 : ein Verfahrensschema der mobilen Tankstelle;

Der Einsatz der mobilen Tankstelle erfolgt vorzugsweise in Verbindung mit Lagerbehältern nach DIN 6608, DIN 6616, DIN 6618, DIN 6619, DIN 6624, DIN 6625, DIN 4119 und anderen der Bauart nach zugelassenen Tanks **1** in der Anordnung als Einzeltank oder als Tankgruppe. Die erfindungsgemäße mobile Tankstelle **2** ist ein statisch in sich geschlossenes Gebilde. Die mobile Tankstelle besteht im wesentlichen aus den Baugruppen Zapfcontainer **3** und einem Fahrbahnelement **4** als Abfüllplatz.

Der Zapfcontainer **3** ist ein in sich geschlossenes Gebilde mit einem Rückhaltevolumen einer Auffangwanne **5** von vorzugsweise höchstens 1000 Liter. Die Auffangwannen **5** der Zapfcontainer **3** sind flüssigkeitsdicht ausgeführt. Zur Leckageerkennung ist eine für den Anwendungsfall geeignete Öl-Wasser-Sonde **6** installiert. Ein über der Wanne im Zapfcontainer **3** eingebauter Lichtgitterrost **7** dient der Trittsicherheit. Der Zugang in den Zapfcontainer **3** ist mit einem Rollladen **8** verschließbar.

Weiterhin sind in den Zapfcontainern **3** Zapfeinrichtungen **9**, jeweils mit dazugehörigem Zapfschlauch **45** und Zapfpistole **46** zum Betanken der Fahrzeuge und Arbeitsmaschinen vorzugsweise in Verbindung mit einem Tankautomat **10** und falls erforderlich, die Einrichtung für die Befüllung und Entleerung der Tankfahrzeuge installiert. Zusätzlich kann der Zapfcontainer **3** im Bedarfsfall mit weiteren Lagerbehältern **11**, vorzugsweise nach DIN 6616/2 bzw. DIN 6625 mit Innenhülle ausgestattet werden. Ein ABC-Feuerlöscher **12** in der nach den Brandschutzbestimmungen erforderlichen Größe ist wahlweise am Zapfcontainer **3** installiert.

Weiterhin ist der Zapfcontainer **3** Bedienort für den Tankwagenfahrer und bietet Witterungsschutz während des Befüll- oder Entnahmevorganges.

Von hier aus erfolgt die Quittierung der Anwesenheit des Tankwagenfahrers beim Befüll- und Entnahmevorgang im 40-Sekunden-Intervall, wodurch auch hier eine stete Überwachung durch den Tankwagenfahrer sichergestellt wird.

Im Zapfcontainer **3** ist neben der Wandsteckarmatur für Grenzwertgeber **13** der unterschiedlich angeschlossenen Lagerbehälter **1** oder **11** sowie ein Öl-Wasser-Warngerät **14** installiert. Damit ist im Zapfcontainer **3** eine elektrotechnische Schaltung realisiert, die zusätzlich gegen Überfüllung der Tankanlage auch eine sichere Abschaltung des Tankfahrzeuges bei Leckagen im Zapfcontainer **3** bewirkt.

Der Abfüllbereich besteht aus einem Fahrbahnelement **4** mit integrierten Auffangwannen **15** mit vorzugsweise höchstens 1000 Liter Auffangvolumen. Die Herstellung erfolgt auf der Grundlage der Stahlwannenrichtlinie; die Beständigkeit ist durch die Wahl des Werkstoffes sicher gestellt.

Das Fahrbahnelement **4** hat vorzugsweise maximale Abmessungen (H x B x L) von 0,3 m x 3,5 m x 12 m, üblicherweise von 0,18 m x 3,0 m x 6,0 m. Die Maße für das Fahrbahnelement **4** ergeben sich aus den konstruktiven Erfordernissen. Das Fahrbahnelement **4** ist vorzugsweise aus Stahlblech (S 235 J R Werkstoff-Nr. 1.0037), mit einer Wandstärke entsprechend den statischen Erfordernissen ausgeführt. Die Befahrbarkeit des Fahrbahnelementes **4** wird durch ein Deckblech **16** mit einer Wandstärke entsprechend den statischen Erfordernissen (als Tränenblech ausgeführt) gewährleistet. Das Deckblech **16** verfügt über ein Gefälle von 1 - 5 % zu der Ablaufrinne **17**.

In den Abbildungen 4 und 5 ist das erfindungsgemäße Fahrbahnelement **4** von oben und im Längsschnitt dargestellt. In den Abbildungen 6 bis 8 sind weitere Querschnitte und Ansichten des Fahrbahnelements **4** und seiner wesentlichsten Bestandteile dargestellt. Das Fahrbahnelement **4** besteht aus einem Deckblech **16** und einem Bodenblech **16a** und ist selbsttragend und eigenstabil, was durch eine Anzahl von Tragprofilen **18**, vorzugsweise mit doppel-T-Querschnitt, die zwischen diesen beiden Blechen **16**, **16a** vorgesehen und mit diesen fluiddicht verbunden sind, erreicht wird. Vorzugsweise an einer Längsseite ist die Ablaufrinne **17** vorgesehen, die mit einem Lichtgitterrost **21** abgedeckt ist. Zwischen den beiden Blechen **16**, **16a** ist mindestens eine Auffangwanne **15** definiert. Die Ablaufrinne **17** muß nicht notwendigerweise seitlich am Fahrbahnelement **4** sondern kann genauso in der Mitte desselben vorgesehen sein, sofern die Neigung des Deckbleches **16** stets in Richtung der Ablaufrinne **17** ausgebildet ist.

Wie in Abbildung 4 durch gestrichelte Linien dargestellt, ist das Fahrbahnelement **4** der dargestellten Ausführungsform mit drei Auffangwannen **15a, 15b, 15c** versehen, die vorzugsweise etwa gleiche Größe haben. Wie in Abbildung 6 dargestellt, sind je zwei benachbarte Auffangwannen **15a** und **15b** bzw. **15b** und **15c** durch ein Tragprofil **18** gegeneinander abgegrenzt, und jeweils über eine Überlauföffnung **60** miteinander derart verbunden, daß die aufgenommene Flüssigkeit von einer Auffangwanne in die nächste laufen kann, sofern der Flüssigkeitsspiegel die Höhe der Überlauföffnung **60** erreicht. Die Überlauföffnungen **60** sind in der Höhe von ca. 60 % - 90 %, vorzugsweise etwa 80% der Höhe der Auffangwannen **15** (dem Abstand der beiden Bleche **16** und **16a**) vorgesehen. Das Fahrbahnelement **4** besteht aus einem Trägerrost. Der Trägerrost ist mit dem Bodenblech **16a** und den Seitenwänden **61** fest verschweißt. Das Bodenblech **16a** und die Seitenwände **61** sind so miteinander verschweißt, dass sie eine flüssigkeitsdichte Auffangwanne **15** bilden. Das Deckblech **16** des Fahrbahnelementes **4** ist auf dem Trägerrost geschraubt. Der Abstand und die Dimension der Tragprofile **18** ergibt sich aus den statischen Erfordernissen.

Es gibt zwei sich unterscheidende Ausführungsformen der Erfindung, nämlich eine Ausführung mit Dach **23** (Abbildung 1) sowie eine Ausführung ohne ein derartiges Dach. Diese Ausführungsformen unterscheiden sich im wesentlichen nur durch die Ausbildung der Ablaufrinne **17**, da bei der Ausführungsform ohne Dach erhebliche Regenmengen in die Ablaufrinne **17** gelangen können, die abgeleitet werden müssen.

In Abbildung 7 ist die Ausbildung der Ablaufrinne **17** für eine Ausführungsform mit Dach **23** (Abbildung 1) dargestellt. Die Ablaufrinne **17** ist bei dieser Ausführungsform durch eine Trennwand **61** von den Auffangwannen **15a, 15b, 15c** abgetrennt und steht über eine Überlauföffnung **62** mit einer der Auffangwannen **15** in Verbindung. Diese Überlauföffnung **62** liegt relativ hoch, mindestens über der Überlauföffnung **60**, so dass

unterhalb der Überlauföffnung **62** ein Rinnensumpf **63** ausgebildet ist, in dem die in die Ablaufrinne **17** eintretende Flüssigkeit zunächst gesammelt wird. Sofern der Flüssigkeitsspiegel im Rinnensumpf **63** bis zur Höhe der Überlauföffnung **62** ansteigt, laufen die überschüssigen Flüssigkeiten in die erste Auffangwanne **15c**. In der ersten Auffangwanne **15c** steigt der Flüssigkeitsspiegel dann solange an, bis die Höhe der Überlauföffnung **60** (Abbildung 6) erreicht ist und läuft anschließend in die zweite Auffangwanne **15b** und von dort auf gleiche Weise weiter in die dritte Auffangwanne **15a**.

In Abbildung 8 ist in drei Ansichten eine Ausführungsform ohne Dach dargestellt, die im Gegensatz zur Ausführung gemäß Abbildung 7 keine Überlauföffnung **62** zwischen Ablaufrinne **17** und Auffangwanne **15** aufweist, sondern zwei Verschlußventile **24, 53**. Über das Verschlußventil **53** steht der Rinnensumpf **63** mit einem Auslass **64** in Verbindung, der entweder ins freie Gelände oder in einen Abwasseranschluß mündet.

Darüber hinaus existiert (anstelle der Überlauföffnung **62** der ersten Ausführung, Abbildung 7) eine über ein zweites Verschlußventil **24** verschließbare Verbindung zwischen der Ablaufrinne **17** und mindestens einer Auffangwanne **15**, wobei der Anschluß zur Ablaufrinne **17** oberhalb des Anschlusses zur Auffangwanne **15** angeordnet ist, so dass bei offenem Verschlußventil **24** Flüssigkeiten von der Ablaufrinne **17** zur Auffangwanne **15** strömen können.

Die beiden Verschlußventile **24, 53** werden automatisch durch die Steuerung der Zapfeinrichtung **9** wechselweise geschaltet. Im Ruhezustand ist das Verschlußventil **53** offen, so daß die Ablaufrinne **17** mit dem Auslass **64** verbunden ist und alle in die Ablaufrinne **17** eintretenden Flüssigkeiten, vor allem unbelastetes Niederschlagswasser, aus der Ablaufrinne **17** in die Umgebung abgeleitet wird. Sobald durch Betätigung der Steuerung wassergefährdende Flüssigkeiten gefördert werden und damit die Gefahr entsteht, daß diese Flüssigkeiten „auslaufen",

also auf das Fahrbahnelement **4** austreten (von wo diese zur Ablaufrinne **17** fliessen würden), wird das Verschlußventil **53** automatisch geschlossen und damit die Verbindung zur Umgebung unterbrochen. Gleichzeitig wird das Verschlußventil **24** geöffnet, so dass damit die Ablaufrinne **17** direkt mit einer Auffangwanne **15** verbunden ist und alle in die Ablaufrinne **17** eintretenden wassergefährdenden Flüssigkeiten nach Überschreitung eines gewissen Flüssigkeitsspiegels (wenn die Verbindungsleitungen zum Verschlußventil **24** erreicht ist) in die Auffangwanne **15** weiterlaufen. Nach dem Abschluß des Umfüllvorgangs wird automatisch nach Ablauf einer vorgegebenen Zeitspanne von 2 bis 10, vorzugsweise 5 min. wieder das Verschlußventil **53** geöffnet und das Verschlußventil **24** geschlossen. Dieser Zeitverzug ist erforderlich, um sicherzustellen, dass das nicht mehr der Auffangwanne **15** sondern vielmehr dem Auslass **64** zugeführte Niederschlagswasser wieder unbelastet ist, also alles möglicherweise durch den Austritt mit wassergefährdenden Flüssigkeiten belastete Niederschlagswasser in den Auffangwannen **15** gesammelt wird.

Die Verbindung des Fahrbahnelementes **4** mit dem Zapfcontainer **3** wird flüssigkeitsdicht, vorzugsweise mittels eines Anschlusselementes **19** mit Ableitblech **20** hergestellt. Weiterhin sind in jeder Auffangwanne **15** zur Leckageerkennung je eine Öl-Wasser-Sonde **22** installiert. Ist der Abfüllplatz überdacht, so ist die Überdachung **23** mit Überständen von 0,6 x L (L = lichte Öffnung zwischen Bodenoberkante und Dachunterkante) oder vorzugsweise mit Wandverkleidungen ausgerüstet. Durch die Wandverkleidungen können die Dachüberstände entsprechend verkürzt werden. Wird der Abfüllplatz ohne Überdachung **23** ausgeführt, ist die Ablaufrinne **17** mit Verschlussventilen **24** und **53** ausgerüstet, wobei das Verschlussventil **53** zu einer Rohrleitung ins freie Gelände oder zu einem Abwasseranschluß führt.

Der Betankungsvorgang bzw. Umfüllvorgang wird nur dann freigegeben, wenn die Steuerung **25** der mobilen Tankstelle **2** eingeschaltet ist, keine Leckmeldung von den Sensoren **6, 22** ansteht und keine Störung vorliegt. Unlogische Betriebszustände führen zur Störmeldung und zur Abschaltung des gesamten Vorganges. Alle sicherheitstechnischen Einrichtungen gehen in den sicheren Zustand (fail-save-Stellung).

Die vorhandene Innen- und Außenbeleuchtung **26** gestattet einen sicheren Betrieb auch in der Dunkelheit.

Der Zapfcontainer **3** ist mit einem elektrischen Anschluss von vorzugsweise 400 V ausgerüstet. Die Anlage wird mit Hilfe einer speicherprogrammierbaren Steuerung (SPS) **25** gesteuert. Alle Armaturen und Leitungen sind vorzugsweise mit Nenndruck PN 16 ausgestattet.

Die mobile Tankstelle **2** kann in unterschiedlichen Betriebsarten betrieben werden:

- Betanken von Fahrzeugen und Arbeitsmaschinen mit Hilfe der Zapfeinrichtung **9**;
- Entleeren des Tankfahrzeuges im freien Gefälle in Verbindung mit unterirdischen oder tiefer gelagerten Lagerbehältern **1**;
- Entleeren des Tankfahrzeuges unter Verwendung der Pumpe **27** im Zapfcontainer **3**;
- Entleeren des Tankfahrzeuges unter Verwendung der Pumpe im Tankfahrzeug;
- Befüllen des Tankfahrzeuges aus einem der Lagebehälter **1**, oder **11** unter Verwendung der Pumpe **27** im Zapfcontainer **3**;
- Befüllen des Tankfahrzeuges unter Verwendung der Pumpe im Tankfahrzeug.

Der Entleervorgang wird nur dann freigegeben, wenn eine behälterseitige Überfüllsicherung **28** an das Tankfahrzeug ange-

schlossen, die Steuerung **25** der mobilen Tankstelle **2** eingeschaltet und folgende Betriebszustände vorliegen:

- Es steht keine Leckagemeldung an;
- Es liegt keine Störung vor.

Für den Fall, dass das Tankfahrzeug über keine Schnellschlusseinrichtung verfügt, kann das Fahrzeug mittels eingesetztem Adapter **29** mit Schnellschlussventil **30** verriegelt werden. Der o.g. Adapter **29** mit Schnellschlussventil **30** wird zwischen der Abgabekupplung **31** des Tankfahrzeuges und der Trockenkupplung **32** der mobilen Tankstelle **2** eingesetzt.

Das Absperrventil **33** in der Füllleitung **34** und das Absperrventil **35** in der Entleerleitung **36** der nicht angesteuerten Behälter **1** bleiben beim Entleervorgang geschlossen.

Nach Betätigung der Taste **37** „Start" am Bedientableau **38** wird je nach Erfordernis der Fließweg für die einzelnen Betriebsarten durch eine entsprechende Ansteuerung freigegeben. Nach 30 Sekunden wird der Bediener durch ein Signal zur erneuten Betätigung der Taste **37** „Start" aufgefordert. Wird die Taste **37** „Start" nicht betätigt, schaltet die Pumpe **27** oder die Pumpe im Tankfahrzeug nach weiteren zehn Sekunden ab; unabhängig von der Betriebsart werden alle Absperrventile **33** und **35** geschlossen.

Folgende Arbeitsschritte werden für einen störungsfreien Entleervorgang durchgeführt:

1. Anschluss einer Trockenkupplung **32** an das Tankfahrzeug.
2. Verbindung der Überfüllsicherung **28** des angewählten Behälters **1** mit dem Tankfahrzeug.
3. Auswahl der Betriebsart mittels Taste **39** am Bedientableau **38**.
4. Schnellschlussventil am Tankfahrzeug öffnen.

5. Starten des Entleervorganges mittels Druck der Taste **37** „Start".

Die Lagerbehälter **1** werden mit einer Überfüllsicherung **28** ausgerüstet. Bei Erreichen des Grenzwertes wird die Förderpumpe **27** oder die Pumpe im Tankfahrzeug bei entsprechender Betriebsart abgeschaltet und sämtliche Absperrventile **33** und **35** gehen in den sicheren Zustand; gleichzeitig wird das Schnellschlussventil am Tankfahrzeug geschlossen (fail-save-Stellung).

Nach Abschluss des Entleervorganges wird die Trockenkupplung **32** gelöst und mit dem Schlauch **40** an einer dafür vorgesehenen Halterung **41** im Zapfcontainer **3** fixiert.

Die nachweisliche Abgabe von Kleinmengen aus dem Tankfahrzeug in den Lagerbehälter **1** ist über das Vollschlauchsystem **49** in Verbindung mit der Abfüllsicherung möglich.

Beim Befüllen wird das Produkt mittels der Pumpe **27** oder der Pumpe im Tankfahrzeug aus dem angewählten Lagerbehälter **1** in das Tankfahrzeug gefördert.

Der Befüllvorgang kann nur gestartet werden, wenn die tankfahrzeugseitige Überfüllsicherung **42** an die Steuerung **25** angeschlossen, die Steuerung **25** der mobilen Tankstelle **2** eingeschaltet und folgende Betriebszustände vorliegen:

- Es steht keine Leckagemeldung an;
- Es liegt keine Störung vor;
- Das Schnellschlussventil am Tankfahrzeug ist geöffnet;
- Es werden keine unlogischen Betriebszustände angezeigt.

Die Absperrventile **35** in allen Entleerleitungen **36** und die Absperrventile **33** der nicht angesteuerten Behälter **1** in den Füllleitungen **34** bleiben bei diesem Vorgang geschlossen.

Unlogische Betriebszustände führen zur Störmeldung und zur Abschaltung des Vorganges. Nach Beseitigung der Störung ist mittels der Taste **43** „Störung quittieren" die Störmeldung zu quittieren.

Wenn alle Betriebszustände ein sicheres Befüllen des Tankfahrzeuges gestatten, blinkt in langen Zeitintervallen die Taste **37** „Start".

Nach Betätigung der Taste **37** „Start" am Bedientableau wird die Pumpe **27** oder die Pumpe im Tankfahrzeug in Betrieb gesetzt. Nach 30 Sekunden wird der Bediener durch ein Signal zur erneuten Betätigung der Taste **37** „Start" aufgefordert. Wird die Taste nicht betätigt, schaltet die Pumpe **27** oder die Pumpe im Tankfahrzeug nach weiteren zehn Sekunden ab.

Folgende Arbeitsschritte sind für einen störungsfreien Befüllvorgang erforderlich:

1. Anschluss der Trockenkupplung **32** an das Tankfahrzeug.
2. Überfüllsicherung **42** des Tankfahrzeuges mit der Steuerung **25** verbinden.
3. Schnellschlussventil am Tankfahrzeug öffnen.

Der Füllvorgang wird elektrisch über Tastendruck **37** „Start" gestartet, so dass die Förderpumpe **27** in Betrieb geht oder die Pumpe im Tankfahrzeug freigegeben wird. Bei Erreichen des maximalen Füllstands im Tankfahrzeug spricht die im Tankfahrzeug installierte Überfüllsicherung **42** an, gleichzeitig wird das Schnellschlussventil im Tankfahrzeug geschlossen und die Förderpumpe **27** im Zapfcontainer **3** oder die Pumpe im Tankfahrzeug wird abgeschaltet.

Durch die Überfüllsicherung **42** des Tankfahrzeuges ist eine sichere Abschaltung der Förderpumpe **27** oder der Pumpe im Tankfahrzeug und ein gleichzeitiges Schließen des Absperrventils **33** gewährleistet.

Die Montage der erfindungsgemäßen mobilen Tankstelle erfolgt folgendermaßen: Zunächst wird ein Zapfcontainer **3** aufgestellt und das Fahrbahnelement **4** derart verlegt, daß über die Anschlußelemente **19** eine flüssigkeitsdichte Kopplung hergestellt ist. Bei Bedarf kann ein zweiter Zapfcontainer **3**, wie in Abbildung 1 dargestellt, auf der gegenüberliegenden Seite aufgestellt und auf gleiche Weise angeschlossen werden, so dass LKW beidseitig gleichzeitig betankt werden können. Sofern eine Überdachung **23** vorgesehen ist, wird diese anschließend montiert.

Schutzansprüche

1. Mobile Tankstelle (2) für wassergefährdende Flüssigkeiten mit mindestens einer in einem Zapfcontainer (3) untergebrachten Zapfeinrichtung (9), sowie einer Auffangeinrichtung (4) zum Auffangen von verschütteter Flüssigkeit, dadurch gekennzeichnet, dass die Auffangeinrichtung als statisch selbsttragendes und eigenstabiles, vom zu betankenden Fahrzeug befahrbaren Fahrbahnelement (4) mit mindestens einer integrierten Auffangwanne (15) ausgeführt ist, die flüssigkeitsdicht mit dem Zapfcontainer (3) verbunden ist.

2. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass das befahrbare Fahrbahnelement (4) mit einer Überdachung (23) versehen ist.

3. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, daß in der Auffangwanne (15) eine Fluidwarnsonde (6) vorgesehen ist, die im Fall eines Auslösesignals mindestens die Förderpumpe in der Zapfeinrichtung (9) abschaltet.

4. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, daß im Fahrbahnelement (4) zwei oder mehr miteinander über Überlauföffnungen (60) verbundene Auffangwannen (15) vorgesehen sind.

5. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass der Zapfcontainer (3) eine separate flüssigkeitsdichte Stahlauffangwanne (5) umfasst, in der eine weitere Fluidsonde (6) vorgesehen ist, die beim Auslösesignal die Förderpumpe in der Zapfeinrichtung (9) abschaltet.

6. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass das Fahrbahnelement (4) über Auffahrrampen (48) befahrbar ist.

7. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass das Fahrbahnelement (4) mindestens eine mit der mindestens einen Auffangwanne (15) verbundene Ablaufrinne (17) aufweist und die Fahrbahndecke in Richtung der Ablaufrinne (17) geneigt ist.

8. Mobile Tankstelle nach Anspruch 7, dadurch gekennzeichnet, dass oberhalb der Ablaufrinne (17) ein Lichtgitterrost (21) angeordnet ist.

9. Mobile Tankstelle nach Anspruch 8, dadurch gekennzeichnet, dass die Ablaufrinne (17) über eine Öffnung (62) mit der mindestens einen Auffangwanne (15) verbunden ist, wobei diese Öffnung (62) mindestens über der Überlauföffnung (60) liegt, so dass unterhalb der Überlauföffnung (62) ein Rinnensumpf (63) ausgebildet ist, in dem die in die Ablaufrinne (17) eintretende Flüssigkeit zunächst gesammelt wird.

10. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass die mindestens eine Auffangwanne (15) mittels jeweils eines Saug-Anschluss-Stutzens (50) entleerbar ist.

11. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass zwischen dem unteren Bereich der Ablaufrinne (17) und der mindestens einen Auffangwanne (15) ein Verschlussventil (24) angeordnet ist, das geöffnet wird, wenn der Umfüllvorgang gestartet wird und zeitverzögert nach Beendigung des Umfüllvorgangs geschlossen wird.

12. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass die Ablaufrinne (17) über ein Verschlussventil (53) mit einem Ablauf (64) verbunden ist, wobei das Verschlussventil (53) geschlossen wird, wenn der Umfüllvorgang gestartet wird und zeitversetzt nach Ende des Umfüllvorgangs wieder geöffnet wird.

13. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass das Fahrbahnelement (4) über ein Anschlusselement (19) mit dem Zapfcontainer (3) verbunden ist.

14. Mobile Tankstelle nach Anspruch 1, dadurch gekennzeichnet, dass das Fahrbahnelement (4) aus einem Trägerrost besteht.

15. Mobile Tankstelle nach Anspruch 14, dadurch gekennzeichnet, dass der Trägerrost mit dem Bodenblech (16a) und den Seitenwänden (61) fest verschweißt ist.

16. Mobile Tankstelle nach Anspruch 15, dadurch gekennzeichnet, dass das Bodenblech (16a) und die Seitenwände (61) so miteinander verschweißt sind, dass sie eine flüssigkeitsdichte Auffangwanne (15) bilden.

17. Mobile Tankstelle nach Anspruch 14, dadurch gekennzeichnet, dass das Deckblech (16) des Fahrbahnelementes (4) auf den Trägerrost geschraubt ist.

Abbildung 1

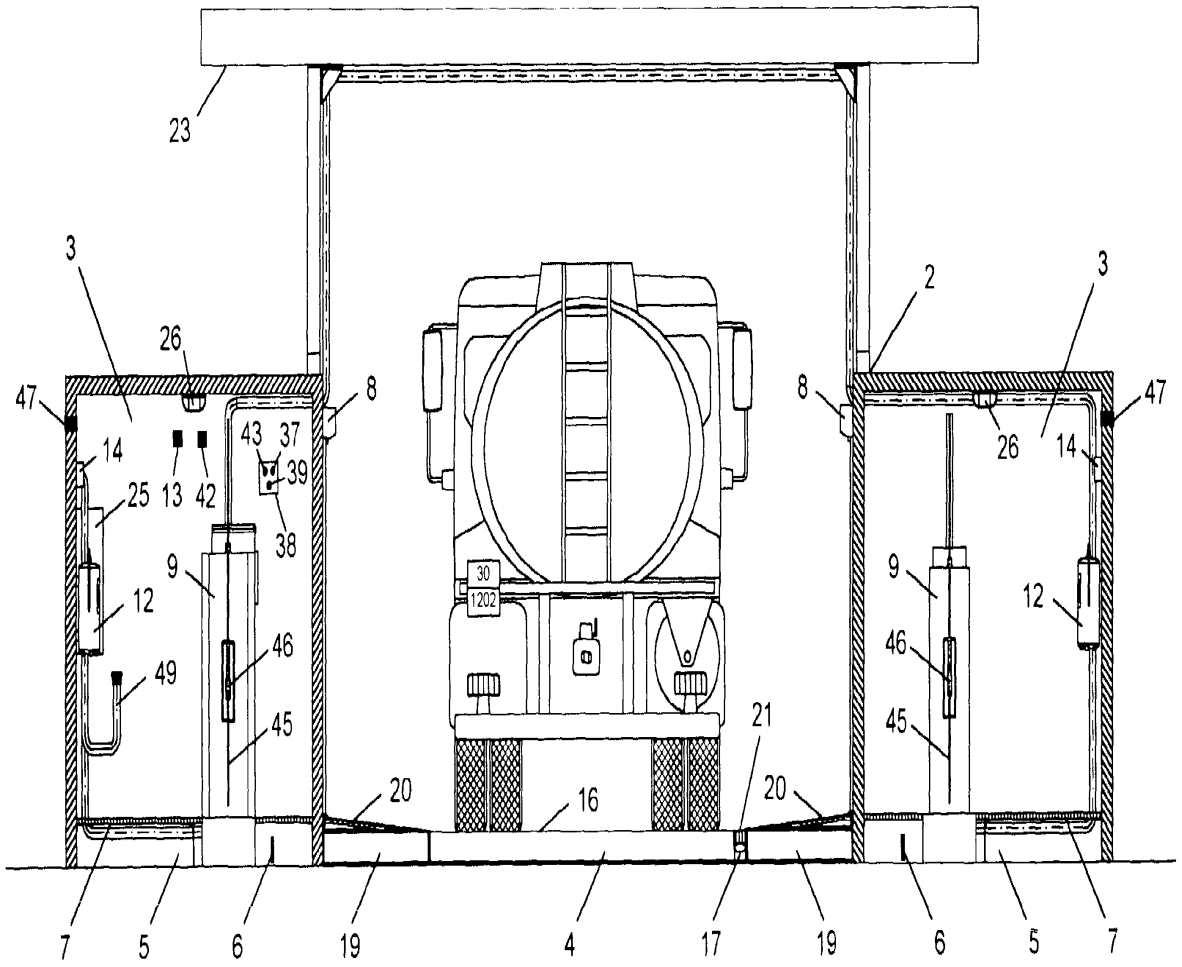
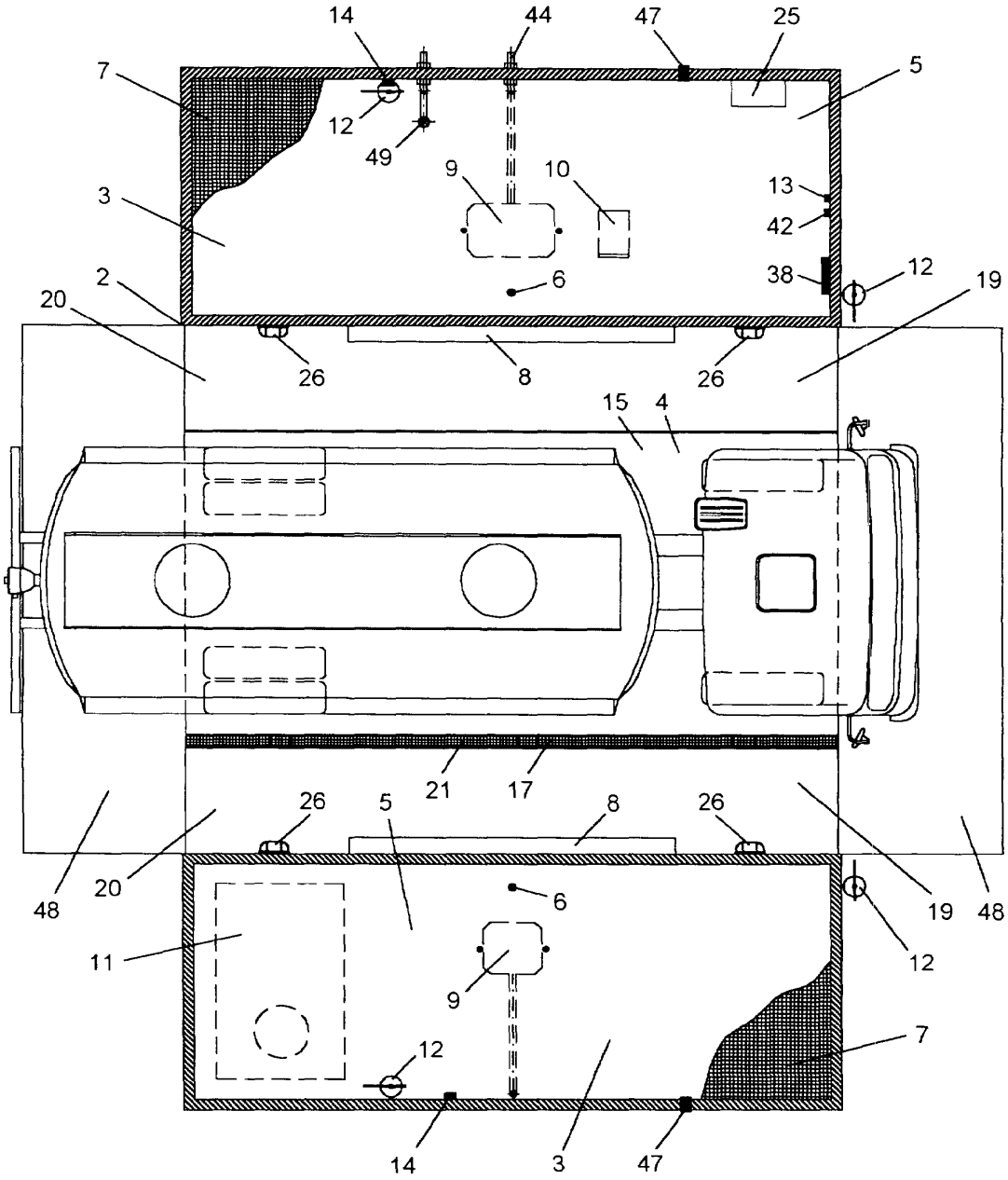

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Abbildung 2

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Abbildung 3



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Abbildung 4

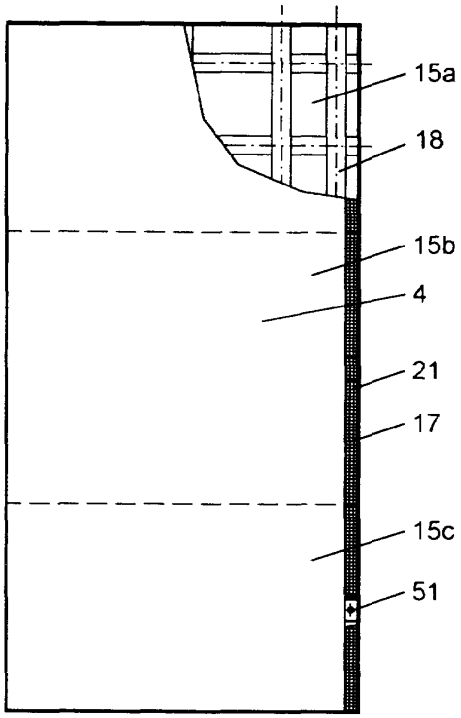


Abbildung 5

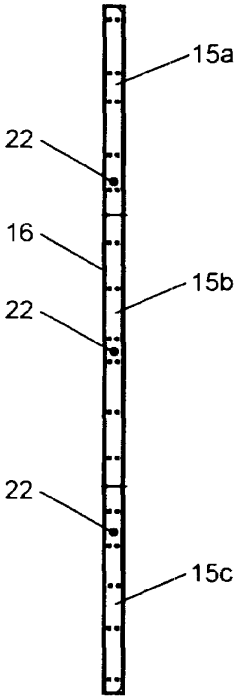


Abbildung 6

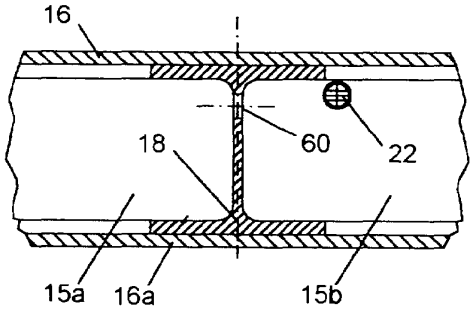


Abbildung 7

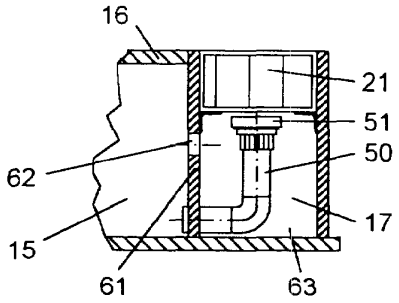
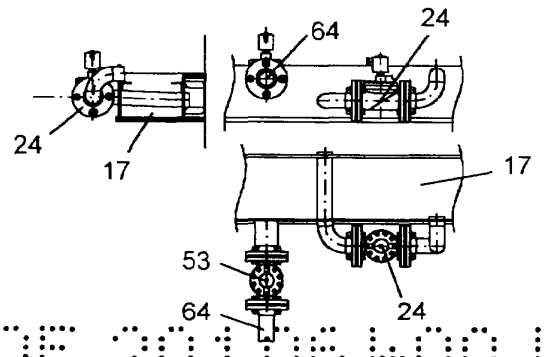


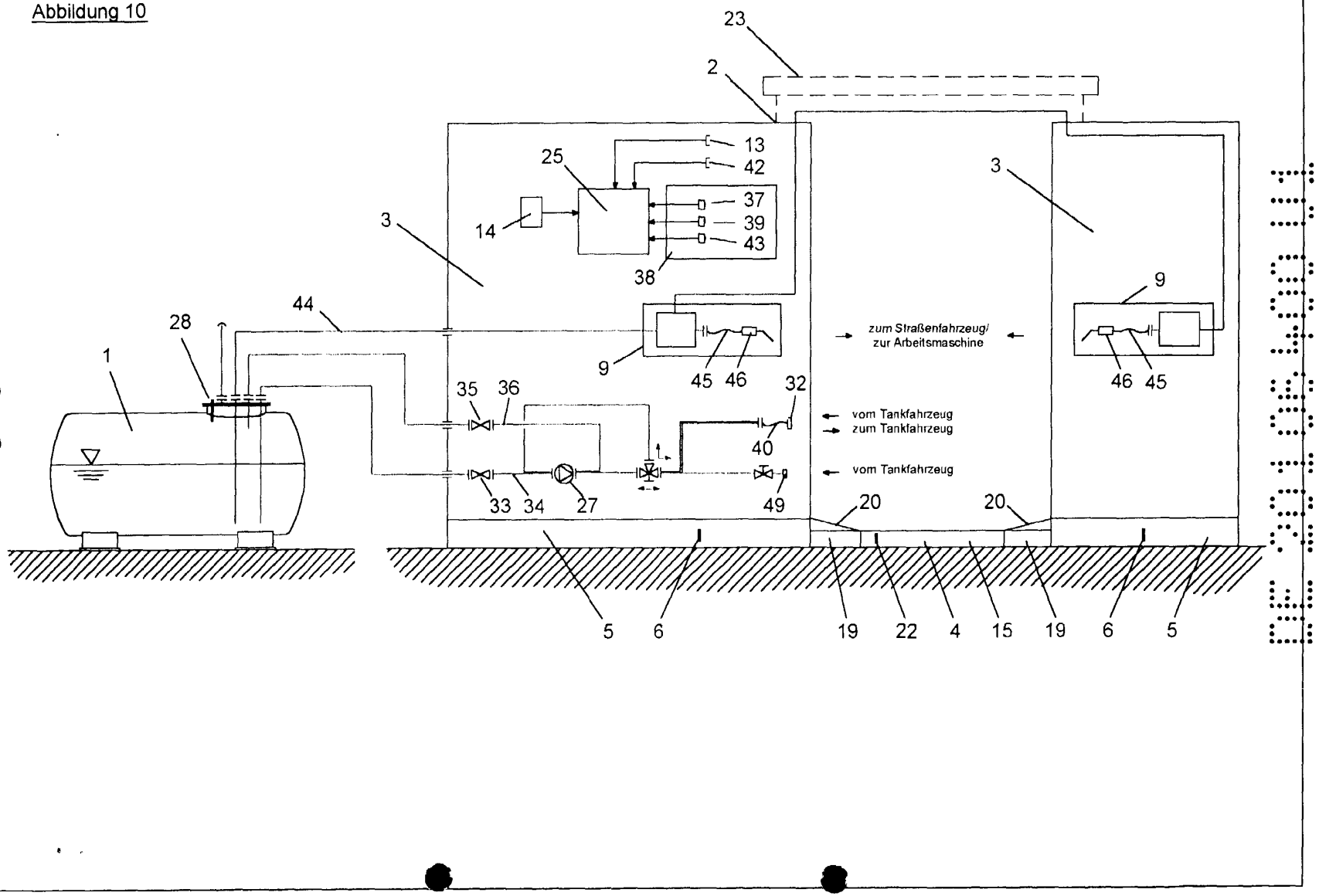
Abbildung 8



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Abbildung 9

Abbildung 10



Espacenet

Bibliographic data: DE102006026025 (A1) — 2006-12-21

Control element for liquid food has an inlet for a substance, a control area for the substance and an outlet for the substance

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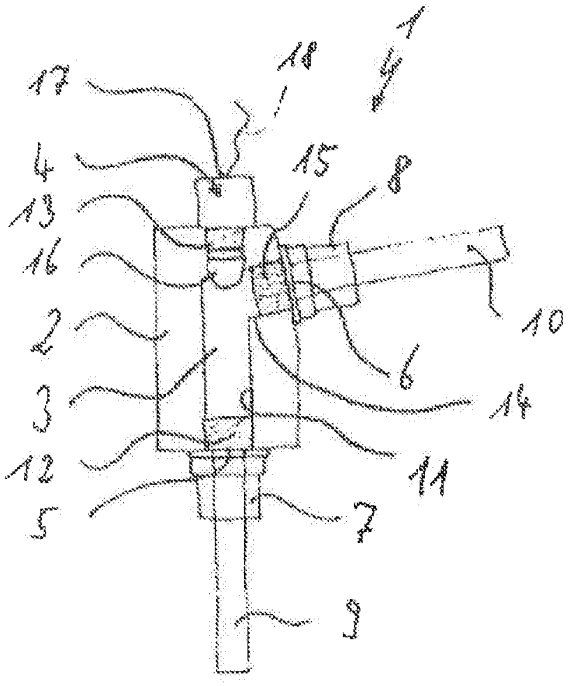
Classification: **- international:** ***B67D1/02; B67D1/04; B67D1/08; G01F23/00***
- cooperative: B67D1/1247; G01N21/53

Application number: DE20061026025 20060601

Priority number(s): DE20051028073 20050616 ; DE20051030068 20050627 ; DE20051038105 20050810 ; DE20061026025 20060601

Abstract of DE102006026025 (A1)

A power gate (1) has a sensor casing (2) to hold an optical sensor (4) and a control area (3) for a substance that extends from an inlet (5) to an outlet (6), which each connect screw fittings (7,8) for feed (9) and drain (10) lines for the substance. An independent claim is also included for a structure with control element for liquid food.



(19) Bundesrepublik Deutschland
Deutsches Patent- und Markenamt

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B67D 1/04 (2006.01)
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G01F 23/00 (2006.01)

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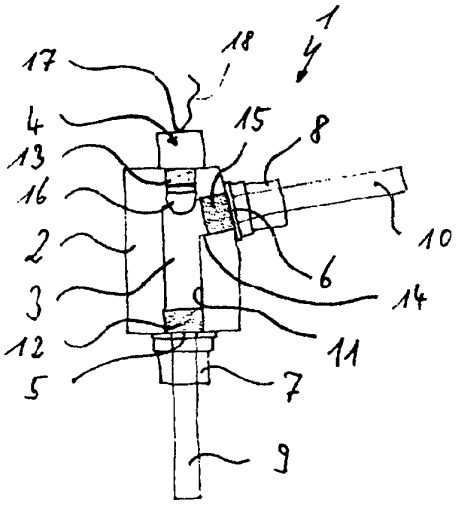
(74) Vertreter:
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(72) Erfinder:
gleich Anmelder

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

(54) Bezeichnung: **Leitungselement für flüssige Lebensmittel und Anordnung mit einem Leitungselement**

(57) Zusammenfassung: Ein Leitungselement für flüssige Lebensmittel weist einen Einlass für ein Medium, einen Mediumleitungsbereich und einen Auslass für das Medium auf. Im Mediumleitungsbereich ist ein optischer Sensor angeordnet, der bei Luft im Medium ein Signal abgibt.
Derartige Leistungselemente werden dazu verwendet, bei Leerwerden eines Behälters ein Leermeldungssignal an eine Zapfanlage weiterzugeben.



Beschreibung

[0001] Die Erfindung betrifft ein Leitungselement für flüssige Lebensmittel mit einem Einlass, einem Mediumleitungsbereich und einem Auslass, wobei im Mediumleitungsbereich ein Gassensor angeordnet ist.

Stand der Technik

[0002] In der Lebensmittelindustrie werden häufig aus Behältern Flüssigkeiten gezapft. Hierzu werden in der Regel Pumpsysteme verwendet, die die Flüssigkeit vom Behälter zum Zapfhahn fördern. Insbesondere bei dem Zapfen kohlesäurehaltiger Getränke wird der meist im Keller stehende Getränkebehälter mit einem Gasdruck, meistens CO_2-Gas, beaufschlagt, der dafür sorgt, dass beim Öffnen des Zapfhahns das Getränk in einer Steigleitung aufsteigt und zum Zapfhahn fließt.

[0003] Alle diese Systeme haben den Nachteil, dass bei einem Leerwerden des Behälters Luft oder Gas gefördert wird und erst nach Befüllung der Steigleitung mit Gas am Zapfhahn erkannt wird, dass der Behälter ausgetauscht werden muss.

[0004] Nach Austausch des Getränkebehälters wird die Steigleitung erneut mit Getränk gefüllt, indem überflüssiges Gas am Zapfhahn abgelassen wird.

[0005] Diese Vorgehensweise ist insbesondere bei automatischen Zapfanlagen nachteilhaft, bei denen definierte Getränkemengen abgefüllt werden. Beispielsweise in der Gastronomie werden Zapfanlagen eingesetzt, die auf Knopfdruck eine bestimmte Menge eines Getränkes in ein Glas abfüllen. Wenn hierbei Getränkebehälter leer werden, gelangen Gase in die Zapfanlage und die angestrebte definierte Glasbefüllung wird hierdurch behindert. Der gesamte Betriebsablauf muss dann solange angehalten werden bis der Behälter ausgetauscht und nach Entfernen der Gase aus der Steigleitung eine definierte Füllung der Gläser wieder sichergestellt werden kann.

[0006] Häufig werden erst beim Zapfen von Getränken kohlesäurehaltiges Wasser und Sirup zusammen gemischt. Bei derartigen Postmix-Anlagen wird das kohlensäurenhaltige Wasser beim Leerwerden des Sirupbehälters mit Gas aus dem Sirupbehälter gemischt, wodurch der Zapfvorgang behindert wird.

[0007] Solange die Zapfanlage von geschultem Personal bedient wird, wird an der Veränderung der Getränkeeigenschaften leicht erkannt, dass ein Behälter ausgetauscht werden muss. Beispielsweise in Selbstbedienungsrestaurants führt ein Leerwerden eines Behälters jedoch oft zu Beanstandungen der Kunden und zu einem Personenstau an der Getränkezapfanlage.

[0008] Zur Lösung dieses Problems wurden verschiedene Sensoren vorgeschlagen, die die Leitfähigkeit des Mediums messen. Auch mechanische Einrichtungen sind bekannt, bei denen während der Förderung von Gasen sich Schwimmer bewegen, die ein elektrisches Signal auslösen.

[0009] Die bekannten Einrichtungen sind jedoch sehr aufwändig in der Herstellung und sie benötigen eine genaue Kalibrierung, die auf die örtlichen Gegebenheiten und das Fördermedium abgestimmt ist. Dies führt zu hohen Anschaffungskosten und zu Wartungsarbeiten, die die Verbreitung derartiger Einrichtungen beeinträchtigen.

[0010] Eine besondere Schwierigkeit in der Lebensmittelindustrie besteht darin, dass sich viele Sensoreinrichtungen in das Medium hinein erstrecken müssen und dadurch zu Verschmutzungen, Ablagerungen und Gaseinschüssen führen.

[0011] Außerdem ist bei derartigen Einrichtungen eine Reinigung des Leitungselementes häufig erschwert.

Aufgabenstellung

[0012] Der Erfindung liegt daher die Aufgabe zugrunde, ein gattungsgemäßes Leitungselement derart weiterzubilden, dass es leicht zu reinigen ist und möglichst wartungsfrei eine sichere Leermeldung des angeschlossenen Behälters ermöglicht.

[0013] Diese Aufgabe wird dadurch gelöst, dass der Sensor ein optischer Sensor ist. Es hat sich gezeigt, dass optische Sensoren derart in Leitungselemente einbaubar sind, dass das Leitungselement weiterhin einfach zu reinigen ist und ohne hohen Kalibrieraufwand eine sichere Meldung über das Leerwerden eines angeschlossenen Behälters erreicht werden kann.

[0014] Vorzugsweise ist der Sensor ein Gassensor. Spezielle optische Sensoren sind als Gassensoren ausgebildet und als solche im Handel erhältlich. Diese Sensoren reagieren auf Gasblasen im Medium und sie sind daher für Leitungen von Getränkezapfanlagen besonders geeignet.

[0015] Eine vorteilhafte Ausführungsform sieht vor, dass der Sensor in einer Baueinheit Signale abgibt und misst. Ein einziger vorzugsweise kuppelförmiger Messkopf dient hierbei dazu Lichtwellen abzugeben, die je nach Beschaffenheit des Mediums mehr oder weniger reflektiert werden. Die reflektierten Lichtstrahlen werden gemessen, wodurch bei erhöhter Gaskonzentration im Medium ein Signal ausgelöst wird.

[0016] Um einen möglichst großen Flüssigkeitsbe-

reich vom Sensor zu erfassen, wird vorgeschlagen, dass im Mediumleitungsbereich dem Sensor gegenüberliegend eine freie Wegstrecke von mindestens 20 mm, vorzugsweise mindestens 35 mm und besonders bevorzugt von mehr als 45 mm, vorgesehen ist. Diese freie Wegstrecke des Mediums vor dem Sensor ermöglicht es, dass die vom Sensor abgegebenen Lichtsignale möglichst weit in das Medium eindringen können, um in unterschiedlichem Abstand vom Sensor reflektiert werden zu können.

[0017] Eine gute Funktion des Sensors wird vor allem dadurch erreicht, dass die Luftblasen zum Sensor hin aufsteigen. Hierzu wird vorgeschlagen, dass die freie Wegstrecke im Einbauzustand des Leitungselementes vom Sensor weg zumindest 10°, vorzugsweise mindestens 40° und besonders bevorzugt von mehr als 80° von der Waagerechten nach unten weist. Eine Einbaulage des Sensors in eine senkrechten Wandung des Mediumleitungsbereichs ist daher weniger vorteilhaft als eine Einbaulage des Sensors in einer waagerechten Wandung des Mediumleitungsbereichs, da im zweiten Fall Luftblasen innerhalb des Mediumleitungsbereichs zum Sensor hin aufsteigen können und während des Aufsteigens der Blasen vom Sensor erfasst werden können.

[0018] Vorteilhaft ist es, wenn der Sensor im Wesentlichen dem Ein- oder Auslass gegenüberliegend angeordnet ist. Dies führt dazu, dass während der Strömung des Mediums durch das Leitungselement Luftblasen im Medium vom Sensor erfasst werden können. Hierbei liegt vorzugsweise der gesamte Strömungsweg im „Blickwinkel" des Sensors.

[0019] Um den Sensor optimal im Strömungsweg anzuordnen wird vorgeschlagen, dass der Einlass und der Auslass in einem stumpfen Winkel zueinander angeordnet sind.

[0020] Weiterhin ist es von Vorteil, wenn der Sensor dem Ein- oder Auslass direkt benachbart angeordnet ist.

[0021] Eine spezielle Einbauvariante, die auch den Einbau einer Entlüftung ermöglicht, sieht vor, dass Ein- und Auslass dem Sensor gegenüber angeordnet sind.

[0022] Es wird daher weiterbildend vorgeschlagen, dass das Leitungselement eine Entlüftung aufweist. Eine derartige Entlüftung ist insbesondere bei Bierleitungen von Vorteil, um nach Leerwerden des Bierbehältnisses Schaum und Gase aus dem Leitungselement zu entfernen.

[0023] Bei allen Einbauvarianten ist es von Vorteil, wenn der Sensor in Einbaulage im oberen Bereich des Leitungselementes angeordnet ist. Dies führt dazu, dass unabhängig von der Strömungsrichtung des Medium nach oben steigende Gasblasen sich zum Sensor hin bewegen und der Strömungsweg innerhalb des Leitungselementes im „Blickwinkel" des Sensors liegt.

[0024] Die der Erfindung zugrunde liegende Aufgabe wird auch mit einer Anordnung insbesondere mit einem oben beschriebenen Leitungselement gelöst, die eine Anzeigeeinrichtung für den Sensorzustand und eine Schalteinrichtung aufweist.

[0025] Die Anzeigeeinrichtung zeigt beispielsweise durch eine grün leuchtende LED, dass keine Luft im Leitungselement gemessen wurde und daher der Behälter nicht leer ist. Eine rote LED zeigt Luft im Leitungselement und somit einen leeren Behälter an. Die Schalteinrichtung ist vorzugsweise als Reset-Taste ausgebildet und dient als Anzapfaktivierung. Die Anzeige der Luft im Leitungselement kann somit solange unterdrückt werden, bis das Leitungselement wieder luftfrei ist.

[0026] Vorteilhaft ist es, wenn die Anordnung eine Schnittstelle zum Anschluss eines Personalcomputers aufweist. Dies ermöglicht es, die Daten eines oder vorzugsweise mehrerer Leitungselemente an einem Personalcomputer aufzunehmen, um den augenblicklichen Zustand der Mediumzuführung zu einer Zapfanlage darzustellen. Der Personalcomputer kann auch dazu dienen, aus den Eingangssignalen der Schnittstelle neue Signale zu generieren, mit denen auf die Mediumversorgung einer Zapfanlage eingewirkt werden kann. Hierbei können beispielsweise Zapfhähne ausgeschaltet oder Ventile umgeschaltet werden, um beispielsweise bei Leerwerden eines ersten Behälters aus einem vollen neuen Behälter Medium zur Zapfanlage zu führen.

[0027] Da vermieden werden soll, dass bei Leerwerden eines Behälters am Zapfhahn Luft oder ein falsches Mediumsmischungsverhältnis austritt, wird vorgeschlagen, dass die Anordnung eine Zapfhahnschalteinrichtung aufweist. Diese Schalteinrichtung sorgt dafür, dass bei Leerwerden eines Behälters der Zapfhahn ausgeschaltet wird. Alternativ oder kumulativ kann auch auf einen weiteren Behälter umgeschaltet werden.

[0028] Vorteilhaft ist es, wenn die Zapfhahnschalteinrichtung eine Anzeigeeinrichtung aufweist. Dies ermöglicht es, am Zapfhahn sofort zu erkennen, dass der Zustrom ausgeschaltet ist und daher eine Bedienung des Zapfhahns erfolglos bleibt.

[0029] Bei einem Defekt des Leitungselementes oder einer Trennung des Leitungselementes von der Zapfeinrichtung sollte sichergestellt sein, dass hierdurch das Getränkezapfen nicht behindert wird. Es wird daher vorgeschlagen, dass die Zapfhahnschalteinrichtung bei einer Trennung vom Leitungselement

das gleiche Signal wie bei einem gasfreien Leitungselement abgibt.

[0030] Drei Ausführungsbeispiele von Leitungselementen und eine schematische Darstellung einer Anordnung mit einem Leitungselement sind in der Zeichnung dargestellt und werden im folgenden beschrieben. Das Ausführungsbeispiel zeigt, dass verschiedene Ausführungsvarianten möglich sind, um die der Erfindung zugrunde liegende Aufgabe zu lösen.

Ausführungsbeispiel

[0031] Darüber zeigen die Ausführungsvarianten, dass auch der körperliche Aufbau des Leitungselementes erfindungswesentlich ist und für unterschiedliche Sensoren einsetzbar ist. Der Aufbau des Leitungselementes ist somit nicht nur für optische Sensoren sondern auch für andere Sensoren geeignet.

[0032] Es zeigt,

[0033] Fig. 1 eine Wandausführung eines Leitungselementes in schematische dargestellter, geschnittener Darstellung,

[0034] Fig. 2 ein Aufsatzgehäuse zum Aufschrauben direkt auf einen Zapfkopf in schematisch dargestellter, geschnittener Darstellung,

[0035] Fig. 3 ein Leitungselement als Schaumkontrollarmatur in schematisch dargestellter, geschnittener Darstellung,

[0036] Fig. 4 eine schematisch dargestellte Skizze eines Aufbauprinzips eines Leermeldesystems,

[0037] Fig. 5 eine schematische Skizze eines Fassleermelde- und Abschaltsystems und

[0038] Fig. 6 eine schematisch dargestellte Skizze einer automatischen Fassleerabschaltung.

[0039] Das in der Fig. 1 gezeigte Leitungselement 1 besteht im Wesentlichen aus einem Sensorgehäuse **2**, in dem sich der Mediumleitungsbereich **3** befindet und dem Sensor **4**. Der Mediumleitungsbereich **3** erstreckt sich von einem Einlass **5** zu einem Auslass **6**, die jeweils eine Verschraubung **7** bzw. **8** für eine Mediumzuführleitung **9** und eine Mediumabführleitung **10** anbinden.

[0040] Das Sensorgehäuse **2** ist ein Formkörper aus lebensmittelechtem Kunststoff. Der Formkörper hat eine zentrale Bohrung **11**, die als Mediumleitungsbereich **3** dient und die in Einbaulage des Sensorgehäuses an ihrem unteren Ende ein Gewinde **12** für die Verschraubung **7** aufweist und diesem Ende gegenüberliegend in Einbaulage des Sensorgehäuses im oberen Bereich ein Gewinde **13** aufweist, in das der Sensor **4** eingeschraubt ist.

[0041] In einem stumpfen Winkel von etwa 100° zur Bohrung **11** ist eine weitere Bohrung **14** im Kunststoffkörper des Sensorgehäuses **2** angebracht. Diese Bohrung **14** weist ein Gewinde **15** auf, in das die Verschraubung **8** des Auslasses **6** eingeschraubt ist. Die Bohrung **14** trifft am oberen Ende der Bohrung **11** auf diese Bohrung, so dass ein abgewinkelter Flüssigkeitskanal den Mediumleitungsbereich **3** bildet.

[0042] Am oberen Ende dieser Abwinklung befindet sich der eingeschraubte Sensor **4**, dessen halbkugelförmiges Ende **16** in den Mediumleitungsbereich **3** hineinragt. In Einbaulage ist der Sensor **4** in senkrechter Position angeordnet, so dass der Sensorgrundkörper **17** außerhalb des Sensorgehäuses **2** liegt, ein sich daran anschließender Sensorbereich innerhalb der Bohrung **13** angeordnet ist und das halbkugelförmige Sensorende **16** in den Mediumleitungsbereich **3** hineinragt.

[0043] Wenn ein Medium durch die Leitung **9** in den Leitungsbereich **3** einströmt, wird dieses Medium am halbkugelförmigen Ende **16** des Sensors **4** vorbei in die im stumpfen Winkel angeordnete Bohrung **14** und weiter in die Leitung **10** geleitet. Die inneren Bereiche der Mediumsleitung sind hierbei so ausgeführt, dass sie leicht reinigbar sind. Die beschriebene Konstruktion erlaubt eine Ausführung, bei der Spalten und Toträume vermieden werden. Versuche haben gezeigt, dass in allen Bereichen des Leitungselementes **1** das Medium mit etwa gleich großer Geschwindigkeit fließt, so dass Ablagerungen vermieden werden und Reinigungsflüssigkeiten bei einer Durchströmung des Leitungselementes ihre volle Wirksamkeit entfalten können. Der freie Leitungsquerschnitt innerhalb des Leitungselementes entspricht auch an der schmalsten Stelle etwa dem Innendurchmesser der Zuleitung **9**, so dass auch Reinigungsbälle aus Schaumstoff durch das Leitungselement geführt werden können.

[0044] Sofern über die Zuleitung **9** Medium mit Luft oder anderen Gasen in das Leitungselement **1** gelangt, bewegen sich die Luftblasen auf einer freien Wegstrecke innerhalb des Leitungselementes **1** von etwa 50 mm auf den Sensor **4** zu. Erst im Bereich des Sensors wird die Flüssigkeit abgelenkt und zur Ausgangsleitung **10** geführt. Der Sensor hat somit eine relativ lange Wegstrecke, auf der er prüfen kann, ob im Medium Gaseinschlüsse vorliegen. Sowie Gaseinschlüsse detektiert werden, gibt der Sensor über die Leitung **18** ein Signal an eine Anzeigeeinrichtung (nicht gezeigt).

[0045] Bei dem vorliegenden Ausführungsbeispiel kommt die Zuleitung **9** von einem Sirupbehälter und die Leitung **10** führt zu einem Post-Mix-Hahn, an dem

der Sirup mit kohlensäurenhaltigem Wasser gemischt wird. Das über die Leitung **18** abgegebene Signal sorgt dafür, dass der Hahn geschlossen bleibt, wenn im Leitungselement detektiertes Gas die Entleerung des Sirupbehälters anzeigt.

[0046] Das in Fig. 2 gezeigte Leitungselement **20** ist ein Aufsatzgehäuse, das direkt auf einen Zapfkopf **21** aufgeschraubt ist. Das Leitungselement entspricht der in Fig. 1 beschrieben Ausführungsvariante. Die einzigen Unterschiede liegen in modifizierten Anschlüssen **22** am Eingang des Gehäuses **23** und einer modifizierten Ausgangsverschraubung **24** am Ausgang des Gehäuses **23**.

[0047] Das Aufsatzgehäuse hat den Vorteil, dass es direkt am Zapfkopf **21** eines Behälters (nicht gezeigt) befestigbar ist und daher ein schnellstmögliches Ansprechen auf ein Leerwerden des Behälters ermöglicht. Sowie Gas aus dem Behälter austritt, gelangt es unmittelbar in das Aufsatzgehäuse **20**, so dass es sofort durch den Sensor **25** erkannt und zu einem Signal an der Leitung **26** führt.

[0048] Das Leitungselement kann auch mit einer Entlüftung kombiniert sein. Eine derartige Ausführungsvariante ist in Fig. 3 dargestellt.

[0049] Das Leitungselement **30** wird bei dieser Variante von einem Zylinder **31** gebildet, der an seiner Oberseite eine schmalere Abschlussplatte **32** aufweist und an seiner Unterseite durch eine breitere Abschlussplatte **33** begrenzt wird. In der breiteren Anschlussplatte **33** befinden sich ein Einlass **34** und ein Auslass **35**, die jeweils von einem Rohr gebildet werden. Am Ende dieser Rohrleitungen befinden sich Verschraubungen **36** bzw. **37** an denen eine Zuleitung bzw. eine Ableitung angeschraubt werden kann.

[0050] Das als Einlass **34** dienende Rohr erstreckt sich relativ weit in das Zylinderelement **31** des Leitungselements **30** hinein, so dass ein Medium in vom Zylinderrohr **31** umgrenzenden Mediumleitungsbereich **38** entgegen der Einlassrichtung zum Auslass zurückströmen muss, bevor es den Mediumleitungsbereich durch den Auslass **35** verlässt.

[0051] In der oberen Abschlussplatte **32** ist dem Einlass gegenüber liegend eine Entlüftung **39** angeordnet und daneben ist der Sensor **40** so in die Abschlussplatte **32** eingebaut, dass das halbkugelförmige Ende **41** des Sensors **40** in den Mediumleitungsbereich **38** hineinragt.

[0052] Ein in das Leitungselement **30** gelangendes Medium wird somit durch das Einlassrohr **34** zunächst zur Entlüftung **39** geführt und anschließend strömt es unter dem Sensor **40** zurück zum Ausgang **35** auf einer senkrechten Wegstrecke von 30 bis 50 mm.

[0053] Sofern Luft in das Leitungselement gelangt, kann diese durch das Entlüftungssystem **39** sofort entfernt werden. Sowie mehr Gas in das Entlüftungselement gelangt, gelangt dieses in den „Blickwinkel" des Sensors **40**, so dass ein Signal über die Leitung **42** abgegeben wird. Wenn dann der Ausgang – beispielsweise durch Schließen eines Zapfhahns – geschlossen wird, sammelt sich die Luft im oberen Bereich des Zylinders **31** und sie kann durch die Entlüftung **39** entweichen.

[0054] Nach einem Reset am Sensor kann somit erneut der Hahn geöffnet werden und sofern nicht weiter Gas in das Leitungselement eindringt, kann weiterhin gezapft werden. Derartige Einrichtungen werden vor allem für das Wechseln von Bierfässern oder Bierkegs verwendet, da hierbei nicht nur Luft sondern vor allem auch Schaum entsteht, sowie das Fass nicht mehr voll ist. Dieser Schaum soll jedoch nach Möglichkeit nicht in den Auslass **35** gelangen sondern vorher durch die Entlüftung **39** aus dem System entweichen.

[0055] Versuche haben gezeigt, dass bereits nach weniger als einem Fünftel Luftanteil im Mediumleitungsbereich **38** der Sensor **40** die Luft oder das Gas erfasst und seine Leermeldung ausgibt. Durch die Kombination aus Sensor **40** und Entlüftung **39** wird sichergestellt, dass keine Luft oder kein Gas in die Getränkeleitung gelangen kann, wodurch nach dem Anzapfen problemlos und ohne Schaumbildung weiter gezapft werden kann.

[0056] Die folgende Funktionsbeschreibung betrifft eine Erweiterung mit „Automatischer Entlüftung".

[0057] Die in Fig. 3 gezeigte manuelle Entlüftung **39** kann durch ein elektrisches Ventil ersetzt werden. Nachdem der optische Sensor **40** Gas erkannt und den Zapfvorgang unterbrochen hat, befindet sich das System im „Anzapfmodus". Sobald nun das neue Fass angezapft wurde oder bei automatischer Fassumschaltung die Umschaltung erfolgt ist, tritt nun die Entlüftung in Kraft.

[0058] Dies bedeutet: Bevor der Zapfhahn wieder geöffnet wird, erfolgt die Entlüftung. Diese dauert solange an, bis der optische Sensor wieder „blasenfreies Getränk" erfasst. Danach wird der Zapfvorgang weitergeführt. Eine manuelle Entlüftung ist nicht mehr erforderlich.

[0059] Die Fig. 4 zeigt eine Möglichkeit, wie die Signale mehrerer Sensoren weiter geleitet und weiter verarbeitet werden können. Die Sensoren **50** leiten über einzelne Leitungen **51** ihre Leermeldungssignale an eine Anzeigeeinrichtung **52**, in der LED's **53** entsprechend den Leermeldungssignalen aufleuchten. Darüber hinaus weist die Anzeigeeinrichtung Reset-Taster **54** auf, die beim Anzapfen Verwendung

finden, um nach Austausch des Behälters die Leermeldung zu unterdrücken.

[0060] Optional ist in der Anzeigeeinrichtung **52** eine Schnittstelle **55** zu einem Personal-Computer vorgesehen, der sämtliche Meldungen der Sensoren und der Reset-Taster anzeigt und dokumentieren kann. Außerdem kann die Anzeigeeinrichtung über eine Schnittstelle **56** mit einer Computerschankanlage in Verbindung stehen. Die Computerschankanlage erhält dann die Leermeldungen der einzelnen Behälter, damit bei leeren Behältern der Zapfvorgang unterbrochen wird. Die Abschaltung der Zapfhähne, Meldung und Registrierung oder automatische Fassumschaltung werden dann automatisch ausgeführt.

[0061] Sofern keine Computerschankanlage vorliegt, können die Signale von der Anzeigeeinrichtung **52** zu einer Zapfhahnschalteinrichtung **57** übermittelt werden. Die Zapfhahnschalteinrichtung **57** weist eine Relaisschaltbox für Zapfhähne und eine Zustandsanzeige mit LED's auf.

[0062] Das beschriebene Leermeldesystem führt somit automatisch dazu, dass bei einer Leermeldung des Sensors **50** diese vorzugsweise im Keller über die Anzeigeeinrichtung **52** angezeigt wird und in der Nähe der Zapfhähne Relais zum Abschalten der Zapfhähne ansteuert werden und auch dort der Zustand der Getränkebehälter über LED's angezeigt wird. Die Anzeige und Schalteinrichtung **52** wird auch als Sensorbox bezeichnet und steht über zwei Patchkabel mit der Zapfhahnschalteinrichtung **57** in Verbindung.

[0063] Die Zapfhähne werden über zugeordnete Relais abgeschaltet, wodurch ein Leerlaufen der Getränke- oder Grundstoffleitung verhindert wird. Nach dem Anzapfen kann bei Bedarf über die einzelnen Reset-Taster die Leermeldung kurzzeitig deaktiviert werden, um ein Füllen der Getränkeleitung ohne manuelle Entlüftung zu ermöglichen.

[0064] Das gesamte System ist auf aktive Abschaltung aufgebaut. Dies bedeutet, nur wenn eine Leermeldung ausgegeben wird, erfolgt eine Abschaltung des Zapfhahnes. Wird ein Sensor vom System getrennt, bleibt der Betrieb der Zapfanlage so erhalten als wenn keine Leermeldung installiert wäre. Eine Systemblockierung bei Fehlfunktion kann somit ausgeschlossen werden.

[0065] Die Fig. 5 zeigt ein Fassleermelde- und Abschaltsystem **60**, das dazu geeignet ist, Zapfverluste und leere Getränkeleitungen zu vermeiden. Ein wartungsfreier optischer Sensor **61** überwacht die Zapfleitung direkt am Fass **62**. Ist das Fass **62** oder ein Container leer, wird über eine Steuerung **63** der Zapfhahn **66** sofort geschlossen, bevor sich die Getränkeleitung **65** leert.

[0066] Das Fassleermelde und Abschaltsystem **60** ist speziell für Postmix- und Premix-Anlagen konzipiert. Es kann aber auch für Bier, Wein- und Spirituosen-Systeme eingesetzt werden.

[0067] Der direkt am Fass **62** angeordnete optische Sensor **61** arbeitet auf Grund seiner Bauweise auch mit zähflüssigen Sirupen störungsfrei. Ist der Container **62** leer, wird über die Steuerung **63** der Zapfhahn **66** sofort geschlossen, bevor sich die Leitung **65** leert.

[0068] Die Steuerung **63** kann direkt an eine herkömmliche Computerschankanlage **67** oder einen Zapfhahn **64** angeschlossen werden. Eine optionale externe Überwachungs- und Steuereinheit **68** ermöglicht es, die Steuerung **63** mit Fremdsystemen zu kombinieren.

[0069] Der Aufbau einer automatischen Fassleerabschaltung mit Schaumkontrolle ist in Fig. 6 dargestellt. Das Fassleerabschaltungssystem **70** hat als zentrale Einheit den wartungsfreien optischen Sensor **71**, der über eine elektronische Zapfhahnsteuerung **72** ein Abschaltsignal über die Leitung **73** an die Zapfsäule **74** meldet. Dort wird auf Grund des Abschaltsignals der Fluss von der Bierleitung **75** zum Zapfhahn **76** unterbrochen. Das Abschaltsignal wird sofort dann an die Steuerung **72** gemeldet, wenn der optische Sensor **71** im Schauglas **77** erkennt, dass das Schauglas nicht vollständig mit Bier gefüllt ist. Nach dem Anschließen eines neuen Fasses **78** wird somit zunächst solange entlüftet, bis das Schauglas **77** vollständig mit Bier gefüllt ist. Anschließend wird die Restmenge zur Befüllung des Glases **79** am Zapfhahn **76** freigegeben. Somit kann ohne Verluste und Schaum am Hahn nach einem Fasswechsel weiter gezapft werden.

[0070] Der im Schauglas **77** angeordnete optische Sensor **71** blockiert als elektronischer Schaumstopper den Schaum, bevor er in die Leitung kommt und dadurch Zeit und Mengenverluste beim Anzapfen verursachen würde. Der einfache Aufbau der Vorrichtung schließt eine Fehlbedienung aus und sorgt für einen reibungslosen Schankbetrieb.

[0071] Der elektronische Schaumstopper entlüftet automatisch ohne mechanische Teile wie Schwimmer etc.. Er ist daher weniger störanfällig als herkömmliche Einrichtungen und leichter zu reinigen.

Patentansprüche

1. Leitungselement für flüssige Lebensmittel mit einem Einlass, einem Mediumleitungsbereich und einem Auslass, **dadurch gekennzeichnet**, dass im Mediumleitungsbereich ein Sensor angeordnet ist.

2. Leitungselement nach Anspruch 1, dadurch

gekennzeichnet, dass der Sensor ein optischer Sensor ist.

3. Leitungselement nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass der Sensor ein Gassensor ist.

4. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Sensor in einer Baueinheit Signale abgibt und misst.

5. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass im Mediumleitungsbereich dem Sensor gegenüberliegend eine freie Wegstrecke von mindestens 20 mm, vorzugsweise mindestens 35 mm und besonders bevorzugt von mehr als 45 mm vorgesehen ist.

6. Leitungselement nach Anspruch 5, dadurch gekennzeichnet, dass die freie Wegstrecke im Einbauzustand des Leitungselementes vom Sensor weg zumindest 10°, vorzugsweise mindestens 40° und besonders bevorzugt mehr als 80° von der Waagerechten nach unten weist.

7. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Sensor im Wesentlichen dem Ein- oder Auslass gegenüber angeordnet ist.

8. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Einlass und der Auslass in einem stumpfen Winkel zueinander angeordnet sind.

9. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Sensor dem Ein- oder Auslass direkt benachbart angeordnet ist.

10. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass Ein- und Auslass dem Sensor gegenüber angeordnet sind.

11. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass es eine Entlüftung aufweist.

12. Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass der Sensor in Einbaulage im oberen Bereich des Leitungselementes angeordnet ist.

13. Anordnung, insbesondere mit einem Leitungselement nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass sie eine Anzeigeeinrichtung für den Sensorzustand und eine Schalteinrichtung aufweist.

14. Anordnung nach Anspruch 13, dadurch gekennzeichnet, dass sie eine Schnittstelle zum Anschluss eines PC's aufweist.

15. Anordnung nach Anspruch 13 oder 14, dadurch gekennzeichnet, dass sie eine Zapfhahnschalteinrichtung aufweist.

16. Anordnung nach Anspruch 15, dadurch gekennzeichnet, dass die Zapfhahnschalteinrichtung eine Anzeigeeinrichtung aufweist.

17. Anordnung nach Anspruch 15 oder 16, dadurch gekennzeichnet, dass die Zapfhahnschalteinrichtung bei einer Trennung vom Leitungselement das gleiche Signal wie bei einem Entfernen des Leitungselementes abgibt.

Es folgen 4 Blatt Zeichnungen

Anhängende Zeichnungen

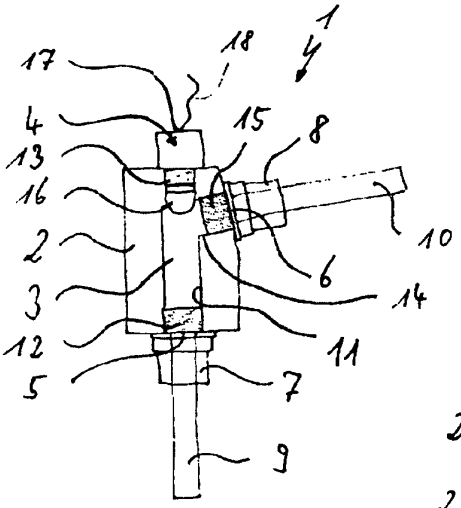


Fig. 1

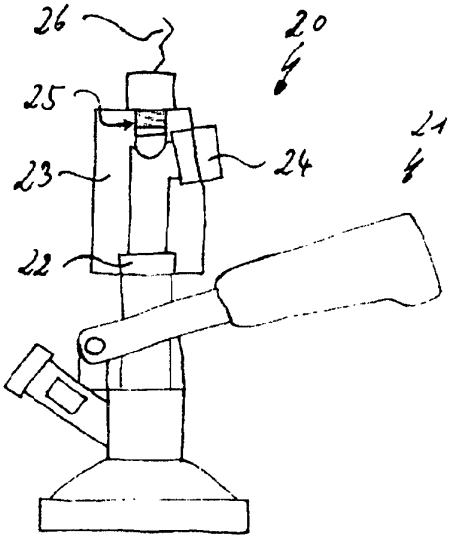


Fig. 2

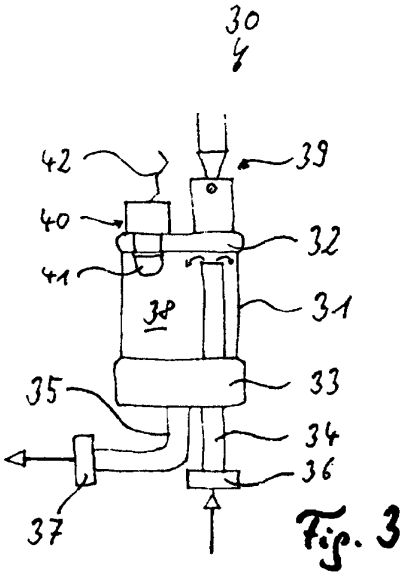


Fig. 3

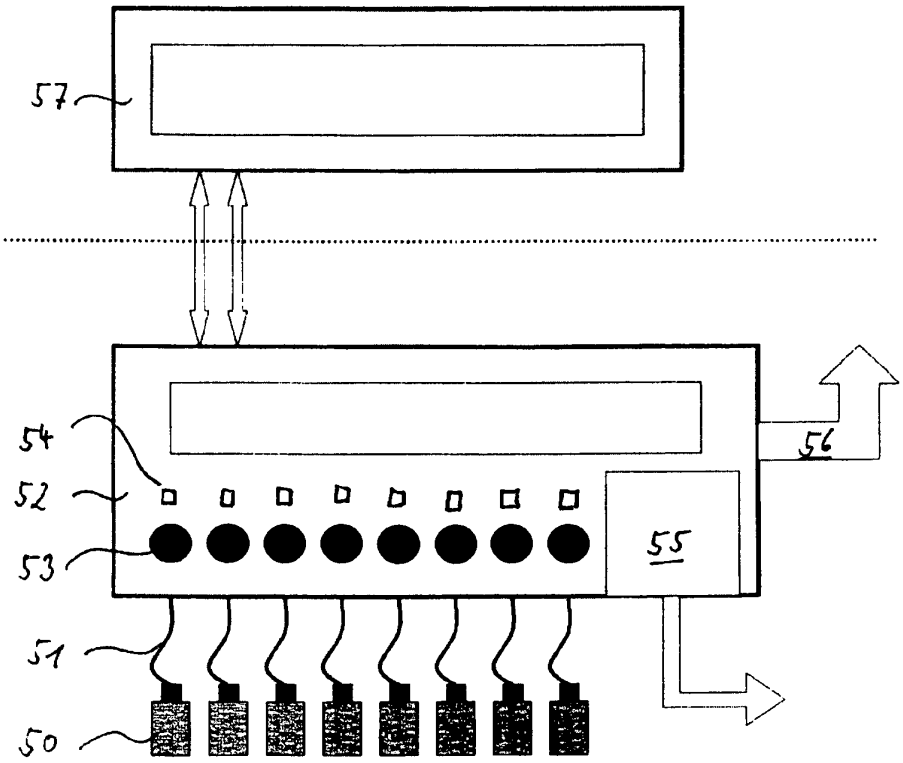


Fig. 4

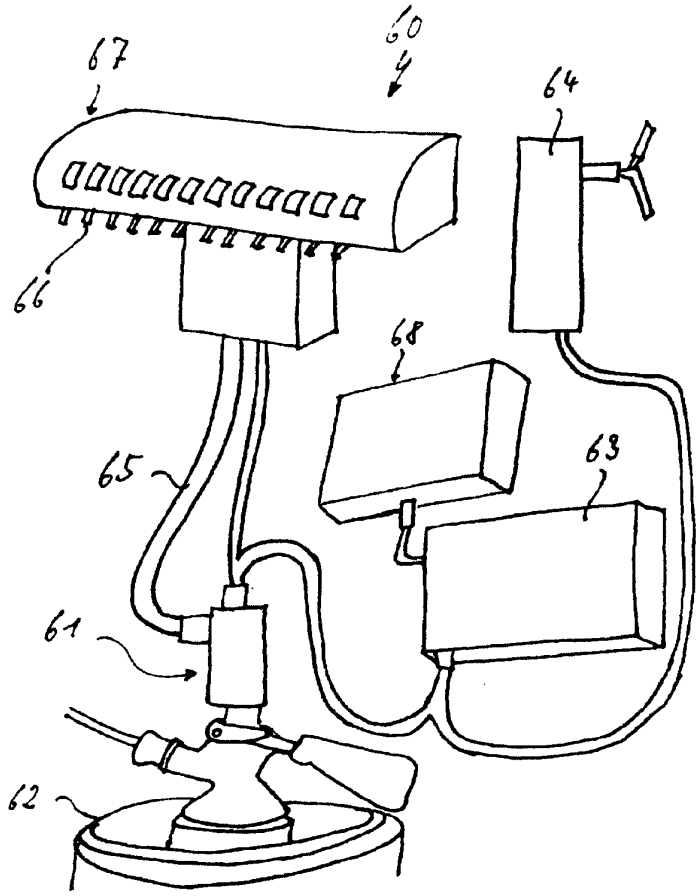


Fig. 5

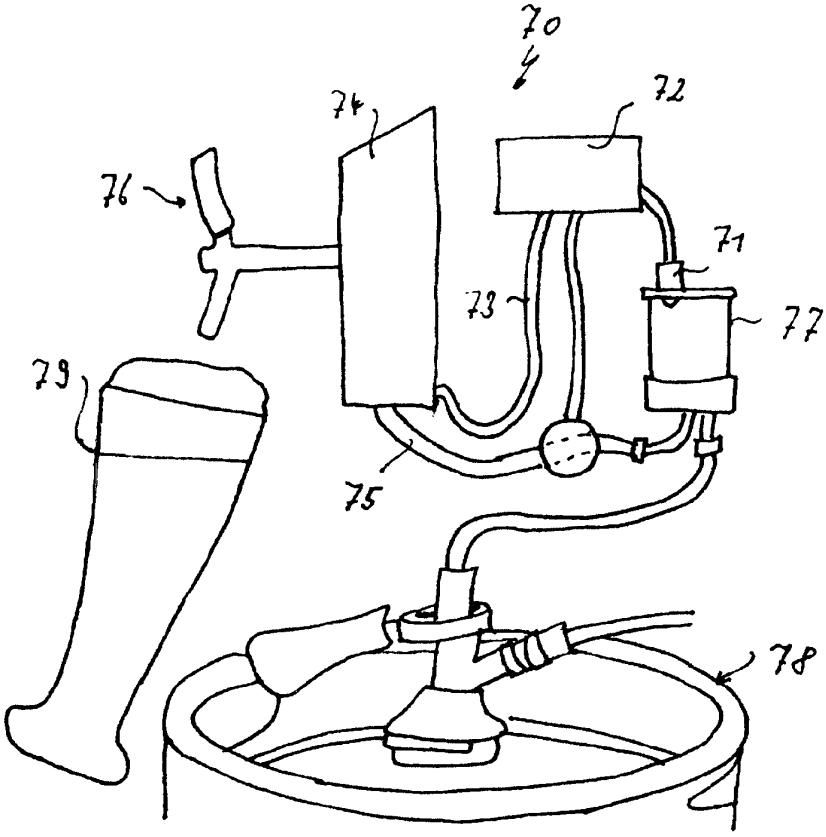


Fig. 6

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(54) **Self-fill system.**

(57) In connection with a beverage dispensing machine, an automatic self-fill control apparatus for the machine for controlling the filling of the liquid tank, which liquid tank is fed with a combination of water and a concentrate syrup adapted to be mixed with the water within the tank. A sensor member is disposed in the tank in a position so as to be responsive to the rise and fall of liquid in the tank. Pump means are provided adapted to pump the syrup to the tank. Control of water flow to the tank is also carried out. The sensor member has a low probe for detecting a low predetermined level of liquid in the tank and a high probe for detecting a high predetermined level of liquid in the tank and adapted to respectively generate low and high probe signals. Control circuit means is provided receiving and responsive to these low and high probe signals for controlling the pump to operate when the low probe is uncovered and terminating the pumping action when the liquid level reaches the high probe position so that the liquid level in the tank is always maintained at a level between the low and high probes. Also provided is a third sensor for determining an unsafe condition referred to herein as a system override to shut the system down in the event that the high probe is covered and that the liquid level proceeds to the even higher third probe. Also in the system of the present invention, there is provided a sensor for detecting an out-of-syrup condition.

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SELF-FILL SYSTEM

Background of the Invention

The present invention relates very generally to liquid dispensing machines and pertains, more particularly, to automatically controlled apparatus for providing for self-fill of the tank of a dispensing machine. Even more particularly, the invention relates to an automatic self-fill apparatus embodied in control circuit means for use with a machine that dispenses a liquid comprised of water and a concentrate syrup adapted to be jointly fed to a tank of the machine.

Machines that dispense a beverage are typically comprised of a tank for the storage of a beverage. The beverage is typically made up of a mixture of water and a concentrate syrup maintained at a cool temperature by means of evaporation cooling coils. These machines may have a water inlet feed but for the most part, the beverage in the storage tank of the dispenser is replenished by means of emptying a container of the syrup concentrate into the tank when the tank is sufficiently low to enable the tank to receive the full amount of concentrate in the concentrate container. Water is then added in an appropriate amount to provide the proper concentration of the beverage. This normal operation of replenishing the beverage in the tank is relatively messy to carry out and is time consuming. This prior technique is also a drawback in that the machine is required to be out of operation for a period of time while the replenishment takes place. Also, in replenishing the beverage it is necessary to wait a significant period of time until the entire content of the tank is cooled to serving temperature.

Accordingly, it is an object of the present invention to

provide an improved dispensing machine for beverages in which the dispenser is automatically filled. This means that a relatively large syrup concentrate reservoir can be used with the concentrate being replenished and supplied into the storage tank on a demand basis.

Another object of the present invention is to provide an automatic self-fill apparatus for a dispensing machine in which the fill operates in an automatic fashion so as to maintain the level of the beverage within a certain range in the tank. This normally maintains the beverage between set upper and lower limits as far as the level of beverage in the tank of the dispensing machine is concerned.

A further object of the present invention is to provide an automatic self-fill apparatus for a dispensing machine which is safe in operation, is relatively easy to maintain, and which can be incorporated into the dispensing machine relatively inexpensively. In accordance with the present invention, it is preferred to have a safety override so that even should the upper level limit be exceeded, there is an override mechanism by which the machine can be shut down for servicing or to take other action.

Still another object of the present invention is to provide an automatic self-fill apparatus further having the feature of achieving automatic-fill with an adjustable, consistant proportioning of syrup to water and thus provide the desired concentration of the beverage.

Summary of the Invention

To accomplish the foregoing and other objects of this invention, there is provided an automatic self-fill apparatus for a machine that dispenses beverages which are generally comprised of water and a concentrate syrup which are adapted to be mixed together within a tank of the dispensing machine. The apparatus of the present invention comprises a sensor member

disposed in the tank in a position so as to be responsive to the rise and fall of liquid in the tank. The sensor member preferably comprises a support post disposed in an upright position in the tank. Pump means are provided to pump the syrup to the tank. Water control means is also provided such as a water solenoid valve for controlling water flow to the tank. The lines that couple to the tank preferably include fill pipes that are adapted to feed the water and syrup concentrate to a top end of the tank. The sensor member comprises probes which include a low probe for detecting a low predetermined level of liquid in the tank and a high probe for detecting a high predetermined level of liquid in the tank and adapted to respectively generate low and high probe signals. Control circuit means is used responsive to the low and high probe signals for controlling the pump and water fill valve to operate when the low probe is uncovered and terminating pumping action when the liquid level reaches the high probe position, thereby maintaining the liquid level in the tank at a level between the low and high probes at all times. There is preferably also provided a third probe disposed over the high probe and functioning as a system override whereby the control circuit means is disabled to shut the apparatus down in the event that the liquid level exceeds the high probe position and reaches the system override probe.

When one is out-of-syrup then it is not desired to provide any additional pumping into the tank until the syrup can be replenished. In this way the liquid in the tank is not diluted.

Brief Description of the Drawings

Numerous other objects, features and advantages of the invention should now become apparent upon a reading of the following detailed description taken in conjunction with the accompanying drawings, in which:

FIGS. 1A and 1B illustrate logic control circuitry for providing automatic self-fill in connection with a dispensing machine such as one that dispenses fruit juices or other beverages;

FIG. 2 is a front perspective view of a twin tank dispensing machine with one of the tanks partially cut away to illustrate the fill pipes and probe assembly as in accordance with the present invention;

FIG. 3 is a cross-sectional view taken along line 3-3 of FIG. 2 showing further details of the fill pipe and probe assembly;

FIG. 4 is a further cross-sectional view taken along line 4-4 of FIG. 3 showing the probe; and

FIG. 5 is a rear perspective view of the dispensing machine illustrated in FIG. 2.

Detailed Description

With reference to the drawing, there is depicted in FIGS 1A and 1B the control circuitry of the present invention for providing the automatic self-fill in connection with a dispensing machine. The dispensing machine with which the concepts of the invention are practiced may be of the general type depicted in FIGS. 2-5 herein, although, the concepts of the invention may also be practiced with many other forms of dispensing machine. FIGS. 2-5 herein illustrate the preferred embodiment of the automatic self-fill dispensing machine in accordance with the present invention. In this connection FIG. 2 illustrates a front perspective view of the twin tank dispensing machine with one of the tanks partially cut away to illustrate the fill pipes and probe assembly. FIG. 3 is a cross sectional view taken along line 3-3 showing further details thereof. FIG. 4 is a further cross sectional view taken along line 4-4 of FIG. 3 showing further details of the probe assembly. FIG. 5 is a rear perspective view of the

dispensing machine with the housing cut away.

FIGS 1A and 1B show logic control circuitry for providing automatic self-fill in connection with a dispensing machine such as one that dispenses flavored fruit beverages. A portion of the control circuitry may be separated into two sections; one associated with a left liquid tank 8 and the other associated with a right liquid tank 9. Each of these tanks has associated therewith basically three probes the physical arrangement of which is depicted in FIGS. 2-4. In this regard there is provided in each tank a support post 11 illustrated, for example, in FIG. 3, disposed between two fill pipes 13 and 15. These fill pipes are for respectively receiving water and the syrup concentrate. On the support post 11 there are provided probes including a low probe ring 17, a high probe ring 19, and a top probe cap 21 which is for a system override function. In connection with the control circuitry the different probes are identified at the input control terminals by like reference characters. In addition there is also provided an out-of-syrup probe 23 which operates to provide an indication when the main syrup reservoir is empty. It is also noted that as depicted in FIGS. 2-4 that the details are given of the low probe ring 17, high probe ring 19, and top probe cap 21.

Prior to discussing the operation of the circuitry of FIGS. 1A and 1B reference is now made to FIG. 2 which shows the dispensing machine with its base B and associated drip tray T upon which a cup can rest under either one of the dispensing nozzles. There is, of course, a dispensing nozzle associated with each of the tanks 8 and 9. Also depicted in FIG. 2 is a first syrup concentrate reservoir R1 and a second syrup concentrate reservoir R2. FIG. 1 also illustrates an indicator I and switches SW1 and SW2. The indicator I is an out-of-syrup light. The switch SW1 is a prime switch to be discussed in detail hereinafter in connection with the circuit diagram. The

switch SW2 (switch 52 in FIG. 1B) is a power switch for enabling automatic filling.

FIG. 3 shows the fill pipes 13 and 15 along with the support post 11 which comprises part of the overall probe assembly. FIG. 3 also shows the probe rings 17, 19, and probe cap 21. The fill pipes and the support post 11 are all mounted from the evaporator coil housing H. In FIG. 3 the evaporator coils C are shown. Also shown in FIG. 3 are the three wires at W which couple from the respective probe rings. Again, further reference is made hereinafter to the probes and their operation in conjunction with the overall circuitry.

In the following discussion of the operation of the circuitry, a distinction is made between the left and right probes and associated fill pipes and in this connection, the suffixes L and R are used in association with the reference characters.

In connection with FIG. 3, it is to be noted that the construction of the evaporator section is well known with the exception that in accordance with the present invention the evaporator housing is also used in a dual manner as a support for the fill pipes and the probe assembly.

It is also noted in FIG. 3 that the water fill pipe 13 preferably extends from the evaporator housing at the middle thereof. This is desired so that the evaporator coils C do not interfere with the water fee. If this line is located too close to the evaporator coils C, then freezing of the water may occur.

FIG. 4 shows the cross sectional details of the probe assembly. The majority of the probe assembly is made of an insulating dielectric material with the exception of the probe contacts which are conductive. FIG. 4 shows the wiring W individually connecting to the probe contacts such as by being soldered thereto. A filler material M may then be used to seal everything together. This may be epoxy.

FIG. 5 shows further details of the rear of the dispenser which includes a housing 100 for containing and supporting many of the components used in completing the system. Previously,

reference has been made to the syrup reservoirs R1 and R2. The line 102 couples from the syrup reservoir associated with the left tank while line 104 couples from the syrup reservoir associated with the right tank. The line 102 connects to a left tank syrup sensor 106 while the line 104 couples to a right tank syrup sensor 108. The details of the syrup sensor are found in a co-pending application. Basically, each of the probe electrodes 23L and 23R in sensors 106 and 108, respectively, detects the presence of syrup in the respective lines 102 and 104. When the reservoirs are out of syrup then the out-of-syrup sensors give an indication of such which is coupled to the circuitry shown in FIGS. 1A and 1B.

From sensor 106 there is a line 110 which couples to the left tank peristaltic pump 112. A further line 114 connects from the output of the pump to the left tank to one of the syrup pipes 15L. Similarly, the output of the sensor 108 couples by way of a line 115 to the peristaltic pump 116 associated with the right hand tank. A further line not shown in FIG. 5 couples from the output of the pump 116 to the syrup fill tube 15R located in a right hand tank 9.

A water inlet is also shown in FIG. 5 at water line 120. This line splits into lines 122 and 124. The line 122, for example, couples to the solenoid valve 128. The output of the solenoid valve 128 couples to a water flow control device 130. Associated with the flow control device 130 is a water adjustment 132 shown in FIG. 2. This is used to adjust the volume of water flow to the output line 134 and the check valve 136. The water then enters the water fill tube 13R and then enters the right tank 9.

On the left hand side there is a similar set up in which the line 124 couples to the solenoid valve 140. The output of the solenoid valve 140 couples to the water flow control device 142 which also has an associated water adjustment on the front panel. The output line 144 couples from the output of the water flow control device 142 to the check valve 146 and from there to the water fill pipe 13L in the left tank.

There are basically two reasons for the above described

fill apparatus. One is interested in maintaining a sanitary environment and is thus concerned with any back siphoning of a beverage into a water line if the supply line pressure fails and a vacuum occurs. If a below level entry were used, a product could be drawn into the water line, unless a highly restrictive and expensive double ball valve were employed. In case the operator forgets to replace the inlet lines, a single ball check valve is located at the inlet to the unit. Thus, this illustrates one of the features described herein of providing fill pipes in which the liquid filling occurs in a position wherein liquid presently in the tank cannot pass back into the fill lines. This is clearly illustrated in FIG. 2 herein, wherein the fill pipes 13 and 15 extend above the top of the probe assembly. Thus, by providing the fill pipes having their outlet above the top of the probe assembly, back siphoning is not possible. Also, the apparatus can be made more simply, not requiring the use of an expensive double ball valve to prevent the product from being drawn into the water line.

A second reason for the above-beverage level inlets for water and syrup is the ease that the Brix or water syrup ratio is checked. One can merely place a bifurcated measuring cup under the syrup and water line outlets and catch the water and syrup flow, or catch both in a single glass and check the Brix with a refractometer. Brix adjustment is easily made by adjusting the water flow screw, such as the screw 132 shown in FIG. 2, located at the bottom front on each side of the unit. Control via screw 132 controls the water/syrup ratio by permitting more or less water flow during the filling sequence.

Also depicted in FIG. 5 are a series of fans F1 and F2 which are used for cooling the pump motor. Also shown are switches SW1 and SW2 along with the indicator I. In addition to the switches and indicators shown in FIGS. 2 and 5, on the opposite or left hand side of the unit there is also an

indicator associated with an out-of-syrup sensor associated with the reservoir R1. There are also a pair of switches on that side including a prime switch associated with the left tank and the reset switch. There is also a water flow adjustment port associated with the left tank in the same position as the adjustment 132 shown in FIG. 2 but on the corresponding side of the dispenser.

As indicated previously, the dispensing unit includes four switches, two on each side, such as depicted by switches SW1 and SW2 in FIG. 2. As will be described hereinafter, the reset switch comprises a portion of the system override (SOR) circuitry which shuts down the unit if the beverage level rises to the system override probe cap 21. The logic in the system override circuit also deactivates the unit after a power failure and of course, when the unit is first plugged in and started. For the moment it is assumed that the system override circuit has been reset and the power supply is energized.

The circuit diagram also shows the high line 50 coupling to a transformer T1 which has a primary winding P and a secondary winding S. The output from the secondary winding couples to a full wave rectifier bridge circuit 65 comprised of diodes D1-D4. The output from this circuit couples to filter capacitor C9 and to the zener diode Z1, resistor R7 and transistor Q2. A sufficient DC voltage is established at the base of transistor Q2 so as to enable transistor Q2 to be conductive. Basically the power supply may be considered as an emitter follower circuit driven by a Zener diode shunt regulator. Further assuming that the system override function has not taken place, then transistor Q1 is also conductive; this then provides power to the relay K1 which has a diode D5 coupled there across. The circuit diagram also shows a momentary action reset switch 66 and an associated indicator lamp 68. This may be a neon discharge lamp with a series resistor. The power neutral at line 70 couples to both the

reset switch 66 and the indicator 68. The line 70 also couples to one side of contact K1A associated with relay coil K1.

At an initial phase of operation the reset switch 66 is closed provide a path from the neutral line 70 through line 71 to the primary winding P of the transformer T1. This causes the AC power to be coupled to the rectifier bridge 65 and in turn provides DC power to the transistors Q1 and Q2 causing energization of the relay K1 and closure of its associated contact K1A. This latches the power circuit.

Reference is now made to the portion of the control circuitry associated with the left tank 8 and with the relay coil K3. This control circuitry includes gates 12, 14, 16, 18, 20, 22, 24 and a common gate 26. All of these gates are NAND gates. The gates 12, 14, 18 and 26 have associated therewith input capacitors C5, C6, C7 and C4, respectively. These gates provide for Schmitt triggering hysteresis inherent in the 4093 chip that is used. The Schmitt trigger action is provided at the probe input terminals so as to stabilize the logic particularly as the probes gradually dry upon a condition of a receding liquid level. The gates 14 and 16 are cross-coupled to form a binary or flip-flop device.

Thus, the high probe terminal 19L couples to the NAND gate 12; the low probe terminal 17L couples to the NAND gate 14; the out-of-syrup terminal 23L couples to the NAND gate 18; and the override probe 21L couples to the NAND gate 26. It is noted that each of these probe input circuits also includes a resistor such as the respective resistors R8, R9, R10 and R4 each coupling to the negative voltage supply. The NAND gates that are used have a logic low output when both inputs are at a logic high and alternatively they have a logic high output when either or both of the inputs are at a logic low level. In connection with the logic that is described herein the gates are connected to the liquid level probes and the probes are grounded by contact with the liquid. In the absence of the

conductive liquid, these probes are driven to the negative voltage such as the -13 volts shown by means of the aforementioned resistors.

In the logic circuit that is depicted the ground level signal corresponds to a logic high or logic "1" and the signal -13 volts corresponds to the logic low or logic "0". The ground voltage has been used for logic high to prevent electrolysis corrosion of the probe electrodes by driving them at a negative voltage with respect to the liquid. The probes are cathodes which are protected by a cathodic protection principle.

In connection with the operation of the control circuit, it may first be considered that, at start-up, there is no liquid in the dispenser (tank). Thus, each of the four liquid sensing probes is ungrounded and the input to each of the corresponding gates 12, 14, 18 and 26 is at its low level (-13 volts). The outputs of these gates are thus at their high level or logic "1" (0 volts). The high output from gate 14 cross-couples to one input from gate 16 and the output from gate 16 is thus low because both of its inputs are high. The high output from gate 14 also couples to gate 20. The high output from gate 18 is converted into a low output at the output of gate 22. This, in turn, causes a high output from the gate 20 which in this logic is a ground signal. This means that the relay K3 is not energized. Also, the gate 24 received at its input two high level signals causing a low at its output which illuminates the indicator light 25L (indicator I in FIG. 2). Thus, at this point in the operation the circuit is in a static state with pump action not having yet commenced.

Each side of the dispensing unit has its individual prime switch, such as the switch SW1 shown in FIG. 2. It also has an out-of-syrup light emitting diode or indicator I which glows red when the syrup sensor is empty of syrup, which occurs when the unit is at initial start-up. To start one side, with the

syrup source properly connected, one presses the momentary contact prime switch such as switch SW1 (contacts 53 and 55 or 59 and 61 in FIG. 1B). This starts the pump motor 54 but shuts off the solenoid valve 56 so as not to prefill the bowl with water while the pump is pulling the syrup into the unit. When the syrup fills the syrup sensor, the LED I will go out. The button is released and the unit will fill both syrup and water.

Once the system is manually primed the out-of-syrup probe 23L is grounded by the syrup. This causes a low output from gate 18 and a high output from gate 22. This thus causes gate 20 to have two high inputs causing its output to go low or to the voltage level of -13 volts. This energizes the relay coil K3 so as to allow syrup pumping and water flow. Relays K2 and K3 each energize both a water flow solenoid and a peristaltic pump when the prime switch is released.

The aforementioned operation causes the liquid to rise in the tank 9 until the liquid contacts the low probe 17L. This causes a high logic level to be coupled to the gate 14 but this does not have any effect on the gate 14 because the other input to gate 14 from the output of gate 16 is low. Thus, the output of gate 14 remains at its high logic level state. This means that both inputs to the gate 20 are still at their high logic level state and thus the low level output from the gate 20 maintains tne relay coil K3 energized. Thus, when the tank is being filled with liquid the contact of the low probe 17L in effect causes no action to be taken and the pumping simply continues.

It is to be noted that the fluid conductivity that the various probes measure is to "ground". This conductive path is provided by metallic tubing, cooling domes, and the fill tubes, so that there is, of course, a complete circuit path.

Now, when the high probe 19L is reached the input to the gate 12 goes to its high logic level state and the output of the gate 12 is thus at its low logic level state. This output

couples to the gate 16 causing a high output from the gate 16. This high logic output couples back to the input of gate 14 and because the other input to gate 14 is also now high by virtue of the low probe being contacted previously, then the output of the gate 14 goes to its low state. This signal is coupled to the gate 20 for causing the output of the gate 20 to go to its high voltage level state (ground voltage). This de-energizes the relay coil K3. This in turn ceases the filling action as is desired.

When the output of the gate 12 goes to its low level state, this signal is also coupled to the gate 24 causing the output of gate 24 to go to its high state. This causes the LED 25 to cease illumination. The LED 25L illuminates only during the time that both inputs to the gate 24 are high which occurs before reaching the high probe and when out of syrup.

As the liquid is drawn from the tank the liquid level decreases and the liquid level falls below the probe 19L. When that occurs the output of the gate 12 goes high but again this has no effect on the gate 16 and thus the output of the gate 20 is still high maintaining the relay coil K3 de-energized. However, as the liquid level falls, the low probe 17L is eventually uncovered and thus the signal on line 17L to the gate 14 eventually goes low. This resets the bistable device comprised of gates 14 and 16 so that the output of gate 14 goes high. The other input to the gate 20 is also high and thus the output from gate 20 is low. This causes a re-energization of the relay coil K3, thus turning the liquid pump (and water solenoid) back on. They will remain on until the high probe is contacted, at which time the output of the gate 20 goes to its high state again de-energizing the relay coil K3. This action repeats itself and thus maintains the liquid level between the low probe 17L and the high probe 19L.

In addition to these two probes there is also provided an override probe 21L which couples to the corresponding terminal

21L. This input couples to the NAND gate 26 and the output of the NAND gate 26 couples to the base of transistor Q1 by way of resistor R6. The NAND gate 26 functions as an inverter as well as providing Schmitt trigger/driver action.

Normally, the top probe cap 21L is not contacted and thus the output of the gate 26 is high, maintaining the transistor Q1 in conduction. However, if due to a malfunction, the probe cap 21L is contacted, then the output of the gate 26 goes low and the transistor Q1 ceases conduction. The relay K1 is thus de-energized, removing power from the pump motors, solenoids, and logic circuitry.

The control circuit also has an input from the out of syrup sensor indicated at terminal 23L and coupling to the NAND gate 18, which also functions as a inverter. As long as there is syrup in the sensor block 106, the output of the gate 18 is low and the output of gate 22 in turn is high. The high output of gate 22 enables gate 20 and thus, as long as the system is not out of syrup, the relay K3 is capable of being energized in a selective manner under control from the output of the bistable device which comprises NAND gates 14 and 16 connected in a cross-coupled manner as illustrated.

In the event that the syrup reservoir runs out of syrup then the terminal 23L is no longer grounded and the input to the gate 18 is thus low. This causes a high output from gate 18 which is inverted by gate 22 to a low output. This low output to gate 20 over-rides the other input to gate 20 from the bistable device and causes a high output from the gate 20 which in turn de-energizes the relay K3. Thus, in accordance with the present invention there is provided for automatic interruption of any filling and pumping in the event that there is a detection that one is in an out-of-syrup state.

The operation of the control circuitry in connection with the right tank is substantially the same as the previous operation described in connection with the left tank. There

can be considered at start-up that there is no liquid in the right tank or pump. Thus, each of the four liquid sensing probes associated with the right tank are ungrounded and thus input to each of the corresponding gates 32, 34, 38 and 26 is at its low level (-13 volts). The outputs of these gates are thus at their high level or logic "1" (0 volts). The high output from gate 34 cross-couples to one input from gate 36 and the output from gate 36 is thus low because both of its inputs are high. The high output from gate 34 also couples to gate 40. The high output from gate 38 is converted into a low output at the output of gate 42. This, in turn, causes a high output from the gate 40 which in this logic is a ground signal. This means that the relay K2 is not energized. Thus, at this point in the operation the circuit is in a static state with filling not having yet commenced.

Once the system is manually primed, the out-of-syrup probe 23R is grounded. This causes a low output from gate 38 and a high output from gate 42. This thus causes gate 40 to have two high inputs causing its output to go low or to the voltage level of -13 volts. This energizes the relay K2 so as to allow fluid pumping and fluid flow.

The aforementioned operation causes the liquid to rise in the tank 9 until the liquid contacts the low probe 17R. This causes a high logic level to be coupled to the gate 34 but this does not have any effect on the output of gate 34 because the other input to gate 34 from the output of gate 36 is low. Thus, the output of gate 34 remains at its high logic level state. This means that both inputs to the gate 40 are still at their high logic level state and thus the low level output from the gate 40 maintains the solenoid coil K2 energized. Thus, when the tank is being filled with liquid the contact of the low probe 17R in effect causes no action to be taken and the pumping simply continues.

Now, when the high probe 19R is reached the input to the

gate 32 goes to its high logic level state and the output of the gate 32 is thus at its low logic level state. This output couples to the gate 36 causing a high output from the gate 36. This high logic output couples back to the input of gate 34 and because the other input to gate 34 is also now high by virtue of the low probe being contacted previously, then the output of the gate 34 goes to its low state. This signal is coupled to the gate 40 for causing the output of the gate 40 to go to its high voltage level state or to ground voltage. This de-energizes the solenoid coil K2. This in turn ceases the filling action as is desired.

When the output of the gate 32 goes to its low level state, this signal is also coupled to the gate 44 causing the output of gate 44 to go to its high state. This prevents the LED 25R from illuminating. The LED 25R illuminates when both of the inputs to the gate 44 are high which occurs before reaching the high probe and when out of syrup.

As the liquid is drawn from the tank the liquid level decreases and the liquid level falls below the probe 19R. When that occurs the output of the gate 32 goes high but now this has no effect on the gate 36 and thus the output of the gate 40 is still high maintaining the solenoid coil K2 de-energized. However, as the liquid level falls, the low probe 17R is eventually uncovered and thus the signal on line 17R to the gate 34 eventually goes low. This resets the bistable device comprised of gates 34 and 36 so that the output of gate 34 goes high. The other input to the gate 40 is also high and thus the output from gate 40 is low. This causes a re-energization of the relay coil K2. This thus turns the syrup pump and water solenoid valve back on and remains on until the high probe is contacted at which time the output of the gate 40 again goes to its high state again de-energizing the relay coil K2. This action repeats itself and maintains the liquid level thus between the low probe 17R and the high probe 19R.

In addition to these two probes there is also provided an over-ride probe 21R which couples to the left override probe 21L and hence may be considered an extension of that probe, the function of which has already been discussed. Also, in connection with FIG. 1A it is noted that the gates identified as gates U1 and U3 are 4093 type NAND gates providing Schmitt trigger action. The other gates such as gates U2 and U4 are standard NAND gates which may be of type 4011. The latter gates are not directly connected to the probes.

The control circuitry depicted herein (particularly in FIG. 1B) also includes a high input power line 50 coupled by way of the power switch 52 to both left and right pumps and solenoids. With regard to the left tank, it is noted that there is provided a pump motor 54 and associated water solenoid valve 56 (see valve 140 in FIG. 5). Similarly, with regard to the right tank there is provided a pump motor 58 and associated water solenoid valve 60 (see valve 128 in FIG. 5). The motors 54 and 58 preferably drive peristaltic pumps (see the pumps 112 and 116 in FIG. 2) that are adapted to pump syrup and operate at a speed of 160 RPM. The water flow is controlled by a 1.0 GPM flow control device and requires 30-35 PSIG flowing pressure to operate.

Similar operation also occurs with regard to the right tank. In this regard it is noted that there is a contact 61 which is operated from the prime switch 59 and which is adapted to open the path to the solenoid 60 when the prime switch 59 is operated. When either of the prime switches 55 or 59 is de-activated, they being momentary switches, then the contact 53 or 61 reverts to its normally closed position and permits the operation of the respective solenoid.

The syrup is contained in a reservoir and flows through a syrup sensor which is the subject matter of a co-pending application serial No. , filed . The syrup is drawn past the syrup sensor by the peristaltic

pump and from there is discharged into the bowl, above the beverage level. The out-of-syrup circuit allows the apparatus to run when the high resistance but conductive syrup conducts current from its sensor point through the syrup to ground. The sensor tip extends into the syrup flow and conducts current. When the syrup reservoir is empty, the syrup level drops in the sensor housing and the tip is no longer contacted by the syrup. It then no longer conducts and the logic controlling the system shuts down the apparatus.

With regard to the solenoid valves, they are adapted to deliver about two gallons per minute of water when both sides are filling. They use a 3/8ths inch OD copper line to connect to the machine. The water flow comes in from a main pipe and divides flowing through copper lines to the solenoid valves 56 and 60. From there the water flows through a flow control valve with its needle valve adjustment. From the water valve the water flows through a check valve and then through stainless steel tubing into the bowl or tank. Again, like the syrup line, the water line discharges water into the beverage bowl above the liquid level. With regard to the aforementioned FIG. 2 the line 15 may be for syrup and the line 13 for water.

In accordance with one of the important features of the present invention as highlighted previously, it is noted that the fill pipes 13 and 15 are disposed so that they extend above the probe assembly. This is clearly illustrated in FIG. 1 and even more so in FIG. 3. This prevents a back siphoning of beverage into the water line in case of a vacuum in the water line.

Having described one preferred embodiment of the present invention, it should now be apparent to those skilled in the art that numerous other embodiments and modifications thereof are contemplated as falling within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. An automatic self-fill apparatus for a machine that dispenses a liquid comprised of water and a flavored concentrate syrup adapted to be mixed with the water, said apparatus comprising;

a tank that is adapted to be automatically filled with the liquid,

a sensor member disposed in the tank in a position so as to be responsive to the rise and fall of liquid in the tank,

pump means adapted to pump the syrup to the tank under selective control,

said sensor member having a low probe means for detecting a low predetermined level of liquid in the tank and a high probe means for detecting a high predetermined level of liquid in the tank and adapted to respectively generate low and high probe signals,

and control circuit means receiving and responsive to said low and high probe signals for controlling said pump means to operate when said low probe is uncovered and terminating said pump means operation when the liquid level reaches the high probe position,

whereby the liquid level in the tank is maintained at a level between said low and high probes.

2. An automatic self-fill apparatus as set forth in claim 1 wherein the dispensing machine has a pair of tanks each with a respective sensor member, pump means and water filling means.

3. An automatic self-fill apparatus as set forth in claim 1 wherein said tank has at least one fill pipe for directing the liquid to the tank.

4. An automatic self-fill apparatus as set forth in claim 1 wherein said sensor member comprises a post member and means supporting the post member in an upright position in the tank.

5. An automatic self-fill apparatus as set forth in claim 4 wherein each probe means comprises a probe ring with the high probe ring disposed on the post member a spaced distance above the low probe ring.

6. An automatic self-fill apparatus as set forth in claim 5 including a third probe ring disposed over the high probe ring functioning as a system over-ride whereby the control circuit means is disabled to shut the apparatus down in the event of the liquid level reaching the third probe ring.

7. An automatic self-fill apparatus as set forth in claim 1 including a third probe means disposed over the high probe means for providing a system over-ride signal.

8. An automatic self-fill apparatus as set forth in claim 7 wherein said control circuit means includes means for sensing the over-ride signal to disable the control circuit means.

9. An automatic self-fill apparatus as set forth in claim 1 wherein said control circuit means comprises a bistable device having one input for receiving the low probe signal and another input for receiving the high probe signal.

10. An automatic self-fill apparatus as set forth in claim 9 including a relay for operating the pump means and means coupling the output of the bistable device to the relay for activation thereof.

11. An automatic self-fill apparatus as set forth in claim 10 wherein said bistable device comprises a pair of cross-coupled gates.

12. An automatic self-fill apparatus as set forth in claim 11 wherein said means coupling the output of the bistable device includes an AND type gate.

13. An automatic self-fill apparatus as set forth in claim 12 including a sensor for determining when the machine is out-of-syrup for generating an out-of-syrup signal coupled to said NAND gate to de-energize said solenoid and stop said pump means in the event that the machine is out of syrup.

14. An automatic self-fill apparatus as set forth in claim 13 including a prime switch initially used to prime the syrup and initiate automatic operation.

15. An automatic self-fill apparatus as set forth in claim 1 including a means for priming said pump means including control means that interrupts water flow during said priming so as not to dilute the liquid in the tank.

16. An automatic self-fill apparatus as set forth in claim 15 wherein said means for priming includes a prime switch associated with each tank.

17. An automatic self-fill apparatus as set forth in claim 1 including a pair of fill pipes associated with the tank, one for carrying water and the other for carrying said syrup.

18. An automatic self-fill apparatus as set forth in claim 17 wherein both of said fill pipes extend to terminate and introduce liquid flow into the tank at a top position thereof.

19. An automatic self-fill apparatus as set forth in claim 18 wherein said fill pipes introduce liquid into the tank at a position above the sensor member.

20. An automatic self-fill apparatus as set forth in claim 18 wherein said fill pipes introduce liquid into the tank at a position above the high probe so as to thereby prevent back syphening of beverage into the water line in the event of a vacuum in the water supply line.

21. In a dispensing machine that dispenses a liquid comprised of water and a flavored concentrate syrup which is adapted to be mixed with the water, and including a tank that is adapted to be automatically filled with the liquid, a method for providing automatic self-fill of said tank comprising the steps of;

sensing the liquid level in the tank including sensing a low predetermined level of liquid in the tank and sensing a high predetermined level of liquid in the tank adapted to respectively generate low and high level signals, and controlling the filling of the tank with the water and syrup so as to cause filling thereof when the liquid level decreases to the low predetermined level and interrupting the filling when the liquid level reaches the high predetermined level whereby the liquid level in the tank is always maintained at a level between said low and high predetermined levels.

22. A method as set forth in claim 21 including sensing a third position of liquid level at a liquid level height greater than the high predetermined level so as to interrupt further operation of the machine.

23. A method as set forth in claim 20 including determining the concentration between the water and syrup and adjusting the concentration therebetween so as to provide a proper predetermined concentration thereof.

24. A filling apparatus for a machine that dispenses a liquid comprised of water and a flavored concentrate syrup adapted to be mixed with the water, said apparatus comprising;

a tank that is adapted to be filled with the liquid,

a pump means adapted to pump the syrup to the tank under selective control,

a pair of fill pipes associated with the tank, one for carrying water and the other for carrying said syrup,

said fill pipes each having output port ends that introduce liquid flow into the tank at a top position thereof above the maximum desired predetermined liquid level in the tank.

25. An apparatus as set forth in claim 24 wherein each fill pipe extends substantially vertical with the output port therefrom disposed at a turn in the pipe at the top end thereof so as to at least partially direct the liquid downwardly therefrom.

26. An apparatus as set forth in claim 24 in combination with a sensor probe assembly and in which the fill pipes introduce liquid into the tank at a position above the sensor probe assembly.

27. An apparatus as set forth in claim 26 wherein said sensor probe assembly includes a low probe means for detecting a low predetermined level of liquid in the tank and a high probe means for detecting a high predetermined level of liquid in the tank and adapted to respectively generate low and high probe signals, and control circuit means receiving and responsive to said low and high probe signals for controlling said pump means to operate when said low probe is uncovered and terminating said pump means operation when the liquid level reaches the high probe position, whereby the liquid level in the tank is maintained at a level between said low and high probes.

28. A filling apparatus for a machine that dispenses a liquid comprised of water and a flavored concentrate syrup, said apparatus comprising; a tank that is adapted to be filled with the liquid, a sensor means disposed in the tank in a position so as to be responsive to the rise and fall of liquid in the tank, pump means adapted to pump the syrup to the tank under selective control, said sensor means having automatic control means for controlling said pump means to maintain the liquid level in the tank at a level between upper and lower limits, and a sensor for determining when the machine is out of syrup.

0161042

Fig. 1A

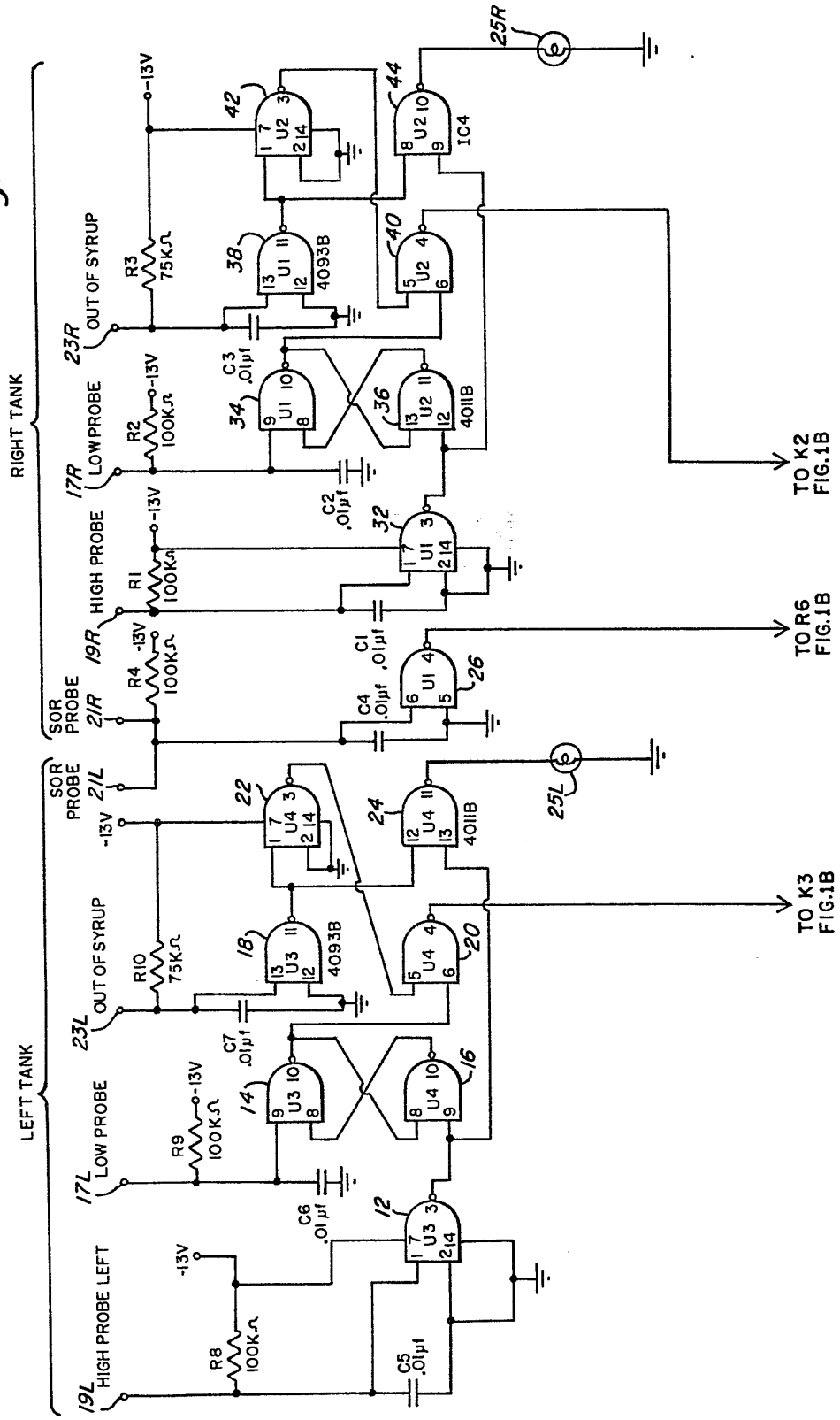


Fig. 1B

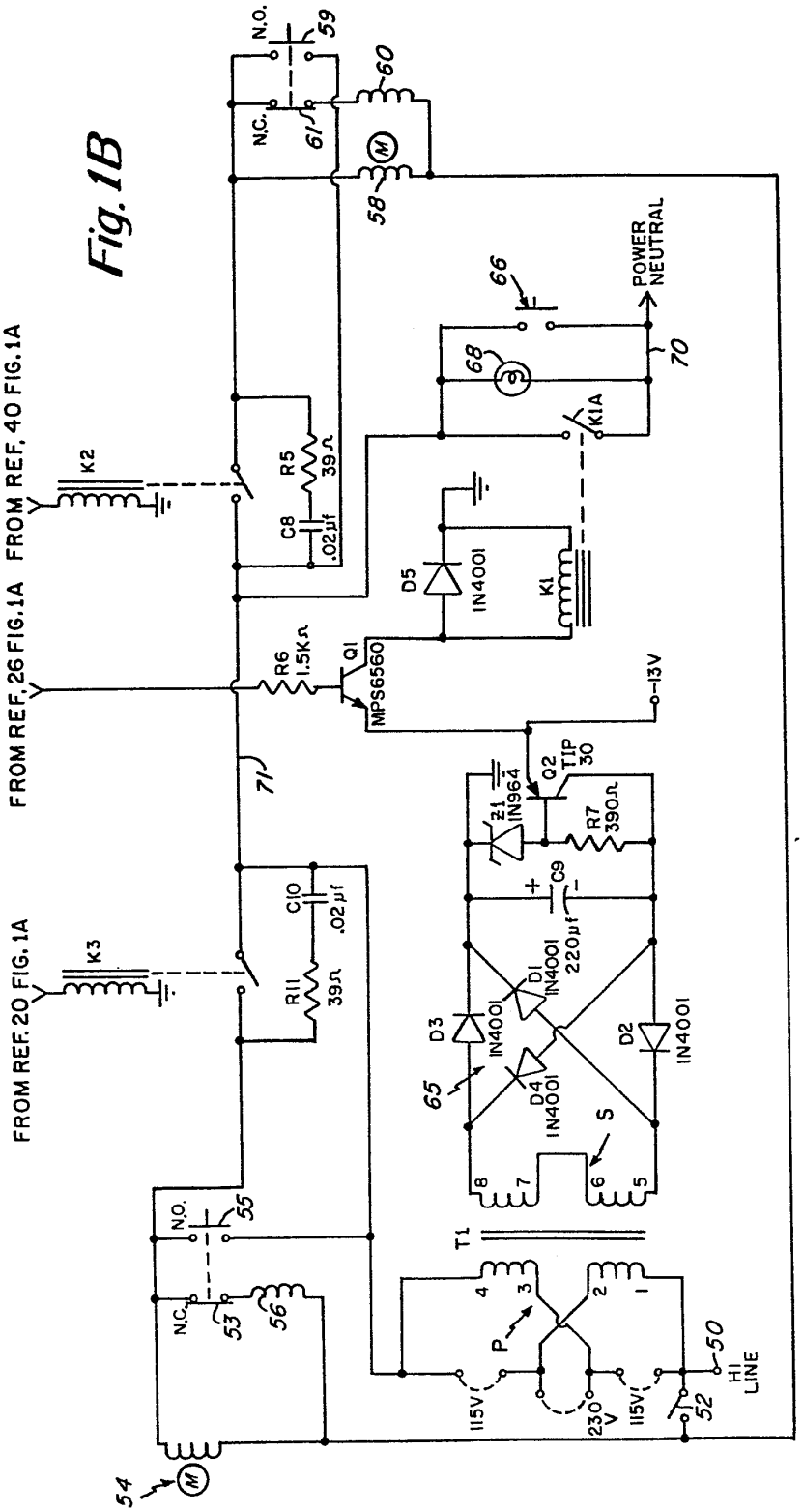

FROM REF. 40 FIG. 1A
FROM REF. 26 FIG. 1A
FROM REF. 20 FIG. 1A
K2
K3
R5 39Ω
C8 .02μf
R6 1.5KΩ
Q1 MPS6560
D5 IN4001
K1
K1A
POWER NEUTRAL
70
66
68
-13V
Z1 IN964
Q2 TIP 30
R7 390Ω
C9 220μf
C10 .02μf
R11 39Ω
D1 IN4001
D2 IN4001
D3 IN4001
D4 IN4001
65
S
T1
N.O.
N.C.
59
60
61
58
55
53
56
54
50
52
HI LINE
115V
230 V
P
71

Fig. 2

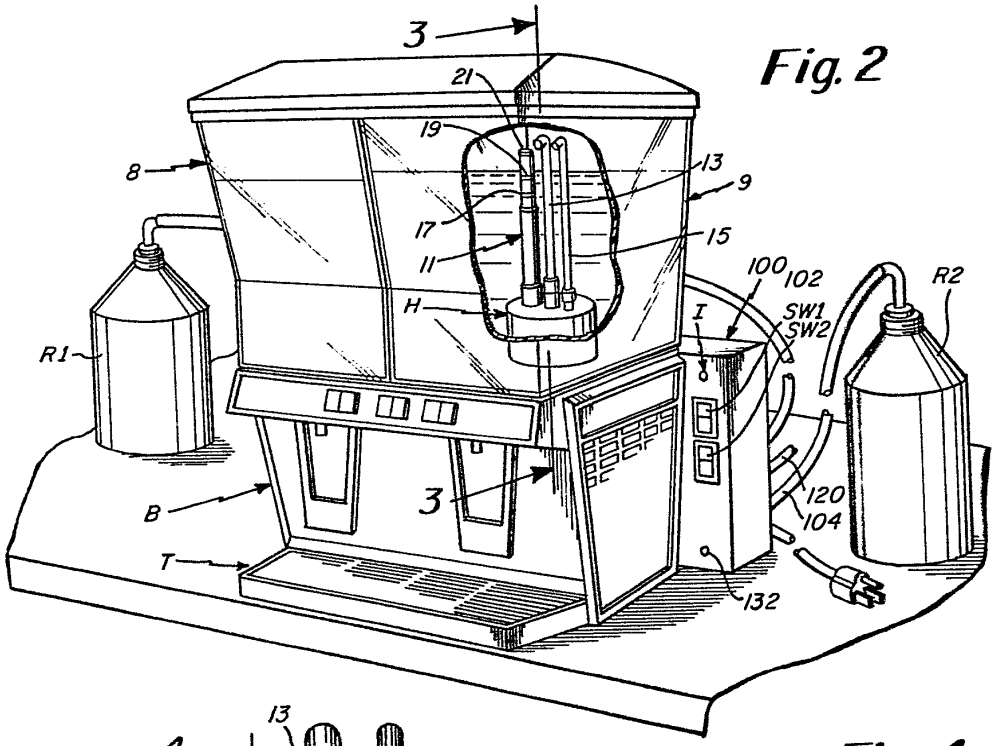


Fig. 3

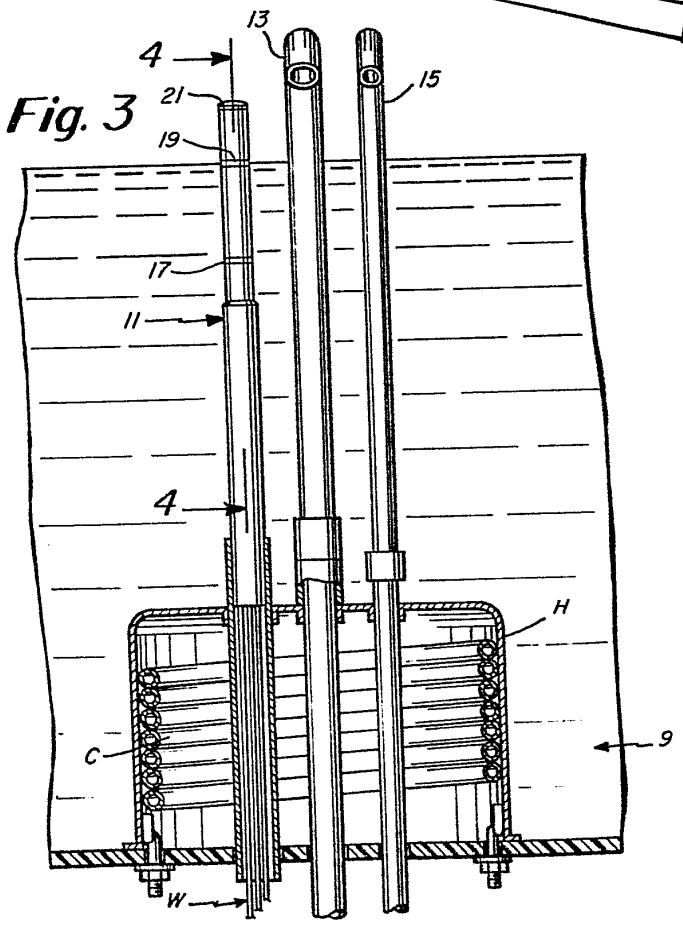


Fig. 4

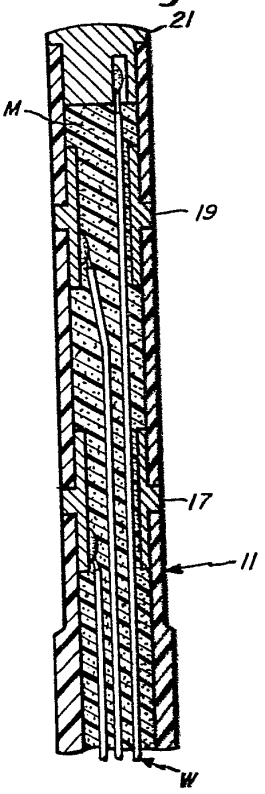
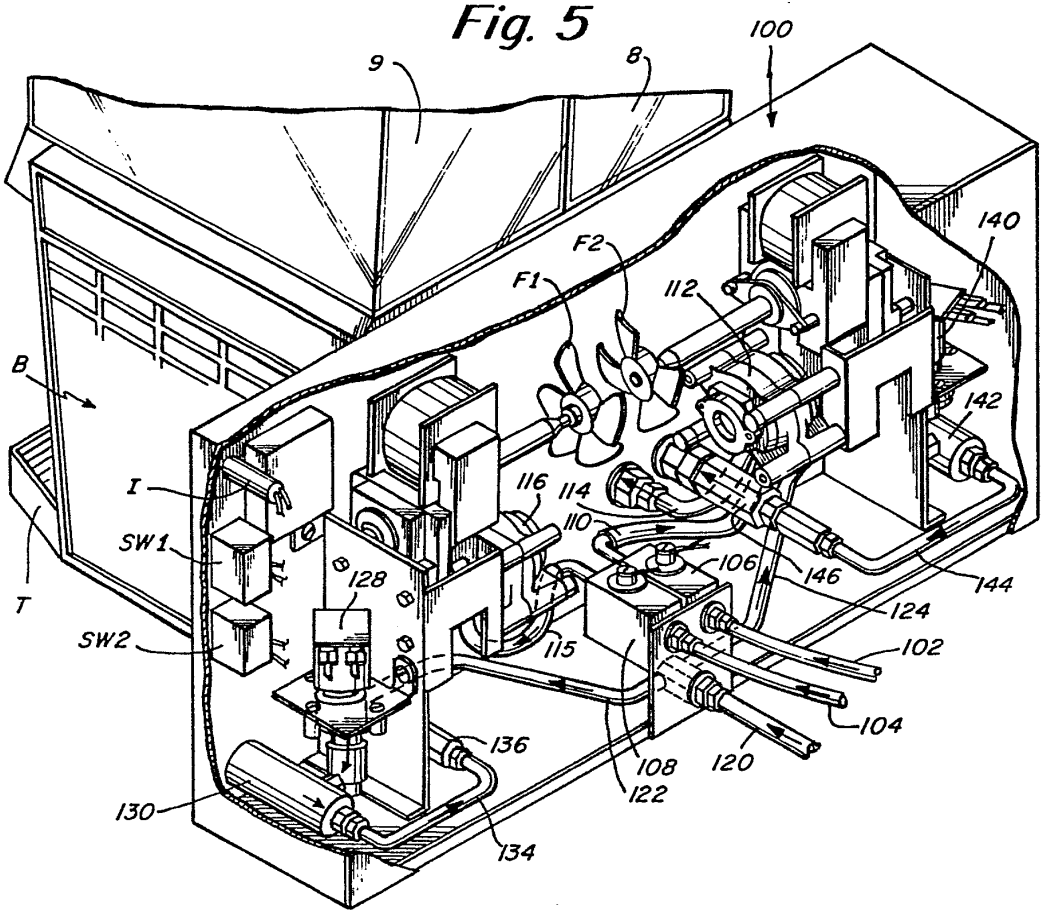


Fig. 5


100
9
8
140
F2
F1
112
B
142
I
116
114
110
SW1
106
146
144
128
124
T
SW2
115
102
104
136
108
120
122
130
134

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(54) A fuel dispenser system.

(57) A fuel dispensing system includes a manifold (38) for receiving one or more grades of fuel at individual input ports and a plurality of output ports. The output ports are each connected to individual input ports of selection valves (13, 17 and 21), the latter having output ports connected to inlets of nozzles and hose assemblies (23, 25, 27 and 41). A controller (29) is included that is site programmable for designating a particular hose/nozzle assembly for dispensing a particular straight grade or blend of fuel. The controller (29) is responsive to the selection of a given nozzle (41) by a user for energising and controlling one or more flow control valves (5, 7), and the selection valve (13, 17 or 21) associated with the selected nozzle, for delivering the required grade or grades of fuel to the manifold (33) for dispensing the grade of fuel associated with the selected nozzle, in a desired amount under closed loop control.

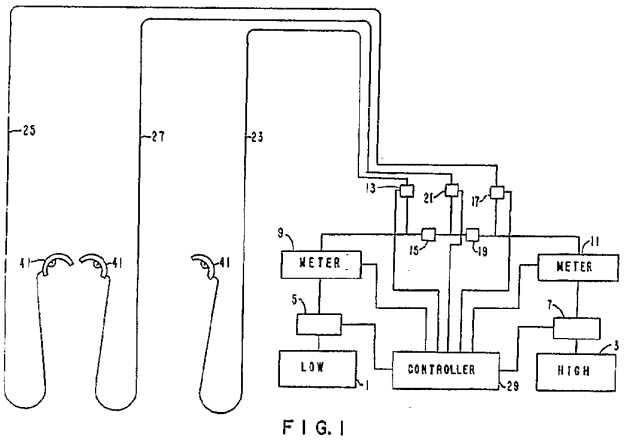


FIG. 1

EP 0 433 041 A2

A FUEL DISPENSER SYSTEM

This invention relates generally to dispensing systems for delivering at least a high octane fuel, a low octane fuel, and a fixed blend of the two to a user.

Certain petrol stations include fuel dispensers for dispensing at least three grades or octane levels of fuel, one of which may be a blend. Typically, a blending dispenser includes alternative dispensing of a high octane fuel, a low octane fuel, and a blend of the two. The blended fuel is a fixed blend predetermined at the fuel site where the fuel dispenser is located. Such dispensers usually include orifice flow technology, that is orifices of fixed size to control the blend ratio of the typically high and low octane fuels for obtaining the intermediate grade or octane fuel. If it is desired to change the intermediate fuel blend ratio at the site, the changing of orifices is time consuming, and awkward. To overcome this problem, recent fuel dispensing systems have been developed to use proportional flow valves with electronic feedback control in place of the orifices. In such a fuel dispenser, the controller is programmed at the site in order to provide the desired fixed blend of the high and low octane fuels at the fuel dispenser island. In such full three grade multiple product fixed blend fuel dispensers, a total of four flow meters would be typically required for each bank of three hoses, with one fuelmeter being required for tracking the volume of fuel dispensed for each one of the low and high octane fuels, and two flow meters being required in the blending operation for the intermediate grade fuel.

One known system for providing dispensing of high and low octane fuels, and a third fixed blended fuel, is the Gilbarco "MPD Fixed Blender" product line (manufactured by Gilbarco Inc., Greensboro, N.C.) This system uses orifice flow technology, and meters the blended fuel.

Another known system for providing a site selectable blended fuel of high and low octane fuels, in combination with dispensing of each of the latter two, is the "Wayne Series 590 Fixed-Ratio Blending Dispenser" (manufactured by Wayne Pump Division of Dresser Industries, Inc., Salisbury, Md.). This system includes stepper motor operated valves for adjusting the flow rates of the fuels being dispensed, and also for adjusting the blend ratio between the high and low fuels for blending the two to provide an intermediate grade fuel.

Many other fuel dispensing apparatus for blending two or more fuels are known in the field of the present invention. One example is Krone et al. US 3,847,302 which teaches the control of a plurality of solenoid operated valves for dispensing a desired blend or grade of fuel. Preset valve openings are used in Krone in order to provide a predetermined intermediate blend. The valves are preset via the use of needle control secondary valves within one solenoid valve of each one of two pairs of solenoid valves included in a digital valving arrangement. A related system is disclosed in Krone et al. US 3,895,738.

Kierbow et al. US 4,265,266 discloses a system for blending at least two products together. The system includes proportional flow control valves, and closed loop control for at least one of two products being blended. Microprocessor control is utilized for setting the openings of the proportional flow control valves to in turn control hydraulic motors, for controlling pumps in the pumping of liquids being blended together with dry materials, in the example given.

Vetter et at. US 4,440,314 discloses a method and apparatus for blending at least one liquid component, such as a hardener, with a primary lacquer. Closed loop control of the liquids being blended is maintained for controlling the flow rate of one of the liquids to insure maintenance of the desired blend. The speed of pumps pumping the liquids is controlled via feedback from tachometers associated with the pump for providing signals indicating the flow rate of liquid being pumped at any given time.

Shannon US 4,252,253 teaches a drink dispensing apparatus that includes a microprocessor for controlling the pressurisation and actuation of pumps to dispense a desired blend of products for obtaining a particular beverage.

Goodwin et al. US 4,083,473 discloses a liquid blending system for providing three grades of fuel, gasoline in the example given, high and low octane grades of fuel are provided, along with a fixed blend portion of the two. A blend control valve 9 is operated via a first solenoid to one extreme position for dispensing the high grade of fuel, by another solenoid to an opposite extreme position for dispensing a low grade of fuel, and is also operated by an electromagnetic clutch for rotating the mechanical control valve to a predetermined intermediate position for dispensing an intermediate grade of fuel having a fixed blend ratio. A closed loop control system monitors flow meters associated with the high and low octane fuel for maintaining the desired intermediate blend of the two.

Lombard US 4,043,300 teaches an apparatus and associated control electronics for comparing the flow rates of air and fuel being delivered to an engine, for controlling a valve setting the flow rate

FAS 2004 - Page 115

of either the air or the fuel, in order to maintain a desired ratio of air to fuel in mixing the two.

Gulbrandsen US 3,717,283 discloses a fuel blending apparatus including a low octane fuel dispenser for dispensing low octane fuel from a storage tank, a premium or high octane fuel dispenser for dispensing high octane fuel from a second storage tank, and an intermediate grade fuel dispenser for dispensing an intermediate grade of fuel that is a blend of the premium and low octane fuels. Two solenoid operated valves are included for permitting high octane fuel to be delivered to a mixing point for mixing with low octane fuel for delivery to the intermediate fuel dispenser whenever such a grade of fuel is selected by a user. The low octane fuel is independently delivered to the low octane dispenser from the storage tank for such fuel. The solenoid operated valves are selectively energised for either permitting only high octane fuel to be delivered to the high octane dispenser, or for permitting high octane fuel to be delivered to a mixing point for mixing with low octane fuel being pumped through to the intermediate dispenser, for providing the intermediate grade of fuel at a given time.

Ernyei US 3,410,293 discloses a system for delivering first and second products to a tank 3, for providing a blend of the products when they are mixed within the tank. Digital flow meters are connected in series with each product supply line to monitor the volume of the associated product being delivered to the tank. A control circuit monitors the output from the respective flow meters for controlling a control valve 14 connected in series with one of the product lines for adjusting the flow rate of that product for maintaining the desired blend of the two products within the tank.

Gross US 3,229,077 teaches a similar system to Ernyei US 3,410,293, for monitoring the flow rate of two fluids, and adjusting the flow rates of one of the fluids via control of a servo valve in series with the product line for the one fluid, for maintaining a desired blend of the two fluids.

This invention seeks to provide an improved multiple product blending system in a fuel dispenser.

According to the present invention there is provided a fuel dispensing system comprising:

a plurality of fuel flow control means each capable of supplying a known or determinable quantity of a particular grade of fuel;

connection means including a plurality of inlets each receiving a respective different grade of fuel from a respective fuel flow control means, and a plurality of outlets, at least one of which is capable of providing a blend of fuel received from at least two fuel flow control means; and

a plurality of selection valves each for controlling the flow of fuel from a respective outlet of the connection means.

By employing the present invention it is possible to reduce the number of flow meters required in a multi-product dispenser for dispensing at least two fuels, each at a given grade, and a third fuel that is a blend of the two.

Various embodiment of the invention will now be described by way of example only with reference to the drawings, in which like items are indicated by the same reference number, wherein:

Fig. 1 is a block diagram showing one embodiment of the invention.

Fig 2 is a hydraulic/schematic diagram showing in greater detail the embodiment of Fig. 1 applied for use in a fixed blending dispenser with three dispensing hoses on each side of the dispenser for dispensing three different octane levels of fuel per side, respectively.

Fig. 3 is a block diagram showing pump operating switch locations for the typical fuel dispenser of Fig. 2.

Fig. 4 is a block schematic diagram of the pump operating switch circuit of an embodiment of the invention.

Fig. 5 is a block diagram of yet another embodiment of the invention.

Fig. 6 shows a hydraulic/schematic diagram of the embodiment of Fig. 5 applied for use as a site programmable fixed blender having pump handles configured substantially as shown in the embodiment of Fig. 3.

Fig. 7 is an isometric view looking down from the right of a manifold embodiment of the invention for use in the embodiment of Figs. 5 and 6.

Fig. 8 is an isometric view of the manifold of Fig. 7 with the manifold turned 180° and rotated 90° clockwise relative to Fig. 7.

Referring to Figure 1, a fuel dispenser includes a source of low octane fuel 1, and a source of high octane fuel 3 for delivery under pressure via associated fuel pumps (not shown) to proportional flow control valves 5 and 7, respectively. Flow meters 9 and 11 are connected in series with the proportional valves 5 and 7, respectively. The output port of flow meter 9 is connected in common to the input ports of a selection solenoid valve 13, and a non-return valve 15. Similarly, an output port of flow meter 11 is connected in common to an input port of a selection valve 17, and an input port of a non-return valve 19. Output ports of the non-return valves 15 and 19 are connected in common to an input port of a third selection valve 21. The output ports of the selection valves 13, 17 and 21, are connected to one end of a low octane fuel delivery line 23, a high octane fuel delivery line 25, and a blended or intermediate octane fuel delivery line 27, respectively. The other ends of the fuel deliver

FAS 2004 - Page 116

lines 23, 25, and 27, are each connected to a dispensing nozzle 41, respectively, as shown.

In this example, the selection valves 13, 17 and 21 are solenoid flow control valves, which in an engineering prototype were provided by ASCO 222-763 valves, manufactured by Automatic Switch Company, Florham Park, New Jersey. The proportional flow control valves 5, and 7, and the flow meters 9 and 11, are in this example the same as taught in McSpadden et al. US 4,876,653, issued October 24, 1989. In addition, controller 29 is substantially the same as the controller of US 4,876,653, but the controller 29 of the subject invention is programmed to provide the operation and functions to be illustrated below. All of the teaching of US 4,876,653 are incorporated herein by reference, which teachings include monitoring of flow meters 9 and 11, for controlling proportional valves 5 and 7, for maintaining a particular blend of the low octane fuel 1 and high octane fuel 3.

Operation of the embodiment of Fig. 1 will now be described. A user first must select the particular octane level of fuel desired by lifting the appropriate nozzle 41 from a boot 440 (see Fig. 4), and activating a switch 443 to be closed, either manually or automatically, for signalling controller 29 that one of the three octane levels of fuel is to be dispensed. Note that the "pump operating switch" configuration will be described in greater detail below with reference to Fig. 4. If a low octane fuel is selected, controller 29 responds by turning on selection valve 13, and controlling the operating of proportional valve 5 via monitoring of the output signals from flow meter 9, for delivering a desired quantity of low octane fuel via hose or fuel line 23 and the associated nozzle 41. Once a particular octane level of fuel is selected by removal of a nozzle 41 from an associated boot 440, the ones of the selection valves 13, 17, 21, and proportional valves 5, and 7 not associated with the fuel to be delivered are maintained in an inactive state, even if one of the other nozzles 41 happen to be removed from an associated boot 440 during delivery of another octane level of fuel during a particular dispensing cycle.

In a similar manner to dispensing low octane fuel 1, if at the initiation of a given dispensing cycle the nozzle 41 associated with the high octane fuel 3 is removed from its boot 440, controller 29 responds by turning on proportional flow valve 7 and selection valve 17, for delivering a desired quantity of high octane fuel 3 via monitoring of output signals from flow meter 11.

If an intermediate octane level or grade of fuel is desired, a nozzle 41 associated with the blended fuel line 27 is removed from its boot 440. Controller 29 responds by turning on the two proportional flow control valves 5 and 7, and selection valve 21. Low octane fuel 1 flow through non-return valve 15 to the input port of selection valve 21, and high octane fuel 3 flows through non-return valve 19 to the selection valve 21. The low and high octane fuels 1, 3, respectively, are mixed in flowing from non-return valves 15 and 19, and through selection valve 21, for delivery from blended fuel line or hose 27 via the associated nozzle 41. The controller 29 is programmed for operating the proportional flow valves 5 and 7 to maintain a predetermined blend of the low octane fuel 1 and high octane fuel 3, for providing a particular intermediate grade or octane level of fuel, as described.

In Fig. 2, the embodiment of the invention of Fig. 1 is shown duplicated in a hydraulic diagram for delivering one of three octane levels of fuel at any given time at either side of a fuel dispenser 30, as shown in Fig. 3. As shown, the fuel dispenser 30 has an "A" side, and a "B" side. On the "A" side three pump operating switches (see Fig. 4) are referenced as "A1" and "B1" for low-octane fuel, "A2" and "B2" for a blended or intermediate grade of fuel, and "A3" and "B3" for a high-octane fuel. Note that fuel filters 31 are shown connected in series between the low octane fuel supply 1 and the proportional flow meters 5A1 and 5B1 respectively, and between the high octane fuel supply 3 and the proportional flow valves 7A3 and 7B3.

Operation of the dispenser configuration of Fig. 2 is substantially the same for each side of the dispenser 30 (see Fig. 3) as that of Fig. 1. Selection valves 13A1 and 13B1 are associated with the delivery of low octane fuel, 17A3 and 17B3 with the delivery of high octane fuel, and 21A2 and 21B2 with the delivery of a blend of the low octane fuel 1 and high octane fuel 3. Note also that the particular blend of the low octane fuel 1 and high octane fuel 3 for delivery of an intermediate grade of fuel via dispensing or fuel line 27 is in this example site programmable. In other words, controller 29 is capable of being programmed at the site of the fueling station for delivering a predetermined blend of fuel to a user.

In operation of the dispenser of Fig. 2, controller 29 is programmed for responding to appropriate boot signals to turn on valves 5A1 and 13A1 for delivering low octane fuel via fuel line 23A1; turning on valves 5B1 and 13B1 for delivering low octane fuel via fuel line 23B1; turning on valves 7A3 and 17A3 for delivering high octane fuel via fuel line 25A3; turning on valves 7B3 and 17B3 for delivering high octane fuel via fuel line 25B3; turning on valves 5B1, 21B2, and 7B3, for delivering a blended fuel via fuel line 27B2; and valves 5A1, 7A3, and 21A2 for delivering a blended fuel via fuel line 27A2. The controller 29 can be programmed at the site for responding to signals from meters 9A1, 9B1, 11A3 and 11B3, for operating the proportional

FAS 2004 - Page 117

valves 4A1, 5B1, 7A3 and 7B3 to deliver a desired quantity of high, low, or blended or intermediate octane fuel from the associated nozzle 41 at either side "A" or "B" of the dispenser 30, in this example.

With reference to Figs. 3 and 4, the pump operating switches "A1" through "A3", and "B1" through "B3", are identically configured pump operating switches 400 as shown in Fig. 4. The reference designations shown in Fig. 4 are identical to the reference designations used in McSpadden et al. US 4,876,653 for the same elements. Each pump switch configuration 400 includes a nozzle boot 440 with a pump handle element 442 that includes an SPST (single-pole-single-throw) switch 443 operated by an associated pump handle lever 42. When the nozzle 41 is inserted into its associated boot 440, the pump handle 442 is moved counter-clockwise, in turn causing the SPST switch 443 to open, for signalling the end of a transaction via a signal line 444. When a new transaction is to be initiated, the associated nozzle 41 for delivering a desired octane level of fuel, is removed from its boot 440. The pump handle 442 must be manually rotated in the direction of arrow 446 (clockwise in this example), for closing the SPST switch 443 for applying a +12.0VDC signal (+V_s in this example) along signal line 444. The signal is connected via signal line 444 to a level shifter network 402, and therefrom to controller 29.

More specifically, the level shifter network 402 includes an isolation resistor 446 with one end connected to signal line 444, and its other end connect in common to grounding resistor 448 and an input terminal of a CMOS buffer level shifter 450. In this example, +V volts is connected to the level shifter 450, for changing the voltage level of the +12VDC signal to the logic level of +5VDC, in this example. As shown in Fig. 4, in association with pump handle A1, a signal line 452 is connected from the output of the level shifter 402 (output of level shifter 450) to the controller 29. When controller 29 receives this signal, indicating the initiation of a dispensing operation, controller 29 responds by turning on selection valve 13A1 and proportional valve 5A1, for delivering low octane fuel via fuel line 23A, as shown in the embodiment of Fig. 2. Otherwise the operation of the dispensing cycle is substantially the same as that of McSpadden et al. US 4,867,653. As shown in Fig. 4, each pump handle or pump handle station A1 through A3, and B1 through B3 operate in substantially the same manner as that for pump handle A1. The associated initiation of operation signals are provided over signal lines 452-457, for pump handles A1-A3, and B1 through B3, respectively.

In the embodiment of the invention of Fig. 1, the associated fuel dispenser is fixed at the factory relative to the positioning of the low, high, and intermediate grades or octane levels of fuel associated with fuel lines or fuel hoses 23, 25, and 27 respectively. One site programming of controller 29 can only be made of changing the blend ratio of the low octane fuel 1 and high octane fuel 3 delivered via fuel hose 27. As will be described, in an alternative embodiment of the invention, controller 29 is site programmable for selectively designating which ones of the fuel lines or fuel hoses 23, 25 and 27 are to be used for dispensing low, high, or intermediate octane levels or grades of fuel, in addition to providing for programming of the octane level for the intermediate grade of fuel via adjustment of the blend ratio between the low and high octane fuels 1, 3, respectively.

In the alternative embodiment of the invention of Fig. 5, the basic configuration is substantially the same as that of Fig. 1, but with the addition of the manifold 33. Note that up to a practical limit, the manifold 33 can be provided to have more than three output ports for delivering fuel to more than three selection valves 13, 17, and 21, up to a higher number of selection valves S_n, as shown. However, for purposes of illustration, the alternative embodiment will be described for a manifold having three output ports for connection to the selection valves 13, 17, and 21, respectively. Also, the number of series connected non-return valves, flow meters, flow control valves, and sources of different grades of fuel can be extended within practical limits to Cn, Mn, Vn and Fn, respectively. The number of input ports of manifold 33 would also be extended to some number n, when "n" is an integer number.

In the alternative embodiment, the non-return valves 15 and 19 receive at their input ports low octane fuel 1 and high octane fuel 3, respectively. The output ports of non-return valve 15 and 19 are connected to input ports of manifold 33. As will be described in greater detail below, the manifold included in the preferred embodiment of the invention is of a relatively compact minimum volume design, for reducing the contamination of one grade of fuel delivered at the initiation of the dispensing cycle from fuel remaining of another octane level within the manifold from a last completed dispensing cycle. Controller 29 is site programmable for selecting the one of the selection valves 13, 17, and 21 to be turned on with proportional valve 5 for delivering low octane fuel into the associated fuel line or hose 23, 25, 27, respectively. Similarly, controller 29 is site programmable for selecting which one of the selection valves 13, 17, and 21 is to be turned on in combination with proportional valve 7 for delivering high octane fuel to the associated one of the fuel hoses 23, 25, 27,

FAS 2004 - Page 118

respectively. Lastly, controller 29 is site programmable for selecting which one of the selection valves 13, 17, and 21 is to be turned on in combination with each one of the proportional valves 5 and 7 for delivering a programmed blend of the low and high octane fuels 1, 3 to an associated one of the fuel hoses 23, 25, and 27, respectively. In this manner, a fueling station is given the flexibility of programming controller 29 to select which ones of the fuel hoses 23, 25, and 27 are to be associated with either a low octane fuel 1, high octane fuel 3, or a particular blend of the two for offering an intermediate grade of fuel.

The alternative embodiment of the invention of Fig. 5 can be duplicated as shown in Fig. 6 for providing the functions thereof in a dispenser 30, as shown in Fig. 3. As shown, non-return valves 35 through 38 are included for preventing fuel delivering to the manifolds 40 and 42 (each being substantially identical to manifold 33) from returning fuel from the manifolds 40, 42 back to associated feed lines 44 through 47, respectively. In comparing the alternative embodiment of Fig. 6 to that of Fig. 2, the alternative embodiment includes the addition of two manifolds 40 and 42, and a different arrangement for the associated non-return valves 35 through 38. As shown, in the illustrated example, low octane fuel is delivered via a feed line 44, through non-return valve 35, to one input port of manifold 40, and high octane fuel is delivered via feedline 45, through non-return valve 36 to another input port of manifold 40. The output ports of manifold 40 are connected to input ports of selection valves 13A1, 21A2, and 17A3, respectively. Similarly, low octane fuel is delivered via feedline 46, through non-return valve 37 to one input port of manifold 42, and high octane fuel is delivered via feedline 47 through non-return valve 38 to the other input port of manifold 42. The output ports of manifold 42 are connected to input ports of selection valves 17B3, 21B2, and 13B1. Controller 29 is site programmable for selecting (1) which individual one of selection valves 13A1, 21A2, and 17A3 are to be individually turned on at the same time as proportional valves 5A1, for delivering low octane fuel to an associated one of the dispensing hoses 23A1, 27A2, and 25A3; (2) which other one of the selection valves 13A1, 21A2, and 17A3 are to be turned on in combination with proportional valve 7A3 for delivering high octane fuel; and (3) which remaining one of the three valves 13A1, 21A2 and 17A3 is to be turned on in combination with proportional valves 5A1 and 7A3, for delivering an intermediate grade of fuel provided by a mixture of the low and high octane fuels 1, and 3 that are initially mixed in manifold 40 for delivering to a user. Similarly, controller 29 is programmed for selecting the one of selection valves 17B3, 21B2, and 13B1, associated with manifold 42, are to be turned on in combination with proportional valve 5B1 for delivering low octane fuel; which one is to be turned on in combination with proportional valve 7B3 for delivering high octane fuel; and which one is to be turned on in combination with proportional valve 7B3 for delivering high octane fuel; and which one is to be turned on in combination with proportional valves 5B1 and 7B3 for delivering or dispensing an intermediate grade of fuel to an associated one of fuel lines or hoses 25B3, 27B2, and 23B1. Accordingly, the alternative embodiment provides a site manager with greater flexibility in programming controller 29 to dispense fuel of a particular octane level through a particular one of the dispensing hoses located on either side of a fuel dispenser 30, as previously described for the example given. Also as previously indicated, the manifolds 40 and 42, for providing a greater number of intermediate blends of fuel between the high and low octane grades, as would be apparent to one of ordinary skill in the art.

As previously indicated, in the preferred embodiment of the invention, the manifold 33 is designed to be as compact and of minimal volume as possible. Figs. 7 and 8 illustrate such a manifold 33 used in an engineering prototype for the alternative embodiment. In the pictorials shown for the manifold 33, for purposed of illustration, assume that port 49 is an input of port for low octane fuel, port 51 is an input port for high octane fuel, and that ports 53, 55, 57 are output ports. For purposes of simplicity, mounting holes and/or mounting studs are not shown. Note that the design of the manifold 33 is made compact with a centrally located distribution chamber 59 providing very short flow passageways between any given two of the various ports. In this manner, contamination of a fuel dispensed in one cycle from fuel remaining in the just previous dispensing cycle is substantially reduced. The manifold 33 as applied for use in an engineering prototype was approximately 14cm long and 6.25cm square at each end, with the flanges associated at each port being about 5.5cm square.

Many other advantages and variations of the present embodiments in the invention may be apparent to those of skill in the art, wherein such variations or alternative embodiments are meant to be covered by the spirit and scope of the appended claims. Certain of these variations have been mentioned in the above description of the invention. Also, with further reference to Fig. 6, valves 13A1 and 17A3 can be programmed to open with different blend combinations of flow valves 5A1 and 7A3, in a manner similar to that previously described for line 27A2 and valve 21A2.

FAS 2004 - Page 119

Claims

1. A fuel dispensing system comprising:
   a plurality of fuel flow control means each capable of supplying a known or determinable quantity of a particular grade of fuel;
   connection means including a plurality of inlets each receiving a respective different grade of fuel from a respective fuel flow control means, and a plurality of outlets, at least one of which is capable of providing a blend of fuel received from at least two fuel flow control means; and
   a plurality of selection valves each for controlling the flow of fuel from a respective outlet of the connection means.

2. A fuel dispensing system as claimed in Claim 1, comprising a plurality of hoses, each being connected at one end to the output of a respective selection valve, each being connected at its other end to a respective nozzle through which fuel is dispensable and each being associated with a respective different grade or blend of fuel.

3. A fuel dispensing system as claimed in Claim 1 or 2 for dispensing low and high grades of fuel, and a blended combination thereof providing an intermediate grade of fuel, wherein in operation:
   said selection valves are each responsive to an individual selection signal for opening to permit the flow of fuel therethrough;
   a plurality of pump operating switch means (443) associated with individual ones of a plurality of nozzles (41), respectively, generate individual pump handle signals, indicative of the selection of a particular one of said nozzles (41) for dispensing an associated grade or blend of fuel;
   a first and a second fuel flow control means are each responsive during a given dispensing cycle to individual fuel distribution signals for delivering to respective inlet ports of the connection means, either said low grade of fuel, or said high grade respectively, or a desired mixture of the two fuels; and
   a controller means (29) is programmable for responding to said individual pump handle signals, for generating a combination of particular ones of said selection and fuel distribution signals, for delivering a grade of fuel preprogrammed to be associated with the selected one of said nozzles for dispensing said fuel.

4. The fuel dispensing system as claimed in Claim 3, wherein each said fuel flow control means include:
   a flow control valve (5, 7) having an inlet port for receiving a respective grade of fuel, and an outlet port connected to an inlet port of respective selection valves (13, 17, 21), wherein:
   the flow control valve (5) of said first flow control means (the first flow control valve), is responsive to a first fuel distribution signal for opening to permit said low grade of fuel to flow to a first selection valve;
   the flow control valve (7) of said second flow control means, (the second flow control valve), is responsive to a second fuel distribution signal for opening to permit said high grade of fuel to a second selection valve;
   the first and second flow control valves are responsive to a third fuel distribution signal, for permitting respective high and low grades of fuel to flow to a third selection valve (21) for dispensing a blend of the two from an associated one of said plurality of nozzles (41); and
   said controller means (29) is responsive (a) to a low grade pump handle signal for producing first selection and fuel distribution signals for opening said first selection valve and first flow control valve; (b) to a high grade pump handle signal for producing second selection and fuel distribution signals for opening second second selection valve and second flow control valve; and (c) to an intermediate grade pump handle signal for producing third selection and fuel distribution signals for opening said third selection valve, first flow control valve, and second flow control valve.

5. The fuel dispensing system of Claim 4, wherein said first and second flow control valves are each proportional flow control valves, and said first and second fluid flow control means further includes first and second fuel flow meter (9, 11) respectively connected in series with said first and second flow control valves respectively, said flow control means being responsive to flow rate signals from said first and second flow meters, for controlling the operation of said first and second flow control valves in a closed-loop manner.

6. The fuel dispensing system as claimed in any one of Claims 3 to 5, wherein said connection means includes a manifold (33) having a first inlet port for receiving a low grade of fuel, a

FAS 2004 - Page 120

second inlet port for receiving a high grade of fuel, a plurality of outlet ports individually connected to a respective inlet port of said plurality of selection valves (13, 17, 21), and a fuel chamber common to said first and second inlet ports, and said plurality of outlet ports.

7. The fuel dispensing system of Claim 6, further including a first non-return valve (15) between said first inlet port of said manifold and an outlet port of a first fuel control means for said low grade of fuel, and a second non-return valve between said second inlet port of said manifold and an outlet port of a second fuel flow control means for said high grade fuel, said first and second non-return valves preventing the flow of fuel from said manifold back towards said fuel flow supply means.

8. The fuel dispensing system as claimed in any one of Claims 3 to 7, further including:

first, second and third ones of associated pairs of said hoses and nozzles on one side of a housing of said dispensing system;

fourth, fifth and sixth ones of associated pairs of said hoses and nozzles on an opposite side of said housing;

a first connection means having first and second inlet ports for receiving said low and high grades of fuel, respectively, and first, second and third outlet ports connected to individual inlet ports of first, second and third ones of said plurality of selection valves, respectively, for providing the same grade of fuel thereto during a given dispensing cycle;

a second connection means having first and second inlet ports for receiving said low and high grades of fuel, respectively, and first, second and third outlet ports connected to individual inlet ports of fourth, fifth and sixth ones of said plurality of selection valves, for providing the same grade of fuel thereto during a given dispensing cycle; and

said controller means further including site programmable means for selecting the grade of fuel to be dispensed by each one of first through sixth nozzles, respectively.

9. A fuel dispensing system as claimed in any one of Claims 3 to 8 comprising:

site programmable means for designating each one of said hose and nozzle assemblies for dispensing a given grade of fuel, including means for sensing the selected one of said nozzles for producing a selection signal to activate the associated one of said selection valves, and means for delivering the appropriate grade(s) of fuel to a manifold means in the required volume for completing a given dispensing cycle.

10. The fuel dispensing system of Claim 9, wherein said site programmable means further includes microprocessor means responsive to signals from said sensing means, and to flow rate signals, for producing appropriate ones of selection signals, and for operating said flow control means for dispensing a desired amount of the programmed grade of fuel associated with a selected nozzle in a closed loop manner during a given dispensing cycle.

11. The fuel dispensing system of Claim 4 or Claim 8 when dependent on Claim 4, wherein said connecting means includes a first and second non-return valves between the inlet ports of said first and second selection valves, and between the inlet ports of said second and third selection valves respectively, for preventing fuel at the inlet port of said third selection valve from flowing back towards the outlet port of said first and second flow control valves, respectively, said third selection valve being located between said first and second non-return valves.

12. The fuel dispensing system as claimed in any claim dependant on Claim 4, wherein each one of said plurality of fuel flow control valves includes a proportional flow valve.

13. The fuel dispensing system of any one of Claims 3 to 12, wherein said controller means includes a microprocessor for monitoring and controlling the operation of said fuel dispensing system.

14. The fuel dispensing system as claimed in any preceding claim, wherein said plurality of selection valves each include a solenoid actuated valve.

FAS 2004 - Page 121

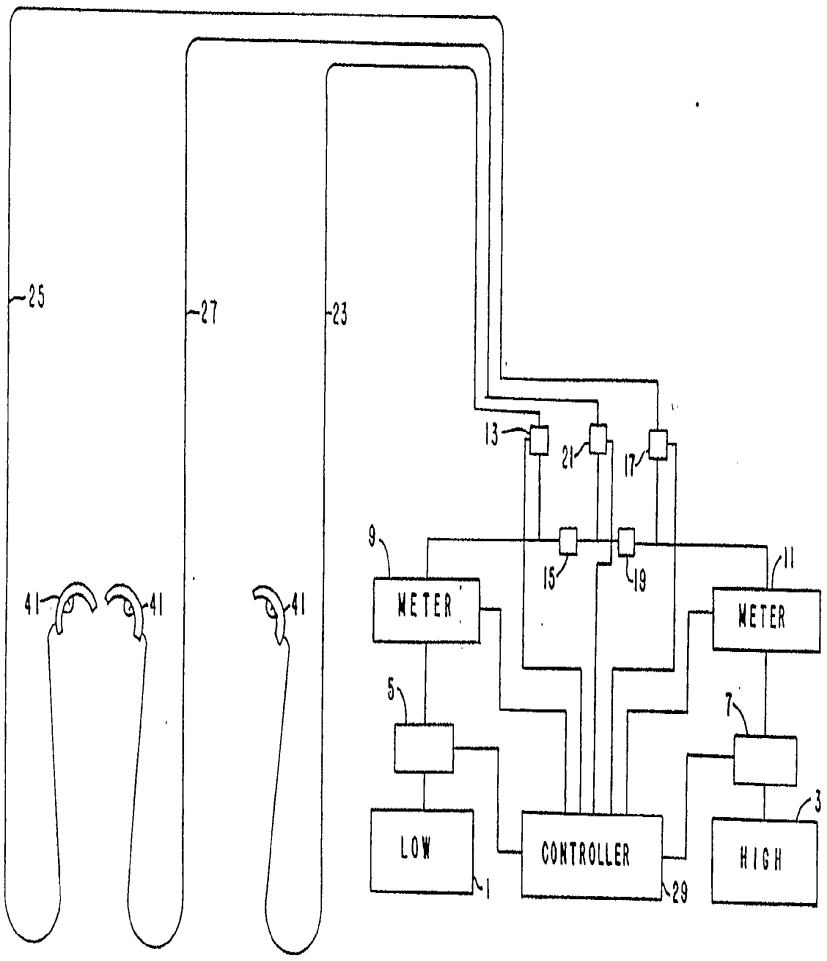

25
27
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13
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41
41
METER
METER
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7
3
LOW
CONTROLLER
HIGH
1
29

FIG. 1

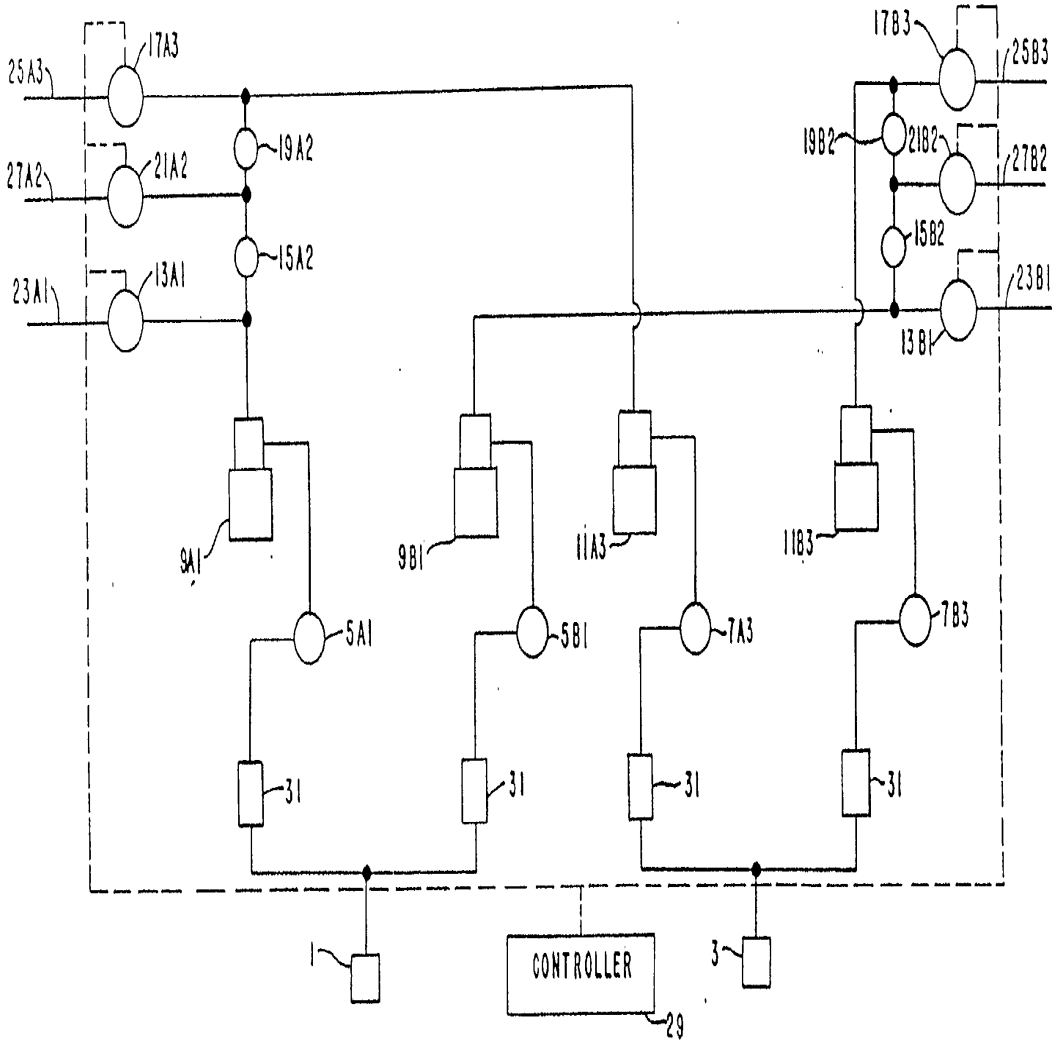


FIG. 2

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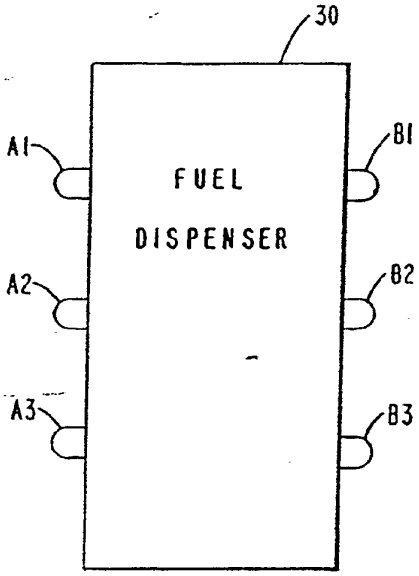


FIG. 3

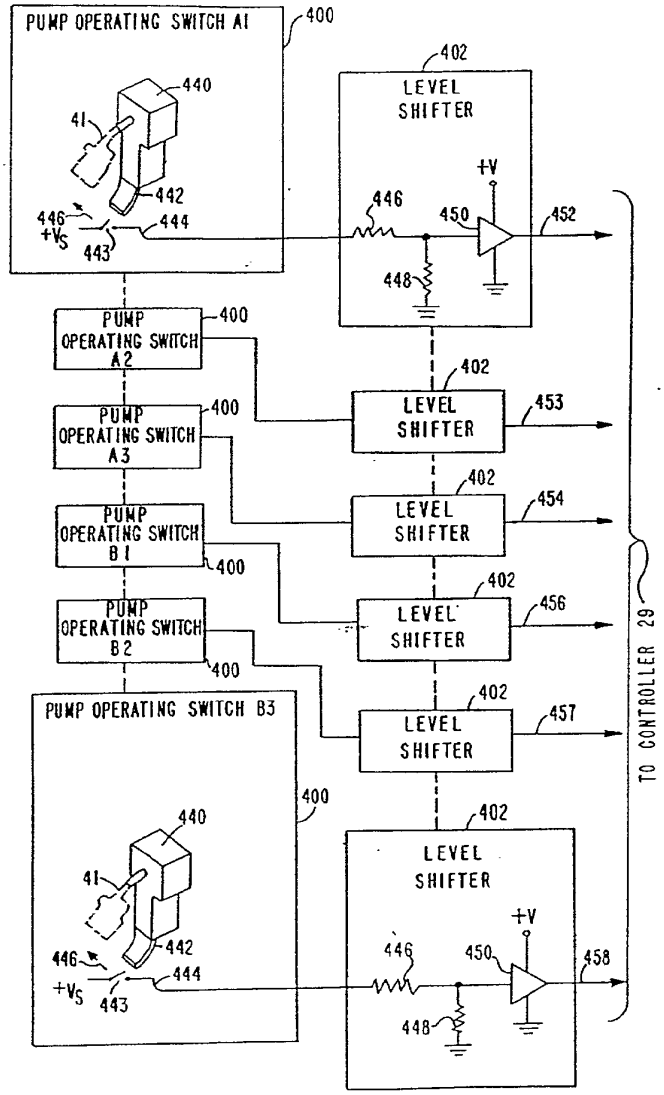

PUMP OPERATING SWITCH A1
400
402
LEVEL SHIFTER
440
41
442
446
+Vs
444
443
+V
446
450
452
448
PUMP OPERATING SWITCH A2
400
402
LEVEL SHIFTER
453
PUMP OPERATING SWITCH A3
400
402
LEVEL SHIFTER
454
PUMP OPERATING SWITCH B1
400
402
LEVEL SHIFTER
456
PUMP OPERATING SWITCH B2
400
402
LEVEL SHIFTER
457
PUMP OPERATING SWITCH B3
400
402
LEVEL SHIFTER
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41
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446
+Vs
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443
+V
446
450
458
448
TO CONTROLLER 29

FIG. 4

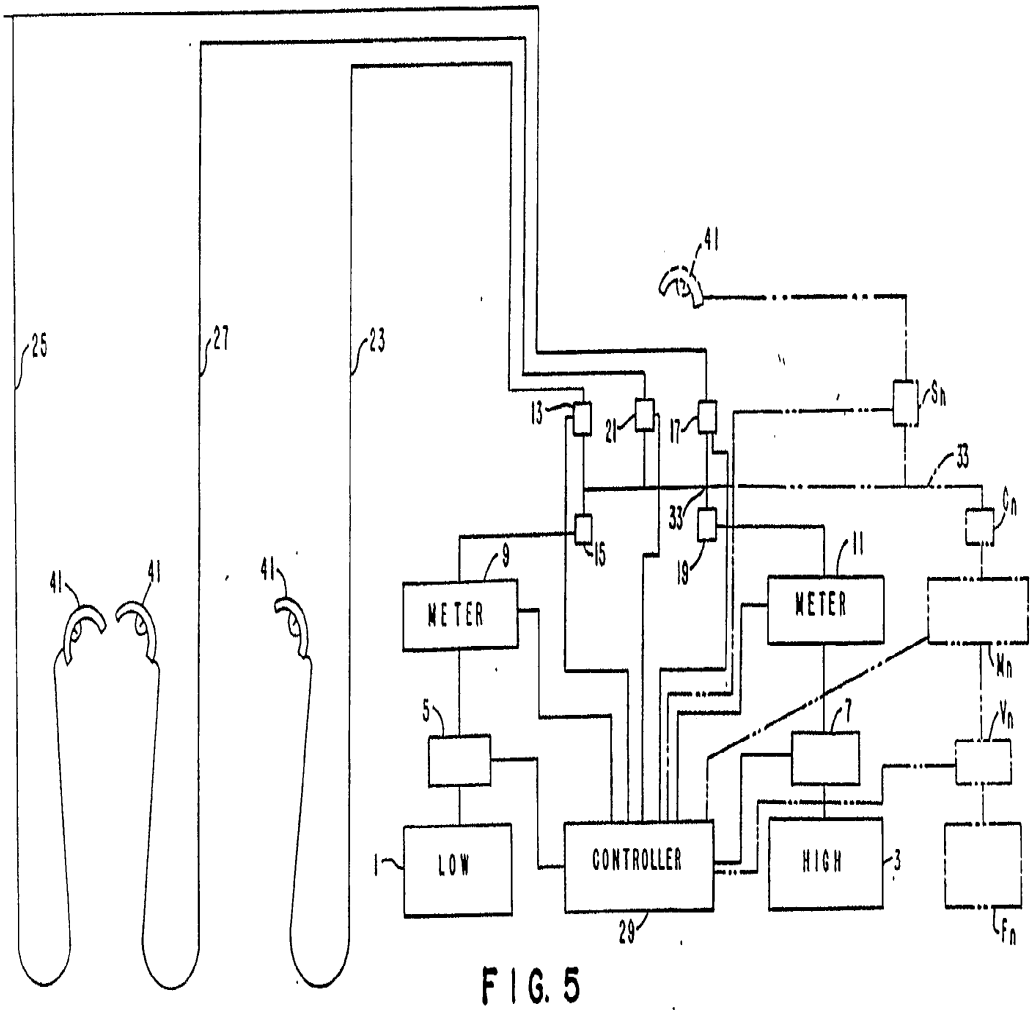

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METER
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Vn
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LOW
CONTROLLER
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29
Fn

FIG. 5

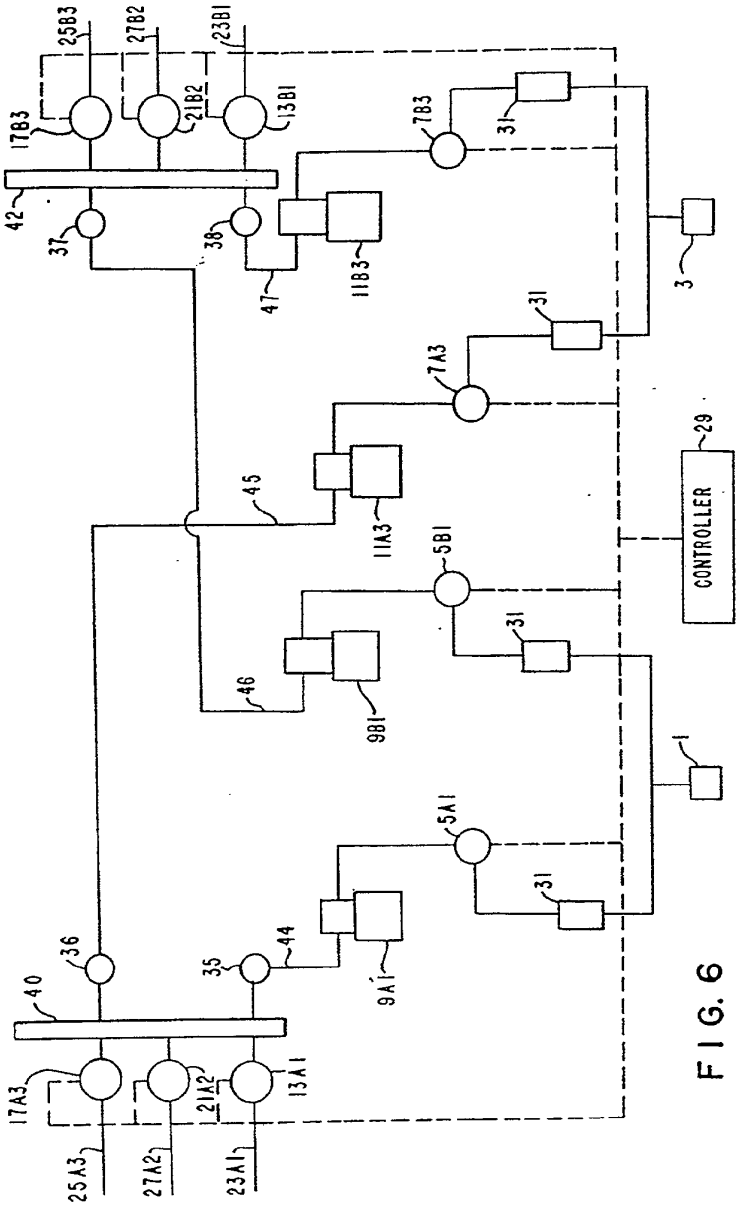


FIG. 6

FAS 2004 - Page 127

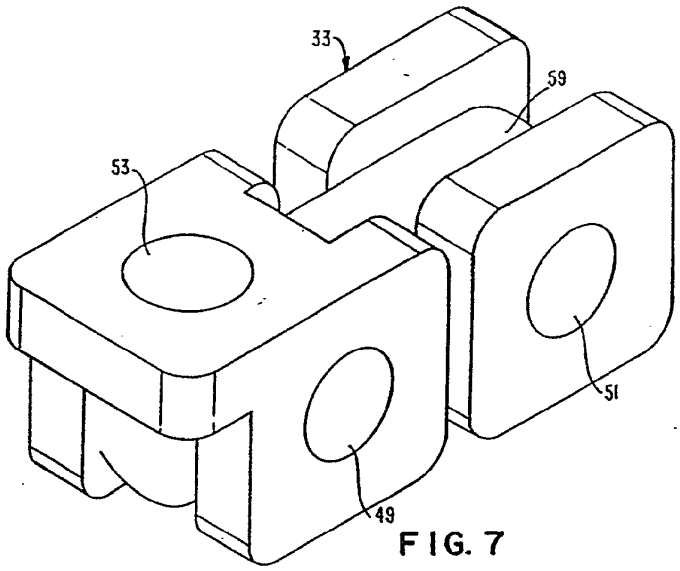


FIG. 7

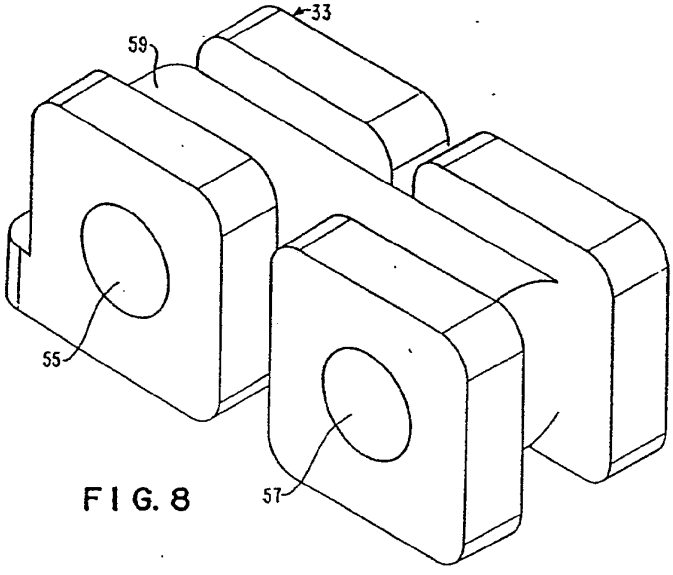


FIG. 8

FEDERAL REPUBLIC OF GERMANY CL. **42 e 23/55**

INTERNAT. CL. **G 05 d**

GERMAN PATENT OFFICE

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W 29141 IXb / 42 e

APPLICATION DATE: DECEMBER 22, 1960

PUBLICATION OF THE APPLICATION AND ISSUANCE OF THE PUBLISHED, EXAMINED APPLICATION: APRIL 18, 1963

Level Regulating Device for Liquids, in Particular Adhesive Liquids and Dye Liquids in Paper Processing Machines and Printing Machines

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Applicant:

Windmüller & Hölscher, Lengerich (Westph.)

Gottfried Espel, Lengerich (Westph.) is named as inventor.

The invention relates to a level regulating device for liquids, in particular adhesive liquids and dye liquids in paper processing machines and printing machines.

It was customary up to the present in such machines to pour the cited liquids either as needed manually into the receiving container or to pump them continuously by a pump in an excess from a storage container into the receiving containers from which excess transported liquid flowed back through an overflow pipe to the storage container.

When managing the liquids manually, the correct liquid level depends on the alertness of the operator, and it is clear that the maintaining of an approximately constant liquid level can practically not be achieved in this manner since that would mean a constant refilling of liquid because the glue rollers and/or dye rollers constantly remove liquid from the container. In particular, it can very readily occur due to a lack of attention that the liquid level reaches too low a value and therefore waste occurs in the machine.

During the pump delivery with return of the excess transported medium by an overflow line the very problematic circumstance becomes noticeable in the case of adhesives that the supplied amount of adhesive to be adjusted by a valve to be adjusted manually in the supply line does not remain constant but rather when the valve becomes clogged the amount becomes less and less. Therefore, this valve must be constantly readjusted so that the secure delivery of the required adhesive level again depends on the attentiveness of the operator, which on the one hand should be avoided by the system and on the other hand can also lead to waste in that the adhesive level drops below the theoretical value.

Another disadvantage in the regulation of the level by an overflow pipe is the dependency on the viscosity of the medium which occurs. The thicker the liquid is, the higher the liquid level builds up on the overflow pipe so that an adjustment of the height of the overflow pipe in the case of liquids with different viscosities is necessary for maintaining a prescribed liquid level.

In the case of very viscous adhesives the problematic circumstance becomes noticeable in the overflow system that the adhesive supplied for maintaining a sufficient adhesive level on the side of the adhesive container that is remote from the inlet position of the adhesive does not flow rapidly enough to the also remote overflow pipe so that an inadmissible accumulation of adhesive results at the inlet side which can result in an overflowing over the container wall.

In order to eliminate these deficiencies of the known method for supplying liquid in the processing of paper the inventor posed himself the problem of creating a liquid level scanner which is used to maintain the liquid level constant in that a signal is given to engage a supply pump or to open a valve located in a supply line when the liquid level drops.

The best-known liquid level scanners operate with floats. However, a float cannot be used with adhesive or dye since these media dry on the float and change its weight so that its display is no longer correct. Furthermore, floats require a relatively large amount of space for their usage.

A scanning with a photocell would, in the first place, be quite expensive and in the second place could not be used on account of the adhering of the adhesive or of the dye to a window, with which the container wall must be provided. A scanning in a capacitive manner requires relatively large surface electrodes and a correspondingly large liquid surface which has an appropriately plane level so that this type of scanning in the first place causes difficulties of space and in the second place can hardly be used in the present instances since the removal rollers shape the liquid level in a very non-uniform manner so that the prerequisites for a capacitive scanning are not given.

It is also already known (British patent 663 297) to place the one pole of a weak current circuit on the adhesive liquid and the other pole on an electrode dipping into an adhesive web forming on the application site.

As soon as the electrode no longer makes contact with any adhesive, the current circuit is interrupted, which is utilized for initiating a secondary current circuit.

It is possible to determine by an electrode dipping into a liquid web being produced on the application site when the adhesive level has dropped so far in the receiving container that no removal of adhesive is taking place and there is already waste. A constant maintaining of the level, which the inventor posed to himself as the problem, cannot be achieved in this manner.

However, an electrode which stands still and is arranged in accordance with the known technology at the height of the theoretical level can only be used with liquids with separate cleanly from the electrode so that the electrode is actually completely freed from the liquid in order to interrupt the current circuit. Liquids which remain hanging while forming threads on the electrode or coat the electrode and dry in it, forming a crust, cannot be scanned in this manner as regards their level. However, this is the case for all the adhesives and the thicker dies.

The inventor has now overcome this hindrance for the using of an electrode which stands still in the case of viscous and adhesive liquids and suggests in accordance with the invention that the electrode be rotated, as a result of which during the dropping of the liquid level the residual liquid adhering to the electrode is cast off so that on the one hand the current circuit is immediately and securely interrupted and on the other hand the electrode is not encrusted, which could

prevent the forming of a contact when the liquid level rises again and furthermore would change the length of the electrode which determines the level.

An immersion electrode with a needle shape proved to be especially advantageous, wherein its rotational speed can lower the adhesion force of the liquid to be scanned and it can also become zero in the case of a liquid which ideally separates off.

The invention is explained in detail in the following using an distributor device shown in the drawings and inside an adhesive supply system with several centrally loaded adhesive removal positions. Specifically,

Fig. 1 shows an entire view of the adhesive supply system equipped according to the invention,

Fig. 2 shows a section along the line A-B in fig. 1 on an enlarged scale,

Fig. 3 shows a view along the arrow C in fig. 1 on an enlarged scale, and

Fig. 4 shown a plan of the electrical circuit for the device according to fig. 1.

The removal of the adhesive from an adhesive pan **1** filled to the required height with adhesive takes place in a known manner by an immersion roller **2** from which the adhesive is removed in the desired form and is transferred onto the material web. The rotating immersion roller **2** brings about a revolution of the adhesive liquid in the adhesive pan **1** whose approximate flow image is illustrated in fig. 2. A wave crest **3** is formed in front of the immersion roller **2** as a consequence of the rotation and a corresponding valley **4** is formed behind it. A backflow **5***a* forms around the front sides of the immersion roller **2**, favoured by the rounding sheets **5** (fig. 3) in the corners of the adhesive pan **1**. The wave crest **3** flattens in this area to a wave comb **6** and the wave valley **4** is filled by the

FAS 2004 - Page 133

backflow 5*a* in this area to a level 7. The placing of the electrode 8 used in the level regulating therefore takes place most advantageously at this location since the slightest fluctuations of the adhesive liquid level between the operating state and the resting state occur there and therefore too great a supplying in the operating state can be avoided, which can possibly lead in the resting state to an overflowing of the pan.

The level regulation takes place by a preferably needle-shaped electrode 8 which is fastened in the shaft 9 of a small electromotor 10, for example of an alternating-current motor. The alternating-current motor 10 is clamped fast in a clamp 11 which is provided on the inside with an insulation and therefore carries the motor in an insulated manner. The clamp 11 is movably arranged in a longitudinal slot 12 of the holder 13 by a wingnut 14. The height of the needle-shaped probe 8 and with it at the same time the adhesive liquid level can be adjusted by loosening the wing nut 14 and moving the clamp 11 in the longitudinal slot 12 of the holder 13. The holder 13 is firmly connected by screws 15 to a side wall 16 of the machine. Support bearings 18, 19 are also fastened to the side wall 16 and to the opposite side wall 17 (fig. 1) by screws 20, 21 on which bearings the adhesive pan 1 is movably arranged and can be clamped fast by clamping levers 22, 23. The immersion roller 2 is rotatably supported by its shaft in flange supports 24, 25 fastened in the side walls 16, 17. The immersion roller 2 is driven by a gear 26 fasted on its shaft and which is connected to a drive via intermediate gears in a manner which is not shown.

If the needle-shaped electrode 8, which is rotating with a speed that is sufficient according to the consistency of the adhesive, comes in contact with the adhesive liquid with the level regulation engaged, then a current circuit is closed which puts a motor 27 (fig. 1) for driving an adhesive pump 28 out of operation by

a relay **50** (fig. 4). The pump **28** interrupts the transport of adhesive, which takes place from a storage container **29** via a suction line **30** into a pressure line **31** which can run directly via the lines **33**, **34**, for example, to the adhesive pan **1**. Since a constant removal of adhesive from the adhesive pan takes place during operation by the immersion roller **2**, the height of the adhesive liquid level soon drops again in the adhesive pan **1** and the current circuit via the needle -shaped electrode **8** and the adhesive liquid is interrupted, as a result of which the motor **27** is reengaged via the relay **50**, the pump **28** is driven and the adhesive is again transported out of the storage container **29 into the adhesive pan 1** until the current circuit is again closed by the needle -shaped electrode **8** and the transportation is again stopped.

Instead of the adhesive pump **27**, in the case of a manual loading a signal system can also be turned on and off by the relay **50** so that the operator is made aware that the adhesive level has dropped below "normal" and that a refilling must take place.

The above-described system can advantageously operate in a single adhesive removal position. However, if several adhesive removal positions are to be centrally supplied by a single pump system, the system can be designed in the following manner - as shown;

The motor **27** is connected to a single current source which is completely separated from the entire system (cf. also fig. 4). If the motor **27** is put in operation by a main switch **32**, it drives the pump **28** in an uninterrupted manner. The transportation of the adhesive takes place again from the storage container **29** via a suction line **30** to the pump **28** and further into the pressure line **31**. The pressure line **31** is connected to a collector line **33** from which individual feed lines **34**, **35**, **36** run to the individual adhesive removal position of which only one is shown.

Moreover, the collector line **33** is connected to an excess pressure valve **37** from which a pipeline **38** runs back to the storage container **29**.

The feed line **34** runs to a manometer **39** which indicates the particular operating pressure in the line, past it to an electromagnetically activatable valve **40** and further to the adhesive pan **1**. The feed line **34** extends with its outlet opening under the lowest edge of the immersion roller **2** so that it always dips into the adhesive liquid in the adhesive pan **1**. A drying of the adhesive remaining in the feed line **34** is therefore excluded.

The level regulation takes place again by the needle-shaped electrode **8** which rotates in accordance with the consistency of the adhesive and is adjusted at a certain height. When the needle-shaped electrode makes contact with the adhesive liquid a current circuit is closed which starts from a rectifier **51** (fig. 4) fed by a secondary winding **41***a* of a transformer **41** whose primary side lies on alternating voltage. This current circuit runs on the one hand via the line **52** to a relay **50** which is further connected via the line **53** to the earthing **44** of the adhesive pan **1**. On the other hand, this current circuit runs via the lines **54**, **55** and via a resistor **56** to the earthing **43** on the electromotor **10**. The relay **50**, the rectifier **51** and the resistor **56** are combined to a structural unit **42** shown in dotted lines in fig. 4 (cf. also fig. 1). The closing of the previously mentioned current circuit induces a switching movement of the relay **50**, wherein its resting contacts **57** open a second current circuit which is formed by a second secondary coil **41***b* of the transformer **41**, the magnetic valve **40**, a switch **58** and a time relay **45** connected to it in parallel as well as by the lines **59** to **66**.

The opening of this second current circuit results in the magnetic valve **40** in a closing of the feed line **34** and in the time relay **45** in the interruption of its excitation.

FAS 2004 - Page 136

The transportation of the adhesive from the collector line **33** into the adhesive pan **1** through the feed line **34** was interrupted by the closing of the magnetic valve **40**. However, since the pump **28** continues to transport in an uninterrupted manner, an excess pressure is created in the collector line **33** and the individual feed lines **34, 35, 36** up to their magnetic valves, when all magnetic valves should be simultaneously closed. In this case the excess pressure valve **37** opens and the adhesive flows through the pipeline **38** back into the storage container **29**.

As a result of the continuous removal of adhesive from the adhesive pan **1** the adhesive liquid level drops again and the current circuit is interrupted via the electrode **8** on the adhesive level, whereupon the relay **50** drops and closes via the resting contacts **57** the current circuit via the magnetic valve **40** with time relay **45** connected in parallel with closed switch **58**, which brings about an opening of the feed line **34** in the magnetic valve **40** and excites the time relay **45**. If the time relay **45** is not cut out via the relay **50** within the adjusted time period, which is dimensioned to be longer than the normal duration of the particular refilling of adhesive, then it closes a third current circuit via its working contact **67**, which circuit is formed by a secondary winding **46***a* of a transformer **46** lying with its primary winding on a source of alternating current and by a signaling device, for example a horn **47**, and by the lines **68** to **70**, and a signal sounds.

This signal indicates that during the adjusted time the adhesive level has not yet reached the prescribed height again and a disturbance of the adhesive supply or another error has occurred.

The drive of the needle-shaped electrode **8** takes place by the motor **10**, wherein the winding of the motor is connected to a secondary winding **48***a* of a transformer **48** whose primary winding is connected to a source of direct current.

The current circuit conducted via the adhesive pan **1** and the adhesive to the electrode **8** is self-secure, that is, it is so weak as a consequence of the intermediately connected resistor **56** that neither a formation of sparks nor a disturbing electrolysis can occur in the liquid. The very weak, "self-secure" current of the first current circuit can be amplified previously even more for actuating the relay **50**, advantageously by an amplifier with a low-performance input which is not shown in fig. **4** for the sake of simplification.

The concerned removal location can be cut off manually from the further supply of adhesive on the switch **58** if this removal position should be stopped, for example, or if no more adhesive is to be supplied for other reasons.

If the inlet of the adhesive takes place remote from the electrode, as shown, then a turning on and off of the supply of adhesive which takes place too rapidly in succession is avoided by the inertia of the adhesive since a certain time elapses until the adhesive level has risen on the electrode. Inversely, the adhesive level on the electrode still rises a little for the same reason after the first contacting, which creates a small storage which prevents a too-rapid reactivation of the supply of adhesive. This damping property can be allowed to occur stronger and weaker as required by selecting the interval of the inlet point of the electrode.

CLAIMS:

1. A level regulating device for liquids, in particular adhesive liquids and dye liquids in paper processing machines and printing machines using an electrode which dips into the liquid and which interrupts the control current circuit if it does not make contact with the liquid, **characterized by** a rotating electrode (**8**) which closes the control current circuit upon contacting the liquid level and when the

FAS 2004 - Page 138

liquid level drops it reopens the current circuit by casting off the residual liquid adhering on the electrode.

2. The level regulating device according to Claim **1**, characterized in that the electrode (**8**) is constructed with a needle-like shape.

3. The level regulating device according to Claim **1** or **2**, characterized in that the electrode (**8**) forms the prolongation of the shaft (**9**) of an electromotor (**10**) which is arranged above the liquid.

4. The level regulating device according to Claim **3**, characterized in that the electromotor (**10**) is adjustably fastened, for example, in height above the liquid by a longitudinal slot (**12**).

5. The level regulating device according to Claims **1** to **4** in an application device operating with a removal roller rotating in a pan, characterized in that the electrode (**8**) is arranged in the area of the backflow (**5***a*) forming on the front side of the removal roller (**2**).

6. The level regulating device according to Claims **1** to **5**, characterized in that the first current circuit (**43**, **44**, **52** to **55**) closed by the electrode (**8**) and the liquid (**7**) excites a relay (**50**) whose resting contacts (**57**) open a second current circuit (**59** to **64**) by which a signaling system, a liquid transporting pump or a liquid valve is cut in or opened.

7. The level regulating device according to Claim **6** for several liquid removal locations, characterized in that the various removal locations are each connected to a common transportation pump (**28**) by a magnetic valve (**40**) in each second current circuit (**59** to **64**), the pressure line of which pump furthermore runs to a safety valve (**37**).

8. The level regulating device according to Claim 7, characterized in that a time relay (45) is connected in parallel to each of the magnetic valves (40) located in the second current circuit (59 to 64), the working contacts (67) of which relay cut in a signaling device (47) after the passage of the normal refilling time.

9. The level regulating device according to one of Claims 6, 7 or 8,, characterized in that a manual switch (58) is arranged in the second current circuit (59 to 64).

10. The level regulating device according to one of the previous claims, characterized in that the feed line (34) empties into the liquid container at a location remote from the electrode (8).

1 page of drawings

309 550/142 4.63

1 147 397

DRAWINGS PAGE 1 ISSUE DATE: APRIL 18, 1963 **DAS 1147 397**

CL. **42e 23/55**

INTERNAT. CL. **G 05d**

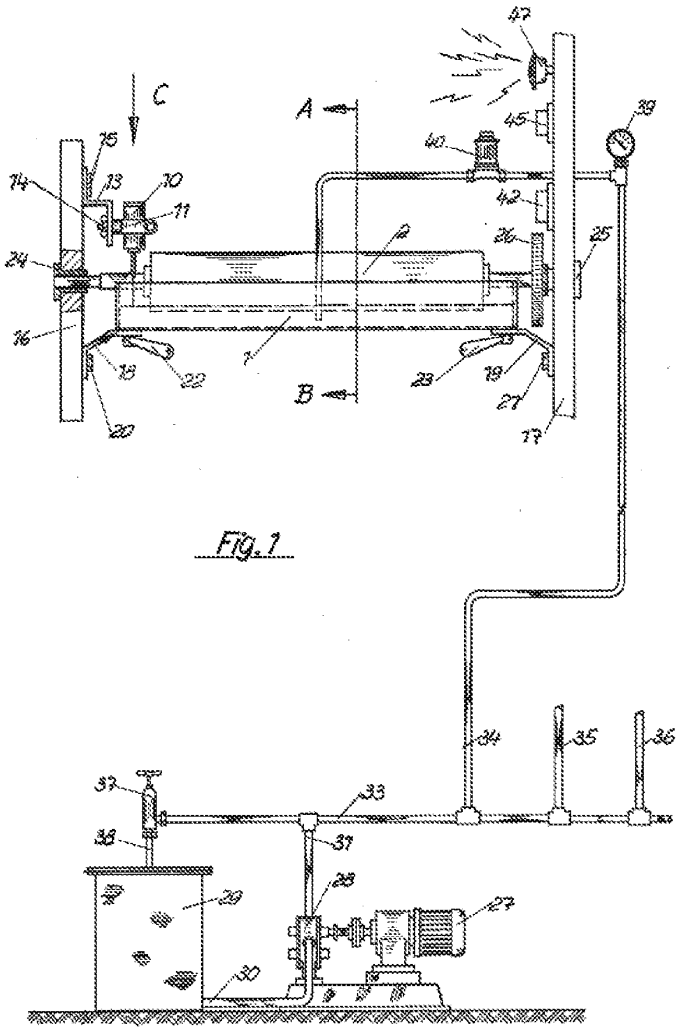


Fig. 1

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DRAWINGS PAGE 1 ISSUE DATE: APRIL 18, 1963 **DAS 1147 397**

CL. **42e 23/55**

INTERNAT. CL. **G 05d**

Fig.2

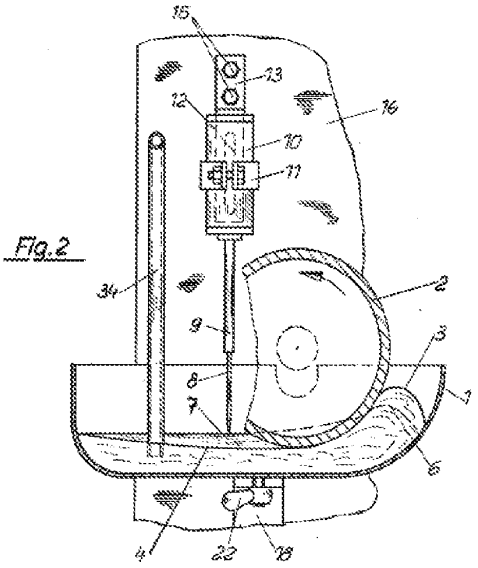
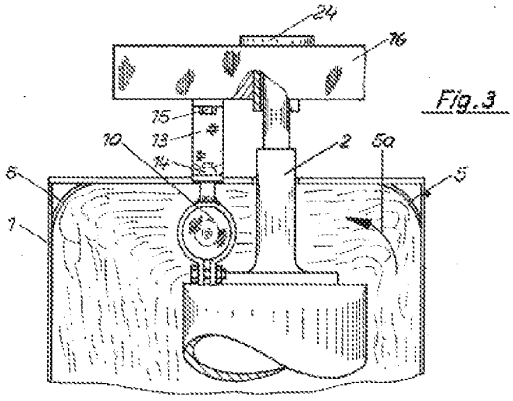


Fig.3



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DRAWINGS PAGE 1 ISSUE DATE: APRIL 18, 1963 **DAS 1147 397**

CL. **42e 23/55**

INTERNAT. CL. **G 05d**

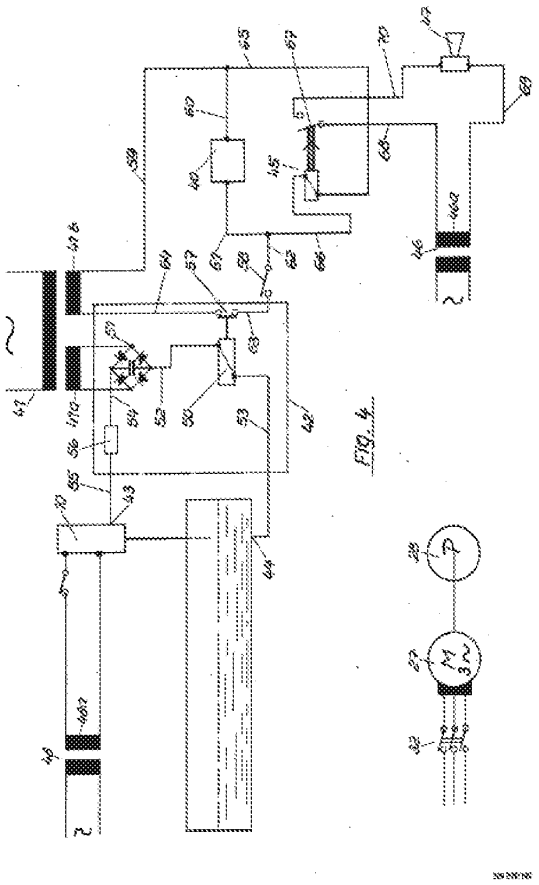


Fig. 4.

(10) DE 103 09 307 A1 2004.09.16



(19)
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(12) **Unexamined, Published Application**

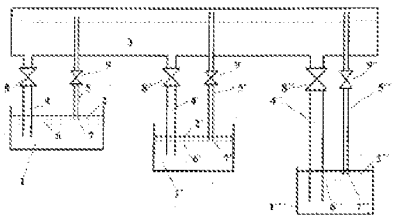
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Grad. Phys. Rainer Berthold, 69251 Gaiberg, DE	**Same as applicant**

The following data was taken from documents filed by the applicant

(54) Title: **Method and Device for Regulating the Levels of Liquids in Any Number of Open Containers Whose Liquid Levels Are Located at Different Heights and Which Have a Common Storage Vessel**

(57) Abstract: In the method and the device for regulating liquid levels in any number of open containers whose levels are at different heights and which have a common storage vessel the containers are connected by liquid lines and pressure compensation lines to a storage vessel. The bottom openings of the



pressure compensation lines end at the liquid levels of the open containers. Blocking components are built into the liquid lines and pressure compensation lines which components automatically open and close in series at adjustable time intervals in order that always only the liquid level of one container is regulated at given time intervals.

Specification

[0001] The invention relates to a method and a device for regulating the levels of liquid in any number of open containers whose liquid levels are at different heights and which have a common storage vessel. In order to measure the liquid level in containers the known electromechanical devices such as lever sensors or float switches are still often used.

[0002] These devices, which act via the buoyancy on a sensor, are conducted via resistance loop rings to evaluation circuits or display instruments. Another known device, for example for checking motor oil or checking the gasoline level in internal combustion engines, consists of a capacitor which is attached to a flexible sheet and acts by virtue of its different dielectric as a frequency-determining member on an electronic oscillator.

[0003] For the checking of liquid levels in particular in cooling water, wash water, brake liquid, fuel, motor oil of internal combustion engines piezo-resonators are also used. Here, a piezo-ceramic resonator is moistened by the liquid to be measured, which acts in a damping manner on a connected oscillation circuit.

[0004] In order to check or monitor the oil in the oil pan of a motor a system is furthermore known in which a sensor is located at the end of the oil dipstick.

[0005] This modified dipstick is used instead of the normally present dipstick. The sensor consists of a highly precise measuring resistor through which a constant current with a set duration is sent. The change in resistance by the heating of the measuring resistor dipped into the oil pan is different in the case of a low oil level than it is in the case of a high oil level. An evaluation of the change in resistance takes place in an electronic circuit.

[0006] The use of sensors for checking the level of liquids which are still customary today is described, among other things, in the Journal "Mikroperipherik", March 1986, sheet IX.

[0007] The utility model G 82 09 565.5 describes a device for the automatic refilling of oil from a storage vessel into a housing partially filled with oil, preferably into the crankcase of an internal combustion engine, wherein the storage vessel and the casing are connected to one another by an oil refilling line. The storage vessel, which is arranged higher than the casing, is sealed airtight to the outside. The air chamber of the storage vessel communicates with the casing via an airline which extends through the air chamber of the casing and empties at the height of the theoretical value oil level.

[0008] This device is only suitable for a casing or a container and was already known over 100 years ago as a chicken drinking tank. This device fails already in the case of two containers with different liquid levels because the higher level is always adjusted and therefore the lower container overflows.

[0009] GB 2 054 856 A describes an arrangement which also serves to regulate a liquid level. Liquid flows from a storage vessel which is located above the liquid level to be regulated into a container located underneath it when, similar to in G 82 09 565.5, the opening of an air compensation line is freed by the dropping of the liquid level to be regulated. The same also applies to this arrangement as to the device in G 82 09 565.5: it is only suitable for one container.

[0010] German patent 42 14 768 describes an arrangement for regulating the oil level in a crankcase of a gasoline engine or of a diesel engine, which is provided with a pressure-tight storage vessel which is located above the oil level of the crankcase and is connected to the crankcase by an oil supply line and by a pressure

compensation line. The oil line and the pressure compensation line are built from below with the aid of a cap nut system into the crankcase and the end of the pressure compensation line lying in the crankcase is bent down. A valve arranged in the pressure compensation line opens the pressure compensation line for the regulating procedure in a time-delayed manner after having turned the engine off and closes it again after the regulating procedure, wherein when the valve is open and given an oil level below the opening of the pressure compensation line, oil flows out of the storage vessel into the crankcase until the opening of the pressure compensation line is closed again by the rising oil level. Even this method is only suitable for one container. The device known from 0S DE 44 24 691 differs from that in G 82 09 565.5 in that only one refilling line is present and that it is substantially horizontally arranged. The pressure compensation takes place via the refilling line, which, however, requires a correspondingly large cross section.

[0011] All these methods only function when the level is to be regulated exclusively in an open vessel.

[0012] Therefore, all these methods have the common disadvantage of not being able to be used for several open containers.

Posing of the problem

[0013] The invention therefore has the problem of eliminating this deficiency and of finding a simple, economical method and a simple, economical device for regulating the levels of liquids in any number of open containers whose liquid levels are located at different heights and which have a common storage vessel.

[0014] The problem of the invention is solved in a generic device by the characterizing features of Claim 1. Advantageous embodiments and supplements can be gathered from the subordinate claims.

[0015] The novel method and the novel device for regulating liquid levels in any number of open containers whose levels are located at different heights and which have a common storage vessel are characterized in that the containers are connected to the storage vessel by liquid lines or by liquid lines and pressure compensation lines, and that the lower levels of the liquid lines or pressure compensation lines end at the liquid levels in the containers, and that blocking components are built into the liquid lines and pressure compensation lines which are released manually automatically or semi-automatically and open and close one after the other at adjustable time intervals.

[0016] A special advantage of the regulating device according to the invention is on the one hand the lack of an electrical or pneumatic regulator and on the other hand the extremely simple manner of regulating the level of any liquid in any number of open containers which are located at different levels without pumps , only with the aid of gravity as auxiliary energy.

[0017] The device according to the invention comprises a vacuum-tight storage vessel which is arranged above the liquid levels of all open containers and contains one of the many known level monitoring devices. The level monitoring device is provided with electrical, analog and digital regulating and controlling outputs and with acoustical and optical signal components so that the storage vessel can be filled up in a timely manner manually, semi-automatically or automatically as is described in detail further below.

[0018] The open containers are filled up to certain, different liquid levels. If one of the liquid levels slowly drops by use, the pressure compensation line opens in this container and makes it possible that liquid runs through the liquid line from the storage vessel into the container located below it until the liquid level moves back

again into its initial position and the opening of the pressure compensation line has closed again.,

[[0019] It is advantageous for many applications if the pressure compensation lines are built with the aid of ascending lines from below into the storage vessel and if their upper openings project over the level of the liquid in the storage vessel.

[0020] Other applications make it necessary that the pressure compensation lines are introduced above the liquid level of the storage vessel.

[0021] In order that the other open containers are not able to overflow, blocking components are arranged in their liquid lines and pressure compensation lines of which each two (in the liquid line as well as in the pressure compensation line) automatically open and reclose at adjustable time intervals.

[0022] These components can be magnetic valves, electrically or electromagnetically operated slides and cocks, flaps and the like.

[0023] Suitable cocks are also motor-driven multiple ball cocks or motor-driven slides whose actuation takes place with the aid of a motor-driven crankshaft.

[0024] The next two blocking components may not begin with their opening and closing procedures until after the first blocking components have ended their opening and closing procedures and therefore have performed a possibly necessary level regulation. The other blocking components open and close according to the same scheme.

[0025] The storage vessel can also consist of transparent material on whose outer wall a scale for the level display is attached.

[0026] In order that no liquid can run into the open containers during the filling of the storage vessel, all blocking components are closed for the duration of the refilling and the storage vessel is ventilated.

[0027] According to the invention the method can be designed as an emergency exit method during which all blocking components close if more than a certain, set amount of liquid has run out of the storage vessel into one of the open containers, which could happen, for example, as a result of a leak in the storage vessel. The signal required for this (volume per time unit) emits the liquid measuring device of the storage vessel when it can continuously measure the level.

[0028] If the liquid level in one of the open containers drops so far that the opening of the pressure compensation line is freed, then this line is emptied which was previously filled to the same level as the storage vessel. If the level rises and closes the opening again, liquid is drawn like previously into the pressure compensation line. If solids are contained in it they can hinder the valve built into the lines in their function. Therefore, the valves are arranged so high above the level of the storage vessel that they cannot be reached by the liquid.

[0029] The following arrangement is even better in this connection for preventing the drawing in of solid particles:

It is characterized in that the lower openings of the pressure compensation lines are provided with solid-retaining devices such as, for example, with protective pipes which are open at the top and communicate with the containers, with filters or with sieves.

[0030] If the accuracy of the level regulation is not too important the pressure compensation lines can be eliminated. The blocking components and the liquid lines which connect the storage vessel to the open containers must then, however,

have sufficiently large diameters so that the pressure compensation takes place in that the air can flow in the form of bubbles through the filled liquid lines upward into the storage vessel. This procedure is indicated by the recurring sound of glugging. The advantage is that the pressure compensation lines and the blocking components contained in them are eliminated, which lowers the complexity in particular during the mounting and therefore saves costs.

[0031] Another advantageous embodiment of the invention results if in certain applications the many containers in accordance with the invention are reshaped to one container in that the containers are closed and are provided with ascending pipes in which the liquid levels are at the same level as the level of the uppermost container.

[0032] For applications such as occur, e.g., in workshops with several rotating machines, milling machines and planing machines a closing of the cooling agent containers and the use of ascending pipes is, however, extremely complicated and expensive and in many instances quite impossible.

Exemplary embodiment

[0033] The method of the invention and the corresponding device will be explained in detail using several exemplary embodiments.

[0034] In **Fig.** 1 (**1**, **1'**, **1"**) denote several open containers whose liquid levels (**2**, **2'**, **2"**) are located at different levels above which a vacuum-tight storage vessel (**3**) is arranged which is connected to the open containers (**1**, **1'**, **1"**) by liquid lines (**4**, **4'**, **4"**) and pressure compensation lines (**5**, **5'**, **5"**)

[0035] After, for example, the liquid level (**2**) has dropped down by consumption of the liquid according to (**6**), a pressure compensation takes place via the opening (**7**)

which is now open so that liquid can run into the open container (**1**) until the opening (**7**) of the pressure compensation line (**5**) is again closed.

[0036] All open containers (**1**, **1'**, **1''**) located at different levels have blocking components (**8**, **8'**, **8''**) in their liquid level supply lines (**4**, **4'**, **4''**) and blocking components (**9**, **9'**, **9''**) in their pressure compensation lines which automatically open and close again in series and in adjustable time intervals so that the heights of the liquid levels (**2**, **2'**, **2''**) can be monitored and regulated at constant values at regular intervals.

[0037] A customary level detector, which is not shown, with electrical signal output is attached in the storage vessel (**3**) and which emits an electrical analog and digital signal and optical and acoustic signals upon reaching a minimal level.

[0038] The storage vessel (**3**) can also consist of transparent material in order to be able to attach a scale, not shown, for level display on its outer wall.

[0039] In order that no liquid can run into the open containers (**1**, **1'**, **1''**) during the filling of the storage vessel (**3**) via a vacuum-tight, closable opening, which is not shown, all blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) are closed for the duration of the filling. For an easier assembly the liquid lines (**4**, **4'**, **4''**) and the pressure compensation lines (**5**, **5'**, **5''**) are provided with cap nut systems, not shown here.

[0040] According to the invention the liquid lines (**4**, **4'**, **4''**) and the pressure compensation lines (**5**, **5'**, **5''**) can be connected to each other and laid by , e.g.. comb-like line branches, which are not shown here, so that only two lines (a liquid line and a pressure compensation line) run into the storage vessel (**3**).

[0041] **Fig.** 2 shows an application for several tool machines, in which the storage vessel (**3**) is automatically loaded with two liquids which can be mixed with one another, in this case with a mixture of water and of a cooling liquid concentrate.

[0042] If the sensor (**13**) emits the signal "fill" to a control unit (**14**), all blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) close, the blocking components (**15**), (**16**) and (**27**) are opened and the two liquids are supplied from the containers (**17**) and (**18**) to the mixer (**19**) which fills them in after mixing by the line (**20**) into the storage vessel (**3**) until the sensor (**21**) emits the signal for cutting off the filling process to the unit (**14**). The latter cuts out the mixer (**19**), closes the blocking components (**15**), (**16**), (**27**) and opens, as described in **fig.** 1, the blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) again one after the other for the level regulation of the liquid level (**2**, **2'**, **2''**) in the containers (**1**, **1'**, **1''**). Even here pumps, which are not shown, can be used behind the blocking components (**15**) and (**16**) or the blocking components can be entirely replaced by pumps.

[0043] In the latter case, for example, immersion pumps can be built into the containers (**17**) and (**18**). All control tasks are taken care of by the unit (**14**).

[0044] Whereas the water is taken from the public water supply network, the concentrate must be filled manually in the container (**18**) as soon as the level detector (**22**) reacts and a signal is generated by the unit (**14**) in (**23**). The container (**17**) is filled with the aid of the blocking component (**24**) as soon as the detector (**25**) has reported the lowering of its water level to the unit (**14**). The detector (**26**) emits a signal to the unit (**14**) when the container is full. This brings about the closing of the blocking component (**24**).

[0045] The level regulating process in the container (**17**) can also be carried out independently of the unit (**14**), for example with one of the known, simple float regulations.

[0046] **Fig.** 3 shows another exemplary embodiment of the device according to the invention.

[0047] The water container (**17**) shown in **Fig.** 2 is omitted since a mixer (**19**) is used which is flanged onto the concentrate container (**18**) and water is automatically supplied via the blocking component (**24**). Since the mixing ratio can also depend on the counter pressure in the discharge line of the mixer (**19**), a blocking component (**27**) must ventilate the storage vessel (**3**) during the filling process (as in **fig.** 2).

[0048] Since the mixture in the storage vessel (**3**) can become unmixed in the course of time, the mixture must be kept constantly in movement, for example by an agitator (**28**). This also applies, of course, to the example of use in **fig.** 2.

[0049] Since the blocking components (**15** and **16**) of **fig.** 2 were also eliminated, a blocking component (**29**) must be present between the mixer (**19**) and the storage vessel (**3**). The regulation of the level (**2, 2', 2''**) of the containers (**1, 1', 1''**) takes place as initially described, after the mixer (**19**) was turned off, the blocking components (**27**) and (**29**) were closed and the blocking components (**8, 8', 8'',9, 9', 9''**) again cyclically open and close.

[0050] It is also shown here how all liquid lines and pressure compensation lines (**4, 4', 4'', 5, 5', 5''**) are introduced via a double comb arrangement (**11**) with only two lines (**12, 12'**) into the storage vessel (**3**). The sensors (**13**) and (**21**) belong to the level monitoring electronics integrated in the control unit (**14**).

[0051] The **fig.** 4a to 4d show four of many other conceivable arrangements for the laying of the pressure compensation lines (**5, 5', 5'''**), wherein only the relevant parts and only one container are shown in each one in which the liquid level is to be regulated.

[0052] In the figures:

[0053] **Fig.** 4a shows an arrangement for a container (**1**) which is connected by the pressure compensation line (**5**) to the storage vessel (**3**) and ends above the liquid level (**30**). (**8**) and (**9**) are blocking components in the liquid line (**4**).

[0054] **Fig.** 4b shows an arrangement without a pressure compensation line in which the pressure compensation takes place after the opening of the blocking component (**8'**) by the liquid line (**4'**). (In this arrangement large diameters are necessary in the blocking component and in the liquid line.)

[0055] **Fig.** 4c shows an arrangement in which the pressure compensation line (**5''**) runs laterally over the level of the liquid level (**30**) into the storage vessel (**3**).

[0056] **Fig.** 4e shows an arrangement in which the pressure compensation line (**5''**) is introduced from above into the storage vessel (**3**).

[0057] **Fig.** 5 shows an arrangement with only one liquid line (**4**). In it, (**1,1', 1''**) denote several containers which are also located at different levels above which a vacuum-tight storage vessel (**3**) is arranged and is connected to the container (**1**) via a pressure compensation line (**5**) and a liquid line (**4**).

[0058] After the liquid level (**2**) has briefly dropped by consumption of the liquid in any container (**1,1', 1''**) according to (**2'**), a pressure compensation takes place via the now free opening (**7**) so that liquid can run into the containers (**1,1', 1''**) until the opening (**7**) in the container (**1**) is closed again.

[0059] The other containers (**1', 1''**) located at different levels are connected according to the invention to one another and to the container (**1**) according to the principle of communicating pipes by lines (**33, 33'**) and are provided with ascending pipes (**31, 31'**) open at the top so that their liquid levels are also regulated to the given constant value.

[0060] A level monitoring device (**34**) with an electrical signal output (**23**) is attached in the storage vessel (**3**) which emits an electrical analog and/or digital signal and/or an optical and/or acoustical signal when a minimum level is reached.

[0061] The storage vessel (**3**) can also consist of transparent material in order to be able to attach a scale (**35**) for displaying the level on its outer wall.

[0062] In order that no liquid can run into the containers (**1**,**1'**, **1''**) during the filling of the storage vessel (**3**), the blocking component (**8**) is built into the liquid line (**4**).

[0063] **Fig.** 6 shows an exemplary embodiment in which one of the different pressure compensation lines (**5**) is provided with a device (**36**) which is arranged in the container (**1**) and consists of a pipe open at the top and at the bottom so that liquid can penetrate in according to the principle of communicating pipes.

[0064] The liquid contaminated, for example, with bore chips or milling chips rests in this pipe so that the chips sink to the bottom and are no longer sucked into the storage vessel (**3**) by the pressure compensation line (**5**) during the pressure compensation procedure.

Claims

1. A method and a device for regulating liquid levels in any number of open containers (**1**,**1'**, **1''**) whose levels (**2**, **2'**, **2''**) are located at different heights and which have a common storage vessel (**3**), **characterized in that** the containers (**1**,**1'**, **1''**) are connected to the storage vessel (**3**) either by liquid lines(**4**, **4'**, **4''**) or by liquid lines and pressure compensation lines (**4**, **4'**, **4''** and **5**, **5'**, **5''**), and that either as in the first case the lower openings (**7**, **7'**, **7''**) of the liquid lines or as in the second case the pressure compensation lines (**5**, **5'**, **5''**) end at the liquid levels (**2**, **2'**, **2''**) of the containers (**1**,**1'**, **1''**), and that blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) are arranged in the liquid lines (**4**, **4'**, **4''**) or in the liquid lines (**4**, **4'**, **4''**) and in the pressure compensation lines (**5**, **5'**, **5''**), which blocking components are successively released manually at adjustable time intervals and open and close semi-automatically or completely automatically.

2. The method and the device according to Claim 1, characterized in that the blocking components (**9**, **9'**, **9''**) and the pressure compensation lines (**5**, **5'**, **5''**) are eliminated in the case of sufficiently large diameters of the blocking components (**8**, **8'**, **8''**) and of the liquid lines (**4**, **4'**, **4''**) so that the pressure compensation takes place by the liquid lines (**4**, **4'**, **4''**) and the blocking components (**8**, **8'**, **8''**).

3. The method and the device according to Claim 1, characterized in that the container (**1**) is connected by only one liquid line (**4**) and only one pressure compensation line (**5**) to the storage vessel (**3**), and that the other containers (**3'**, **3''**) located on different levels area connected to one another and to the container (**3**) according to the principle of communicating pipes by lines (**33**, **33'**) and are provided with ascending pipes (**31**, **31'**) which are open at the top in order to

prevent the containers (**1'**,**1''**) from overflowing and to make their communicating possible.

4. The method and the device according to Claim 1, characterized in that the pressure compensation lines (**5**, **5'**, **5''**) are built with the aid of ascending lines (**31**) from below into the storage vessel (**3**) and that The method and the device according to Claim **1**, characterized in that the their upper openings project over the level (**30**) of the liquid in the vessel (**3**).

5. The method and the device according to Claims 1, 3 and 4, characterized in that the pressure compensation lines (**5**, **5'**, **5''**) are introduced above the liquid level (**30**) into the vessel (**3**).

6. The method and the device according to Claims 1 to 5, characterized in that the blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) consist of magnetic valve, cocks, slides or similar components.

7. The method and the device according to Claims 1 to 6, characterized in that the blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) are motor-driven multiple ball cocks.

8. The method and the device according to Claims 1 to 7, characterized in that the blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) are motor slides controlled by the crankshaft.

9. The method and the device according to Claims 1 to 8, characterized in that a continuous or two-point level monitoring device (**13**; **21**; **14**) with analog and/or digital regulating and/or control outputs and/or acoustical and/or optical signal components (**23**) is provided in the storage vessel (**3**).

10. The method and the device according to Claims 1 to 9, characterized in that all lines are attached with the aid of cap nut systems or known screw systems to the containers and vessels.

11. The method and the device according to Claims 1 to 10, characterized in that all lines are connected to each other and laid by, for example, comb-like line branches (**11**) in such a manner that the storage vessel (**3**) has to be tapped only twice, namely, by the lines (**12**; **12'**).

12. The method and the device according to Claims 1 to 11, characterized in that the storage vessel (**3**) is filled from two liquid containers (**17**) and (**18**) after the liquids were removed from them and can be mixed with one another have flowed through the blocking components (**15**, **16**) and the mixer (**19**).

13. The method and the device according to Claims 1 to 12, characterized in that the control of all blocking components (e.g., **8**, **8'**, **8''**,**9**, **9'**, **9'**, **15**, **16**) takes place by a control unit (**14**).

14. The method and the device according to Claims 1 to 13, characterized in that the container (**17**) is a water container which is connected to the public water line by a blocking component (**24**), which water line is opened or closed as needed by the control unit (**14**) when the corresponding signal "open" or "close" is emitted by the level detectors (**25**) and (**26**).

15. The method and the device according to Claims 1 to 14, characterized in that all blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**, **15**; **16**; **24**) close like an emergency exit method (failsafe) if more than a certain set amount of liquid begins to flow out of the storage vessel (**3**) into one of the containers (**1**,**1'**, **1''**).

16. The method and the device according to Claims 1 to 15, characterized in that the container (**18**) is filled with a liquid that can be mixed with water and which is mixed with water by the mixer (**19**) and flows into the storage vessel (**3**).

17. The method and the device according to Claims 1 to 16, characterized in that before the filling of the storage vessel (**3**) all blocking components (**8**, **8'**, **8''**,**9**, **9'**, **9''**) are closed in order that no pressure compensation takes place and that the containers (**1**,**1'**, **1''**) cannot overflow.

18. The method and the device according to Claims 1 to 17, characterized in that instead of the blocking components (**15**) and (**16**), pumps are arranged which are cut in by the control unit (**14**) as needed.

19. The method and the device according to Claims 1 to 18, characterized in that the level of the water container (**17**) is not held constant by the unit (**14**) but rather by an automatic level-regulating device, for example by a simple float regulation.

20. The method and the device according to Claims 1 to 19, characterized in that the mixer (**19**) rests on the container (**18**) and that the mixer (**19**) automatically supplies its water directly from the water line network.

21. The method and the device according to Claims 1 to 20, characterized in that during the filling procedure the storage vessel (**3**) is ventilated via the blocking component (**27**).

22. The method and the device according to Claims 1 to *21*, characterized in that the liquid mixture in the storage vessel (**3**) is put in motion by an agitator mechanism (**28**) constantly or according to certain times which can be set in advance.

23. The method and the device according to Claims 1 to 22, characterized in that the lower openings of the pressure compensation lines are provided with devices (**36**) which retain solids such as, for example, with protective pipes which are open at the top and communicate with the containers (**1**,**1'**, **1''**) and/or with filters and sieves.

24. The method and the device according to Claims 1 to 23, characterized in that the blocking components (**9**, **9'**, **9''**) are arranged in the pressure compensation lines (**5**, **5'**, **5''**) above the highest level of the liquid in the container (**3**).

6 sheets of drawings follow

Attached drawings

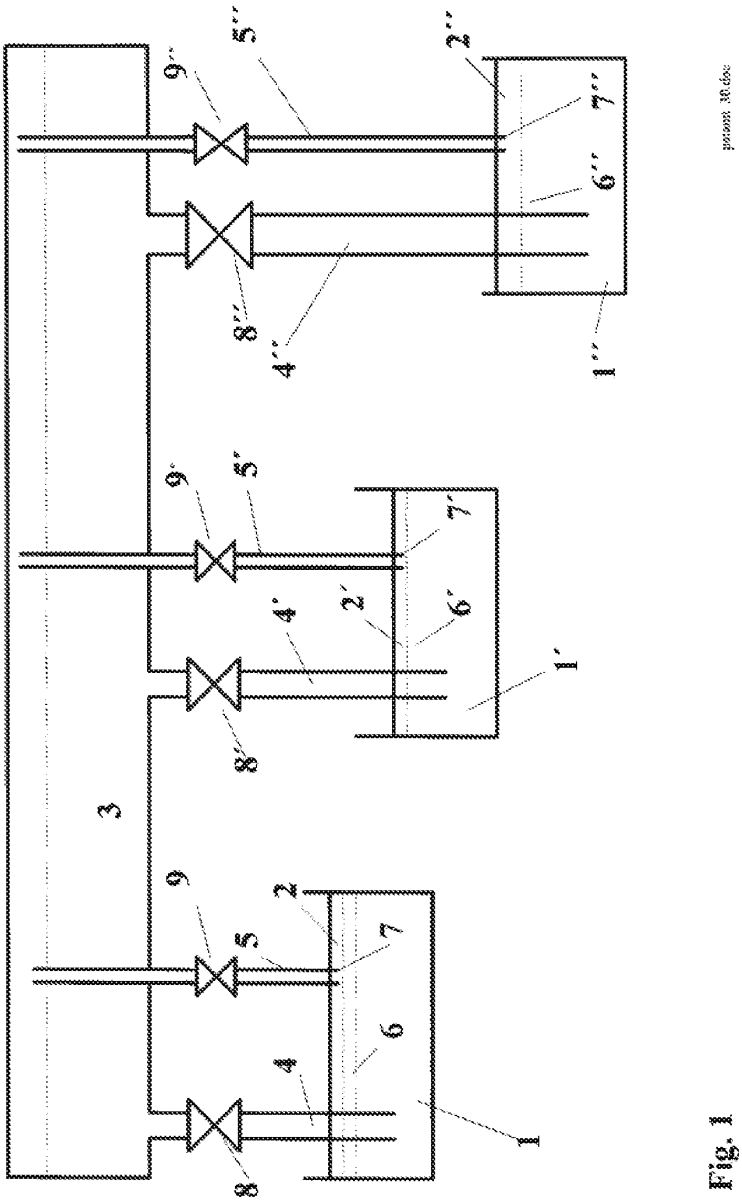


Fig. 1

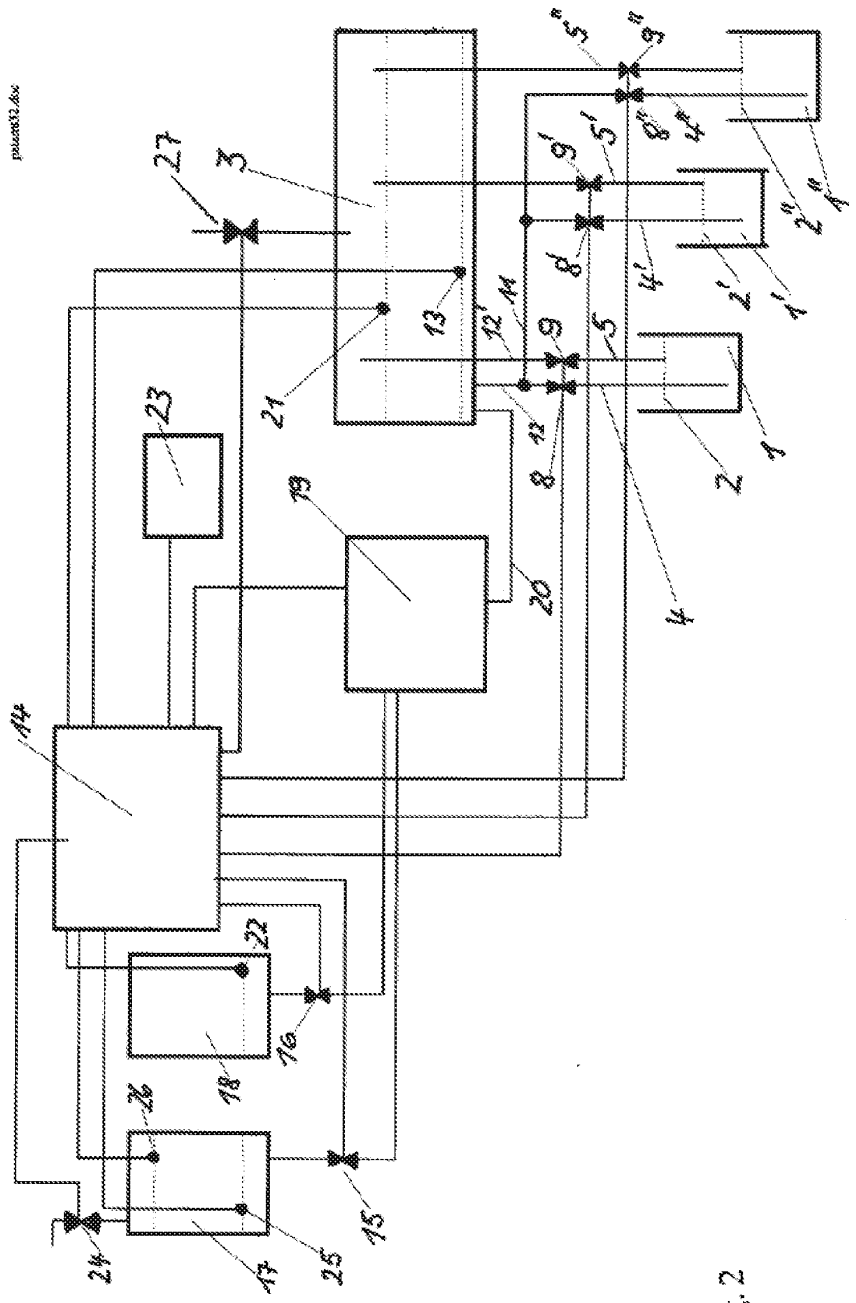

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5'
8'
4'
2'
1'
9"
5"
8"
4"
2"
1"

Fig. 2

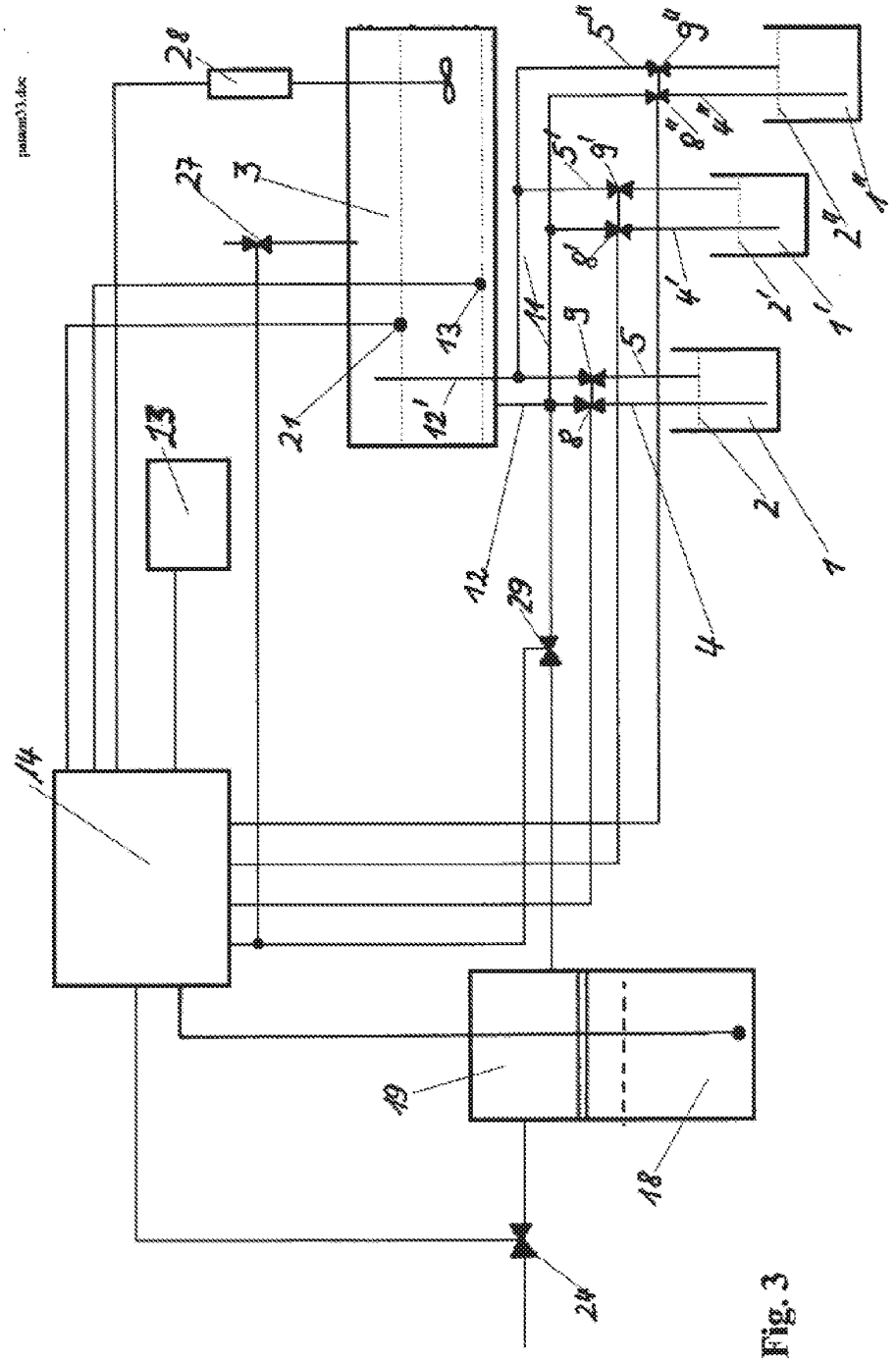


Fig. 3

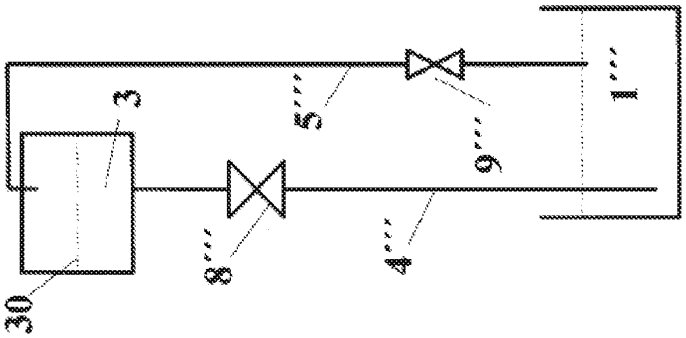


Fig. 4d

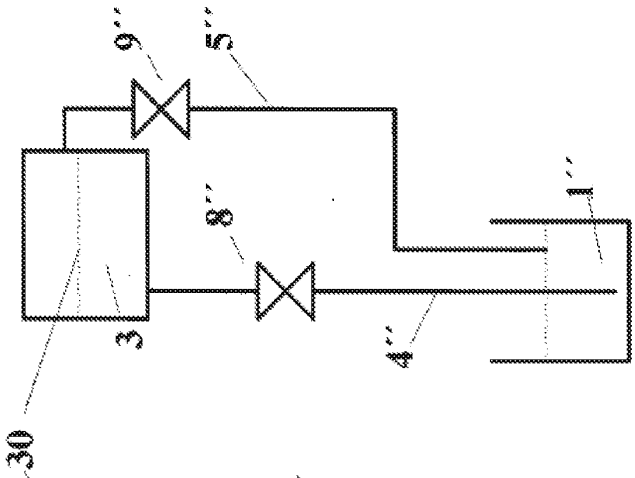


Fig. 4c

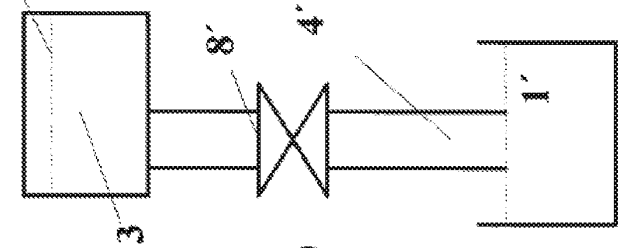


Fig. 4b

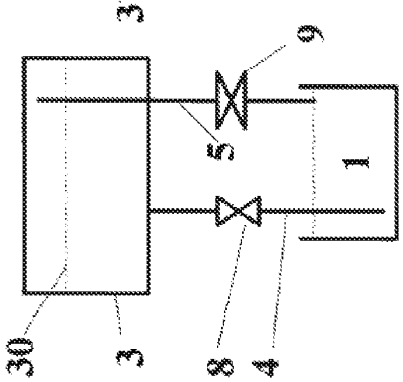


Fig. 4a

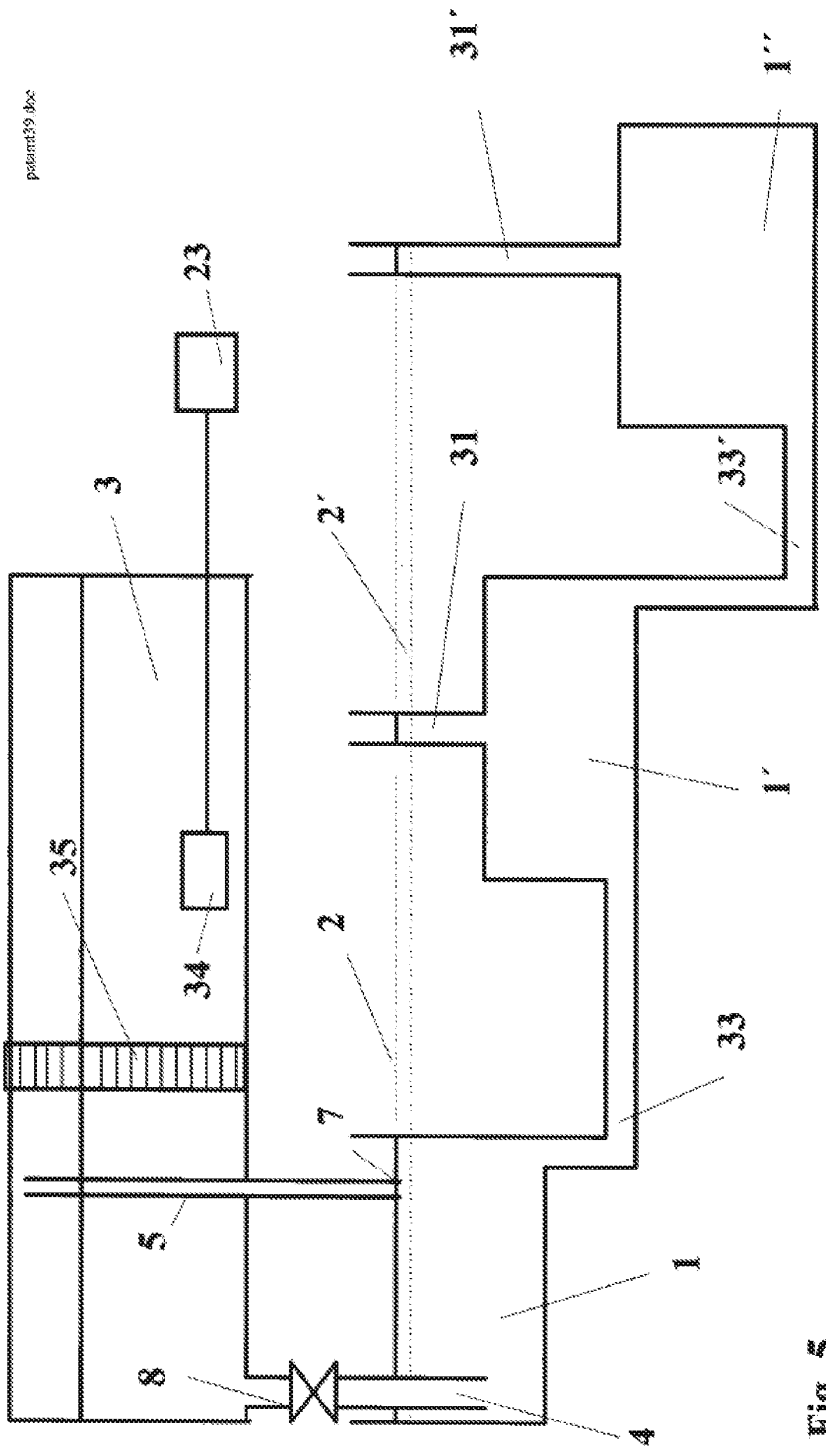


Fig. 5

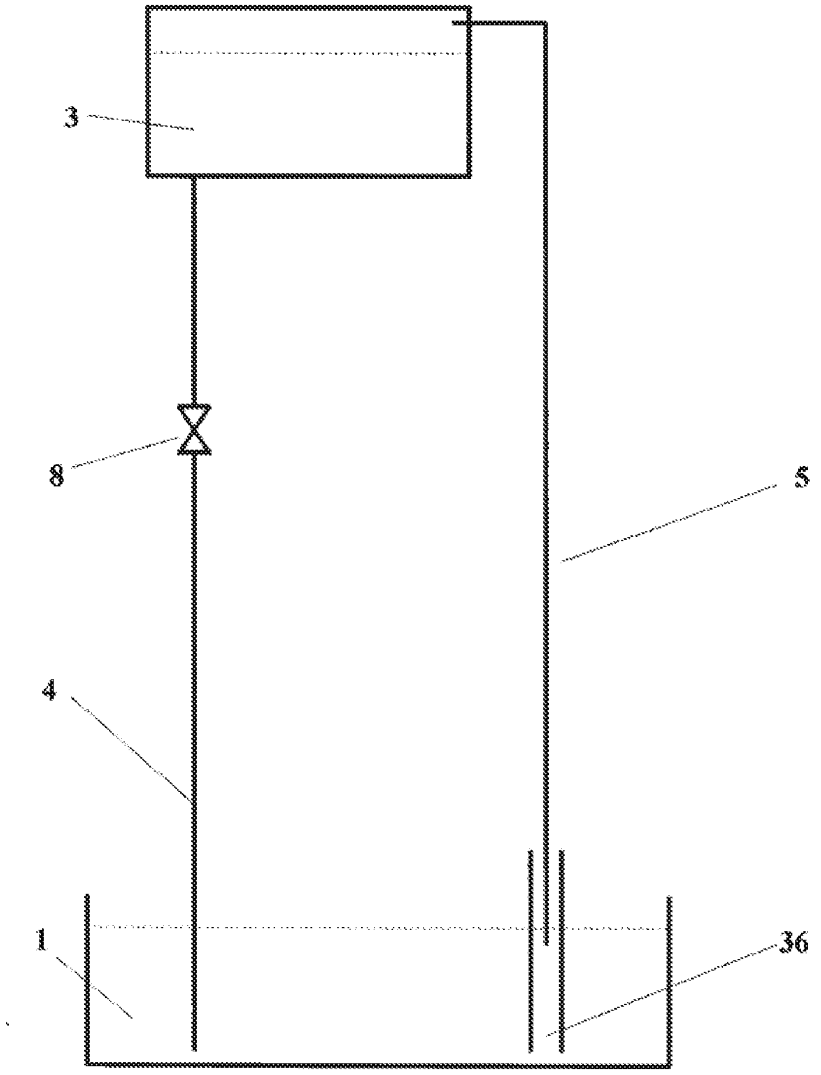


Fig. 6

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B65B 3/04 (2006.01)

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(56) Documents considered for the evaluation of patentability:
US 34 20 282 A
DE-E 8586 III/64 b – 17.11.1955;

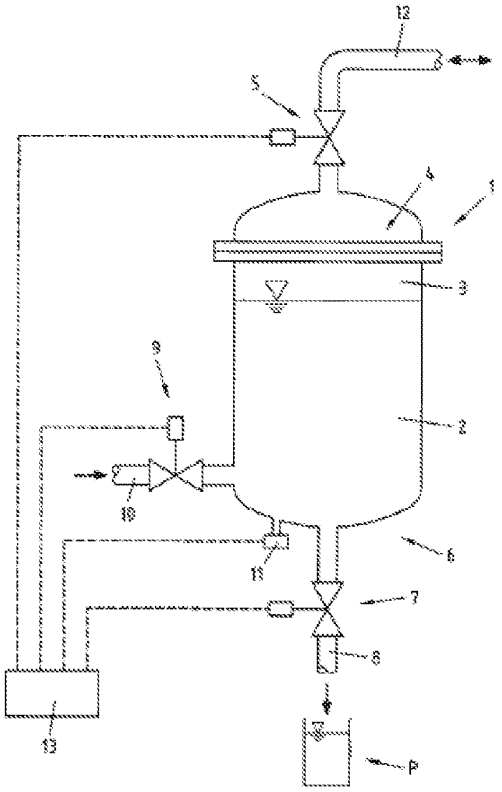
The following data was taken from documents filed by the applicant

Request for examination made according to § 44 PatG

(54) Title: **Method for the Regulation of Tank Pressure for Emptying a Product**

(57) Abstract: A method for the regulation of tank pressure for a preferably sterile emptying of a product from a tank into a plurality of containers is shown and described. In order to save maintenance costs and at the same time to be able to reduce the standstill times of the emptying system, the following steps are provided in the method:

- Opening of the filling valve (7) repeatedly for a repeated emptying of product (2),
- Monitoring of a measured value as a function of a level of the product (2) in the tank (1),
- Changing a degree of opening a product supply valve (9) for filling the tank (1) as a function of the monitored measured value, and
- Holding an aeration valve (5) for filling the tank (1) during the repeated opening of the filling valve (7), the monitoring of the measured value and of the changing of the degree of opening in a closed position.



Specification

[0001] The invention relates to the regulation of tank pressure for a preferably sterile emptying of a product from a tank into a plurality of containers.

[0002] During the emptying of a sterile product from a tank which is a type of intermediate storage a sterile atmosphere must always be maintained in a head area of the tank above the product. At the same time, it is important for the emptying of filling amounts which are always the same that the pressure in the head area of the tank remains as constant as possible. As a result of the repeated emptying of product, the product level and with it also the pressure in the head area can clearly drop. This can result in lesser filling amounts. On the other hand, an intermediate filling of too great an amount of product can so greatly compromise the atmosphere in the head area of the tank that pressures which are too high and therefore filling amounts which are too large are the consequence.

[0003] The known methods for the regulation of pressure for the preferably sterile emptying of the product from the tank therefore make use of a special device for regulating the pressure in the head area of the tank. One also speaks in this connection of a so-called sterile air node. This device is to be associated either with the head area of the tank or with lines for aerating and ventilating the tank. In addition to a pressure recorder the device also comprises a pressure adjuster.

[0004] If the pressure drops in the head area below a given value, then sterile air is pressed into the tank until the desired pressure is adjusted in the head area. In addition, the tank pressure is lowered as needed with the same device by blowing sterile air out of the head area.

[0005] The known method for regulating tank pressure has the disadvantage of the high expense for the maintenance of the sterile air node and the standstill times of the emptying system associated with the failure of a sterile air node.

[0006] Therefore, the present invention has the basic problem of designing and further developing the initially cited method for regulating a tank pressure is which was previously described in detail in such a manner that the maintenance costs are saved and the standstill time of the emptying system are reduced.

[0007] This problem is solved for the method of the initially cited type by the following steps:

- Opening of the filling valve repeatedly for a repeated emptying of product,
-Monitoring a measured value depending on a level of the product in the tank,
- Changing a degree of opening of a product supply valve for filling the tank as a function of the monitored measured value, and
-Holding an aeration valve for aerating the tank in a closed position during the repeated opening of the filling valve, the monitoring of the measured value and during the changing of the degree of opening.

[0008] The invention surprisingly recognized that the pressure regulating device used in the method of the prior art can be eliminated without negative effects on the reliability of the method. Consequently, according to the invention the maintenance expense for the pressure regulating device designed with its expensive apparatuses can be saved.

[0009] Furthermore, the invention recognized that greater operational safety and therefore reduced standstill times can be achieved with the method according to the invention and in comparison to the methods known from the prior art.

[0010] According to the invention during the repeated, successively occurring emptying of the same filling amounts of product into different containers the amount of a sterile gas in the head area of the tank is maintained constant. In other words, this means that during a series of successively occurring emptying processes neither sterile gas is pressed into the head area nor is it let out of this area. The aeration valve is instead maintained in a closed position for the entire time of the emptying.

[0011] However, during this time a measured value is monitored which varies with the level of the product in the tank. Initiated by variation of the measured value, the product supply valve is opened at least at times and at least partially and/or at least somewhat wider. As a result of the product flowing into the tank the sterile gas in the head area of the tank is then compressed until the desired conditions for the following emptying processes, preferably the desired pressure in the head area, have/has been adjusted.

[0012] The sterile gas is preferably sterile air. However, it can also be any other preferably inert gas. Also, it basically makes no difference which type of product is involved. However, it is

preferably a flowable product. The flowable products here include, in addition to the liquid products, also pasty products and products with liquid as well as lumpy components. The method can basically also be used to empty pourable products. However, this is less preferred since the pourable particles of the product are as a rule surrounded by a compressible medium such as air, which makes the regulation of the tank pressure more difficult.

[0013] The method makes an emptying of the product possible under atmospheric conditions as well as under an excess pressure or a vacuum, even if the emptying in a vacuum is basically not preferred and only preferred in special instances. Liquid products with a low viscosity are mainly emptied under atmospheric pressure whereas higher-viscous products are preferably emptied under an excess pressure into the containers in order that they can pass at all or more rapidly into the containers.

[0014] The term container should denote in the following any vessel which can be provided for receiving a certain filling amount of the product. It is preferably a cardboard/plastic composite packaging.

[0015] According to a teaching of the invention, as soon as the measured value drops below a first boundary value, the degree of opening of the product supply valve is enlarged, if necessary entirely opened. Additionally or alternatively, the degree of opening of the product supply valve can also be reduced or brought into the closed position if the measured value exceeds a second boundary value.

[0016] The concepts "drops below" and "exceeds" are not to be necessarily understood literally here. The using of the concepts serves only for a better understanding since the plurality of the measured values influenced by the level of the product such as hydrostatic pressure, level height, capacity and the like also drop as the level drops. The "exceeding" and the "dropping" of the particular boundary value differ solely in that whether the measured values are larger or smaller directly before the attainment of the measured value, independently of whether the concept "exceeding" or "dropping" is associated with rising or falling measured values and therefore corresponds to the customary usage of the language. In order to correspond to the general usage of the language the measured value can also be multiplied, if necessary, by the factor "-1".

[0017] If the degree of opening of the product supply valve only varies during the exceeding of and/or the dropping below the particular boundary value, only a slight technical regulating expense is required.

[0018] The expense can be alternatively or additionally reduced in that the degree of opening of the product supply valve is changed only from a preferably completely closed position to a preferably completely open position. If such a change of the degree of opening takes place as a function of the exceeding of and/or dropping below a corresponding boundary value, the method for the regulation of tank pressure is based as needed on a simple control.

[0019] The circumstance that in such a case one can actually not speak of a method for regulating tank pressure according to the generic part of Claim 1, should be accepted without limitation of the invention for the sake of simplicity in combination with the invention.

[0020] The stability and the reliability of the method can be improved if the degree of opening can be changed as needed in a plurality of possible intermediate steps between the preferably completely closed position and the preferably completely open position of the product supply valve. The method can be selectively based on a controlling or on a regulating.

[0021] The degree of opening of the product supply valve can also be changed as a function of a deviation between an actual value of the measured value and a theoretical value of the measured value, wherein the theoretical value can be previously set or can vary during the carrying out of the method. This is then a regulation in the actual sense. A corresponding regulator must be provided for the method. However, the stability and the reliability of the method can be raised in this manner.

[0022] This can also be alternatively or additionally achieved in that the degree of opening is changed as a function of the history of the measured value. If needed, the degree of opening can also be changed as a function of the history of the deviation between the actual value and the theoretical value.

[0023] In order to determine the measured value, for example the pressure in the head area of the tank, the pressure of the product at a height below the level, in particular in the bottom area of the tank can be recorded without a very great expense for the measuring technology. A more expensive but possibly also more exact method uses one of the previously cited pressure values

for determining a measured value only by computer. For the determination by computer, many suitable parameters and also another one of the previously cited pressure values can be used as input magnitudes for the calculation.

[0024] For the rest, the invention is not limited to the recording of pressure values. Additionally, or alternatively to one or more of the previously cited pressure values, for example even a primarily electrical level measuring can be used for the method.

[0025] If more than only one measured result or measured value form an input magnitude for the determination of the measured value by computer, they can be measurements of different physical magnitudes but preferably measurements of the same physical magnitude at different measuring sites. A known measuring device can preferably be used for recording each of the physical magnitudes used at each measuring site used.

[0026] It is preferred in general if the aeration valve for aeration at least the head area of the tank with the sterile gas is opened in an introductory step of the method so that at least the head area of the tank but preferably the tank itself is filled at first under sterile conditions with the sterile gas, preferably air. The introductory opening of the aeration valve can also serve to adjust the desired pressure in the tank already filled with product prior to the first emptying.

[0027] The aeration valve is not opened again until the product is to be replaced at a later time, maintenance work or cleaning work is to be performed or the method has to be interrupted for some other reason. This can serve for an aeration as well as for a ventilation.

[0028] The invention will be explained in detail using only one figure which schematically shows a device for carrying out the method.

[0029] The device shown and preferred comprises a tank **1** with a product **2** under a sterile atmosphere of air **3** in the head area **4** of the tank **1**. The head area **4** can be aerated and ventilated via the aeration valve **5**. A connection piece connected to a filling valve **7** is provided in the bottom area **6** of the tank **1** through which piece the product **2** located in the tank **1** is emptied via a filling line **8** into the various containers. The already emptied product, by whose volume the level of the product **2** in the tank **1** was reduced, can be replaced via a product supply line **10** comprising a product supply valve **9**. Furthermore, the tank **1** shown in the sole figure comprises a pressure recorder **11** in the bottom area **6** for measuring the level.

[0030] The method provides that at first the tank **1** is cleaned and sterilized. Then the tank **1**, the aeration valve **5**, the filling valve **7** and/or the product supply valve **9** are closed as needed so that no contaminants can pass into the tank **1**. Furthermore, the tank **1** is filled with sterile air for this purpose.

[0031] The product supply valve **9** is opened for filling the tank **1** with the product **2**. Product **2** flowing into the tank **1** displaces the sterile air present in the tank. Depending on whether the aeration valve **5** is closed or is still open, the sterile air in the head area **4** of the tank **1** is compressed or the compressed, sterile air escapes via the aeration valve **5** and the aeration line **12**. If the aeration valve **5** is still not yet closed during the first filling of the tank **1** with product **2**, this takes place with the achieving of a predetermined level of the product **2** but in any case with the end of the filling of product **2** into the tank **1**.

[0032] If the product **2** is a medium with a rather high viscosity, the aeration valve **5** is closed prematurely in order that the product can be emptied better and more rapidly under an excess pressure into the containers **8** provided to this end. In the case of liquids with a low viscosity, the aeration valve **5** is preferably not closed until, preferably shortly before the end of the filling of product **2** into the tank **1**, since a distinct excess pressure is not necessary for the emptying of such liquids.

[0033] The rise of the level can be followed during the first filling of the tank **1** with product **2** by the pressure recorder **11** provided in the bottom area **6**. The repeated emptying of product **2** into the various containers **8** is initiated in that the filling valve **7** is repeatedly and successively opened and closed.

[0034] In the course of time the level then drops in the tank **1**. During this time the pressure recorder **11** generates, preferably continuously, a measured value dependent of the level and conducts further it to a regulating device **13**. The latter stores and processes the incoming measured values and decides using given regulating parameters whether product **2** should be supplied. If this is the case, the regulating device **13** controls the product supply valve **9**, whereupon it opens entirely or partially.

[0035] The product **2** flowing into the tank **1** now influences for its part the measured value so that the regulating device **13** subsequently performs a varied control of the product supply valve

9 as needed. Then, the product supply valve **9** is either opened somewhat further or is somewhat later, if necessary, completely closed.

[0036] Although the aeration valve **5** remains closed, preferably for a long time, the aeration valve **5** is also controlled by the regulation device **13** in the method shown and therefore preferred for the sake of simplicity. However, the aeration valve **5** could basically also be controlled by a different adjusted value transmitter or even actuated manually.

[0037] Furthermore, as can be gathered from the sole figure, the filling valve **7** is also controlled by the regulating device **13**. In this manner the cost for apparatuses is reduced even if the controlling of the filling valve **7** basically has nothing to do with the controlling of the product supply valve **9**. Therefore, the controlling of the filling valve **7** could also be assumed by another adjusted value transmitter. Only the pressure recorder **11** and the product supply valve **9** have to be connected to one another by the regulating device **13**.

[0038] The aeration valve **5** is preferably not opened again until maintenance work is necessary, a cleaning of the tank is necessary, the product replacement is imminent or the like. During the entire time in which the aeration valve **5** is closed it is ensured with the aid of the regulating device **13** and by the controlling of the product supply valve **9** as well as of the corresponding changing of the degree of opening of the latter that there is always sufficient product **2** in tank **1** for being emptied into the containers P and that the pressure of the sterile air in the headroom **4** of the tank **1** is maintained substantially constant.

Claims

1. A method for regulating the tank pressure for a preferably sterile emptying of a product (**2**) from a tank (**1**) in a plurality of containers (**8**), characterized by
the following steps:
- Opening of the filling valve (**7**) repeatedly for a repeated emptying of product (2),
-Monitoring a measured value depending on a level of the product (**2**) in the tank (1),
- Changing a degree of opening of a product supply valve (**9**) for filling the tank (1) as a function of the monitored measured value, and
- Holding an aeration valve (**5**) for aerating the tank (**1**) in a closed position during the repeated opening of the filling valve (**7**), the monitoring of the measured value and during the changing of the degree of opening.

2. The method according to Claim 1, characterized in that the product supply valve (**9**) is opened when a first boundary value of the measured value is dropped below.

3. The method according to Claim 1 or 2, characterized in that the product supply valve (**9**) is closed when a second boundary value of the measured value is exceeded.

4. The method according to one of Claims 1 to 3, characterized in that the degree of opening of a closed position is changed into an open position and vice versa.

5. The method according to one of Claims 1 to 4, characterized in that the degree of opening is changed as needed in intermediate steps between the closed position and the open position.

6. The method according to one of Claims 1 to 5, characterized in that the degree of opening is changed as a function of a deviation between an actual value of the measured value and a theoretical value of the measured value.

7. The method according to one of Claims 1 to 6, characterized in that the degree of opening is changed as a function of the history of the measured value or of the history of the of the deviation between the actual value and the theoretical value.

8. The method according to one of Claims 1 to 7, characterized in that in order to determine the measured value the pressure in the head area (**4**) of the tank (**1**) is recorded.

9. The method according to one of Claims 1 to 8, characterized in that in order to determine the measured value the pressure in the area of the tank (**1**) above a minimum level is recorded.

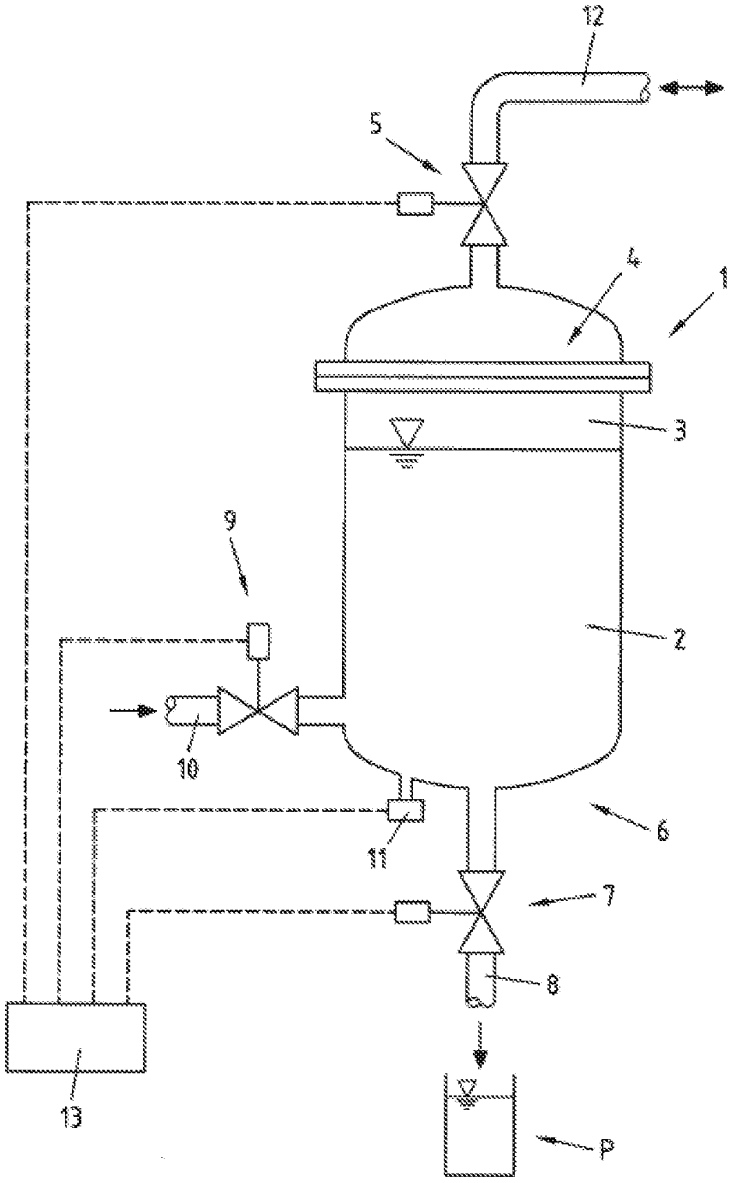
10. The method according to one of Claims 1 to 9, characterized in that in order to determine the measured value the pressure in the area of the tank (**1**) below the minimum level is recorded.

11. The method according to one of Claims 1 to 10, characterized in that in order to determine the measured value a measurement of the level of the product (**2**) in the tank (**1**) is carried out.

12. The method according to one of Claims 1 to 11, characterized in that initially the aeration valve (**5**) is open for aerating at least the head area (**4**) of the tank (**1**) with a sterile gas.

One sheet of drawings follows

Attached drawings



(4) Kokai No. 4-62289

Title of the Invention:	Abrasive Supply Method of Liquid Jet Processing Device and Device Thereof
Applicant(s):	Electric Power Development Co., Ltd. Kaihatsu Koji KK (Currently, JP Hytec Co., Ltd.) The Japan Steel Works, Ltd.
Publication Date:	[1992.2.27]
Filing Date:	[1990.6.29]
Application No.	2-174277
Priority Claimed:	None
Counterpart(s)	None

JPP '289 describes an abrasive feed device for a liquid jet machining apparatus which is provided on a mobile carriage.

The liquid jet machining device 4 is provided on the mobile carriage 2 and has a mixing nozzle 4a whose position and direction are adjustable. Highly pressurized water supplied from the liquid tank 8 through the pump 10, and water and abrasive supplied from the movable tank 6 provided on the carriage 2 are mixed by the mixing nozzle 4a and are sprayed as a high-pressure liquid jet 72 onto a workpiece 70.

The liquid tank 8 which stores therein water is arranged remotely from the carriage 2 and is connected to the pump 10, the pressurizing pump 14 and the supplementing pump 20. The discharge port of the pump 10 is connected to one of the inlets of the nozzle 4a through the first piping 40. The discharge port of the pressurizing pump 14 is bifurcated into two ports, one of which is provided with a first valve 32 in the piping 44. The pressurizing pump 14 is provided in the piping 48 with a valve 36. Likewise, valves 36 and 38 are provided in the pipings 48 and 52.

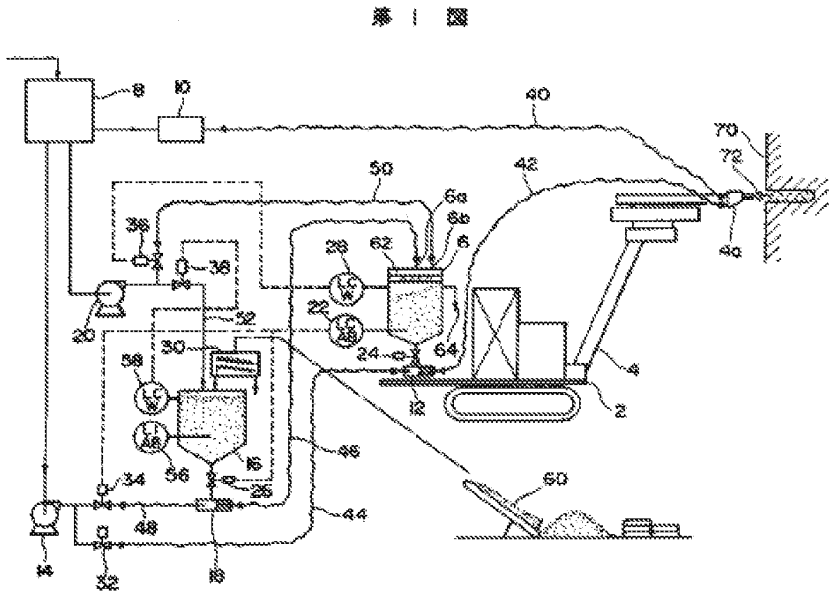
The movable tank 6 is provided therein with a first abrasive level sensor 22 which detects the amount of abrasive and a first surface level detector 28 which detects the surface level of the water.

The amount of water and abrasive in the movable tank 6 decreases in accordance with the progression of the liquid jet machining. When the first abrasive level detector 22 in the movable tank 6 detects that the level of the abrasive decreases to a predetermined lower limit, a signal is sent to the second valve 34 to open the same. As a result, the nozzle 18 in the stationary tank 16 is operated to draw the water and abrasive from the stationary tank 16

through the second flow rate control valve 26.

When the abrasive is supplemented to a predetermined upper limit, the first abrasive level detector 22 no longer outputs a signal, so that the second valve 34 is closed. When the first liquid surface detector 28 detects that the water surface level in the movable tank 6 decreases to a predetermined lower limit, a signal is sent to the third valve 36 to open the same. As a result, water in the tank 8 is supplied to the movable tank 6 from the supplementing pump 20 through the sixth piping 50, etc. When the water reaches a predetermined upper limit, the first water level detector 28 no longer outputs a signal, so that the third valve 36 is closed.

FIG. 1



⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平4−62289

⑤Int.Cl.[5]　識別記号　庁内整理番号　⑬公開　平成4年(1992)2月27日

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7903−2D　E 21 B 7/18

審査請求　未請求　請求項の数 7　(全8頁)

⑭発明の名称　液体ジェット加工装置の研磨材供給方法及び装置

⑳特　願　平2−174277

㉒出　願　平2(1990)6月29日

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明　細　書

1．発明の名称

液体ジェット加工装置の研磨材供給方法及び装置

2．特許請求の範囲

1.研磨材を混合した液体を高圧で噴射することにより加工物を加工する移動可能な液体ジェット加工装置(4)に、研磨材を供給する方法において、

液体ジェット加工装置(4)と共に移動可能な移動タンク(6)を設け、これに液体及び研磨材を収容し、これらを液体ジェット加工装置(4)に供給し、移動タンク(6)内の研磨材が減少したとき、定置される定置タンク(16)内の液体と研磨材とを、移動タンク(6)に補給することを特徴とする液体ジェット加工装置の研磨材供給方法。

2.研磨材を混合した液体を高圧で噴射することにより加工物を加工する移動可能な液体ジェット加工装置(4)に、研磨材を供給する方法において、

液体ジェット加工装置(4)と共に移動可能な移動タンク(6)を設け、これの中に液体及び研磨材を研磨材が液面下に位置するように収容し、移動タンク(6)内の液体と研磨材とを、高圧液体のスプレー作用により吸引して液体ジェット加工装置(4)に供給し、移動タンク(6)内の研磨材が所定の下限レベル以下に減少したとき、定置される定置タンク(16)内の液体とこれの液面下に位置するように収容される研磨材とを、高圧液体のスプレー作用により吸引して移動タンク(6)に補給することを特徴とする液体ジェット加工装置の研磨材供給方法。

3.移動可能な台車(2)上に設けられ、混合ノズル(4a)から研磨材を混合した液体を高圧で噴射することにより加工物を加工する液体ジェット加工装置(4)に、研磨材を供給する研磨材供給装置において、

台車(2)上に液体ジェット加工装置(4)に隣接して、液体及び研磨材を収容した移動タンク

FAS 2004 - Page 183

（６）が設けられており、これの液体及び研摩材を液体ジェット加工装置（４）の混合ノズル（４ａ）に供給可能であり、

液体及び研摩材を収容した定置タンク（１６）が定置部に設けられており、これの液体及び研摩材を移動タンク（６）に補給可能である液体ジェット加工装置の研摩材供給装置。

4.移動可能な台車（２）上に設けられ、混合ノズル（４ａ）から研摩材を混合した液体を高圧で噴射することにより加工物を加工する液体ジェット加工装置（４）に、研摩材を供給する研摩材供給装置において、

液体を入れた液槽（８）と、液槽（８）に接続された加圧ポンプ（１４）及び補給ポンプ（２０）と、定置部に設けられており研摩材を液面下に収容する定置タンク（１６）と、定置タンク（１６）の出口側に設けられた補給研摩材加速ノズル（１８）と、台車（２）上に載置され研摩材を液面下に収容する移動タンク（６）と、移動タンク（６）の出口側に設けられた加速ノズル（１２）と、を有しており、

加圧ポンプ（１４）は、補給研摩材加速ノズル（１８）及び加速ノズル（１２）に加圧した流体を供給可能であり、

補給研摩材加速ノズル（１８）は、定置タンク（１６）内の流体と研摩材とを吸引して移動タンク（６）に供給可能であり、

加速ノズル（１２）は、移動タンク（６）内の流体と研摩材とを吸引して混合ノズル（４ａ）に供給可能であり、

補給ポンプ（２０）は、液槽（８）の液体を定置タンク（１６）及び移動タンク（６）に供給可能である液体ジェット加工装置の研摩材供給装置。

5.移動タンク（６）に、これの研摩材のレベルを検出する研摩材レベル検出器（２２）が設けられており、

研摩材レベル検出器（２２）は、移動タンク（６）の研摩材のレベルが所定の下限レベルよりも低くなったときに、液体及び研摩材の補給を指令する信号を出力する請求項３又は４記載の液体ジェット加工装置の研摩材供給装置。

6.移動タンク（６）から混合ノズル（４ａ）に供給される液体及び研摩材は、研摩材が５０～６０重量パーセントの高濃度スラリーとされており、

定置タンク（１６）から移動タンク（６）に補給される液体及び研摩材は、研摩材が５０重量パーセントよりも少ない低濃度スラリーとされている請求項３、４又は５記載の液体ジェット加工装置の研摩材供給装置。

7.定置タンク（１６）の上部に、研摩材をふるい分けて定置タンク（１６）に供給するふるい分け装置（３０）が設けられている請求項３、４、５又は６記載の液体ジェット加工装置の研摩材供給装置。

３．発明の詳細な説明

（イ）産業上の利用分野

本発明は、移動可能な台車上に設けられた液体ジェット加工装置に研摩材を供給する研摩材供給方法及び装置に関するものである。

（ロ）従来の技術

液体ジェット加工装置は、研摩材の懸濁液を高圧・高速で加工物（コンクリート、岩石、鉄など）に噴射して加工する装置である。このような装置を用いて能率よく加工するためには、研摩材を連続的に供給する装置が必要となる。特開平１－１７７９９９号公報には、研摩材を含む懸濁液を収容する供給タンクが示されている。供給タンクから研摩材を含む懸濁液が液体ジェット加工装置に供給され、これによって液体ジェット加工が行われる。使用済の懸濁液は、回収されて再生処理装置で選別され、通常は、切りくずと研摩材が廃棄処分され、残りの液状のものが調整タンクに送られ、ここで研摩材などを加えて所定の濃度及び比重を有する再生懸濁液とされ、供給タンクに戻されるようになっている。これにより、連続的にジェット加工を行うことができる。

（ハ）発明が解決しようとする課題

上述のような、液体ジェット加工装置を台車な

FAS 2004 - Page 184

どに据え付けて移動可能に構成すると、広い面積範囲の加工が容易に行えて便利である。しかし、液体ジェット加工装置の移動範囲が広くなると、液体ジェット加工装置と調整タンクとの間の距離が長くなる。研磨材の比重は一般的に液体の３～８倍あり、輸送距離が長いと、研磨材が管路内にとり残されやすい。このため、比重の違うものが混在している懸濁液を長い距離、一定の混合比を保ったまま輸送することは、なかなか困難であった。

そこで、研磨材のみを供給タンクまで空気輸送することが考えられるが、実際には、研磨材が吸湿して固まり状となったり、連続的につながったブリッジを生じたりして、輸送困難になるという問題点があった。

本発明は、上記のような課題を解決することを目的としている。

（ニ）課題を解決するための手段

本発明は、台車上に液体ジェット加工装置とともに移動タンクを設け、これに液体と研磨材とを収容して液体ジェット加工装置に供給し、別置きの定置タンクに液体と研磨材とを収容して、移動タンク中の研磨材が減少したとき、定置タンクから移動タンクに液体と研磨材とを補給することにより、上記課題を解決する。すなわち、本発明による液体ジェット加工装置の研磨材供給方法は、研磨材を混合した液体を高圧で噴射することにより加工物を加工する移動可能な液体ジェット加工装置（４）に、研磨材を供給する場合に、

液体ジェット加工装置（４）と共に移動可能な移動タンク（６）を設け、これに液体及び研磨材を収容し、これらを液体ジェット加工装置（４）に供給し、移動タンク（６）内の研磨材が減少したとき、定置される定置タンク（１６）内の液体と研磨材とを、移動タンク（６）に補給するようにしている。

また、液体ジェット加工装置（４）と共に移動可能な移動タンク（６）を設け、これの中に流体及び研磨材を研磨材が液面下に位置するように収容し、移動タンク（６）内の液体と研磨材とを、高圧液体のスプレー作用により吸引して液体ジェット加工装置（４）に供給し、移動タンク（６）内の研磨材が所定の下限レベル以下に減少したとき、定置される定置タンク（１６）内の液体とこれの液面下に位置するように収容される研磨材とを、高圧液体のスプレー作用により吸引して移動タンク（６）に補給するようにすることもできる。

また、上記方法を実施するための装置は、移動可能な台車（２）上に設けられ、混合ノズル（４ａ）から研磨材を混合した液体を高圧で噴射することにより加工物を加工する液体ジェット加工装置（４）に、研磨材を供給するものを対象としており、

台車（２）上に液体ジェット加工装置（４）に隣接して、液体及び研磨材を収容した移動タンク（６）が設けられており、これの液体及び研磨材を液体ジェット加工装置（４）の混合ノズル（４ａ）に供給可能であり、

液体及び研磨材を収容した定置タンク（１６）が定置部に設けられており、これの液体及び研磨材を移動タンク（６）に補給可能である。

また、液体を入れた液槽（８）と、液槽（８）に接続された加圧ポンプ（１４）及び補給ポンプ（２０）と、定置部に設けられており研磨材を液面下に収容する定置タンク（１６）と、定置タンク（１６）の出口側に設けられた補給研磨材加速ノズル（１８）と、台車（２）上に載置され研磨材を液面下に収容する移動タンク（６）と、移動タンク（６）の出口側に設けられた加速ノズル（１２）と、を有しており、

加圧ポンプ（１４）は、補給研磨材加速ノズル（１８）及び加速ノズル（１２）に加圧した流体を供給可能であり、

補給研磨材加速ノズル（１８）は、定置タンク（１６）内の流体と研磨材とを吸引して移動タンク（６）に供給可能であり、

加速ノズル（１２）は、移動タンク（６）内の流体と研磨材とを吸引して混合ノズル（４ａ）に供給可能であり、

FAS 2004 - Page 185

補給ポンプ（２０）は、液槽（８）の液体を定置タンク（１６）及び移動タンク（６）に供給可能である。

なお、移動タンク（６）に、これの研摩材のレベルを検出する研摩材レベル検出器（２２）が設けられており、

研摩材レベル検出器（２２）は、移動タンク（６）の研摩材のレベルが所定の下限レベルよりも低いときに、液体及び研摩材の補給を指令する信号を出力するようにしてもよい。

さらに、移動タンク（６）から混合ノズル（４ａ）に供給される液体及び研摩材は、研摩材が５０～６０重量パーセントの高濃度スラリーとし、　定置タンク（１６）から移動タンク（６）に補給される液体及び研摩材は、研摩材が５０重量パーセントよりも少ない低濃度スラリーとするとよい。

なお、定置タンク（１６）の上部に、研摩材をふるい分けて定置タンク（１６）に供給するふるい分け装置（３０）を設けるようにするとよい。

（ホ）作用

移動タンクから液体と研摩材とが液体ジェット加工装置の混合ノズルに供給される。移動タンクと混合ノズルとの間は短い距離とすることが可能なので、液体に対する研摩材の比率が高い、高濃度のスラリーを混合ノズルに供給することができ、これにより切削速度の大きい液体ジェット加工を行うことができる。また、定置タンクと移動タンクとの間の距離は、一般的に移動タンクと混合ノズルとの間の距離に比較して著しく長いので、上記の高濃度のスラリーよりも濃度の低い、低濃度のスラリーとすることにより、研摩材及び液体が減少した場合に、定置タンクから遠距離にある移動タンクに安定した比率のスラリーを補給することができる。

（ヘ）実施例

第１図に本発明による研摩材供給装置及び液体ジェット加工装置の全体の構成を概略的に示す。

移動可能な台車２に液体ジェット加工装置４が載置されている。液体ジェット加工装置４は、位置及び方向を調節可能な混合ノズル４ａを有しており、後述の研摩材供給装置の液槽８からポンプ１０を通して供給された高圧水と、後述の移動タンク６から供給された水及び研摩材とを、混合ノズル４ａにより混合して高圧の液体ジェット７２として加工物７０に噴射することが可能である。

以下に主として研摩材供給装置を説明する。台車２から離れた場所に、水を入れた液槽８が配置されている。液槽８には、ポンプ１０、加圧ポンプ１４及び補給ポンプ２０が接続されている。ポンプ１０の吐出口は、第１配管４０を介して液体ジェット加工装置４の混合ノズル４ａの一方の入口に接続されている。加圧ポンプ１４の吐出口は２つに分岐しており、これの一方の第３管路４４には、これを開閉する第１バルブ３２が設けられている。第３管路４４の他端は、後述する加速ノズル１２の一端に接続されている。加圧ポンプ１４の他方の第５管路４８にはこれを開閉するプ３６が設けられている。第６管路５０の他端は、後述する移動タンク６の他方の接続口６ｂに接続している。また、他方の第７管路５２には、これを開閉する第４バルブ３８が設けられている。第７管路５２の他端は、後述する定置タンク１６に接続している。

定置タンク１６が、台車２から離れた場所に固定されている。定置タンク１６は、研摩材及び水を混合した状態で収容することが可能である。研摩材は、液面下に位置するように、これのレベルが設定されている。定置タンク１６のホッパ状に縮径された供給口には供給量調節装置である第２流量調整弁２６が設けられている。これの下流側には補給研摩材加速ノズル１８が設けられている。補給研摩材加速ノズル１８は、第４図に示すように、左方の上流側に配置されたオリフィス１８ａと、右方の下流側に配置されたディフューザノズル１８ｂとを有しており、オリフィス１８ａは、下流側ほど流路の断面積が小さくなるように形成されており、また、ディフューザノズ

FAS 2004 - Page 186

ように、左方の上流側に配置されたオリフィス１８ａと、右方の下流側に配置されたディフューザノズル１８ｂとを有しており、オリフィス１８ａは、下流側ほど流路の断面積が小さくなるように形成されており、また、ディフューザノズル１８ｂは、下流側ほど流路の断面積が大きくなるように形成されている。オリフィス１８ａの出口とディフューザノズル１８ｂの入口との間に定置タンク１６の供給口が第２流量調整弁２６を介して開口するようになっている。補給研摩材加速ノズル１８の下流側は、第４管路４６によって後述する移動タンク６の一方の接続口６ａに連通している。定置タンク１６の図中上部に振動式ふるい分け装置３０が配置されている。振動式ふるい分け装置３０は、コンベア６０に接続されている。コンベア６０は、振動式ふるい分け装置３０に研摩材を供給することが可能である。また、振動式ふるい分け装置３０は、コンベア６０から送られてきた研摩材を所定の粒度範囲にふるい分けて定置タンク１６に供給することが可能である。定置タンク１６の側面部に、第２研摩材レベル検出器５６が設けられている。第２研摩材レベル検出器５６は、研摩材の貯蔵量の上限と下限とをそれぞれ設定することが可能であり、研摩材の貯蔵量が所定の下限レベル以下に下がったときに信号を出力し、また、上限位置において信号の出力を停止することが可能である。第２研摩材レベル検出器５６が設けられている位置よりも図中上部に、水位を検出するための第２液面検出器５８が設けられている。第２液面検出器５８は、貯水量の上限と下限とをそれぞれ設定することが可能であり、貯水量の下限位置において信号を出力し、また、上限位置において信号の出力を停止することが可能である。台車２に移動タンク６が、液体ジェット加工装置４とともに載置されている。移動タンク６の内部には、研摩材及び水が収容されている。研摩材は、液面下に位置するように、これのレベルが設定されている。移動タンク６の供給口側には、供給量調節装置である第１流量調整弁２４が設けられており、これの下流側に加速ノズル１２が設けられている。加速ノズル１２は、第４図にかっこ内の符号で示すように、補給研摩材加速ノズル１８と同様の構成とされている。すなわち、左方の上流側に配置されたオリフィス１２ａと、右方の下流側に配置されたディフューザノズル１２ｂとを有しており、オリフィス１２ａは、下流側ほど流路の断面積が小さくなるように形成されており、また、ディフューザノズル１２ｂは、下流側ほど流路の断面積が大きくなるように形成されている。オリフィス１２ａの出口とディフューザノズル１２ｂの入口との間に移動タンク６の供給口が第１流量調整弁２４を介して開口するようになっている。移動タンク６の上部には、２つの接続口６ａ及び６ｂが設けられている。移動タンク６の内部には案内板６２が設けられている。案内板６２は、第２及び３図に示すように、板部材をＶ字形に折り曲げ、Ｖ字を上下反対にして、間隔をあけて多数並べて形成してあり、図示したものは上下に２段としてある。案内板６２は、定置タンク１６から一方の接続口６ａを経て供給される水と混合した研摩材を、衝突・分散させて、タンク内に平均的に積み上げられるように案内する。移動タンク６の内部側壁には研摩材の量を検出する第１研摩材レベル検出器２２が設けられている。同様に、第１研摩材レベル検出器２２が設けられている位置よりも図中上部に水位を検出する第１液面検出器２８が設けられている。なお、研摩材レベル検出器２２及び５６は同じものが用いられており、同様に液面検出器２８及び５８は同じものが用いられている。移動タンク６の側面部には、オーバフロー管６４が取り付けられている。オーバフロー管６４は、これより図中上部にあふれた水をタンク外に排出可能である。

次にこの実施例の作用について説明する。移動タンク６には、水と研摩材とがそれぞれ所定のレベルで収容されている。研摩材は液面下にあるように、そのレベルが設定されている。同様に、定置タンク１６には、水と研摩材とがそれぞれ所定のレベルで収容されている。研摩材は液面下にあ

FAS 2004 - Page 187

るように、そのレベルが設定されている。液槽８の水は、ポンプ１０によって１５００ｋｇ／ｃｍ²の高圧水とされ、第１管路４０を通って流体ジェット加工装置４の混合ノズル４ａに供給される。一方、液槽８の水は、加圧ポンプ１４によって２０～３０ｋｇ／ｃｍ²に加圧され、第１バルブ３２を通って第３管路４４内を通り、加速ノズル１２によって加速される。これにより移動タンク６から水と研摩材とが第１流量調整弁２４を経て吸引され、研摩材濃度５０～６０重量パーセントの高濃度スラリーとして第２管路４２に送り出される。スラリー濃度は、第１流量調整弁２４の開度を調整することにより調整することが可能である。これらの水と研摩材とは、混合ノズル４ａに供給され、第１管路４０からの高圧水と混合され、液体ジェット加工が行われる。液体ジェット加工の進行につれて、移動タンク６内の水及び研摩材の量がそれぞれ減少していく。移動タンク６の第１研摩材レベル検出器２２は、移動タンク６内の研摩材のレベルを検出しており、これが所定の下限位置よりも低くなると、第２バルブ３４に信号を出力して、これを開く。これにより定置タンク１６の補給研摩材加速ノズル１８が作動し、定置タンク１６から水と研摩材が、第２流量調整弁２６を経て吸引され、研摩材濃度３０重量パーセント程度の低濃度スラリーとして第４管路４６に送り出される。スラリー濃度は、第２流量調整弁２６の開度を調整することにより調整することが可能である。研摩材濃度を上記のようにすることにより、５０ｍ以上の長距離であっても、水と研摩材とを一定濃度のスラリーとして輸送することができる。これらの水と研摩材とは、移動タンク６の一方の接続口６ａを経て移動タンク６内に供給され、案内板６２に案内されてタンク内に分散して積み上げられる。所定の上限レベルまで研摩材が補給されると、第１研摩材レベル検出器２２は信号を出力しなくなり、第２バルブ３４が閉じられる。また、第１液面検出器２８は、移動タンク６内の水位を検出しており、水位が所定の下限レベル以下に下がると、第３バルブ３６に信号を出力して、これを開き、補給ポンプ２０から液槽８の水を第６管路５０及び他方の接続口６ｂを経て移動タンク６内に補給する。所定の上限レベルまで水が補給されると、第１液面検出器２８は信号を出力しなくなり、第３バルブ３６は閉じられる。なお、定置タンク１６から水と研摩材とが移動タンク６に補給される際、水があふれるような場合には、この余分な水は、オーバフロー管６４から外部に排出される。

一方、定置タンク１６の第２研摩材レベル検出器５６は、定置タンク１６の研摩材のレベルを検出しており、これが所定の下限レベルよりも低くなると、第２研摩材レベル検出器５６から警告信号が出力される。このとき、たとえば手動操作によってコンベア６０及び振動式ふるい分け装置３０を駆動すればよい。これによりコンベア６０から研摩材が、振動式ふるい分け装置３０に供給され、振動式ふるい分け装置３０は、所定の粒度範囲の研摩材をふるい分けて定置タンク１６に供給し、これ以外の粒度の研摩材を取り除いて廃棄する。研摩材が所定の上限レベルまで供給されると、研摩材レベル検出器５６は信号を出力しなくなるので、振動式ふるい分け装置３０及びコンベア６０を停止させる。一方、第２液面検出器５８は、定置タンク１６の水位を検出しており、これが所定の下限レベルよりも低くなると、第２液面検出器５８から第４バルブ３８に信号を出力して、これを開き、補給ポンプ２０及び第７管路５２を経て、水が液槽８から定置タンク１６に供給される。所定の上限レベルになると、第２液面検出器５８は信号を出力しなくなり、第４バルブ３８が閉じられる。

なお、上記説明では、液槽８には水を入れるものとしたが、水よりも比重の大きい重液を入れるようにしてもよく、また、重液と界面活性剤とを混合した液体を入れるようにしてもよい。

なお、上記説明では、研摩材レベル検出器２２が移動タンク６の研摩材のレベルが低下したことを検出したときに、水と研摩材とを自動的に

FAS 2004 - Page 188

補給するようにしており、また、同様に移動タンク６及び定置タンク１６の水位も自動的に一定範囲内にあるように制御するものとしたが、これらは手動で操作しても差し支えない。

また、上記説明では、振動式ふるい分け装置３０を用いるものとしたが、ほかの形式のふるい分け装置を用いることもできる。

（ト）発明の効果

以上説明してきたように、本発明によると、移動可能な台車上に液体ジェット加工装置と移動タンクとを設けたので、高濃度のスラリーを液体ジェット加工装置に円滑に供給することができる。これにより液体ジェット加工装置の加工速度を大きくすることができる。また、定置タンクからは、低濃度のスラリーを移動タンクに補給するようにしたので、定置タンク及び移動タンク間の距離が長い場合でも、研磨材及び液体の安定した輸送ができ、しかも従来と比較して単位時間当たり大量の研磨材が供給可能となる。

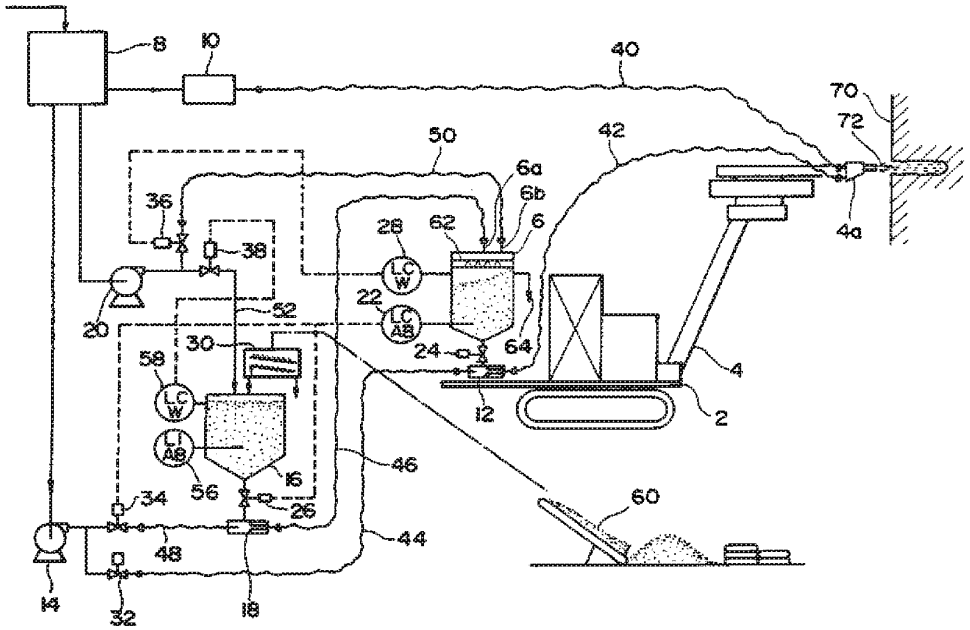
４．図面の簡単な説明

第１図は本発明の実施例を示す図、第２図は本発明に用いられる案内板の作用を示す図、第３図は案内板の上面図、第４図は本発明に用いられる加速ノズル又は補給研磨材加速ノズルを示す図である。

２・・・台車、４・・・液体ジェット加工装置、４ａ・・・混合ノズル、６・・・移動タンク、８・・・液槽、１０・・・ポンプ、１２・・・加速ノズル、１４・・・加圧ポンプ、１６・・・定置タンク、１８・・・補給研磨材加速ノズル、２２・・・研磨材レベル検出器、２８・・・第１液面検出器、３０・・・振動式ふるい分け装置、３２・３４・３６・３８・・・バルブ、４０・４２・４４・４６・４８・５０・５２・・・管路、５６・・・第２研磨材レベル検出器、５８・・・第２液面検出器。

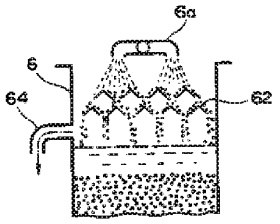
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第１図

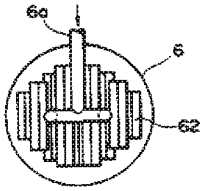


FAS 2004 - Page 189

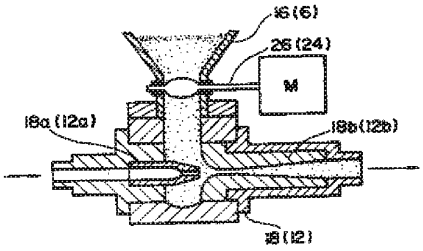
第 2 図



第 3 図



第 4 図



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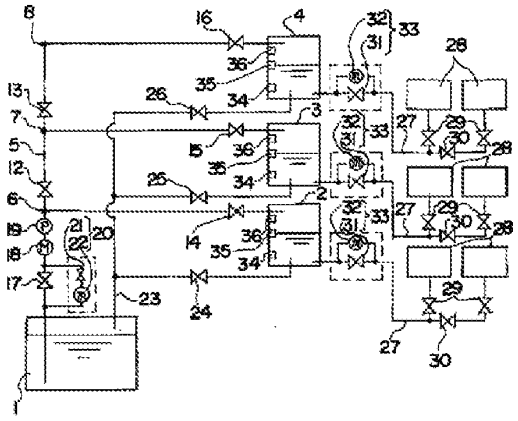
F terms (reference) 3E083 AA02 AA03 AB04 AC02 AE06 AE12 AJ07

(54) Title of Invention CENTRALIZED OIL SUPPLY SYSTEM

(57) Abstract

[Problem] To provide a centralized oil supply system that can sense a minute oil leak in an initial stage in a centralized oil supply system.

[Resolution Means] A space between a storage tank 1 and relay tanks 2, 3, 4 is connected with a main pipe 5 and branched pipes 9, 10, 11; the main pipe 5 is provided with an oil supply pump 19, a main pipe flow meter 18, and a main pipe opening and closing valve 17, and a main pipe oil leak sensing part 20 composed of an oil leak sensing flow meter 22 that senses minute flow rates and an oil leak sensing opening and closing valve 21 is provided bypassing the main pipe 5 opening and closing valve 17, allowing the oil supply rate under the normal oil supply process to be sensed by the main pipe flow meter 18, and during oil leak sensing, because the existence of an initial stage oil leak can be confirmed by the oil leak sensor flow meter 22 that senses minute flow rates, even minute flow rates of an initial stage oil leak can be sensed.



[Scope of Patent Claims]
What is claimed is:

[Claim 1]
An oil supply system, comprising:
a storage tank for storing liquid fuel, a main pipe for supplying liquid fuel inside the storage tank, a branched pipe that branches from the main pipe, a relay tank connected to the branched pipe for accumulating liquid fuel supplied from the storage tank, and a distribution pipe for supplying liquid fuel in the relay tank to a combustion instrument; wherein
the main pipe, in a centralized oil supply system provided with a supply pump for feeding liquid fuel in a storage tank, a main pipe flow meter for sensing the flow rate of liquid fuel in the main pipe, and a main pipe opening and closing valve for opening and closing the main pipe, the branched pipe is provided with a branched pipe opening and closing valve for opening and closing the pipe, and the main pipe is provided with an oil leak sensing part composed of an oil leak sensing flow meter for sensing minute flow rates and an oil leak sensing opening and closing valve for opening and closing the flow of liquid fuel into the oil leak sensing flow meter, bypassing the main pipe opening and closing valve.
[Claim 2]
The centralized oil supply system according to claim 1, wherein the centralized oil supply system is provided with a control device having an oil leak sensing mode for determining that an oil leak is occurring when the oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the oil leak sensing opening and closing valve is opened and the oil supply pump is operated after closing the main pipe opening and closing valve and the branched pipe opening and closing valve.
[Claim 3]
The centralized oil supply system according to claim 2, wherein the relay tank has connected thereto a return pipe having a return pipe opening and closing value for opening and closing the pipe, for returning liquid fuel in the relay tank to the storage tank, and a control device is provided that, at the beginning of oil leak sensing mode, when liquid fuel is supplied from the storage tank until a predetermined amount of liquid fuel is accumulated in the relay tank and a predetermined amount is not accumulated after a predetermined amount of time passes from starting to supply oil, determines that an oil leak is occurring and opens the return pipe opening and closing valve.
[Claim 4]
The centralized oil supply system according to claim 3, wherein main pipe separating opening and closing valves are provided on the part of the main pipe between the branched pipe and the branched pipe, and a control device is provided that, when it determines that an oil leak is occurring in oil leak sensing mode, repeatedly executes oil leak sensing mode by executing oil leak sensing mode from a state of all main pipe separating opening and closing valves being closed and sequentially opening them every time oil leak sensing mode is executed from a main pipe separating opening and closing valve on the upstream side of the main pipe until it is determined that an oil leak is occurring.
[Claim 5]
The centralized oil supply system according to claim 1, wherein the connecting portions of the distribution pipe with the relay tank are provided with a distribution pipe sensing opening and closing valve, and is provided with a distribution pipe oil leak sensing flow meter bypassing the

distribution pipe sensing opening and closing valve, load opening and closing valves are provided between the combustion instrument and the distribution pipe, and a control device is provided having a distribution pipe oil leak sensing mode for determining that an oil leak is occurring and opening the return pipe opening and closing valves when the distribution pipe oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the distribution pipe sensing opening and closing valve is closed after closing all of the load opening and closing valves.

[Claim 6]

The centralized oil supply system according to claim 5, wherein a distribution pipe separating opening and closing valve are provided between the connecting portion of the combustion instrument and the distribution pipe and the connecting portion of the next combustion instrument and distribution pipe, and a control device is provided that, when it determines that an oil leak is occurring in distribution pipe oil leak sensing mode, repeatedly executes distribution pipe oil leak sensing mode by executing distribution pipe oil leak sensing mode from a state of all distribution pipe separating opening and closing valves being closed and sequentially opening them every time distribution pipe oil leak sensing mode is executed from a distribution pipe separating opening and closing valve on the upstream side of the distribution pipe until it is determined that an oil leak is occurring.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a centralized oil supply system for feeding liquid fuel in a storage tank installed underground or above ground to a plurality of combustion instruments via a relay tank.

[0002]

[Related Art] Conventionally, this sort of thing is installed underground or above ground, where 101 is a storage tank storing a large amount of liquid fuel such as kerosene, and supplies liquid fuel to relay tanks 102, 103, 104 that are installed on each floor of a multistory structure, such as a building, as illustrated in FIG. 6, for example.

[0003] 105 is a main pipe, one end of which is provided in the storage tank 101, and the other end of which is connected to the relay tank 104 in the top story of a building; the main pipe is branched partway therethrough and connects to the relay tanks 102, 103, on each floor.

[0004] On the side of the storage tank 101 of the main pipe 105 is provided a main pipe opening and closing valve 106 for performing opening and closing of the connection of the main pipe 105 to the storage tank 101; a main pipe flow meter 107 which measures and displays the liquid fuel supplied to the relay tanks 102, 103, 104 from the storage tank 101; and an oil supply pump 108 which feeds the liquid fuel in the storage tank 101 to the relay tanks 102, 103, 104. Branched part opening and closing valves 109, 110, 111 for opening and closing the connection of the relay tanks 102, 103, 104, to the main pipe are provided on each branched portion in front of the connecting portion of the main pipe 105 and each relay tank 102, 103, 104.

[0005] 112 is a return pipe with one end provided in the storage tank 101, and the other end is branched and connected to each relay tank 102, 103, 104; also, return opening and closing valves 113, 114, 115 for opening and closing the connection of the return pipe 112 and the relay tanks 102, 103, 104 in the branched part are provided at each branched portion.

[0006] 116 is a distribution pipe with one end connected to the relay tanks 102, 103, 104 and the other end branched partway and connected to each combustion instrument 117 such as a heater

or water heater for that floor; a load opening and closing valve 118 which performs the opening and closing of the connection of the combustion instrument 117 and the distribution pipe 112 is provided in the connecting portion of each combustion instrument 117.
[0007] Provided in the relay tanks 102, 103, 104 are a supply sensing sensor 119 that outputs a supply signal when the liquid fuel in a tank decreases to a predetermined lower limit amount, a stop sensing sensor 120 that outputs a stop signal when the liquid fuel in a tank increases to a predetermined upper limit amount, and an overflow sensing sensor 121 that outputs an overflow signal when the liquid fuel in a tank increases to a limit amount that exceeds the predetermined upper limit amount.
[0008] The operation of this centralized oil supply system is described next. First, when the liquid fuel in a tank that is one of the relay tanks 102, 103, 104 decreases to a predetermined lower limit amount and a supply signal is outputted from the supply sensing sensor 119 of that tank, the control part (not illustrated) of the centralized oil supply system changes the branched part opening and closing valve 109, 110, 111 of the tank that the supply signal is outputted from a closed state to an open state, changes the main pipe opening and closing valve 106 of the main pipe 105 from a closed state to an open state, drives the oil supply pump 108, and supplies liquid fuel from the storage tank 101 to the tank that outputted the supply signal.
[0009] Then, when the liquid fuel in the tank that outputted a supply signal increases and reaches a predetermined upper limit amount, a stop signal is outputted from the stop sensing sensor 120 of that tank, causing the control part to stop the oil supply pump 108, change the main pipe opening and closing valve 106 and the branched part opening and closing valve 109, 110, 111 thereof from an open state to a closed state, and the supplying of liquid fuel ends; when a supply signal is outputted from a plurality of relay tanks 102, 103, 104, the branched part opening and closing valve 109, 110, 111 of the tank that outputted a stop signal is changed from an open state to a closed state, the supply pump 108 is stopped at the time a stop signal is outputted from all of the relay tanks 102, 103, 104 that outputted a supply signal, the main pipe opening and closing valve 106 is changed from an open state to a closed state, and the supplying of liquid fuel ends.
[0010] At this time, when the stop sensing sensor 120 malfunctions, the branched part electromagnetic valve 109, 110, 111 malfunctions, or the like, and the liquid fuel in the relay tank 102, 103, 104 exceeds a predetermined upper limit amount and increases to the limit amount, the overflow sensing sensor 121 outputs an overflow signal, causing the control part to change the return electromagnetic valve 113, 114, 115 for that tank from a closed state to an open state and return the liquid fuel in the tank to the storage tank 101 via the return pipe 112.
[0011]
The oil leak sensing operation of this centralized oil supply system is described next. First, all of the branched part opening and closing valves 109, 110, 111 are changed to the closed state, and in that state, the main pipe opening and closing valve 106 of the main pipe 105 is changed from a closed state to an open state; the oil supply pump 108 is driven, and at that time, if the main pipe flow meter 107 displays a flow rate, the controller determines that an oil leak is occurring somewhere on the main pipe 105 between the main pipe flow meter 107 and the branched part opening and closing valves 109, 110, 111, and until repairs are complete and the oil leak occurrence sensing of the controller is reset, the supply of liquid fuel from the storage tank 101 to the relay tanks 102, 103, 104 is stopped.
[0012]
[Problem to be Resolved by the Invention] However, a conventional centralized oil supply system had a problem in that because the flow rate that the main pipe flow meter 107 usually

measures is a flow rate of 50 liters or 100 liters per hour, a flow rate of, for example, 0.1 liters per hour of the initial stage of an oil leak could not be measured, and because it is not displayed, an oil leak could be sensed only is a state of the oil leak becoming larger.
[0013] Further, even if an oil leak is sensed, where on the main pipe 105 between the main pipe flow meter 107 and the branched part opening and closing valves 109, 110, 111 the oil leak was occurring could not be ascertained, and the worker performing the repair needed to look for the location causing the oil leak.
[0014] Also, it was not possible to perform sensing of an oil leak in the distribution pipe 116 from the relay tanks 102, 103, 104 to the combustion instrument 117.
[0015] In view of the foregoing problems, an object of the present invention is to provide a centralized oil supply system that can sense an oil leak in its initial stage and ascertain the location of the oil leak.
[0016]
[Means for Resolving the Problem] Because the present invention focuses on these points and resolves the aforementioned drawbacks, in particular, the configuration thereof is provided in claim 1 as a storage tank for storing liquid fuel, a main pipe for supplying liquid fuel inside the storage tank, a branched pipe that branches from the main pipe, a relay tank connected to the branched pipe for accumulating liquid fuel supplied from the storage tank, and a distribution pipe for supplying liquid fuel in the relay tank to a combustion instrument; wherein the main pipe, in a centralized oil supply system provided with a supply pump for feeding liquid fuel in a storage tank, a main pipe flow meter for sensing the flow rate of liquid fuel in the main pipe, and a main pipe opening and closing valve for opening and closing the main pipe, the branched pipe is provided with a branched pipe opening and closing valve for opening and closing the pipe, and the main pipe is provided with an oil leak sensing part composed of an oil leak sensing flow meter for sensing minute flow rates and an oil leak sensing opening and closing valve for opening and closing the flow of liquid fuel into the oil leak sensing flow meter, bypassing the main pipe opening and closing valve.
[0017] Further, in particular, the configuration of the centralized oil supply system according to claim 2 of the present invention is, relating to claim 1, given such that the centralized oil supply system is provided with a control device having an oil leak sensing mode for determining that an oil leak is occurring when the oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the oil leak sensing opening and closing valve is opened and the oil supply pump is operated after closing the main pipe opening and closing valve and the branched pipe opening and closing valve.
[0018] Further, in particular, the configuration of the centralized oil supply system according to claim 3 of the present invention is, relating to claim 2, given such that the relay tank has connected thereto a return pipe having a return pipe opening and closing value for opening and closing the pipe, for returning liquid fuel in the relay tank to the storage tank, and a control device is provided that, at the beginning of oil leak sensing mode, when liquid fuel is supplied from the storage tank until a predetermined amount of liquid fuel is accumulated in the relay tank and a predetermined amount is not accumulated after a predetermined amount of time passes from starting to supply oil, determines that an oil leak is occurring and opens the return pipe opening and closing valve.
[0019] Further, in particular, the configuration of the centralized oil supply system according to claim 4 of the present invention is, relating to claim 3, given such that the main pipe separating opening and closing valves are provided on the part of the main pipe between the branched pipe

and the branched pipe, and a control device is provided that, when it determines that an oil leak is occurring in oil leak sensing mode, repeatedly executes oil leak sensing mode by executing oil leak sensing mode from a state of all main pipe separating opening and closing valves being closed and sequentially opening them every time oil leak sensing mode is executed from a main pipe separating opening and closing valve on the upstream side of the main pipe until it is determined that an oil leak is occurring.

[0020] Further, in particular, the configuration of the centralized oil supply system according to claim 5 of the present invention is, relating to claim 1, given such that the connecting portion of the distribution pipe with the relay tank is provided with a distribution pipe sensing opening and closing valve, and is provided with a distribution pipe oil leak sensing flow meter bypassing the distribution pipe sensing opening and closing valve, load opening and closing valves are provided between the combustion instrument and the distribution pipe, and a control device is provided having a distribution pipe oil leak sensing mode for determining that an oil leak is occurring and opening the return pipe opening and closing valves when the distribution pipe oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the distribution pipe sensing opening and closing valve is closed after closing all of the load opening and closing valves.

[0021] Further, in particular, the configuration of the centralized oil supply system according to claim 6 of the present invention is, relating to claim 5, given such that distribution pipe separating opening and closing valves are provided between the connecting portion of the combustion instrument and the distribution pipe and the connecting portion of the next combustion instrument and distribution pipe, and a control device is provided that, when it determines that an oil leak is occurring in distribution pipe oil leak sensing mode, repeatedly executes distribution pipe oil leak sensing mode by executing distribution pipe oil leak sensing mode from a state of all distribution pipe separating opening and closing valves being closed and sequentially opening them every time distribution pipe oil leak sensing mode is executed from a distribution pipe separating opening and closing valve on the upstream side of the distribution pipe until it is determined that an oil leak is occurring.

[0022]

[Mode of Carrying Out the Invention] According to the centralized oil supply system of the aforementioned configuration described in claim 1, the space between the storage tank that stores liquid fuel and the relay tanks that accumulate liquid fuel supplied from the storage tank is connected with a main pipe and branched pipes that branch from the main pipe; the main pipe is provided with an oil supply pump, a main pipe flow meter, and a pipe opening and closing valve; and an oil leak sensing part composed of an oil leak sensing flow meter that senses minute flow rates and an oil leak sensing opening and closing valve that opens and closes the flow of liquid fuel into the oil leak sensing flow meter is provided bypassing the main pipe opening and closing valve.

[0023] This allows the oil supply rate of the normal oil supply process to be sensed by the main pipe flow meter, and during oil leak sensing, because the existence of an oil leak can be confirmed by the oil leak sensing flow meter that senses minute flow rates, even minute flow rates of an initial stage oil leak can be sensed, and furthermore, for that reason, complex sensing structures are unnecessary, and the cost can be kept low.

[0024] According to the centralized oil supply system of the aforementioned configuration described in claim 2, the centralized oil supply system of claim 1 is provided with a control device having an oil leak sensing mode for determining that an oil leak is occurring when the oil

leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the oil leak sensing opening and closing valve is opened and the oil supply pump is operated after closing the main pipe opening and closing valve and the branched pipe opening and closing valve.

[0025] Even when an oil leak is occurring in the main pipe and the branched pipes from the oil leak sensing part of the main pipe to the branched part opening and closing valves, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the oil leak sensing flow meter, by changing the value of the predetermined flow rate set beforehand, it can be adjusted.

[0026] According to the centralized oil supply system of the aforementioned configuration described in claim 3, the centralized oil supply system of claim 2 has the relay tanks and the storage tank connected with a return pipe having a return pipe opening and closing valve that opens and closes the pipe, and is provided with a control device that supplies oil to the relay tank at the beginning of the oil leak sensing mode, and when a predetermined amount does not accumulate in the relay tanks after a predetermined time has elapsed from starting the oil supply, determines that an oil leak is occurring and opens the return pipe opening and closing valves.

[0027] Because of this, when it is determined that an oil leak is occurring with the oil leak sensing mode, even if oil is not supplied from the storage tank to the relay tanks from then until an inspection and repairs are completed, a predetermined amount of liquid fuel is accumulated inside the relay tanks, whereby the combustion instrument process can be performed for a while even after it is determined that an oil leak is occurring, and even if an oil leak is occurring in the main pipe and the branched pipes, a centralized oil supply system with few inconveniences is provided.

[0028] According to the centralized oil supply system of the aforementioned configuration described in claim 4, the centralized oil supply system of claim 3 is provided with main pipe separating opening and closing valves in the main pipe portion between the branched pipe and the branched pipe, and a control device is provided that, when it determines that an oil leak is occurring in oil leak sensing mode, repeatedly executes oil leak sensing mode by executing oil leak sensing mode from a state of all main pipe separating opening and closing valves being closed and sequentially opening them every time oil leak sensing mode is executed from a main pipe separating opening and closing valve on the upstream side of the main pipe until it is determined that an oil leak is occurring.

[0029] Because of this, after it is determined that an oil leak is occurring, first, it is checked whether the oil leak is occurring between the main pipe and the branched pipe between the oil leak sensing part of the main pipe to the relay tank connected to the branched pipe on the most upstream side of the main pipe; if it is not occurring, next, it is checked whether an oil leak is occurring between the main pipe and the branched part between the oil leak sensing part of the main pipe and the relay tank connected to the second upstream side branched pipe of the main pipe; next, it is the relay tank connected to the third upstream side branched pipe of the main pipe, and it continues to do the oil leak check of the branched pipe of the main pipe from the upstream side, whereby it can be ascertained to a degree in which portion of the main pipe and the branched pipe the oil leak is occurring, reducing the labor of the repair worker searching for the location the oil leak is occurring, and greatly shortening the labor time.

[0030] According to the centralized oil supply system of the aforementioned configuration described in claim 5, the centralized oil supply system of claim 1 has the connecting portions of

the distribution pipe with the relay tank provided with a distribution pipe sensing opening and closing valve, is provided with a distribution pipe oil leak sensing flow meter bypassing the distribution pipe sensing opening and closing valve, load opening and closing valves are provided between the combustion instrument and the distribution pipe, and a control device is provided having a distribution pipe oil leak sensing mode for determining that an oil leak is occurring and opening the return pipe opening and closing valves when the distribution pipe oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the distribution pipe sensing opening and closing valve is closed after closing all of the load opening and closing valves.

[0031] Because of this, even when an oil leak is occurring in the distribution pipe from the distribution pipe oil leak sensing flow meter to the load opening and closing valve, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the oil leak sensing flow meter, by changing the value of the previously set predetermined flow rate, it can be adjusted; moreover, when it is determined that an oil leak is occurring, the liquid fuel inside the relay tanks is returned to the storage tank via the return pipe, whereby the oil leak from the distribution pipe can be prevented until repairs and inspection are complete.

[0032] According to the centralized oil supply system of the aforementioned configuration described in claim 6, the centralized oil supply system of claim 5 has a distribution pipe separating opening and closing valve provided between the connecting portion of the combustion instrument and the distribution pipe and the connecting portion of the next combustion instrument and distribution pipe, and a control device is provided that, when it determines that an oil leak is occurring in distribution pipe oil leak sensing mode, repeatedly executes distribution pipe oil leak sensing mode by executing distribution pipe oil leak sensing mode from a state of all distribution pipe separating opening and closing valves being closed and sequentially opening them every time distribution pipe oil leak sensing mode is executed from a distribution pipe separating opening and closing valve on the upstream side of the distribution pipe until it is determined that an oil leak is occurring.

[0033] Because of this, after it is determined that an oil leak is occurring, first, it is checked whether the oil leak is occurring between the distribution pipe oil leak sensing flow meter and the most upstream side load opening and closing valve of the distribution pipe; if it is not occurring, next, it is checked whether the oil leak is occurring between the distribution pipe oil leak sensing flow meter and the second upstream side load opening and closing valve of the distribution pipe; next, it is the third upstream side load opening and closing valve of the distribution pipe, and it continues to do the oil leak check from the upstream side of the distribution pipe, whereby it can be ascertained to a degree in which portion of the distribution pipe the oil leak is occurring, reducing the labor of the worker performing the repair searching for the location the oil leak is occurring, and greatly shortening the labor time.

[0034]

[Examples] Next, the centralized oil supply system related to this invention is described with an example illustrated in the drawings. 1 is a storage tank which stores a large amount of a liquid fuel such as kerosene, is installed below ground or above ground, and supplies liquid fuel to relay tanks 2, 3, 4 installed on each floor of a multistory structure, such as a building.

[0035] 5 is a main pipe, one end of which is provided in the storage tank 1, and the other end of which is provided until the height of the height of the relay tank 4 in the top story of a building;

the branched pipes 9, 10, 11 which branch from the branch parts 6, 7, 8 of the main pipe 5 are connected in the relay tanks 2, 3, 4 of each floor.

[0036] A main pipe separating opening and closing valve 12is provided between the branch part 6 and the branch part 7 of the main pipe 5; also, a main pipe separating opening and closing valve 13 is provided between the branch part 7 and the branch part 8; also, branched pipe opening and closing valves 14, 15, 16 are provided in each branched pipe 9, 10, 11, respectively.

[0037] 17 is a main pipe opening and closing valve, is provided on the side of the storage tank 1 of the main pipe 5, and performs the opening and closing of the connection of the storage tank 1 and the main pipe 5; further, a main pipe flow meter 18 which measures and displays the liquid fuel supplied to the relay tanks 2, 3, 4 from the storage tank 1, and an oil supply pump 19 which feeds the liquid fuel in the storage tank 1 to the relay tanks 2, 3, 4 via the main pipe 5, are provided in series between the main pipe opening and closing valve 17 and the first branch part 6.

[0038] 20 is a main pipe oil leak sensing part, is provided in parallel bypassing the main pipe opening and closing valve 17, is connected in series with the oil leak sensing opening and closing valve 21 and the oil leak sensing opening and closing valve 21, and is composed of an oil leak sensing flow meter 22 capable of measuring and displaying a minute flow rate.

[0039] 23 is a return pipe with one end provided in the storage tank 1, and the other end is branched and connected to the bottom part of each relay tank 2, 3, 4; also, return pipe opening and closing valves 24, 25, 26 which perform the opening and closing of the connection of the return pipe 23 and the relay tanks 2, 3, 4 in the branched branch part are provided.

[0040] 27 is a distribution pipe and is provided from the relay tanks 2, 3, 4, to the building interior, with one end connected to the relay tanks 2, 3, 4, and the other end branched partway and connected to each combustion instrument 28 such as a heater or water heater for that floor; a load opening and closing valve 29 which performs the opening and closing of the connection of the combustion instrument 28 and the distribution pipe 27 is provided in the connecting portion of each combustion instrument 28.

[0041] A distribution pipe separating opening and closing valve 30 is provided between the branch portion of the distribution pipe 27 and the next branch portion, and a distribution pipe sensing opening and closing valve 31 connected in series to the distribution pipe 27 and a distribution pipe oil leak sensing part 33 composed of a distribution pipe sensing opening and closing valve 31 and distribution pipe oil leak sensing flow meter 32 that can measure and display a minute flow rate provided in parallel and bypassing the distribution pipe sensing opening and closing valve 31, is provided in the connecting portion of the relay tanks 2, 3, 4.

[0042] Further, provided in the relay tanks 2, 3, 4 are a supply sensing sensor 34 that outputs a supply signal when the liquid fuel in a tank decreases to a predetermined lower limit amount, a stop sensing sensor 35 that outputs a stop signal when the liquid fuel in a tank increases to a predetermined upper limit amount, and an overflow sensing sensor 36 that outputs an overflow signal when the liquid fuel in a tank increases to a limit amount that exceeds the predetermined upper limit amount.

[0043] 37 is a control device, having a control part 38 composed of a microcomputer; a flow rate input part 39 that inputs as signals the flow rate values sensed by each flow meter, which are the main pipe flow meter 18, the oil leak sensing flow meter 22, the distribution pipe oil leak sensing flow meter 32; an operation part 40 provided with buttons or switches for each kind of operation and setting such as an oil supply process button (not illustrated) that performs a centralized oil supply process, an oil leak sensing button (not illustrated) that performs the oil leak sensing of

the main pipe 5 and the branched pipes 9, 10, 11, and a manual opening and closing switch (not illustrated) for each opening and closing valve; a display part 41 that displays the flow rate value sensed by each flow meter, the estimated flow rate, process state, abnormal state, and the like of the main pipe 5 and each branched pipe 27; a pump drive part 42 that controls the process of the oil supply pump 19; an opening and closing valve drive part 43 that controls the opening and closing operation of each opening and closing valve; a timer part 44 that counts the time when an oil leak is sensed; a determining part 45 that determines whether an oil leak is occurring or not when an oil leak is sensed; a liquid level signal input part 46 that inputs the supply signal, stop signal, and overflow signal from the supply sensing sensor 34, stop sensing sensor 35, and the overflow sensing sensor 36 in the relay tanks 2, 3, 4.

[0044] The oil supply process of this centralized oil supply system is described next. First, when the oil supply process button of the operation part 40 of the control device 37 is operated to be on, the control device 38 will confirm whether a supply signal is input from any of the relay tanks 2, 3, 4; when a supply signal is input, among the branched pipe opening and closing valves 14, 15, 16 that are normally closed when the oil supply process is not being performed, the branched pipe opening and closing valves 14, 15, 16 of the branch pipes 9, 10, 11 of the relay tanks 2, 3, 4 outputting the supply signal are changed from a closed state to an open state, and the main pipe opening and closing valve 17 of the main pipe 5 that is normally closed when the oil supply process is not being performed is changed from a closed state to an open state, and oil supply pump 19 is driven.

[0045] Therefore, the kerosene in storage tank 1 passes through the branched pipes 9, 10, 11 with the branched pipe opening and closing valves 14, 15, 16 from the main pipe 5 in the open state, and is supplied to the relay tank 2, 3, 4 that is outputting the supply signal; if the kerosene amount in the relay tank 2, 3, 4 increases and a stop signal is output from the stop sensing sensor 35 of that tank, and if at that time a supply signal is output by another relay tank 2, 3, 4, once the branched pipe opening and closing valve 14, 15, 16 of the branched pipe 9, 10, 11 connected to the relay tank 2, 3, 4 outputting the stop signal is in a closed state, it proceeds to supply oil to the other relay tank 2, 3, 4 that is outputting the supply signal; if a supply signal is not output by another relay tank 2, 3, 4, the oil supply pump 19 is stopped, the main pipe opening and closing valve 17 of main pipe 5 is put in a closed state, and the branched pipe opening and closing valve 14, 15, 16 that was in an open state is put in a closed state and the oil supply process is stopped.

[0046] Next the oil leak sensing of this centralized oil supply system will be described. First, when the oil leak sensing button of the operation part 40 of the control device 37 is operated to be on (S1), the control part 38 will first start the main pipe side check mode that performs the oil leak sensing of the main pipe 5 (S2), first it checks the state of each relay tank 2, 3, 4 that has filled to the predetermined upper limit, or in other words is outputting the stop signal (S3), if a stop signal is not being outputted from each relay tank 2, 3, 4, then the branched pipe opening and closing valve 14, 15, 16 of the branched pipe 9, 10, 11 of the relay tank 2, 3, 4 that is not outputting the stop signal is put in an open state (S4), the main pipe opening and closing valve 17 is put in an open state and the oil supply pump 19 is driven (S5), and the timer part 44 is started (S6).

[0047] It is then confirmed whether a stop signal was output by any of the relay tanks 2, 3, 4 that started supplying (S7); if a stop signal is not being output by any of them, it is checked whether a predetermined time t has elapsed since the timer part 44 started (S8); if the predetermined time t has not elapsed it returns to (S7) and confirms if a stop signal was output from any of the relay tanks 2, 3, 4, and if the predetermined time t has elapsed, for example even if the liquid fuel

inside the tank has decreased to a predetermined lower limit amount, after starting the supplying it is sufficiently increased to a predetermined upper limit amount and can output a stop signal, and by not outputting or inputting a stop signal even if a predetermined time t which is a sufficient supply time has elapsed, it can clearly be determined that an abnormality such as a large oil leak is occurring, the oil supply pump 19 is stopped, and the main pipe opening and closing valve 17 and all the branched pipe opening and closing valves 14, 15, 16 are closed (S9).

[0048] Then a display to the effect that a large oil leak is occurring in the relay tank 2, 3, 4 that is not outputting a stop signal from the main pipe is performed in the display part 41 of the control device 37 (S10), and for the safety of the relay tank 2, 3, 4 with the non-outputted stop signal, the return pipe opening and closing valves 24, 25, 26 of the return pipe 23 connected to the tank will be opened and the liquid fuel inside the tank will be returned to the storage tank 1 (S11), and there the oil leak sensing will end (S12).

[0049] Further, in (S7), if a stop signal was output from any of the relay tanks 2, 3, 4 that began supplying oil, the branched pipe opening and closing valves 14, 15, 16 of the relay tank 2, 3, 4 that output the stop signal will be put in a closed state (S13); next, it is confirmed whether a stop signal was output from all relay tanks 2, 3, 4 (S14), and if a stop signal is being output from all relay tanks 2, 3, 4, it will proceed to (S3) assuming all relay tanks 2, 3, 4 were supplied to a predetermined upper limit amount, and if a stop signal is not being output by all relay tanks 2, 3, 4, it will proceed to (S8) assuming that they are not yet supplied to the predetermined upper limit amount or that an oil leak is occurring.

[0050] Also, when it is confirmed in (S3) that a stop signal is being output by all relay tanks 2, 3, 4, the oil supply pump 19 is stopped (S15), and next the main pipe opening and closing valve 17 and all the branched pipe opening and closing valves 14, 15, 16 are put in a closed state (S16).

[0051] Even if an initial minute oil leak is sensed in the main pipe 5 by the oil leak sensing main pipe side check mode and oil supply processes are not performed until repairs are completed, this increases the convenience for the consumer of the kerosene in the building by being able to have spare time until oil supply is necessary as each of the relay tanks 2, 3, 4 are in a so-called full state.

[0052] Then, next the oil leak sensing opening and closing valve 21 of the main pipe oil leak sensing part 20 is put in an open state from a closed state (S17), and from there the time count is started with the timer part 44 of the control device 37 (S18), and the oil supply pump 19 is driven (S19).

[0053] Also when the oil leak sensing flow meter 22 of the main pipe oil leak sensing part 20 senses a minute flow rate, that sensed flow rate value is output to the flow rate input part 39 as a signal, causing the control device 37 to compare the flow rate value m that determines the initial oil leak set beforehand and the sensed flow rate value with the determining part 45, and determine whether an oil leak is occurring (S20); if the sensed flow rate value is determined to be an oil leak at or above the flow rate value m that was set beforehand (S21), the oil supply pump is stopped (S22), and it proceeds to the main pipe side oil leak site check mode that specifies the location where the oil leak is occurring (S23).

[0054] Further, in (S20), the flow rate value m that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is less than the flow rate value m that was set beforehand, it checks if a predetermined time T has elapsed since starting the timer part 44 (S24), and if the predetermined time T has not elapsed, it returns to (S20) and continues to compare the flow rate value m that was set beforehand and the sensed flow rate value; if the predetermined time T has elapsed, it determines that an oil leak is not occurring in the main pipe

5, the oil supply pump 19 is stopped, the oil leak sensing opening and closing valve 21 is put in a closed state from an open state (S25), the main pipe side check mode ends (S26), and it proceeds to the branched pipe side check mode (S27).

[0055] Then, when it proceeds from the main pipe side check mode to the main pipe side oil leak site check mode, first when the main pipe side oil leak site check mode starts (S28), the main pipe separating opening and closing valve 12 is closed (S29), then the oil supply pump 19 is driven (S30), and the time count with the timer part 44 is started (S31).

[0056] Then, when the oil leak sensing flow meter 22 of the main pipe oil leak sensing part 20 senses a minute flow rate, that sensed flow rate value is output to the flow rate input part 39 as a signal, causing the control device 37 to compare the flow rate value m that determines the initial stage oil leak that was set beforehand and the sensed flow rate value with the determining part 45, and determines whether an oil leak is occurring (S32), and as a result, if it is determined that the sensed flow rate value is at or above the flow rate value m that was set beforehand and oil is leaking, the main pipe separating opening and closing valve 12 is provided between the first branched pipe 6 of the first floor of the main pipe 5 and the next branched pipe 7 for the second floor and in a site directly behind the branch part 6, and the branched pipe opening and closing valve 14 is provided directly in front of the connecting portion of the first floor relay tank 2 and the branched pipe 9 connected thereto, whereby an initial stage minute oil leak occurs between the oil leak sensing flow meter 22 and the branched pipe opening and closing valve 14 of the first floor relay tank 2, or in other words it is determined that an initial stage minute oil leak is occurring in the first floor distribution pipe portion of the main pipe 5 side, and the oil supply pump 19 is stopped (S33).

[0057] Then, a display to the effect that an initial stage minute oil leak is occurring in the first floor distribution pipe portion on the main pipe 5 side is performed in the display part 41 of the control device 37 (S34), the main pipe side oil leak site check mode ends, and it proceeds from the main pipe side oil leak site check mode to the distribution pipe side check mode (S35).

[0058] Further, in (S32), the flow rate value m that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is below the flow rate value m that was set beforehand, it is checked if a predetermined time T has elapsed since the timer part 44 was started (S36); if the predetermined time T has not elapsed, it returns to (S32) and continues to compare the flow rate value m that was set beforehand and the sensed flow rate value; if the predetermined time T has elapsed, it is determined whether an initial stage minute oil leak is occurring in the first floor distribution pipe portion of the main pipe 5 side; next the main pipe separating opening and closing valve 12 is opened, the main pipe separating opening and closing valve 13 is closed (S37), and it is checked whether an initial stage minute oil leak has is occurring in the second floor distribution pipe portion of the main pipe 5 side.

[0059] In other words, the main pipe separating opening and closing valve 13 is provided in a site directly behind the branch part 8 and between the second floor branch part 7 of the main pipe 5 and the next third floor branch part 8; the branched pipe opening and closing valve 15 is provided directly in front of the connecting portion of the second floor relay tank 3 and the branched pipe 10 connected thereto, whereby the second floor distribution pipe portion on the main pipe 5 side is put in an open state, determining that an initial stage minute oil leak is not already occurring in the first floor distribution pipe portion of the main pipe 5 side; if it is determined that an oil leak is occurring in this state, it can be determined that an initial stage minute oil leak is occurring in the second floor distribution pipe portion.

[0060] Then, the time count with the timer part 44 is started (S38), and when the oil leak sensing flow meter 22 of the main pipe oil leak sensing part 20 senses a minute flow rate, that sensed flow rate is output to the flow rate input part 39 as a signal, causing the control device 37 to compare the flow rate value m determined to be an initial stage oil leak that was set beforehand and the sensed flow rate value with the determining part 45, and determines whether an oil leak is occurring (S39); as a result, if it is determined that the sensed flow rate amount is at or above the flow rate value m that was set beforehand and is an oil leak, then the initial stage minute oil leak occurring between the oil leak sensing flow meter 22 to the branched pipe opening and closing valve 15 of the second floor relay tank 3, or in other words it determines the minute oil leak is occurring in the second floor distribution pipe portion of the main pipe 5 side, and the oil supply pump 19 is stopped (S40).

[0061] Then, a display to the effect that an initial stage minute oil leak is occurring in the second floor distribution pipe portion of the main pipe 5 side is performed in the display part 41 of the control device 37 (S41), the main pipe side oil leak site check mode ends, and it proceeds from the main pipe oil leak site check mode to the distribution pipe side check mode (S35).

[0062] Further, in (S39), the flow rate value m that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is below the flow rate value m that was set beforehand, it is checked if a predetermined time T has elapsed since the timer part 44 was started (S42); if the predetermined time T has not elapsed, it returns to (S39) and continues to compare the flow rate value m that was set beforehand and the sensed flow rate value; if the predetermined time T has elapsed, it determines that an initial stage minute oil leak is not occurring in the second floor distribution pipe portion of the main pipe 5 side; next the main pipe separating opening and closing valve 12 and the main pipe separating opening and closing valve 13 are put in an open state (S43), and it is checked whether an initial stage minute oil leak is occurring in the third floor distribution pipe portion of the main pipe 5 side.

[0063] In other words, the main pipe separating opening and closing valve 13 is provided in a site directly behind the branch part 7 and between the second floor branch part 7 of the main pipe 5 and the next third floor branch part 8; The branched pipe opening and closing valve 16 is provided directly in front of the connecting portion of the third floor relay tank 4 and the branched pipe 11 connected thereto, whereby the third floor distribution pipe portion of the main pipe 5 is put into an open state, it is already determined that an initial stage minute oil leak is not occurring in the first floor and second floor distribution pipe portion, so if it Is determined that an oil leak is occurring in this state, it can be determined that the initial stage minute oil leak is occurring in the third floor distribution portion.

[0064] Then, the time counter with the timer part 44 is started (S44), then when the oil leak sensing flow meter 22 of the main pipe oil leak sensing part 20 senses a minute flow rate, that sensed flow rate value is output to the flow rate input part 39 as a signal, whereby the control device 37 compares the flow rate value m that determines the initial stage oil leak that was set beforehand and the sensed flow rate value with the determining part 45 and determines whether an oil leak is occurring (S45); as a result, if the sensed flow rate value is determined to be an oil leak at or above the flow rate value m that was set beforehand, the initial stage minute oil leak is occurring between the oil leak sensing flow meter 22 to the third floor relay tank 4 branched pipe opening and closing valve 16, or in other words, it is determined that the initial stage minute oil leak is occurring in the third floor distribution pipe portion of the main pipe 5 side, and the oil supply pump 19 is stopped (S46).

[0065] Then, a display to the effect that an initial stage minute oil leak is occurring in the third floor distribution portion of the main pipe 5 is performed on the display part 41 of the control device 37 (S47), the main pipe side oil leak site check mode ends, and it proceeds from the main pipe oil leak site check mode to the distribution pipe side check mode (S35).
[0066] Further, in (S45), the flow rate value m that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is less than the flow rate value m that was set beforehand, it is checked if a predetermined time T has elapsed since the timer part 44 was started (S48); if the predetermined time T has not elapsed, it returns to (S45) and continues comparing the flow rate value m that was set beforehand and the sensed flow rate value; if the predetermined time T has elapsed, it is determined that an initial stage minute oil leak is not occurring in the third floor distribution portion of the main pipe 5, the main pipe side oil leak site check mode ends, and it proceeds from the main pipe side oil leak site check mode to the distribution pipe side check mode (S35).
[0067] Then, when it proceeds from the main pipe side check mode or the main pipe side oil leak site check mode to the distribution pipe side check mode, first, when the distribution side check mode is started (S49), it confirms whether all combustion instrument 28 connected to the distribution pipe 27 is stopped (S50); if they are all stopped, the load opening and closing valves 29 of all combustion instruments 28 are all closed (S51); if the combustion instruments 28 are not all stopped, an "oil leak check in progress" is displayed on the display part 41 of the control device 37 and the display unit in the room (not illustrated) (S52), then the load opening closing valve 29 of all the combustion instruments 28 are all closed (S51).
[0068] Since all the combustion instruments 28 are put into a stopped state in (S51), next, the distribution pipe separating opening and closing valves 30, provided in the portion of the distribution pipe 27 between the combustion instrument 28 connected to the distribution pipe 27 and the combustion instrument 28 connected to the distribution pipe 27 downstream from the former combustion instrument 28, are all closed (S53).
[0069] Since the distribution pipe separating opening and closing valve 30 is provided in the distribution pipe 27 that is downstream and directly behind the connecting portion of the distribution pipe 27 and the combustion instrument 28, when the distribution pipe separating opening and closing valves 30 are all closed, the distribution pipe from the connecting portion of the distribution pipe 27 and the relay tanks 2, 3, 4 to the first distribution pipe separating opening and closing valve 30 is put into an open state.
[0070] Next, the distribution pipe sensing opening and closing valve 31 provided in the connecting portion of the relay tanks 2, 3, 4 and the distribution pipe 27 is closed (S54), then the time count with the timer 44 is started (S55).
[0071] Then, when the distribution pipe oil leak sensing flow meter 32 of the distribution pipe oil leak sensing part 33 senses a minute flow rate, that sensed flow rate value is output to the flow rate input part 39 as a signal, whereby the control device 37 compares the flow rate value n that determines an oil leak that was set beforehand and the sensed flow rate value with the determining part 45, and determines whether an oil leak is occurring (S56); as a result, if it is determined that the sensed flow rate value is an oil leak at or above the flow rate value n that was set beforehand, it is determined that the initial stage minute oil leak is occurring between the distribution pipe oil leak sensing flow meter 32 to the first distribution pipe separating opening and closing valve 30; a display to the effect that an initial stage minute oil leak is occurring in the distribution pipe portion between the distribution pipe oil leak sensing flow meter 32 and the first

distribution pipe separating opening and closing valve 30 is performed on the display part 41 of the control device 37 (S57).

[0072] Then, for safety, the return pipe opening and closing valves 24, 25, 26 of the return pipe 23 of the relay tanks 2, 3, 4 that are connected to the distribution pipe 27 that is determined to have an initial stage minute oil leak occurring in the distribution pipe portion between the distribution pipe oil leak sensing flow meter 32 and the first distribution pipe separating opening and closing valve 30 is put into an open state, the kerosene inside that relay tank 2, 3, 4 is returned to the storage tank 1 (S58), the distribution pipe side check mode ends (S59), and the oil leak sensing ends (S60).

[0073] Further, in (S56), the flow rate value n that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is less than the flow rate value n that was set beforehand, it is checked if a predetermined time T has elapsed since the timer part 44 was started (S61); if the predetermined time T has elapsed, it returns to (S56) and continues to compare the flow rate value n that was set beforehand and the sensed flow rate value; if the predetermined time T has not elapsed, it is determined that an initial stage minute oil leak is not occurring between the distribution pipe oil leak sensing flow meter 32 to the first distribution pipe separating opening and closing valve 30, all the distribution pipe separating opening and closing valves 30 are closed (S62), and the time count with the timer part 44 is started (S63).

[0074] Then, when the distribution pipe oil leak sensing flow meter 32 of the distribution pipe oil leak sensing part 33 senses a minute flow rate, that sensed flow rate is output to the flow rate input part 39 as a signal, whereby the control device 37 compares the flow rate value n that determines an oil leak previously set and the sensed flow rate value with the determining part 45, and determines whether an oil leak is occurring (S64).

[0075] As a result, if it is determined that the sensed flow rate value is at or above the flow rate value n that was set beforehand and is an oil leak, it is determined that the initial stage minute oil leak is occurring between the distribution pipe separating opening and closing valve 30 to the last load opening and closing valve 29, and a display to the effect that an initial stage minute oil leak is occurring in the distribution pipe portion between the distribution pipe separating opening and closing valve 30 to the last load opening and closing valve 29 is performed on the display part 41 of the control device 37 (S65).

[0076] Further, in (S64), the flow rate value n that was set beforehand and the sensed flow rate value are compared, and when the sensed flow rate value is less than the flow rate value n that was set beforehand, it is checked if a predetermined time T has elapsed since the timer part 44 was started (S66); if the predetermined time T has not elapsed, it returns to (S64) and continues comparing the flow rate value n that was set beforehand and the sensed flow rate value; if the predetermined time T has elapsed, it is determined that an initial stage minute oil leak is not occurring between the distribution pipe separating opening and closing valve 30 to the last load opening and closing valve 29, the distribution pipe side check mode ends (S59), and the oil leak sensing ends (S60).

[0077] In the present example, one main pipe 5 separating opening and closing valve 12, 13 is provided between the branched part 6, 7, 8, but it is not limited to this; a plurality may be provided, and the oil leak sensing distribution pipe portion may be separated into a plurality to sense oil leaks.

[0078] Further, in the present example, one branched pipe opening and closing valve 14, 15, 16 was provided to the branched pipes 9, 10, 11 respectively, but it is not limited to this; one may be provided in each branched pipe portion between the load opening and closing valves 29 of each

combustion instrument 28, and the oil leak sensing distribution pipe portion may be separated into a plurality to sense oil leaks.

[0079] Further, in the present example it is automatically performed from the main pipe side check mode to the main pipe side oil leak site check mode and the distribution pipe side check mode, but it is not limited to this; start up buttons such as a main pipe side check mode button, a main pipe side oil leak site check mode button, and a distribution pipe side check mode button may each be provided in the operation part 40, and operation may be done by manually operating them.

[0080] As above, because the space between the storage tank 1 that stores liquid fuel and the relay tanks 2, 3, 4 that accumulate liquid fuel supplied from the storage tank 1 is connected with the main pipe 5 and the branched pipes 9, 10, 11 that branch from the main pipe 5; the main pipe 5 is provided with an oil supply pump 19, a main pipe flow meter 18, and a main pipe opening and closing valve 17; and a main pipe oil leak sensing part 20 composed of an oil leak sensing flow meter 22 that senses minute flow rates and an oil leak sensing opening and closing valve 21 that opens and closes the flow of liquid fuel into the oil leak sensing flow meter 22 is provided bypassing the main pipe opening and closing valve 17, the oil supply rate of the normal oil supply process can be sensed by the main pipe flow meter 18, and during oil leak sensing, because the existence of an initial stage oil leak can be confirmed by the oil leak sensing flow meter 22 that senses minute flow rates, even minute flow rates of an initial stage oil leak can be, and furthermore, for that reason, complex sensing structures are unnecessary, and the cost can be kept low.

[0081] Further, because after the main pipe opening and closing valve 17 and the branched pipe opening and closing valve 14, 15, 16 are closed, when the oil leak sensing opening and closing valve 21 is opened and the oil supply pump 19 is operated, when the oil leak sensing flow meter 22 senses a flow rate larger than the predetermined flow rate that was set beforehand, a control device 37 having an oil leak sensing mode for determining that an oil leak is occurring is provided, even when an oil leak is occurring in the main pipe 5 and the branched pipes 9, 10, 11 from the main pipe oil leak sensing part 20 of the main pipe 5 to the branched pipe opening and closing valves 14, 15, 16 of the branched pipes 9, 10, 11, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the oil leak sensing flow meter 22, by changing the value of the predetermined flow rate set beforehand, it can be adjusted.

[0082] Further, because the relay tanks 2, 3, 4 and the storage tank 1 are connected with a return pipe 23 having a return pipe opening and closing valve 24, 25, 26 that opens and closes the pipe, and is provided with a control device 37 that supplies oil to the relay tanks 2, 3, 4 at the beginning of the oil leak sensing mode, and when a predetermined amount does not accumulate in the relay tanks 2, 3, 4 after a predetermined time has elapsed since starting the oil supply, determines that an oil leak is occurring and opens the return pipe opening and closing valves 24, 25, 26, when it is determined that an oil leak is occurring with the oil leak sensing mode, even if oil is not supplied from the storage tank 1 to the relay tanks 2, 3, 4 from then until an inspection and repairs are completed, a predetermined amount of liquid fuel is accumulated inside the relay tanks 2, 3, 4, whereby the combustion instrument 28 process can be performed for a while even after it is determined that an oil leak is occurring, and even if an oil leak is occurring in the main pipe 5 and the branched pipes 9, 10, 11, a centralized oil supply system with few inconveniences is provided.

[0083] Further, because main pipe separating opening and closing valves 12, 13 are provided in the main pipe 5 portion between the branched pipe 9, 10, 11 and the branched pipe 9, 10, 11, and a control device 37 is provided that, when it determines that an oil leak is occurring in oil leak sensing mode, repeatedly executes oil leak sensing mode by executing oil leak sensing mode from a state of all main pipe separating opening and closing valves 12, 13 being in a closed state and sequentially opening them every time oil leak sensing mode is executed from a main pipe separating opening and closing valve 12 on the upstream side of the main pipe 5 until it is determined that an oil leak is occurring, after it is determined that an oil leak is occurring, first, it is checked whether the oil leak is occurring between the main pipe 5 and the branched pipe 9 between the main pipe oil leak sensing part 20 of the main pipe 5 to the relay tank 2 connected to the branched pipe 9 on the most upstream side of the main pipe 5; if it is not occurring, next, it is checked whether an oil leak is occurring between the main pipe 5 and the branched part 10 between the main pipe oil leak sensing part 20 of the main pipe 5 and the relay tank 3 connected to the second upstream side branched pipe 10 of the main pipe 5; next, it is the relay tank 4 connected to the third upstream side branched pipe 11 of the main pipe 5, and it continues to do the oil leak check of the branched pipe 11 of the main pipe 5 from the upstream side, whereby it can be ascertained to a degree in which portion of the main pipe 5 and the branched pipe 9, 10, 11 the oil leak is occurring, reducing the labor of the repair worker searching for the location the oil leak is occurring, and greatly shortening the labor time.

[0084] Further, because the connecting portions of the relay tanks 2, 3, 4 of the distribution pipe 27 are provided with a distribution pipe sensing opening and closing valve 31, is provided with the distribution pipe oil leak sensing flow meter 32 is provided bypassing the distribution pipe sensing opening and closing valve 31, load opening and closing valves 29 are provided between the combustion instrument 28 and the distribution pipe 27, and a control device 37 is provided having a distribution pipe oil leak sensing mode for determining that an oil leak is occurring and opening the return pipe opening and closing valves 24, 25, 26 when the distribution pipe oil leak sensing flow meter 32 senses a flow rate larger than a predetermined flow rate set beforehand, when the distribution pipe sensing opening and closing valve 31 is closed after closing all of the load opening and closing valves 29, even when an oil leak is occurring in the distribution pipe 27 from the distribution pipe oil leak sensing part flow meter 32 load opening and closing valves 29, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the distribution pipe oil leak sensing flow meter 32, by changing the value of the predetermined flow rate set beforehand, it can be adjusted, and moreover, when it is determined that an oil leak is occurring, the liquid fuel inside the relay tanks 2, 3, 4 is returned to the storage tank 1 via the return pipe 23, whereby the oil leak from the distribution pipe 27 can be prevented until repairs and inspection are completed.

[0085] Further, because a distribution pipe separating opening and closing valve 30 is provided between the connecting portion of the combustion instrument 28 and the distribution pipe 27 and the next connecting portion of the combustion device 28 and the distribution pipe 27, a control device 37 is provided that, when it determines that an oil leak is occurring in the distribution pipe oil leak sensing mode, repeatedly executes distribution pipe oil leak sensing mode by executing distribution pipe oil leak sensing mode from a state of all distribution pipe separating opening and closing valves 30 being closed and sequentially opening them every time distribution pipe oil leak sensing mode is executed from a distribution pipe separating opening and closing valve 30 on the upstream side of the distribution pipe 27 until it is determined that an oil leak is

occurring until it is determined that an oil leak is occurring, after it is determined that an oil leak is occurring, first, it is checked whether the oil leak is occurring between the distribution pipe oil leak sensing flow meter 32 and the most upstream side load opening and closing valve 29 of the distribution pipe 27; if it is not occurring, next it is checked whether the oil leak is occurring between the distribution pipe oil leak sensing flow meter 32 and the second upstream side load opening and closing valve 30 of the distribution pipe 27; next, it is the third upstream side load opening and closing valve 30 of the distribution pipe 27, and it continues to do the oil leak check from the upstream side of the distribution pipe 27, whereby it can be ascertained to a degree in which portion of the distribution pipe 27 the oil leak is occurring, reducing the labor of the worker performing the repair searching for the location the oil leak is occurring, and greatly shortening the labor time.

[0086]

[Effect of the Invention] According to the centralized oil supply system of claim 1, the space between the storage tank and the relay tanks is connected with a main pipe and a branched pipe; the main pipe is provided with an oil supply pump, a main pipe flow meter, and a pipe opening and closing valve; and an oil leak sensing part composed of an oil leak sensing flow meter that senses minute flow rates and an oil leak sensing opening and closing valve is provided bypassing the main pipe opening and closing valve, allowing the oil supply rate under the normal oil supply process to be sensed by the main pipe flow meter, and during oil leak sensing, because the existence of an initial stage oil leak can be confirmed by the oil leak sensor flow meter that senses minute flow rates, even minute flow rates of an initial stage oil leak can be sensed, and furthermore, for that reason, complex sensing structures are unnecessary, and the cost can be kept low.

[0087] According to the centralized oil supply system of claim 2, after the main pipe opening and closing valve and the branched pipe opening and closing valve are closed, when the oil leak sensing opening and closing valve is opened and the oil supply pump is operated, when the oil leak sensing flow meter senses a flow rate that is larger than a predetermined flow rate set beforehand, determines that an oil leak is occurring; because of this, even when an oil leak is occurring in the main pipe and the branched pipe from the oil leak sensing part of the main pipe to the branched part opening and closing valve, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the oil leak sensing flow meter, by changing the value of the previously set predetermined flow rate, it can be adjusted.

[0088] According to the centralized oil supply system of claim 3, when oil is supplied to the relay tank at the beginning of the oil leak sensing mode, and when a predetermined amount does not accumulate in the relay tank after a predetermined time has elapsed from starting the oil supply, it is determined that an oil leak is occurring and the return pipe opening and closing valve is opened; because of this, when it is determined that an oil leak is occurring with the oil leak sensing mode, even if oil is not supplied from the storage tank to the relay tanks from then until an inspection and repairs are completed, a predetermined amount of liquid fuel is accumulated inside the relay tanks, whereby the combustion instrument process can be performed for a while even after it is determined that an oil leak is occurring, and even if an oil leak is occurring in the main pipe and the branched pipes, a centralized oil supply system with few inconveniences is provided.

[0089] According to the centralized oil supply system of claim 4, when it determines that an oil leak is occurring in oil leak sensing mode, it repeatedly executes oil leak sensing mode by

executing oil leak sensing mode from a state of all main pipe separating opening and closing valves being closed and sequentially opening them every time oil leak sensing mode is executed from a main pipe separating opening and closing valve on the upstream side of the main pipe until it is determined that an oil leak is occurring; because of this, after it is determined that an oil leak is occurring, first, it is checked whether the oil leak is occurring between the main pipe and the branched pipe between the oil leak sensing part of the main pipe to the relay tank connected to the branched pipe on the most upstream side of the main pipe; if it is not occurring, next, it is checked whether an oil leak is occurring between the main pipe and the branched part between the oil leak sensing part of the main pipe and the relay tank connected to the second upstream side branched pipe of the main pipe; next, it is the relay tank connected to the third upstream side branched pipe of the main pipe, and it continues to do the oil leak check of the branched pipe of the main pipe from the upstream side, whereby it can be ascertained to a degree in which portion of the main pipe and the branched pipe the oil leak is occurring, reducing the labor of the repair worker searching for the location the oil leak is occurring, and greatly shortening the labor time.

[0090] According to the centralized oil supply system of claim 5, it is determined that an oil leak is occurring and the return pipe opening and closing valves are opened when the distribution pipe oil leak sensing flow meter senses a flow rate larger than a predetermined flow rate set beforehand, when the distribution pipe sensing opening and closing valve is closed after closing all of the load opening and closing valves; because of this, even when an oil leak is occurring in the distribution pipe from the distribution pipe oil leak sensing flow meter to the load opening and closing valve, it can be sensed with a single oil leak sensing, and further, by changing the value of the predetermined flow rate set beforehand, the state of the sensed oil leak can be set, and further, if there is a measurement error in the oil leak sensing flow meter, by changing the value of the previously set predetermined flow rate, it can be adjusted; moreover, when it is determined that an oil leak is occurring, the liquid fuel inside the relay tanks is returned to the storage tank via the return pipe, whereby the oil leak from the distribution pipe can be prevented until repairs and inspection are complete.

[0091] According to the centralized oil supply system of claim 6, when it determines that an oil leak is occurring in distribution pipe oil leak sensing mode, repeatedly executes distribution pipe oil leak sensing mode by executing distribution pipe oil leak sensing mode from a state of all distribution pipe separating opening and closing valves being closed and sequentially opening them every time distribution pipe oil leak sensing mode is executed from a distribution pipe separating opening and closing valve on the upstream side of the distribution pipe until it is determined that an oil leak is occurring; because of this, after it is determined that an oil leak is occurring, first, it is checked if the oil leak is occurring between the distribution pipe oil leak sensing flow meter and the most upstream side load opening and closing valve of the distribution pipe; if it is not occurring, next, it is checked whether the oil leak is occurring between the distribution pipe oil leak sensing flow meter and the second upstream side load opening and closing valve of the distribution pipe; next, it is the third upstream side load opening and closing valve of the distribution pipe, and it continues to do the oil leak check from the upstream side of the distribution pipe, whereby it can be ascertained to a degree in which portion of the distribution pipe the oil leak is occurring, reducing the labor of the worker performing the repair searching for the location the oil leak is occurring, and greatly shortening the labor time.

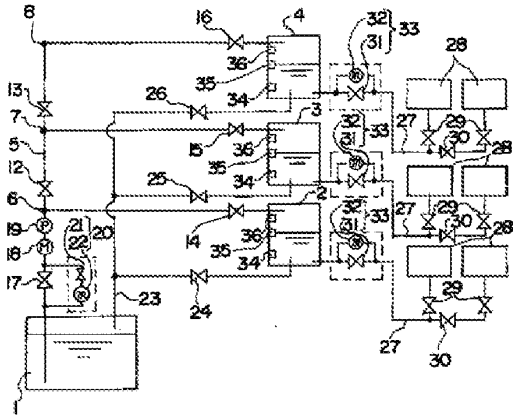
[Brief Description of the Drawings]

[FIG. 1] An overall configuration drawing of the centralized oil supply system of an example of the present invention.
[FIG. 2] A configuration drawing of the control device of the same centralized oil supply system.
[FIG. 3] A flow chart of the oil leak sensing of the same centralized oil supply system.
[FIG. 4] The same flow chart.
[FIG. 5] The same flow chart.
[FIG. 6] An overall configuration drawing of a conventional example of a centralized oil supply system.

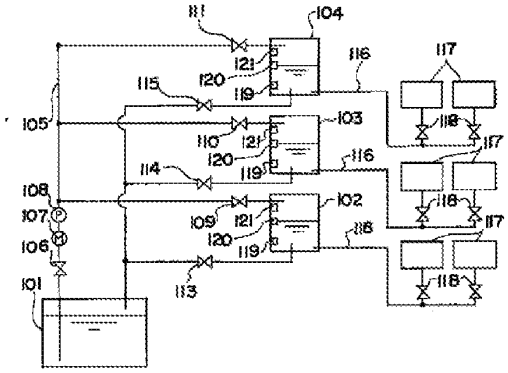
[Description of Symbols]

1	storage tank
2, 3, 4	relay tank
5	main pipe
9, 10, 11	branched pipe
14, 15, 16	distribution pipe opening and closing valve
17	main pipe opening and closing valve
18	main pipe flow meter
19	oil supply pump
20	main pipe oil supply sensing part
21	oil leak sensing opening and closing valve
22	oil leak sensing flow meter
27	distribution pipe

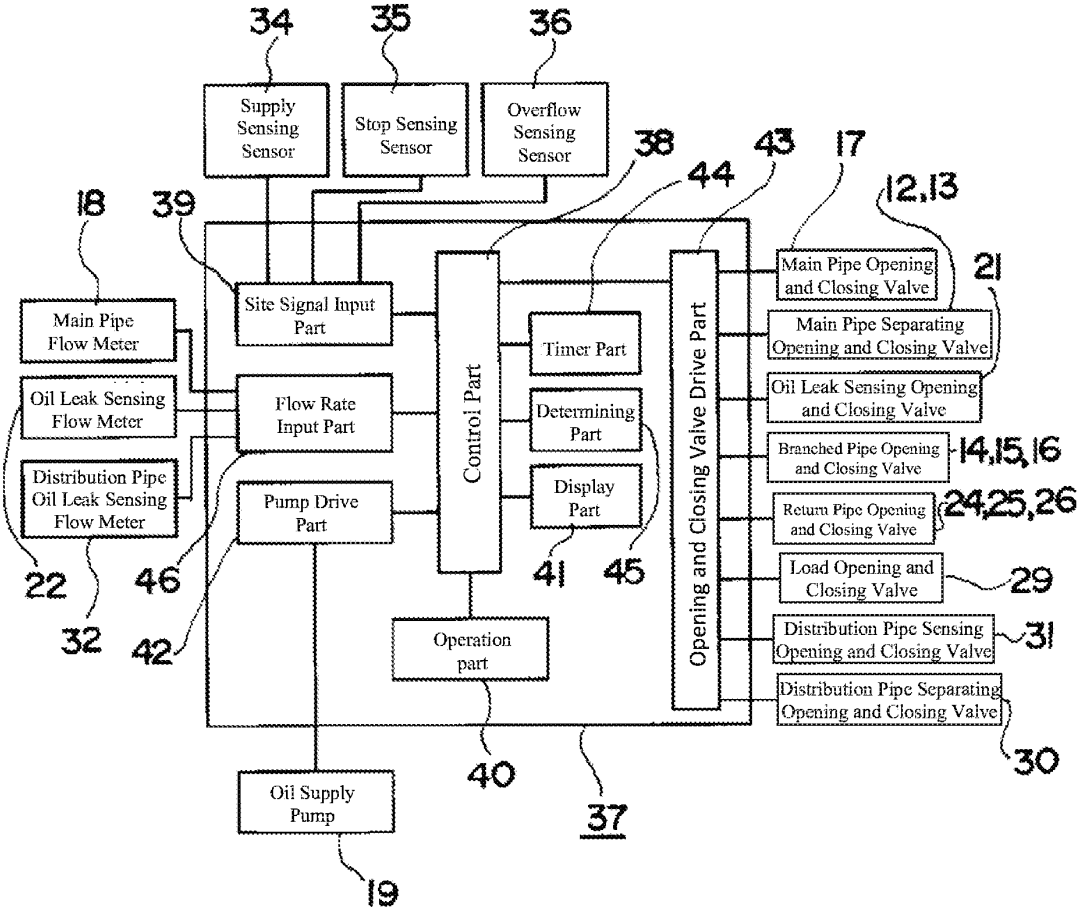
[FIG. 1]



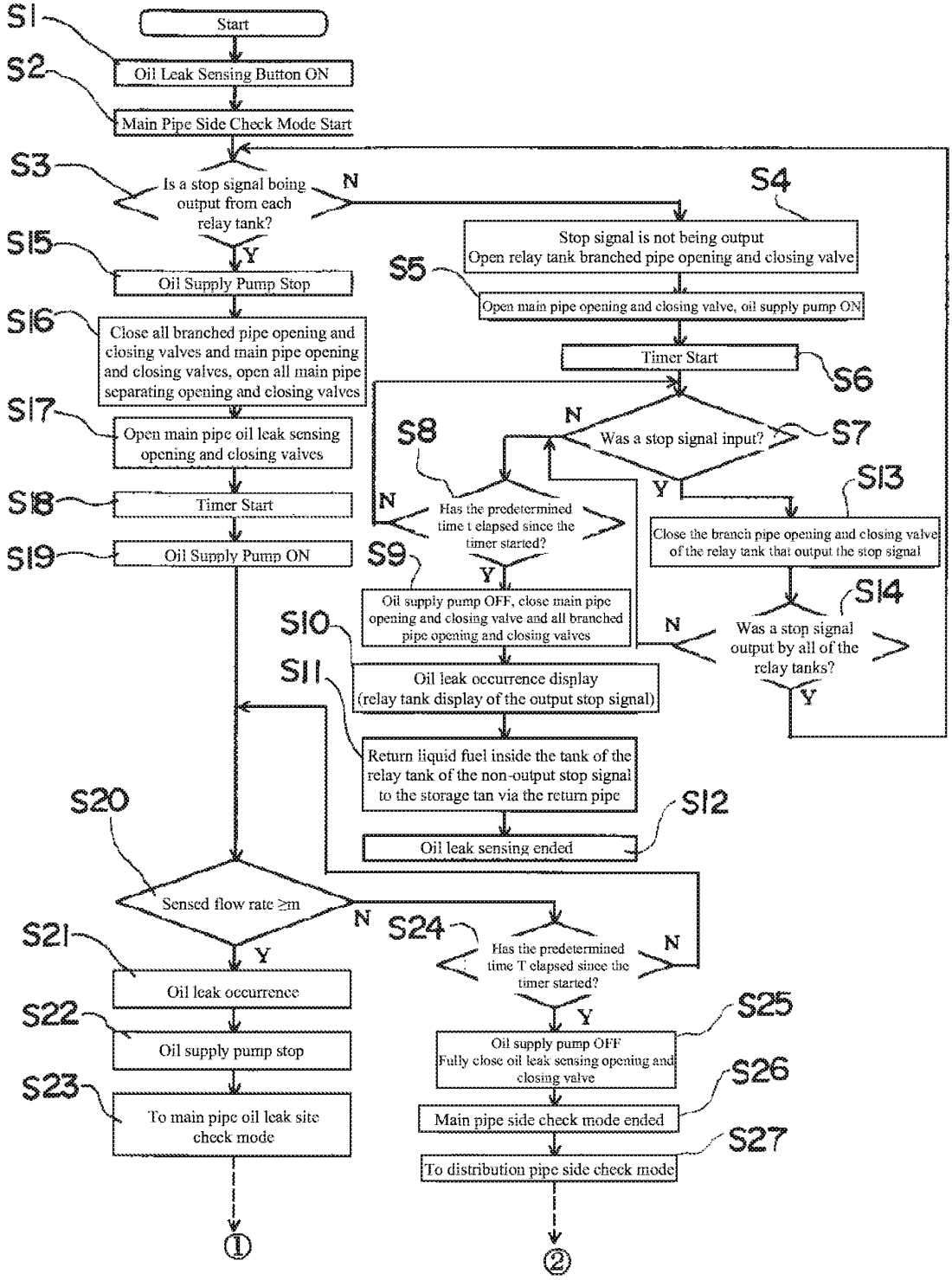
[FIG. 6]



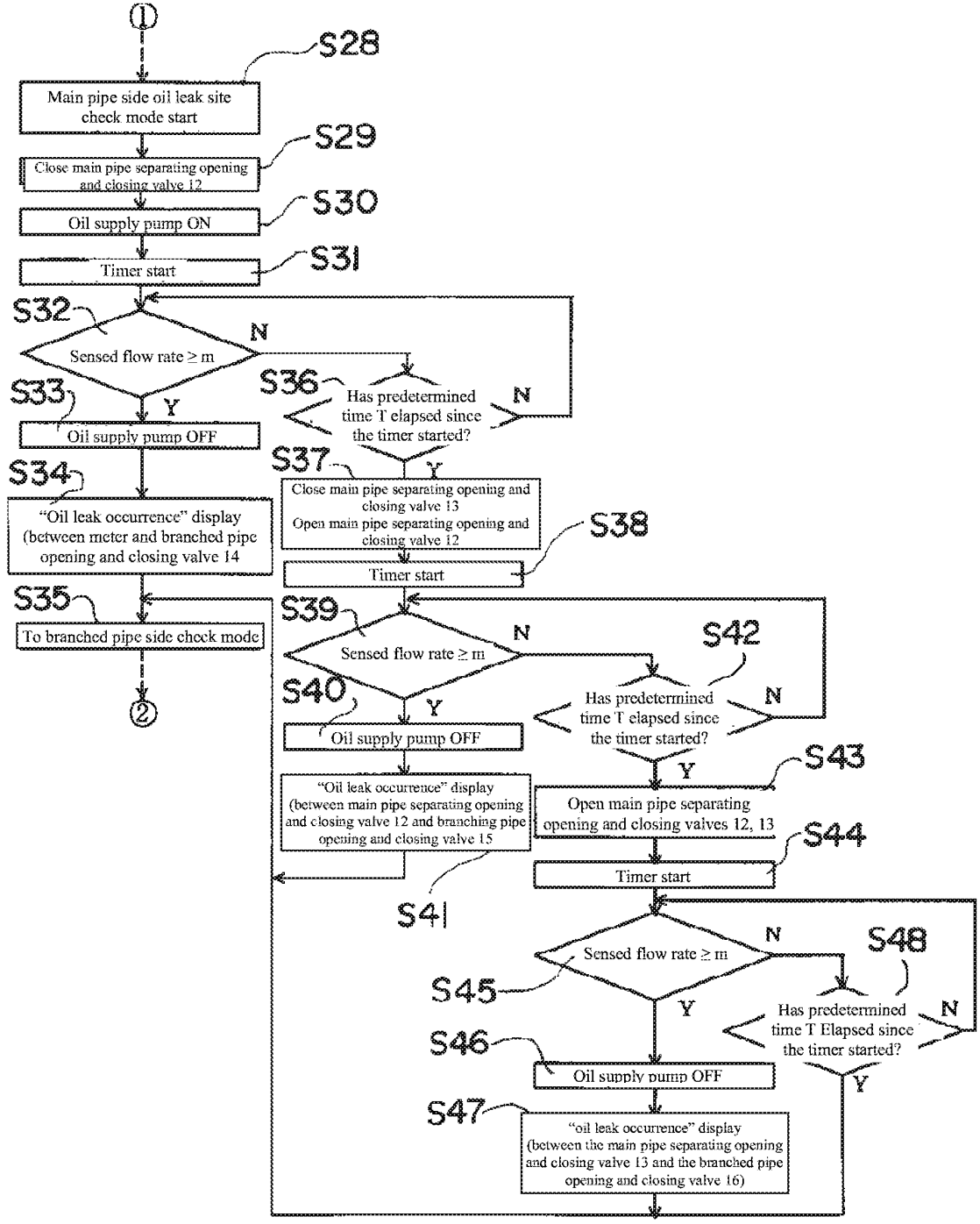
[FIG. 2]



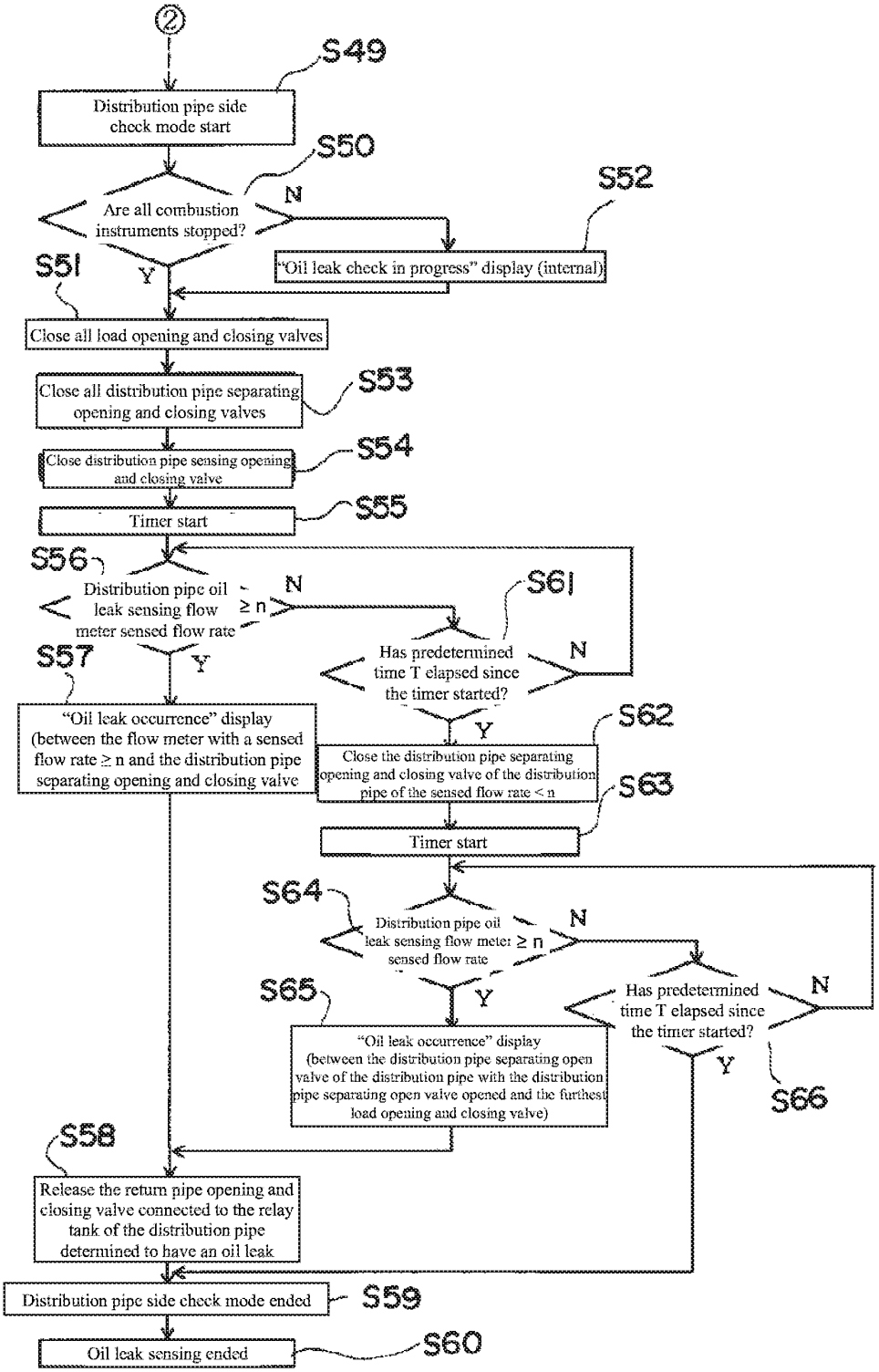
[FIG. 3]


S1
Start
S2
Oil Leak Sensing Button ON
Main Pipe Side Check Mode Start
S3
Is a stop signal boing output from each relay tank?
N
Y
S4
Stop signal is not being output
Open relay tank branched pipe opening and closing valve
S5
Open main pipe opening and closing valve, oil supply pump ON
Timer Start
S6
S7
Was a stop signal input?
N
Y
S8
Has the predetermined time t elapsed since the timer started?
N
Y
S9
Oil supply pump OFF, close main pipe opening and closing valve and all branched pipe opening and closing valves
S10
S11
Oil leak occurrence display (relay tank display of the output stop signal)
Return liquid fuel inside the tank of the relay tank of the non-output stop signal to the storage tan via the return pipe
S12
Oil leak sensing ended
S13
Close the branch pipe opening and closing valve of the relay tank that output the stop signal
S14
Was a stop signal output by all of the relay tanks?
N
Y
S15
Oil Supply Pump Stop
S16
Close all branched pipe opening and closing valves and main pipe opening and closing valves, open all main pipe separating opening and closing valves
S17
Open main pipe oil leak sensing opening and closing valves
S18
Timer Start
S19
Oil Supply Pump ON
S20
Sensed flow rate ≥m
N
Y
S21
Oil leak occurrence
S22
Oil supply pump stop
S23
To main pipe oil leak site check mode
①
S24
Has the predetermined time T elapsed since the timer started?
N
Y
S25
Oil supply pump OFF
Fully close oil leak sensing opening and closing valve
S26
Main pipe side check mode ended
S27
To distribution pipe side check mode
②

[FIG. 4]


①
S28
Main pipe side oil leak site check mode start
S29
Close main pipe separating opening and closing valve 12
S30
Oil supply pump ON
S31
Timer start
S32
Sensed flow rate ≥ m
N
Y
S33
Oil supply pump OFF
S34
"Oil leak occurrence" display (between meter and branched pipe opening and closing valve 14
S35
To branched pipe side check mode
②
S36
Has predetermined time T elapsed since the timer started?
N
Y
S37
Close main pipe separating opening and closing valve 13
Open main pipe separating opening and closing valve 12
S38
Timer start
S39
Sensed flow rate ≥ m
N
Y
S40
Oil supply pump OFF
"Oil leak occurrence" display (between main pipe separating opening and closing valve 12 and branching pipe opening and closing valve 15
S41
S42
Has predetermined time T elapsed since the timer started?
N
Y
S43
Open main pipe separating opening and closing valves 12, 13
S44
Timer start
Sensed flow rate ≥ m
N
Y
S45
S46
Oil supply pump OFF
S47
"oil leak occurrence" display (between the main pipe separating opening and closing valve 13 and the branched pipe opening and closing valve 16)
S48
Has predetermined time T Elapsed since the timer started?
N
Y

[FIG. 5]


②
S49
Distribution pipe side check mode start
S50
Are all combustion instruments stopped?
N
S52
"Oil leak check in progress" display (internal)
S51
Y
Close all load opening and closing valves
Close all distribution pipe separating opening and closing valves
S53
Close distribution pipe sensing opening and closing valve
S54
Timer start
S55
S56
Distribution pipe oil leak sensing flow meter sensed flow rate ≥ n
N
S61
Has predetermined time T elapsed since the timer started?
N
S57
Y
Y
"Oil leak occurrence" display (between the flow meter with a sensed flow rate ≥ n and the distribution pipe separating opening and closing valve
S62
Close the distribution pipe separating opening and closing valve of the distribution pipe of the sensed flow rate < n
S63
Timer start
S64
Distribution pipe oil leak sensing flow meter sensed flow rate ≥ n
N
S65
Y
Has predetermined time T elapsed since the timer started?
N
Y
S66
"Oil leak occurrence" display (between the distribution pipe separating open valve of the distribution pipe with the distribution pipe separating open valve opened and the furthest load opening and closing valve)
S58
Release the return pipe opening and closing valve connected to the relay tank of the distribution pipe determined to have an oil leak
Distribution pipe side check mode ended
S59
Oil leak sensing ended
S60

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5/04		5/04		Ａ
5/06		5/06		Ｚ
5/16		5/16		

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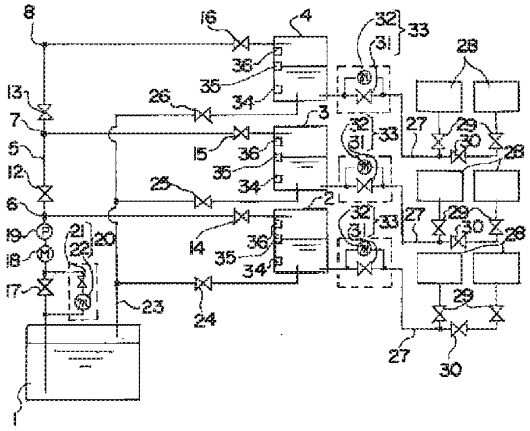
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(54)【発明の名称】　集中給油システム

(57)



(2)

1 2

10

20

30

40

50

2

(3)

3 4

10

20

30

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50

3

(4)

5 6

10

20

30

40

50

4

(5)

7 8

10

20

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40

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5

(6)

9 10

10

20

30

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6

(7)

11 12

10

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7

(8)

13 14

10

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(9)

15 16

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17 18

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(11)

19 20

10

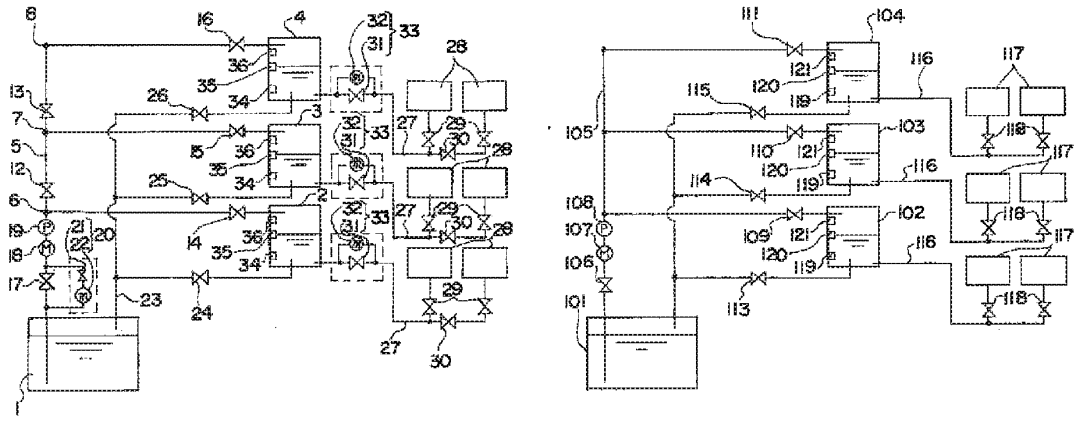
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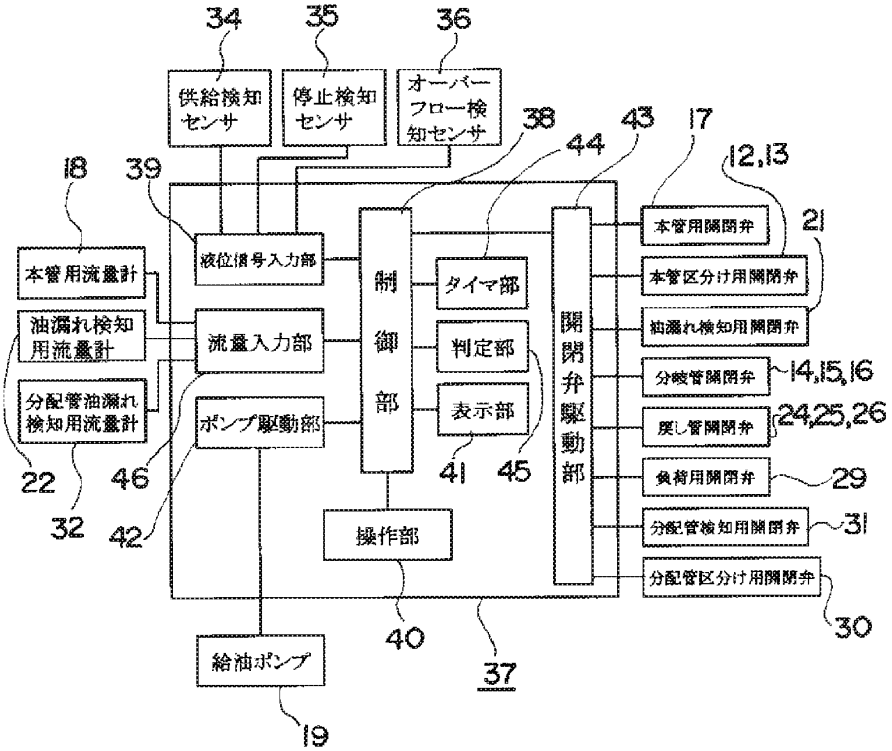
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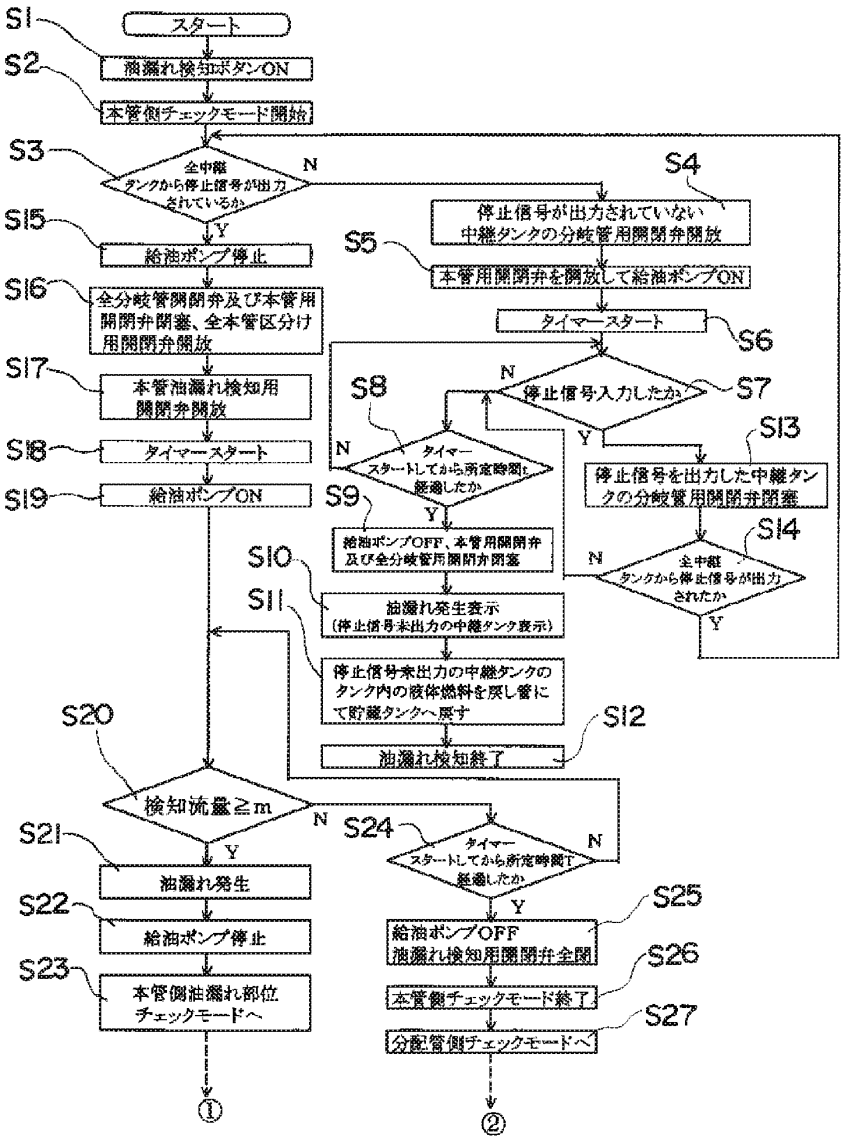
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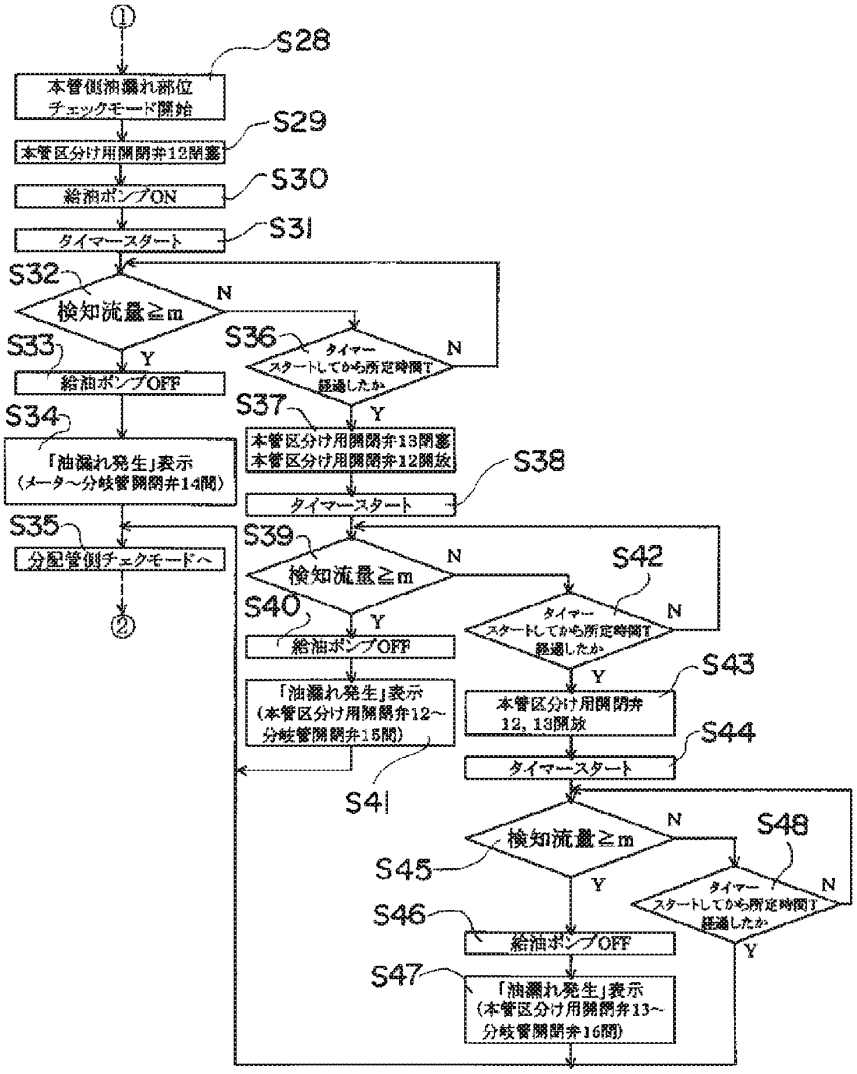
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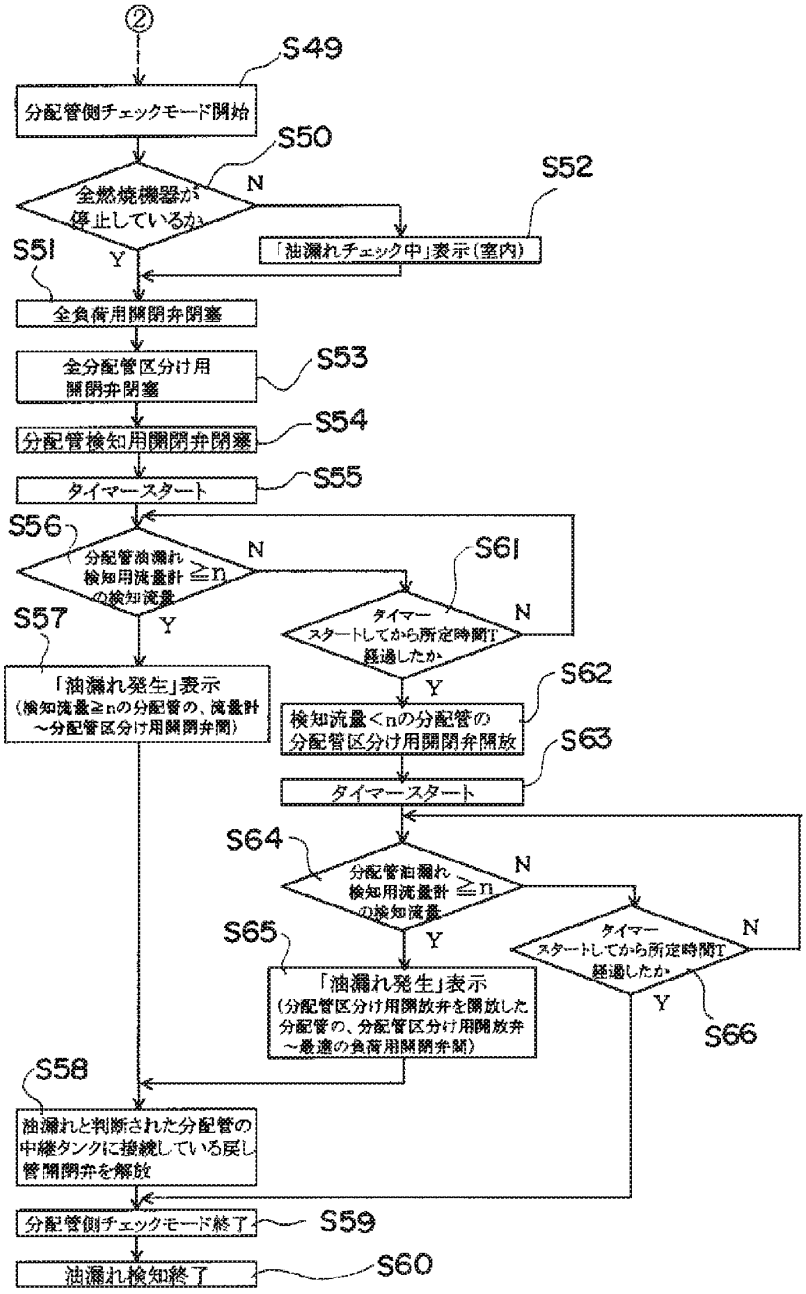




FAS 2004 - Page 227


S1
スタート
S2
漏油れ検知ボタンON
本管側チェックモード開始
S3
全中継タンクから停止信号が出力されているか
N
Y
S4
停止信号が出力されていない中継タンクの分岐管用開閉弁開放
S5
本管用開閉弁を開放して給油ポンプON
タイマースタート
S6
S7
停止信号入力したか
N
Y
S8
タイマースタートしてから所定時間t経過したか
N
Y
S9
給油ポンプOFF、本管用開閉弁及び全分岐管用開閉弁閉塞
S10
油漏れ発生表示（停止信号未出力の中継タンク表示）
S11
停止信号未出力の中継タンクのタンク内の液体燃料を戻し管にて貯蔵タンクへ戻す
S12
油漏れ検知終了
S13
停止信号を出力した中継タンクの分岐管用開閉弁閉塞
S14
全中継タンクから停止信号が出力されたか
N
Y
S15
給油ポンプ停止
S16
全分岐管開閉弁及び本管用開閉弁閉塞、全本管区分け用開閉弁開放
S17
本管油漏れ検知用開閉弁開放
S18
タイマースタート
S19
給油ポンプON
S20
検知流量≧m
N
Y
S21
油漏れ発生
S22
給油ポンプ停止
S23
本管側油漏れ部位チェックモードへ
①
S24
タイマースタートしてから所定時間T経過したか
N
Y
S25
給油ポンプOFF
油漏れ検知用開閉弁全閉
S26
本管側チェックモード終了
S27
分配管側チェックモードへ
②


①
S28
本管側油漏れ部位チェックモード開始
S29
本管区分け用開閉弁12閉塞
S30
給油ポンプON
S31
タイマースタート
S32
検知流量≧m
N
Y
S33
給油ポンプOFF
S34
「油漏れ発生」表示（メータ～分岐管開閉弁14間）
S35
分配管側チェックモードへ
②
S36
タイマースタートしてから所定時間T経過したか
N
Y
S37
本管区分け用開閉弁13閉塞
本管区分け用開閉弁12開放
S38
タイマースタート
S39
検知流量≧m
N
Y
S40
給油ポンプOFF
「油漏れ発生」表示（本管区分け用開閉弁12～分岐管開閉弁15間）
S41
S42
タイマースタートしてから所定時間T経過したか
N
Y
S43
本管区分け用開閉弁12、13開放
S44
タイマースタート
S45
検知流量≧m
N
Y
S46
給油ポンプOFF
S47
「油漏れ発生」表示（本管区分け用開閉弁13～分岐管開閉弁16間）
S48
タイマースタートしてから所定時間T経過したか
N
Y



FAS 2004 - Page 230

Patents RU28347 Sign in

Fueling vehicle (variants)

RU28347U1
RU Grant

Other languages: Russian

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Priority date: 2002-09-16

Family: RU (1)

Date	App/Pub Number	Status
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2003-03-20	RU28347U1	Grant

Info: Cited by (1), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (4)

translated from Russian

1. The fueling vehicle comprising a cargo vehicle mounted thereon with a breather tank, fuel receiving system including a receiving socket or adapter for attachment refueling hose and the associated receiving fuel, the fuel dispensing system including a dispensing fuel, the pump unit, fuel filters and distributing fuel hoses with nozzles for supplying fuel to the consumer, the control system comprising a level switch, flow meter and the shut-off and regulating valves, wherein the fuel tank further comprises a bottom valve, and a two-level limiter filling its fuel indicator the presence of water in the sump tank and the venting system, the fuel dispensing system provided with a filter water separator with indication of the presence of water in the sump of the filter, fuel hoses dispensing system fuel two on each side are wound on the reels, mounted on the rear side of the tank on both sides of its longitudinal axis, in the control system as a shut-off regulative th fittings used ball valves and a system warning indication of nesmotannyh fuel hose and open door control module, iccated in the cab.

2. fueling vehicle comprising a cargo vehicle mounted thereon with a breather tank, fuel receiving system including a receiving socket or adapter for attachment refueling hose and the associated receiving fuel, the fuel dispensing system including a dispensing fuel, the pump unit, fuel filters and distributing fuel hoses with nozzles for supplying fuel to the consumer, the control system comprising a level switch, flow meter and the shut-off and regulating rmaturu, characterized in that it contains ground circuit continuity checking system grounding, fuel lines and the fuel tank is made of a material excluding the possibility of fuel contamination, wherein the tank further comprises a forced and bottom flaps, two-level alarm filling fuel indicator the presence of water in the sump the tank and the venting system, the fuel dispensing system is provided with a filter water separator indicator of the presence of water in the sump filter and liquid counter with RE nnym unit hydraulically for winding and unwinding fuel hoses, representing two dispensing sleeves of different diameter, wound on reels, mounted on the rear wall of the tank on either side of its longitudinal axis, the control system has a display system of nesmotannyh hoses and unclosed door control module placed in the driver's cab.

3. fueling vehicle comprising a cargo vehicle mounted thereon with a breather tank, fuel receiving system including a receiving socket or adapter for attachment refueling hose and the associated receiving fuel, the fuel dispensing system including a dispensing fuel, the pump unit, fuel filters and distributing fuel hoses with nozzles for supplying fuel to the consumer, the control system comprising a level switch, flow meter and the shut-off and regulating valve, characterized in that the pipes and the fuel tank is made of a material excluding the possibility of fuel contamination, the tank is provided with an additional bottom and forced valves and breakwaters to quench the fuel strikes the motion, two-level stop filling the tank, signaling the presence of water in the sump tank and the system venting fuel receiving system is provided with a filter water separator, the system has a fuel dispensing unit fuel preparation comprising neutralizer stati Cesky electricity installed after the fluid meter, and dampers for damping hydraulic shocks over the dispensing conduit, as of valves used ball valves, there is a vane pump with a hydraulic motor for pumping fuel from the fuel hoses representing dispensers sleeves of different diameter, wound on reels, placed on the rear wall of the tank and each fitted with its hydraulic drive for winding and unwinding hoses, the control system is provided with a pressure relief system with Lock avke, system control operator involvement during refueling, the system display a door closure control and nesmotannyh dispensing sleeves disposed in the cab compartment, wherein the fueling vehicle is equipped with earthing system and equipotential bonding, the complementary box hydraulic, pneumatic system of special equipment to control the operation of the bottom and the forced valve supercharged dampers fuel receiving system, filling and stopper brake lock operation system with the door open by seca management and nesmotannyh hoses.

4. fueling vehicle according to claims 1-3, characterized in that the fuel tank is provided with a platform for servicing placed outside on its upper portion and provided with a railing.

Figure 00000001

Description

translated from Russian

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MCI-7: B60S 5/00, 5/02

B64F 1/28,

E B64D 37/14

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bowsers

(Variants)

The invention relates to the means of maintenance of vehicles and rvmemno - for supplying fuel to vehicles parked for refueling aircraft and land transport, and can be widely used in the transport sector and aviation. Known fueling vehicle disclosed in the same paragraph. RF № 2090460 tml. B64F 1/28, s. 06.07.95, op. 09.20.97.

Known fueling vehicle comprises a tractor-engine, a tank semitrailer disposed thereon installation with a drive mounted on are motor hydraulic pump, a mechanism kinematically coupled with motor are motor, and a hydraulic motor hydraulically connected to the hydraulic pump by means of pipes, movably interconnected with two degrees of freedom in the vertical and horizontal planes. The disadvantage of bowsers is that it with sufficient simplicity of design has limited operational capabilities and is very safe to use. Known fueling vehicle disclosed in the same paragraph. .Nfe RF 2113367 tml. V60R 3/22, s. 08.06.97, op. 06.20.98.

Known fueling vehicle comprises a vehicle mounted thereon with the fuel tank breather fuel receiving system including a receiving pggutser or adapter for attachment schlanga filling and the associated receiving fuel, the fuel dispensing system including a dispensing

fuel, pumps, shut-reguliruyushuyu valve, fuel filters, litromery dispensers fittings with fuel hoses for fuel supply to the consumer or storage capacity, the system stable fence priming from the storage and system nitriding supplied into the fuel tank of the fuel and of cooling nadtoplivnogo of the fuel tank, comprising a vessel for liquid nitrogen associated with the vessel and the evaporator manifold for supplying the cold gaseous nitrogen nadtoplivnoe space qi thorns mounted downstream of the evaporator compressor, the associated high-pressure manifold connected to the cylinders the high pressure gas reducer at the outlet of high pressure reservoir connected to the column nitriding embedded in the fuel and having a nozzle for supplying nitrogen into the fuel stream, wherein the manifold is located in the the upper portion of the fuel tank away from the accommodations the breathing valve and sustainable fuel intake system includes more than that of a tank with a useful volume toplivozaprav full-time pshanga and fuel prior to entry into the pump assembly, the fuel with a check valve for the pump unit outlet connections to the fuel tank mounted in a fuel tank float valve coupled to a fuel line check valve and the fuel pipe with a tap for connecting the fuel tank to the refueling hose into inlet which is built operated check valve, wherein the fuel tank is mounted doshy controllable valve connected to the receiving and dispensing fuel lines.

The disadvantage of this design complexity fueling vehicle is due to the presence of fuel intake systems and sustainable system of cooling and nitriding fuel nadtoplivnogo space.

The closest in technical essence to the claimed fueling vehicle is described in the same patent RF 2158208 № tml. V60R 3/22, B60S 5/02, B67D 5/32, s. 02.03.99, op. 27.10.2000 and was selected as a prototype.

Known fueling vehicle comprises a vehicle carrying a fuel tank with the breathing valve and sensors of the lower and upper levels, the drain-filler tube disposed at the bottom thereof and connected through the diaphragm valve to the inlet conduit with a valve inlet and a system of fuel dispensing, comprising in series fuel filter pipe for, and dispensing pggutserov counter with fuel hoses for supplying fuel to the consumer, the pump unit, shut-off control valves in a valve, a gas supply pipe to the tank, with the upper part of the tank mounted sensor gazoanalizagora concentration hydrocarbon vapor, a check valve, the two solenoid valves and a control unit for the sequence of operations, the inputs of which are connected with the sensors of the gas analyzer, the upper and lower levels and data output valve installed at the entrance of the receiving trubotfovoda, and the control unit outputs are connected to the drive pump and the control inputs of the solenoid valves, a gas supply conduit is connected through a normally closed first solenoid valve and the check valve to the oil-handling conduit tank to the installation point of the diaphragm valve and via the first normally open and the first normally closed contact of the second electromagnetic valve connected respectively to nadmembrannoy and submembrane cavities membrane valve nadmembrannaya cavity which normally za1fyty through the second contact, and submembrane cavity through the second normally open contact of the second elec netic valve

communicated with the atmosphere.

A disadvantage of the known fueling vehicle is on the one hand, design complexity, due to the presence of the gas analyzer, the gas supply pipe, solenoid valves, diaphragm valves with above submembrane s cavities. In addition, the fueling vehicle has limited performance capabilities, as it can zshhravlyat only one vehicle or discharging fuel filling station (gas station). On the other hand, known fueling vehicle, although it has a fire protection means for the analysis of gases in the tank and to feed neutral gas, it nevertheless nedotatochno reliable in terms of operational safety. The purpose of the claimed utility model is:

the first and second embodiments - simplification avtotoplivozapravpschka rasgoirenii structure at its operating capacity and ensuring reliable operation;

-In the third variant - the Enhance reliability and safety of operation.

The goal is achieved by the fact that:

-to the first embodiment, the fueling vehicle comprising a cargo vehicle mounted thereon with a breather tank, fuel receiving system including a receiving schtutser or adapter for attachment schlanga filling and the associated receiving fuel, the fuel dispensing system including a dispensing fuel, a pump unit, fuel filters and fuel dispensing nozzles with schlangami for supplying fuel to potreb1ggelyu, the control system comprising a signaling Zfovnya counter flow and shut-adjusting) the armature SOG.LASNO UTILITY MODEL, the fuel tank further comprises

UTILITY MODEL, the fuel tank comprises donolnitelno bottom valve as well as two-level limiter filling its fuel indicator presence of water in the tank sump and vent system, the fuel dispensing system provided with a filter water separator with indication of the presence of water in the sump of the filter, the fuel dispensing system fuel hoses two on each side are wound on the reels, mounted on the rear side of the tank on both sides of its longitudinal axis, in the control system as a shut-off control valves isp lzovany ball valves, control system equipped with a warning indicator system on nesmotannyh fuel hose and open door control module, located in the cockpit

driver;

- in the second execution in fueling vehicle comprising a cargo vehicle mounted thereon tank with the breathing valve, fuel receiving system including a receiving pggutser or adapter prisoedineshya refueling hose and the associated receiving fuel, the fuel dispensing system including a dispensing fuel, the pump unit , fuel filters and fuel

dispensing nozzles with pshangami for supplying fuel to the consumer, the control system comprising a level switch, flow meter and shut-off control valves UNDER NOLEZNOY MODELS are ground circuit, the system checks the grounding continuity, fuel lines and the fuel tank is made of a material excluding the possibility of fuel contamination, wherein the tank further comprises a forced and bottom flaps, two-level indicator fuel filling, the label indicating water in the sump tank and the venting system, the fuel dispensing system is provided with a filter water separator indicator of the presence of water in the sump filter and score liquid ICOM

the electronic control unit, the hydraulic drive for the winding and unwinding of fuel hoses, which are two dispensing hoses of different diameter wound on reels mounted on the rear wall of the tank on either side of its longitudinal axis, the control system has a display system ot nesmotannyh pshangah and open door control module placed in the driver's cab; - in the third embodiment in avtotoplivozapravpschike containing cargo vehicle mounted thereon tank with the breathing valve, fuel admission system vklyuchayup1uyu receiving fitting shsh adapter for joining the filling hose and the associated receiving fuel, the fuel dispensing system vklyuchayushuyu dispensing fuel, a pump unit, fuel filters and dispensing nozzles with fuel hoses for supplying fuel to the consumer, the control system comprising a level switch, counter flow shut-off and control valves UNDER THE UTILITY MODEL, pipes and the fuel tank are made of a material excluding the possibility of fuel contamination, the tank is provided with an additional bottom and forced valves and breakwaters to quench the fuel strikes the motion, two-level stop filling the tank, signaling the presence of water in the sump tank and the venting system, the fuel system is provided with a filter receiving vodotdelitelem-in system fuel dispensing unit are fuels preparation va, vklyuchayupschy converter static electricity, mounted after the fluid meter, and dampers for damping hydraulic shocks over the dispensing conduit, a vane pump with a hydraulic motor for pumping fuel from the fuel hoses representing dispensers sleeves of different diameter, wound on reels, placed with the rear wall of the tank and provided with their separate hydraulic drive for winding and unwinding

, The control system is equipped with a pressure-limiting system when refueling control system operator involvement in the process of charging, the display system of door closure control and nesmotannyh distributing sleeves compartment, located in the cab, as of valves used in ball valves, thus fueling vehicle equipped with a system earthing and equipotential bonding, the complementary box hydraulic, pneumatic system for controlling the operation of special equipment and forced bottom lapane supercharged dampers in the system of fuel dispensing, filling and operation of the limiter lock brake system with the door open control and nesmotannyh dispensing compartment.

Furthermore, in all embodiments, the fuel tank may be provided with a platform for servicing placed outside on its upper part.

Execution in the fuel tank to the first embodiment, a bottom valve in conjunction with the presence of two-level limiter filling the tank with fuel at an early stage of filling protects it from overflowing and then by overflow signal feed pump shutdown, and automatic closing of the bottom valve; presence in the system issuing fuel filter water separator not only clean fuel from mechanical impurities, but also to separate free water, which is signsled by LEDs in the sump tank and the filter. Use as a shut-off valves reguirfuyuschey ball valves provide a sufficiently simple konstrz ktsii reliable operation of the device, and the presence of warning indicator system on nesmotannyh gas fuel hoses and unlocked the door control module ensures safe operation. Winding on reels 2 fuel hoses on each side of the longitudinal axis h

. tank allows simultaneous charging of four units. In the second embodiment vynolnenie fuel tank and totsdivoprovodov materials precluding fuel contamination, together with the presence in the settler tank indicator the presence of water and filtravodootdelitelya system fuel dispensing provides expansion of its ekspluagatsionnyh opportunity - namely, charging the aircraft and the control of the filling via liquid counter with an electronic unit that accounts for instantaneous one-off and total fuel consumption; presence in the cistern forced valve provides accelerated in the tank with the atmospheric pressure equalization at its refueling and supply of machine ground continuity testing system provides a fire- and explosion safety and reliability of operation. The presence of the hydraulic drive system fuel vschachi gives the ability to adjust the speed of unwinding and winding dispensing hoses that when placing them on the two drums at the rear of the tank provides an open and a closed aircraft refueling facilities and ease of use. in the third embodiment of the tank and fuel from materials precluding fuel contamination, in conjunction with the introduction of a system of fuel fuel conditioning unit of issue, and in avtotoplivozagfavpschk - control means of the quality of signaling the presence of water in the fuel, and performance of the system issuing fuel oil hoses in the form of sleeves of different diameter dispenser pozvo.11yaet objects safely refuel aircraft, require fuel of a higher quality; presence in the tank of breakwaters to quench the fuel strikes during transportation and filling of the tank bilevel limiter provides in conjunction with the presence in it and forced bottom valve

secure filling and transportation of the tank with fuel. Introduction to the system of controls for automatic pressure limitation when refueling facilities nashdchii technology in hydraulic drives for unwinding and winding of distributing arms to regulate the charging rate when using the control system operator involvement in the process of refueling and ensures reliability and safety during refueling facilities engineering. Supply unit avtotoplivozapravpschike additionel hydraulic and pneumatic system for controlling the operation of special equipment in conjunction with the presence therein of earthing and equipotential bonding and interlocking motion with dispensing nesmotannyh sleeves and unlocked door upravlevmya compartment ensures reliable and safe operation of the entire machine. In comparison with the prototype claimed fueling vehicle in all embodiments is novel, differing from it:

in the first embodiment - fuel tank performing forced and bottom valves, vent system, placement of fuel hoses in fuel system vvdachi on two reels, mounted on opposite sides of the plane of the back of the tank, using a shut-off and regulating valve shgfovgh; taps providing a plurality of achieving the desired result;

- Second embodiment - performing tank and piping material, precluding fuel contamination, installing therein forced and bottom valves bilevel signaling fuel filling, an indication of whether the water in the sump, the presence of the venting system, the presence in the system issuing fuel filtravodootdelitelya and liquid counter with an electronic unit, the hydraulic drive for winding and unwinding of two dispensing hoses of different diameters, and in the control - the display system of the unlocked door of the control cabinet h and dispensing irregularly wound sleeves, located in the driver's cab, and the integrity of the system ground Exalt indication, obesnechivayuschih sovokupnostl in achieving the desired result; - in the third embodiment, - performing tank and piping of a material excluding the possibility of fuel contamination, by the presence in the tank of breakwaters to quench the fuel strikes the two-level filling limiter, an indication of whether the water in the sump bottom and forced valves administration in liquid receiving counter fuel Electronically water separator unit and the filter, the presence in the fuel dispensing system unit fuel preparation and vane pump with a hydraulic motor for pumping fuel from the dispensing hoses, at otannyh spool (drums) provided with each their hydraulic drive, the presence in the system of fuel-pressure limitation control system when fueling and control system operator involvement in the process of filling and using a lock shield valve ball valves, supply avtotoplivozapravpschika earthing system and equipotential bonding, the complementary box hydraulic and a pneumatic system for controlling the operation of special equipment, providing a plurality of predetermined result. Utility model illyustrfuetsya drawings, showing: A) in the first embodiment: -fig 1 - Search the fueling vehicle type; - fig. 2 - view of the fuel tank side sectional view; -fig. 3 - view from the top of the tank; -fig. 4 - Rear view of the tank; v -fig. 6 - the general view fueling vehicle; -fig.7 - view of the fuel tank side sectional view; -fig. 8 - view from the top of the tank; -fig. 9 - view of the control module; -fig. 10- view of receiving systems and the fuel supply; B) for the third embodiment on: -fig. 11- perspective view fueling vehicle; -fig. 12 - a side view of the fuel tank; -fig. 13 - view of the tank top and the back; FIG. 14, 15 - fuel admission system; -fig. 16,17 - fuel supply system. The claimed fueling vehicle in the first embodiment (FIGS. 1-5) for refueling equipment ground objects and comprises a cargo vehicle 1 on schassi-trailer which has a fuel tank 2, the system 3 receiving fuel, the fuel dispensing system 4 and control system 5 partially housed in the cab 6 of the driver. As the vehicle may be used, in particular tractor "Ural. Tanker 2 (FIGS. 2, 3) has in the upper part of the neck 8 kryschkoy 9 for pouring fuel and is provided with the breathing valve 10, predohrashggelnym valve 11 and bottom valve 12. it also set alarm level of the transmitter 13 and sensor 14 level limiter . In the upper part of the tank 2 has a manhole 16 and can also be arranged to service platform having a guard rail 17 (not shown) and provided with a ladder 18 in the front part of the tank 2. There is a vent system in the form of pipe 19 and discharging the mixture into parovozduschnoy a tube 20. in the bottom of the tank has a sump 21 (FIG. 4). In the rear part of the tank 2 (Fig. 4) is placed compartment system 5

12 control, which houses the administration and control of major functional systems bowsers. Receiving fuel system 3 includes a receiving tube 22 with a coarse filter (not indicated in the drawings and not shown) and the fuel pipe 23. The fuel dispensing system 4 comprises a pump unit 24, in particular in the form of a pump-type SCL-20-24G, fuel 25, a filter-dehydrator 26, fuel (dispensers) dispensing hoses 27 with fittings 28, 29 wound on the reels, arranged on both sides of the rear wall surface of the tank 2.

FAS 2004 - Page 233

R1meetsya handheld actuator 30 drums 29. The system control unit 5 includes a locking and regulating) in Mathur in ide ball valves 31, 32 on lines 23 and 25 and receive the fuel pump, the liquid flow meter 33, sensors 34, pressure indicator 35 the fuel level (gauge 13) and a system 36 indicating a door closure control and nesmotannyh fuel hoses in the driver's compartment (not shown). Fueling vehicle, in accordance with GOST 50913-96, 37 is provided with fire extinguishers, grounding system 38 (FIG. 1) and breakwaters 39 (FIG. 2). Avtotoplivozapravpschik works as follows. Avtotoshshvozapravpschka main functions are as follows: filling of the tank; delivery of petroleum products to the consumer; issuance of oil products to the consumer. Pouring fuel into the tank 2 by means of system 3 receiving fuel - from the mouth portion 8 or through the receiving mouth 22; wherein the coarse filter retains large particles of impurities in the fuel. After loading fueling vehicle, e.g , automobile gasoline, the air-gas space of the fuel tank 2 In a short time (about one hour) saturated with vapors of gasoline, the pressure increases and opens the respiratory x valve 10, providing through the tube 20 out vapor-air mixture with a high concentration hydrocarbons to the atmosphere and the pressure equalization. Fueling vehicle delivers the fuel to the refueling facilities. The operator unwinds from pomopts w manual actuator 30, the fuel hoses 27 from the reels 29, attaches the dispensing nozzles 28 to the necks hatches refueled objects opens ball valve 32 in the conduits 25 of the system 4, the fuel supply includes pump 24 and fuel from the tank 2 via filter-water separator 26 delaying mechanical impurities, manifolds 25 and the fuel hoses 27 enters the tanks refueled objects. When this counter 33 indicates the amount of fuel consumed for refilling. At the end of filling the operator turns off the pump 24, disconnects the dispensing nozzles 28 of the hatches fueled facilities is wound onto the drum 29, the fuel hose 27, and closes the door control cabinet door. If the operator did not close the cabinet doors or forgot to wind the fuel hoses 27, in the driver's cab illuminate warning indicator 36 of these outstanding actions and the driver shall take the necessary measures. Fueling vehicle in the second and third embodiments is intended for refueling of aircraft on the ground. in the second embodiment (FIGS. 6-10) comprises avtotoplivozapravpschik cargo vehicle 1 mounted on the chassis of the semitrailer tank 2, system 3 receiving fuel, the fuel dispensing system 4 and control system 5. The fuel tank 2 is at the top hatch 6, the neck 7 with a cover 8, in the lower part - sump 9. It is equipped with breathing, safety and bottom flaps 10, 11, 12 as well as two-level filling fuel signaling - 13 float level indicator and fuel level sensor 14 - 15, retraction tube

vapor mixture and the indicator 16 (not shown), the presence of water in the sump 9 of water in the tank 2. The tank 2 is made of a material excluding the possibility of contamination of the fuel, for example, stainless steel or aluminum alloys.

Receiving fuel system 3 includes a receiving tube 17 with a coarse filter, the conduit 18c ball valve 19.

System 4 comprises fuel dispensing conduit 20 with the ball valve 21, the fuel hose 22. The fuel pipe 22 are sleeves of different diameters dispensers with dispenser fittings 23 wound on drums 24 mounted on the rear wall of the tank 2 on either side of its longitudinal axis and having a hydraulic actuator 25 for winding and unwinding hoses. Fuel dispensing system 4 has a high performance pump 26 (not shown). There grounding circuit 27 and the system 28 checks the integrity of the ground circuit. The system is equipped with filters 29 -vodootdelitelyami.

5 control system includes shut-reguliruyushuyu reinforcement in the form of ball valves 19, 21, indicators 13, 14 level system 30 indicating a unlocked door control and nesmotannyh hoses 22, arranged in the driver's cab, the counter 31, the liquid flow compartments with the electronic unit, sensors 32 pressure.

The tank 2 is equipped with a platform 33, stairs 34 and 35. Avtotogshivozapravschik breakwaters according to GOST above, provided ognetupshtelyami 36. Pipelines 18 and 20 also vsholmeny stainless steel or of aluminum alloy to prevent contamination of the fuel.

Avtotopiryuozapravschik works as follows. When filling the tank 2 produces its filling fuel via gorlovrshu 7 through suction inlet 17 and the receiving conduit 18. In this two-level alarm is activated filling (13 x 14), preventing overflow tank 2 and overflows. Gases accumulated when filling the upper part of the tank are discharged via tube 15. fueling vehicle transports the fuel to the refueling facilities. The operator via hydraulic drive 25 unwinds from the dispensing arm 22 b Abanya 24, attaches fitting 23 to dispensing hatches refueled objects includes a pump 26, a high productivity and produces refilling of fuel. The presence in the sump 9 of the tank 2 water availability indicator 16, and the fuel dispensing system filtrovvodootdeliteley 29 not only allows to remove mechanical impurities, but also to remove free water from the fuel. Counter 31 with the electronic control unit detects the instant, a single and the total fuel consumption. Sensors 32 monitor the fuel pressure in the system piping. If the operator has not closed the door of the control cabinet or forgot to wind distributing sleeve, the driver's cab warning lights display system 30. In a third embodiment (Figures 11-16.) Avtotoplivozapravpschik consists of main parts - a truck tractor 1 and a semitrailer - tanks 2, interconnected a coupling device. Mounted on the chassis of the semitrailer fuel tank 2. At the fueling vehicle system 3 are also receiving fuel, the fuel dispensing system 4, the control system 5, system 6 and the equipotential grounding system 7 controls an operator at refueling system pozharopodavleniya 8, an additional hydraulic unit 9, special equipment pneumatic system 10 for controlling the operation of individual components and systems. Tanker 2 is made of stainless steel or aluminum alloy and is provided with a breather, a bottom and a safety valve 11, 12, 13. in the upper part of the tank there manhole 14, the neck 15 with a cover tube 16 for discharging gas, while the lower part - decanter 17 18 signaling the presence of water therein. Inside IijiCTq) Ha 2 has breakwaters 19 for damping shocks when moving the fuel; the bottom of the settling tank 20. The tank has 2 is also provided with a two-level limiter level for protection against overflow and overflow of the filling limiter sensor 21, the float level indicator 22, the float device 23, the limiter 21 filling. There are 24 stairs with a handrail 25 fences. System 2 includes receiving a fuel suction inlet 26 and a receiving line 27 with a tap 28; it is provided with filtromvodootdelitelem 29 and pump 30 performance. System 4 fuel dispensing is provided with fuel preparation unit 31 and also comprises a conduit 32 with a ball valve 33, filter dehydrator 34, the pump 35 of high performance, dispensing sleeves 36 of different diameter dispenser fittings 37 wound on b abany 38 razmep; ennye on the rear wall tank 2 and each equipped with its hydraulic drive 39 for winding and unwinding hoses 36. The unit 31 for preparing fuel converter 40 includes a static electricity, dampers 42 for damping hydraulic shocks in the cavity to form the buffer portion t uboprovods 32 and divided into two cavities removable elastic membrane 43 (not shown). Neutralizer 40 is a circular chamber inside the arrester installed in the conduit 32 downstream of the filter 34 and the fluid meter. There is also a vane pump 44 for pumping topirsha residues of dispensing hoses 36. Pipelines 27 and 32 are made of stainless steel or aluminum alloys, non-polluting fuel. 5 control system includes a fuel system 45 during refueling the pressure limiting unit in the form of pressure sensors, the system 46 kongrolya operator involvement in the process of refueling system 47 (in the drawings L

s

17 is not shown) indikatsni door closure control module n nesmotannyh dispensing arms 36, fuel flow meter 47 to an electronic unit. System 45 is an automatic pressure limiting. The pressure is set by pressing the remote control buttons 48. On exceeding predetermined pressure switch delivers the control signal to reduce the fuel transfer pump 18 turns 35. Signaling the presence of water in the sump 17 of the tank 2 and in the settling tank (not indicated in the drawings and not shown) of the filter - the water separator 29 form a fuel quality monitoring system avtotoshshvozapravschike. System 6 and equipotential grounding includes special conductive jumpers, wires and other devices (not shown), providing elektricheskiykontaktmezhduotdelnymichastyami fueling vehicle is withdrawn accumulate static electricity charges mapshny earthing electrical connection with vneshnimi objects. The control system 7 operator involvement in the process of refueling ensures safe operation in the event of a sudden loss of working capacity of the operator. Operator every 2.5-3 minutes should confirm continuation of the refueling by pressing on the handle remote gorge) The pressure on the console 48. If the handle is pressed, the time switch switches off the pump 35. Bowsers works as follows: When refilling the tank 2 fuel operator connects the filling hose to the source and fuel tank 15 through the neck 2 or 2 protects the tank from perenolneniya. The gases accumulated in the upper part of the tank during filling are output through the vent tube 16. Then delivers fuel to the fueling vehicle fueling facilities. When transporting the fuel as a result of vehicle movements in the tank having waves that breakwaters 19 are suppressed, softening the force of water hammer. In place of filling the operator with the aid of hydraulic drives 39 unwinds dispensing hose 36 connects them with the ald dispensers to 37 pputserov hatches refueled objects and includes a pump 35 for pumping performance of fuel tanks in aircrafts. Counter 47 with the electronic unit counts the instant, a single obshego and fuel consumption. The unit 31 fuel preparation, vkiyuchayupschy a dampeners 42 and the neutralizer 40 of static electricity, dampens the shock wave voznikayup th during refueling of the aircraft at the moment of closing the aircraft onboard valve, and reduces the density of electric charges generated in the fuel flow as it passes through conduit 32 to filter 34. The filter 34 cleans the fuel from mechanical impurities and removes water. Counter 47 uchigyvaet one-time and total fuel consumption. Additional hydraulic unit 9 can change the performance of the pump 35. The system 6 and the equipotential grounding ensures the removal of accumulated charges of static electricity and grounding fueling vehicle. The control system 7 operator involvement in the process of refueling

ensures safe operation when filling in the sudden loss of efficiency by the operator by continuously confirm them to continue refueling by pressing the remote control handle to the console 48. If the handle is pressed, the time switch (not shown and indicated) disables pump 35. If the operator forgot to close the door compartments of the board and / or had looped

dispensing sleeve 36 in the driver's cab display lights 46 unfilled and actions triggered pnevmosistema 10 controls fueling vehicle braking operation to avoid blocking dvizhe1shya avtotoplivozapravpschka. in case of fire, the system operates 8 pozharopodavleniya.

in comparison with the prototype claimed fueling vehicle in the first and second embodiments it is simpler in construction and sufficiently reliable and safe in operation, while the third embodiment provides a reliable operation and secure operation.

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Family To Family Citations

* Cited by examiner, † Cited by third party, ‡ Family to family citation

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Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
RU2002124388U	2002-09-16	2002-09-16	Fueling vehicle (variants)

Applications Claiming Priority (1)

Application	Filing date	Title
RU2002124388U	2002-09-16	Fueling vehicle (variants)

Legal Events

Date	Code	Title	Description
2003-01-27	MM1K	Utility model has become invalid (non-payment of fees)	**Effective date:** 20030917

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B64D37/14

ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ,
ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

(12) СВИДЕТЕЛЬСТВО НА ПОЛЕЗНУЮ МОДЕЛЬ

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(54) АВТОТОПЛИВОЗАПРАВЩИК (ВАРИАНТЫ)

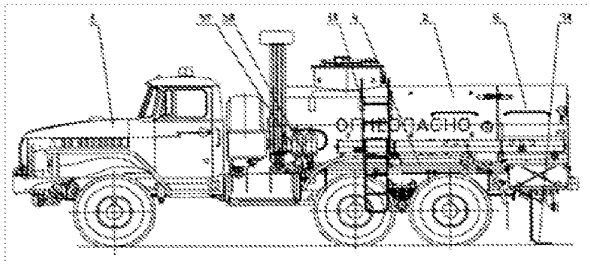
Формула полезной модели

1 Автотопливозаправщик, содержащий грузовое автотранспортное средство, установленную на нем цистерну с дыхательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры, и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, отличающийся тем, что топливная цистерна содержит дополнительно донный клапан, а также двухуровневый ограничитель наполнения ее топливом, индикатор наличия воды в отстойнике цистерны и систему газоотвода, система выдачи топлива снабжена фильтром-водоотделителем с индикатором наличия воды в отстойнике фильтра, топливные шланги системы выдачи топлива по два с каждой стороны намотаны на барабаны, установленные на задней стороне цистерны по обеим сторонам от ее продольной оси, в системе управления в качестве запорно-регулирующей арматуры использованы шаровые краны и имеется система предупредительной индикации о несмотанных топливных шлангах и незакрытой двери отсека управления, размещенной в кабине водителя.

2. Автотопливозаправщик, содержащий грузовое автотранспортное средство, установленную на нем цистерну с дыкательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, отличающийся тем, что в нем имеются цепь заземления, система проверки целостности цепи заземления, топливопроводы и топливная цистерна выполнены из материала, исключающего возможность загрязнения топлива, причем цистерна содержит дополнительно принудительный и донный клапаны, двухуровневый сигнализатор наполнения топливом, индикатор наличия воды в отстойнике цистерны и систему газоотвода, система выдачи топлива снабжена фильтром-водоотделителем с индикатором наличия воды в отстойнике фильтра и счетчиком жидкости с электронным блоком, гидроприводом для намотки и размотки топливных шлангов, представляющих собой два раздаточных рукава разного диаметра, намотанные на барабаны, установленные на задней стенке цистерны по обе стороны от ее продольной оси, в системе управления имеется система индикации о несмотанных шлангах и незакрытых дверях отсека управления, размещенная в кабине водителя.

3. Автотопливозаправщик, содержащий грузовое автотранспортное средство, установленную на нем цистерну с дыкательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры, и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, отличающийся тем, что трубопроводы и топливная цистерна выполнены из материала, исключающего возможность загрязнения топлива, цистерна снабжена дополнительно донным и принудительным клапанами, а также волнорезами для гашения ударов топлива при движении, двухуровневым ограничителем наполнения цистерны, сигнализатором наличия воды в отстойнике цистерны и системой газоотвода, система приема топлива снабжена фильтром-водоотделителем, в системе выдачи топлива имеется агрегат подготовки топлива, включающий нейтрализатор статического электричества, установленный после счетчика жидкости, и демпферы для гашения гидроударов над выдачным трубопроводом, в качестве запорно-регулирующей арматуры использованы шаровые краны, имеется пластинчатый насос с гидромотором для откачки топлива из топливных шлангов, представляющих собой раздаточные рукава разного диаметра, намотанные на барабаны, размещенные на задней стенке цистерны и снабженные каждый своим гидроприводом для намотки и размотки рукавов, система управления снабжена системой ограничения давления при заправке, системой контроля участия оператора в процессе заправки, системой индикации о незакрытой двери отсека управления и несмотанных раздаточных рукавах, размещенной в кабине водителя, при этом автотопливозаправщик оборудован системой заземления и выравнивания потенциалов, дополнительным блоком гидрооборудования, пневмосистемой спецоборудования для управления работой донного и принудительного клапанов, наддувом демпферов в системе приема топлива, ограничителя наполнения и работой системы блокировки тормозов при открытой двери отсека управления и несмотанных шлангах.

4. Автотопливозаправщик по пп.1-3, отличающийся тем, что топливная цистерна снабжена площадкой для обслуживания, размещенной снаружи на ее верхней части и снабженной перилами.



ФАКСИМИЛЬНОЕ ИЗОБРАЖЕНИЕ

МКИ-7: B60S 5/00, 5/02
B64F 1/28,
B64D 37/14

2002124388

АВТОТОПЛИВОЗАПРАВЩИК

(варианты)

Полезная модель относится к средствам обслуживания транспортных средств, а именно - для подачи топлива к транспортным средствам для заправки на стоянке летательных аппаратов и наземного транспорта и может широко использоваться в транспортном хозяйстве и авиации.

Известен автотопливозаправщик, описанный в одноименном п. РФ № 2090460 по кл. B64F 1/28, з. 07.06.95, оп. 20.09.97.

Известный автотопливозаправщик содержит автотягач с двигателем, цистерну-полуприцеп, размещенную на ней установку с приводом, установленный на автотягаче гидронасос, кинематически связанный с двигателем автотягача, и гидромотор, гидравлически связанный с гидронасосом при помощи труб, подвижно соединенных между собой с двумя степенями свободы в вертикальной и горизонтальной плоскостях.

Недостатком известного автотопливозаправщика является то, что он при достаточной простоте конструкции имеет ограниченные эксплуатационные способности и не очень безопасен в работе.

Известен автотопливозаправщик, описанный в одноименном п. РФ № 2113367 по кл. B60P 3/22, з. 08.08.97, оп. 20.06.98.

Известный автотопливозаправщик содержит автотранспортное средство, установленную на нем топливную цистерну с дыхательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной

топливопровод, насосные агрегаты, запорно-регулирующую арматуру, топливные фильтры, литромеры и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю или емкости хранилища, систему устойчивого забора самовсасыванием из хранилища и систему азотирования поступающего в топливную цистерну топлива и захолаживания надтопливного пространства топливной цистерны, включающую в себя сосуд для жидкого азота, связанные с сосудом испаритель и коллектор для подачи холодного газообразного азота в надтопливное пространство цистерны, установленный после испарителя компрессор, связанный с ним коллектор высокого давления, соединенный с баллонами высокого давления, газовый редуктор на выходе коллектора высокого давления, соединенный с колонкой азотирования, встроенной в топливопровод и имеющей форсунки для подачи азота в поток топлива, причем коллектор расположен в верхней части топливной цистерны в удалении от места размещения дыхательного клапана, а система устойчивого забора топлива включает в себя бачок с полезным объемом, превышающим объем топливозаправочного шланга и топливопровода до входа в насосный агрегат, топливопровод с обратным клапаном для соединения выхода насосного агрегата с топливным бачком, установленный в топливном бачке поплавковый клапан, соединенный с топливопроводом обратным клапаном, и топливопровод с краном для соединения топливного бачка с заправочным шлангом, во вход которого встроен управляемый обратный клапан, причем в топливной цистерне установлен управляемый донный клапан, соединенный с приемным и выдачным топливопроводами.

Недостатком известного автотопливозаправщика является сложность конструкции, обусловленная наличием системы устойчивого забора топлива и системы азотирования топлива и захолаживания надтопливного пространства.

Наиболее близким по технической сущности к заявляемому является автотопливозаправщик, описанный в одноименном патенте РФ № 2158208 по кл. B60P 3/22, B60S 5/02, B67D 5/32, з. 03.02.99, оп. 27.10.2000 г. и выбранный в качестве прототипа.

Известный автотопливозаправщик содержит транспортное средство, несущее топливную цистерну с дыхательным клапаном и датчиками нижнего и верхнего уровней, сливно-наливной патрубок, размещенный в нижней ее части и подключенный через мембранный клапан к приемному трубопроводу с клапаном на входе и системе выдачи топлива, состоящей из установленных последовательно на трубопроводе топливного фильтра, счетчика и раздаточных штуцеров с топливными шлангами для подачи топлива к потребителю, насосный агрегат, запорно-регулирующую арматуру в виде задвижек, трубопровод подачи газа в цистерну, при этом в верхней части цистерны установлен чувствительный элемент газоанализатора концентрации паров углеводородов, обратный клапан, два электромагнитных клапана и блок управления последовательностью операций, входы которого соединены с датчиками газоанализатора, верхнего и нижнего уровней и информационным выходом клапана, установленного на входе приемного трубопровода, а выходы блока управления подключены к приводу насоса и управляющим входам электромагнитных клапанов; трубопровод подачи газа подключен через нормально закрытый контакт первого электромагнитного клапана и обратный клапан к сливно-наливному патрубку цистерны до точки установки мембранного клапана и через первый нормально открытый и первый нормально закрытый контакты второго электромагнитного клапана связан соответственно с надмембранной и подмембранной полостями мембранного клапана, надмембранная полость которого через второй нормально закрытый контакт, а подмембранная полость через второй нормально открытый контакт второго электромагнитного клапана

сообщены с атмосферой.

Недостатком известного автотопливозаправщика является, с одной стороны, сложность конструкции, обусловленная наличием газоанализатора, трубопровода подачи газа, электромагнитных клапанов, мембранного клапана с над -и подмембранной полостями. Кроме того, данный автотопливозаправщик имеет ограниченные эксплуатационные возможности, т.к. он может заправлять только одно транспортное средство или сливать топливо в АЗС (автозаправочную станцию).

С другой стороны, известный автотопливозаправщик, хотя и имеет пожарозащиту в виде средств для анализа концентрации газов в цистерне и подачи туда нейтральных газов, тем не менее он недотаточно надежен с точки зрения эксплуатационной безопасности.

Целью заявляемой полезной модели является:

- в первом и втором вариантах - упрощение конструкции автотопливозаправщика при расширении его эксплуатационных возможностей и обеспечении надежной работы;
- в третьем варианте - повышение надежности работы и безопасности эксплуатации.

Поставленная цель достигается тем, что:

- в первом варианте выполнения в автотопливозаправщике, содержащем грузовое автотранспортное средство, установленную на нем цистерну с дыхательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры, и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, СОГЛАСНО ПОЛЕЗНОЙ МОДЕЛИ, топливная цистерна содержит дополнительно

ПОЛЕЗНОЙ МОДЕЛИ, топливная цистерна содержит дополнительно донный клапан, а также двухуровневый ограничитель наполнения ее топливом, индикатор наличия воды в отстойнике цистерны и систему газоотвода, система выдачи топлива снабжена фильтром-водоотделителем с индикатором наличия воды в отстойнике фильтра, топливные шланги системы выдачи топлива по два с каждой стороны намотаны на барабаны, установленные на задней стороне цистерны по обеим сторонам от ее продольной оси, в системе управления в качестве запорно-регулирующей арматуры использованы шаровые краны, система управления снабжена системой предупредительной индикации о несмотанных топливных шлангах и незакрытой двери отсека управления, размещенной в кабине водителя;

- во втором варианте выполнения в автотопливозаправщике, содержащем грузовое автотранспортное средство, установленную на нем цистерну с дыхательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, СОГЛАСНО ПОЛЕЗНОЙ МОДЕЛИ, имеются цепь заземления, система проверки целостности цепи заземления, топливопроводы и топливная цистерна выполнены из материала, исключающего возможность загрязнения топлива, причем цистерна содержит дополнительно принудительный и донный клапаны, двухуровневый сигнализатор наполнения топливом, индикатор наличия воды в отстойнике цистерны и систему газоотвода, система выдачи топлива снабжена фильтром-водоотделителем с индикатором наличия воды в отстойнике фильтра и счетчиком жидкости с

электронным блоком, гидроприводом для намотки и размотки топливных шлангов, представляющих собой два раздаточных рукава разного диаметра, намотанные на барабаны, установленные на задней стенке цистерны по обе стороны от ее продольной оси, в системе управления имеется система индикации о несмотанных шлангах и незакрытых дверях отсека управления, размещенная в кабине водителя;

- в третьем варианте выполнения в автотопливозаправщике, содержащем грузовое автотранспортное средство, установленную на нем цистерну с дыхательным клапаном, систему приема топлива, включающую приемный штуцер или переходник для присоединения заправочного шланга и связанный с ним приемный топливопровод, систему выдачи топлива, включающую выдачной топливопровод, насосный агрегат, топливные фильтры, и раздаточные штуцеры с топливными шлангами для подачи топлива к потребителю, систему управления, включающую сигнализаторы уровня, счетчик расхода и запорно-регулирующую арматуру, СОГЛАСНО ПОЛЕЗНОЙ МОДЕЛИ, трубопроводы и топливная цистерна выполнены из материала, исключающего возможность загрязнения топлива, цистерна снабжена дополнительно донным и принудительным клапанами, а также волнорезами для гашения ударов топлива при движении, двухуровневым ограничителем наполнения цистерны, сигнализатором наличия воды в отстойнике цистерны и системой газоотвода, система приема топлива снабжена фильтром-водотделителем, в системе выдачи топлива имеются агрегат подготовки топлива, включающий нейтрализатор статического электричества, установленный после счетчика жидкости, и демпферы для гашения гидроударов над выдачным трубопроводом, пластинчатый насос с гидромотором для откачки топлива из топливных шлангов, представляющих собой раздаточные рукава разного диаметра, намотанные на барабаны, размещенные на задней стенке цистерны и снабженные каждый своим гидроприводом для намотки и размотки

рукавов, система управления снабжена системой ограничения давления при заправке, системой контроля участия оператора в процессе заправки, системой индикации о незакрытой двери отсека управления и несмотанных раздаточных рукавах, размещенной в кабине водителя, в качестве запорно-регулирующей арматуры использованы шаровые краны, при этом автотопливозаправщик оборудован системой заземления и выравнивания потенциалов, дополнительным блоком гидрооборудования, пневмосистемой спецоборудования для управления работой донного и принудительного клапанов, наддувом демпферов в системе выдачи топлива, ограничителя наполнения и работой системы блокировки тормозов при открытой двери отсека управления и несмотанных раздаточных рукавах.

Кроме того, во всех вариантах выполнения топливная цистерна может быть снабжена площадкой для обслуживания, размещенной снаружи на ее верхней части.

Выполнение в первом варианте топливной цистерны с донным клапаном в совокупности с наличием двухуровневого ограничителя наполнения цистерны топливом на ранней стадии наполнения предохраняет ее от перелива, а затем от переполнения подачей сигнала на отключение насоса и автоматическое закрытие донного клапана; наличие в системе выдачи топлива фильтра-водоотделителя позволяет не только очистить топливо от механических примесей, но и отделить свободную воду, о чем сигнализируют индикаторы в отстойнике цистерны и в самом фильтре. Использование в качестве запорно-регулирующей арматуры шаровых кранов обеспечивает при достаточно простой конструкции надежную работу устройства, а наличие системы индикации предупреждения о несмотанных заправочных топливных шлангах и незапертой двери отсека управления обеспечивает безопасность эксплуатации. Намотка на барабаны по 2 топливных шланга с каждой стороны от продольной оси

цистерны дает возможность заправки одновременно четырех единиц техники.

Во втором варианте выполнение топливной цистерны и топливопроводов из материалов, исключающих загрязнение топлива, в совокупности с наличием в отстойнике цистерны индикатора присутствия воды и фильтра-водоотделителя в системе выдачи топлива обеспечивает расширение его эксплуатационных возможностей, а именно - возможность заправки летательных аппаратов и контроль этой заправки с помощью счетчика жидкости с электронным блоком, позволяющим учитывать мгновенный, разовый и суммарный расход топлива; наличие в цистерне принудительного клапана обеспечивает ускоренное выравнивание давления в цистерне с атмосферным при ее заправке, а снабжение машины системой проверки целостности цепи заземления обеспечивает пожаро-, взрывобезопасность и надежность эксплуатации. Наличие гидропривода в системе выдачи топлива дает возможность регулировать скорость размотки и намотки раздаточных рукавов, что при размещении их на двух барабанах на задней стороне цистерны обеспечивает проведение открытой и закрытой заправки объектов авиатехники и удобство эксплуатации.

В третьем варианте выполнение цистерны и топливопроводов из материалов, исключающих загрязнение топлива, в совокупности с введением в систему выдачи топлива агрегата подготовки топлива, а в автотопливозаправщик – средств контроля его качества в виде сигнализаторов наличия воды в топливе, и выполнением в системе выдачи топлива топливных шлангов в виде раздаточных рукавов разного диаметра позволяет безопасно производить заправку объектов авиационной техники, требующих топлива более высокого качества; наличие в цистерне волнорезов для гашения ударов топлива при транспортировке и двухуровневого ограничителя наполнения цистерны обеспечивает в совокупности с наличием в ней донного и принудительного клапанов

безопасную заправку и транспортировку цистерны с топливом. Введение в систему управления средств для автоматического ограничения давления при заправке объектов техники при наличии гидроприводов для размотки и намотки раздаточных рукавов, позволяющих регулировать скорость заправки, при использовании системы контроля участия оператора в процессе заправке также обеспечивает надежность и безопасность процесса заправки объектов техники. Снабжение автотопливозаправщика дополнительным блоком гидрооборудования и пневмосистемой для управления работой спецоборудования в совокупности с наличием в нем систем заземления и выравнивания потенциалов и блокировки движения при несмотанных раздаточных рукавах и незапертой двери отсека управления гарантирует надежную и безопасную работу всей машины.

В сравнении с прототипом заявляемый автотопливозаправщик во всех вариантах выполнения обладает новизной, отличаясь от него:

- в первом варианте - выполнением топливной цистерны с принудительным и донным клапанами, системой газоотвода, размещением топливных шлангов в системе выдачи топлива на двух барабанах, установленных на разных сторонах задней плоскости цистерны, использованием в качестве запорно-регулирующей арматуры шаровых кранов, обеспечивающих в совокупности достижение заданного результата;
- во втором варианте - выполнением цистерны и трубопроводов из материала, исключающего загрязнение топлива, установкой в ней принудительного и донного клапанов, двухуровневого сигнализатора наполнения топливом, индикатора наличия воды в отстойнике, наличием системы газоотвода, наличием в системе выдачи топлива фильтра-водоотделителя и счетчика жидкости с электронным блоком, гидропривода для намотки и размотки двух раздаточных рукавов разного диаметра, а в системе управления - системы индикации о незапертой

двери шкафа управления и несмотанных раздаточных рукавах, размещенной в кабине водителя, и системы индикации целостности цепи заземления, обеспечивающих в совокупности достижение заданного результата;

- в третьем варианте - выполнением цистерны и трубопровода из материала, исключающего возможность загрязнения топлива, наличием в цистерне волнорезов для гашения ударов топлива, двухуровневого ограничителя наполнения, индикатора наличия воды в отстойнике, донного и принудительного клапанов, введением в систему приема топлива счетчика жидкости с электронным блоком и фильтра - водоотделителя, наличием в системе выдачи топлива агрегата подготовки топлива и пластинчатого насоса с гидромотором для откачки топлива из раздаточных рукавов, намотанных на катушки (барабаны), снабженные каждая своим гидроприводом, наличием в системе управления системы ограничения давления топлива при заправке и системы контроля участия оператора в процессе заправки и использованием в качестве запорно-регулирующей арматуры шаровых кранов, снабжением автотопливозаправщика системой заземления и выравнивания потенциалов, дополнительным блоком гидрооборудования и пневмосистемой для управления работой спецоборудования, обеспечивающих в совокупности получение заданного результата.

Полезная модель иллюстрируется чертежами, где показаны:

А) для первого варианта на:

- фиг. 1 - общий вид автотопливозаправщика ;
- фиг.2 - вид топливной цистерны сбоку в разрезе ;
- фиг. 3 – вид цистерны сверху;
- фиг. 4 - вид цистерны сзади ;
- фиг. 5 - вид отсека системы управления;

Б) для второго варианта выполнения на:

- фиг. 6 - общий вид автотопливозаправщика ;
- фиг.7 - вид топливной цистерны сбоку в разрезе;
- фиг. 8 – вид цистерны сверху;
- фиг. 9 – вид отсека управления;
- фиг.10 - вид систем приема и подачи топлива;

В) для третьего варианта выполнения на:

- фиг. 11- общий вид автотопливозаправщика ;
- фиг. 12 - вид топливной цистерны сбоку;
- фиг. 13 - вид цистерны сверху и сзади;
- фиг. 14, 15 - вид системы приема топлива;
- фиг. 16, 17 - вид системы подачи топлива.

Заявляемый автотопливозаправщик в первом варианте выполнения (фиг. 1-5) предназначен для заправки топливом наземных объектов техники и содержит грузовое автотранспортное средство 1, на шасси-полуприцепе которого размещены топливная цистерна 2, система 3 приема топлива, система 4 выдачи топлива и система 5 управления, частично размещенная в кабине 6 водителя. В качестве автотранспортного средства может быть использован, в частности, седельный тягач «Урал».

Цистерна 2 (фиг.2, 3) имеет в верхней части горловину 8 с крышкой 9 для заливки топлива и снабжена дыхательным клапаном 10, предохранительным клапаном 11 и донным клапаном 12. В ней также установлены сигнализаторы уровня в виде уровнемера 13 и датчика 14 ограничителя уровня. В верхней части цистерны 2 имеется люк-лаз 16 и может быть также размещена площадка для обслуживания, имеющая ограждение 17 (на чертежах не показано) и снабженная лестницей 18 в передней части цистерны 2. Имеется система газоотвода в виде трубы 19 и отвода паровоздушной смеси в виде трубки 20. В дне цистерны имеется отстойник 21 (фиг. 4).

В задней части цистерны 2 (фиг. 4) размещен отсек системы 5

управления, в котором расположены органы управления и контроля основных функциональных систем автотопливозаправщика.

Система 3 приема топлива включает в себя приемный патрубок 22 с фильтром грубой очистки (не обозначен и на чертежах не показан) и топливопровод 23.

Система 4 выдачи топлива содержит насосный агрегат 24, в частности, в виде насоса типа СЦЛ-20-24Г, топливопровод 25, фильтр-водоотделитель 26, топливные (раздаточные) шланги 27 с раздаточными штуцерами 28, намотанные на барабанах 29, расположенных с обеих сторон поверхности задней стенки цистерны 2. Имеется также ручной привод 30 барабанов 29.

Система 5 управления включает в себя запорно-регулирующую арматуру в виде шаровых кранов 31, 32 на трубопроводах 23 и 25 приема и подачи топлива, счетчик 33 расхода жидкости, датчики 34 давления, индикатор 35 уровня топлива (от уровнемера 13) и систему 36 индикации о незакрытой двери отсека управления и несмотанных топливных шлангах в кабине водителя (на чертежах не показана). Автотопливозаправщик, согласно ГОСТ 50913-96, снабжен огнетушителями 37, системой заземления 38 (фиг. 1) и волнорезами 39 (фиг. 2).

Автотопливозаправщик работает следующим образом.

Основными функциями автотопливозаправщика являются : наполнение цистерны; доставка нефтепродуктов потребителю; выдача нефтепродуктов потребителю.

Налив топлива в цистерну 2 осуществляется с помощью системы 3 приема топлива - через горловину 8 или через приемный патрубок 22; при этом фильтр грубой очистки задерживает крупные частицы примесей в топливе.

После налива автотопливозаправщика, например, автомобильным бензином, воздушно-газовое пространство топливной цистерны 2 в течение небольшого времени (до одного часа) насыщается парами автобензина, при этом давление повышается и открывается дыхательный

клапан 10, обеспечивая через трубку 20 выход паровоздушной смеси с высокой концентрацией углеводородов в атмосферу и выравнивание давлений.

Автотопливозаправщик доставляет топливо к объектам заправки. Оператор разматывает с помощью ручного привода 30 топливные шланги 27 с барабанов 29, присоединяет раздаточные штуцеры 28 к горловинам люков заправляемых объектов. открывает шаровые краны 32 в трубопроводах 25 системы 4 подачи топлива, включает насос 24 и топливо из цистерны 2 через фильтры-водоотделители 26, задерживающие механические примеси, трубопроводы 25 и топливные шланги 27 поступает в баки заправляемых объектов. При этом счетчик 33 показывает объем израсходованного на заправку топлива. По окончании заправки оператор выключает насос 24, отсоединяет раздаточные штуцеры 28 от люков заправляемых объектов, сматывает на барабаны 29 топливные шланги 27 и закрывает дверцы шкафа отсека управления. Если оператор не закрыл дверцы шкафа или забыл смотать топливные шланги 27, в кабине водителя загорается предупредительная индикация 36 о названных невыполненных действиях и водитель принимает необходимые меры.

Автотопливозаправщик во втором и третьем вариантах выполнения предназначен для заправки топливом на земле летательных аппаратов.

Во втором варианте выполнения (фиг. 6—10) автотопливозаправщик содержит грузовое автотранспортное средство 1, установленную на шасси полуприцепа цистерну 2, систему 3 приема топлива, систему 4 выдачи топлива и систему 5 управления.

Топливная цистерна 2 имеет в верхней части люк-лаз 6, горловину 7 с крышкой 8, в нижней части – отстойник 9. Она снабжена дыхательным, предохранительным и донным клапанами 10, 11, 12, а также двухуровневым сигнализатором наполнения топливом - поплавковым указателем 13 уровня и датчиком 14 уровня топлива,- трубкой 15 отвода

паровоздушной смеси и индикатором 16 (на чертежах не показан) наличия воды в отстойнике 9 воды в цистерне 2. Цистерна 2 выполнена из материала, исключающего возможность загрязнения топлива, например, из нержавеющей стали или алюминиевых сплавов.

Система 3 приема топлива включает приемный патрубок 17 с фильтром грубой очистки, трубопровод 18 с шаровым краном 19.

Система 4 выдачи топлива содержит трубопровод 20 с шаровым краном 21, топливные шланги 22. Топливные шланги 22 представляют собой раздаточные рукава разных диаметров с раздаточными штуцерами 23, намотанные на барабаны 24, установленные на задней стенке цистерны 2 по обе стороны от ее продольной оси и имеющие гидропривод 25 для намотки и размотки рукавов. Система 4 выдачи топлива имеет насос 26 высокой производительности (на чертежах не показан). Имеется цепь 27 заземления и система 28 проверки целостности цепи заземления. Система оборудована фильтрами –водоотделителями 29.

Система 5 управления включает запорно-регулирующую арматуру в виде шаровых кранов 19, 21, индикаторы 13, 14 уровня, систему 30 индикации о незапертой двери отсека управления и несмотанных шлангах 22, размещенную в кабине водителя, счетчик 31 расхода жидкости с электронным блоком, датчики 32 давления.

Цистерна 2 оборудована лестницей 33 с площадкой 34 и волнорезами 35. Автотопливозаправщик, согласно вышеупомянутому ГОСТу, снабжен огнетушителями 36. Трубопроводы 18 и 20 также выполнены из нержавеющей стали или из алюминиевых сплавов, чтобы исключить загрязнение топлива.

Автотопливозаправщик работает следующим образом.

При заправке цистерны 2 производят ее наполнение топливом через горловину 7 или через приемный патрубок 17 и приемный трубопровод 18. При этом срабатывает двухуровневый сигнализатор наполнения (13,

14), предохраняя цистерну 2 от перелива и переполнения. Газы, скопившиеся при заправке в верхней части цистерны, отводятся с помощью трубки 15. Автотопливозаправщик транспортирует топливо к объектам заправки.

Оператор с помощью гидропривода 25 разматывает раздаточные рукава 22 с барабанов 24, присоединяет раздаточные штуцера 23 к люкам заправляемых объектов, включает насос 26 высокой производительности и производит заправку их топливом. Наличие в отстойнике 9 цистерны 2 индикатора 16 наличия воды, а в системе выдачи топлива фильтров-водоотделителей 29 позволяет не только удалить механические примеси, но и удалить свободную воду из топлива. Счетчик 31 с электронным блоком фиксирует мгновенный, разовый и суммарный расход топлива. Датчики 32 контролируют давление топлива в трубопроводах системы.

Если оператор не закрыл двери шкафа управления или забыл смотать раздаточные рукава, то в кабине водителя загорается предупредительная индикация системы 30.

В третьем варианте (фиг.11-16) автотопливозаправщик состоит из основных частей - седельного тягача 1 и полуприцепа - цистерны 2, связанных между собой сцепным устройством. На шасси полуприцепа смонтирована топливная цистерна 2. На автотопливозаправщике имеются также система 3 приема топлива, система 4 выдачи топлива, система 5 управления, система 6 заземления и выравнивания потенциалов, система 7 контроля участия оператора в заправке, система 8 пожароподавления, дополнительный блок 9 гидрооборудования, пневмосистема 10 спецоборудования для управления работой отдельных узлов и систем.

Цистерна 2 выполнена из нержавеющей стали или алюминиевых сплавов и снабжена дыхательным, донным и предохранительным клапанами 11, 12, 13. В верхней части цистерны имеются люк-лаз 14, горловина 15 с крышкой, трубка 16 для отвода газа, а в нижней части – отстойник 17 с

сигнализатором 18 наличия воды в нем. Внутри цистерна 2 имеет волнорезы 19 для гашения ударов топлива при движении; в нижней части имеется отстойник 20. Цистерна 2 снабжена также двухуровневым ограничителем уровня для предохранения от перелива и переполнения в виде датчика 21 ограничителя наполнения, поплавкового указателя 22 уровня, поплавкового устройства 23 ограничителя 21 наполнения. Имеется лестница 24 с перилами 25 ограждения.

Система 2 приема топлива включает приемный патрубок 26 и приемный трубопровод 27 с шаровым краном 28; она снабжена фильтром-водоотделителем 29 и насосом 30 высокой производительности.

Система 4 выдачи топлива снабжена агрегатом 31 подготовки топлива и содержит также трубопровод 32 с шаровым краном 33, фильтр – водоотделитель 34, насос 35 высокой производительности, раздаточные рукава 36 разного диаметра с раздаточными штуцерами 37, намотанные на барабаны 38, размещенные на задней стенке цистерны 2 и снабженные каждый своим гидроприводом 39 для намотки и размотки рукавов 36. Агрегат 31 для подготовки топлива содержит нейтрализатор 40 статического электричества, демпферы 42 для гашения гидроударов в виде буферной полости на участком трубопровода 32 и разделенной на две полости эластичной сменной мембраной 43 (на чертежах не показаны). Нейтрализатор 40 представляет собой круглую камеру с разрядником внутри, установленную в трубопроводе 32 после фильтра 34 и счетчика жидкости. Имеется также пластинчатый насос 44 для откачки остатков топлива из раздаточных рукавов 36.

Трубопроводы 27 и 32 выполнены из нержавеющей стали или из алюминиевых сплавов, не загрязняющих топливо.

Система 5 управления включает в себя систему 45 ограничения давления топлива при заправке в виде узла сигнализаторов давления, систему 46 контроля участия оператора в процессе заправки, систему 47 (на чертежах

не показана) индикации о незакрытой двери отсека управления и несмотанных раздаточных рукавах 36, счетчик 47 расхода топлива с электронным блоком.

Система 45 ограничения давления является автоматической . Давление задается нажатием кнопок на пульте 48 управления. При превышении заданного давления сигнализатор подает сигнал управления на снижение оборотов топливоперекачивающего насоса 35.

Сигнализаторы 18 наличия воды в отстойнике 17 цистерны 2 и в отстойнике (на чертежах не обозначен и не показан) фильтра – водоотделителя 29 образуют систему контроля качества топлива в автотопливозаправщике.

Система 6 заземления и выравнивания потенциалов включает специальные токопроводящие перемычки, провода и другие приспособления (на чертежах не показаны), обеспечивающие электрический контакт между отдельными частями автотопливозаправщика, отвод накапливающихся зарядов статического электричества, заземление машины, электрическое соединение с внешними объектами.

Система 7 контроля участия оператора в процессе заправки обеспечивает безопасность работ в случае внезапной потери оператором работоспособности. Оператор через каждые 2,5-3 минуты должен подтверждать продолжение заправки нажатием на рукоятку дистанционного управления на пульте 48. Если рукоятка не нажата, реле времени отключает насос 35.

Автотопливозаправщик работает следующим образом

При заправке цистерны 2 горючим оператор подключает заправочный шланг к источнику топлива и через горловину 15 цистерны 2 или приемный патрубок 26 и приемный трубопровод 27 заполняет цистерну 2 топливом. При этом двухуровневый ограничитель из узлов 21-23

предохраняет цистерну 2 от переполнения. Газы, скопившиеся в верхней части цистерны при заправке, выводятся через трубку 16 газоотвода.

Затем автотопливозаправщик доставляет топливо к объектам заправки. При транспортировке топлива в результате движения автомашины в цистерне возникают волны, которые гасятся волнорезами 19, смягчая силу гидроударов.

На месте заправки оператор с помощью гидроприводов 39 разматывает раздаточные рукава 36, присоединяет их с помощью раздаточных штуцеров 37 к люкам заправляемых объектов и включает насос 35 высокой производительности для перекачки топлива в баки летательных аппаратов. Счетчик 47 с электронным блоком производит подсчет мгновенного, разового и общего расхода топлива. Агрегат 31 подготовки топлива, включающий в себя демпферы 42 и нейтрализатор 40 статического электричества, гасит ударную волну, возникающую при заправке летательного аппарата в момент закрытия бортового клапана ЛА, и снижает плотность электрических зарядов, образующихся в потоке топлива при прохождении его по трубопроводу 32 к фильтру 34. Фильтр 34 очищает топливо от механических примесей и удаляет воду. Счетчик 47 учитывает разовый и суммарный расход топлива. Дополнительный блок 9 гидрооборудования позволяет изменить производительность насоса 35.

Система 6 заземления и выравнивания потенциалов обеспечивает отвод накапливающихся зарядов статического электричества и заземление автотопливозаправщика. Система 7 контроля участия оператора в процессе заправки обеспечивает безопасность работ при заправке в случае внезапной потери оператором работоспособности путем постоянного подтверждения им продолжения заправки нажатием на рукоятку дистанционного управления на пульте 48. Если рукоятка не нажата, реле времени (на чертежах не показано и не обозначено) отключает насос 35.

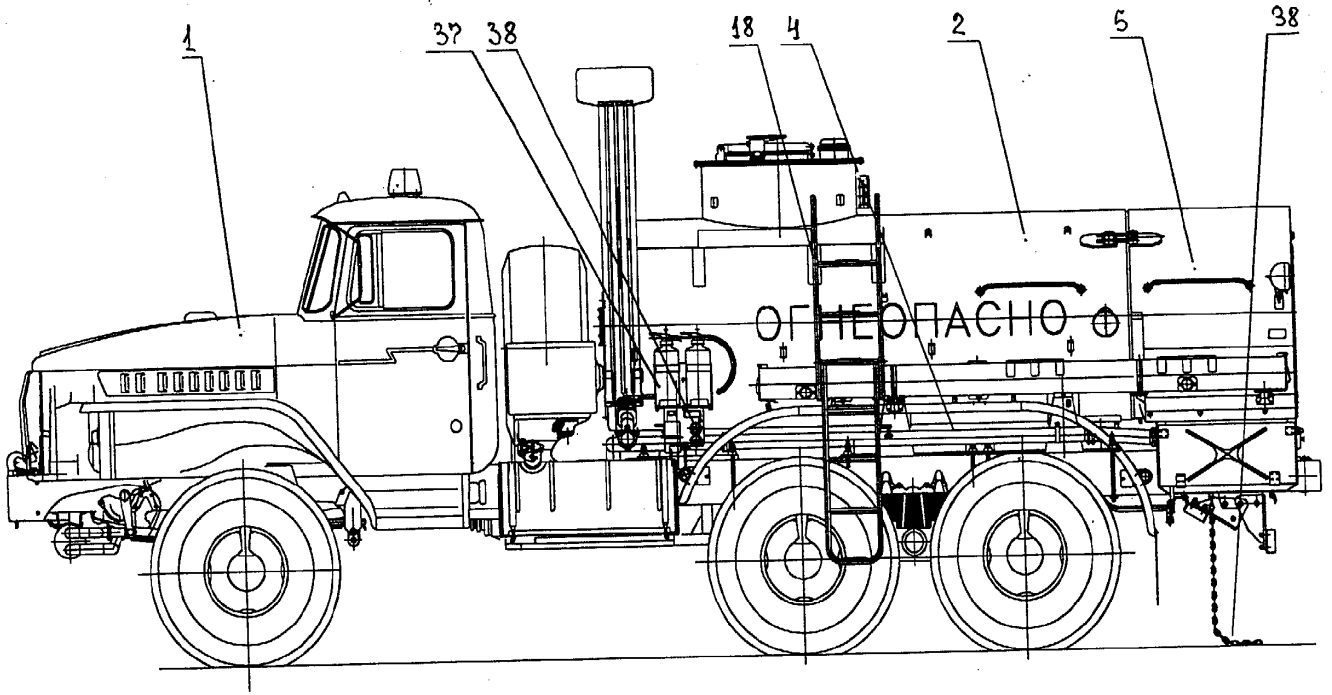
Если оператор забыл закрыть дверь отсека управления и / или не смотал

раздаточные рукава 36, в кабине водителя загорается индикация 46 о невыполненных действиях и срабатывает пневмосистема 10 управления работой блокировки тормозов автотопливозаправщика для исключения движения автотопливозаправщика. В случае возникновения пожара срабатывает система 8 пожароподавления.

В сравнении с прототипом заявляемый автотопливозаправщик в первом и втором вариантах выполнения является более простым по конструкции и достаточно надежным и безопасным в работе, а в третьем варианте - обеспечивает надежную работу и безопасную эксплуатацию.

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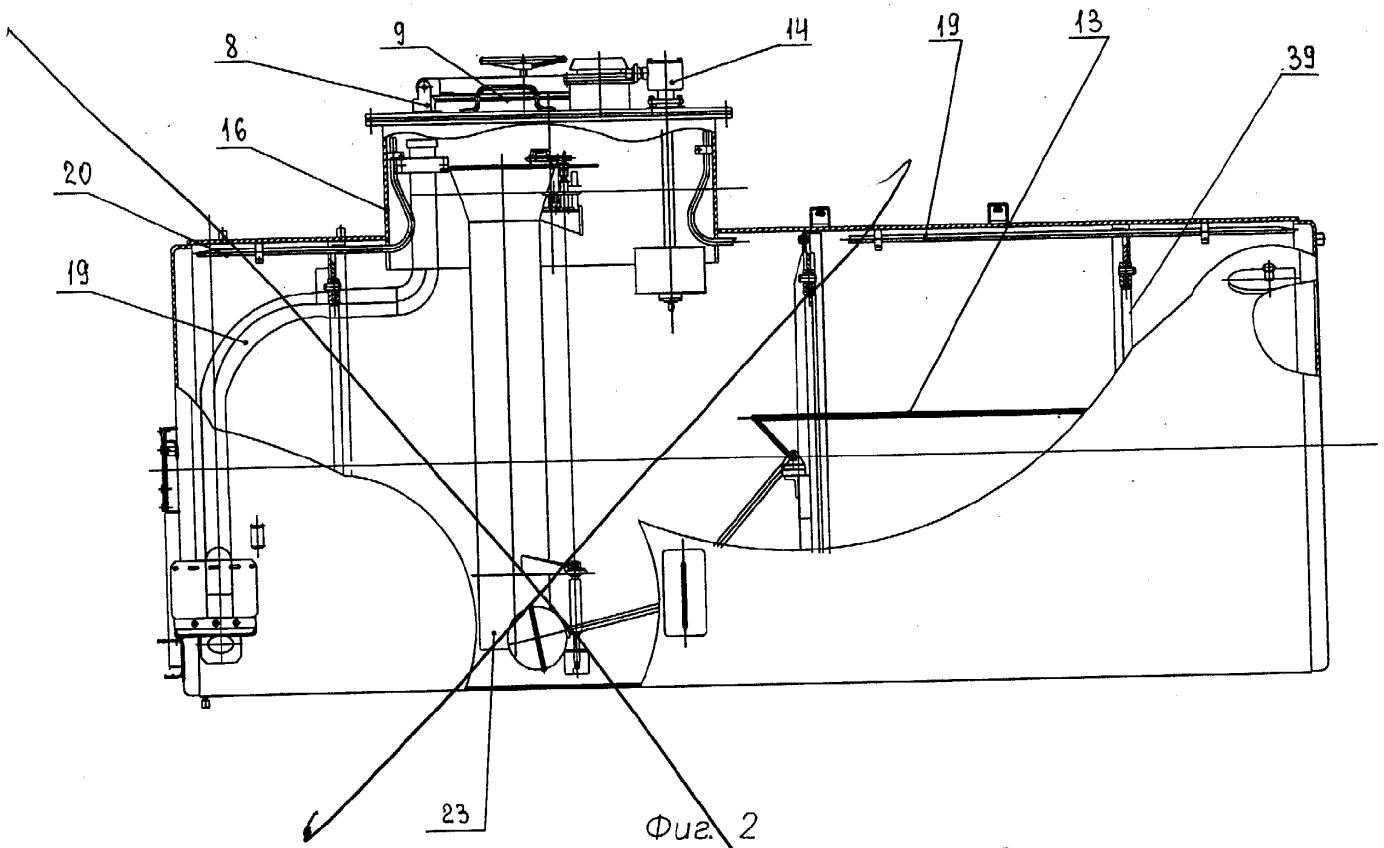
Автотопливозаправщик
(варианты)



Фиг. 1

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Автотопливозаправщик
(варианты)



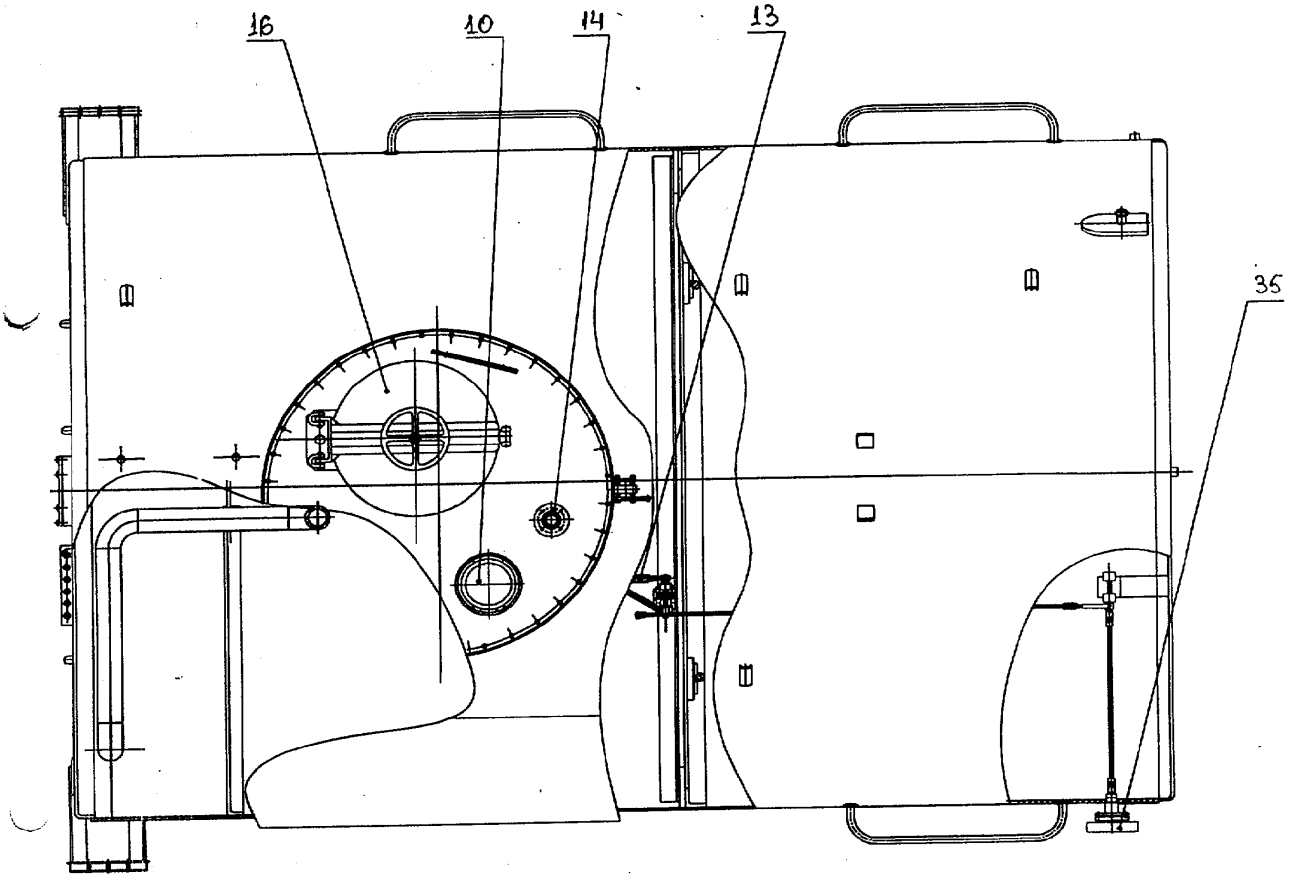
Фиг. 2

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Автотопливозаправщик
(варианты)

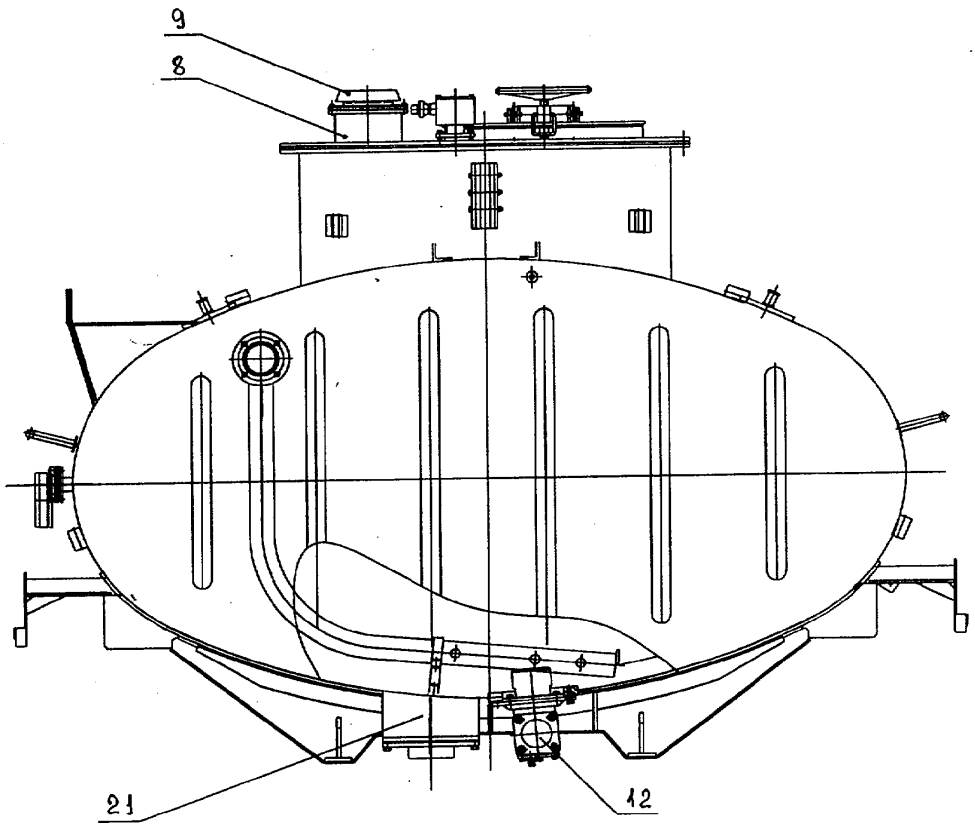


Фиг. 3

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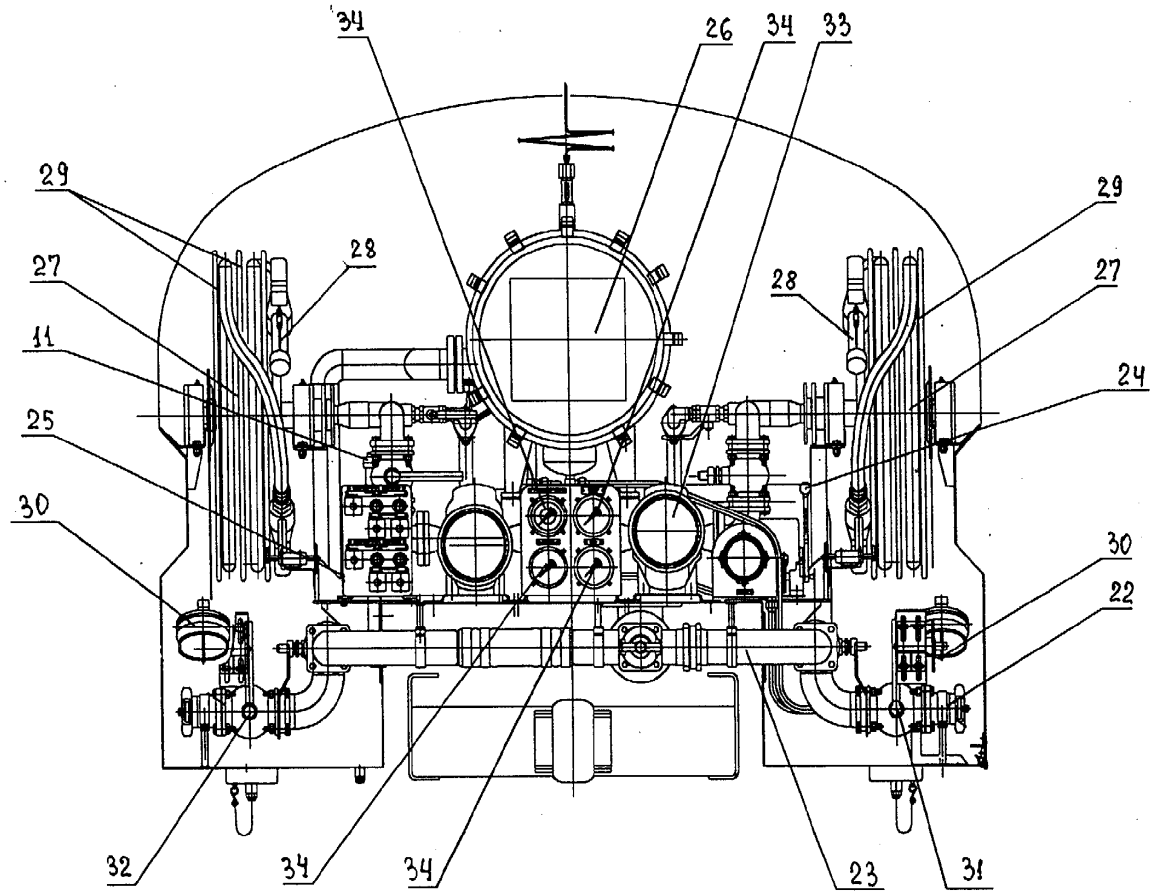
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Автотопливозаправщик
(варианты)



Фиг. 4

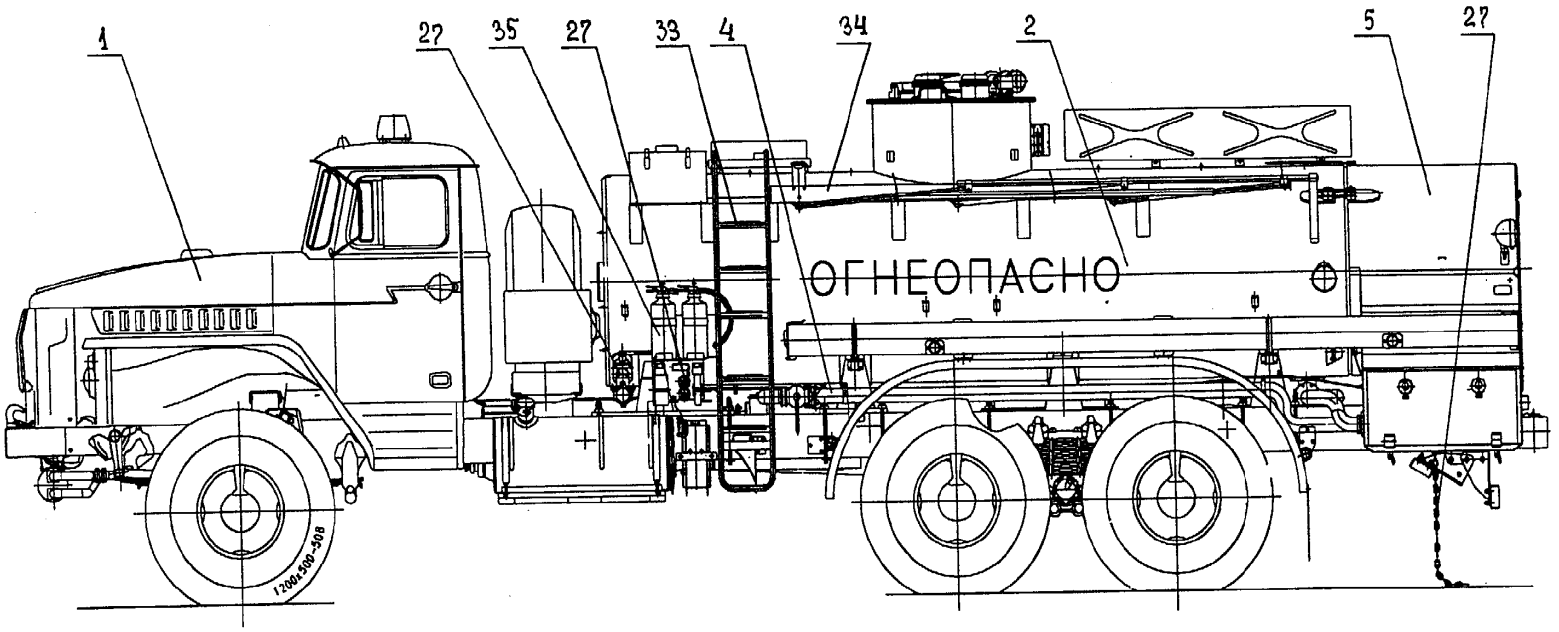
Авторы Ядрихинский В. Н.
Десятников И. С.
Фишер С. О.
Розенфельд В. А.
Гольдштейн Ю. Я.



Фиг. 5

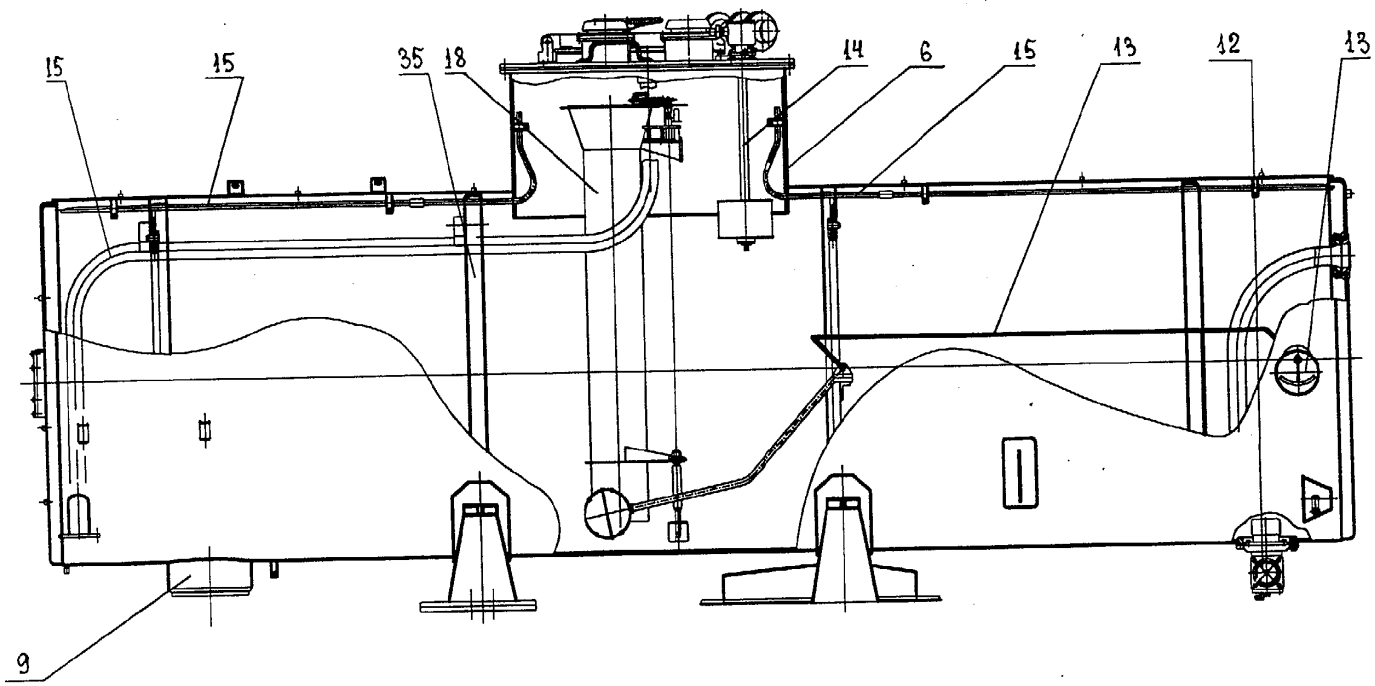
Авторы Ядрихинский В.Н.
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Автотопливозаправщик
(варианты)



Фиг. 6

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Фишер С.О.
Розенфельд В.А
Гольдштейн Ю.Я.

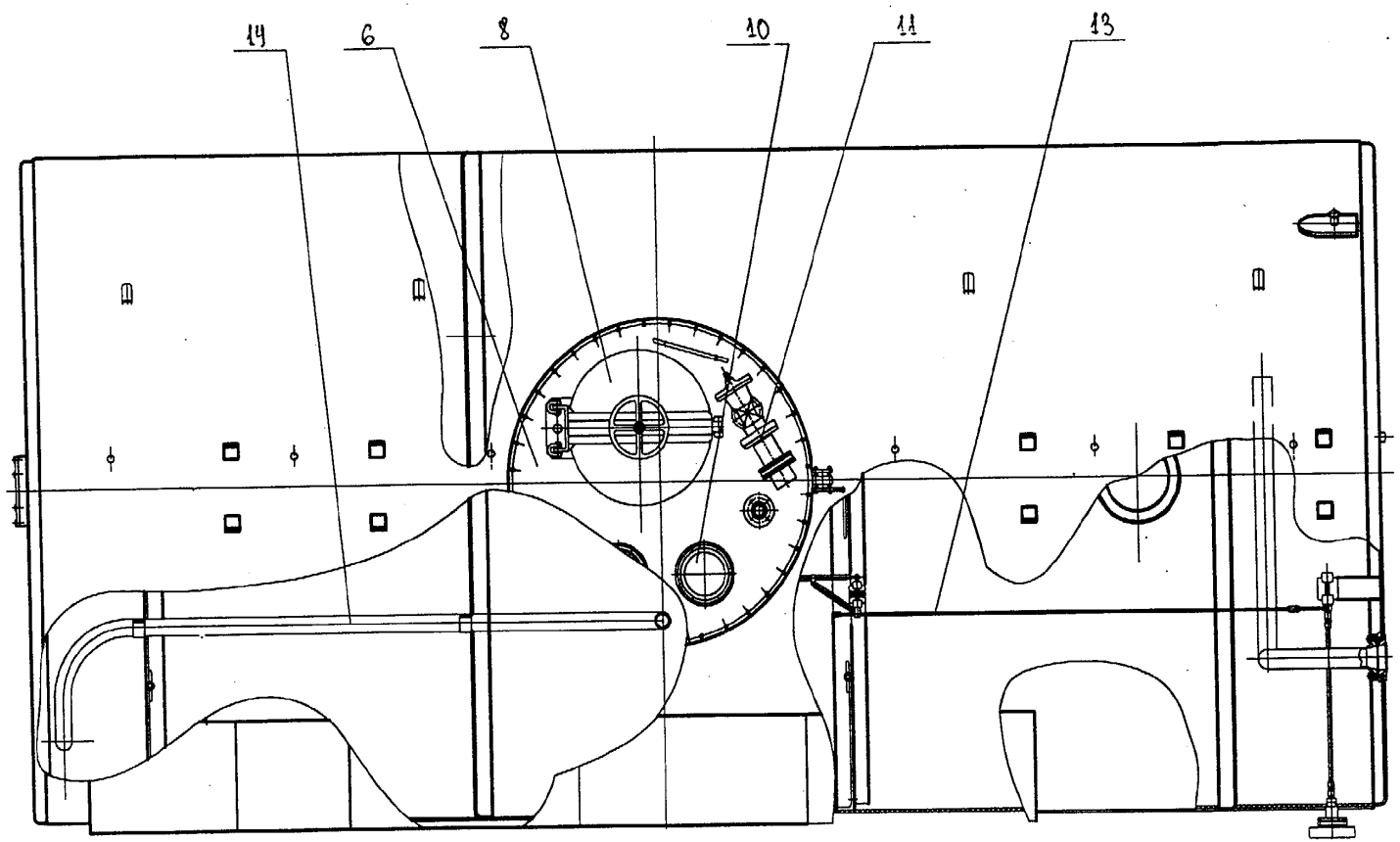


Фиг. 7

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2001121398

Автотопливозаправщик
(варианты)

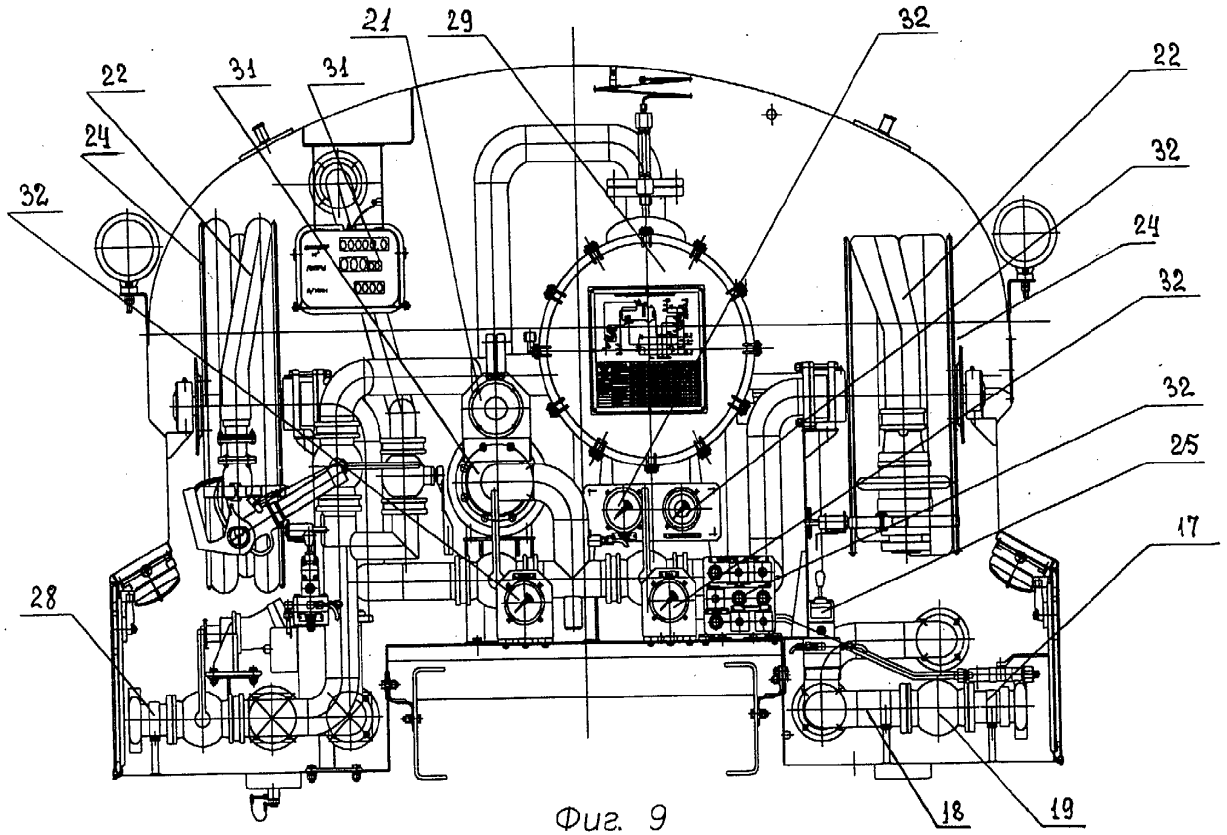


Фиг. 8

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2003/04/38 K

Автотопливозаправщик
(варианты)

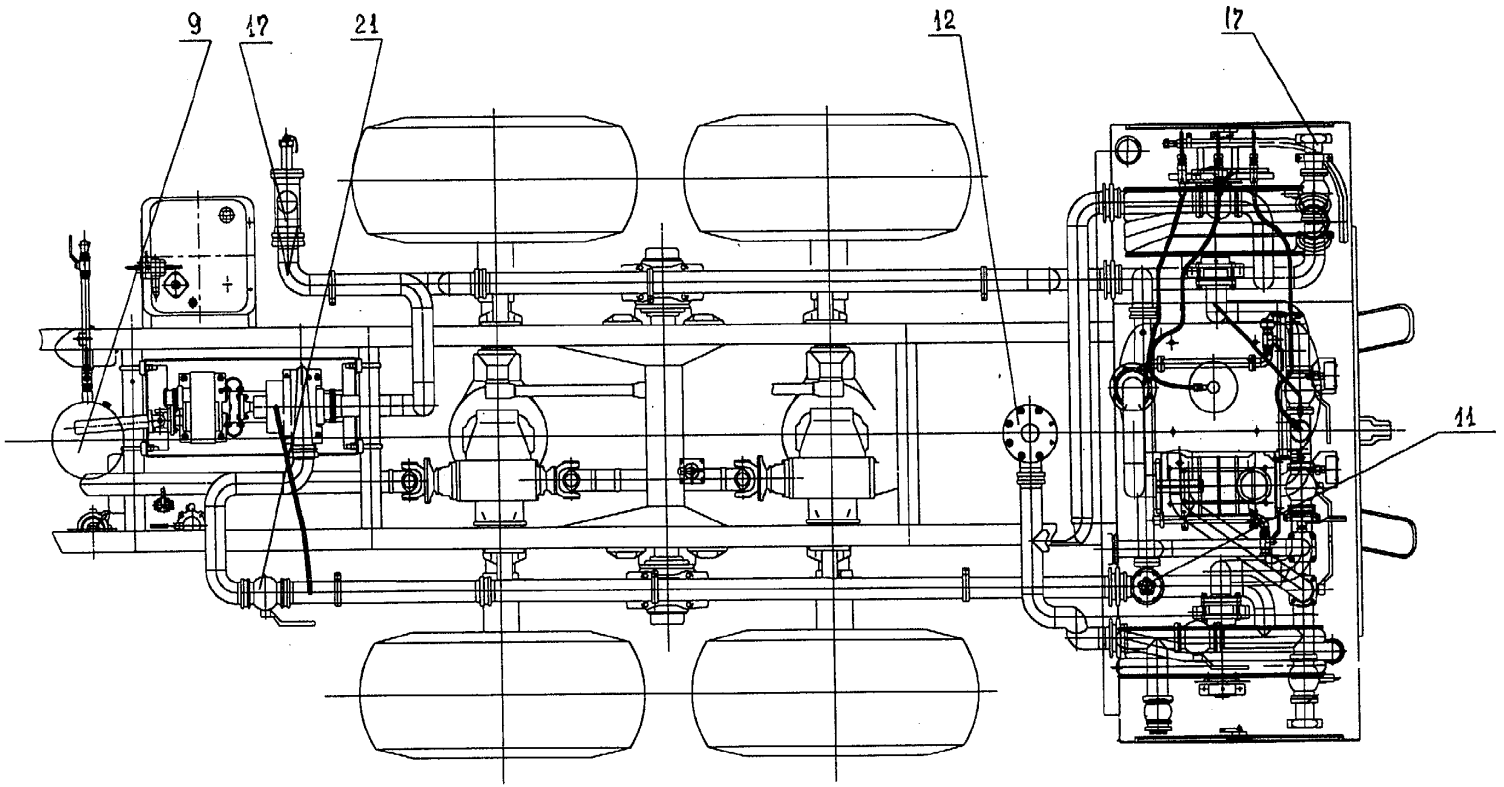


Фиг. 9

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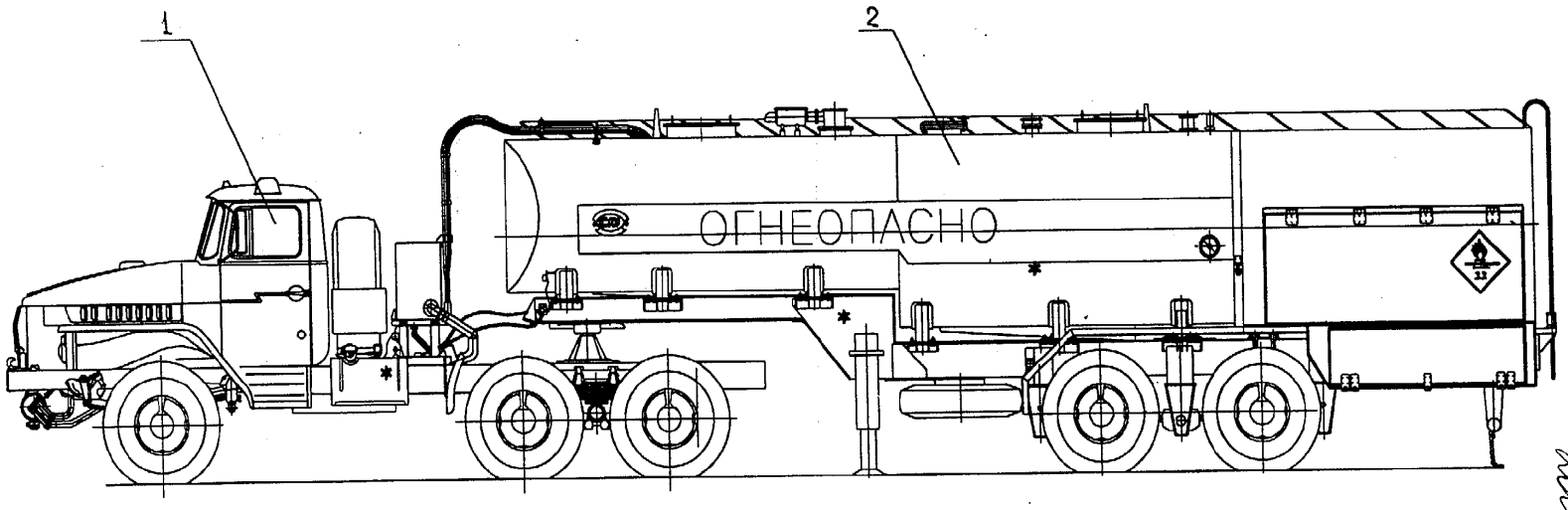
Автотопливозаправщик
(варианты)



Фиг. 10

Авторы Ядрихинский В.Н.
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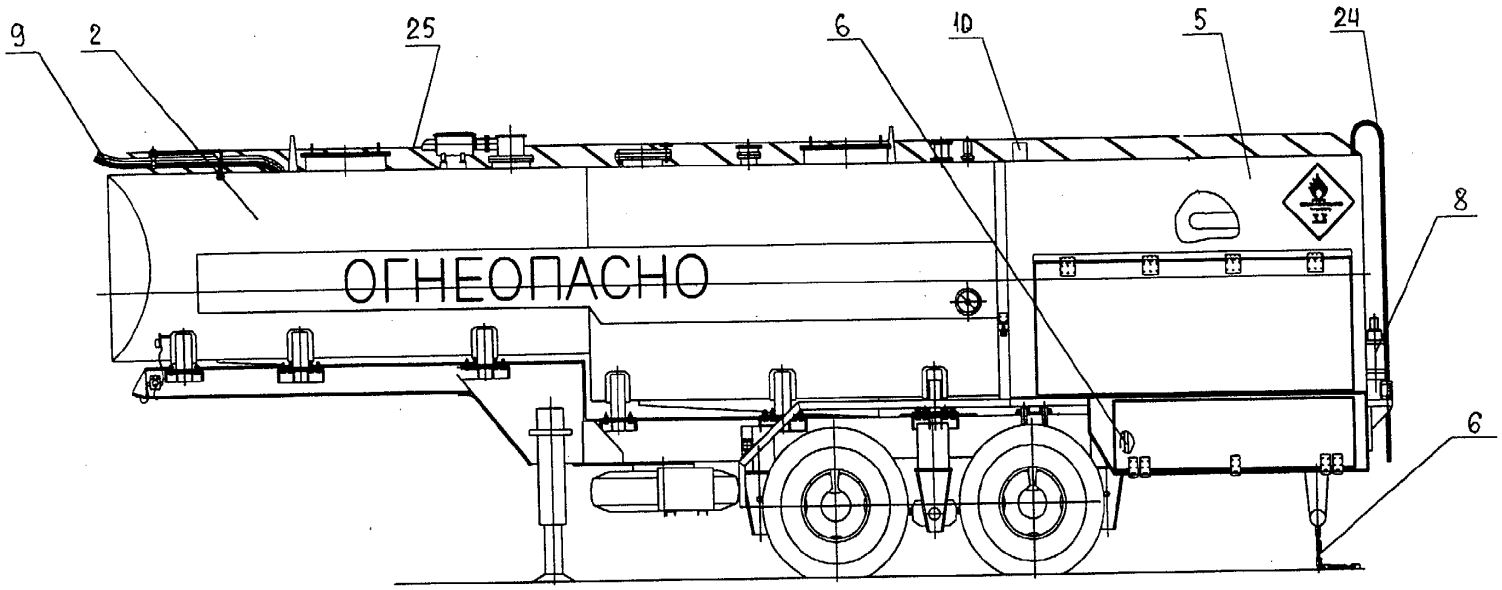
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Фиг. 11

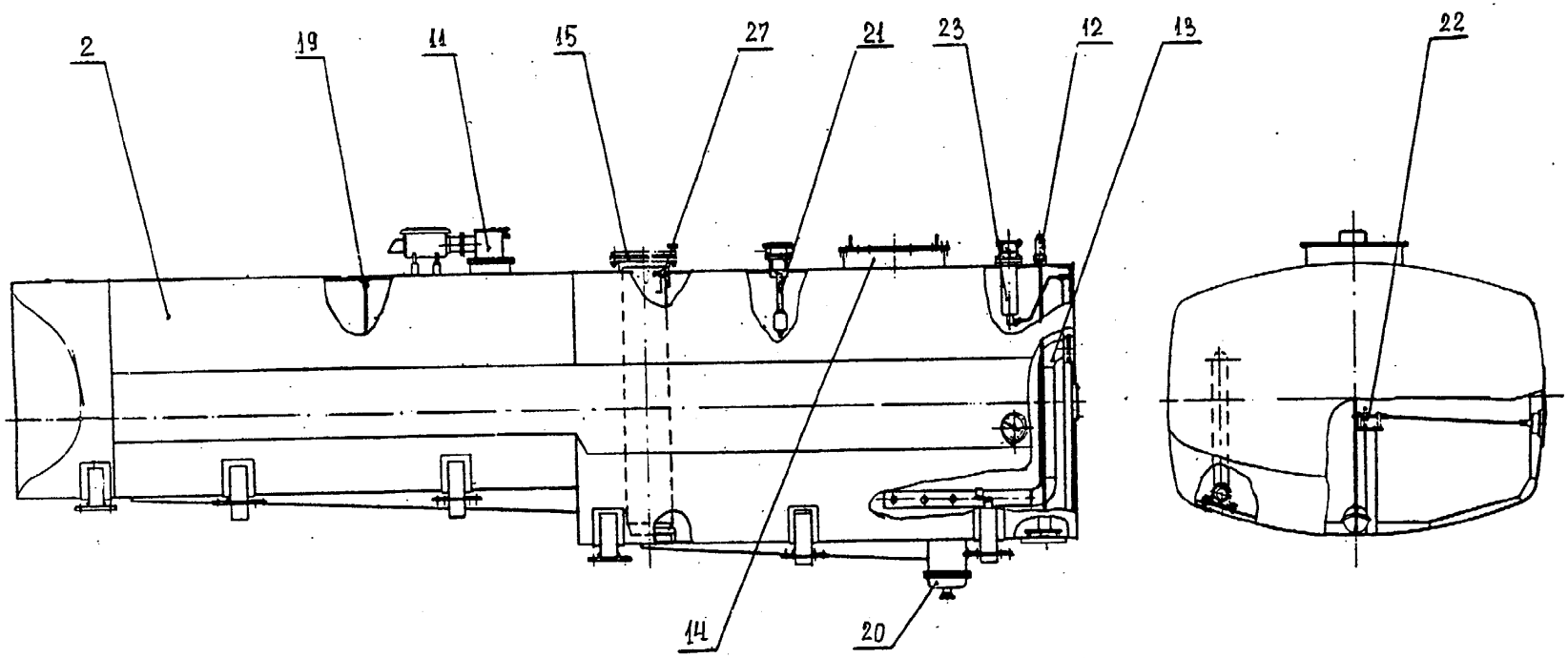
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Автотопливозаправщик
(варианты)



Фиг. 12

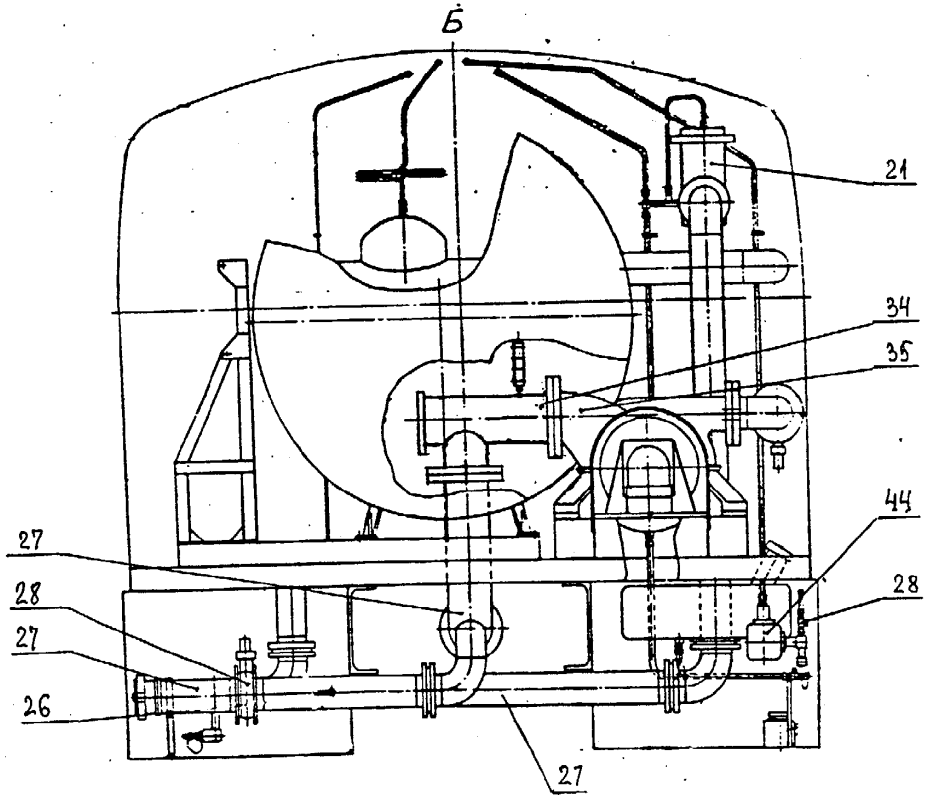
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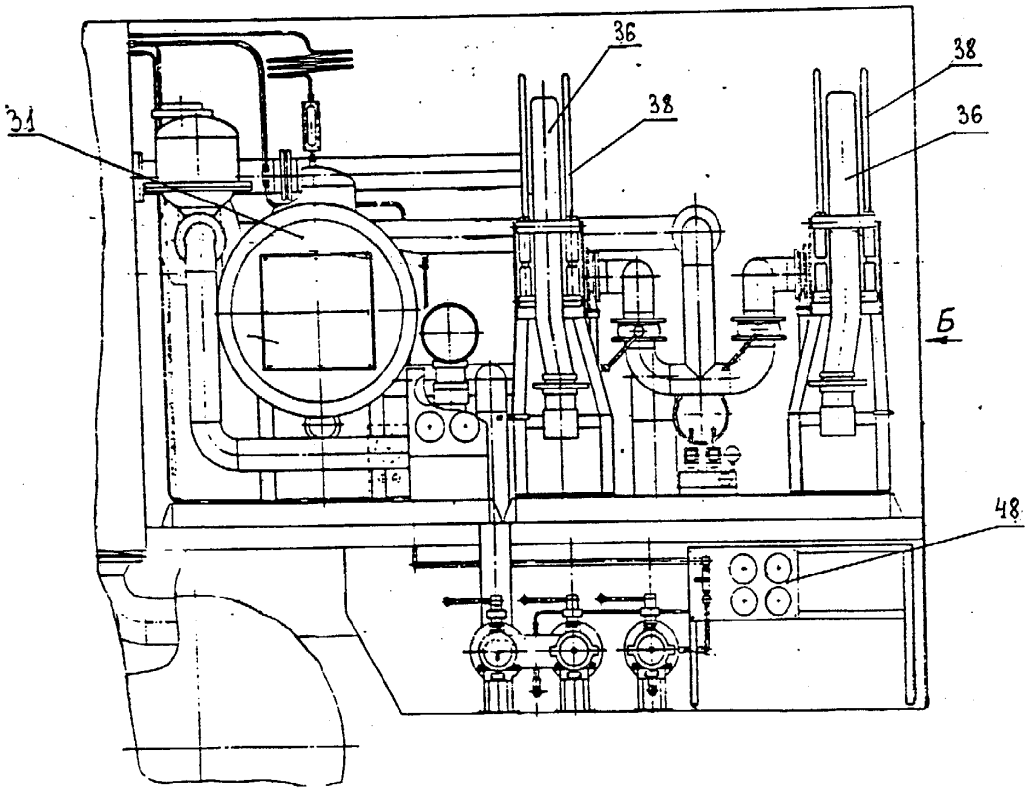
2002112413 A



Фиг. 14

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2003124138



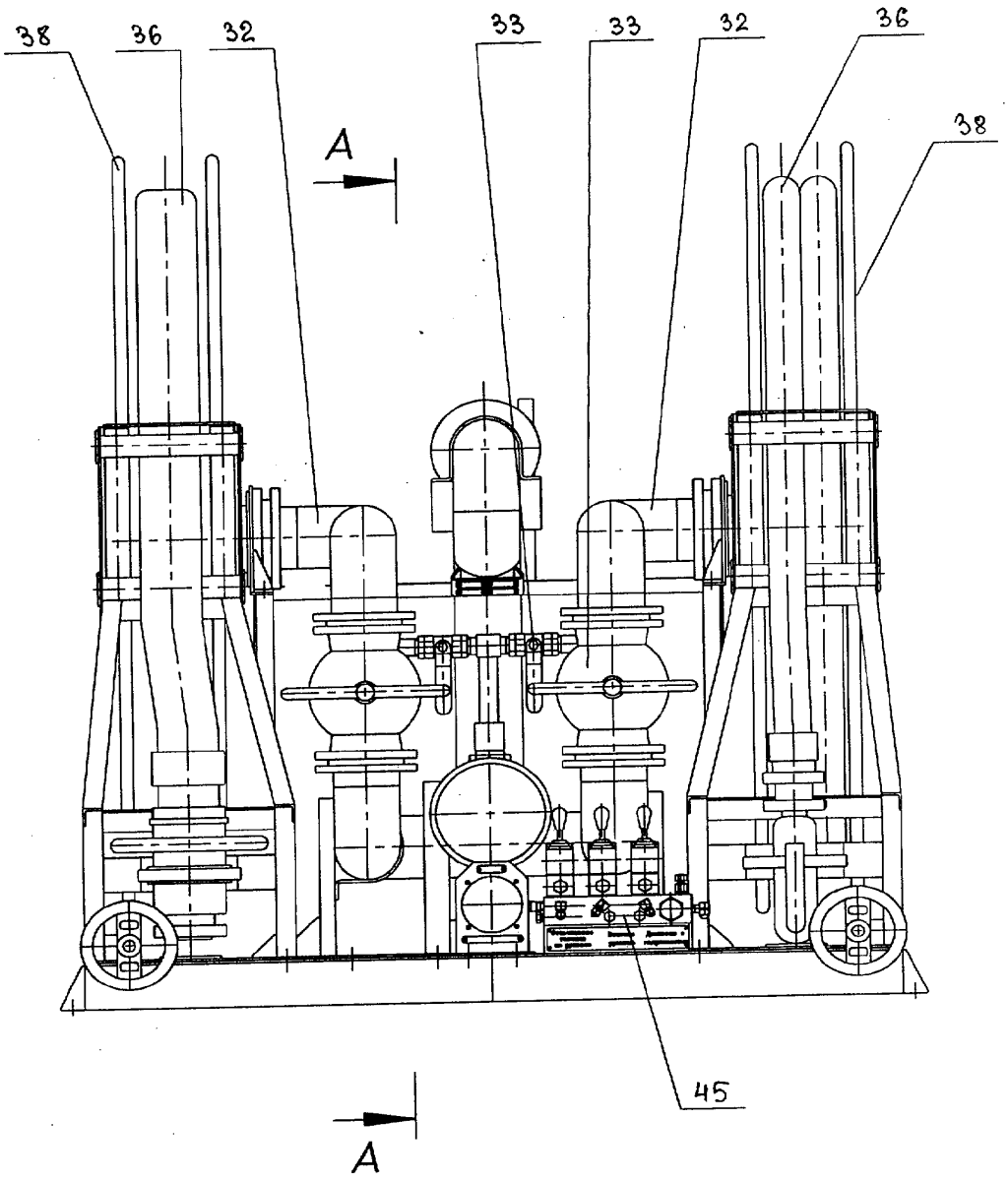
Фиг. 15

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2003124389

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Автотопливозаправщик
(варианты)

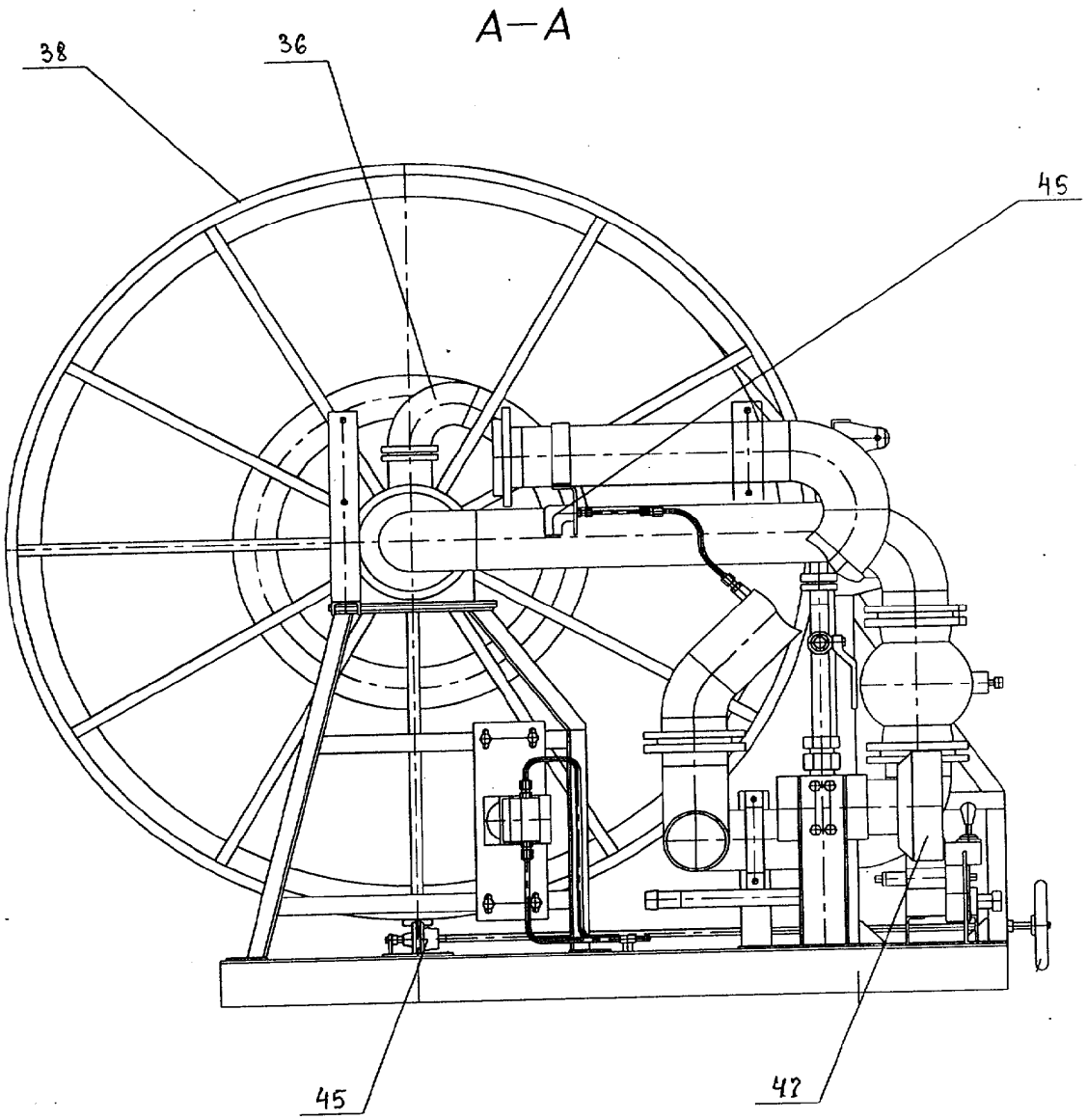


Фиг. 16

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2002124 78 C

Автотопливозаправщик
(Варианты)



Фиг. 17

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Фишер С. О.
Розенфельд В. А.
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Espacenet

Bibliographic data: JP2007182242 (A) — 2007-07-19

LIQUID SUPPLY SYSTEM

Inventor(s): AMEMORI HIROYUKI; HASHIZAWA TADASHI; SAKAGUCHI KENICHI; ASAI JUNKO; MAEDA HIRONORI; DOTANI ISAMU ± (AMEMORI HIROYUKI, ; HASHIZAWA TADASHI, ; SAKAGUCHI KENICHI, ; ASAI JUNKO, ; MAEDA HIRONORI, ; DOTANI ISAMU)

Applicant(s): TOKIKO TECHNO KK ± (TOKIKO TECHNO KK)

Classification: **- International:** ***B67D7/06; B67D7/78; B67D99/00***
- cooperative:

Application number: JP20060001298 20060106 Global Dossier

Priority number(s): JP20060001298 20060106

Abstract of JP2007182242 (A)

PROBLEM TO BE SOLVED: To provide a liquid supply system which replenishes an internal tank with a makeup liquid when a liquid in the internal tank of a fuel supply unit decreases. ;SOLUTION: The liquid supply system 10 includes a plurality of liquid supply units 12 (12<SB>1</SB>to 12<SB>n</SB>), an external tank 14 buried underground, and a makeup pump 16 which pumps up a liquid (ureal water) stored in the external tank 14. A plurality of branch pipelines 30 (30<SB>1</SB>to 30<SB>n</SB>) are so branched that one end of each of the branch pipelines 30 (30<SB>1</SB>to 30<SB>n</SB>) communicates with a delivery port of the makeup pump 16 and the other end of the same communicates with each of switching valves 40 (40<SB>1</SB>to 40<SB>n</SB>) buried underground. The switching valves 40 (40<SB>1</SB>to 40<SB>n</SB>) are arranged to correspond to the liquid supply units 12 (12<SB>1</SB>to 12<SB>n</SB>), respectively. When the liquid levels of internal tanks 22 (22<SB>1</SB>to 22<SB>n</SB>) go down, the switching valves 40 (40<SB>1</SB>to 40<SB>n</SB>) are changed in connection to allow makeup pipelines 42 (42<SB>1</SB>to 42<SB>n</SB>) and the branch pipelines 30 (30<SB>1</SB>to 30<SB>n</SB>) to communicate with each other as the makeup pump 16 is driven. ;COPYRIGHT: (C)2007,JPO&INPIT

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特開2007-182242
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(43)公開日　平成19年7月19日(2007.7.19)

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B67D 5/06	(2006.01)	B67D	5/06	A	
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審査請求 未請求　請求項の数 3　OL　（全 11 頁）

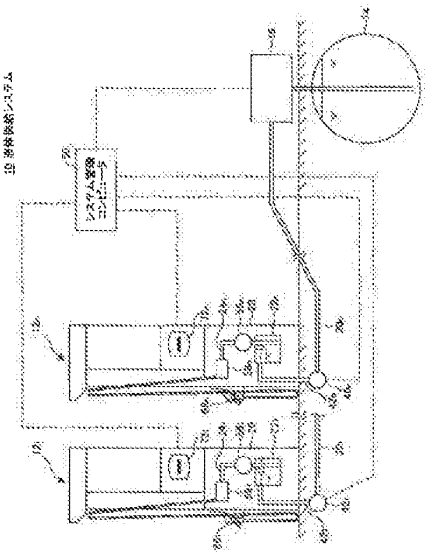
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最終頁に続く

(54)【発明の名称】液体供給システム

(57)【要約】
【課題】本発明は燃料供給機の内部タンクの液体が減少すると内部タンクに液体を補給することを課題とする。
【解決手段】液体供給システム１０は、複数の液体供給機１２（12_1～12_n）と、地下に埋設された外部タンク１４と、外部タンク１４に貯留された液体（本実施例では、尿素水）を汲み上げる補給ポンプ１６とを有する。複数の分岐管路３０（30_1～30_n）は、一端が補給ポンプ１６の吐出口に連通され、他端が地中に埋設された切替弁４０（40_1～40_n）の夫々に連通されるように分岐されている。この複数の切替弁４０（40_1～40_n）は、夫々複数の液体供給機１２（12_1～12_n）に対応して設けられており、内部タンク２２（22_1～22_n）の液面が低下すると、補給ポンプ１６の駆動と共に、補給管路４２（42_1～42_n）と分岐管路３０（30_1～30_n）とを連通するように切り替えられる。
【選択図】図１



【特許請求の範囲】
【請求項１】
筐体内に内部ポンプ、液体貯留用の内部タンク、流量計が配置された液体供給経路を有し、該内部ポンプから吐出された液体を該液体供給径路に接続された供給ノズルにより被供給体へ供給する液体供給機と、
前記液体が貯留された外部タンクと、
該外部タンクと前記内部タンクとを連通する補給経路と、
該補給経路を介して前記外部タンクの液体を前記内部タンクに補給する外部ポンプと、
を有することを特徴とする液体供給システム。
【請求項２】
前記外部タンクと複数の液体供給機の各内部タンクとを前記補給経路を介してそれぞれ連通すると共に、前記補給経路に液体供給方向を切り替える切替弁を設け、
前記複数の内部タンクのうち何れかの内部タンクに前記外部タンクの液体を補給するように前記切替弁を切り替える切替制御手段を備えたことを特徴とする請求項１に記載の液体供給システム。
【請求項３】
前記切替制御手段は、前記複数の内部タンクのうち、前記供給ノズルから液体を供給している前記液体供給機の内部タンクに前記外部タンクの液体を補給するように前記切替弁を切り替えることを特徴とする請求項２に記載の液体供給システム。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、液体供給システムに係り、特に液体供給機の内部タンクの液体を被供給体に供給すると共に、内部タンクに液体を補給するよう構成された液体供給システムに関する。
【背景技術】
【０００２】
例えば、車両のタンクに燃料などの液体を供給するための液体供給装置としては、下記の(1)(2)のような２種類のものが存在する。
【０００３】
(1)筐体内に内部ポンプ、液体貯留用の内部タンク、流量計が配置された液体供給経路を有し、該内部ポンプから吐出された液体を該液体供給径路に接続された供給ノズルにより被供給体へ供給するもの。なお、この内部タンクは、筐体内に収納しうる大きさであり、その容量は外部タンクに比べて必然的に小さくなるため、内部タンクへの液体の補給は外部タンクに比べて頻繁に行わなくてはならず、この補給作業は人手により行われている。(2)地下タンクの液体を液中ポンプ（サブマージポンプ）によって複数の液体供給機に供給するもの（例えば、特許文献１参照）。
【特許文献１】特許２５２６０６９号公報
【発明の開示】
【発明が解決しようとする課題】
【０００４】
しかしながら、上記(1)の液体供給機では、上述のとおり内部タンクへの液体の補給作業を人手により行う必要があり、この液体の使用量が多ければ多いほど、手数がかかることとなる。
【０００５】
また、上記(2)（特許文献１）の液体供給機では、地下タンクの液面高さの変動によって揚程が変化するのに伴って液中ポンプによる吐出量が変化するため、車両等のタンクに液体を補給する際の補給時間が安定しない。
【０００６】
また、上記特許文献１の構成では、１台の液中ポンプにより送液された液体を複数の液

体供給機に供給する構成であるので、液体供給機の稼動台数によって各液体供給機から車両等のタンクに供給される供給量が変動するため、各液体供給機が同時に稼動されて供給不足とならないように液中ポンプの容量を大きくしなければならない。

【０００７】

さらに、筐体内に内部タンクを有する燃料供給機では、各内部タンクの残量減少に応じて液体補給をタイミング良く行なうことが要望されている。

【０００８】

そこで、本発明は上記事情に鑑み、課題を解決した液体供給システムを提供することを目的とする。

【課題を解決するための手段】

【０００９】

上記課題を解決するため、本発明は以下のような手段を有する。

【００１０】

上記請求項１の発明は、筐体内に内部ポンプ、液体貯留用の内部タンク、流量計が配置された液体供給経路を有し、該内部ポンプから吐出された液体を該液体供給径路に接続された供給ノズルにより被供給体へ供給する液体供給機と、前記液体が貯留された外部タンクと、該外部タンクと前記内部タンクとを連通する補給経路と、該補給経路を介して前記外部タンクの液体を前記内部タンクに補給する外部ポンプと、を有することを特徴とする。

【００１１】

上記請求項２の発明は、前記外部タンクと複数の液体供給機の各内部タンクとを前記補給経路を介してそれぞれ連通すると共に、前記補給経路に液体供給方向を切り替える切替弁を設け、前記複数の内部タンクのうち何れかの内部タンクに前記外部タンクの液体を補給するように前記切替弁を切り替える切替制御手段を備えたことを特徴とする。

【００１２】

上記請求項３の発明は、前記切替制御手段が、前記複数の内部タンクのうち、前記供給ノズルから液体を供給している前記液体供給機の内部タンクに前記外部タンクの液体を補給するように前記切替弁を切り替えることを特徴とする。

【発明の効果】

【００１３】

本発明によれば、液体供給機よりの液体の供給は、内部タンク内の液体を内部ポンプにより汲み上げて供給ノズルより吐出するので、液体供給機の稼動台数にかかわらず一定の供給量での液体の供給が可能となり、かつ、内部タンクへの液体の補給は外部タンク内の液体を外部ポンプにより汲み上げることにより行われるので、内部タンクへの人手による補給作業をなくすことができる。

【００１４】

また、本発明によれば、複数の液体供給機の内部タンクのうちどの内部タンクに外部タンクの液体を補給するかを切り替える切替弁を有しているため、例えば、液体の貯留量の少ない内部タンクを優先して外部タンク内の液体を補給することができる。更に、外部ポンプは内部ポンプへの液体の供給に使用されるだけであり、その液体の供給量が変動したとしてもそれにより液体供給機からの液体の供給量は変動しないため、外部ポンプの容量（吐出能力）を小さくすることができる。

【００１５】

また、本発明によれば、供給ノズルから液体を供給している液体供給機の内部タンクに外部タンクの液体を補給するため、複数の液体供給機があっても液体の補給が必要な液体供給機に優先して液体を補給することが可能になり、液体供給を効率良く行なえる。

【発明を実施するための最良の形態】

【００１６】

以下、図面を参照して本発明を実施するための最良の形態について説明する。

【実施例１】

【００１７】
図１は本発明による液体供給システムの一実施例を示す系統図である。図１に示されるように、液体供給システム１０は、複数の液体供給機１２（１２$_1$～１２$_n$）と、地下に埋設された外部タンク１４と、外部タンク１４に貯留された液体（本実施例では、尿素水）を汲み上げる補給ポンプ１６とを有する。外部タンク１４は、複数の液体供給機１２（１２$_1$～１２$_n$）の筐体２０の内部に収納された内部タンク２２よりも十分に大きい容量を有している。例えば、内部タンク２２の容量が６０Ｌ～１００Ｌ（リットル）とすると、外部タンク１４は、２ＫＬ～５ＫＬ(キロリットル)の容量を有している。
【００１８】
また、補給ポンプ１６は、液体供給機１２（１２$_1$～１２$_n$）の各内部タンク２２の液面が満タン以下に低下すると、当該内部タンク２２に液体を補給するものであるからその供給能力（単位時間当たりの吐出量）は、液体供給機１２（１２$_1$～１２$_n$）の供給能力と同等、あるいはそれ以下となるように設定されている。さらに、補給ポンプ１６は、液中ポンプと異なり、外部タンク１４の液面高さによる揚程の変動に拘わらず、一定の吐出量で液体を補給することができるので、内部タンク２２への供給が安定する。
【００１９】
複数の分岐管路（補給経路）３０（３０$_1$～３０$_n$）は、一端が補給ポンプ１６の吐出口に連通され、他端が地中に埋設された切替弁４０（４０$_1$～４０$_n$）の夫々に連通されるように分岐されている。この複数の切替弁４０（４０$_1$～４０$_n$）は、夫々複数の液体供給機１２（１２$_1$～１２$_n$）に対応して設けられており、例えば、電磁弁などからなり、分岐管路３０を閉鎖する閉弁状態と、内部タンク２２（２２$_1$～２２$_n$）に挿入された補給管路（補給経路）４２（４２$_1$～４２$_n$）と分岐管路３０（３０$_1$～３０$_n$）とを連通する開弁状態との何れかに切り替えられる。
【００２０】
切替弁４０（４０$_1$～４０$_n$）は、後述するように内部タンク２２（２２$_1$～２２$_n$）の残量が所定量以下に減少した場合に当該液体供給機１２に対応する切替弁４０のみが開弁されて当該液体供給機１２の内部タンク２２に液体を補給する。
【００２１】
システム管理コンピュータ５０は、通信線５２を介して複数の液体供給機１２（１２$_1$～１２$_n$）とデータ通信可能に接続されており、内部タンク２２の残量が所定量以下に減少したことを検出した信号が送信されると、当該内部タンク２２に対応する切替弁４０を開弁状態に切り替えると共に、補給ポンプ１６を駆動制御する。これにより、外部タンク１４に貯留された液体が当該液体供給機１２に対応する分岐管路３０及び補給管路４２を介して一の内部タンク２２に補給される。
【００２２】
図２は液体供給機１２の概略構成を模式的に示す構成図である。図２に示されるように、液体供給機１２は、筐体２０内に内部タンク２２と、内部タンク２２の液体を供給する液体供給経路２４とを有する。液体供給経路２４には、上流から内部ポンプ５６、流量計５８、電磁弁６０が設けられており、さらに、液体供給経路２４は筐体２０側面のホース継ぎ手６２、ホース６４、供給ノズル６６に連通されている。内部ポンプ５６の吸込み口に連通された吸込み管路６８は、上方から内部タンク２２に挿入され、下端が内部タンク２２の底部近傍まで延在されている。また、内部タンク２２には、液面が満タン位置であることを検出する液面センサ７０が設けられている。尚、内部ポンプ５６の供給能力は、前述した補給ポンプ１６と同等となるように設定されており、補給ポンプ１６の供給能力が低くても供給ノズル６６からの供給量は内部ポンプ５６の供給能力によって決まるので、補給ポンプ１６は内部ポンプ５６より小型のものでも良い。
【００２３】
また、内部タンク２２に貯蔵される液体としては、例えば、自動車等の車両の燃料として用いられる油液、あるいは燃料以外の化学薬品（例えば、自動車の排気ガスを浄化する浄化装置で消費される尿素など）がある。

【００２４】
また、供給ノズル６６は、吐出口に液体供給により発生する負圧により空気を吸引するための空気導入口を有しており、この空気導入口が液面によって閉塞されると、供給ノズル６６に内蔵された弁機構が自動的に閉弁動作して液体の供給を停止するように構成されている。このような液面検知による自動閉弁機構は、周知のものであるので、ここではその詳細な説明を省略する。
【００２５】
流量計５８により計測された液体の供給量、または液体の補給量を表示する流量表示部７２と、各弁やポンプなどを制御するCPU（Central processing unit）を有する制御装置８０と、記憶手段としてのメモリ８２とが設けられている。
【００２６】
また、筐体１２の側面には、使用しないときの供給ノズル６６を掛止するノズル掛け７４が設けられている。そして、ノズル掛け７４には、供給ノズル６６を検出するノズル掛けスイッチ７６が設けられている。このノズル掛けスイッチ７６は、ポンプ起動スイッチとして機能するスイッチであり、供給ノズル６６がノズル掛け７４に掛止されているときにオンになり、供給ノズル６６がノズル掛け７４から外れるとオフになる。そして、供給ノズル６６がオフになると、内部ポンプ５６に駆動電圧が印加されてポンプ制御が行われる。
【００２７】
ここで、液体供給機１２の制御装置８０が実行する制御処理について図３のフローチャートを参照して説明する。図３に示されるように、制御装置８０は、Ｓ１１でノズルスイッチ７６がオフになったかどうかをチェックする。作業員が供給ノズル６６をノズル掛け７４から外すと、Ｓ１１でノズル掛けスイッチ７６がオフになるため、Ｓ１２に進み、ポンプ駆動信号を出力して内部ポンプ５６を駆動する。続いて、Ｓ１３に進み、電磁弁６０を開弁させ、Ｓ１４で流量積算量をゼロリセットする。
【００２８】
次のＳ１５では、プリセット値が設定されているか否かをチェックする。Ｓ１５において、プリセット値が設定されていないときは、Ｓ１６に進み、満タン供給モードを設定する。続いて、Ｓ１７では、流量計５８から流量パルスが出力されたか否かをチェックする。作業員が供給ノズル６６の吐出口を被供給体として容器（図示せず）の供給口に挿入して供給ノズル６６のノズルレバーを開弁位置に操作すると、内部タンク２２に貯蔵された液体が供給ノズル６６を介して被供給体に供給される。この供給量は、流量計５８により計測されており、Ｓ１７において、流量計５８からの流量パルスがあると、Ｓ１８で流量パルスを積算して流量積算値を流量表示部７２に表示する。
【００２９】
Ｓ１９では、ノズル掛けスイッチ７６がオンになったか否かをチェックしており、ノズル掛けスイッチ７６がオフのときは、液体供給中であるのでＳ１７に戻り、Ｓ１７～Ｓ１９の処理を繰り返す。
【００３０】
供給ノズル６６の液面検知機構（図示せず）により満タン供給が終了した場合には、作業員が供給ノズル６６をノズル掛け７４に戻し、ノズル掛けスイッチ７６がオンになる。そのため、Ｓ１９において、ノズル掛けスイッチ７６がオンのときは、液体供給終了であるので、Ｓ２０に進み、電磁弁６０を閉弁し、Ｓ２１で内部ポンプ５６の駆動を停止する。
【００３１】
また、上記Ｓ１５において、プリセット値が設定されているときは、Ｓ２２に進み、プリセット供給モードを設定する。続いて、Ｓ２３では、流量計５８から流量パルスが出力されたか否かをチェックする。作業員が供給ノズル６６の吐出口を被供給体として容器（図示せず）の供給口に挿入して供給ノズル６６のノズルレバーを開弁位置に操作すると、内部タンク２２に貯蔵された液体が供給ノズル６６を介して被供給体に供給される。この

供給量は、流量計５８により計測されており、Ｓ２３において、流量計５８からの流量パルスがあると、Ｓ２４で流量パルスを積算して流量積算値を流量表示部７２に表示する。

【００３２】

Ｓ２５では、流量積算値がプリセット値に達したか否かをチェックする。Ｓ２５において、流量積算値がプリセット値に達していないときは、上記Ｓ２３に戻り、Ｓ２３～Ｓ２５の処理を繰り返す。また、Ｓ２５において、流量積算値がプリセット値に達したときは、プリセット供給が終了したため、上記Ｓ２０、Ｓ２１の処理を行う。

【００３３】

制御装置８０は、図３に示す液体供給処理を実行すると共に、図４に示す液面センサ検出処理も所定時間毎に並行して実行する。図４に示されるように、制御装置８０は、Ｓ３１で内部タンク２２に設けられた液面センサ７０の検出信号を読み込む。Ｓ３２では、液面センサ７０の検出信号がオンであるときは内部タンク２２が満タン状態であると判定し、液面センサ７０の検出信号がオフであるときは内部タンク２２の液面が満タン位置よりも低下した位置に変化したものと判定する。

【００３４】

そして、Ｓ３２において、内部タンク２２の液面が満タン位置よりも低下したときは、Ｓ３３に進み、内部タンク２２への液体補給を要求するための補給信号をシステム管理コンピュータ５０に送信する。これにより、システム管理コンピュータ５０は、補給ポンプ１６を駆動する。

【００３５】

また、Ｓ３２において、内部タンク２２の液面が満タンであるときは、Ｓ３４に進み、補給信号の出力を停止する。これにより、システム管理コンピュータ５０は、補給ポンプ１６の駆動を停止する。

【００３６】

ここで、システム管理コンピュータ５０が実行する補給ポンプ１６の制御処理について図５に示すフローチャートを参照して説明する。システム管理コンピュータ５０は、図５に示すＳ４１において、補給信号が液体供給機１２の制御装置８０から送信されたか否かをチェックする。Ｓ４１において、複数の液体供給機12_1～12_nの何れかの制御装置８０から補給信号が入力されたときは、Ｓ４２に進み、補給ポンプ１６に駆動信号を出力する。これにより、補給ポンプ１６は、外部タンク１４に貯留された液体を汲み上げて分岐管路３０へ供給する。

【００３７】

続いて、Ｓ４３では、補給信号を出力した当該液体供給機１２に対応する切替弁４０へ開弁信号を出力し、分岐管路３０を介して供給された液体を当該液体供給機１２の内部タンク２２に液体を補給する。

【００３８】

また、上記Ｓ４１において、補給信号が液体供給機１２の制御装置８０から入力されていないときは、Ｓ４４に進み、補給信号の出力が停止されたか否かをチェックする。Ｓ４４において、補給信号の出力が停止されていないときは、Ｓ４１に戻り、Ｓ４１、Ｓ４４の処理を繰り返す。また、Ｓ４４において、補給信号の出力が停止されたときは、Ｓ４５に進み、補給信号の出力を停止した当該液体供給機１２に対応する切替弁４０への開弁信号の出力を停止する。これにより、当該切替弁４０は閉弁する。

【００３９】

次のＳ４６では、他の液体供給機１２より補給信号が入力されているか否かをチェックする。Ｓ４６において、他の液体供給機１２より補給信号が入力されているときは、上記Ｓ４１に戻り、Ｓ４１以降の処理を実行する。また、上記Ｓ４６において、他の液体供給機１２より補給信号が入力されていないときは、Ｓ４７に進み、補給ポンプ１６への駆動信号の出力を停止する。これにより、補給ポンプ１６は、外部タンク１４に貯留された液体の供給を停止する。

【００４０】

このように、液体供給機１２の内部タンク２２の液面が満タン以下に低下すると、補給ポンプ１６が駆動されて外部タンク１４に貯留された液体が自動的に当該内部タンク２２に供給されるため、作業員による補給作業を無くして作業効率を高められる。

【００４１】

また、上記説明では、複数の液体供給機１２から補給信号が出力された場合には、同時に複数の切替弁４０を開弁させることで複数の内部タンク２２へ同時に液体を補給することも可能である。その場合、補給ポンプ１６からの吐出量が一定であるので、複数の内部タンク２２への補給量が減少するが、供給ノズル６６からの供給量は内部ポンプ５６の吐出能力によって決まるので、補給ポンプ１６から各内部タンク２２への補給量が減少しても供給ノズル６６からの吐出量は減少することはない。

【００４２】

ここで、システム管理コンピュータ５０が実行する補給ポンプ１６の制御処理の変形例について図６に示すフローチャートを参照して説明する。システム管理コンピュータ５０は、図６に示すＳ５１において、補給信号が液体供給機１２の制御装置８０から入力されたか否かをチェックする。Ｓ５１において、複数の液体供給機１２$_1$～１２$_n$の何れかの制御装置８０から補給信号が入力されたときは、Ｓ５２に進み、補給ポンプ１６に駆動信号を出力する。これにより、補給ポンプ１６は、外部タンク１４に貯留された液体を汲み上げて分岐管路３０へ供給する。

【００４３】

次のＳ５３では、補給信号を出力した液体供給機１２が複数あるか否かをチェックする。Ｓ５３において、補給信号を出力した液体供給機１２が複数ある場合には、Ｓ５４に進み、供給ノズル６６を介して液体を供給中の液体供給機１２があるか否かをチェックする。

【００４４】

Ｓ５４において、供給ノズル６６を介して液体を供給中の液体供給機１２があるときは、Ｓ５５に進み、当該補給信号を出力し、且つ液体を供給中の液体供給機１２に対応する切替弁４０へ開弁信号を出力する。これにより、液体を供給中の液体供給機１２の内部タンク２２へ優先的に液体を補給することが可能になる。

【００４５】

また、上記Ｓ５３において、補給信号を出力した液体供給機１２が１台である場合には、Ｓ５６に進み、補給信号を出力した当該液体供給機１２に対応する切替弁４０へ開弁信号を出力する。これにより、液体を供給中の当該液体供給機１２の内部タンク２２へ液体を補給することが可能になる。

【００４６】

また、上記Ｓ５１において、複数の液体供給機１２$_1$～１２$_n$の何れかの制御装置８０からも補給信号が入力されないときは、Ｓ５７に進み、Ｓ５７～Ｓ６０の処理を実行する。このＳ５７～Ｓ６０の処理は、前述した図５のＳ４４～Ｓ４７の処理と同様な処理であるので、ここではその説明を省略する。

【００４７】

このように、本変形例では、複数の液体供給機１２$_1$～１２$_n$から補給信号が出力されている場合には、現在液体供給中の液体供給機１２に優先的に供給することが可能になるので、内部タンク２２の容量が小さい場合でも供給不足になることを防止することができる。

【産業上の利用可能性】

【００４８】

上記実施例では、車両に尿素水を供給する液体供給機を一例として挙げたが、これに限らず、他の液体を供給する液体供給機にも適用できるのは勿論である。

【００４９】

また、上記実施例では、複数の液体供給機を有する液体供給システムを一例としたが、これに限らず、１台の液体供給機に外部から液体を補給する構成のものにも適用できるの

は勿論である。

【００５０】

また、上記実施例では、内部タンク２２に設けられた液面センサ７０が内部タンク２２の満タン時の液面を検出するものとして説明したが、これに限らず、内部タンク２２の任意の液位を検出するように設定しても良いのは勿論である。例えば、満タン時の液位から所定量減少した位置、あるいは内部タンク２２の残量が所定量に減少したことを検出するように設定する構成としても良い。

【図面の簡単な説明】

【００５１】

【図１】本発明による液体供給システムの一実施例を示す系統図である。

【図２】液体供給機１２の概略構成を模式的に示す構成図である。

【図３】液体供給機１２の制御装置８０が実行する制御処理を説明するためのフローチャートである。

【図４】液体供給機１２の制御装置８０が実行する液面センサ検出処理を説明するためのフローチャートである。

【図５】システム管理コンピュータ５０が実行する補給ポンプ１６の制御処理を説明するためのフローチャートである。

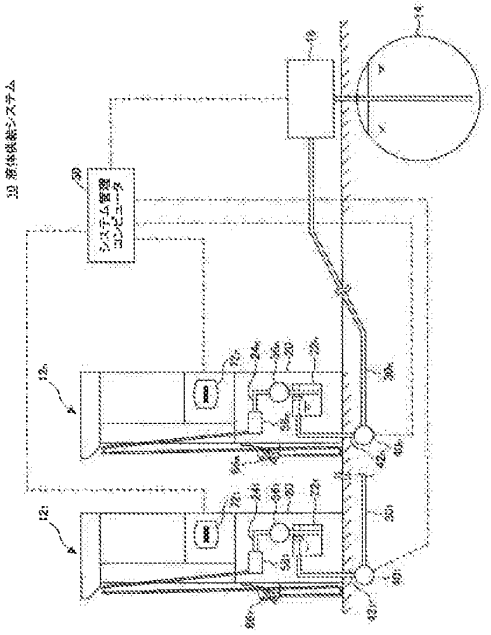
【図６】システム管理コンピュータ５０が実行する補給ポンプ１６の制御処理の変形例を説明するためのフローチャートである。

【符号の説明】

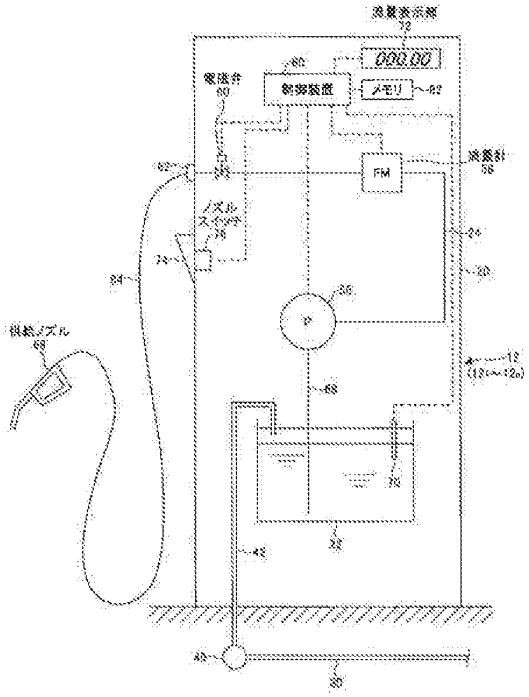
【００５２】

１０　液体供給システム
１２（１２１～１２ｎ）　液体供給機
１４　外部タンク
１６　補給ポンプ
２２　内部タンク
３０（３０１～３０ｎ）　分岐管路
４０（４０１～４０ｎ）　切替弁
４２（４２１～４２ｎ）　補給管路
５０　システム管理コンピュータ
５６　内部ポンプ
５８　流量計
６６　供給ノズル
７０　液面センサ
８０　制御装置
７４　ノズル掛け
７６　ノズル掛けスイッチ

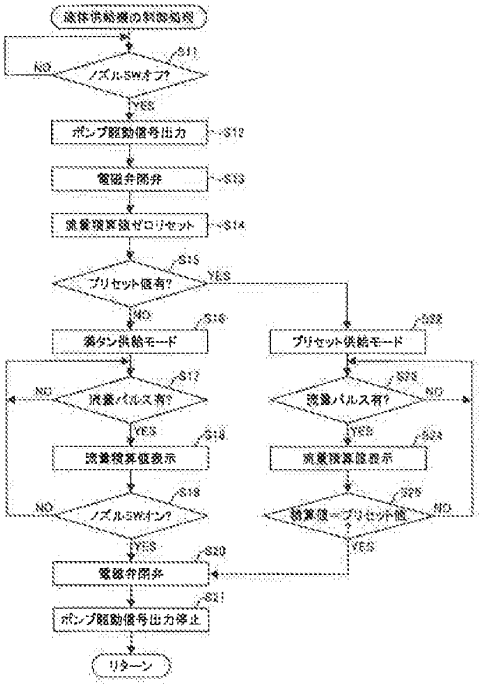
【図１】



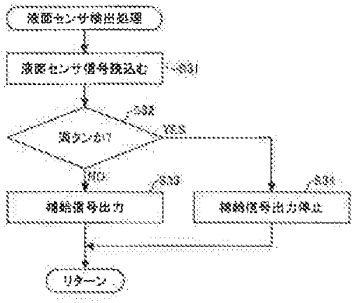
【図２】



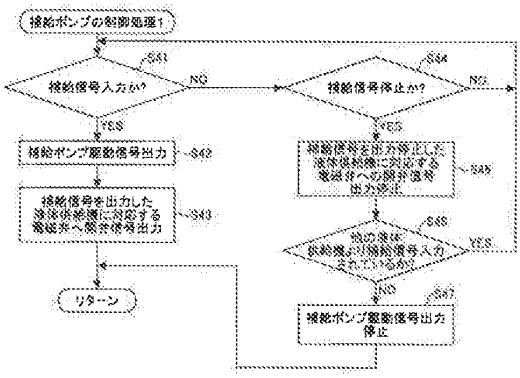
【図３】



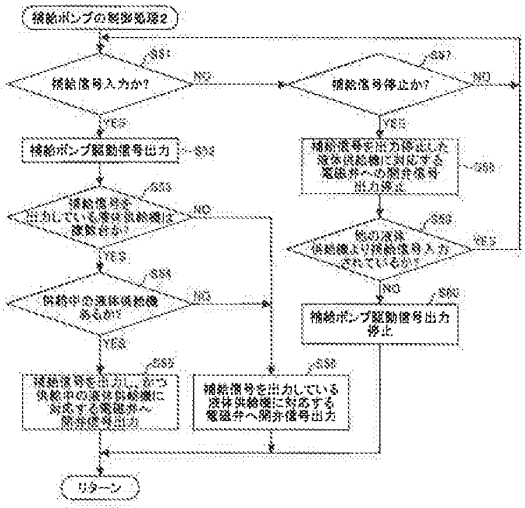
【図４】



【図５】


補給ポンプの制御処理1
S41
補給信号入力か?
NO
YES
S42
補給ポンプ駆動信号出力
S43
補給信号を出力した液体供給機に対応する電磁弁へ開弁信号出力
リターン
S44
補給信号停止か?
NO
YES
S45
補給信号を出力停止した液体供給機に対応する電磁弁への開弁信号出力停止
S46
他の液体供給機より補給信号入力されているか?
YES
NO
S47
補給ポンプ駆動信号出力停止

【図６】


補給ポンプの制御処理2
S51
補給信号入力か?
NO
YES
S52
補給ポンプ駆動信号出力
S53
補給信号を出力している液体供給機と異なるか?
NO
YES
S54
供給中の液体供給機あるか?
NO
YES
S55
補給信号を出力し、かつ供給中の液体供給機に対応する電磁弁へ開弁信号出力
S56
補給信号を出力している液体供給機に対応する電磁弁へ開弁信号出力
リターン
S57
補給信号停止か?
NO
YES
S58
補給信号を出力停止した液体供給機に対応する電磁弁への開弁信号出力停止
S59
他の液体供給機より補給信号入力されているか?
YES
NO
S60
補給ポンプ駆動信号出力停止

フロントページの続き

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FUEL DISTRIBUTOR

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Applicant(s): SANWA ENERGY CO LTD ± (SANWA ENERGY CO LTD)

Classification: **- international:** ***B62B3/00; B67D7/84***
- cooperative:

Application number: JP20070113758 20070424 Global Dossier

Priority number(s): JP20070113758 20070424

Also published as: JP4388969 (B2)

Abstract of JP2008265843 (A)

PROBLEM TO BE SOLVED: To solve the problem that a fuel in an underground fuel tank of a building cannot be efficiently supplied to an external power source device such as of a mobile power source car. ;SOLUTION: The fuel distributor comprises a fuel tank (0201), a fuel inlet (0202) for connecting a hose for filling the tank with the fuel, a fuel outlet (0203) for connecting a hose for feeding the fuel from the tank to a generator, a priming fuel inlet (0204) provided on the tank for filling with a priming fuel for transmitting a negative pressure from the generator and a wheel (0205) provided under the tank. This can efficiently and safely supply the fuel in the underground fuel tank of the building to the external power source device such as a mobile power source car. ;COPYRIGHT: (C)2009,JPO&INPIT

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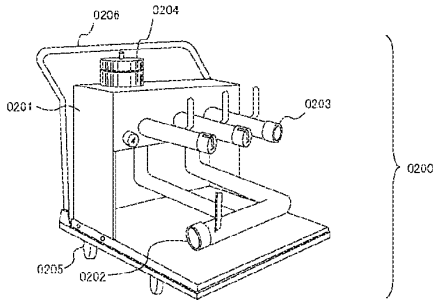
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3E083 AA07 AJ01 AK01

(54)【発明の名称】燃料分配器

(57)【要約】
【課題】建物の地下燃料槽の燃料を効率的に外部の移動電源車等の電源装置へ供給することができなかった。
【解決手段】本発明の移動燃料分配器では、燃料タンク（０２０１）と、前記燃料タンクに燃料を投入するためのホースを接続する燃料投入口（０２０２）と、前記燃料タンクから発電機へ燃料を送るためのホースを接続する燃料送出口（０２０３）と、前記発電機からの負圧を伝達するための呼び燃料を投入する前記タンクに設けられた呼び燃料投入口（０２０４）と、燃料タンク下部に配置された車輪（０２０５）と、からなり、これにより建物の地下燃料槽の燃料を効率的に、かつ、安全に外部の移動電源車等の電源装置へ供給することができる。
【選択図】　図２



【特許請求の範囲】
【請求項１】
燃料タンクと、
前記燃料タンクに燃料を投入するためのホースを接続する燃料投入口と、
前記燃料タンクから発電機へ燃料を送るためのホースを接続する燃料送出口と、
前記発電機からの負圧を伝達するための呼び燃料を投入する前記タンクに設けられた呼び燃料投入口と、
燃料タンク下部に配置された車輪と、
からなる移動燃料分配器。
【請求項２】
前記燃料送出口は複数設けられていることを特徴とする請求項１に記載の移動燃料分配器。
【請求項３】
前記燃料投入口は前記燃料タンクに対して燃料投入管にて接続されるとともに、燃料投入管には予備燃料を投入するための第一予備燃料投入口が設けられていることを特徴とする請求項１又は２に記載の移動燃料分配器。
【請求項４】
前記燃料タンクは、第一予備燃料投入口の口方向と異なる方向から予備燃料を投入するための第二予備燃料投入口が設けられていることを特徴とする請求項３に記載の移動燃料分配器。
【請求項５】
前記燃料投入口は燃料送出口よりも低位にて前記タンクに接続されており、前記燃料タンクと燃料投入口の燃料投入管との接続部には、燃料タンクから燃料投入管へ燃料が逆流しないように逆止弁が設けられていることを特徴とする請求項１から４のいずれか一に記載の移動燃料分配器。
【請求項６】
車輪にて移動させるための押し棒がさらに設けられ、押し棒を押す人が立つ側には燃料口が設けられないように構成されている請求項１から５のいずれか一に記載の移動燃料分配器。
【請求項７】
燃料送出口には、流量を調整するための流量調整弁が取り付けられている請求項１から６のいずれか一に記載の移動燃料分配器。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、地下燃料槽等に蓄積された燃料を分配する燃料分配器の技術に関する。
【背景技術】
【０００２】
企業のオフィスや商業施設が入居している建物は、非常時における電源の確保が最も重要な課題の一つである。特に、高度情報化建築物（インテリジェントビル）といわれる各種機能が付加された建築物では、電源を含めてビル全体で集中管理、自動制御が行われている。これらの建物では、一般的に、非常時における電源を確保すべく建物内部に非常用の発電装置を備えており、該発電装置に対して供給する燃料を地下燃料槽に蓄積している。仮に、該発電装置が作動しない場合や、該発電装置では発電容量が足りない場合には、移動電源車にて発電を行うことになる。
【０００３】
しかしながら、移動電源車にて発電を行う際の燃料として、建築物に備えられた地下燃料槽に蓄積された燃料を緊急時に利用することができない。地下燃料槽はもともと建物内部の発電装置に燃料を供給するように作られているため、蓄積された燃料を建物内部の発電装置に供給するように配管されているが、外部へ供給するようにはなっていない。また

、地下燃料槽へ燃料を蓄積させるための給油口は、通常は燃料を流入するために地下燃料槽上部に設けられているため、装置等を使わずに給油口から燃料を汲み出すことはできない。さらに、移動電源車に配管されているホースを直接地下燃料槽に設けられた給油口に挿入して燃料を汲み出すことは技術的には可能であるが、地下燃料槽の燃料をホース等で配管して直接外部の電源装置に燃料を供給することを消防庁の許可無く行うことが、消防法上禁止されている。なお、燃料を分配するためのマニホールドに関する技術としては、例えば、特許文献１または特許文献２などが挙げられるが、いずれも上記課題を解決するものではない。

【０００４】

このため、緊急時には、移動電源車は地下燃料槽の燃料を利用することはできず、燃料補充用のタンクローリーから直接移動電源車に燃料を供給しなければならなかった。

【特許文献１】特開平２－２２０３６２号公報

【特許文献２】実開平７－１８９７６号公報

【発明の開示】

【発明が解決しようとする課題】

【０００５】

しかしながら、移動電源車の発電容量の増加に伴い、単位時間当たりに使用する燃料は増加している。このため、移動電源車に燃料を供給するためにタンクローリーを何台も待機させる必要があった。また、タンクローリーから移動電源車に供給することができる燃料の容量も消防法上制限されているため、消防法に抵触せずに十分に燃料を供給することができなかった。

【０００６】

そこで、本発明では、消防法に抵触せずに地下燃料槽の燃料を効率的に外部の電源装置へ供給することが可能な装置を提供することを目的とする。

【課題を解決するための手段】

【０００７】

上記課題を解決するために、第一発明は、燃料タンクと、前記燃料タンクに燃料を投入するためのホースを接続する燃料投入口と、前記燃料タンクから発電機へ燃料を送るためのホースを接続する燃料送出口と、前記発電機からの負圧を伝達するための呼び燃料を投入する前記タンクに設けられた呼び燃料投入口と、燃料タンク下部に配置された車輪と、からなる移動燃料分配器を提供する。第二発明では、前記燃料送出口は複数設けられていることを特徴とする第一発明に記載の移動燃料分配器を提供する。第三発明では、前記燃料投入口は前記燃料タンクに対して燃料投入管にて接続されるとともに、燃料投入管には予備燃料を投入するための第一予備燃料投入口が設けられていることを特徴とする第一発明又は第二発明に記載の移動燃料分配器を提供する。第四発明では、前記燃料タンクは、第一予備燃料投入口の口方向と異なる方向から予備燃料を投入するための第二予備燃料投入口が設けられていることを特徴とする第三発明に記載の移動燃料分配器を提供する。第五発明では、前記燃料投入口は燃料送出口よりも低位にて前記タンクに接続されており、前記燃料タンクと燃料投入口の燃料投入管との接続部には、燃料タンクから燃料投入管へ燃料が逆流しないように逆止弁が設けられていることを特徴とする第一発明から第四発明のいずれか一に記載の移動燃料分配器を提供する。第六発明では、車輪にて移動させるための押し棒がさらに設けられ、押し棒を押す人が立つ側には燃料口が設けられないように構成されている第一発明から第五発明のいずれか一に記載の移動燃料分配器を提供する。第六発明では、燃料送出口には、流量を調整するための流量調整弁が取り付けられている第一発明から第六発明のいずれか一に記載の移動燃料分配器を提供する。

【発明の効果】

【０００８】

以上のような構成をとる本発明の移動燃料分配器では、地下燃料槽の燃料と燃料投入口をホースで接続し、かつ、発電機と燃料送出口をホースで接続することで、発電機によって生じさせた負圧を利用して地下燃料槽からの燃料を汲み上げて発電機へ供給することが

できる。本移動燃料分配器は、可動式であり、建物の内部に設置することができるため、本移動燃料分配器までの燃料の汲み上げは建物又は建物の敷地の内部にて行うことが可能であり、消防法上の問題もない。また、本移動燃料分配器自体には動力源は備えられていないため、燃料が引火して炎上するおそれも無い。このため、本移動燃料分配器を利用することで、緊急時に、安全に地下燃料槽に蓄積された燃料を利用することができる。

【発明を実施するための最良の形態】

【０００９】

本発明を実施するための最良の形態について、図面を用いて詳細に説明する。なお、本発明はこれら実施の形態になんら限定されるものではなく、その要旨を逸脱しない範囲において種々なる態様で実施しうる。なお、以下の実施形態と請求項の関係は次のとおりである。実施形態１は主として請求項１、２、６、７などについて説明する。実施形態２は主として請求項３、４、５などについて説明する。

【００１０】

≪実施形態１≫（実施形態１の概念）実施形態１について説明する。図１に本実施形態の移動燃料分配器（０１００）を利用した場合の概念図を示す。一般的な高層ビルなどの建物（０１０１）では、地下燃料槽（０１０２）と緊急時に地下燃料槽から燃料の供給を受けて発電する建物内部に設置された内部発電機（０１０３）を有する。地下燃料槽へは遠方供給口（０１０４）を介してタンクローリー（０１０５）などから燃料を供給することができる。しかし、緊急時になって内部発電機が故障してしまったり、内部発電機の発電容量が少なかったりした場合には、外部から発電機（０１０６ａ：図は移動電源車）を持ち込んで利用することになる。このとき、本移動燃料分配器（０１００）は、地下燃料槽寄りの建物の内部又は建物の敷地内に設置されて、移動燃料分配器と地下燃料槽、移動燃料分配器と外部の発電機をそれぞれホースにて接続する。そして、外部発電機を作動させることにより、移動燃料分配器内に負圧が生じるため、地下燃料槽からの燃料が汲み上げられる。これにより、地下燃料槽からの燃料を外部発電機に供給することができる。なお、移動燃料分配器に燃料送出口が複数設けられている場合には、複数の外部の発電機（０１０６ａ、０１０６ｂ）に燃料を配分することも可能である。

【００１１】

（実施形態１の構成）図２に本実施形態の移動燃料分配器の構成の一例を示す。本実施形態にかかる「移動燃料分配器」（０２００）は、「燃料タンク」（０２０１）と、「燃料投入口」（０２０２）と、「燃料送出口」（０２０３）と、「呼び燃料投入口」（０２０４）と、「車輪」（０２０５）とからなる。また、さらに「押し棒」（０２０６）を有していても良い。

【００１２】

（実施形態１の構成の説明）「移動燃料分配器」（０２００）は、燃料タンク（０２０１）、燃料投入口（０２０２）、燃料送出口（０２０３）、呼び燃料投入口（０２０４）、車輪（０２０５）から構成される装置であり、押し棒（０２０６）を有していても良い。ただし、移動燃料分配器は、これらの構成及び機能に限られるものではなく、例えば、実施形態２以降に記載の構成を付加しても良い。図２に示す移動燃料分配器の外観寸法は、高×幅×長が８００ｍｍ×４５０ｍｍ×７３０ｍｍ程度であり、重量は２４ｋｇ程度である。また、移動燃料分配器は、緊急時等に利用される場合が多いため、その存在が目立つように赤や朱色などに着色することが望ましい。

【００１３】

「燃料タンク」（０２０１）は、移動燃料分配器に投入された燃料を一時的に蓄積するように構成されている。また、燃料タンクに燃料投入口、燃料送出口、呼び燃料投入口が設けられており、燃料投入口等から投入された燃料は燃料タンクを経て燃料送出口へ送出される。燃料タンクは、金属製であることが望ましく、さらにはステンレス製（ＳＳ４００など）であることがより望ましい。また、燃料タンクを構成する板厚は４．５ｃｍ程度であれば、燃料タンクが堅牢となりなおよい。図２に示す燃料タンクでは、所定高さにタンク部分が設けられており、タンク下部は開口部となっている。燃料投入口は燃料タンク

下部から突出させた送水管の先端に設けられており、燃料送出口は燃料タンクの側方から突出させた送水管の先に設けられており、呼び燃料投入口は燃料タンク上部に設けられている。このため、燃料タンク下部の燃料投入口から投入された燃料は、燃料タンクを介して燃料タンク側方の燃料送出口へ流出する。

【００１４】

「燃料投入口」（０２０２）は、燃料タンクに設けられており、燃料タンクに燃料を投入するためのホースを接続するように構成されている。一端が燃料投入口に接続されたホースは、他端が地下燃料槽のなるべく低位に達する長さのものを利用することが望ましい。図２では、燃料タンク下方に配置されたステンレス製の管の先端部に燃料投入口を設けている。燃料投入口の材質はアルミニウム合金などからなり、カプラーなどを用いてホースとの接続を行う。ホースはフッ素樹脂などからなり、ホースの先端部もアルミニウム合金などの材質を用いる。燃料投入口から燃料タンク下部に接続している送水管は、一箇所で燃料タンクと接続されていても良いが、燃料タンクへ効率的に燃料を送水するために二箇所で燃料タンクと接続されていることが望ましい。

【００１５】

「燃料送出口」（０２０３）は、燃料タンクに設けられており、燃料タンクから発電機へ燃料を送るためのホースを接続するように構成されている。一端が燃料送出口に接続されたホースは、他端で発電機に接続される。なお、燃料送出口を燃料タンクに複数設けることで、一度に複数の発電機とホースで接続することができ、複数の発電機に同時に燃料を供給することができる。図２では、燃料タンク側方に配置されたステンレス製の管の先端部に燃料送出口を設けている。燃料送出口の材質はアルミニウム合金などからなり、カプラーなどを用いてホースとの接続を行う。

【００１６】

燃料送出口には、燃料を調節するための流量調節弁が取り付けられていても良い。流量調節弁は、バルブなどを利用して燃料送出口の開閉及び開口面積を調節可能とすることで、燃料送出口から送出される燃料の送出量を調節することができる。燃料送出口が複数設けられている場合には、各々の燃料送出口に流量調節弁を設けることが望ましい。例えば、発電装置の燃料消費量が６００リットル／時である発電機Ａと、３００リットル／時である発電機Ｂがそれぞれ燃料送出口とホースを介して接続されている場合、発電機Ａと発電機Ｂの燃料送出割合を２：１となるように流量を調節することも可能である。利用しない燃料供給口は、燃料送出口用の蓋を用いて口を塞いでおく、または、バルブにて燃料送出口を閉口しておく。

【００１７】

「呼び燃料投入口」（０２０４）は、燃料タンクに設けられており、発電機からの負圧を伝達するための呼び燃料を投入するように構成されている。「呼び燃料」とは、いわゆる呼び水のようなものである。移動燃料分配器の燃料送出口と発電機がホースにて接続され、発電機を起動させると、発電機の燃料投入口には、発電機自体に燃料を供給するための吸引力が生じる。該吸引力はホースを介して移動燃料分配器の燃料タンクに伝達されるため、燃料タンク内に負圧が生じる。これにより、燃料投入口及びこれに接続されたホースにも負圧が生じ、これにより地下燃料槽から燃料を汲み上げることができる。このとき、発電機からの純粋な吸引力のみでは地下燃料槽から燃料を汲み上げることが困難であることから、燃料タンクに予め呼び燃料を投入しておくことで、発電機からの負圧を効率的に伝達して最大限利用することができる。なお、発電機からの負圧を効率的に利用するためには、負圧が逃げないように呼び燃料を投入した投入口を密閉する必要がある。図２は、呼び燃料投入口を密閉した状態を示している。

【００１８】

呼び燃料は、負圧を生じさせるために必要なものであるが、通常の燃料としても利用されるため、地下燃料槽に蓄積されている燃料と同様なものを利用することが望ましい。また、呼び燃料は、手動で燃料タンクに投入することになるため、呼び燃料投入口は燃料を投入し易いように広口であることが望ましい。また、燃料の投入には、注入ノズル付きの

ポリタンクなどが用いられる。そして、ポリタンクを呼び燃料投入口付近に一時的に載置し、ポリタンクの注入ノズルを呼び燃料投入口に挿入して傾けることで燃料を投入することができる。このため、燃料タンク上部には、ポリタンクを一時的に載置するスペースがあることが望ましい。

【００１９】

「車輪」（０２０５）は、燃料タンク下部に配置されており、移動燃料分配器を移動可能としている。上記構成に加えて、さらに、車輪にて移動させるための「押し棒」（０２０６）を設けても良い。押し棒を設ける場合には、押し棒を押す人が立つ側には燃料投入口及び燃料送出口、呼び燃料投入口などの燃料口が設けられないように構成する。押し棒を設けることで、燃料タンク下部に配置された車輪にて円滑に移動燃料分配器を移動させることができ、かつ、押し棒を押す人が立つ側には燃料口を設けないこととしているため、移動燃料分配器を移動させる際に燃料口が押し棒を押す人の邪魔になることはない。なお、押し棒を備えていなくても車輪のみで移動燃料分配器を移動させることも可能である。この場合には、燃料口の配置は特段限定されず、移動燃料分配器の四側方のいずれの方向に向けて燃料口を配置しても良い。

【００２０】

（実施形態１の具体例）図２～図４を用いて本実施形態の移動燃料分配器の具体的な構成を示す。これらの図と、図１に示した概略図を用いて移動燃料分配器の具体的な利用方法を説明する。なお、図２～図４及び下記の具体的な構成は、本実施形態の移動燃料分配器の機能を発揮させるための一例であり、これらの具体的な構成に限定されるものではない。図２は、上記の通り、移動燃料分配器の外観を示す図である。図３は移動燃料分配器の側面図である。図４は移動燃料分配器の上面図である。

【００２１】

概要にて説明したように、建物内部に設置された内部発電機が故障してしまったり、内部発電機の発電容量では不十分であったりした場合には、まず、本移動燃料分配器を地下燃料槽の近辺まで移動させる。このとき、移動には車輪（０３０５、０４０５）又は押し棒が設けられている場合には車輪（０３０５、０４０５）及び押し棒（０３０６、０４０６）が利用される。

【００２２】

移動燃料分配器を地下燃料槽近辺にまで移動させた後、移動燃料分配器の燃料投入口（０３０２、０４０２）にホースの一端を接続し、該ホースの他端を地下燃料槽の管理用のマンホールや地下燃料槽への燃料供給口から地下燃料槽へ挿入させる。該ホースは、先端部分の重量を重くし、先端が地下燃料槽の底面近くにまで達する程度の長さの物を用いることが望ましい。

【００２３】

次に、移動燃料分配器の燃料送出口（０３０３、０４０３）に別のホースの一端を接続し、該ホースの他端を発電機の燃料投入口に接続する。ホースを接続しない燃料送出口は蓋又はバルブで閉じておく。図１では、発電機として移動電源車を利用しているが、移動電源車等は建物内部に入り込むことができないため、該ホースは、屋外又は敷地外の移動電源車に達するのに十分な長さのものを用いることが望ましい。なお、移動燃料分配器の燃料送出口が複数設けられている場合には、ホースを介して移動燃料分配器と複数の発電機とを繋ぐことができる。なお、燃料投入口と燃料送出口のホースの接続順序は逆であっても良い。

【００２４】

移動燃料分配器と地下燃料槽の燃料、移動燃料分配器と発電機が接続されると、次に、呼び燃料投入口（０３０４、０４０４）の蓋を開けて、ポリタンクなどに入っている呼び燃料を燃料タンク（０３０１、０４０１）に投入する。このとき、呼び燃料を燃料タンクに投入することで、発電機からの負圧を効率的に利用するためには、負圧が逃げないように呼び燃料を投入した後に投入口を密閉する必要がある。また、発電機と接続されていない燃料送出口（０３０３、０４０３）や接続されているが稼動しない発電機と接続された

燃料送出口についても塞ぐ必要がある。燃料送出口に送出する燃料の流量を調節するために流量調節弁としてバルブ（０３０７、０４０７）が設けられている場合には、該流量調節弁にて燃料投入口を塞ぐことも可能である。また、呼び燃料が流出しないように燃料投入口にもバルブ（０３０８、０４０８）を設けて口の開閉を可能とすることとしても良いし、実施形態２にて記載するように逆止弁を用いても良い。

【００２５】

次に、燃料送出口とホースを介して接続された発電機を起動する。そして、発電機が接続された燃料送出口のバルブを開くと燃料タンク内に負圧が生じ、これと同時に燃料投入口のバルブを開くと、負圧により地下燃料槽から燃料を汲み上げることができる。汲み上げられた燃料は、燃料投入口から燃料タンクに流入し、燃料タンクに流入した燃料は燃料送出口から発電機に送出される。発電機では、この燃料を利用して発電を行うことができる。燃料送出口が複数設けられている場合には、燃料タンク内の燃料を複数の発電機に分配して送出することができる。

【００２６】

（実施形態１の効果）以上のような構成をとる本移動燃料分配器では、地下燃料槽の燃料と燃料投入口をホースで接続し、かつ、発電機と燃料送出口をホースで接続することで、発電機によって生じさせた負圧を利用して地下燃料槽からの燃料を汲み上げて発電機へ供給することができる。本移動燃料分配器は、可動式であるため、建物の内部に設置することができるため、本移動燃料分配器までの燃料の汲み上げは建物又は建物の敷地の内部にて行うことが可能であるため、消防法上の問題もない。また、本移動燃料分配器自体には動力源は備えられていないため、燃料が引火して炎上するおそれも無い。このため、本移動燃料分配器を利用することで、緊急時に、安全に地下燃料槽に蓄積された燃料を利用することができる。

【００２７】

≪実施形態２≫（実施形態２の概念）実施形態２について説明する。図５に本実施形態の移動燃料分配器（０５００）を利用した場合の概念図を示す。建物（０５０１）内部に設けられた発電機（０５０３）の故障又は容量不足時に、本移動燃料分配器（０５００）と地下燃料槽（０５０２）の燃料と、移動燃料分配器（０５００）と外部の発電機（０５０６ａ、０５０６ｂ）とをホースで接続することは実施形態１と同様である。そして、さらに、移動燃料分配器に地下燃料槽からの燃料以外の燃料を投入するための予備燃料投入口が設けられていることを特徴とする。これにより、ホースを介して予備燃料投入口とタンクローリー（０５０５）とを接続することが可能となり、地下燃料槽の燃料が少なくなってしまった場合でも発電機に対して燃料の供給を継続することができる。また、予備燃料投入口から投入された燃料を移動燃料分配器から地下燃料槽へ送出することができるため、遠方供給口（０５０４）を利用しなくても地下燃料槽に燃料を補充することもできる。

【００２８】

（実施形態２の構成）図６に本実施形態の移動燃料分配器の構成の一例を示す。本実施形態にかかる「移動燃料分配器」（０６００）は、「燃料タンク」（０６０１）と、「燃料投入口」（０６０２）と、「燃料送出口」（０６０３）と、「呼び燃料投入口」（０６０４）と、「車輪」（０６０５）とからなり、「押し棒」（０６０６）を有していても良い。そして、さらに、「第一予備燃料投入口」（０６０７）及び／又は「第二予備燃料投入口」（０６０８）を有することを特徴とする。

【００２９】

（実施形態２の構成の説明）本実施形態の「燃料投入口」（０６０２）は、燃料タンクに対して燃料投入管（０６０９）にて接続されるとともに、燃料投入管には予備燃料を投入するための「第一予備燃料投入口」（０６０７）が設けられている。「予備燃料」とは、地下燃料槽から供給される燃料を補うために利用される予備的な燃料である。ただし、予備燃料は地下燃料槽からの燃料とともに利用されるため、地下燃料槽に蓄積されている燃料と同質の燃料であることが望ましい。「燃料投入管」は、材質がステンレスなどから

なる枝分かれした管であり、燃料投入口を本管部分に配し、第一予備燃料投入口を枝管部分に配する。第一予備燃料投入口は、燃料投入口と同様に材質がアルミニウム合金などからなり、カプラーを介してホースを接続することができるようになっている。

【００３０】

「第一予備燃料投入口」（０６０７）は、ホース等を介して外部の燃料槽と接続することができる。外部の燃料槽とは、地下燃料槽以外に燃料を保持するものであって、より具体的にはタンクローリーなどが該当する。燃料送出口と発電機を接続した後、ホースを介して第一予備燃料投入口とタンクローリーを接続すると、発電機が稼動中であれば燃料タンク内に生じた負圧が燃料投入管を介して第一予備燃料投入口にも伝達される。このため、地下燃料槽の燃料が減少した場合に、タンクローリーからの燃料を燃料タンクに送り込んで発電機を継続的に稼動させることができる。一方、発電機が稼動していない場合には、燃料タンクには負圧は生じず、第一予備燃料投入口から投入された燃料は、燃料投入管を介して地下燃料槽へ供給される。これにより、発電機が稼動していない場合には、第一予備燃料投入口から投入された燃料を地下燃料槽へ供給することができ、減少した地下燃料槽中の燃料の補充をすることができる。このため、発電機が稼動していない場合に、タンクローリーから地下燃料槽に燃料を補充すれば、発電機の再開のためにタンクローリー等が待機する必要がなくなる。

【００３１】

なお、燃料投入管が燃料送出口よりも低位に設けられている場合には、発電機が稼動していないと燃料タンクに負圧が生じないため、第一予備燃料投入口からの燃料だけではなく、燃料タンクからの燃料も逆流して地下燃料槽に流れ出てしまう。燃料タンクからの燃料が流れ出てしまうと、発電機を再度起動する際には再び燃料タンクに呼び燃料を投入することが必要となってしまう。このため、燃料投入口が燃料送出口よりも低位にて燃料タンクに接続されている場合には、燃料タンクと燃料投入口の燃料投入管との接続部には、燃料タンクから燃料投入管へ燃料が逆流しないように逆止弁が設けられていることが望ましい。

【００３２】

「第二予備燃料投入口」（０６０８）は、第一予備燃料投入口の口方向と異なる方向から予備燃料を投入するために燃料タンクに設けられる。第二予備燃料投入口は、燃料投入口と同様に材質がアルミニウム合金などからなり、カプラーを介してホースを接続することができるようになっている。第一予備燃料投入口には、ホースを介してタンクローリーを接続することができるが、タンクローリーの形状等により、第一予備燃料投入口が向けられている方向から接続することができない場合も生じうる。そこで、第一予備燃料投入口とは異なる方向に向けられた第二予備燃料投入口を設けることで、第一燃料投入口に接続できない形状のタンクローリー等の接続を可能とし、緊急時に迅速に接続することが可能となる。

【００３３】

（実施形態２の具体例）図６～図８を用いて本実施形態の移動燃料分配器の具体的な構成を示す。これらの図と、図５に示した概略図を用いて移動燃料分配器の具体的な利用方法を説明する。なお、図６～図８及び下記の具体的な構成は、本実施形態の移動燃料分配器の機能を発揮させるための一例であり、これらの具体的な構成に限定されるものではない。図６は、上記の通り、移動燃料分配器の外観を示す図である。図７は移動燃料分配器の側面図である。図８は移動燃料分配器の上面図である。

【００３４】

本移動燃料分配器は、燃料投入口（０７０２、０８０２）と地下燃料槽の燃料とを接続し、燃料送出口（０７０３、０８０３）と発電機とを接続することが可能であることは実施形態１と同様である。そして、本移動燃料分配器では、第一予備燃料投入口（０７０７、０８０７）とタンクローリー等の燃料供給源を接続することができる。また、第二予備燃料投入口を有する場合には、第二予備燃料投入口（０７０８、０８０８）に燃料供給源を接続することも可能である。第一予備燃料投入口と第二予備燃料投入口は、開口部が異

なる方向に向けられているため、いずれかの予備燃料投入口に接続を試みることができ、タンクローリー等の形状に関わらず接続できる可能性が向上するため汎用性が高い。

【００３５】

第一予備燃料投入口及び第二燃料投入口に燃料供給源のタンクローリーを接続すると、燃料送出口に接続された発電機が稼動中であれば、燃料タンク（０７０１、０８０１）に生じる負圧により地下燃料槽からの燃料の供給と、予備燃料投入口からの燃料の供給を同時に行うことができる。また、いずれの燃料投入口にも口を開閉するためのバルブを設けて、いずれかの燃料投入口からの燃料を選択的に投入するようにしても良い。そして、燃料送出口に接続された発電機が稼動していない場合には、燃料タンク内に負圧が生じないため、予備燃料投入口から投入された燃料は、地下燃料槽に流れ出して地下燃料槽に燃料を供給することができる。

【００３６】

ただし、燃料投入口が燃料送出口よりも低位にて燃料タンクに接続されている場合には、燃料タンクからの燃料も逆流して地下燃料槽に流れ出てしまうが、燃料タンクと燃料投入口の燃料投入管との接続部に燃料タンクから燃料投入管へ燃料が逆流しないように逆止弁（０７０９）を設けることで燃料タンク内の燃料まで流れ出してしまうことはない。このため、発電機の稼動を再開した場合には、燃料タンク内に残存している燃料が再び呼び燃料として発電機からの負圧を効率的に伝達することができる。

【００３７】

（実施形態２の効果）以上のような構成をとる本移動燃料分配器では、実施形態１の効果に加えて、発電機が稼動していない場合には、第一予備燃料投入口から投入した燃料を地下燃料槽へ供給することもできる。また、第二予備燃料投入口を設けることで、様々な形状の燃料供給源からの燃料の投入を受け入れることができるため、汎用性を向上させることができる。

【図面の簡単な説明】

【００３８】

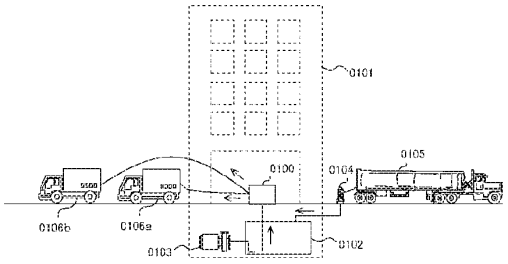
【図１】実施形態１の移動燃料分配器の利用方法を説明する概略図
【図２】実施形態１の移動燃料分配器の外形図
【図３】実施形態１の移動燃料分配器の側面図
【図４】実施形態１の移動燃料分配器の上面図
【図５】実施形態２の移動燃料分配器の利用方法を説明する概略図
【図６】実施形態２の移動燃料分配器の外形図
【図７】実施形態２の移動燃料分配器の側面図
【図８】実施形態２の移動燃料分配器の上面図

【符号の説明】

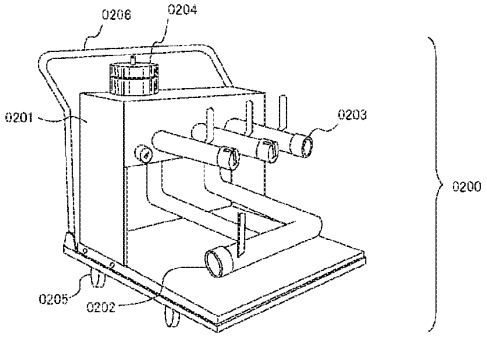
【００３９】

０２００　移動燃料分配器
０２０１　燃料タンク
０２０２　燃料投入口
０２０３　燃料送出口
０２０４　呼び燃料投入口
０２０５　車輪
０２０６　押し棒

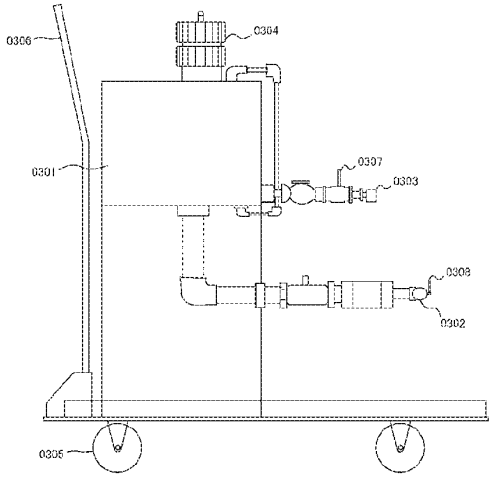
【図１】



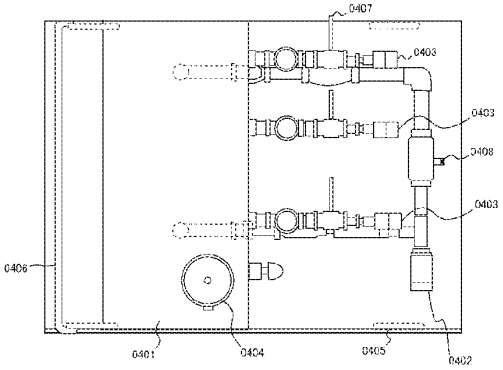
【図２】



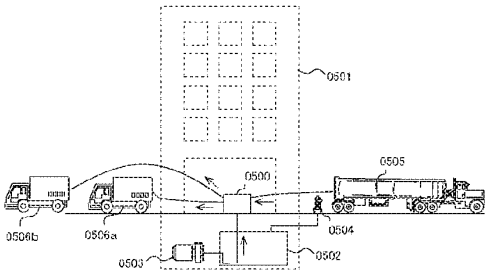
【図３】



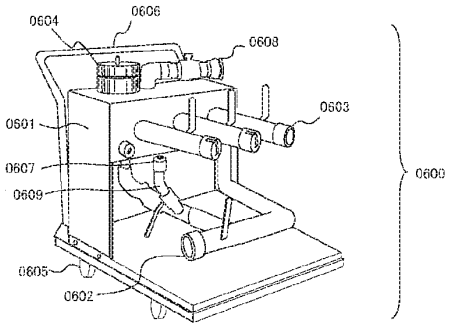
【図４】



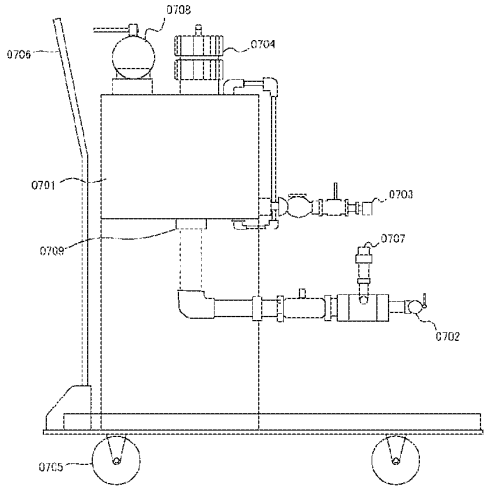
【図５】



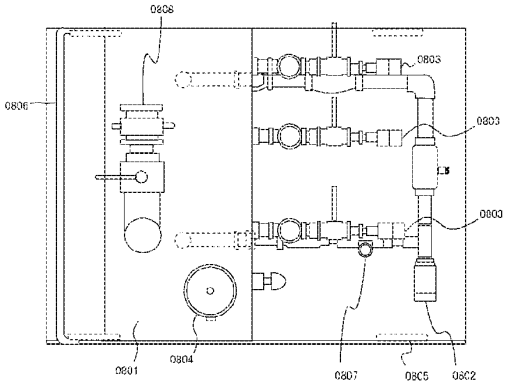
【図６】



【図７】


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【図８】


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ABSTRACT RU91135

A gas supply system for a multi-storey building comprising a main gas pipeline, an underground shutdown device, a shutdown device, an emergency gas shutdown device, a supply pipeline, gas pipelines, shut-off valves, gas consumers, gas leakage detectors, signal feed buttons, a sensor line, control, the control panel, wherein the main gas pipeline is connected to the supply line in series through the shut-off device and the gas emergency shutdown facility , the gas distribution pipelines are connected to the supply pipeline through the stop valves, the gas consumers are connected to the distributing gas pipelines through the appropriate stop valves, gas consumers are installed on each operating floor of the multi-storey house, gas leakage sensors are installed on each operating floor in the gas consumers installation area, on each operated floor, the control unit of its input is connected to the control panel, gas leakage sensors and signal feed buttons with are connected to the inputs of the control unit via the sensor line and the signal line respectively, the control unit of its output is connected to the gas emergency shutdown facility.

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ФЕДЕРАЛЬНАЯ СЛУЖБА
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ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

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(54) **СИСТЕМА ГАЗОСНАБЖЕНИЯ МНОГОЭТАЖНОГО ДОМА**

(57) Реферат:

Полезная модель относится к средствам своевременного отключения подачи газа в помещения домов (зданий) в случае утечки газа и информирования о возникновении данной аварийной ситуации в системе газоснабжения здания. Решение может быть использовано при создании, например, дистанционной системы для многоквартирного дома, обеспечивающей контроль утечки газа, оперативное отключение подачи газа с одновременными включениями звуковой и/или световой сигнализации, вентиляции и выключением электроэнергии (исключая аварийное освещение), а также выдачей информационного сообщения о возникновении аварийной ситуации в сети газоснабжения здания. Целью предлагаемой полезной модели является создание устройства с датчиковой системой контроля утечки газа и сигнальной линией связи, содержащего средства аварийного отключения газа с дистанционным управлением их электроприводами, устанавливаемого в подводящих газопроводах здания, и обеспечивающего своевременное отключение подачи газа и,

тем самым, минимизацию ущерба от возможного взрыва и возгорания помещения (дома) и, как следствие, - спасение жизни жильцов. При работе в автоматическом режиме блок управления 7 после квалификации аварийной ситуации формирует и передает на пульт управления 8 информационный сигнал, содержащий данные о месте и характере аварии (утечке газа). После получения информационного сигнала от блока управления 7 на монитор пульта управления 8 производится вывод полученной информации об аварии и включается (при необходимости) аварийная звуковая и/или световая сигнализация. Если аварийная ситуация квалифицирована блоком управления 7 как незначительная или допустимая (исходя из допустимого уровня концентрации газа в помещении), то блок управления 7 переходит в штатный режим ожидания сигналов (о снижении или повышении уровня концентрации газа) от датчиков утечки газа 3 или команды от пульта управления 8. Если же аварийная ситуация квалифицирована блоком управления 7 как недопустимая (исходя из превышения допустимого уровня концентрации газа в помещении), то блок управления 7 выдает сигнал (например, электрический импульс напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14, при срабатывании которого происходит перекрытие подачи газа в подводящий газопровод 1. Так как средство аварийного отключения газа 14 переводится из состояния «открыто» в состояние «закрыто» и из состояния «закрыто» в состояние «открыто» путем подачи сигнала (например, электрического импульса напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14 (при этом процесс открытия или закрытия, на пример, газового шарового крана завершается срабатыванием одного из концевых выключателей, входящих в состав его электропривода), то блок управления 7 блокирует повторную подачу сигнала на сработавшее средство аварийного отключения газа 14 до получения соответствующей команды на его открытие от пульта управления 8 или команды «Сброс аварии» от пульта управления 8 (в случае «ручного» открытия средства аварийного отключения газа 14).

Область техники

Полезная модель относится к средствам своевременного отключения подачи газа в помещения домов (зданий) в случае утечки газа и информирования о возникновении данной аварийной ситуации в системе газоснабжения здания. Решение может быть использовано при создании, например, дистанционной системы для многоквартирного дома, обеспечивающей контроль утечки газа, оперативное отключение подачи газа с одновременными включениями звуковой и/или световой сигнализации, вентиляции и выключением электроэнергии (исключая аварийное освещение), а также выдачей информационного сообщения о возникновении аварийной ситуации в сети газоснабжения здания.

Уровень техники

Известно устройство для обеспечения газоснабжения жилых зданий (http://stroyanka.ru/publ/3-1-0-9), состоящее из газового оборудования, включающего в себя домовую сеть газоснабжения (от запорного устройства на вводе) и газовую аппаратуру и приборы (плиты, водоподогреватели, отопительные печи и т.п.), использующие газ в качестве топлива. Домовая сеть газоснабжения включает следующие внутридомовые газопроводы - магистральную линию, стояки и разводящие сети, выполненные из черных стальных газовых труб. При этом стояки проложены в нежилых помещениях, а разводящие сети подводят газ к приборам (кухонные плиты, газовые колонки, печи, котлы и т.п.). Данные устройства нашли широкое применение в системах газоснабжения для многоквартирных домов, в том числе системах автономного газоснабжения для многоквартирных домов (.id= 12).

Недостатками известного технического решения является недостаточная надежность газоснабжения.

Целью предлагаемой полезной модели является повышение надежности газоснабжения.

Поставленная цель достигается за счет того, что в системе газоснабжения многоэтажного дома, содержащей магистральный газопровод, подземное отключающее устройство, отключающее устройство, средство аварийного отключения газа, подводящий газопровод, разводящие газопроводы, запорную арматуру, потребителей газа, датчики утечки газа, кнопки подачи сигнала, датчиковую линию связи, сигнальную линию связи, блок управления, пульт управления, при этом магистральный газопровод соединен с подводящим газопроводом последовательно через отключающее устройство и средство аварийного отключения газа, разводящие газопроводы соединены с подводящим газопроводом через запорную арматуру, потребители газа соединены с разводящими газопроводами через соответствующую запорную арматуру, потребители газа установлены на каждом эксплуатируемом этаже многоэтажного дома, датчики утечки газа установлены на каждом эксплуатируемом этаже в зоне установки потребителей газа, кнопки подачи сигнала установлены на каждом эксплуатируемом этаже, блок управления своим входом соединен с пультом управления, датчики утечки газа и кнопки подачи сигнала соединены со входами блока управления посредством датчиковой линии связи и сигнальной линии связи соответственно, блок управления своим выходом соединен со средством аварийного отключения газа.

Краткое описание чертежей

Полезная модель поясняется чертежом, где на фигуре изображена схема размещения элементов устройства внутри здания и их возможного соединения между собой.

На чертеже обозначены: подводящий газопровод 1, разводящий газопровод 2, датчик утечки газа 3, кнопка подачи сигнала 4, датчиковая линия связи 5, сигнальная линия связи 6, блок управления 7, пульт управления 8, сетевой провод 9, внутренний источник электропитания 10, магистральный газопровод 11, подземное отключающее устройство 12, отключающее устройство 13, средство аварийного отключения газа 14, потребитель газа 15, запорная арматура 16.

Раскрытие полезной модели

Основными элементами устройства являются - датчики утечки газа 3, блок управления 7 и средства аварийного отключения газа 14, обеспечивающие непосредственное выполнение основной целевой функции устройства - аварийное отключение подачи газа в подводящие газопроводы 1 здания посредством закрытия входящих в состав средств аварийного отключения газа 14 исполнительных устройств, например, быстродействующих запорных шаровых кранов (или отсечных клапанов) с электроприводом, по соответствующей команде, поступающей от блока управления 7.

Магистральные газопроводы 11 представляют собой подземные газовые магистрали низкого давления, выполненные из черных стальных газовых труб, и предназначены для подачи газа к зданиям. Для управления потоком газа, подаваемого по магистральным газопроводам 11 низкого давления, используются подземные отключающие устройства 12, например, шаровые краны в подземном исполнении, т.е. когда сам кран расположен в земле, а управление им выведено наружу. При этом подземное отключающее устройство 12 изолируются от воздействия земли и грунтовых вод, причем изоляция не должна нарушаться в течение всего срока эксплуатации, например, более десяти лет.

Подводящий газопровод 1 является элементом внутридомовой сети газоснабжения, предназначенным для подачи газа от магистрального газопровода 11 к разводящим

газопроводам 2. Подводящий газопровод 1 представляет собой трубопровод низкого давления, выполненный из черных стальных газовых труб и проложенный, как правило, в нежилых помещениях, а в месте соединения с магистральным газопроводом 11 - вне здания. Непосредственно у ввода в здание (жилой дом) подводящий газопровод 1 оборудуется отключающим устройством 13 (запорным устройством) на высоте не более 1,8 м от поверхности земли. В качестве отключающего устройства 13, установленного на подводящем газопроводе 1, может быть использована запорная арматура 16, например, в виде газового шарового крана, обеспечивающего стопроцентную надежность перекрытия потока подаваемого газа.

Разводящий газопровод 2 является элементом внутридомовой сети газоснабжения, предназначенным для подачи газа от подводящего газопровода 1 к потребителям газа 15, т.е. к газовым аппаратам и приборам, например, газовым плитам, газовым проточным водонагревателям, газовым отопительным аппаратам (котлам) и т.п. Разводящий газопровод 2 представляет собой сеть трубопроводов низкого давления, выполненных из черных стальных газовых труб и проложенных открыто в жилых помещениях, например, кухнях, ванных комнатах, подсобных (технических) помещениях и т.п. В непосредственной близости к местам подключения разводящих газопроводов 2 к потребителям газа 15 каждый из них оборудуется запорной арматурой 16, например, в виде газового шарового крана, обеспечивающего стопроцентную надежность перекрытия потока газа, подаваемого к конкретному потребителю газа 15.

Средство аварийного отключения газа 14 предназначено для быстрого перекрытия потока газа в аварийных ситуациях. Средство аварийного отключения газа 14 установлено между магистральным газопроводом 11 и подводящим газопроводом 1. Конструктивно средство аварийного отключения газа 14 может быть выполнено, например, в виде быстродействующего запорного (отсечного) шарового крана с электроприводом или нормально открытого предохранительного запорного клапана с электромагнитным управлением с электропитанием напряжением 12 В и временем срабатывания - до 1 с. Средство аварийного отключения газа 14 подключено к блоку управления 7. Управление работой средства аварийного отключения газа 14 производится посредством электрического сигнала (электрического импульса).

Датчик утечки газа 3 устанавливается в жилых помещениях, например, кухнях, ванных комнатах, подсобных (технических) помещениях, т.е. в местах установки потребителей газа 15, и предназначен для обнаружения утечек бытового, природного и сжиженного газа в закрытых помещениях. Датчик утечки газа 3 представляет собой многофункциональное устройство, обеспечивающее установление как самого факта утечки газа, так и определение степени загазованности помещения (уровня концентрации газа) с выдачей сигналов аварийной звуковой и/или световой сигнализации и трансляцией соответствующих сигналов в блок управления 7 (и, соответственно, на пульт управления 8). Датчик утечки газа 3 имеет возможность автоматического прекращения подачи сигналов тревоги при падении концентрации газа в помещении ниже установленных значений. Конструктивно датчик утечки газа 3 может быть выполнен, например, как единое интегрированное устройство с полупроводниковым датчиком, использующим электрохимический метод обнаружения газов, и вычислительным средством, выполненным как аппаратное или аппаратно-программное устройство, с монитором, рядом светодиодных индикаторов, звуковым сигналом и кнопкой (клавишей) «Вкл.-Откл.». Датчики утечки газа 3 подключены к датчиковой линии связи 5, при этом их электропитание обеспечивается от блока управления 7.

Датчиковая линия связи 5 представляет собой многожильный кабель, обеспечивающий либо непосредственное подключение датчиков утечки газа 3 к блоку управления 7, либо их соединение по системной шине.

Кнопка подачи сигнала 4 монтируется в квартире и предназначена для формирования и выдачи в блок управления 7 сигнала тревоги об утечке газа в помещении, а также голосового сообщения о возможной аварийной ситуации. Конструктивно кнопка подачи сигнала 4 может быть выполнена, например, в виде небольшого устройства, содержащего на передней панели кнопку (клавишу или тумблер), нажатие на которую (или переключение которого) обеспечивает выдачу в блок управления 7 сигнала о возможной утечке газа в помещении. При этом кнопка подачи сигнала 4 как устройство может быть оборудована средствами голосовой связи (например, микрофоном, громкоговорителем, усилителем, кнопкой «Вкл.-Выкл.» связи и др.) с пультом управления 8, работающими в режиме, например, дуплексной связи. Кроме того, кнопка подачи сигнала 4 как устройство может содержать, например, комплект расположенных в определенном порядке дополнительных функциональных кнопок (клавиш и т.п.) для выдачи сигналов аварийной звуковой и/или световой сигнализации, а также кнопку (клавишу) “Сброс”, предназначенную для отключения сигнала тревоги. Кнопки подачи сигнала 4 подключены к сигнальной линии связи 6, при этом их электропитание обеспечивается от блока управления 7.

Сигнальная линия связи 6 представляет собой многожильный кабель, обеспечивающий либо непосредственное подключение кнопок подачи сигнала 4 к блоку управления 7, либо их соединение по системной шине.

Пульт управления 8 монтируется в служебном помещении (диспетчерской, комнате дежурного и т.п.) и предназначен для информирования эксплуатирующего персонала о наличии и характере аварийной ситуации по утечке газа на внутридомовых газопроводах, а также выдачи соответствующих команд в блок управления 7 на срабатывание соответствующего средства аварийного отключения газа 14. Пульт управления 8 может представлять собой, например, вычислительное средство, выполненное как аппаратное или аппаратно-программное устройство, с монитором и клавиатурой. В качестве монитора может быть использован, например, LCD монитор или сенсорный монитор, а в качестве клавиатуры - пульт с ограниченным набором функциональных клавиш (кнопок) либо изображение на экране сенсорного монитора. Пульт управления 8 может быть дополнительно оснащен средствами аварийной звуковой и/или световой сигнализации, например, сиреной и/или светодиодами, которые могут проинформировать об утечке газа в той или иной части подводящего газопровода 1 или разводящего газопровода 2. Кроме того, пульт управления 8 может быть оборудован средствами голосовой связи (например, микрофоном, громкоговорителем, усилителем, кнопкой «Вкл.-Выкл.» связи и др.), работающими в режиме, например, дуплексной связи, для реализации режима громкоговорящей связи с конкретным абонентом кнопки подачи сигнала 4. Пульт управления 8 с помощью многожильного кабеля подключен непосредственно к блоку управления 7 либо соединен по системной шине, при этом электропитание пульта управления 8 обеспечивается от блока управления 7.

Блок управления 7 монтируется в служебном помещении (диспетчерской, комнате дежурного и т.п.). Блок управления 7 предназначен для получения и обработки сигналов от датчиков утечки газа 3, подключенных к нему с помощью датчиковой линии связи 5, получения и обработки сигналов от кнопок подачи сигнала 4, подключенных к нему с помощью сигнальной линии связи 6, выдачи (трансляции) соответствующих сигналов и голосовой информации на пульт управления 8, трансляции голосовой информации с пульта управления 8 на соответствующую кнопку подачи сигнала 4, получения и обработки команд от пульта управления 8, а также выдачи команд (управляющих сигналов) на исполнительное устройство - средство аварийного отключения газа 14, с целью его срабатывания, т.е. перекрытия подводящего газопровода 1 либо последующего его открытия. Блок управления 7

представляет собой вычислительное средство, выполненное как аппаратное или аппаратно-программное устройство, изготовленное как отдельный блок с непосредственным подключением к нему или с подключением по системной шине датчиков утечки газа 3 (по датчиковой линии связи 5), кнопок подачи сигнала 4 (по сигнальной линии связи 6) и пульта управления 8, а также средств аварийного отключения газа 14 и внутреннего источника электропитания 10.

Внутренний источник электропитания 10 предназначен для снабжения электрической энергией безопасным напряжением, например, 12 В всех элементов устройства и может представлять собой, например, источник бесперебойного питания, содержащий в своем составе аккумуляторную батарею, обеспечивающую электропитание устройства при отключении напряжения в электросети. Внутренний источник электропитания 10 подключается к промышленной однофазной электрической сети напряжением 220 В с помощью сетевого провода 9.

Осуществление полезной модели

Полезная модель реализуется следующим образом.

Датчики утечки газа 3 и кнопки подачи сигнала 4 установлены в квартирах (причем датчики утечки газа 3 в помещениях, например, кухнях, ванных комнатах, подсобных (технических) помещениях, т.е. в местах установки потребителей газа 15, а кнопки подачи сигнала 4 - в общедоступных местах) и с помощью, соответственно, датчиковой линии связи 5 и сигнальной линии связи 6 подключены к блоку управления 7. Блок управления 7, пульт управления 8 и внутренний источник электропитания 10 установлены в служебном помещении (диспетчерской, комнате дежурного и т.п.), при этом блок управления 7 и пульт управления 7 соединены между собой с помощью многожильного кабеля, а внутренний источник электропитания 10 подключен к блоку управления 7. Внутренний источник электропитания 10 с помощью сетевого провода 9 подключен к промышленной однофазной электрической сети напряжением 220 В. Функционирование датчиков утечки газа 3, кнопок подачи сигнала 4 и пульта управления 8 осуществляется как с применением напряжения 220 В от промышленной однофазной электрической сети, так и безопасного напряжения, например, 12 В, выдаваемого через блок управления 7.

Средства аварийного отключения газа 14 установлены между магистральным газопроводом 11 и подводящими газопроводами 1 непосредственно после установленных отключающих устройств 13. Электроприводы, входящие в состав средств аварийного отключения газа 14, подключены к блоку управления 7 и снабжаются от него либо напряжением 220 В, либо безопасным напряжением, например, 12 В.

При увеличении концентрации газа в помещении выше установленных значений происходит срабатывание датчика утечки газа 3 с одновременным определением величины концентрации газа в помещении, после чего соответствующий сигнал по датчиковой линии связи 5 передается в блок управления 7. Одновременно информация о зафиксированной величине концентрации газа выдается на монитор датчика утечки газа 3 и дублируется включением соответствующего светодиодного индикатора и звуковой сигнализации. Так как в блоке управления 7 все датчики утечки газа 3 строго идентифицированы по месту их установки, то после получения сигнала блок управления 7 локализует место возможной утечки газа, диагностирует характер (степень) аварийности и квалифицирует аварийную ситуацию.

В случае получения сигнала от какой-либо из кнопок подачи сигнала 4, строго идентифицированных в блоке управления 7 по месту их установки, блок управления 7 локализует место возможной утечки газа и квалифицирует ситуацию как аварийную с формированием команды на открытие голосовой связи между пультом управления 8 и сработавшей кнопкой подачи сигнала 4.

Блок управления 7 может функционировать в двух режимах - информационном и автоматическом.

При работе в информационном режиме блок управления 7 после квалификации аварийной ситуации формирует и передает на пульт управления 8 информационный сигнал, содержащий данные о месте и характере аварии (утечке газа), после чего сам блок управления 7 переходит в режим ожидания команды от пульта управления 8. После получения информационного сигнала от блока управления 7 на монитор пульта управления 8 производится вывод полученной информации об аварии (утечке газа) и включается (при необходимости) аварийная звуковая и/или световая сигнализация. Нажатием соответствующей кнопки (клавиши) на пульте управления 8 дежурный оператор (или иное ответственное должностное лицо) передает в блок управления 7 команду, которая исполняется им путем подачи сигнала (электрического импульса, например, напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14. После этого блок управления 7 блокирует повторную выдачу сигнала на сработавшее средство аварийного отключения газа 14 (т.е. блокирует повторные сигналы нажатия соответствующей аварийной кнопки на пульте управления 8 в отношении сработавшего средства аварийного отключения газа 14) до получения соответствующей команды на его открытие от пульта управления 8 или команды «Сброс аварии» от пульта управления 8 (в случае «ручного» открытия средства аварийного отключения газа 14).

При работе в автоматическом режиме блок управления 7 после квалификации аварийной ситуации формирует и передает на пульт управления 8 информационный сигнал, содержащий данные о месте и характере аварии (утечке газа). После получения информационного сигнала от блока управления 7 на монитор пульта управления 8 производится вывод полученной информации об аварии и включается (при необходимости) аварийная звуковая и/или световая сигнализация. Если аварийная ситуация квалифицирована блоком управления 7 как незначительная или допустимая (исходя из допустимого уровня концентрации газа в помещении), то блок управления 7 переходит в штатный режим ожидания сигналов (о снижении или повышении уровня концентрации газа) от датчиков утечки газа 3 или команды от пульта управления 8. Если же аварийная ситуация квалифицирована блоком управления 7 как недопустимая (исходя из превышения допустимого уровня концентрации газа в помещении), то блок управления 7 выдает сигнал (например, электрический импульс напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14, при срабатывании которого происходит перекрытие подачи газа в подводящий газопровод 1. Так как средство аварийного отключения газа 14 переводится из состояния «открыто» в состояние «закрыто» и из состояния «закрыто» в состояние «открыто» путем подачи сигнала (например, электрического импульса напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14 (при этом процесс открытия или закрытия, например, газового шарового крана завершается срабатыванием одного из концевых выключателей, входящих в состав его электропривода), то блок управления 7 блокирует повторную подачу сигнала на сработавшее средство аварийного отключения газа 14 до получения соответствующей команды на его открытие от пульта управления 8 или команды «Сброс аварии» от пульта управления 8 (в случае «ручного» открытия средства аварийного отключения газа 14).

После ликвидации аварии дежурный оператор (или иное ответственное должностное лицо) посредством нажатия соответствующей кнопки (клавиши), например, на открытие средства аварийного отключения газа 14, на пульте управления 8 передает в блок управления 7 команду, которая исполняется им путем

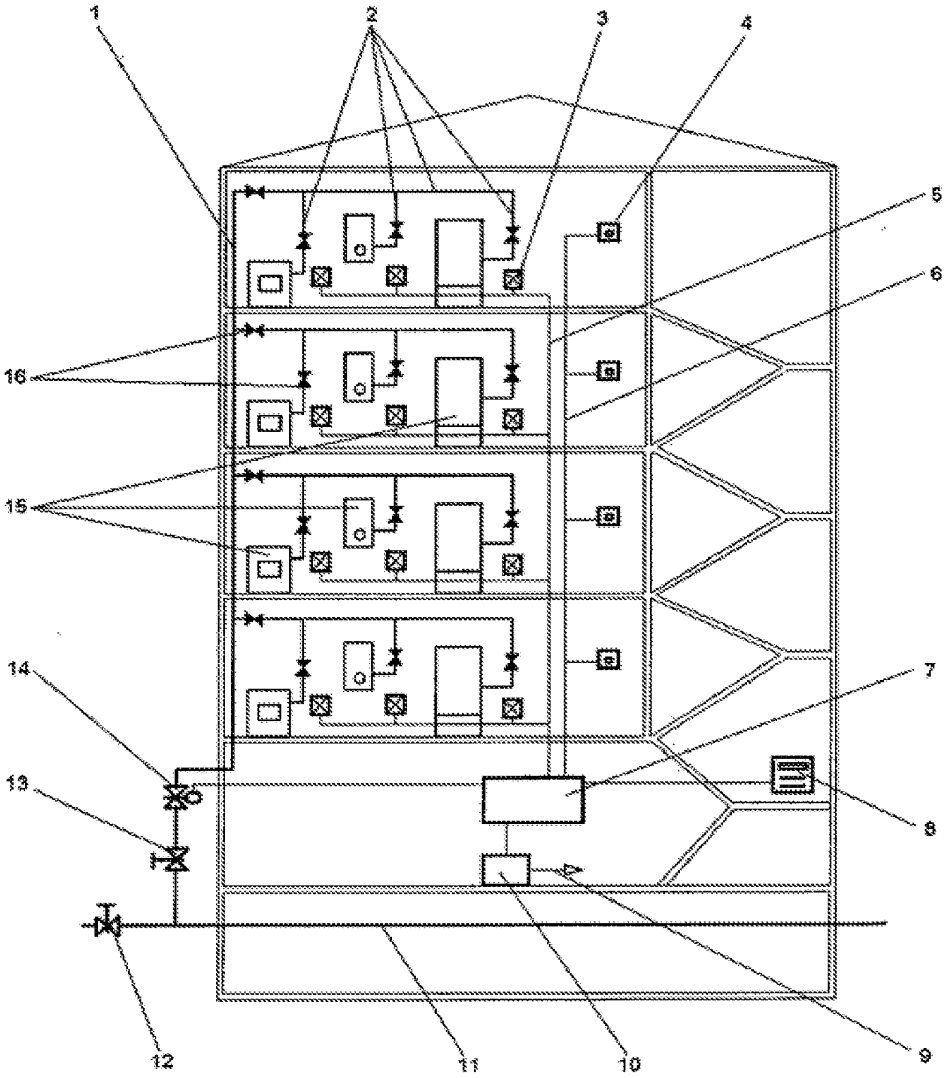
подачи сигнала (например, электрического импульса напряжением 220 В или 12 В) на электропривод соответствующего средства аварийного отключения газа 14, в результате чего происходит открытие ранее закрытого средства аварийного отключения газа 14, а блок управления 8 переходит в штатный режим ожидания сигналов от датчиков утечки газа 3. В случае «ручного» открытия после ликвидации аварии ранее закрытого средства аварийного отключения газа 14 дежурный оператор (или иное ответственное должностное лицо) посредством нажатия соответствующей кнопки (клавиши), например, «Сброс аварии», на пульте управления 8 передает в блок управления 7 команду, по которой блок управления 7 переходит в штатный режим ожидания сигналов от датчиков утечки газа 3.

Таким образом, в предлагаемом устройстве реализована двухканальная система контроля утечки газа, основанная на системе датчиков утечки газа 3 и сигнальной линии связи 6, объединяющей кнопки подачи сигнала 4, с установкой в подводящих газопроводах 1 здания средств аварийного отключения газа 14 с дистанционным управлением их электроприводами, что позволяет обеспечить оперативное и своевременное отключение подачи газа и, тем самым, минимизировать ущерб от возможного взрыва и возгорания помещения (дома) и, как следствие, - спасение жизни жильцов.

Формула полезной модели

Система газоснабжения многоэтажного дома, содержащая магистральный газопровод, подземное отключающее устройство, отключающее устройство, средство аварийного отключения газа, подводящий газопровод, разводящие газопроводы, запорную арматуру, потребителей газа, датчики утечки газа, кнопки подачи сигнала, датчиковую линию связи, сигнальную линию связи, блок управления, пульт управления, причем магистральный газопровод соединен с подводящим газопроводом последовательно через отключающее устройство и средство аварийного отключения газа, разводящие газопроводы соединены с подводящим газопроводом через запорную арматуру, потребители газа соединены с разводящими газопроводами через соответствующую запорную арматуру, потребители газа установлены на каждом эксплуатируемом этаже многоэтажного дома, датчики утечки газа установлены на каждом эксплуатируемом этаже в зоне установки потребителей газа, кнопки подачи сигнала установлены на каждом эксплуатируемом этаже, блок управления своим входом соединен с пультом управления, датчики утечки газа и кнопки подачи сигнала соединены со входами блока управления посредством датчиковой линии связи и сигнальной линии связи соответственно, блок управления

своим выходом соединен со средством аварийного отключения газа.



Espacenet

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TEST EQUIPMENT FOR TESTING AIRCRAFT ADDITIONAL CENTER TANK SYSTEM

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Abstract of RU2452668 (C2)

FIELD: physics. ^ SUBSTANCE: invention relates to test equipment for testing aircraft additional centre tank (ACT) system. The test equipment comprises at least one of the following test modules: a first test module and a second test module. The first test module can be connected to the ACT system in place of part of control apparatus which performs an auxiliary fuel management computer (AFMC) function. The first test module has apparatus for generating one or more test signals imitating one or more ACT valve control instructions. The second test module can be connected to the ACT system in place of the control apparatus which performs an auxiliary level sensing control unit (ALSCU) function, while the other part of the control apparatus which performs the AFMC function remains in place in the ACT system. The second test module has apparatus for generating one or more test signals imitating one or more fuel level readings in the ACT. ^ EFFECT: high efficiency of testing characteristics of an aircraft ACT system. ^ 15 cl, 3 dwg

РОССИЙСКАЯ ФЕДЕРАЦИЯ



ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ

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RU 2452668 C2

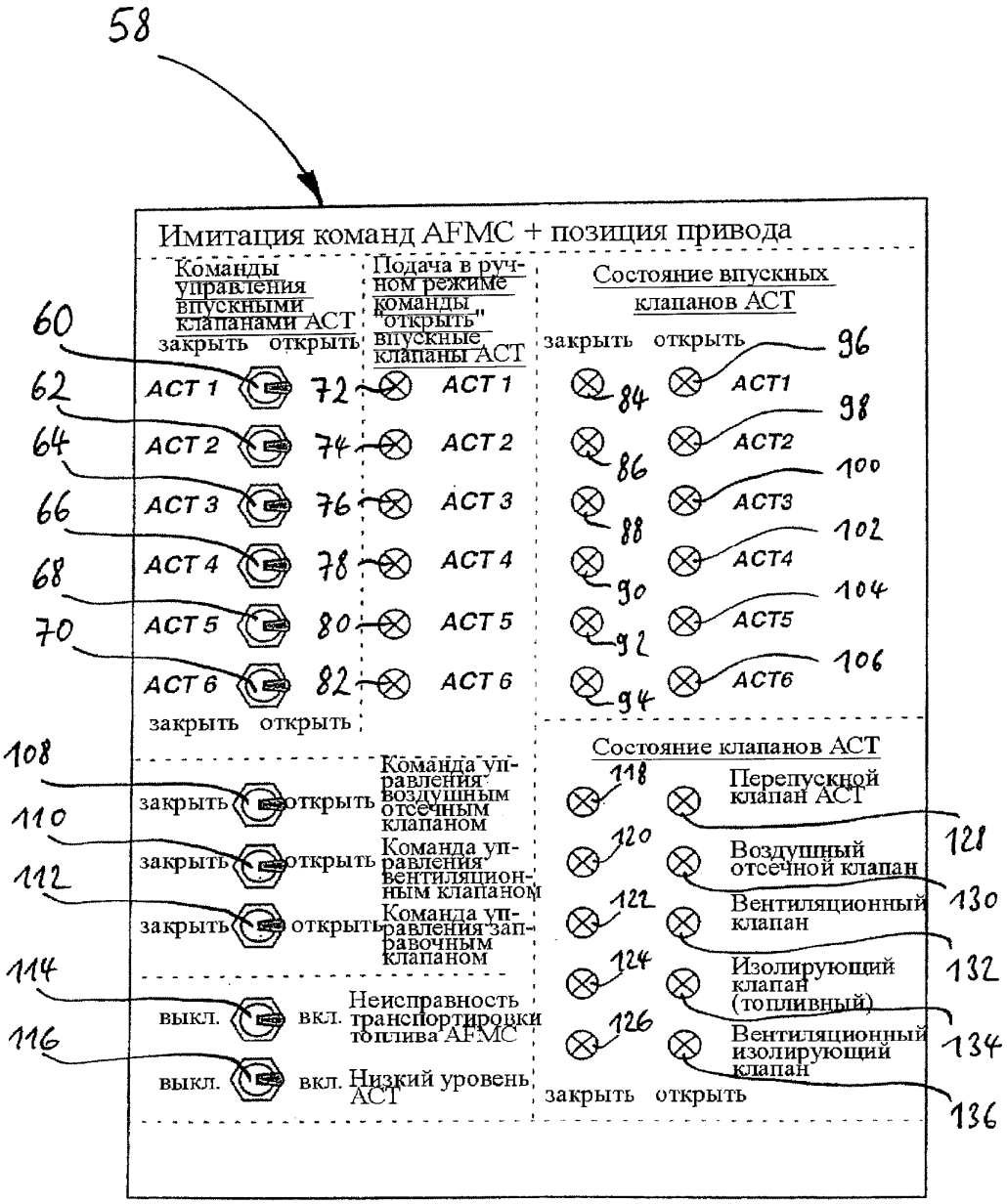
RU 2452668 C2

(54) ИСПЫТАТЕЛЬНОЕ УСТРОЙСТВО ДЛЯ ТЕСТИРОВАНИЯ СИСТЕМЫ ДОПОЛНИТЕЛЬНЫХ ЦЕНТРАЛЬНЫХ ТОПЛИВНЫХ БАКОВ ВОЗДУШНОГО СУДНА

(57) Реферат:

Изобретение относится к испытательным устройствам для тестирования системы дополнительных центральных топливных баков (системы ACT) воздушного судна. Испытательное устройство содержит по меньшей мере один из следующих испытательных модулей: первый испытательный модуль и второй испытательный модуль. Первый испытательный модуль выполнен с возможностью подключения к системе ACT вместо части средства управления, выполняющей функции AFMC (вспомогательного вычислительного устройства регулирования расхода топлива). При этом первый испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одну или более команд управления клапанами ACT. Второй испытательный модуль выполнен с возможностью подключения к системе ACT вместо части средства управления, выполняющей функции ALSCU (вспомогательного управляющего устройства измерения уровня топлива), в то время как другая часть средства управления, выполняющая функции AFMC, остается на месте в системе ACT. Второй испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одно или более показаний

уровня топлива в АСТ. Достигается повышение эффективности тестирования характеристик системы АСТ воздушного судна. 14 з.п. ф-лы, 3 ил.



ФИГ. 2

RU 2452668 C2

RU 2452668 C2

FAS 2004 - Page 311

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RU 2452668 C2

(54) TEST EQUIPMENT FOR TESTING AIRCRAFT ADDITIONAL CENTER TANK SYSTEM

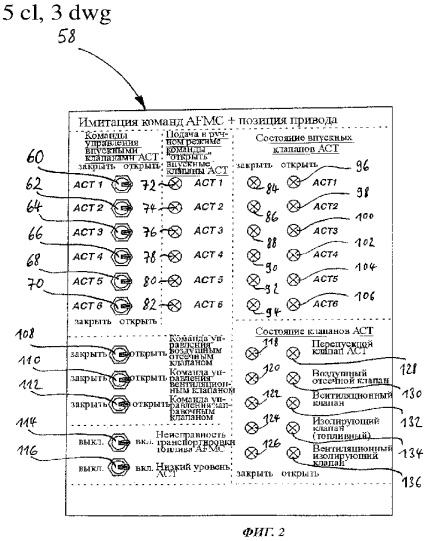
(57) Abstract:

FIELD: physics.

SUBSTANCE: invention relates to test equipment for testing aircraft additional centre tank (ACT) system. The test equipment comprises at least one of the following test modules: a first test module and a second test module. The first test module can be connected to the ACT system in place of part of control apparatus which performs an auxiliary fuel management computer (AFMC) function. The first test module has apparatus for generating one or more test signals imitating one or more ACT valve control instructions. The second test module can be connected to the ACT system in place of the control apparatus which performs an auxiliary level sensing control unit (ALSCU) function, while the other part of the control apparatus which performs the AFMC function remains in place in the ACT system. The second test module has apparatus for generating one or more test signals imitating one or more fuel level readings in the ACT.

EFFECT: high efficiency of testing characteristics of an aircraft ACT system.

15 cl, 3 dwg



ФИГ. 2

RU 2452668 C2

FAS 2004 - Page 312

Область техники, к которой относится изобретение

Настоящее изобретение относится к испытательному устройству для тестирования системы дополнительных центральных топливных баков (additional center tank, ACT) воздушного судна.

Уровень техники

Современные грузовые и пассажирские воздушные суда кроме системы основных топливных баков могут быть снабжены системой дополнительных центральных топливных баков (ACT). Система ACT может включать в себя один или более дополнительных центральных топливных баков, все они располагаются в фюзеляже воздушного судна. Так, например, модель воздушного судна Airbus™ A319CJ может содержать до шести дополнительных центральных топливных баков. Система основных топливных баков обычно содержит один или более топливных баков в каждом крыле и один центральный топливный бак в фюзеляже воздушного судна.

Система ACT включает множество клапанов, необходимых для подачи топлива в ACT, из ACT и между ACT (во время заправки и слива топлива, а также при перекачке топлива во время полета), а также для вентиляции ACT. Примерами таких клапанов являются впускной клапан топлива для каждого дополнительного центрального топливного бака, один или более перепускных клапанов для подачи топлива в дополнительные центральные топливные баки из системы основных топливных баков, один или более заправочных клапанов для заправки дополнительных центральных топливных баков на земле, один или более отсечных воздушных клапанов для регулирования потока сжатого воздуха, подаваемого в дополнительные центральные топливные баки и т.п. Специалистам в данной области техники, как правило, известны конструкция и функционирование систем ACT воздушного судна, в частности, в серии моделей Airbus™.

Управление подачей топлива системы ACT можно обеспечить средствами управления, общими для системы основных топливных баков и системы ACT, однако известны воздушные суда, в которых для выполнения этой задачи предусмотрены отдельные средства управления. Одной из этих моделей является вышеуказанная модель Airbus™ A319CJ. Отдельные средства управления системой ACT могут содержать вспомогательное вычислительное устройство регулирования расхода топлива (Auxiliary Fuel Management Computer, AFMC), работающее вместе со вспомогательным управляющим устройством измерения уровня топлива (Auxiliary Level Sensing Control Unit, ALSCU) при помощи релейной системы. AFMC управляет, помимо прочего, автоматической транспортировкой топлива из ACT в основной центральный топливный бак и обратно, а также между ACT таким образом, чтобы сбалансировать воздушное судно при транспортировке топлива и обеспечить сохранение центра тяжести воздушного судна в определенных границах.

Датчики уровня, связанные с ACT, определяют наличие или отсутствие топлива на различных уровнях в топливных баках. Система определения уровня топлива в баках может содержать, в частности, датчик высокого уровня в каждом ACT для определения наличия топлива на высоком уровне и окончания заправки топливом соответствующего топливного бака. Она может также содержать датчики низкого уровня для определения наличия топлива на низком уровне в топливном баке. ALSCU обрабатывает результаты определения уровней топлива в топливных баках и производит сравнение мокрого состояния датчиков нижнего уровня для того, чтобы контролировать исправность транспортировки топлива ACT и в случае необходимости подавать предупредительный сигнал в кабине экипажа. В

FAS 2004 - Page 313

соответствии с этим датчики уровня ACT и ALSCU участвуют в контроле транспортировки топлива ACT.

ALSCU может также содержать логический блок, который позволяет определить повреждение вентиляционных и заправочных/транспортировочных трубопроводов ACT и их последующую изоляцию.

Кроме того, AFMC получает данные о количестве топлива и другую информацию, связанную с системой основных топливных баков, от вычислительного устройства индикации количества топлива (Fuel Quantity Indicating Computer, FQIC). AFMC использует информацию, полученную от ALSCU и FQIC, для расчета количества топлива в ACT и на всем воздушном судне для вывода результата на электронный центральный монитор воздушного судна (Electronic Centralized Aircraft Monitor, ECAM), расположенный в кабине экипажа, или другим потребителям, а также для управления автоматической заправкой ATC.

AFMC и ALSCU могут представлять собой отдельные блоки, подключаемые к специальным штекерным интерфейсным разъемам системы ACT. Альтернативно AFMC и ALSCU могут быть объединены в один блок управления.

Испытания перед поставкой, а также наземные испытания при проведении планового технического обслуживания требуют, помимо прочего, проверки правильности функционирования клапанов ACT, и/или AFMC, и/или ALSCU, т.е. правильной реакции соответствующих компонентов на определенные условия и/или определенные команды. Такие команды могут включать команды управления клапанами, вручную подаваемые из кабины экипажа воздушного судна. Так, например, в ответ на команду срабатывания впускного клапана должен вырабатываться соответствующий сигнал, который заставляет определенное индикаторное средство, расположенное, например, в кабине экипажа, отображать, что ручная команда срабатывания клапана подана на клапан ACT. Затем каждый раз при подаче команды на срабатывание клапана необходимо проверять действительное срабатывание соответствующего клапана согласно команде на его срабатывание. И, наконец, необходимо проверять, занимают ли клапаны ACT предварительно определенные позиции после обнаружения неисправности системы ACT (например, неисправность транспортировки топлива ACT или низкий уровень топлива в ACT).

Раскрытие изобретения

В соответствии с вышесказанным задача настоящего изобретения состоит в том, чтобы обеспечить испытательное устройство, которое позволяет просто и эффективно тестировать по меньшей мере определенные характеристики системы ACT воздушного судна.

Для решения этой задачи настоящее изобретение предусматривает испытательное устройство для тестирования системы ACT воздушного судна, при этом система ACT содержит средство управления, сконфигурированное с возможностью выполнения функций вспомогательного вычислительного устройства регулирования расхода топлива (AFMC) и вспомогательного управляющего устройства измерения уровня топлива (ALSCU), содержащее по меньшей мере один испытательный модуль, выполненный с возможностью подключения к системе ACT вместо по меньшей мере части средства управления, при этом указанный испытательный модуль содержит средство генерирования одного или более тестовых сигналов и подачи тестовых сигналов в систему ACT.

Испытательный модуль предпочтительно содержит переключатель, предназначенный для включения и выключения одного или более тестовых сигналов.

FAS 2004 - Page 314

Такой переключатель может иметь ручное управление. Дополнительно или альтернативно испытательное устройство может содержать тестовую программу, предназначенную для выполнения процессором, при этом тестовая программа сконфигурирована таким образом, чтобы генерировать один или более предварительно определенных тестовых сигналов или одну или более последовательностей предварительно определенных тестовых сигналов, выводимых испытательным модулем.

В простом варианте осуществления тестовые сигналы могут представлять собой сигналы с высоким или низким электрическим потенциалом, при этом низкий уровень соответствует нулевому потенциалу, а высокий уровень соответствует положительному или отрицательному потенциалу, отличному от нулевого потенциала. Высокий потенциал может соответствовать, в частности, номинальному напряжению бортовой системы электропитания воздушного судна, и испытательный модуль может получать сигналы с высоким потенциалом от бортовой системы электропитания. Разумеется, испытательное устройство может также содержать свой собственный источник электрического напряжения, независимый от бортовой системы электропитания.

В одном варианте осуществления испытательное устройство содержит первый испытательный модуль, выполненный с возможностью подключения к системе ACT вместо части средства управления, выполняющего функции AFMC, при этом первый испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одну или более команд управления клапанами ACT. Этот вариант может быть полезным для тестирования правильности функционирования различных клапанов ACT.

Указанные одна или более команд управления клапанами ACT могут содержать, в частности:

- команду управления впускным клапаном ACT, которая относится к впускному клапану ACT или к каждому из впускных клапанов ACT, и/или
- команду управления воздушным отсечным клапаном ACT; и/или
- команду управления вентиляционным клапаном ACT; и/или
- команду управления заправочным клапаном ACT.

Первый испытательный модуль может также содержать средство генерирования одного или более тестовых сигналов, имитирующих по меньшей мере одно предварительно установленное состояние AFMC неисправности транспортировки топлива, управляемой, и предварительно установленное состояние AFMC низкого уровня топлива.

Первый испытательный модуль может также содержать средство для приема одного или более сигналов состояния клапанов ACT, представляющих открытое и закрытое состояние одного или более клапанов ACT, при этом первый испытательный модуль содержит также первое средство индикации, предназначенное для визуального отображения состояний одного или более клапанов ACT.

Первое средство индикации может быть сконфигурировано с возможностью отображения, в частности:

- состояния впускного клапана ACT, которое относится к впускному клапану ACT или к каждому из впускных клапанов ACT; и/или
- состояния воздушного отсечного клапана ACT; и/или
- состояния вентиляционного клапана ACT; и/или
- состояния топливного изолирующего клапана ACT; и/или

- состояния перепускного клапана ACT; и/или
- состояния вентиляционного изолирующего клапана ACT.

Первое средство индикации предпочтительно содержит по два светоизлучающих диода для клапана ACT или для каждого из клапанов ACT, при этом один светоизлучающий диод во включенном состоянии отображает открытую позицию клапана, а другой светоизлучающий диод во включенном состоянии отображает закрытую позицию клапана. Один светоизлучающий диод может быть, например, зеленым, а другой - красным.

Первый испытательный модуль может содержать также второе средство индикации, предназначенное для отображения генерирования одной или более команд для клапанов ACT, подаваемых в ручном режиме при помощи одного или более элементов управления клапанами, предусмотренных в кабине экипажа воздушного судна.

В другом варианте осуществления испытательное устройство содержит второй испытательный модуль, выполненный с возможностью подключения к системе ACT вместо части средства управления, выполняющей функции ALSCU, в то время как другая часть средства управления, выполняющая функции AFMC, остается на месте в системе ACT, при этом второй испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одно или более показаний уровня топлива в ACT. Этот вариант осуществления является полезным, в частности, для тестирования правильности функционирования блока AFMC средства управления.

Второй испытательный модуль может содержать, в частности, двухпозиционный переключатель для дополнительного центрального топливного бака, или для каждого из дополнительных центральных топливных баков, для генерирования одного или более тестовых сигналов, имитирующих мокрое и сухое состояния топливных баков.

Второй испытательный модуль может также содержать средство генерирования одного или более тестовых сигналов, имитирующих:

- команду управления клапаном для запуска первого серводвигателя топливного изолирующего клапана; и/или
- команду управления клапаном для запуска второго серводвигателя топливного изолирующего клапана; и/или
- команду управления клапаном для запуска первого серводвигателя вентиляционного изолирующего клапана; и/или
- команду управления клапаном для запуска второго серводвигателя вентиляционного изолирующего клапана.

Учитывая вышесказанное, следует понимать, что по меньшей мере некоторые из множества клапанов, обычно установленных в системе ACT, могут быть снабжены двумя независимыми сервоприводами (серводвигателями) для того, чтобы обеспечить резервирование. Исключение может представлять заправочный клапан, который часто оснащают только одним сервоприводом.

Второй испытательный модуль может также содержать средство генерирования одного или более тестовых сигналов, имитирующих:

- показание повреждения трубопровода; и/или
- команду замыкания цепи подачи предупредительного сигнала; и/или
- предварительно определенное неисправное состояние транспортировки топлива ACT.

Второй испытательный модуль может также содержать средство индикации,

FAS 2004 - Page 316

которое показывает, является ли замкнутой цепь подачи предупредительного сигнала и/или исправен ли источник аварийного электропитания воздушного судна.

Краткое описание чертежей

Далее приведено более подробное описание настоящего изобретения со ссылками на прилагаемые чертежи, на которых представлены:

Фигура 1 - схематический вид сверху системы дополнительных центральных топливных баков воздушного судна,

Фигура 2 - передняя панель испытательного модуля для имитации команд управления клапанами ACT, и

Фигура 3 - передняя панель испытательного модуля для имитации сигналов ALSCU.

Осуществление изобретения

На фигуре 1 показан схематический вид сверху общего расположения системы топливных баков коммерческого пассажирского или грузового воздушного судна согласно одному из примеров осуществления изобретения. Система топливных баков включает систему основных топливных баков и систему дополнительных центральных топливных баков (систему ACT). Система ACT в целом обозначена на чертеже ссылочным номером 10. Система основных топливных баков содержит левый крыльевой топливный бак 12, правый крыльевой топливный бак 14 и центральный топливный бак 15.

В примере осуществления, показанном на чертеже, воздушное судно оснащено шестью ACT, которые обозначены ссылочными номерами 16, 18, 20, 22, 24 и 26. ACT 16-26 расположены в грузовом отсеке фюзеляжа воздушного судна и соединены друг с другом при помощи топливопровода 28. Кроме того, они соединены с основными крыльевыми топливными баками 12, 14 и центральным топливным баком 15 при помощи топливопровода 30. Топливопровод 30 представляет собой основную магистраль заправки/слива топлива.

Каждый из дополнительных центральных топливных баков (ACT) 16-26 снабжен топливным впускным клапаном 32, 34, 36, 38, 40, 42, соответственно.

Заправочный клапан 44 позволяет производить заправку топливом системы ACT. Во время заправки топливом заправочный клапан 44 устанавливается в открытую позицию и закрывается на все остальное время.

Насос 46 перекачки топлива и перепускной клапан 48 системы ACT образуют механизм перекачивания топлива между системой основных топливных баков и системой 10 ACT. Такое перекачивание топлива производится не только во время заправки топливом, но также и во время полета, когда топливо, загруженное на борт воздушного судна, постепенно сжигается, начиная с топлива ACT. Для этой цели топливо ACT может перекачиваться по топливопроводу 30 в основной центральный топливный бак 15, при этом последовательно опорожняется один ACT за другим.

Для того чтобы обеспечить вентилирование системы ACT, предусмотрен вентиляционный трубопровод 50, соединенный со всеми дополнительными центральными топливными баками 16-26 и с вентиляционным трубопроводом 52 центрального топливного бака. Вентиляционные клапаны, не показанные на фигуре 1, позволяют проводить селективное вентилирование дополнительных центральных топливных баков 16-26.

После удаления топлива из дополнительных центральных топливных баков 16-26 в них подают сжатый воздух, чтобы предотвратить образование потенциально взрывоопасной газообразной смеси в указанных дополнительных центральных топливных баках. Сжатый воздух подают через воздушный отсечной клапан 54,

FAS 2004 - Page 317

установленный в трубопроводе 56 наддува воздуха, в дополнительные центральные топливные баки 16 и 22. Поскольку все АСТ 16-26 гидравлически соединены друг с другом при помощи вентиляционного трубопровода 50, сжатый воздух, подаваемый в АСТ 16 и 22, поступает также в остальные АСТ 18, 20, 24 и 26.

Управление системой АСТ 10 осуществляет вспомогательное вычислительное устройство регулирования расхода топлива (Auxiliary Fuel Management Computer, AFMC), работающее вместе со вспомогательным управляющим устройством измерения уровня топлива (Auxiliary Level Sensing Control Unit, ALSCU), которые не показаны на чертежах. Перед поставкой нового воздушного судна заказчику, а также при проведении регулярного технического обслуживания необходимо проводить тестирование всей системы АСТ, включая ее клапаны и AFMC, для того чтобы убедиться в правильности функционирования системы.

На фиг.2 показан неограничительный пример осуществления передней панели 58 испытательного модуля, предназначенного для имитации команд управления клапанами АСТ. Указанный испытательный модуль заменяет AFMC. Иными словами, для применения указанного испытательного модуля необходимо предварительно отключить AFMC от системы 10 АСТ. Затем испытательный модуль следует подключить к системе 10 АСТ, используя то же самое электрическое соединительное средство интерфейса, которым подключают AFMC.

В левой верхней части передней панели 58, показанной на Фиг.2, расположен вертикальный ряд из шести двухпозиционных переключателей (вкл./выкл.) 60, 62, 64, 66, 68, 70 с ручным управлением. Из них переключатель 60 предназначен для имитации команды управления впускным клапаном 32, связанным с АСТ 16, переключатель 62 предназначен для имитации команды управления впускным клапаном 34, связанным с АСТ 18, и т.д. Включение переключателей 60-70 путем перемещения их перекидных рычагов в правую позицию, как показано на Фиг.2, соответствует имитации команды "открыть", т.е. команды, которая заставляет открываться впускные клапаны АСТ. С другой стороны, перемещение перекидных рычагов влево на фиг.2 соответствует имитации команды "закрыть" для впускных клапанов АСТ.

Справа от переключателей 60-70 на передней панели 58 расположен вертикальный ряд светоизлучающих диодов 72-82, которые показывают, подана ли в ручном режиме команда впускным клапанам АСТ "открыть" с панели команд управления клапанами (не показана), установленной в кабине экипажа воздушного судна. Таким образом, для оператора, проводящего испытания, имеется два варианта тестирования впускных клапанов АСТ: один - путем имитации команд управления клапанами при помощи переключателей 60-70 испытательного устройства, показанных на фиг.2, и другой - при помощи панели команд управления клапанами из кабины экипажа воздушного судна. Команды управления впускными клапанами, которые генерируются с панели команд управления клапанами в кабине экипажа, поступают в испытательный модуль через вышеуказанное соединительное средство интерфейса системы 10 АСТ.

Для того чтобы простым образом проверить, приводит ли команда управления впускными клапанами АСТ (подаваемая с испытательного устройства или с панели команд из кабины экипажа) к занятию соответствующим впускным клапаном АСТ желаемой позиции, справа от ряда светоизлучающих диодов 72-82 предусмотрено два вертикальных ряда светоизлучающих диодов. Эти два вертикальных ряда отображают открытое и закрытое положение впускных клапанов 32-42. Первый ряд светоизлучающих диодов 84-94 состоит из шести красных светоизлучающих диодов, которые во включенном состоянии указывают, что соответствующие впускные

FAS 2004 - Page 318

клапаны находятся в закрытой позиции. Второй ряд светоизлучающих диодов 96-106 состоит из шести зеленых светоизлучающих диодов, которые во включенном состоянии указывают, что соответствующие впускные клапаны находятся в открытой позиции.

Ниже ряда переключателей 60-70 в вертикальном ряду расположена еще одна группа из пяти двухпозиционных переключателей (вкл./выкл.) 108-116 с ручным управлением. Их можно использовать для имитации команды управления воздушным отсечным клапаном (переключатель 108), команды управления вентиляционным клапаном (переключатель 110), команды управления заправочным клапаном (переключатель 112), состояния неисправности транспортировки топлива AFMC (переключатель 114) и состояния низкого уровня топлива в ACT (переключатель 116). В то время как переключатели 108 и 112 функционируют таким же образом, как переключатели 60-70, переключатель 110 является реверсированным, т.е. команда "открыть" соответствует левой позиции перекидного рычага переключателя, а команда "закрыть" соответствует правой позиции перекидного рычага переключателя.

Справа от переключателей 108-116 на передней панели 58 расположены еще два вертикальных ряда светоизлучающих диодов, которые аналогичным образом, как описано выше для светоизлучающих диодов 72-82 и светоизлучающих диодов 84-94, отображают позиции перепускного клапана 48, воздушного отсечного клапана 54, вентиляционного клапана, топливного изолирующего клапана и вентиляционного изолирующего клапана.

В случае имитации состояния AFMC неисправности транспортировки топлива (которое может быть вызвано, например, неисправностью насоса 46 перекачки топлива и/или перепускного клапана 48) путем установки переключателя 114 в его правую позицию по меньшей мере часть клапанов ACT, указанных на передней панели 58, должна быть автоматически переведена в определенные предварительно установленные позиции. В зависимости от того, какие из различных светодиодов на передней панели 58 будут освещены, можно проверить, действительно ли соответствующие клапаны находятся в указанных предварительно установленных позициях.

На фиг.3 показан неограничительный пример осуществления передней панели 138 испытательного модуля, выполненного с возможностью имитации сигналов ALSCU. Этот испытательный блок заменяет ALSCU. Иными словами, для использования указанного испытательного блока необходимо вначале отключить ALSCU от системы 10 ACT. Затем испытательный блок следует подключить к системе 10 ACT, используя то же самое электрическое соединительное средство интерфейса, посредством которого подключают ALSCU.

В верхней части передней панели 138 расположен светоизлучающий диод 140, который во включенном состоянии указывает на то, что аварийный блок электропитания, который подает предварительно установленное напряжение на испытательное устройство, функционирует нормально. Аварийный блок электропитания (не показан) содержит реле времени, которое можно установить на предварительно определенное время, например на 20 секунд. Если реле времени функционирует исправно, светоизлучающий диод 140 должен включиться на 20 секунд, а затем выключиться.

Далее, под светодиодами 142, 144 расположен горизонтальный ряд переключателей 146-156, управляемых в ручном режиме, которые служат для имитации предварительно установленных сигналов индикации уровня топлива для

FAS 2004 - Page 319

каждого ACT. Переключатели 146-156 являются двухпозиционными (вкл./выкл.) и имитируют состояние "мокрого" и "сухого" уровня. При помощи переключателей 146-156 можно проверять, правильно ли функционирует, т.е., вызывает ли предварительно определенную реакцию, блок AFMC, который остается на месте в системе ACT во время использования испытательного модуля, заменяющего блок ALSCU. Так, например, может требоваться, чтобы блок AFMC обеспечивал визуальную индикацию уровней топлива на панели дисплея в кабине экипажа.

Под горизонтальным рядом переключателей на передней панели 138 расположен вертикальный ряд двухпозиционных (вкл./выкл.) переключателей 158-170. Переключатель 158 в положении "on" (вкл.) имитирует подачу команды срабатывания на первый серводвигатель изолирующего клапана, расположенного в топливопроводе. Переключатель 160 в положении "on" имитирует подачу команды срабатывания на первый серводвигатель вентиляционного клапана. Переключатель 162 в положении "on" имитирует подачу команды срабатывания на второй серводвигатель топливного изолирующего клапана, а переключатель 164 можно использовать для имитации команды срабатывания второго серводвигателя вентиляционного клапана. При этом можно проверить, обеспечивает ли блок AFMC соответствующую индикацию на дисплее в кабине экипажа, и занимают ли определенные клапаны позицию, соответствующую команде срабатывания.

Переключатель 166 в положении "on" имитирует повреждение вентиляционного трубопровода. При этом можно проверить, обеспечивает ли блок AFMC соответствующую индикацию на дисплее в кабине экипажа. Переключатель 168 в положении "on" имитирует выходной сигнал ALSCU, соответствующий, например, повреждению насоса 46 перекачки топлива. При этом также можно проверить, обеспечивает ли блок AFMC соответствующую индикацию на дисплее в кабине экипажа.

И, наконец, переключатель 170 в положении "on" имитирует команду замыкания цепи подачи предупредительного сигнала обнаружения повреждения вентиляционного трубопровода. Светоизлучающий диод 172, установленный справа от переключателя 170, включается, если цепь подачи предупредительного сигнала успешно замкнута.

Формула изобретения

1. Испытательное устройство для тестирования системы дополнительных центральных топливных баков (системы ACT) воздушного судна, при этом система ACT содержит средство управления, сконфигурированное с возможностью выполнения функций вспомогательного вычислительного устройства регулирования расхода топлива (AFMC) и вспомогательного управляющего устройства измерения уровня топлива (ALSCU), содержащее по меньшей мере один испытательный модуль, выполненный с возможностью подключения к системе ACT вместо по меньшей мере части средства управления, при этом указанный по меньшей мере один испытательный модуль содержит средство генерирования одного или более тестовых сигналов и подачи тестовых сигналов в систему ACT, а также включает в себя по меньшей мере один из следующих испытательных модулей: первый испытательный модуль, выполненный с возможностью подключения к системе ACT вместо части средства управления, выполняющей функции AFMC, при этом первый испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одну или более команд управления клапанами ACT, и второй

FAS 2004 - Page 320

испытательный модуль, выполненный с возможностью подключения к системе АСТ вместо части средства управления, выполняющей функции ALSCU, в то время как другая часть средства управления, выполняющая функции AFMC, остается на месте в системе АСТ, при этом второй испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих одно или более показаний уровня топлива в АСТ.

2. Испытательное устройство по п.1, отличающееся тем, что по меньшей мере один из первого и второго испытательных модулей содержит средства переключения для включения и выключения одного или более тестовых сигналов.

3. Испытательное устройство по п.2, отличающееся тем, что средства переключения имеют ручное управление.

4. Испытательное устройство по п.1, отличающееся тем, что одна или более имитированных команд управления клапанами АСТ содержит: команду управления впускным клапаном АСТ, которая относится к впускному клапану АСТ или к каждому из впускных клапанов АСТ; и/или команду управления воздушным отсечным клапаном АСТ; и/или команду управления вентиляционным клапаном АСТ; и/или команду управления заправочным клапаном АСТ.

5. Испытательное устройство по п.1, отличающееся тем, что первый испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих по меньшей мере одно из следующих состояний: предварительно определенное состояние AFMC неисправности транспортировки топлива и предварительно определенное состояние AFMC низкого уровня топлива.

6. Испытательное устройство по п.1, отличающееся тем, что первый испытательный модуль содержит средство для приема сигналов состояния одного или более клапанов АСТ, представляющих открытое и закрытое состояние одного или более клапанов АСТ, при этом первый испытательный модуль содержит первое средство индикации для визуального отображения состояний одного или более клапанов АСТ.

7. Испытательное устройство по п.6, отличающееся тем, что первое средство индикации сконфигурировано с возможностью отображения: состояния впускного клапана АСТ, которое относится к впускному клапану АСТ, или к каждому из впускных клапанов АСТ; и/или состояния воздушного отсечного клапана АСТ; и/или состояния вентиляционного клапана АСТ; и/или состояния топливного изолирующего клапана АСТ; и/или состояния перепускного клапана АСТ; и/или состояния вентиляционного изолирующего клапана АСТ.

8. Испытательное устройство по п.6, отличающееся тем, что первое средство индикации содержит по два светоизлучающих диода для клапана АСТ, или для каждого из клапанов АСТ, при этом один светоизлучающий диод во включенном состоянии отображает открытую позицию клапана, а другой светоизлучающий диод во включенном состоянии отображает закрытую позицию клапана.

9. Испытательное устройство по п.8, отличающееся тем, что один светоизлучающий диод излучает зеленый свет, а другой - красный.

10. Испытательное устройство по п.1, отличающееся тем, что первый испытательный модуль содержит второе средство индикации для отображения генерирования управляющих команд для одного или более клапанов АСТ, подаваемых в ручном режиме при помощи одного или более элементов управления клапанами, предусмотренных в кабине экипажа воздушного судна.

11. Испытательное устройство по п.1, отличающееся тем, что второй испытательный модуль содержит двухпозиционный переключатель для

FAS 2004 - Page 321

дополнительного центрального топливного бака, или для каждого из дополнительных центральных топливных баков, предназначенный для генерирования одного или более тестовых сигналов, имитирующих мокрое и сухое состояния топливных баков.

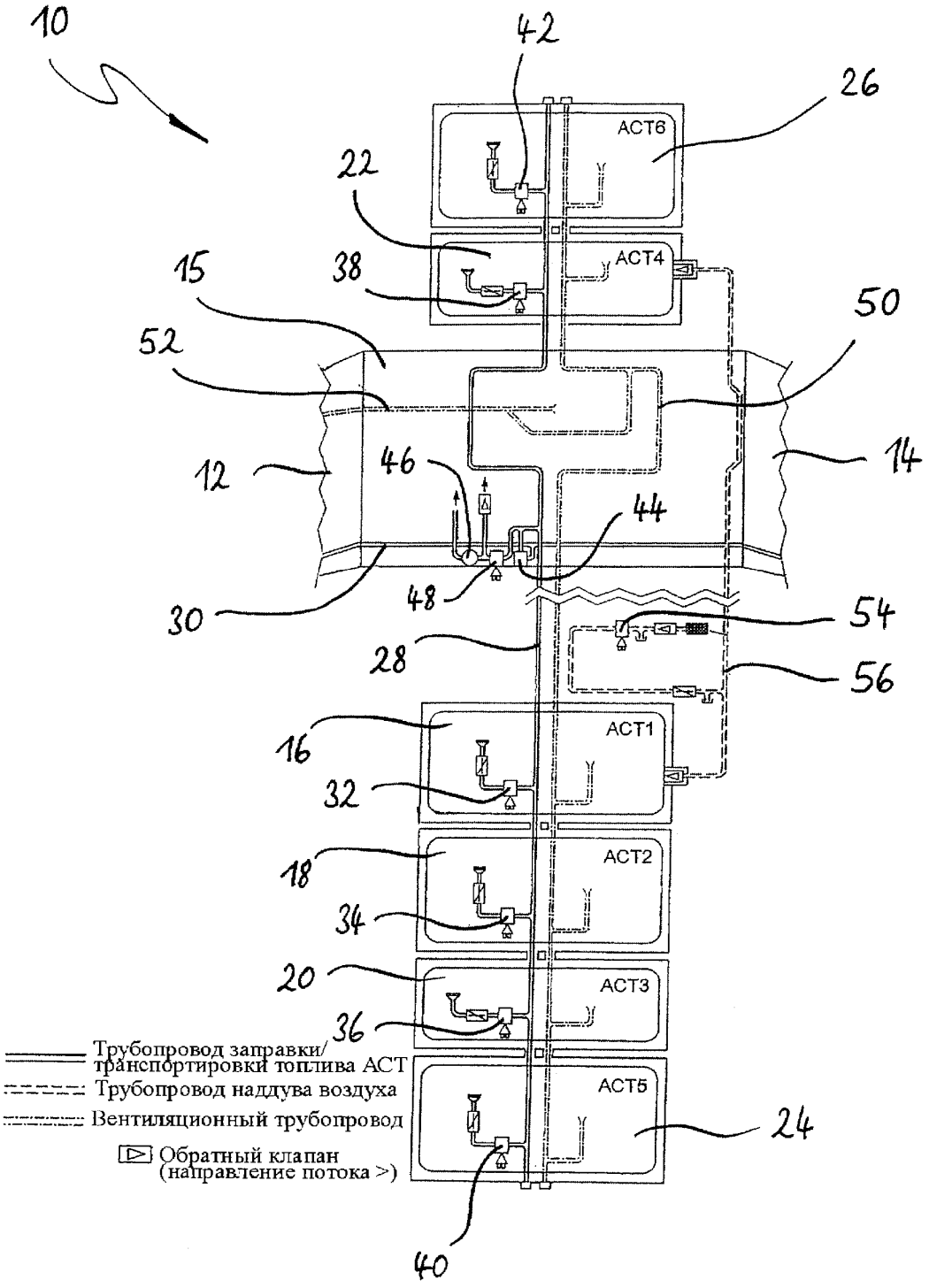
12. Испытательное устройство по п.1, отличающееся тем, что второй испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих: команду управления клапаном для запуска первого серводвигателя топливного изолирующего клапана; и/или команду управления клапаном для запуска второго серводвигателя топливного изолирующего клапана; и/или команду управления клапаном для запуска первого серводвигателя вентиляционного изолирующего клапана; и/или команду управления клапаном для запуска второго серводвигателя вентиляционного изолирующего клапана.

13. Испытательное устройство по п.1, отличающееся тем, что второй испытательный модуль содержит средство генерирования одного или более тестовых сигналов, имитирующих: показание повреждения трубопровода; и/или команду замыкания цепи подачи предупредительного сигнала; и/или предварительно определенное неисправное состояние транспортировки топлива АСТ.

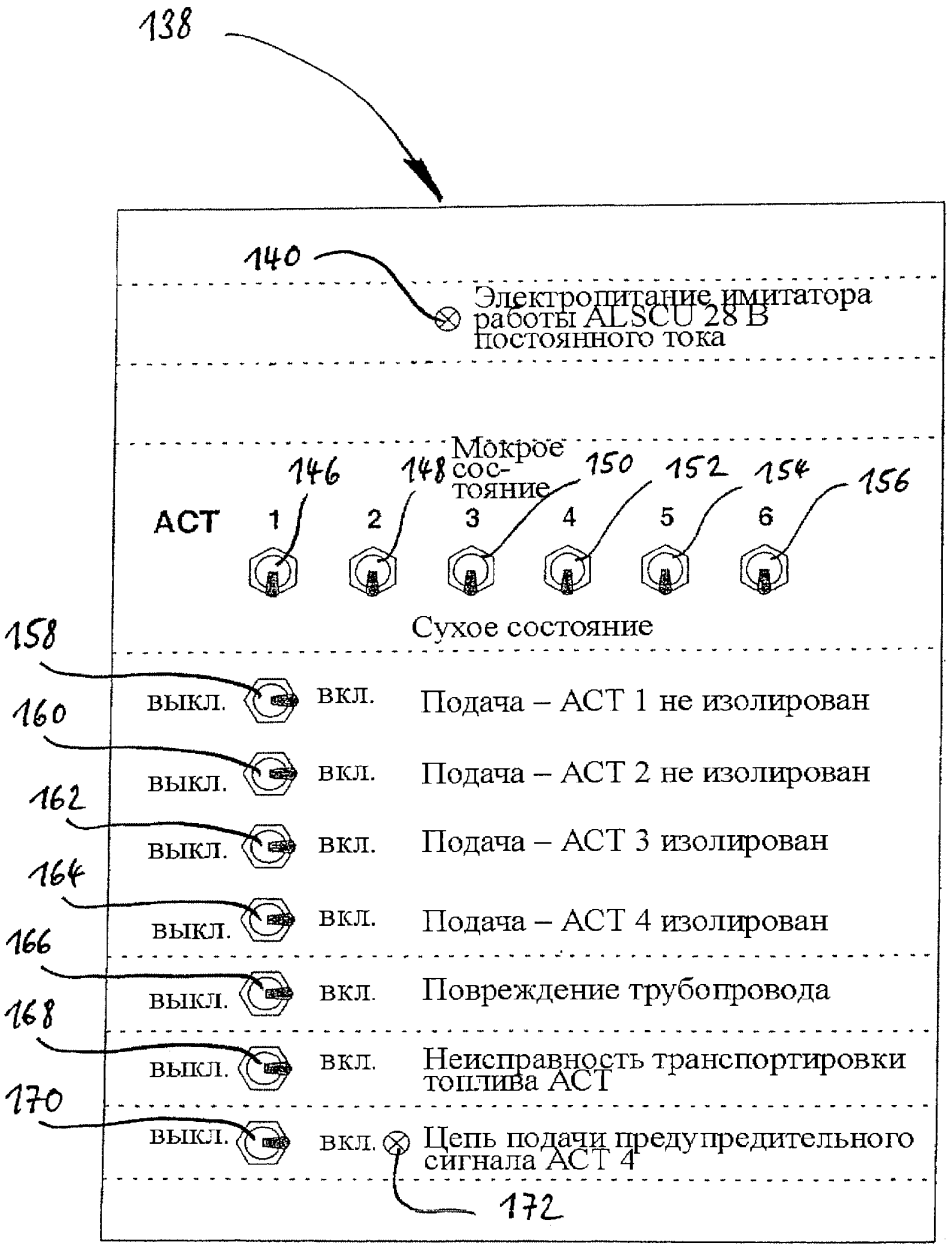
14. Испытательное устройство по п.13, отличающееся тем, что второй испытательный модуль содержит средство индикации, которое показывает, является ли замкнутой цепь подачи предупредительного сигнала.

15. Испытательное устройство по п.1, отличающееся тем, что второй испытательный модуль содержит средство индикации, которое показывает, исправен ли аварийный источник электропитания воздушного судна.

FAS 2004 - Page 322


10
42
26
ACT6
22
ACT4
38
15
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52
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44
48
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54
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56
16
ACT1
32
18
ACT2
34
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ACT3
36
ACT5
24
40
Трубопровод заправки/ транспортировки топлива ACT
Трубопровод наддува воздуха
Вентиляционный трубопровод
Обратный клапан (направление потока >)

ФИГ. 1



ФИГ. 3

FAS 2004 - Page 324

1 of 1 DOCUMENT

SU949644A1 1982-08-07 **SYSTEM FOR REGULATING LIQUID PRESSURE AT FILLING MOTOR VEHICLE AND RAILWAY CONTAINERS** (en)

Standardized Assignees: VOJSKOVAYA CHAST 74242

Original Assignees: VOJSKOVAYA CHAST 74242

Current Assignees: VOJSKOVAYA CHAST 74242

Inventors: NAUMENKO OLEG MIKHAJLOVICH;
VOROGUSHIN GENNADIJ VASILEVICH;
POPOV NIKOLAJ VASILEVICH;
POPOV VIKTOR MIKHAJLOVICH

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English Description:

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The invention relates to automated systems controlling pressure in complex pipeline systems and may be prgadeneno in automation of process of mass pouring automobile and railway tank cars.

The most close to the offered by technical essence is system, consisting of pump, reservoir, compressor, gidroi pneumatic drives with fittings, ogranich1telyaprejdelnogo fuel level, bypass valve and valve-shutoff, included in gishchyusistemu , air distributor, included in the pneumatic system, and zlektrrpnevmoklapana , pneumatic part which through vozdukhoraspreg , 5 divider connected with compressor, and its electromagnet is electrically connected with limiter of limit level, with the aim of prevention of hydro of impact, at an overlap of valve shutoff, is switching of pump JQ with the help of locking device dpya closed cycle ShchNedostatkom known system impossibility of its use in field

conditions, as includes ialichie thick sources of pneumatic-n electric power for switching pump for closed cycle. Besides, reference operation of pump in closed cycle can cause fast warming of petroleum product in pump housing, especially at pumping gasolines, that serves cause fire. Use, of such system will require large expenses on its maintenance, that undesirable during operation in polevrs conditions.

Purpose of the izofeteniya - povyshchenie reliability of system due to protection of its equipment from hydraulic shocks and diffusion possible in the freely chosen pressure and elimination of heating fuel in the pump.

Aim is achieved, in known system of control of pressure liquid sti nri filling automobile irkeleznodorozhnykh tanks, containing connected with reservoir with liquid after pumping device and datchshs pressure, installed on line along-introducing liquid sti, connected to parallel vklyuchenn1M dispensing uprights; with razdatochnymi hoses, including ograshpitslifsdelnogo level of, mounted behind shut-off members, and also valves- otsskateli , regulator of hydraulic characteristics of pumping agregeta , connected with control input of pumping unit, are temperature sensor liquid sti in pumping unit, switch, timer, in each dispensing stand connected in series regulator gyulozhennya valve-shutoff and edektrogidro converter, and also regulator of hydraulic 0 characteristics of supply line liquid sti, the first inputs connected with supply line liquid sti, and the outlet-with discharge line liquid sti, the output of temperature sensor liquid sti in pumping unit is connected with the first regulator inlet hydraulic characteristics of pumping unit, second inputs of which are connected to appropriate outputs of commutator, and output-to the second input of regulator gidravlicheskoi characteristics supply line liquid sti, of timer are connected with corresponding outputs all of position regulators of valves-cutoffs, and output-the control input of the switch, information input connected to output of pressure sensor, input of regulator position of valve-cutoff plate in each dispensing stand connected to outputs of the locking element and ograshchpitelya reference level, and output channels elektrotidropreobrazovatelya are connected with dispensing hose and with nadmembra. nnbi hollow of valve {-shutoff, installed before razdatochnp hose.. in drawing is presented unit-circuit proposed system. System has reservoir 1 with liquid after, pumping unit 2, consisting of engine 3 of internal combustion, reduction gear 4 and pump 5, regulator 6 hydraulic characteristics of pumping unit, sensor 7 pressure, sensor 8 temperature liquid sti in pumping unit (monitoring temperature of fuel in the pump 5) commutator 9, regulator 10, gidoavlicheskoi characteristics supply line liquid sti, consisting of valve 11 discharge of liquid sti, second sensor 12 pressure, unit 13 control and elektrogidro converter 14, line 15 hearth qi liquid sti, line 16 discharge of, timer 17, valves-Cutters 18 with elektrogndropreobrazoiatelyami 19 and regulators 20 position of valves-cutoffs, installed on razda precise stands 21 with razdatochnymirezinotkanevymi hoses 22, locking members 23 and limiters. 24 of limit level. Pressure control system liquid sti operates as follows. At operation of pumping unit 2 open shutoff members 23. At ztom with locking element 23 command is fed in regulator 20, which through elektrogidropre94961 4 obrazovatel 19 opens valve-cutoff 18. Fuel from reservoir 1 pumping unit 2 is fed along line 15 supply of liquid sti through open valve-cutoff 18, rubber hose 22, locking element 23 in tank. When in reservoir preset fuel level, controlled limiter 24 level of filling, the latter operates and generates command in regulator 20, which, acting on winding elektrop1Shch) opreobrazovateyaya 19, causes slow valve closing-cutoff plate 18. Access toplivag is attained, after that, is closing of locking element 23. Due to medpennogo closing the valve-shutoff 18 warned hydraulic impacts in the system. Duration za1fytiya valve-shutoff is determined by value of diameter nozzle, connecting nadipodmembran , space valve-shutoff. For each type of system the duration of valve closing-cutoff plate is adjusted individually and is 10-20 with. Such duration of the closing the valve-shutoff is determined dynamic parameters regulator hydraulic characteristics supply line liquid sti. Their tuning is so, to with minimum deviation from the specified value compensate smooth diffusion lu pressure in system, growth of which obtained decrease of efficiency of pumping unit after closing of one or several valves-cutoffs. In process of their operation regulator 6 hydraulic characteristics of pumping unit, since they take up through commutator 9 signals, pressure pulse from sensor 7 pressure and acting on d igatel 3 of internal combustion, starts smoothly decrease of frequency of shaft rotation of pump, and regulator 10 hydraulic characteristics line 15 supply of liquid sti in this withdraws, part of the pumped liquid sti along line 16 discharge from line 15 feeding in reservoir 1. As only frequency of rotation of pump shaft becomes is equal to value, at which the pressure at the outlet of pumping; unit 2 becomes equal to to preset value at novo feeding, regulator 10 hydraulic characteristics line 15 supply of liquid sti automatically will shut down and removal of zhishchsosti in reservoir 1 will cease. This is achieved, that setters in regula-

tor 16 hydraulic characteristics of pumping unit 2 and unit 13 control regulator 10 hydraulic characterized stiki line 15 supply of liquid sti are on different values. At that operation of regulator 10 hydraulic characteristics line 15 supply of liquid sti is carried out as follows. As only pressure in place of line connection 16 discharge of to line

15 supply of liquid sti provide above given value, signal from sensor 12 pressure goes to unit 13 control, and from it follow command on opening zlektrogidrogfeobrzovatelya 14...

. Liquid st from nadmembrannoi cavities of valve 11 discharge of is displaced through through hole zlektrogidro converter 14 and relief valve 11 opens, providing passage liquid sti from line 15 supply of liquid sti in line

16 discharge and then in reservoir 1. Due to automatic line connection discharge of to

supply line liquid sti hydraulic arakteristika the last changes, providing together with regulator 6 hydraulic characteristics of pumping unit 2 maintenance of with high accuracy pressure on the outlet of pumping unit 2 and in line 15 feeding. In the process of operation of system mass dispensing of liquid posts permanently means of timer 17 and controllers 20 is control for duration of closing klapanovotsekatelei 18. Duration their. closing equal to specified, regulation of pressure in system is regulator of 6 hydraulic characteristics of pumping unit from sensor 7 pressure, controller 10 hydraulic characteristics supply line liquid sti by

. one law. At that commutator 9 signals passes through itself sigialy from flatchika

. 7 pressure.

If in the process of dispensing of liquid posts serviceability of one or several klapaibv -of cutoffs of would be disrupted and they as close faster, than reasonable dimensions specified, then with timer

17 through commutator 9 signals in regulator 6 arrive command, and then it reduces the frequency of shaft rotation pump with higher speed, than in those cases, when klapanyotsekateli 18 are closed by with preset prodolzhiteliostyu. At ztom through commutator 9 signals to regulator 6 pass sigialy

to timer 17 and not pass sigialy from sensor 7 pressure. This you % 1vaet lower lu pressure on the outlet from nasosiogo unit 2 still until approach of pressure wave from locations of valves- otsekatepei 18 and induced their fast closing. Takayasistema of automatic pressure control of liquid posts mass delivery of its in reservoir enables to protect the least strong its equipment from hydro uddrov and diffusion possible in the freely chosen pressure in of & Ich working and emergency situations system. To least lasting equipment-fabric of hose, which pumping unit 2 is connected with line 15 supply of liquid sti and fabric of hose 22, installed on dispensing stands 21.

If in the process of operation of system mass dispensing of liquid posts will cease supply of containers under in pouring over with and all valves-Cutters 18 disappears, supply of liquid sti pumping unit 2 in line 15 will cease. In ztom no case occurred warming liquid sti in the pump 5, in it & temperature sensor is mounted. As only temperature liquid sti in the pump 5 exceeds maximum vozmozhnuyupo conditions of its fire hazard, from sensor in regulator 6, and from it in the control unit 13 goes command. As a result of this instruction regulator reduces frequency of rotation of the engine shaft 3 and pump 5 and partially opens valve

discharge of 11, for transfer of liquid sti pump 5 via line 16 discharge and Your lu of its temperature. As only temperature drops to permissible value, valve 11 discharge of closes and transfer of its

will cease. So is repeated until the, until serves under in pouring over with reservoir and start operate distribution risers.

5 formula invention

Pressure control system liquid sti at charging car and railway tank cars, containing connected with reservoir with liquid after nasosnp unit and pressure sensor, installed on supply line liquid sti, connected to parallel iklyuchennym dispensing uprights with razdatochnymi hoses, including limiters of limit level of, mounted behind shutoff zlementami , and also kLagany -Cutters and regulator of hydraulic characteristics of pumping unit, connected with control input of pumping unit, is distinguished, that, with the aim of diffusion condensate reliability of the system, it has temperature sensor liquid sti in pumping unit, switch, timer, in each dispensing stand, posledovatelyyu connected position regulator valve-shutoff and zlektropshchyugfeobrazovatel , and also regulator gidrashpieskoi characteristics supply line liquid sti, the first inputs connected with supply line liquid sti, and. the outlet-with aiinei discharge of zhishchsosti , the output of temperature sensor liquid sti in pumping unit is connected with the first. regulator inlet gidravshpeskoikharakternstnki pumping unit, second inputs of which are connected to appropriate outputs of commutator, and output-to the second input of regulator hydraulic numbered characteristics of feed line liquid sti, inputs tai-, measure are connected with corresponding outputs all of position regulators of valves- otsekate Leu, and output- soupravlyayushchim input of kommu79496448

tatora , information input podklyuchennogobrannoi cavity valve-shutoff ustaYaovk output of datchnkadavlennya , input of regulator at industrial before dispensing hose, lozhennya valve-shutoff in each dispensing stand connected to outputs of shutoff sources of information, element and limiter of limit level of, s received into account at examination and outlet channels elektrogidropreobrazovate1. Urheberschaft certificate SSSR and 499558,

I are connected with dispensing hose and with iadmem -, Kr. In 67 d 5/04, 1976 (prototype).

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ENGLISH CLAIMS:

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БИБЛИОТЕКА

(54) СИСТЕМА РЕГУЛИРОВАНИЯ ДАВЛЕНИЯ ЖИДКОСТИ ПРИ ЗАПРАВКЕ АВТОМОБИЛЬНЫХ И ЖЕЛЕЗНОДОРОЖНЫХ ЦИСТЕРН

1

Изобретение относится к автоматизированным системам регулирования давления в сложных трубопроводных системах и может быть применено при автоматизации процесса массового залива автомобильных и железнодорожных цистерн.

Наиболее близкой к предлагаемой по технической сущности является система, состоящая из насоса, резервуара, компрессора, гидро- и пневмоприводов с арматурой, ограничителя предельного уровня топлива, перепускного клапана и клапана-отсекателя, включенных в гидросистему, воздухораспределителя, включенного в пневмосистему, и электропневмоклапана, пневматическая часть которого через воздухораспределитель соединена с компрессором, а его электромагнит связан электрически с ограничителем предельного уровня, с целью предотвращения гидроудара, при перекрытии клапана-отсекателя, производится переключение насоса с помощью запорного устройства для работы по замкнутому циклу [1].

Недостатком известной системы является невозможность использования ее в полевых

2

условиях, так как она предполагает наличие мощных источников пневмо-и электроэнергии для переключения насоса для работы по замкнутому циклу. Кроме того, длительная работа насоса по замкнутому циклу может вызвать быстрый разогрев нефтепродукта в корпусе насоса, особенно при перекачке бензинов, что служит причиной пожара. Использование такой системы потребует больших затрат на ее обслуживание, что нежелательно при эксплуатации в полевых условиях.

Цель изобретения – повышение надежности системы за счет защиты ее оборудования от гидравлических ударов и повышенных давлений и ликвидации разогрева топлива в насосе.

Поставленная цель достигается тем, что в известную систему регулирования давления жидкости при заправке автомобильных и железнодорожных цистерн, содержащую связанный с резервуаром с жидкостью насосный агрегат и датчик давления, установленные на линии подачи жидкости, подсоединенной к параллельно включенным раздаточным стоякам с раздаточными рукавами, включающими ограничители

предельного уровня, установленные за запорными элементами, а также клапаны-отсекатели, регулятор гидравлической характеристики насосного агрегата, связанный с управляющим входом насосного агрегата, введены датчик температуры жидкости в насосном агрегате, коммутатор, таймер, в каждом раздаточном стояке — последовательно соединенные регулятор положения клапана—отсекателя и электрогидропреобразователь, а также регулятор гидравлической характеристики линии подачи жидкости, первыми входами связанный с линией подачи жидкости, а выходом — с линией сброса жидкости, причем выход датчика температуры жидкости в насосном агрегате связан с первым входом регулятора гидравлической характеристики насосного агрегата, вторые входы которого подключены к соответствующим выходам коммутатора, а выход — ко второму входу регулятора гидравлической характеристики линии подачи жидкости, входы таймера соединены с соответствующими выходами всех регуляторов положения клапанов—отсекателей, а выход — управляющим входом коммутатора, информационным входом подключенного к выходу датчика давления, вход регулятора положения клапана—отсекателя в каждом раздаточном стояке связан с выходами запорного элемента и ограничителя опорного уровня, а выходные каналы электрогидропреобразователя связаны с раздаточным рукавом и с надмембранной полостью клапана-отсекателя, установленного перед раздаточным рукавом.

На чертеже представлена блок—схема предлагаемой системы.

Система содержит резервуар 1 с жидкостью, насосный агрегат 2, состоящий из двигателя 3 внутреннего сгорания, редуктора 4 и насоса 5, регулятор 6 гидравлической характеристики насосного агрегата, датчик 7 давления, датчик 8 температуры жидкости в насосном агрегате (контроль за температурой топлива в насосе 5), коммутатор 9, регулятор 10, гидравлической характеристики линии подачи жидкости, состоящий из клапана 11 сброса жидкости, второго датчика 12 давления, блока 13 управления и электрогидропреобразователя 14, линию 15 подачи жидкости, линию 16 сброса, таймер 17, клапаны—отсекатели 18 с электрогидропреобразователями 19 и регуляторами 20 положения клапанов—отсекателей, установленными на раздаточных стояках 21 с раздаточными резинотканевыми рукавами 22, запорными элементами 23 и ограничителями 24 предельного уровня.

Система регулирования давления жидкости работает следующим образом.

При работе насосного агрегата 2 открываются запорные элементы 23. При этом с запорного элемента 23 подается команда в регулятор 20, который через электрогидропреобразователь 19 открывает клапан-отсекатель 18. Топливо из резервуара 1 насосным агрегатом 2 подается по линии 15 подачи жидкости через открытый клапан—отсекатель 18, резинотканевый рукав 22, запорный элемент 23 в емкость. При достижении в емкости заданного уровня топлива, контролируемого ограничителем 24 уровня налива, последний срабатывает и выдает команду в регулятор 20, который, воздействуя на обмотку электрогидропреобразователя 19, вызывает медленное закрытие клапана—отсекателя 18. Доступ топлива в емкость прекращается, после чего производится закрытие запорного элемента 23. За счет медленного закрытия клапана—отсекателя 18 предупреждаются гидравлические удары в системе. Продолжительность закрытия клапана—отсекателя определяется величиной диаметра жиклера, соединяющего над- и подмембранное пространство клапана—отсекателя. Для каждого типа системы продолжительность закрытия клапана-отсекателя настраивается индивидуально и составляет 10—20 с. Такая продолжительность закрытия клапана-отсекателя определяется динамическими параметрами регулятора гидравлической характеристики линии подачи жидкости. Их настройка производится так, чтобы с минимальным отклонением от заданного значения компенсировать плавное повышение давления в системе, рост которого вызывается уменьшением производительности насосного агрегата после закрытия одного или нескольких клапанов—отсекателей. В процессе их работы регулятор 6 гидравлической характеристики насосного агрегата, воспринимая через коммутатор 9 сигналов, импульс давления от датчика 7 давления и воздействуя на двигатель 3 внутреннего сгорания, начинает плавно снижать частоту вращения вала насоса, а регулятор 10 гидравлической характеристики линии 15 подачи жидкости в это время отводит часть перекачиваемой жидкости по линии 16 сброса из линии 15 подачи в резервуар 1. Как только частота вращения вала насоса станет равна значению, при котором давление на выходе насосного агрегата 2 станет равно заданному значению при новой подаче, регулятор 10 гидравлической характеристики линии 15 подачи жидкости автоматически отключится и отвод жидкости в резервуар 1 прекратится. Это достигается тем, что задатчики в регуляторе 16 гидравлической характеристики насосного агрегата 2 и блоке 13 управления регулятора 10 гидравлической характеристики линии 15 подачи жидкости настраиваются на разные значения. При этом работа регулятора 10 гидравлической характеристики линии 15 подачи жидкости осуществляется следующим образом. Как только давление в месте подключения линии 16 сброса к линии

FAS 2004 - Page 330

15 подачи жидкости повысится выше заданного значения, сигнал от датчика 12 давления поступит к блоку 13 управления, а от него последует команда на открытие электрогидропреобразователя 14.

Жидкость из надмембранной полости клапана 11 сброса вытесняется через проходное отверстие электрогидропреобразователя 14 и клапан сброса 11 открывается, обеспечивая проход жидкости из линии 15 подачи жидкости в линию 16 сброса и далее в резервуар 1. За счет автоматического подключения линии сброса к линии подачи жидкости гидравлическая характеристика последней изменяется, обеспечивая совместно с регулятором 6 гидравлической характеристики насосного агрегата 2 поддержание с высокой точностью давления на выходе из насосного агрегата 2 и в линии 15 подачи. В процессе работы системы массовой выдачи жидкостей постоянно с помощью таймера 17 и регуляторов 20 осуществляется контроль за продолжительностью закрытия клапанов–отсекателей 18. Если продолжительность их закрытия равна заданной, регулирование давления в системе производится регулятором 6 гидравлической характеристики насосного агрегата от датчика 7 давления, регулятором 10 гидравлической характеристики линии подачи жидкости по одному закону. При этом коммутатор 9 сигналов пропускает через себя сигналы от датчика 7 давления.

Если же в процессе выдачи жидкостей работоспособность одного или нескольких клапанов–отсекателей нарушится и они станут закрываться быстрее, чем это задано, то с таймера 17 через коммутатор 9 сигналов в регулятор 6 поступит команда, и тогда он уменьшает частоту вращения вала насоса с большей скоростью, чем в тех случаях, когда клапаны–отсекатели 18 закрываются с заданной продолжительностью. При этом через коммутатор 9 сигналов к регулятору 6 проходят сигналы от таймера 17 и не проходят сигналы от датчика 7 давления. Это вызывает понижение давления на выходе из насосного агрегата 2 еще до подхода волны давления от мест расположения клапанов–отсекателей 18 и вызванной их быстрым закрытием. Такая система автоматического регулирования давления жидкостей при массовой выдаче ее в емкости позволяет защитить наименее прочное ее оборудование от гидроударов и повышенных давлений при любых рабочих и аварийных ситуациях системы. К наименее прочному оборудованию относятся резинотканевые рукава, которыми насосный агрегат 2 соединяется с линией 15 подачи жидкости и резинотканевые рукава 22, установленные на раздаточных стояках 21.

Если в процессе работы системы массовой выдачи жидкостей прекратится подача емкостей под залив и все клапаны–отсекатели 18 закроются, подача жидкости насосным агрегатом 2 в линию 15 прекратится. Чтобы в этом случае не произошел разогрев жидкости в насосе 5, в нем установлен датчик 8 температуры. Как только температура жидкости в насосе 5 превысит предельно возможную по условиям ее пожароопасности, от датчика в регулятор 6, а от него в блок управления 13 поступит команда. В результате этой команды регулятор снизит частоту вращения вала двигателя 3 и насоса 5 и частично откроется клапан сброса 11, за счет чего обеспечивается перекачка жидкости насосом 5 через линию 16 сброса и снижение ее температуры. Как только температура снизится до допустимого значения, клапан 11 сброса закроется и перекачка ее прекратится. Так повторяется до тех пор, пока не подадут под залив емкости и начнут работать раздаточные стояки.

Формула изобретения

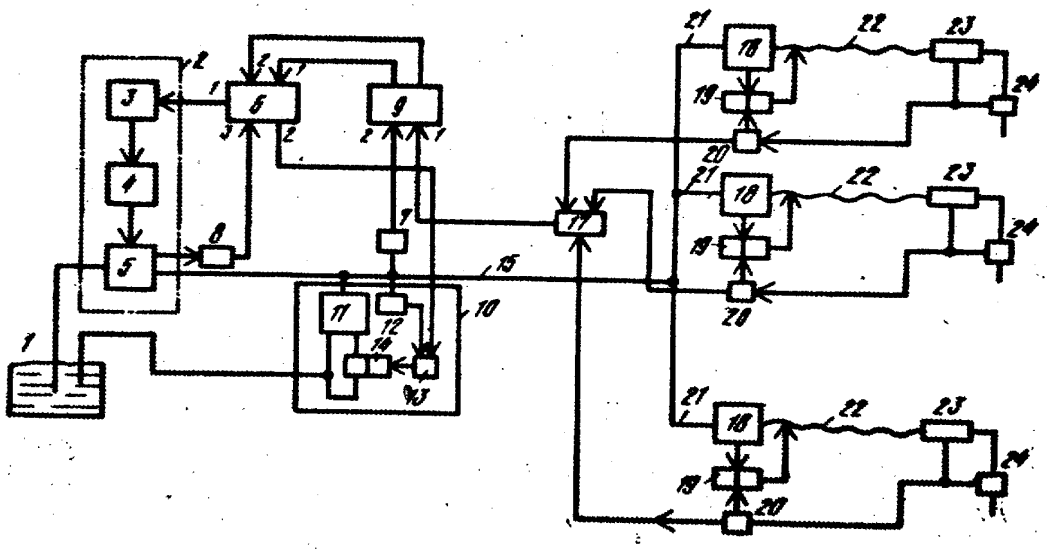
Система регулирования давления жидкости при заправке автомобильных и железнодорожных цистерн, содержащая связанный с резервуаром с жидкостью насосный агрегат и датчик давления, установленные на линии подачи жидкости, подсоединенной к параллельно включенным раздаточным стоякам с раздаточными рукавами, включающими ограничители предельного уровня, установленные за запорными элементами, а также клапаны–отсекатели и регулятор гидравлической характеристики насосного агрегата, связанный с управляющим входом насосного агрегата, о т л и ч а ю щ а я с я тем, что, с целью повышения надежности системы, она содержит датчик температуры жидкости в насосном агрегате, коммутатор, таймер, в каждом раздаточном стояке, последовательно соединенные регулятор положения клапана–отсекателя и электрогидропреобразователь, а также регулятор гидравлической характеристики линии подачи жидкости, первыми входами связанный с линией подачи жидкости, а выходом – с линией сброса жидкости, причем выход датчика температуры жидкости в насосном агрегате связан с первым входом регулятора гидравлической характеристики насосного агрегата, вторые входы которого подключены к соответствующим выходам коммутатора, а выход – ко второму входу регулятора гидравлической характеристики линии подачи жидкости, входы таймера соединены с соответствующими выходами всех регуляторов положения клапанов–отсекателей, а выход – с управляющим входом комму-

FAS 2004 - Page 331

татора, информационным входом подключенного к выходу датчика давления, вход регулятора положения клапана-отсекателя в каждом раздаточном стояке связан с выходами запорного элемента и ограничителя предельного уровня, а выходные каналы электрогидропреобразователя связаны с раздаточным рукавом и с надмембранной полостью клапана-отсекателя, установленного перед раздаточным рукавом.

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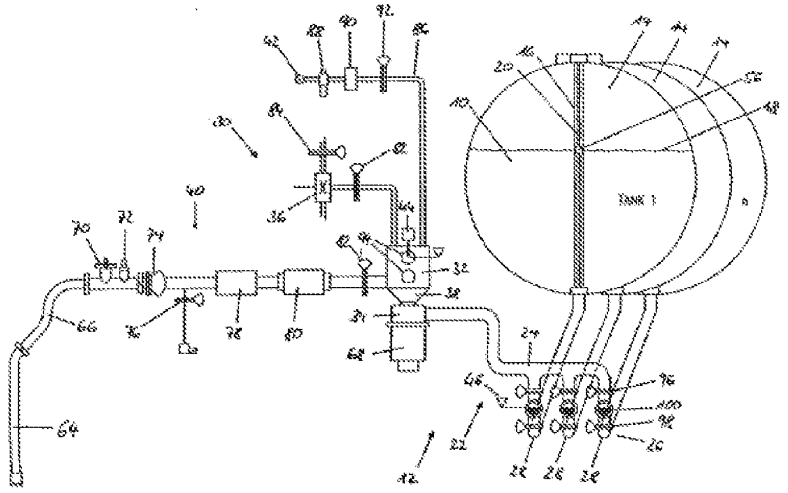
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(54) Title: DEVICE AND METHOD FOR TRANSPORTING A MEDIUM



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(57) Abstract: The invention relates to a device for transporting a medium (10), comprising a conduit assembly (12) which allows several tanks (14) to be filled and/or drained and comprising fill-level gauges (16) located essentially in the interior of the tanks (14), for determining the position of at least one limiting surface (18) of the medium (10) in the tanks. The invention also relates to a method for transporting a medium (10) by means of a conduit assembly (12), wherein the fill level in several tanks (14) is measured by fill-level gauges (16).

Device and Method for Transporting a Medium

The invention relates to a device for transporting a medium according to the generic part of Claim 1. The invention also relates to a method for transporting a medium according to the generic part of Claim 18.

Generic devices and generic methods are used in the milk industry or when distributing fuels.

In the area of the milk industry a tank truck regularly travels to certain milk producers and removes the milk accumulated there, for example, in the course of a day from one or more storage containers. It is important in this removal of milk that the removed amount of milk is precisely measured and registered since a subsequent settling between the producer and the buyer will take place on this basis. This measuring of the amount of milk is subject to the calibration law, which prescribes how the measuring is to take place and which accuracies must be observed (DIN 19217).

A possibility for performing a measuring which satisfies the calibration law consists in the use of flowthrough meters, wherein, however, it is to be ensured that inclusions of air which are necessarily produced when the milk is sucked in and in particular at the beginning and at the end of the receiving process, do not pass into the flowthrough measuring device and result in measuring errors there. Such inclusions of air are avoided by the inserting of gas measuring preventers and gas separators which are also designated as air separators. Basically, air separators are arranged as intermediate containers between the tanks to be filled in the removal container. The milk to be transported remains for a while in the air separator so that inclusions of air in the milk can form again. Only then is the milk conducted,

for example, through a flowthrough meter into the tank to be filled in order to carry out a determination of the amount which is sufficient for the calibration obligation.

However, the using of air separators results in a few disadvantages. On the one hand, the entire apparatus is expensive since the gas separators and the gas measuring preventers are complicated mechanical structures with a large volume and a heavy weight; this entails a reduction of the inadmissible loading weight in the collection vehicles. Furthermore, the air separators are always only admissible for a limited flowthrough amount, which limits the entire suction performance of the collection vehicle.

An arrangement was already described in DE 198 39 112.9 which makes do without the using of air separators. The ability to operate without air separators is based in particular on the fact that an extremely precise determination of volume takes place in the tank to be filled by using a fill-level gauge. It is therefore no longer absolutely necessary to carry out a determination of the amount during the flowing liquid so that even the above-discussed measuring errors due to inclusions of air are avoided. Since the tank simultaneously acts as an air separator, the calibration obligation can be satisfied with a very precise fill-level gauge.

Another disadvantage associated with air separators should be cited. Basically, it should be prevented during the taking of milk that different parts of the raw milk mix with each other. This is becoming increasingly significant precisely in recent times since consumers are becoming more and more aware of the quality. For example, the consumers of biomilk want to be able to rely on the fact that their milk is not mingled or mixed with traditional raw milk. But even otherwise the milk is subdivided into very different quality stages – currently, up to nine quality stages are distinguished. If air separators are used in order to satisfy the necessary

obligation of calibration, then it is immediately apparent that a great expense is required in order to avoid a mixing of milk of different quality stages. Without an expensive transport and conduction technology, mixings of the actually removed milk with milk from a previous removal process (adhering milk) would occur in the air separator.

A safety system for a tank arrangement consisting of several tanks is known from the generic DE 197 50 950 A1 with which the filling and/or emptying of the tanks taking place by a conduit assembly can be controlled. Furthermore, in order to determine the filling amount in the tanks a fill-level gauge is provided in the interior of each tank for determining the position of at least one boundary surface of the medium in the tank.

The invention now has the **problem** of creating a device and a method for transporting a medium in which and by which a filling of one of several tanks with a medium differing from the media to be filled into the other tanks is possible without great expense and while ensuring in any case a low mixing of the medium to be filled in with the other media.

This problem is solved by a device with the features of Claim 1 and by a method with the features of Claim 18.

The invention starts from the generic device in that several tanks can be filled and/or emptied by the conduit assembly, that fill-level gauges are provided substantially in the interior of the tanks for determining the position of at least one boundary surface of the medium in the tanks. In this manner it is possible to carry out a determination of volume which satisfies the obligation of calibration. Furthermore, the raw milk can be separated according to the different quality stages during the receiving procedure without contamination.

To this end the conduit assembly of the invention comprises a distributor device with a primary side and a secondary side, wherein the secondary side comprises individual, blockable distributor paths connected to the tanks. This distributor device serves to separate milk of different quality stages, for example the separation of traditional raw milk and biomilk, which ensures the quality of the milk.

Furthermore, the distributor device comprises level-measuring devices which are associated with the distributor paths. The transport performance of the medium is monitored by the level-measuring devices. Furthermore, the level-measuring devices in the distributor device serve to make available an output signal in the preparation of the system for the receiving of milk in the next tank, namely when the milk was displaced to a sufficient extent from the receiving system.

The device is more economical and lighter due to the ability to operate without the air separators. Furthermore, it requires less space. Since the suction performance is not limited by an air separator, a higher transport performance can be made available.

The primary side is preferably connected to a suction device. This suction device serves to transport the milk from a container make available by the supplier.

The suction device advantageously comprises a first suction container, a centrifugal pump and an ejector. A vacuum can be generated in the suction container by the ejector, which operates according to the principle of a water jet pump. At least one distributor path of the distributor device is filled up to a predetermined filling level by this vacuum. Subsequently, the centrifugal pump assumes the transport, wherein the ejector operating as a vacuum pump can be

optionally delivered only when needed. Whether such a need is present is preferably determined in the distributor device by level measuring.

A vortex breaker is advantageously arranged in the suction range of the centrifugal pump. This vortex breaker reduces the amount of air entering into the centrifugal pump which could otherwise significantly reduce the degree of effectiveness of the centrifugal pump.

It is useful if the suction device can be connected to a supply line. This supply line connects the suction device to the container of the supplier. However, the suction device is not obligatorily connected to a supply line, which can be explained in particular as regards the dispensing of the milk from the tanks which is described below.

Furthermore, it is preferable if the suction device can be connected to a compressed-air connection. Compressed air can be supplied by this compressed-air connection upon the conclusion of the receiving of milk into a certain tank, which compressed air removes the residual milk from the suction system; therefore, the system is available for the receiving of milk into another tank.

The suction device preferably comprises a level-measuring device. An output signal of this level-measuring device makes it possible to recognize, for example, that the suction work of the ejector can be assumed by the centrifugal pump.

It is preferable that a dispensing opening is provided between the suction device and the primary side of the distributor device and that the distributor paths connected to the tanks are connected on the secondary side of the distributor device by a pump circulation line to the suction device. This arrangement of the device according to the invention serves for the selective dispensing of milk out of a

selected tank via the suction container. This has the advantage that the same components which were already used in the receiving of the milk, for example the suction container and the ejector, can be used for the dispensing of the milk.

In another preferred embodiment of the invention the suction device comprises an impeller pump. Impeller pumps have automatic suction, which simplifies the system. Furthermore, impeller pumps are economical, which also has advantages. However, in comparison to the system with vacuum pump and centrifugal pump it should be noted that the milk is received in a less protective manner; furthermore, the suction performance is less than in the system with a centrifugal pump and a separate vacuum pump. The advantages and disadvantages of the embodiment should be considered according to the desired application and the appropriate system should be used.

It is especially preferred in this embodiment that a suction device, in particular an impeller pump is provided for each tank. This avoids a mixing of the different received parts in the suction device.

Another embodiment of the invention operates in such a manner that a first vacuum can be produced in the tanks. The liquid product is sucked into the tank upon the opening of an appropriate valve by the vacuum in the tanks. A mixing of the milk in a suction device is therefore also effectively avoided as a result.

It is especially advantageous in this embodiment if a second suction container can be connected to the tank in which container a second vacuum can be generated, wherein the first vacuum can be generated independently of the second vacuum. This arrangement has the advantage that at first a relatively small suction container is evacuated while the tank maintains its already generated vacuum in its large volume. The product is not transported from the suction container into the tank

until the suction container is filled, which can be detected by a sensor, by the activation of valves. The fact that the first vacuum in the tank is generated independently of the second vacuum in the suction container prevents that a premature pressure rise takes place in the tank by the introduction of air at the beginning or at the end of the receiving; such a pressure rise would have the consequence that the large tank volume would have to be newly evacuated.

It is especially preferable in the embodiment with suction container that the volume of the second suction container is at least as large as the volume of the suction system. The suction container can therefore receive the entire milk located in the suction system (hose plus piping). Even this is useful in regard to the avoidance of a mixing of successive received parts.

The device according to the invention is especially advantageous if the fill-level gauge comprises a transsonar displacement transducer which operates according to the magnetostrictive principle, is coupled to a computer and is provided with the dipstick and at least one float, wherein the float is provided with at least one magnet. The magnetostrictive principle is based on the phenomenon that two magnetic fields crossing one another produce a deformation of the metal in which they are bundled. If an exciter current impulse is now put into the dipstick, an exciter magnetic field results which is axially symmetric as regards the dipstick. This field interacts with the crossing magnetic fields of the float magnets, which generates a brief deformation and a resulting ultrasonic impulse in the dipstick acting as wave guide. A conclusion can be made about the position of the magnets and therefore of the float from the run time of the ultrasonic impulse through the dipstick up to a receiver preferably arranged on the end of the dipstick. It is possible by the device equipped in this manner to measure the position of the float up to an order of magnitude of < 10 µm. Furthermore, transsonar displacement

transducers have long-time stability and therefore satisfy the strict legal regulations regarding the calibration and the measuring accuracy.

A control device is preferably provided which controls the transport of the medium as a function of the measured signals of the fill-level gauge of the tanks and/or of the level-measuring devices of the distributor device and/or of the level-measuring device of the output device. A reliable automation of the receiving of milk and of the dispensing of milk is possible with one or more of these parameters using a control device, wherein in particular an undesired mixing can be avoided.

It can also be advantageous that at least one pressure sensor and/or at least one temperature sensor and/or at least one volume flow measuring device are provided while output signals can be supplied to the control device as input signals. The quality assurance in the receiving and dispensing of milk can be further improved with these other parameters.

It can be advantageous that the connections of the conduit assembly are provided with other system components with a reading device and coded devices (TAGs) so that the correct association of the components can be checked by a control. For example, it can be ensured in this manner that a receiving or dispensing of milk only takes place if all system components are correctly connected.

In the method according to the invention, as it is defined in Claim 18, in order to fill one of the tanks the medium is transported into a distributor path of a distributor device of the conduit assembly, which path is connected to the tank to be filled. Toward the end of the filling, air is also transported into the conduit assembly with the medium. The filling is continued by detecting the filling level in the distributor device until the detected level drops below a given level. As soon as this occurs, the open distributor path is closed to terminate the filling. It is achieved

in this manner that the conduit assembly is free from residual medium up to the closed distributor path. At the same time the closed distributor path between the blocked position in the tank comprises a defined volume so that the total volume of the medium filled into the tank can be readily and very precisely calculated.

The method is especially advantageous in that the tank is selected which is to be filled with the medium, that a vacuum for filling the conduit assembly is generated in a suction line, that a filling level is determined in the suction device, and that the transportation of the medium through the conduit assembly into the selected tank begins as a function of the determined filling level and the generation of the vacuum is terminated. It is ensured in this manner that the determination of the filling level in the suction device can serve as a criterion for the course of the method, in particular also for the determining of the termination of the filling. That the filling should be terminated is shown by the fact that the filling status in the suction device drops below a predetermined value.

At least one other tank is preferably filled after the filling of the selected tank. This is possible since it is ensured with the determination of the filling status, in particular after an expulsion of the milk from the receiving system by compressed air, that the receiving system is sufficiently free of residual milk from the previous reception.

A centrifugal pump for transporting the medium is preferably operated after the generation of the vacuum in the suction device. Such a combination of vacuum pump, for example using an ejector, and of a centrifugal pump makes a large transport performance possible; furthermore, this achieves a protective transporting of the milk.

It is especially preferred that the vacuum pump generating the vacuum is operated as a support for the centrifugal pump if the level determined in the suction line drops below a predetermined level. If, for example, the level determined in the suction line drops below the predetermined level, this can be due to an insufficient transport performance of the centrifugal pump. In this case it can be automatically brought about that the vacuum pump is started up so that the filling level in the particular distributor path again achieves its theoretical level.

It is especially preferable in this connection that the starting up of the centrifugal pump and/or the supporting starting up of the vacuum pump and/or the termination of the filling of a tank are also controlled as a function of the determined filling level in the distributor device. The determination of the filling level in the distributor device therefore also serves for the controlling of several procedures during the course of the method.

Remnants of the medium are preferably removed by suction before the filling of another tank. This supports the fact that no undesired mixing with residual milk from a previous reception of milk occurs during the next reception of milk.

It is also useful in this connection that prior to the filling of another tank, compressed air is fed into the system until a predetermined filling level has been reached in the distributor device. Therefore, the filling level in the distributor device is again used to control a process during the method according to the invention.

The medium is preferably dispensed from the tank in that the tank is selected, at least a part of the medium is pressed by a pump circulation line into a suction container, and the medium from the suction container is dispensed through a dispensing opening arranged between the suction container and the distributor

device. In this manner it is ensured even during the dispensing of the milk that no mixing occurs. It is especially advantageous here that system components are used that were already useful during the reception of the milk.

It can furthermore be advantageous if a first vacuum is generated in a tank so that the tank is filled with the transported medium. An additional suction device can be dispensed with in this method so that the mixing in such a suction device cannot occur even in a natural manner.

It can be especially useful in this connection that a second vacuum is generated independently of the first vacuum in a second suction container connected to the tank, wherein at first the second suction container and thereafter the tank are filled with the transported medium. This has the advantage that at first the relatively small suction container is evacuated while the large-volume tank retains its already generated vacuum. The product is transported into the tank preferably by a non-return valve only when the suction container has been filled, which can be detected, for example, by a sensor, by a switching of valves and the vacuum in the tank. Since the vacuum in the suction container is generated independently of the vacuum in the tank, it is prevented that an entrance of air at the beginning or at the end of the receiving leads to a premature pressure rise in the tank. This would have the consequence that the large tank volume would have to be re-evacuated.

The invention is based on the surprising recognition that it is possible to satisfy the strict calibrating regulations as well as the quality requirements. This is achieved on the one hand by a highly precise determination of volume inside a tank by a fill-level gauge, which eliminates additional air separators. Furthermore, the quality of the milk can be ensured in this manner. The device of the invention is more economical and lighter than the devices of the prior art; it requires less space and

it is capable of a higher performance. The device makes it possible without considerably increased expense for apparatuses to receive milk with numerous different quality levels. It was necessary in the prior art to use a separate air separator for each quality stage; in the case of the invention only an appropriate number of tanks and the corresponding design of the guide system is required.

The invention will now be described with reference made to the accompanying drawings using exemplary embodiments.

Fig. 1 shows a first embodiment of a device according to the invention;

Fig. 2 shows a section of the device in fig. 1 with an expansion;

Fig. 3 shows a second embodiment of a device according to the invention;

Fig. 4 shows a section of the device in fig. 3 with an expansion;

Fig. 5 shows a first tank arrangement which can be used in the framework of the invention;

Fig. 6 shows a second tank arrangement which can be used in the framework of the invention;

Fig. 7 shows a third tank arrangement which can be used in the framework of the invention;

Fig. 8 shows a special embodiment of the distributor device which can be used in the framework of the invention.

Fig. 1 shows a first embodiment of a device according to the invention. A plurality of tanks 14 filled or which can be filled with a medium 10 is connected to a conduit assembly 12. Fill-level gauges 16 are provided inside the tanks 14. The fill-level gauges 16 comprise a dipstick 20 and a float 56 so that a boundary surface 18 of the medium 10 can be measured with the fill-level gauge 16. The conduit assembly 12 comprises a suction lance 64, a suction hose 66 and a feed line 40 to a suction device 30 with a suction container 32. The suction container 32 is connected by a vortex breaker 38 to a centrifugal pump 34 which can be driven by a drive motor 68. The centrifugal pump 34 is connected to the primary side 24 of a distributor device 22. The secondary side 26 of the distributor device 22 empties via distributor paths 28, of which three of them are shown here by way of example, into the tanks 14.

The feed line 40 to the suction container 32 is provided with other components: a vacuum switch 70, a temperature sensor 72, a disk valve 74, a milk check ring valve (MPR valve) 76, a volume flow meter 78, an online sample taker 80 and with another disk valve 82. An ejector 36 is arranged above a valve 83 on the suction container 32. The ejector 36 is provided with a compressed-air valve 84. Furthermore, the suction holder 32 is connected to a compressed-air connection 42. A compressed-air line 86 is provided with a compressed-air reducer 88, a filter 90 (e.g., 200 µm) and with a turnoff valve 92. The suction container 32 is provided with a level-measuring device 44 and with viewing glasses 94. Even the distributor device 22 is provided with level-measuring devices 46 on its different distributor paths 28. The distributor device 22 is provided on its primary side as well as on its secondary side 26 with disk valves 96, 98. Furthermore, viewing glasses 100 are provided.

The device according to the invention functions, for example, as follows when receiving milk. At the beginning of the receiving the appropriate tank 14 (tank segment) is selected on the basis of the milk quality (predetermined) to be received. To this end the appropriate valve 96 on the distributor device 22 is opened. A non-return valve (not shown) prevents a backflow of milk which is possibly already present in the tank 14. Then, a vacuum is generated in the suction container 32. This takes place by the ejector 36 connected to the valve 82 and the compressed-air valve 84. In principle, the ejector 36 can be replaced by a different type of vacuum pump. When the vacuum has reached a certain value, the transporting of the milk begins. At this time the disk valve 74 and the valve 82 are open. The vacuum switch 70 detects the vacuum. The milk is transported past the temperature sensor 72 by the suction lance 64 and the flexible suction hose 66. The temperature sensor 72 serves for an additional assurance of quality. The milk then passes into the volume flow meters 78 in which the actual volume flow is determined. The online sample taker 80 is controlled from the values of the volume flow meter 78 (speed and degree of filling) by a control unit, which is not shown, together with any other values. The specimen is filled into a (not shown) specimen bottle; this also serves for the quality assurance. As soon as the milk in the suction container 32 has reached the level characterized by a triangle, the drive motor 68 of the centrifugal pump 34 is activated and the centrifugal pump 34 forces the milk into a line which runs to the primary side 24 of the distributor device 22. In order to ensure that the suction action of the centrifugal pump 34 does not draw any funnel (paraboloids), a vortex breaker 38 is attached in the inflow area of the centrifugal pump 34. Any entering air would not falsify the measuring of the milk volume since the milk in the tank 14 has sufficient time to outgas; nevertheless, a ventilation is recommended in order to improve and/or maintain the efficiency of the centrifugal pump 34. As soon as the centrifugal pump 38 is running, the

vacuum pump and the ejector 12 can be turned off since the centrifugal pump 32 now ensures the transporting of the milk. Only when the level in the suction container 32 drops below the predetermined level characterized by a triangle, which can be observed at the viewing glasses 94, does the ejector 36 engage in a supporting manner. This level demonstration takes place by the level-measuring device 44 in the suction container 32. Toward the end of the receiving procedure air is also sucked in, the level in the suction container 32 drops and the ejector 36 sucks the suction system free of milk remnants. In addition, a milk testing ring valve 76 (MPR valve) is provided in the described embodiment which ensures that no new receiving can be started before the running receiving has been terminated. This takes place in that the MPR valve 76 opens and therefore floods the suction system with air. Subsequently, the valve 82, which can be designed as a non-return blocking valve, is closed, whereupon the system is pressed empty. This empty pressing of the system takes place by using compressed air which is put on the compressed-air connection 42 and thus passes into the suction container 32. The compressed air is conducted via a compressed-air reducer 88 with filter and water-oil separator and via a blocking valve 92 and is reduced to a pressure which is not dangerous for the system. However, this pressure is so great that it can transport the milk into the highest tank 14. The tank 14 is ventilated at this point in time. A fine filter 90 ensures that the legal food requirements are observed (200 µm). The milk is displaced from the suction container until the level characterized by a triangle in the distributor device 22 has been reached. This is demonstrated by the level-measuring device 46. Since the conduit assembly 12 or the distributor device 22 has a small cross section in this area, the measuring error is minimized. Level-measuring device 46 can be a level switch in practice but can also be a constantly measuring device, in particular a dipstick device.

The piping of the system is designed in such a manner with flow technology that no siphons or recesses are present. This ensures that the milk flows automatically. Therefore, the remaining, adhering amount of milk is low and only a minimal contamination takes place during the next receiving.

As regards the determination of the volume of the received milk, it should be noted that the volume between the transfer level of the distributor device 22 characterized by a triangle and between the tank 14 must be added for the calculation of the total volume.

Fig. 2 shows a section of the device shown in fig. 1. However, the shown device comprises additional components which are used during the dispensing of milk from the tanks. The same reference numerals refer to the same components.

In addition, a pump circulation line 50 is connected by the disk valves 98 to the secondary side of the distributor device 22. This pump circulation line runs via a pump circulation disk valve 104 to the suction container 32. Furthermore, the pump circulation line 50 is provided with a residue removal valve 110. A dispensing disk valve 106 is arranged between the centrifugal pump 34 and the primary side 24 of the distributor device 22. A discharge opening 48 designed as a valve is located between this dispensing disk valve 106 and the centrifugal pump 34. In addition, a level meter 108 is provided in the area of the discharge opening 48.

The device functions as follows during the dispensing of milk from a tank 14. The valve 82 was initially closed in the system is pressed empty. The pressing empty took place, for example, after a previous receiving of milk. The desired tank 14 (tank segment) is now selected in that the appropriate valve 98 is opened. The pump circulation disk valve 104 is also opened. The milk is now pressed by the

force of gravity into the suction container 32 or is drawn by suction by a vacuum from the ejector 36 or from any vacuum pump. The valve 106 is already closed at this point in time. The valve of the dispensing opening 48 is opened. The centrifugal pump 34 is then activated. As a consequence, the milk is dispensed via the dispensing opening 48.

If a partial dispensing of milk takes place, then only the level difference produced in the corresponding tank segment is determined by the fill-level gauge 16 and the volume is recalculated in a corresponding manner.

In the case of a total emptying of the tank 14, the additional volumes, for example, the volume of the pump circulation line 50 are to be calculated according to the previous history (partial dispensing). The last partial volume from the displayed level in the distributor device 22 to the non-return valve 102 is transported by a brief pressure thrust, wherein the disk valve 96 and the dispensing disk valve 106 are open while the valve of the dispensing opening 48 is closed. Consequently, the last partial volume is pressed into the area leading to the tank 14 and into the volume of the a pump circulation line 50. The particular sensor 46 demonstrates this state. Subsequently, the partial volume is transported by vacuum into the suction container 32. At the conclusion of the dispensing the system is pressed empty – the dispensing disk valve 106 is closed, the valve of the dispensing opening 48 is open. This pressing empty takes place until the sensor 108 reacts. On the whole, a dispensing detected by volume was carried out without significant contamination.

It is also possible to carry out a gravity loading. In this case the particular valve 98 runs directly into the container to be filled.

Even combinations of the pump circulation method and of the gravity loading are of course conceivable.

Fig. 3 shows another embodiment of a device according to the invention. Comparable component are characterized by the same reference numerals. The particularity of this embodiment is that an impeller pump 52 is provided as suction device 30. The impeller pump 52 is connected by a valve 114 to the primary side 24 of the distributor device 22. Viewed from the valve 114 downward in the direction of the distributor device 22, a compressed-air connection 42 can be additionally provided. Since the latter is optional, it is shown in the present instance with interrupted lines.

Since the impeller pump 52 has automatic suction, this simplifies the system considerably. For example, no additional vacuum pump, designed, for example, as ejector, is provided. However, the milk is not received is protectively by the impeller pump 52, as takes place, for example, by the combination of vacuum pump/circulation pump of the embodiment shown in fig. 1; furthermore, an impeller pump 52 does not have the same performance as the combination of vacuum pump/circulation pump according to fig. 1. However, it should also be mentioned that the impeller pump 52 as the advantage that it represents a more economical solution.

The impeller pump 52 draws the milk in by suction and presses it into the selected tank 14 when valve 114 is open. When the vacuum switch 70 reacts, the impeller pump 52 is operated further for a certain time in order that the residual milk is removed from the suction system. The impeller pump 52 is then turned off and the valve 114 is closed. The valve 92 is opened whereas the valve 112 remains closed. As a result, the milk remaining in the piping system is pressed up to the level in the

distributor device 22 characterized by a triangle. The valve 92 is subsequently closed and the piping system is ventilated via the valve 112. The line which connects the compressed-air connection 42 to the conduit assembly 12 can be protected from the penetration of milk by a valve (not shown); this simplifies the cleaning of the system.

It can be useful under the certain circumstances in the embodiment according to fig. 3 as well as in the embodiment according to figure 1 to provide each line with its own pump. This is especially useful in the case of impeller pumps 52 since they are difficult to completely empty. However, remnants in the impeller pump 52 would result in a contamination.

Fig. 4 shows a part of the device shown in fig. 3 which is comparable with the one in fig. 3. The same components are characterized by the same reference numerals.

Additional components serve to carry out a dispensing with the system, wherein these components correspond substantially to those in fig. 2. Here too, the same reference numerals are used for similar components. The procedures for the dispensing of milk through the dispensing opening 48 are comparable to those in fig. 2 so that a new description is not necessary.

Fig. 5 shows a device which can be advantageously used in the scope of the invention. A tank 14 is again shown which is filled with a medium 10, for example milk. The medium 10 has a boundary surface 18 which is measured by the fill-level gauge 16 with its dipstick 20. A conduit assembly 12 is connected to the tank 14. A suction hose 118, a coupling 120, a valve 122 and a sensor 124 are arranged on this conduit assembly.

The device according to fig. 5 is operated with a vacuum generated in the tank 14. The advantages of the fill-level gauge 16 with dipstick 20 are especially clear in this device. In tanks 14, which operate with a vacuum, the entire tank is evacuated down to a certain vacuum. The minimum pressure here is determined by the stability of the shape of the tank. As a result of this vacuum the liquid product is then drawn by suction into the tank 14 upon the opening of the appropriate valve 122. Very little contamination is produced here. The filling and the dispensing take place on the same side of the tank 14 in the embodiment shown in fig. 5. The system is shown by way of example without sample taking, which is still frequently requested abroad. The product passes after the opening of the valve 122 into the tank 14 via the flexible suction hose 118 which is connected by a coupling 120 to the filling-dispensing connecting piece. The fill-level gauge 16 with its dipstick 20 can also serve, in addition to determining the volume, as a safety against overfilling. In order to ensure for a dispensing that is detected according to volume that even the entire conduit assembly 12 has been emptied, a sensor 124 is provided.

Fig. 6 shows another device which can be used with advantage in the framework of the present invention. Even in this case a vacuum system is concerned. However, in distinction to fig. 5 the filling of the tank 14 takes place from above whereas the dispensing takes place on the bottom of the tank 14. The conduit assembly 12 on the filling side comprises a valve 128 just as the conduit assembly 12 on the dispensing side comprises a valve 122.

Fig. 7 is a broadened variant of the embodiment according to fig. 6. A suction container 54 is provided here in addition. This arrangement has the advantage that at first the relatively small suction container 54 is evacuated while the tank 14 retains its already generated vacuum. Only when the suction container 54 is filled,

which is detected by the sensor 130, is the valve 128 closed and the valve 122 is opened. The product is transported through the non-return valve 132 by the vacuum in the tank 14 into the tank 14. It is especially advantageous if the vacuum in the suction container 54 is not connected to the vacuum in the tank 14. This prevents that an inclusion of air at the beginning or at the end of the receiving results in a premature pressure rise in the tank 14, because if this should occur, the large volume of the tank 14 would have to be evacuated again. The suction container 54 is dimensioned in such a manner that that it can receive the volume off the suction system.

Fig. 8 shows a distributor device 22 which can be advantageously used in the scope of the present invention. Reading devices 58 and coded devices 60 (TAGs) are arranged at the connections between the hoses 134 and the particular lines 136, 138. The reading devices 58 are capable of reading the code of the TAGs 60 and inputting the result into a control 62. The transmission from the reading devices 58 can take place by a fixed cabling or by a remote transmission device 140. The latter can emit, for example, radio signals or infrared signals. Furthermore, a safety against overfilling 142 can be arranged in the system. The system can now be arranged in such a manner that the valves 146 to the tanks 14 are only freed for opening by the control if the codes correctly read by the TAGs 60 and the corresponding reading signals are transmitted by the reading devices 58. This increases the safety during the receiving of milk so that an unintended mixing by a false connection is prevented. In order to additionally counteract, for example, manipulations, the connections between the lines in the hoses can be sealed by a lead seal 144.

If a mechanical seal is provided and attached, the TAGs and TAG readers could be eliminated at the inner end.

The features of the invention disclosed in the previous description, the drawings and in the claims can be essential for the realizing of the invention individually as well as in any combination.

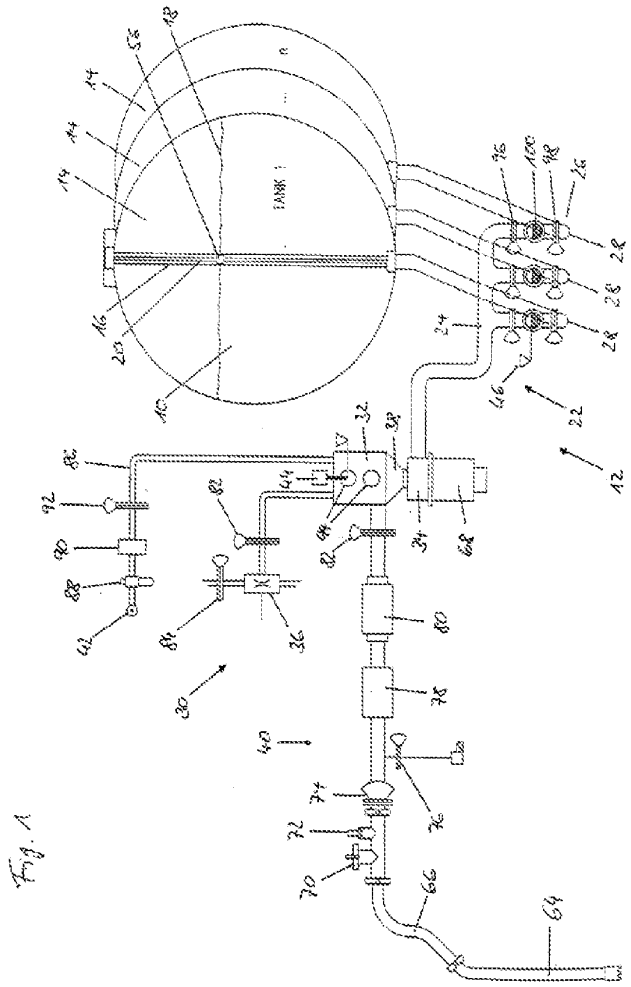


Fig. 1

Fig. 2

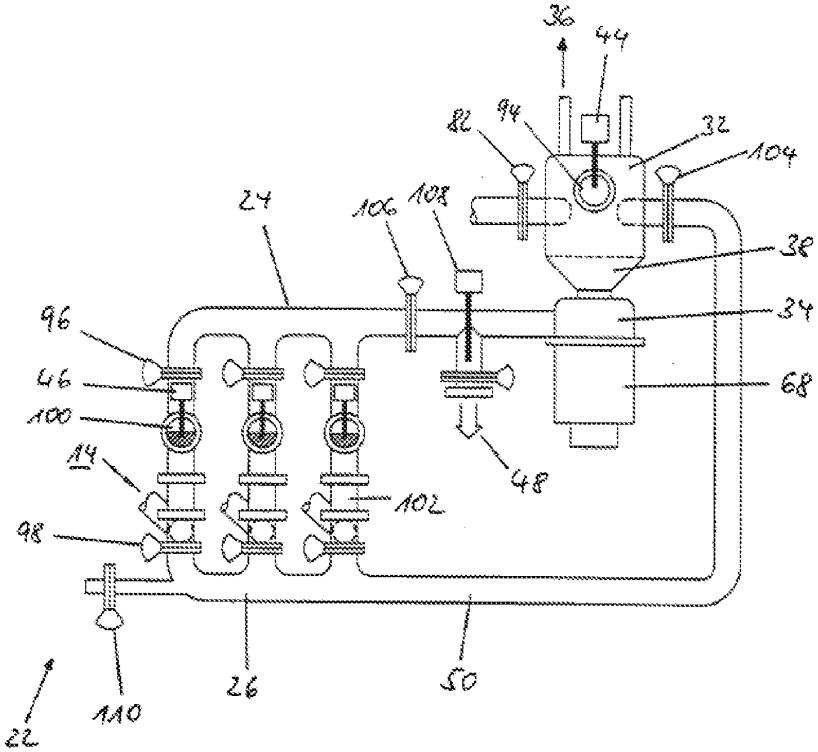

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Fig. 3

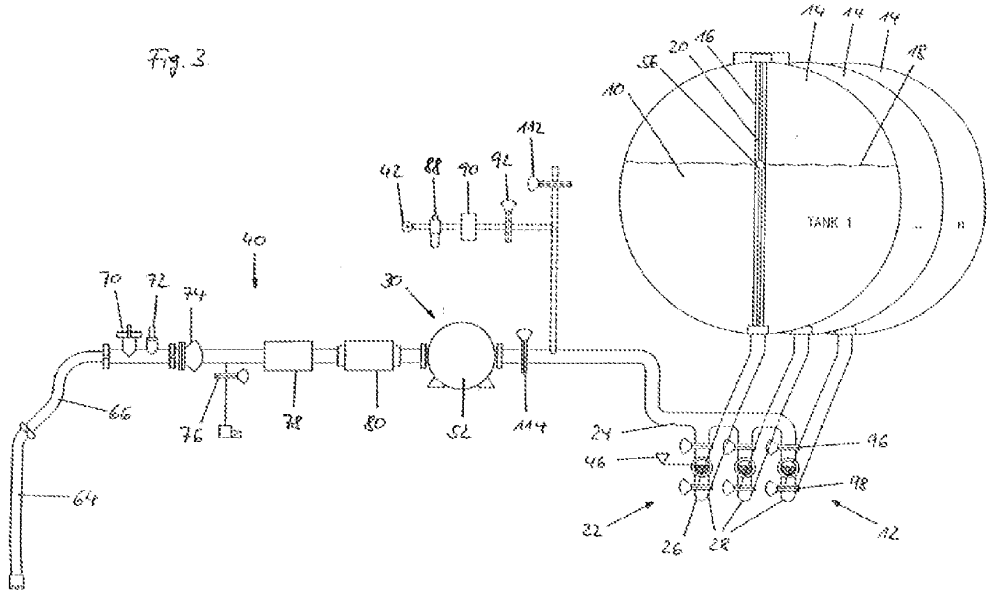

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Fig. 4

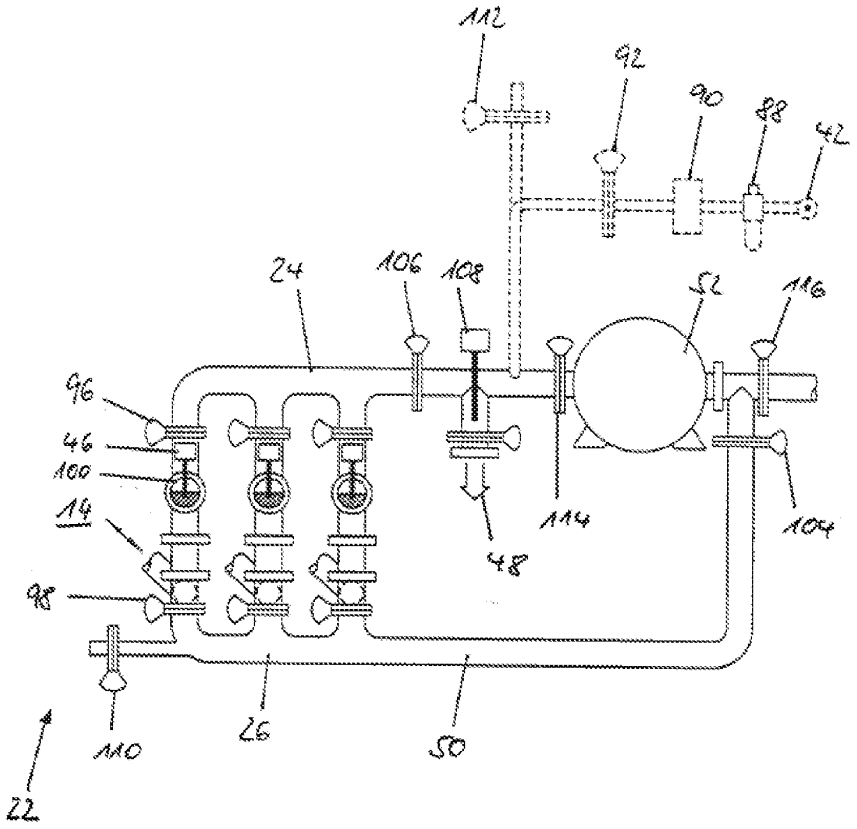

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Fig. 5

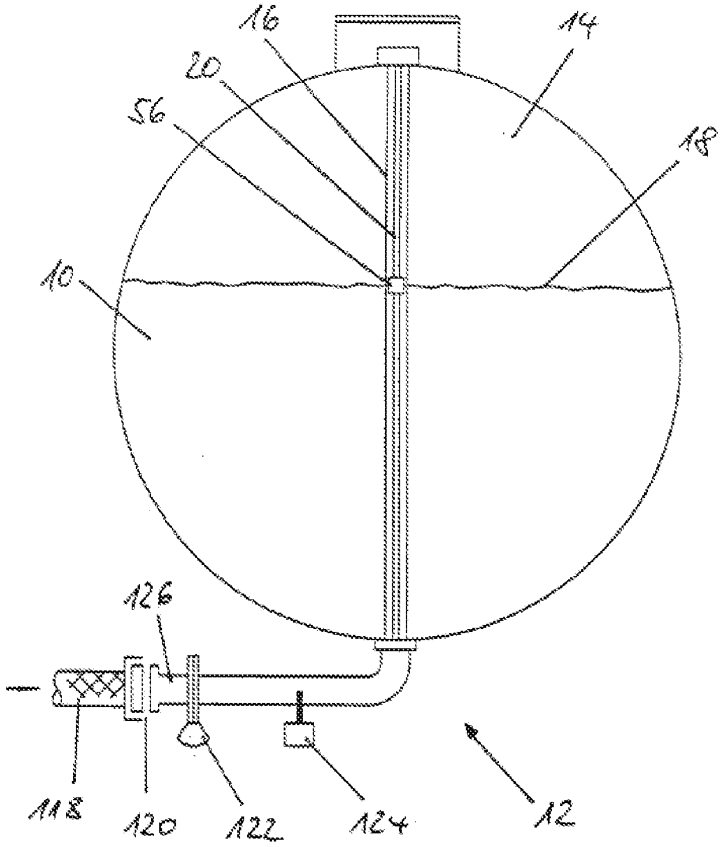


Fig. 6

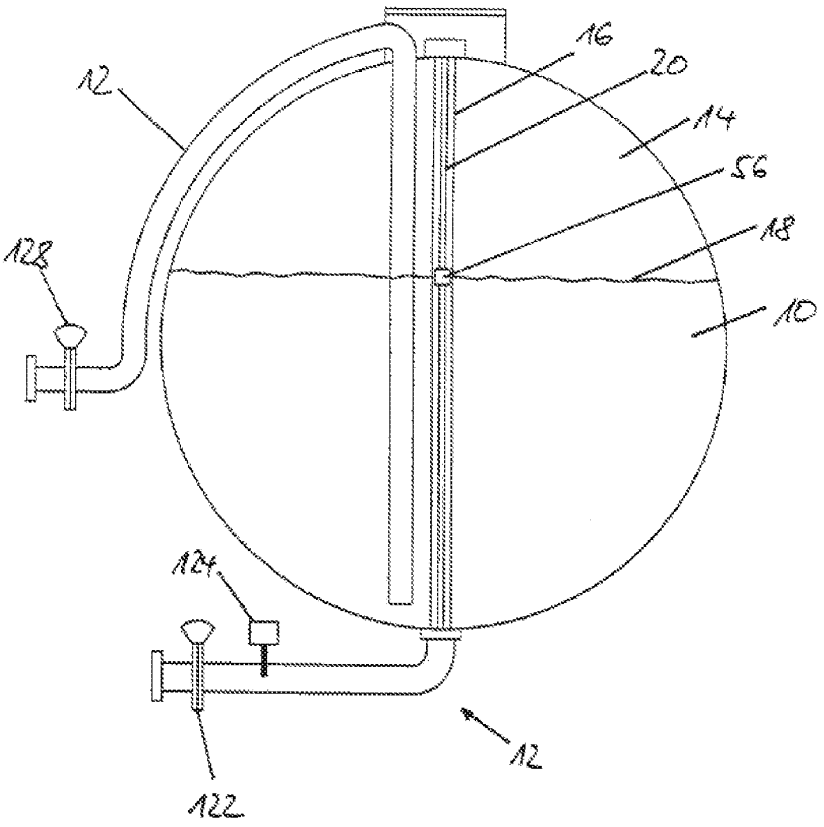


Fig. 7

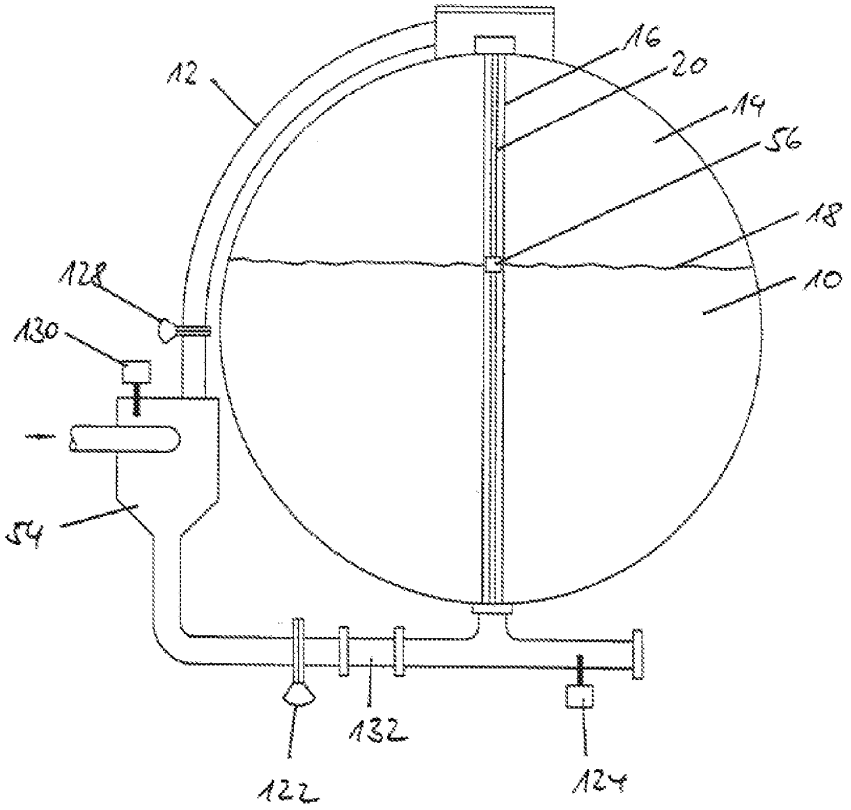
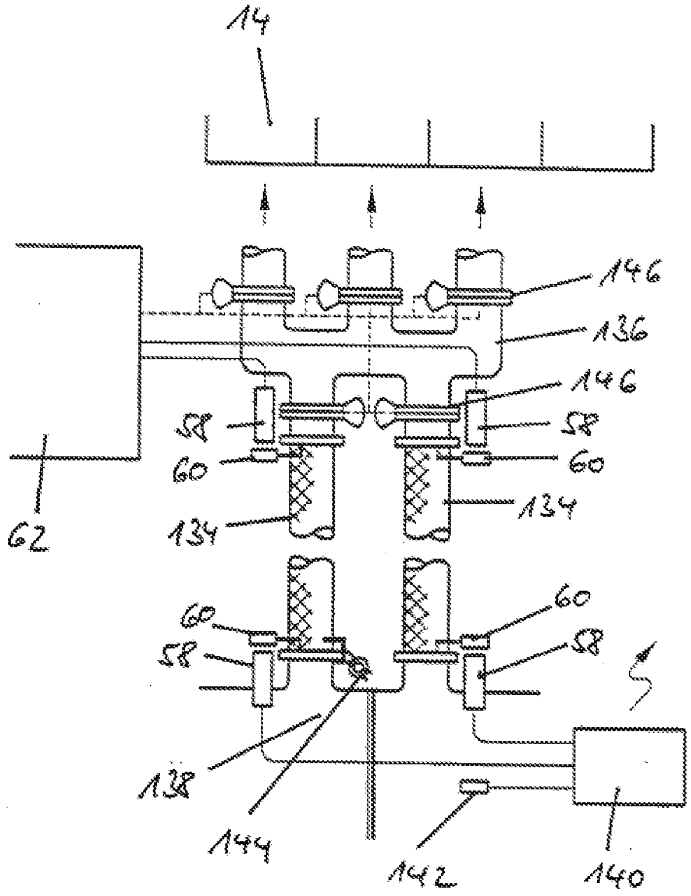


Fig. 8



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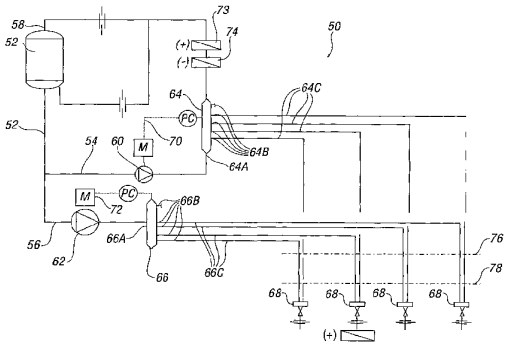
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[Continued on next page]

(54) Title: FLUID DELIVERY SYSTEM



(57) Abstract: A fluid delivery system is described whereby sterile liquid may be delivered efficiently to a number of remote locations while nevertheless maintaining a continuous fluid flow through the system to prevent any bacterial growth. The system includes a storage tank feeding a first pipework loop including a first pump which urges fluid through said first loop at a first pressure and which returns to the tank, and also includes at least one pipework branch fed from the tank and having a second pump which urges fluid through the branch at a second pressure downstream of the second pump. The system functions efficaciously in that a branch manifold terminates each branch and a return manifold is provided in the first pipework loop. Between these two manifolds are connected one or more supply hoses interrupted by an offtake component which is a simple valve opening through which the fluid can be selectively delivered at the desired location. When one or more offtakes are opened, the conventional fluid flow in the hose which links that offtake to the return manifold is reversed on account of the pressures at which the two pumps in the firs pipework loop and the pipework branches operate. This type of operation allows for practically 100 % diversity, i.e. that condition where as many or as few offtakes in the system can be opened simultaneously without any practical reduction in the availability of fluid.

WO 03/029721 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Fluid Delivery System

This invention relates to a fluid delivery system, and more particularly to a hygienic fluid delivery system, the construction of which requires careful planning and analysis to ensure that the resulting system has minimal stagnancy of flow during operation and that bacteria growth is minimised if not eliminated entirely. The types of fluid delivery systems hereinafter described are typically provided in a wide variety of plant, including Research & Development facilities generally, laboratories, silicon wafer manufacturing plants, breweries, pharmaceutical manufacturing facilities, and any installation where a plurality of sources of sterile water or other liquid may be required in a number of different locations remote from a supply tank for storing the water or other liquid.

Although the following description is provided with almost exclusive reference to hygienic fluid delivery systems which deliver so-called Water for Injection (WFI), Purified Water (PW) and the like, it will be instantly appreciated that the invention has far wider application and may be applied to deliver any liquid to a predetermined location remote from a storage vessel through distribution pipework.

It is also to be appreciated by the reader that the word "sterile" and cognate expressions as used hereinafter is not to be construed in its literal sense and includes liquids having a bacteria, germ or other contaminant content reduced beneath a desired level so that the said liquids are safe or suitable for a particular procedure.

Current systems for the delivery of sterile fluids, in their simplest form, consist essentially of a storage vessel supplied intermittently or continuously with a sufficient volume of pre-

sterilised fluid. A system of steel pipework is routed through the premises, for example a clinical laboratory, wherein WFI is required, said pipework being for the most part conventionally concealed in the ceiling of each room through which said pipework passes and descending from the ceiling only in those locations either where operatives are likely to regularly require a source of WFI or alternatively in locations conveniently accessible by a number of operatives working proximate said location. The pipework is routed through said premises and ultimately returns to the storage vessel to return any excess fluid thereto.

There are a number of important factors which must be taken into account when designing a sterile fluid delivery system, but the most important is that the system as a whole must generally preclude any localised stagnation of fluid, either in the pipework or the storage vessel and be free from crevices or similar areas where bacteria could become trapped and thus allowed to proliferate

Accordingly the pipes are firstly commonly welded together using a very costly technique known as Tungsten Inert Gas (TIG) autogenous welding which ensures that the butt joints between adjacent sections of pipe are secured to one another without introducing unwanted contaminants into the passageway within the pipes and ensuring that the join is as smooth as possible internally. Furthermore the interior surface of the various pipes which are joined together throughout the system is important in that said interior surface must be as smooth as possible and any bends in the pipes must preclude the formation of eddy currents during fluid flow therethrough. It will be appreciated that eddy currents give rise to localised volumes of fluid which are effectively stationary, and thus the temperature of these volumes can quickly drop to a level at which bacteria

most readily thrive with the result that the sterility of the system as a whole is prejudiced.

Secondly, the operating temperature of the system is adjusted and maintained to ensure that any bacteria (for example mesophilic bacteria such as gram-negative pseudomonas commonly present in water) are either prevented from multiplying or are actually eliminated. A common temperature for WFI systems is 80°C and to prevent any gradual reduction of the fluid temperature over time, a heater is commonly connected into the system.

It is to be mentioned that PW and other hygienic fluid systems can be operated at ambient temperatures, so much greater care and attention needs to be given to the construction of these types of systems which on account of the operating temperature are much more prone to bacterial proliferation.

Thirdly, it is important that a turbulent, as opposed to a laminar flow characteristic is developed within all sections of the pipework again to minimise the risk of bacteria proliferation. For example, in both laminar and turbulent fluid flows, it is well known that the velocity of the fluid immediately adjacent a solid surface is minimal if not zero, whereas the velocity of fluid remote from such a surface is much greater. Hence the majority of the volumetric flow through a pipe is achieved through the middle of the pipe whereas only a comparatively small percentage of flow is attributable to the fluid moving proximate the interior surfaces of said pipe. This slow moving or stagnant fluid has the tendency to cool and thus not only are the conditions for bacteria proliferation improved adjacent to the interior surface of the pipe, but the fact that the fluid is either moving very slowly or not at all further increase the likelihood that bacteria will find a site on the pipe surface to germinate.

Turbulent fluid flows within sterile fluid delivery systems are desirable because velocity profile of the fluid proximate the interior surface of the pipe increase significantly more sharply than that of an equivalent laminar flow and the risk of bacteria proliferation and germination is thus mitigated. Biofilm formation on the internal surfaces is discouraged by such fluid velocities.

However, it is well known in fluid dynamics that the existence of turbulent flows within pipes depends on, among other things, the diameter of the pipe, and the velocity of fluid flow therethrough. In general, to the development of turbulent flow in pipes of a larger diameter requires a significantly larger fluid velocity than required to establish turbulent flow in smaller diameter pipes.

Fourthly, it is necessary to ensure that the storage vessel containing the WFI is recharged over a predetermined period of time, for example every two hours. Moreover, the system operates continuously so that the storage vessel is being continually emptied and simultaneously recharged to avoid any stagnation of fluid therein, and the time period is merely an indication of the length of time which would be taken to empty to the storage vessel completely under normal operating conditions without any simultaneous recharge.

It will also be appreciated that the systems with which this invention are concerned may have many tens of outlets or so-called offtakes usually connected in series as an entire laboratory or building may need to be served by a single fluid delivery system. The diameter of the pipes commonly used in such systems may be of the order of 1-2½ inches (25-64mm), and to

ensure a turbulent flow within such a pipe the flow velocities are typically between 1-3m/s.

In order to develop such a flow velocity, substantial and thus costly pumping apparatus is required, and when it is also considered that a number of different offtakes may be in use simultaneously, dynamic control of this pump and/or alternatively some means of pressure regulation is required. Conventional Fluid delivery systems must possess an ability to deliver fluid through a number of off-takes opened simultaneously while nevertheless operating satisfactorily when none of the offtakes are in use, for example overnight. The inherent disadvantage of series-type systems, in which a plurality of offtakes are connected in series such as described, is that the opening of more than a few offtakes simultaneously can have detrimental effect both on the flow characteristics and the ability to draw water at the correct flow and pressure at the various user offtakes. The number of offtakes which can be opened simultaneously in a system expressed as a percentage of the total number of offtakes in a system is known as the diversity.

Various different pipework loop and sub-loop configurations having different benefits and effects on diversity have been proposed.

Referring now to Figures 1, 2, 3, and 4 which show different fluid delivery systems of prior art configuration, each of these systems shows a storage vessel 2 with which pipework 4 communicates to both feed offtakes 6 which are embodied most simply in an openable valve and to return excess fluid to the storage vessel at 8.

Each of the systems shown in the Figures comprises at least one pump 10 and in the case of Figure 2 a second pump 12, each of which urges fluid through the pipework around the system in a flow direction 14.

It can be seen from Figure 1 that the pipework is sloped at 16 between off takes and this is a common feature of such systems to allow for drainage of the fluid from the system for cleaning purposes. A heater 18 and a pressure regulating valve 20 are also provided in series with the various offtakes 6 and it will be appreciated that this simple series system functions in a very similar manner to a simple series electrical circuit, with the pump corresponding to a source of potential difference, the offtakes corresponding to resistances dissipating power and the flow rate corresponding to the current. Indeed the analogy can be extended in the cases of Figures 2, 3, and 4 which effectively show parallel circuits.

The importance of this analogy is that as further offtakes are added into a particular loop, the fluid flow which the system is capable of delivering through each of the offtakes when open is reduced depending on the number of offtakes in that loop. This is identical to the reduction in brightness of lightbulbs connected in series in an electrical circuit as more and more lightbulbs are connected.

In the case of Figure 2 which shows a multiple loop arrangement, a second pump 12 drives fluid through a second loop of the system and effectively provides sufficient flow through said loop to feed the various offtakes in that loop. In the case of Figure 3, a sub-loop or true parallel arrangement is shown, and in the case of Figure 4 a more complex main loop/sub loop arrangement is shown wherein four separate sub loops 22, 24, 26, 28 are fed from a main loop 30. Each of the

sub loops is provided with a diaphragm valve 32 immediately after the join to the main loop, and additionally Constaflo™ flow regulating valves 34 are provided on each of the sub loops, at the most remote end of the main loop, and on a return loop 36 which links the main loop immediately after the pump 10 to the storage vessel 2. Without unnecessary description and analysis of the working of this arrangement, the diaphragm valves, flow regulating valves and return loop are all provided with a view to increasing the effective diversity of the system as a whole and to ensure correct hydraulic balancing of the system.

The fundamental disadvantages of the systems described other than their limited ability to operate at maximum diversity are primarily related to the perceived permanent nature of the construction. For instance, in order to deliver a sufficient quantity of fluid around the system, the pipes must be of large diameter which both increases the cost of materials and construction. Stainless steel pipe sections currently used in the construction of such systems typically are provided in only 6m lengths which necessitates a considerable amount of welding and increases the risk of areas of bacterial germination around the system due to crevices introduced through such welding or alternative jointing procedures.

In the event that an additional offtake is required in an already installed system, it is very difficult and/or costly to modify the system, but perhaps most importantly the disruption to the system caused by modification can be severe. For example, the insertion of an additional offtake would necessitate a full draining of the system, opening the system to insert the additional pipework and offtake required, together with subsequent resterilisation and re-charging. Furthermore, the additional offtake could foreseeably necessitate a larger pump and additional flow and pressure regulating components. It has

been estimated that the average cost of installation of a fluid delivery system is approximately £200 per metre and it will thus be appreciated that these systems can significantly increase the cost of premises construction. The welding process is also subject to rigorous and costly inspection and qualification procedures as part of the regulatory traceability requirements of HM Medicines Inspectorate and the like.

It is an object of this invention to provide a fluid delivery system whose effective diversity is above 90% and preferably approximately 100% but which is significantly less expensive than prior art systems to construct , install, and inspect and subsequently certify.

It is a further object of the invention to provide a system which can be installed with the minimum number of crevices and imperfections in the interior surface of the pipework through which the fluid flows, and additionally to offer the possibility of installing a substantially crevice-free system, at least in the pipework coupling the offtakes to the pumping room. It is a further object of the invention to provide a system with as few joints between respective sections of pipework as possible.

According to the invention there is provided a fluid delivery system comprising a storage vessel for fluid which feeds a first pipework loop including a first pump which urges fluid through said first loop at a first pressure and which ultimately returns to said vessel, said system including at least one pipework branch fed from said storage vessel or said first pipework loop, said pipework branch including a second pump which urges fluid through said pipework branch at a second pressure downstream of said second pump, characterised in that each pipework branch terminates in a branch manifold having at least a fluid inlet and one or more fluid outlets to the latter of which are connected

one or more hoses which feed one or more offtakes from which fluid can be drawn from the system, and in that for each branch manifold there is a corresponding return manifold in fluid communication with said first pipework loop to which said offtakes are connected by further hoses such that fluid can flow from said branch manifold through said hoses and thence through said return manifold ultimately being returned to the tank when the offtakes are closed, said first and second pressures being both above atmospheric pressure such that the opening of said one or more offtakes, and thus the opening of said system to atmospheric pressure at one or more locations causes the direction of fluid flow to reverse in the one or more hoses which connects said one or more opened offtakes with the return manifold, said one or more opened offtakes thus being supplied with fluid from both the branch manifold and the return manifold.

Most preferably, the branch manifold is fed from the storage vessel.

Ideally the branch and return manifolds have at least a fluid inlet and one or more fluid outlets, said branch and return manifolds being disposed downstream of said first and second pumps with fluid communication between said manifolds being achieved by at least one hose connectable to fluid outlets on respective manifolds and including one or more offtakes thus allowing fluid flow from the storage vessel through the pipework branch, branch manifold, hose, return manifold and first pipework loop ultimately returning to said storage vessel and permitting fluid offtake at a desired location.

Preferably, said return manifold is provided with a fluid inlet and a primary fluid outlet to allow for connection of said manifold within the first pipework loop and a plurality of

secondary outlets to which hoses having offtakes may be connected to allow for fluid communication with the branch manifold.

Further preferably the branch manifold is provided with a fluid inlet and only secondary outlets to which hoses having offtakes may be connected such that the fluid flowing into said branch manifold is urged into one or more hoses.

Preferably the fluid pressure within the return manifold is greater than the fluid pressure in the branch manifold, and most preferably both these pressures are above ambient atmospheric pressure such that the opening of an offtake opens the fluid within to atmospheric pressure and the fluid flow direction in the length of hose between said offtake and said return manifold reverses and both manifolds urge fluid towards said open offtake.

In most preferable circumstances, a plurality of hose connections are made between the branch manifold and the return manifold, each connection consisting of a first hose, one end of which is connected to one fluid outlet the branch manifold and the alternate end of which is connected to an offtake, a second hose having one end connected to the offtake and the alternate end connected to a fluid outlet of the return manifold. Most preferably, each hose connection between branch and return manifolds consists only of a single offtake, but alternately, each connection may consist of first and second hoses, ends of which are connected to the branch and return manifolds respectively, alternate ends of said hoses being connected to first and second primary offtakes, and the connection further comprising one or more secondary offtakes interconnected by intermediary hoses between said first and second primary offtakes and second secondary offtakes.

Further preferably each hose is made of a flexible polymeric or plastics material such as PTFE.

Preferably, the hose diameter is in the region of 5-25mm.

Most preferably at least one of the first or second pumps is dynamically controlled depending on the fluid pressure within the respective return or branch manifold, and most preferably the pump driving fluid through the first pipework loop is dynamically controlled depending on the instantaneous fluid requirements of the system, i.e. the number of offtakes which are open at any one instant.

Most preferably only the second pump is dynamically controlled depending on the fluid pressure within the respective return and branch manifolds.

The system described above has the surprising advantage that the opening of any offtake provided on any particular hose connection between the manifolds causes a reversal in the direction of fluid flow in the hose section from the return manifold to the said offtake. Such flow direction reversal is achieved because the fluid pressure developed in the return manifold is greater than the pressure developed in the branch manifold and thus the fluid is urged through the offtake (which is effectively at atmospheric pressure once opened) along both sections of hose linking the offtake to said manifolds.

The system has many attendant advantages resulting from the novel arrangement described, particularly including

1. lower cost of installation and associated validation
2. elimination of need for site-wide welding and the associated hazards of this process;

3. facility for installation by non-specialist contractors (as the hoses and offtakes may be installed by for example electrical cable installers);
4. easy relocation/isolation of individual offtakes;
5. future pre-cleaned offtakes can be easily added to the spare manifold secondary outlets and brought on-line without interruption to the live existing system;
6. offtake hoses can be individually sterilised;
7. hoses can be drained by (sterile) air or gas being blown therethrough thus avoiding extra costs for routing gravity drainage, and
8. hose sterilisation can be achieved by a number of methods, such as chemical recirculation, steam out, hot sterile air (160°C), ozone.

Perhaps the most important advantage is that provided the pumps are effectively dynamically controlled, the diversity of the system remains at almost 100% as more and more offtakes are simultaneously opened. The only limit to the number of offtakes which can be opened simultaneously without any appreciable flow reduction therethrough is the diameter of the pipes and manifolds through which the fluid is urged by the pump (and thus the volume of fluid which can be delivered to the manifolds by said pumps).

A specific embodiment of the invention is now described by way of example with reference to the accompanying drawings wherein

Figures 1-4 schematically show fluid delivery systems of prior art configuration,

Figure 5 schematically shows a fluid delivery systems according to the invention,

Figures 6, 7 show details of possible offtake shroud assemblies,

Figures 8, 9 show perspective views of possible loop and branch manifold assemblies,

Figures 10, 11 show schematically possible offtake assemblies.

Figure 12 shows an alternative arrangement for a system according to the invention.

Referring firstly to Figure 5 there is shown a fluid delivery system 50 comprising a storage vessel feeding pipework 52 which divides into a pipework loop 54 and a pipework branch 56. The loop 54 ultimately returns to the storage vessel 52 at 58 to recharge said vessel with fluid pump around the system.

In each of the loop 54 and the branch 56 are provided pumps 60, 62 respectively which are located upstream of a return manifold 64 and a branch manifold 66 each of which has at least a primary fluid inlet 64A, 66A and a number of secondary fluid outlets 64B, 66B to which hoses 64C, 66C can be connected. Each of the hoses 64C, 66C is connected to an offtake which essentially comprises an openable valve which when closed allows fluid by pass from the hoses 66C to 64C.

In a preferred embodiment, the pumps 60, 62 are dynamically controlled by coupling the pump motor to manifold pressure sensors schematically represented at 70, 72 in response to changes in fluid pressure inside the manifolds 64, 66. In this manner, the fluid flow and pressure can be automatically maintained at required levels when one or more of the offtakes is opened to deliver fluid therethrough. It is to be mentioned that this arrangement provides the most accurate control, but

once the operating limits of a particular system are determined it is more likely that only a single pump need be dynamically controlled.

Downstream of the return manifold, there may optionally be provided a sanitisation unit and/or a heat exchanger 73, 74 to ensure that the desired temperature is maintained during operation. Thereafter fluid is returned to the vessel 52 from which it is later pumped around the system.

Example system operating conditions include a minimum flow rate of 100litres/min in the pipework branch, a maximum flow rate of 160litres/min, a pressure of 6bar in the branch manifold, and a minimum flow rate of 45litres/min in the pipework loop, a maximum flow rate of 225litres/min and a return manifold pressure of 2 bar.

Figure 5 also schematically shows a possible layout of the system in that the bulk of the apparatus used in the system is located in a plant room schematically defined above the dotted line 76, a portion of the length of the hoses 64C, 66C which communicate with the offtakes and the respective loop and branch manifolds are disposed in a roof or wall void represented between dotted line 76 and a further dotted line 78, and the offtakes 68 are optionally connected at the end of shrouds secured to the roof or walls to conceal the hoses.

Examples of such shrouds 80, 82 and offtakes 84, 86 are shown in Figures 6 and 7.

Figures 8, 9 show possible embodiments of the return manifold 64 and branch manifold 66. The manifolds are different because fluid is required to flow through the return manifold 64 from a primary inlet 64A to a primary outlet 64A' in the direction

indicated at 88. There are further provided various secondary fluid outlets 64B the number of which corresponds to the number of offtakes desired in a particular system, and although the word "outlet" is used in connection with these fittings, it is to be appreciated that fluid in generally will only flow out of same when the particular offtake fed by the hose connected to said outlet is opened. In the alternate circumstance when the offtake is closed, fluid will flow into the manifold through outlet and be combined with the fluid flow through the manifold from one end to the other as indicated at 88. A pressure control outlet PC for dynamic pump control and a spare instrument access 90 are also provided.

In the case of the branch manifold 66, a primary inlet 66A is provided, together with a number of secondary outlets 66B to which the hoses 66C are connected. A pressure control outlet PC is disposed at one end of the manifold 66 whereas the opposite end is blanked off at 92 to prevent any fluid escape through said end. In the case of the branch manifold, fluid flows continually through the outlets 66B regardless of whether the offtakes fed by hoses 66C are open or closed.

Referring to Figures 10 and 11, there is shown a schematic representation of an offtake having connectors 94, 96 to which hoses 66C, 64C are connected to feed the offtake with fluid. A chamber 98 is provided which allows for fluid flow from hose 66C to hose 64C when the offtake is closed and for fluid reversal in hose 64C when the offtake is opened, and this in turn is connected to a standard diaphragm valve or similar 100 having actuator 102 if necessary.

A schematic sectional view of the chamber is shown in Figure 11 and it can be seen from this figure that the flow of fluid within

said component may be achieved by orifice plates 104 provided internally thereof.

In circumstances where a user only gradually opens a valve to an offtake, it is foreseeable, depending on the design of the various components within a system, that the fluid flow velocity within hose 64C could merely reduce as opposed to become reversed, and in particular circumstances it may also transpire that on opening an offtake by a predetermined amount, the fluid velocity in the hose 64C reduces to zero, said offtake being supplied entirely by fluid flow to the offtake through hose 66C. Such operating conditions are envisaged only transiently and would not prevail for any significant length of time which could materially affect the hygiene of the fluid within the system as a whole. It is also to be mentioned that these particular operating characteristics will only arise infrequently, and the most desirable system operation will involve the reversal of fluid flow direction through hose 64C.

Finally, referring to Figure 12, there is shown an alternative arrangement of a fluid delivery system which functions in accordance with the invention. In the arrangement shown, a storage vessel 200 is fed with a supply of purified or sterile water at 202, and the vessel 200 is connected within a first pipework loop 204. Within said first pipework loop, there is disposed a low pressure, high volume pump 206 which causes fluid flow around the loop 204. The box 208 in this figure which surrounds the pump and vessel is representative of a site pumping and equipment room, and remaining boxes in dotted lines 210, 212, 214 are representative of either different buildings to which a supply of sterile fluid is required to be delivered, or alternatively different but remotely located zones in the same building.

Accordingly, the first pipework loop is constructed around a path which approaches each zone at a suitable location. In the region of each zone, a branch 218 is taken from the main loop and feeds a pump 220 which may be dynamically controlled at 222 according to instantaneous fluid usage requirements at the various offtakes 224 required or being used in that zone at any time. The pump 220 delivers pressurised fluid to a branch manifold 226 which is connected to said offtakes 224 by hoses 228, which are in turn connected to a return manifold 230 by further hoses 228. Return legs 232, 234 are provided between the return manifold and the first loop 204 on the one hand to enable fluid to rejoin the first loop from said return leg in the event that no offtakes are opened in a particular zone, and on the other hand to allow fluid to fluid towards and through the return manifold in the event that one or more offtakes are opened in that particular zone. It will be appreciated that a second pump may be required in one of the return legs 232, 234 to ensure a fluid flow from the first loop 204 into said return manifold and back to the first loop along the alternate leg, but equally it is envisaged that the system may be designed that such a pump might not be required.

The arrangement shown in the Figure demonstrates that it is not necessary to locate all of the storage vessel, the first pump, the first pipework loop, the pipework branch, and the branch and return manifolds in the same room.

In summary therefore, a fluid delivery system is described whereby sterile liquid may be delivered efficiently to a number of remote locations while nevertheless maintaining a continuous fluid flow through the system to prevent any bacterial growth. The system includes a storage tank feeding a first pipework loop including a first pump which urges fluid through said first loop at a first pressure and which returns to the tank, and also

includes at least one pipework branch fed from the tank and having a second pump which urges fluid through the branch at a second pressure downstream of the second pump. The system functions efficaciously in that a branch manifold terminates each branch and a return manifold is provided in the first pipework loop. Between these two manifolds are connected one or more supply hoses interrupted by an offtake component which is a simple valve opening through which the fluid can be selectively delivered at the desired location. When one or more offtakes are opened, the conventional fluid flow in the hose which links that offtake to the return manifold is reversed on account of the pressures at which the two pumps in the first pipework loop and the pipework branches operate. This type of operation allows for practically 100% diversity, i.e. that condition where as many or as few offtakes in the system can be opened simultaneously without any practical reduction in the availability of fluid.

CLAIMS

1. A fluid delivery system comprising a storage vessel for fluid which feeds a first pipework loop including a first pump which urges fluid through said first loop at a first pressure and which ultimately returns to said vessel, said system including at least one pipework branch fed from said storage vessel or said first pipework loop, said pipework branch including a second pump which urges fluid through said pipework branch at a second pressure downstream of said second pump, characterised in that each pipework branch terminates in a branch manifold having at least a fluid inlet and one or more fluid outlets to the latter of which are connected one or more hoses which feed one or more offtakes from which fluid can be drawn from the system, and in that for each branch manifold there is a corresponding return manifold in fluid communication with said first pipework loop to which said offtakes are connected by further hoses such that fluid can flow from said branch manifold through said hoses and thence through said return manifold ultimately being returned to the tank when the offtakes are closed, said first and second pressures being both above atmospheric pressure such that the opening of said one or more offtakes, and thus the opening of said system to atmospheric pressure at one or more locations causes the direction of fluid flow to reverse in the one or more hoses which connects said one or more opened offtakes with the return manifold, said one or more opened offtakes thus being supplied with fluid from both the branch manifold and the return manifold.

2. A fluid delivery system according to claim 1 characterised in that the branch manifold is fed from the storage vessel.

3. A fluid delivery system according to either claim 1 or 2 characterised in that the branch and return manifolds have at

least a fluid inlet and one or more fluid outlets, said branch and return manifolds being disposed downstream of said first and second pumps with fluid communication between said manifolds being achieved by at least one hose connectable to fluid outlets on respective manifolds and including one or more offtakes thus allowing fluid flow from the storage vessel through the pipework branch, branch manifold, hose, return manifold and first pipework loop ultimately returning to said storage vessel and permitting fluid offtake at a desired location.

4. A fluid delivery system according to any preceding claim characterised in that said return manifold is provided with a fluid inlet and a primary fluid outlet to allow for connection of said manifold within the first pipework loop and a plurality of secondary outlets to which hoses having offtakes may be connected to allow for fluid communication with the branch manifold.

5. A fluid delivery system according to any of claims 1-3 characterised in that the branch manifold is provided with a fluid inlet and only secondary outlets to which hoses having offtakes may be connected such that the fluid flowing into said branch manifold is urged into one or more hoses.

6. A fluid delivery system according to any preceding claim characterised in that the fluid pressure within the return manifold is greater than the fluid pressure in the branch manifold.

7. A fluid delivery system according to any preceding claim characterised in that the pressures in the branch and return manifolds are above ambient atmospheric pressure such that the opening of an offtake opens the fluid within to atmospheric pressure and the fluid flow direction in the length of hose

between said offtake and said return manifold reverses and both manifolds urge fluid towards said open offtake.

8. A fluid delivery system according to any preceding claim characterised in that a plurality of hose connections are made between the branch manifold and the return manifold, each connection consisting of a first hose, one end of which is connected to one fluid outlet the branch manifold and the alternate end of which is connected to an offtake, a second hose having one end connected to the offtake and the alternate end connected to a fluid outlet of the return manifold.

9. A fluid delivery system according to claim 8 characterised in that each hose connection between branch and return manifolds consists only of a single offtake.

10. A fluid delivery system according to claim 8 characterised in that each connection consists of first and second hoses, ends of which are connected to the branch and return manifolds respectively, alternate ends of said hoses being connected to first and second primary offtakes, and the connection further comprising one or more secondary offtakes interconnected by intermediary hoses between said first and second primary offtakes and second secondary offtakes.

11. A fluid delivery system according to any preceding claim characterised in that each hose is made of a flexible polymeric or plastics material such as PTFE.

12. A fluid delivery system according to any preceding claim characterised in that the hose diameter is in the region of 5-25mm.

13. A fluid delivery system according to any preceding claim characterised in that at least one of the first or second pumps is dynamically controlled depending on the fluid pressure within the respective return or branch manifold, and most preferably the pump driving fluid through the first pipework loop is dynamically controlled depending on the instantaneous fluid requirements of the system, i.e. the number of offtakes which are open at any one instant.

14. A fluid delivery system according to claim 13 characterised in that only the second pump is dynamically controlled according to the fluid pressure within the respective return and branch manifolds.

FIG. 1

FIG. 2

FIG. 3

2
36
14
34
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FLOW
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32
14
4
34
32
34
32
34
32
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32
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34
22
24
26
28

FIG. 4

73
58
74
50
52
(+)
(-)
64C
64
PC
52
70
54
60
M
64B
64A
M
PC
66B
72
56
66A
76
62
66
66C
78
68
68
68
68
(+)

FIG. 5

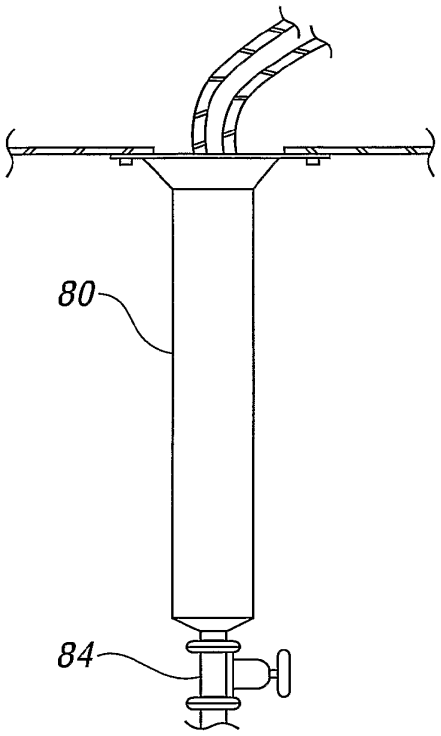


FIG. 6

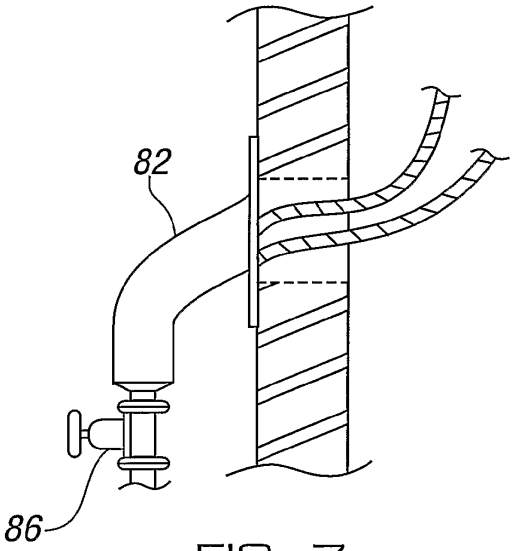


FIG. 7

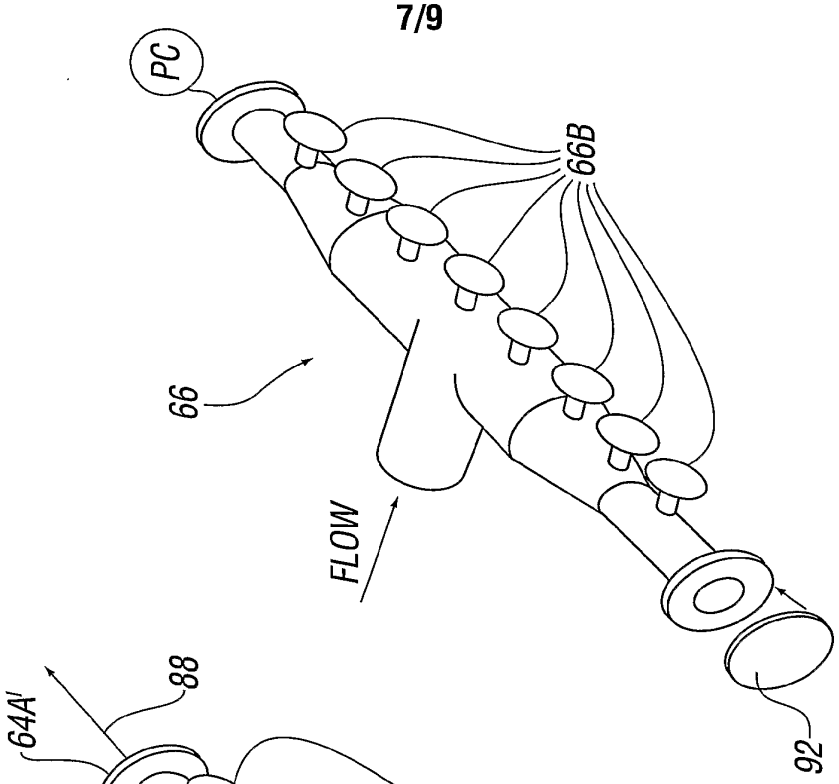


FIG. 9

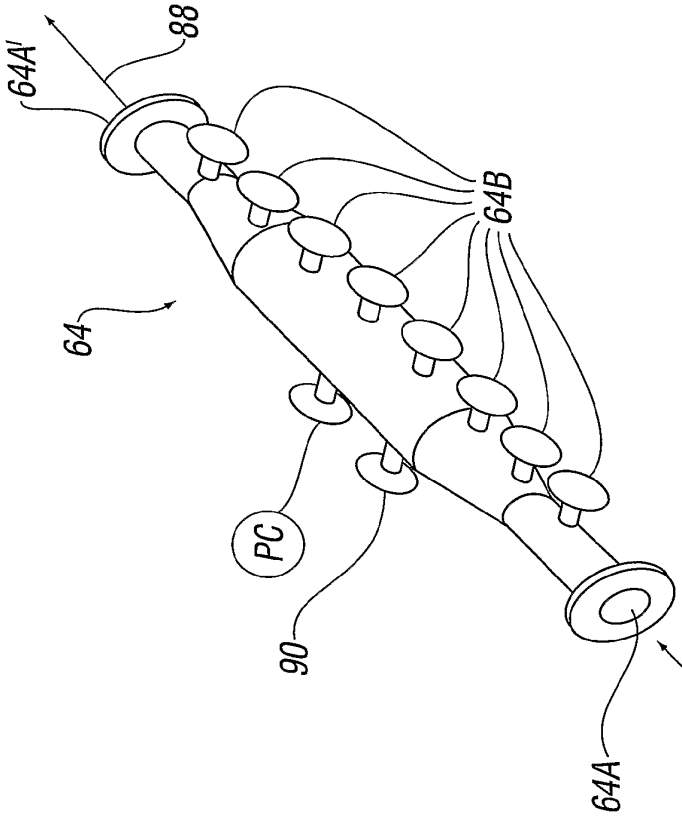


FIG. 8

FIG. 10

FIG. 11

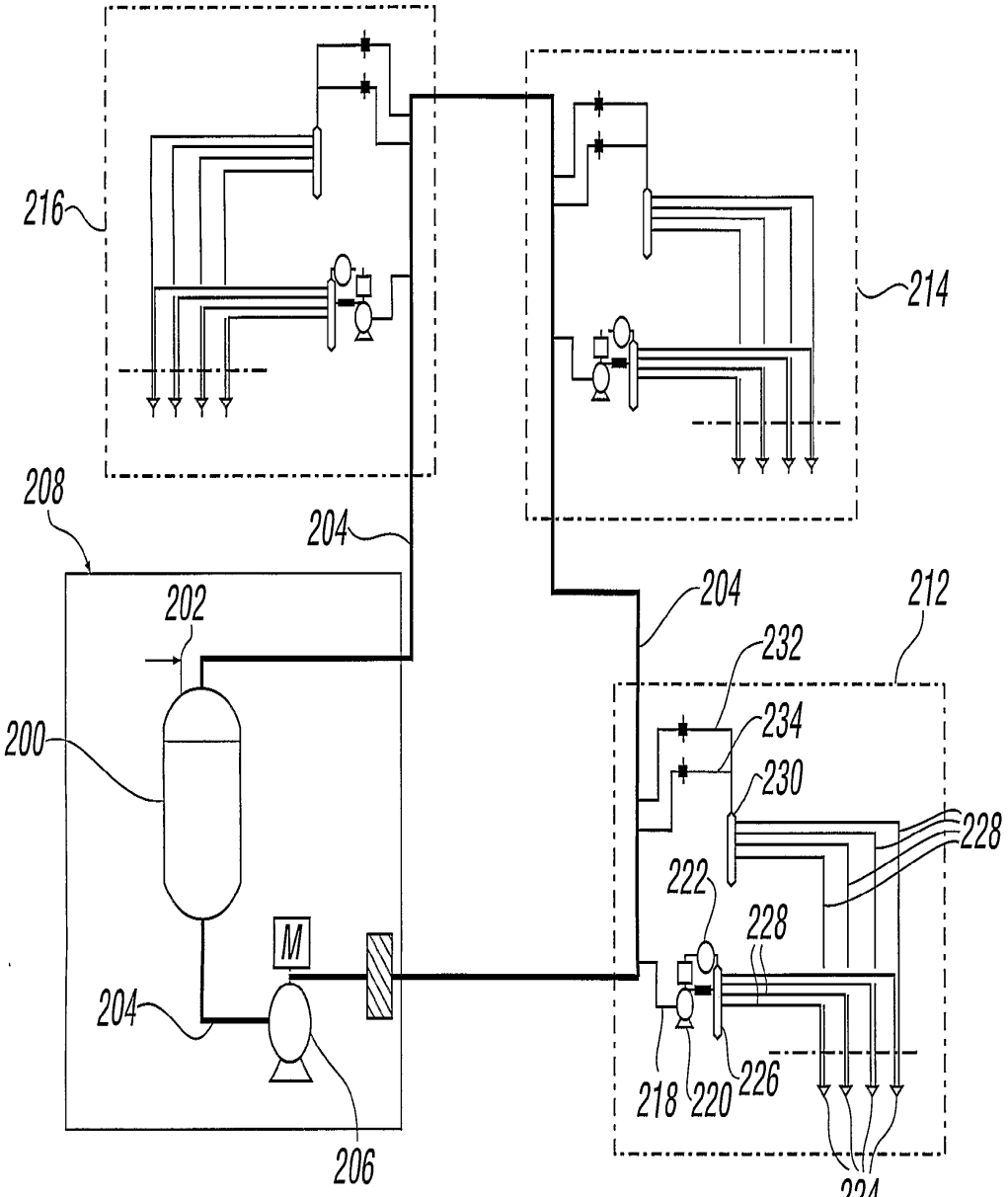

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FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
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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)
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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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 39 19 074 A (DUERR GMBH & CO) 10 January 1991 (1991-01-10) column 2, line 65-68 column 3 column 4, line 1-19; figure 1	1-14
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 February 2003	07/03/2003

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 02/04148

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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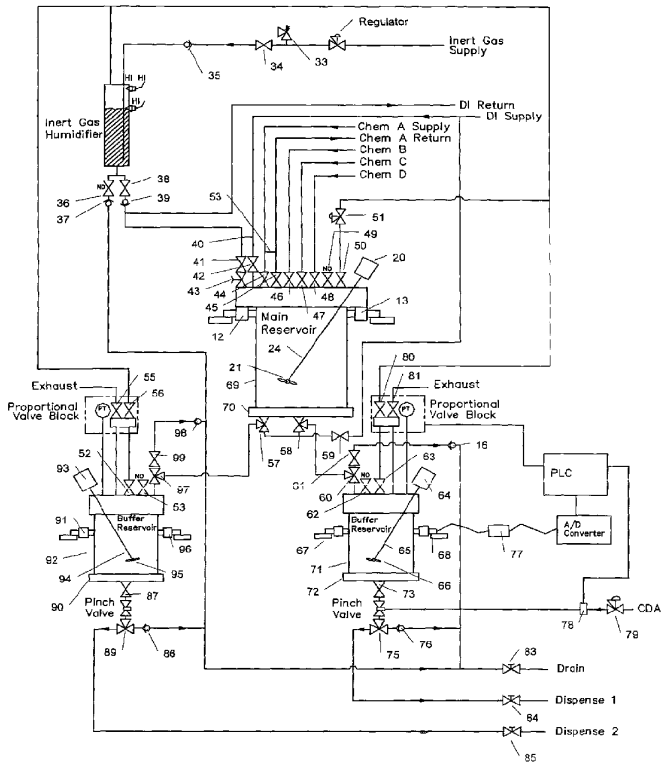
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(54) Title: CHEMICAL MIX AND DELIVERY SYSTEMS AND METHODS THEREOF



(57) Abstract: Chemical delivery systems and methods for delivery of liquid chemicals are disclosed. In on embodiment, systems having multi-reservoir load cell assemblies (Figs. 2, 4, 5, 7, 9, 11) for delivering chemicals used in the semiconductor industry are disclosed. In another embodiment (Fig. 12), the present invention provides a multi reservoir load cell assembly (69, 92, 71), including a controller (PLC), a buffer reservoir (92, 71), a main reservoir (69), one or more load cells (12, 13, 67, 68, 91, 96) coupled to the assembly and to the controller, operable to weigh the liquid in the reservoirs, a plurality of supply lines (A-D), each supply reservoir, and a gas and vacuum sources for withdrawing the liquid from the assembly when demanded by the controller and for refilling the assembly from the supply containers. A proportional valve block including a buffer control Intel (80) and outlet (81) valves adjust the pressure to the buffer reservoirs.

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CHEMICAL MIX AND DELIVERY SYSTEMS AND METHODS THEREOF

BACKGROUND

This application is a continuation-in-part of U.S. Application No. 09/968,566, filed on September 29, 2001, which is a continuation of U.S. Application 09/870,227, filed on May 30, 2001, now U.S. Patent No. 6,340,098, which is a continuation of U.S. Application No. 09/568,926, filed on February 13, 2001, now U.S. Patent No. 6,269,975, which is a continuing prosecution application of U.S. Application No. 09/568,926, filed on May 10, 2000, now abandoned, which is a divisional of U.S. Application No. 09/224,607, filed on December 31, 1998, now U.S. Patent No. 6,098,843, which is a continuation of U.S. Application No. 09/222,003, filed on December 30, 1998, now abandoned. This application incorporates by reference each application and each patent listed above.

The present invention relates generally to systems and methods for mixing and/or delivering of liquid chemical(s), and more particularly, to systems and methods for mixing and delivering liquid chemicals in precise amounts using logic devices and multi-reservoir load cell assemblies.

The present invention has many applications, but may be explained by considering the problem of how to deliver photoresist to silicon wafers for exposure of the photoresist in the process of photolithography. To form the precise images required, the photoresist must be delivered in precise amounts on demand, be free of bubbles, and be of precise uniform thickness on the usable part of the wafer. The conventional systems have problems as discussed below.

As shown in Figure 1, a representative conventional photoresist delivery system includes supply containers 100, 102, typically bottles, which supply photoresist to a single-reservoir 104 by line 117, which is connected to supply lines 106, 108

monitored by bubble sensors 110, 112 and controlled by valves V1 and V2. The bottom of the reservoir is connected to a photoresist output line 114 to a track tool (not shown), which dispenses photoresist on the wafer. The space above the photoresist in the reservoir 104 is connected to a gas line 118 which, based on position of a three-way valve V3, either supplies nitrogen gas to the reservoir 104 from a nitrogen manifold line 126, regulated by needle valve 1, or produces a vacuum in the reservoir 104. To sense the level of the photoresist in the reservoir 104, the system employs an array of capacitive sensors 122 arranged vertically on the walls of the reservoir 104. A two-way valve V4, located between the nitrogen gas manifold and the inlet of a vacuum ejector 124, supplies or cuts off flow of nitrogen to the vacuum ejector 124.

The photoresist delivery system must be "on-line" at all times so the track tool can dispense the photoresist as required. Many of the photoresist delivery systems attempt to use the reservoir to provide an on-line supply of photoresist to the track tool, but the photoresist delivery system must still refill the reservoir on a regular basis, which is dependent on timely replacement of empty supply containers. Otherwise, the track tool will still fail to deliver the photoresist when demanded.

During dispense mode, when the track tool withdraws photoresist from the reservoir 104, the valve V3 permits the nitrogen to flow from the nitrogen manifold to the reservoir 104 to produce a nitrogen blanket over the photoresist to reduce contamination and to prevent a vacuum from forming as the photoresist level drops in the reservoir. Once the photoresist in the reservoir 104 reaches a sufficiently low level the system controller (not shown) initiates refill mode, where a set of problems arise.

During refill mode, the valve V4 is activated so that nitrogen flows from the manifold line 126 to the vacuum ejector 124, which produces a low pressure line 170 thereby producing a low pressure space above the photoresist in the reservoir 104. The bubble sensors 110, 112 monitor for bubbles in the supply lines 106, 108, presumed to develop when the supply containers 100, 102, become empty. If, for example, the bubble sensor 110 detects a bubble, the controller turns off the valve V1 to supply container 100 and the valve V2 opens to supply container 102 to continue refilling the reservoir 104. However, bubbles in the supply line 106 may not mean supply

container 100 is empty. Thus, not all of the photoresist in supply container 100 may be used before the system switches to the supply container 102 for photoresist. Thus, although the conventional system is intended to allow multiple supply containers to replenish the reservoir when needed, the system may indicate that a supply container is empty and needs to be replaced before necessary.

If the supply container 100 becomes empty and the operator fails to replace it and the system continues to operate until the supply container 102 also becomes empty, the reservoir 104 will reach a critical low level condition. If this continues, bubbles may be arise due to photoresist's high susceptibility to bubbles; if a bubble, however minute, enters the photoresist delivered to the wafer, an imperfect image may be formed in the photolithography process.

Further, if the pump of the track tool, connected downstream of the chemical output line 114, turns on when the reservoir is refilling, the pump will experience negative pressure from the vacuum in the single-reservoir pulling against the pump. Several things can happen if this persists: the lack of photoresist delivered to the track tool may send a false signal that the supply containers are empty, the pump can fail to deliver photoresist to its own internal chambers, lose its prime and ability to adequately dispense photoresist, and the pump can even overheat and burn out. The result of each scenario will be the track tool receives insufficient or even no photoresist, known as a "missed shot," which impacts the yield of the track tool.

The present invention also may be explained by considering the problems associated with mixing and delivering slurry for chemical mechanical polishing (CMP). In semiconductor manufacturing, a slurry distribution system (SDS) delivers CMP slurry to the polisher. For example, *Handbook of Semiconductor Manufacturing Technology* (2000), which is incorporated by reference, describes delivery of CMP slurries to a polisher and shows an arrangement for a SDS at page 431. In some applications, the SDS needs to mix the components of the slurry in a mix tank. During mixing and handling of the slurry, the SDS must not damage the slurry by subjecting it to too much shear, which may cause aggregation, or too little shear, which may cause settling. A pump may transfer the slurry to a distribution tank when required by the process tool. The SDS should handle a variety of chemistries because a CMP slurry formulation is often tailored to each process. The SDS should

introduce precise of amounts of the slurry components into a mix tank so that the slurry mixture is known. At times, there also needs to be a precise flow rate to the process tool and/or delivery at low flow rates. At low flow rates sometime microbubbles form in the dispense lines, which prevents slurry delivery. It would be desirable to clear lines without shut down of the SDS. Of course, reliability for flawlessly daily manufacturing and delivery of the slurry is also desired, as well as ease of regular maintenance to avoid varying slurry composition that may affect process results.

Flow meters are commonly used to control the flow rates of chemicals. Flow meters are usually only accurate to within 2-3% of the desired flow rate, and are also susceptible to changes due to input pressure. Second, some chemicals will cause the flow meter to plug up and allow no flow, i.e. slurries. Another method for controlling flow is to use a "push" gas to pressurize a reservoir, and then adjust the push gas pressure to adjust the flow rate. This method also will not allow accurate flow rates, due to the potential of the push gas pressure changing, and the flow rate varying as the level within the reservoir changes.

The present invention addresses these problems as well as avoids waste of chemicals, provides a friendly user interface depicting the amount of chemicals remaining in the supply containers, and reduces system capital and operating costs. If, for example, the amount of chemical in the supply containers cannot be seen, the present invention permits the interface to be provided at a distance by conventional computer network capabilities and the electronics provided.

SUMMARY OF THE INVENTION

The present invention relates to systems using controllers or logic devices and multi-reservoir load cell assemblies for precision mixing and/or delivery of liquid chemicals. It also relates to methods of delivering liquid chemicals from supply sources to processes such that the present invention accurately accounts and adjusts for the dynamic supply and use of the liquid chemical to meet process requirements. Finally, the present invention provides multi-reservoir load cell assemblies for monitoring, regulating, and analyzing the liquid supply available to a process.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a chemical delivery system using a single-reservoir and bubble sensors on the supply lines leading to the single-reservoir.

Figure 2A is a front cross-section of a first embodiment of the multi-reservoir load cell assembly of the present invention.

Figure 2B is a top view of the first embodiment of the multi-reservoir load cell assembly.

Figure 3, a piping and instrument diagram, illustrates embodiments of the chemical delivery system including the multi-reservoir load cell assemblies of Figures 2A-2B or 4A-4B.

Figure 4A is a front cross-section of a second embodiment of the multi-reservoir load cell assembly.

Figure 4B is a side cross-section of the second embodiment of the multi-reservoir load cell assembly.

Figure 5A is a front cross-section of a third and sixth embodiment of the multi-reservoir load cell assembly.

Figure 5B is a side cross-section of the third and sixth embodiment of the multi-reservoir load cell assembly.

Figure 6, a piping and instrument diagram, illustrates embodiments of the chemical delivery system including the multi-reservoir load cell assemblies of Figures 5A-5B or 11A-11B.

Figure 7A is a front cross-section of a fourth embodiment of the multi-reservoir load cell assembly.

Figure 7B is a side cross-section of the fourth embodiment of the multi-reservoir load cell assembly.

Figure 8, a piping and instrument diagram, illustrates an embodiment of the chemical delivery system including the multi-reservoir load cell assembly of Figures 7A-7B.

Figure 9A is a front cross-section of a fifth embodiment of the multi-reservoir load cell assembly.

Figure 9B is a side cross-section of the fifth embodiment of the multi-reservoir load cell assembly.

Figure 10, a piping and instrument diagram, illustrates an embodiment of the chemical delivery system including the multi-reservoir load cell assembly of Figures 9A-9B.

Figure 11A is a front cross-section of a seventh embodiment of the multi-reservoir load cell assembly.

Figure 11B is a side cross-section of the seventh embodiment of the multi-reservoir load cell assembly.

Figure 12, a piping and instrument diagram, illustrates an embodiment of the chemical mix and delivery system.

Figure 13, a flow chart, illustrates a flow rate control system using the diminishing weight of liquid in at least one of the reservoirs.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the first embodiment, the present invention includes a multi-reservoir load cell assembly 200 as shown in Figures 2A-2B. The assembly 200 can be part of the system shown in Figure 3, and can replace the problematic single-reservoir 104 and bubble sensors 110, 112 of Figure 1.

In this embodiment, the assembly 200, constructed of Teflon, SST, polypropylene or any chemical compatible material, includes an upper compartment 202, a main reservoir 206, and a buffer reservoir 208, all in an outer housing 212. The buffer reservoir 208 is sealed from the main reservoir 206 by a separator 209, and an o-ring seal 211 seals the perimeter of the separator 209 to the outer housing 212. The separator 209 uses a center conical hole 250 that allows an internal sealing shaft 204 to form a liquid and gas-tight seal with the separator 209. The separator 209 forms a liquid and gas-tight seal to the pneumatic tube 215 with an o-ring seal 210. The main reservoir 206 contains a middle sleeve 214 that forms a rigid separation between the separator 209 and the reservoir cap 205. O-ring 203 seals the perimeter of the reservoir cap 205 seals against the internal surface of the outer housing 212. The reservoir cap 205 seals against the internal sealing shaft 204, the chemical input tube 217, and the pneumatic tubes 215 and 218 with a set of o-ring seals 207, 220, 222, and 224 (hidden, but location shown in Figure 2B), respectively. Mounted to the reservoir cap 205 is a spacer 244, which also mounts to the pneumatic cylinder 226. The reservoir cap 205 is held in position by the upper sleeve 233 and the middle sleeve 214. The outer Teflon reservoir top 201 is bolted to the outer housing 212 and forms a mechanical hard stop for the upper sleeve 233 and the pneumatic cylinder 226. Pneumatic airlines for the pneumatic cylinder 226 penetrate the outer Teflon reservoir top 201 through the clearance hole 260.

It should be clear that the present invention is not limited to the delivery of CMP slurries or photoresist on silicon wafers. For example, although the invention shows advantages over the conventional system in this environment, the systems of the present invention can deliver other liquid chemicals for other types of processes. Because the novelty of the present invention extends beyond the nature of the chemical being delivered, the following description refers to the delivery of chemicals

to avoid a misunderstanding regarding the scope of the invention.

As shown in Figure 3, the multi-reservoir load cell assembly 200 shown in Figures 2A-2B is suspended on and weighed by a load cell 412, preferably such as a Scaime load cell model no. F60X10C610E and a programmable logic controller (PLC) 330, preferably such as the Mitsubishi FX2N, a computer, or another conventional logic device determines the volume of the chemical in the assembly 200 from the load cell weight and the specific gravity of the chemical. For brevity, we will refer to that logic device as a PLC. As chemical from line 217 is drawn into the main reservoir 206, the load cell 412 outputs a small mV analog signal 324 proportional to the weight on the load cell 412. In one embodiment, an ATX-1000 signal amplifier 326 boosts the small signal 324 to the 4-20 millivolt range and sends it to an analog-to-digital converter 328, such as the Mitsubishi FX2N4-AD, and the output digital signal 332 is sent to the PLC 330. The PLC 330 can be rapidly programmed by conventional ladder logic. During withdrawal of the chemical, the weight of the assembly 200 decreases until the software set point of the PLC 330 is reached.

As further shown in Figure 3, the PLC 330 may control valves V1-V5 using 24 DC Volt solenoid actuated valves, and activate them by an output card such as the Mitsubishi FX2N. Each solenoid valve, when opened, allows pressurized gas from regulator 2 such as a VeriFlow self-relieving regulator, to the pneumatically operated valves V1-V5 to open or close the valves. The sequence of operation of the first embodiment is programmed in the PLC 330 so the components shown in Figures 2A-2B and 3 work as described below.

Once the chemical drops to a certain level, the PLC 330 triggers the system shown in Figure 3 to begin an automatic refill sequence using the multi-reservoir load cell assembly 200 of Figures 2A-2B as follows:

a) A blanket of preferably low pressure, e.g., one psi inert gas is continuously supplied by the regulator 1, such as a Veriflow self-relieving regulator, to the main reservoir 206 by the pneumatic tube 218.

b) The pneumatic cylinder 226 lifts the internal sealing shaft 204, thereby sealing the buffer reservoir 208 from the main reservoir 206.

c) Once the buffer reservoir 208 is sealed, the main reservoir 206 is evacuated to a vacuum of approximately 28 inches of mercury. As shown in Figures 2A-2B, the pneumatic tube 218 from the main reservoir 206 connects to the output side of a three-way valve V4. Valve V4 is actuated so that the tube 218 communicates with the line 316 connected to the vacuum ejector 324 as shown in Figure 3. The vacuum ejector 324 is powered by compressed gas, which is directed to it by the two-way valve V5. Once valve V5 is on, it allows compressed gas to pass through and the vacuum ejector 324 develops about 28 inches of mercury (vacuum) through the line 316 communicating with the main reservoir 206.

d) The vacuum is isolated from the buffer reservoir 208, which has an inert gas slight blanket above it and continues to supply chemical to the process or tool without exposing the chemical being delivered to the tool to negative pressure or a difference in pressure.

e) The vacuum generated in the main reservoir 206 creates a low pressure chemical line that is connected to the valves V1 and V2. Assuming that valve V2 opens, the low pressure line 217 causes chemical from the supply container 102 to flow into the main reservoir 206. During this period of time the main reservoir 206 refills with chemical until a determined full level is achieved.

f) The full level is determined by use of the load cell 412 and weight calculations performed by the PLC 330. For example, one preferred embodiment uses a buffer reservoir 208 with a volume capacity of 439 cubic centimeters (cc) and a main reservoir 206 with a capacity of 695 cc. Using the specific gravity of the chemical, the PLC 330 calculates the volume that the chemical occupies. The PLC 330 then begins a refill sequence once the chemical volume reaches or falls below 439 cc. The refill stops once the chemical volume reaches 695 cc. This sequence allows nearly all of the 439 cc of the chemical in the buffer reservoir 208 to be consumed while refilling the main reservoir 206 with the 695 cc of chemical and prevents overflow of the main reservoir 206 or complete evacuation of chemical from the buffer reservoir 208.

g) Once the main reservoir 206 has refilled, the valve V5 is turned off, thereby stopping gas flow to and vacuum generation by the vacuum ejector 324. The

three-way valve V4 is then switched so that the inert gas line 218 communicates with the main reservoir 206 and an inert gas blanket is again formed over the chemical in the main reservoir 206 at the same pressure as the buffer reservoir 208, since both lines 218, 215 receive gas from the same inert gas manifold 318 (see Figure 3). Also, the valve V2 is closed which now isolates the supply container 102 from the main reservoir 206.

After the main reservoir 206 is full of chemical with an inert gas blanket above, the internal sealing shaft 204 is lowered and allows chemical from the main reservoir 206 to flow into the buffer reservoir 208. Eventually, the buffer reservoir 208 completely fills along with a majority of the main reservoir 206. The pneumatic tube 215 connecting the buffer reservoir 208 fills with chemical until the chemical in the tube 215 reaches the same level as the main reservoir 206, because the pressures in both reservoirs are identical. The internal sealing shaft 204 remains open until it is determined, to once again, refill the main reservoir 206.

Because the first embodiment uses load cells instead of bubble sensors for determining the amount of chemical in the supply containers, the present invention provides a number of very useful features. One can accurately determine in real-time the chemical remaining in the supply containers. If the supply containers are full when connected to the system, the PLC can easily calculate the chemical removed (and added to the multi-reservoir load cell assembly) and how much chemical remains in the supply containers. This information can be used to provide a graphical representation of the remaining amount of chemical in the containers. A second feature is that the PLC can determine precisely when a supply container is completely empty by monitoring the weight gain within the system. If the weight of the reservoir does not increase during a refill sequence then the supply container is inferred to be empty. This causes the valve for the supply container to be closed and the next supply container to be brought on line. A related third feature is the load cell technology provides the ability to accurately forecast and identify the trends in chemical usage. Since the exact amount of chemical is measured coming into the reservoir the information can be easily electronically stored and manipulated and transmitted.

A second embodiment of the multi-reservoir load cell assembly 400 shown in Figures

4A-4B, includes a buffer reservoir 408, fastened and sealed by the o-rings 411 to the bottom cap 410. The output chemical flows through tube connection 401. Connected to the buffer reservoir 408 are a pneumatic tube 415, a chemical valve 407, a load cell separator 413, and the load cell 412. The load cell 412 is securely bolted to the buffer reservoir 408 and the other side is securely bolted to a rigid member (not shown) not part of the multi-reservoir load cell assembly 400. The outer sleeve 404 slips around the buffer reservoir 408 and rests against the bottom cap 410. The outer sleeve 404 is machined to allow the load cell 412 to pass through it unencumbered. End 405 of the valve 407 connects to the main reservoir 406 and the other end 409 connects to buffer reservoir 408. The main reservoir 406 is encapsulated and sealed, by o-rings in the upper cap 403. The upper cap 403 incorporates a stepped edge along its periphery to secure the outer sleeve 404 to it. Pneumatic line 418 and chemical input line 417 are secured to the upper cap 403. The outer sleeve 404 provides the mechanical strength for the separate reservoirs 406 and 408.

The multi-reservoir load cell assembly shown in Figures 4A-4B, and used in the system of Figure 3, is similar to the first embodiment with the following notable differences:

a) Valve 407 provides control of the fluid path between the main reservoir 406 and the buffer reservoir 408.

b) The outer sleeve 404 provides the mechanical support to form the rigid assembly that supports the main reservoir 406 as well as the buffer reservoir 408.

A third embodiment of the multi-reservoir load cell assembly shown in Figures 5A-5B, employs two reservoirs 506, 508 spaced apart from each other but connected by a flexible fluid line 516. The third embodiment uses many of the previous components shown in Figures 4A-4B, except: (i) it does not use an outer sleeve 404; (ii) the buffer reservoir 508 is not mechanically suspended from the main reservoir 506; and (iii) the load cell spacer 513 and the load cell 512 are fastened to the bottom of the main reservoir 506.

The third embodiment operates like the second embodiment except the load cell 512 only measures the volume of chemical in the main reservoir tank 506 as shown in Figures 5A-5B and 6. The advantage of the third embodiment is the precise amount

of chemical brought into the main reservoir 506 is always known and the PLC does not have to infer the amount of chemical that was removed from the buffer reservoir 508 during a refill operation. The third embodiment can be used in the system of Figure 6 with the control system (i.e., PLC, A/D, signal amplifier, etc.) of Figure 3. Note, in the application, the lead digit of the part numbers generally indicates which drawing shows the details of the part, while the trailing digits indicate that the part is like other parts with the same trailing digits. Thus, the buffer reservoir 206 and the buffer reservoir 306 are similar in function, and found in Figures 2A and Figure 3A, respectively.

A fourth embodiment of the multi-reservoir load cell assembly 700 shown in Figures 7A-7B, employs the same components as the third embodiment, however, a second load cell 722 is attached to the buffer reservoir 708. The assembly 700 is preferably used with the system of Figure 8 with the control system of Figure 3 with additional components for the second load cell.

The fourth embodiment of the multi-reservoir load cell assembly 700 shown in Figures 7A-7B, operates much like the second embodiment except that the load cell 712 only measures the chemical in the main reservoir 706 and the load cell 722 only measures the chemical in the buffer reservoir 708. The advantage here is the buffer reservoir 708 is constantly monitored so if the downstream process or tool suddenly consumes large amounts of chemical during a refill cycle, the system can stop the refill cycle short to bring chemical into the buffer reservoir 708 from the main reservoir 706 to prevent the complete evacuation of chemical from the buffer reservoir 708.

A fifth embodiment of the multi-reservoir load cell assembly 900 shown in Figures 9A-9B uses the same components as the third embodiment, except the load cell 912 is attached to the buffer reservoir 908 instead of the main reservoir 906. The fifth embodiment is preferably used in the system depicted in Figure 10 with the control system (i.e., PLC, A/D, signal amplifier, etc.) shown in Figure 3.

Functionally, the fifth embodiment of the multi-reservoir load cell assembly 900 operates the same as the second embodiment, the only difference is the load cell 912 only weighs the chemical in the buffer reservoir 908.

As the process or tool consumes the chemical, the weight of the buffer reservoir 908 remains constant until the main reservoir 906 also becomes empty. Then the weight in the buffer reservoir 908 will start to decrease, indicating that the main reservoir 906 needs to be refilled. At this point the main reservoir 906 is refilled for a calculated period of time. During this sequence the buffer reservoir 908 decreases until the main reservoir 906 has been refilled and the valve 907 has been reopened between the two reservoirs 906, 908.

A sixth embodiment uses the same components of third embodiment shown in Figure 5A-5B. The only notable difference is that the inert gas blanket (see Figure 6) of approximately one psi is increased to approximately 80 psi (more or less depending on the type of chemical). The increased inert gas pressure enables the sixth embodiment to use pressure to dispense the chemical at a constant output pressure, which remains unaffected even during the refill cycle. This method would allow very precise non-pulsed output flow of the chemical. This may be a highly critical feature in an ultra high purity application that pumps the chemical through a filter bank. Any pulsation of the chemical can cause particles to be dislodged from the filter bank into the ultra-pure chemical output flow.

A seventh embodiment uses the same components as the third embodiment with additional components shown in Figures 11A-11B, including a main reservoir 1106, a buffer reservoir 1108, a second chemical input line 1119 added to the main reservoir 1106 through the valve 1122, a valve 1123 added to the chemical input line 1117, and a stir motor 1120 and an impeller assembly 1121.

Functionally, the seventh embodiment operates the same as the third embodiment with the added capability of mixing two chemicals in precise proportions before transferring the mixture to the buffer reservoir 1108. The chemical can be drawn into the main reservoir 1106 through open valve 1123 and the chemical input line 1117 and weighed by the load cell 1112. When the proper amount has been drawn into the main reservoir 1106, the valve 1123 is closed and the valve 1122 is opened to allow the second chemical to enter the main reservoir 1106. When the proper amount has been drawn into the main reservoir 1106, the valve 1122 is closed and the chemicals are blended via the stir motor 1120 and impeller assembly 1121. The stirring of the chemicals can be initiated at any time during the above sequence.

Once the mixing is complete, the valve 1107 opens to allow the chemical to transfer to the buffer reservoir 1108, which is also connected to gas line 1115. This is an ideal way to mix time sensitive chemistries and maintain a constant, non-pulsed output of the blended chemicals.

Figure 12, a piping and instrument diagram, illustrates an embodiment of a chemical mixing and delivery system. For clarity we will discuss how the system can be used to mix components together into CMP slurry, but the system can be used to mix other chemicals. Figure 12 contains many parts, so to avoid clutter we use double-digit part numbers rather than four-digit as the leading and trailing digit convention would require as discussed at page 13.

The system includes a main reservoir 69 with DI water lines supplying DI water through a gross fill valve 41 and a flow control valve 43, and a fine fill valve 42. In an embodiment, the gross fill valve is a 3/8-inch valve, and the fine fill valve is a 1/4-inch valve. As discussed in connection with Figure 3, the PLC may control valves using 24 DC Volt solenoid actuated valves, and activate them by an output card such as the Mitsubishi FX2N. Each solenoid valve, when opened, allows pressurized gas from regulator such as a VeriFlow self-relieving regulator, to the pneumatically operated to open or close the valves. These actuators will be referred to in the specification, but will not be shown in Figure 12 to reduce clutter.

In an embodiment, the PLC sends a signal to such an actuator to open the gross fill valve 41 permitting water to rapidly begin to fill the main reservoir 69. When the main reservoir 69 contains almost sufficient water, the PLC provides another signal to an actuator to close the gross fill valve 41 and to intermittently open and close the fine fill valve 42, so called "chatter" the valve. This permits the system to add the precise balance of DI water required for the mixture. Of course, this gross fill and fine fill arrangement can be used for any component but is most useful if there is a major amount of that component in the final mixture. The flow control valve 43 is a manual or automatic controlled valve that compensates for the different water pressures available at a given facility.

The DI water recirculates through a bypass 40 then back to the DI return. If the velocity of the water recirculating is kept above some level such as seven feet/sec, it

will reduce or eliminate bacteria formation. The purpose of the DI water is to dilute Chem A, which represents slurry. The slurry passes through a fine fill valve 44 to the main reservoir 69, through a bypass 53 and recirculates to the Chem A return, which reduces the settling of abrasives suspended in the Chem A.

Chemicals B-D represent other components used in small amounts such as stabilizers, surfactants, and pad conditioners supplied through fine fill valves 46-48 into the main reservoir 69. The PLC sends control signals to admit Chem A through Chem D sequentially so that the load cells 12 and 13 of the main reservoir 69 can weigh each component accurately. The two load cells shown in Figure 12 may permit higher accuracy than one load cell, but the number of load cells is not essential to the invention. The PLC also sends control signals to the engage the main mixer motor 20, which rotates the shaft 24 and impeller 21, which stirs the components into CMP slurry. Process requirements will define the best time period and rpm for the impeller 21. The impeller 21 will continuously stir certain CMP slurry formulations.

As shown at the top of Figure 12, an inert gas supply provides inert gas through a regulator, a safety pressure relief valve 33, and a check valve 35 to an inert gas humidifier. For some CMP slurries nitrogen is preferred, but other chemicals require other gases. One of ordinary skill will know what inert gas is suitable for a given CMP formulation. For brevity we will discuss the inert gas as being nitrogen, which is bubbled through a tube in the DI water to humidify the nitrogen. This reduces the caking of the CMP slurry mixture inside the main and buffer reservoirs. The humidified nitrogen is supplied through the main reservoir pressure regulator 51, an inlet pressure valve 50, and to the main reservoir 69. The vent valve 49 is a safety valve, which is normally open (NO) when not actuated. As known, the set of check valves 16, 35, 37, 39, 76, 86,and 99 prevent backflow on the associated lines.

The main reservoir 69 transfers the mixed CMP slurry to buffer reservoir(s). In one embodiment, the main reservoir 69 holds two liters so that it can effectively service each of two buffer reservoirs 71, 92, holding one liter each. The transfer of the CMP slurry passes through a main reservoir outlet valve 58, through a line, then to a buffer reservoir inlet valve 60. Likewise, the main reservoir 69 transfers the CMP slurry initially through a main reservoir outlet valve 57, through a line, then to a buffer

reservoir inlet valve 97. The process tool determines when the buffer reservoirs 71 and 92 deliver the CMP slurry through dispense lines 1 and 2. Manual valves 84 and 85 are associated with the dispense lines 1 and 2 lines for safety.

Buffer reservoirs 71 and 92 each include a proportional valve block, which will be used by the PLC to control the pressure in each buffer reservoir. The PLC sends control signals to the proportional valve block to maintain the pressure in the buffer reservoirs that is necessary to achieve a desired flow rate of CMP slurry from the buffer reservoirs. For example, the pressure transducer, PT in Figure 12, reads the pressure in the buffer reservoir 71 and sends a signal indicative of that pressure to the PLC. Based on the measured pressure and the pressure set point, the PLC will send signals to the proportional valve block to either open a buffer control inlet valve 80 to increase the buffer reservoir pressure 71 or open a buffer control outlet valve 81 to decrease the buffer reservoir pressure 71. Likewise, the pressure transducer of buffer reservoir 92 reads the pressure and sends signals to the proportional valve block to maintain the pressure necessary for a desired flow rate of CMP slurry from the buffer reservoir 92. Based on the PLC signals, the proportional valve block will either open a buffer control inlet valve 56 to increase or open buffer control outlet valve 52 to decrease the pressure of the buffer reservoir 92. The buffer reservoir 92 also includes an optional buffer manifold 90, which can be used as a mounting surface to connect multiple buffer outlet valves, but is not required for a single buffer outlet valve 87 as illustrated. The buffer reservoir 71 is shown with a buffer manifold 72, which is also not required for a single buffer outlet valve 73.

A pinch valve is located downstream of the buffer outlet valve 73, and another downstream of buffer outlet valve 87. Figure 12 shows one suitable control arrangement for the pinch valve of buffer reservoir 71, which can be used for other buffer reservoirs such as the buffer reservoir 92. In this arrangement, the PLC connects to an air actuator 78, which controls the flow rate of clean dry air (CDA) passing through a pressure regulator 79. Although not depicted in Figure 12, it should be evident that the same communication channels, clean dry air source, and CDA lines can be used as one embodiment for the control of the pinch valve of the buffer reservoir 92. The signal amplifier 77, the A/D converter, and the load cells shown in Figure 12 can be the same parts and have the same operation described in

the earlier embodiments. The mixer motor 93 rotates shaft 94 and impeller 95 in the buffer reservoir 92, and the mixer motor 71 rotates shaft 65 and impeller 66 in the buffer reservoir 71. The buffer reservoirs 71 and 92 include buffer reservoir vent valves 62 and 53, which are normally open to release pressure when not in service as safety features.

The parts described can be obtained from the following vendors. Partek, A Division of Parker Corporation located in Tucson, AZ can provide suitable gross fill valves, part no. PV36346-01, fine fill valves, part no. PV106324-00, valve manifolds 70, 72, and 90, part no. CASY1449, and check valves part number CV1666. Another suitable PLC is the Mitsubishi AG05-SEU3M. A suitable proportional valve block is part no. PA237 manufactured and/or sold by Proportion Aire, Inc. located in McCordsville, Indiana. A suitable inert gas humidifier part no. 43002SRO1, and pinch valve, part no. PV-SL-.25, are manufactured and/or sold by Asahi America located in Malden, Massachusetts.

In operation, the chemical mix and delivery system has different modes. The initial mode is a fill or refill sequence where the system adds and mixes together the components in the main reservoir 69. In one embodiment, the fill or refill sequence can be implemented as follows:

1. The PLC sends control signals to open the DI line and Chem A-D lines to supply components to the main reservoir 69. Although not the only arrangement, it is preferred to admit these chemical components sequentially to the main reservoir 69 so that the load cells 12 and 13 directly indicate the weight of each component in the final mixture.

2. The PLC sends control signals to an actuator to shut off the inlet pressure valve 50 which would otherwise admit nitrogen to the main reservoir 69 and to open the normally open vent valve 49 so any residual gases can vent from the main reservoir 69.

3. The PLC sends control signals to start the mixer motor 20. In one embodiment, the mixer motor 20 starts when the impeller 21 is covered with DI water or Chem A, but the time is process dependent and not part of the invention. It could start before,

during, or after the time Chem A-D and DI water enter the main reservoir 69.

4. The PLC sends control signals to an actuator to open the inlet pressure valve 50 to increase the nitrogen pressure to a sufficient pressure, e.g., 20 psig, determined by the flow rate and process requirements.

The PLC or logic device(s) will also send control signals to prepare the inert gas humidifier for service as follows:

1. The PLC sends control signals to an actuator to close the DI drain valve 36, which is normally open, of the inert gas humidifier.

2. The PLC sends control signals to open the DI inlet valve 38 so that DI water begins to fill the inert gas humidifier.

3. The HI sensor associated with the inert gas humidifier will subsequently detect a high DI water level and send signals to the PLC to send control signals to close the DI inlet valve 38. Separately, the HI HI sensor functions to send an alarm signal if the DI water fills beyond the operational level.

4. The PLC sends control signals to an actuator to open the valve 34, which admits nitrogen to bubble up through the DI water to humidify the nitrogen that flows from the inert gas humidifier. The valve 34 is either all the way open or all the way closed. It is normally closed (NC) so that when the system is powered down, that is, out of operation, valve 34 closes preventing introduction of the inert gas, e.g., nitrogen into the inert gas humidifier.

5. The inert gas humidifier feeds the nitrogen through the lines up to the inlet pressure valve 50 and the buffer inlet control valves 56 and 80. It should be noted that the pressure supplied through the inlet pressure valve 50 is used to pressure the CMP slurry out of the main reservoir 69 at the desired flow rate.

The system transfers the CMP slurry mixed from the main reservoir to the buffer reservoir as follows:

1. The PLC sends a signal to open main reservoir dispense valve 58 and to open buffer reservoir inlet valve 60.

2. The PLC also sends signals to control the proportional valve block to maintain the desired pressure in the buffer reservoir(s), that is, the set point stored in the PLC. In one embodiment, the set point pressure may be 5-12 psig when the pressure of the main reservoir 69 is held at 20 psig. In one example, a pressure transducer labeled PT in Figure 12 provides the pressure in the buffer reservoir 71 and the buffer control outlet valve 81 opens if the pressure is too high or the buffer control inlet valve 80 opens if the pressure is too low compared to the set point for buffer reservoir 71.

3. The mixer motor 93 or 64 of the buffer reservoir 92 or 71 stirs the components into a mixture. Again, the start time and time period and rpm depend on the process.

In one embodiment, the process tool, for example, polisher, triggers when the dispense valve outlet 87 and 73 of respectively the buffer reservoir 92 and 71 open and close.

The load cells 91 and 96 of the buffer reservoir 92 send signals to the PLC, which will be used to control the main reservoir outlet valve 57 and the buffer inlet valve 97 for transfer of CMP slurry between the main reservoir 69 and the buffer reservoir 92. The buffer reservoir 71 operates by a similar arrangement as shown in Figure 12.

The load cells 12 and 13 associated with the main reservoir 69 will indicate when to add new components to make another batch of CMP slurry. The main reservoir dispense valves 57 and 58 are closed when the components are added to the main reservoir 69 so that the load cells 12 and 13 accurately indicate the weight of each component added to the main reservoir 69.

To clean and/or flush out the main reservoir 69, the PLC can send control signals to close the main reservoir dispense valve 58, open the gross fill valve 41 to admit DI water, open the main reservoir dispense valve 57, close the buffer reservoir inlet valve 97, open the main reservoir drain valve 99 so that the DI water passes from the main reservoir 69 bypassing the buffer reservoir 92. A similar sequence can be used with the buffer reservoir 71.

To clean and/or flush out the buffer reservoir 92, the DI water can pass through opened main reservoir dispense valve 57, opened buffer reservoir inlet valve 97, and closed main reservoir outlet valve 89. The buffer reservoir 71 can be cleaned and/or

flushed by a similar arrangement as shown in Figure 12.

In another embodiment, a fixed orifice pinch valve can be employed in cases where ultra-low flow rates are unattainable due to the properties of the mechanical components and the physical attributes of the mediums being dispensed. This pinch valve uses a flexible flow path that is compressed to a determined set point to create a fixed orifice. This will allow the desired restriction in the flow path necessary to increase or maintain a pressure for the "push" to control very low flow rates. The pinch valve can be actuated to open the flexible flow path to its maximum orifice to allow full flow during a flush sequence and then return to the desired determined set point. For example, a 1/4-inch valve with a 1/4-inch orifice controls the push pressure to the buffer reservoir to dispense the chemical. The output valve for the fluid is also 1/4-inch. As the flow rate decreases the pressure required to push also decreases. In the case of ultra-low flow rate the inherent properties of the valves controlling the push pressure limit the repeatability of the precise volume of gas required to push. By installing the fixed orifice pinch valve and increasing the restriction on the dispense flow path, the push pressure can operate at higher levels resulting in precise repeatable control of ultra-low flow rates.

A PLC and/or operator can adjust the pinch valve's minimum and wide-open orifice size. The wide-open orifice setting can be used to clear obstructions in dispense lines. Turning the pinch valve wide-open is referred to as burping the line. This feature is important for CMP slurries because microbubbles form during low flow rates. The PLC can control the pinch valve so that pressure builds up to permit ultra-low flow rates and burped after a process cycle to clear any obstructions. The time period of the burp may be short such as 0.5 seconds and performed after delivery of the CMP slurry. A typical process only requires delivery of CMP slurry for up to 1.5 minutes and microbubbles may not appear in some CMP slurries for about 5 minutes so post-process burping may suffice. If not, the dispense lines can be burped more frequently without unduly affecting the flow rate over a given process cycle.

Figure 13 illustrates the functional blocks of the PLC that will be associated with one embodiment of the flow rate control system, which uses the diminishing weight of CMP slurry or other chemical mixture in at least one buffer reservoir. The load cells constantly monitor the weight of the CMP slurry and generate analog signals

indicative of the weight of the CMP slurry in the buffer reservoir. An A/D converter converts those analog signals into digital format then sends them to the PLC. The PLC stores the specific gravity of each component to calculate component volumes. In parallel or serially with this activity, the user inputs through a keyboard, keypad, or touch screen a desired volumetric flow rate such as 200 ml/min. The PLC can convert the flow rate to rate per second. Next, the PLC directs that the buffer inlet pressure valves open to apply pressure to the buffer reservoir to produce the desired flow. The PLC monitors the declining weight in a time period and compares the current flow rate to the desired flow rate. If the flow rate is too low, the PLC sends signals to the proportional valve block to increase pressure, and if the flow rate is too high, the PLC sends signals to the proportional valve block to decrease the pressure. If the volumetric flow rate is within a predetermined tolerance, the PLC send signals to the proportional valve block that neither increase nor decrease the pressure to the buffer reservoir.

In other words, a "push" gas is supplied to the buffer reservoir by either a proportional control valve or valves and pressure is monitored via a pressure transducer or transmitter. The desired flow rate is entered, and a calculation is performed to determine the required weight loss from the reservoir during the course of a certain period of time. The PLC causes a signal to be sent to the proportional valve to adjust the push gas pressure, to adjust the weight loss within the reservoir to meet the flow rate requirements. The weight loss can be monitored over the course of time varying from 0.1 seconds to 60 seconds (or higher) depending on the accuracy of the flow rate required. For example, a flow rate of 180 milliliters per minute equals a flow rate of three milliliters per second. The PLC monitors the weight change within each buffer reservoir. If the weight loss is less than three milliliters per second, the pressure is increased. If the weight loss within the buffer reservoir is greater than three milliliters per second, the pressure is decreased. To achieve greater accuracy, the time frame can be shortened to the weight loss achieved during the course of ½ second, or even as low as 0.1 second or lower. The determining factor may be the resolution of the load cells associated with the buffer reservoir. If the load cell is able to resolve 0.1 gram, tighter controls can be implemented.

This embodiment requires no additional components to control flow. Since no additional devices are used, the problems of plugging are eliminated. Because the pressure to the reservoir is controlled by the PLC, varying input pressures are accounted for and proper adjustments are made to keep the flow at the desired rate. The PLC can be used to determine the average pressure utilized to maintain the proper flow rate. Once the level within the buffer reservoir reaches a point to where it needs to be refilled, the average pressure can be utilized to maintain the flow rate while the buffer reservoir is refilling. The volume level is also monitored real time, which alleviates any requirement for additional components to detect level. The buffer reservoir will dispense chemical as required to satisfy a request command transmitted from the process tool. The volume level is replenished when a low volume set point is triggered as the declining weight is monitored. In like manner the volume being replenished is stopped when a high set point is triggered as the increase in weight is monitored.

The present invention provides at least the following benefits. The output chemical can be maintained at a constant pressure. A process tool never experiences a low-pressure chemical line that could prevent a dispense sequence from occurring; therefore the yield of the tool is increased. A multitude of containers and sizes can be connected to the reservoir system as chemical supply containers. If the fluid volume of the supply containers is known before they are connected, the computer can calculate very accurately the amount of chemical that has been removed from the container and therefore present the information to a display for a visual, real time indication of the remaining amount of chemical. The graphical interface communicates to the operator at a "glance" the condition of the supply containers. The load cells can determine when the supply container is completely empty since there will not be a continued weight increase during a refill sequence. This indicates the supply container is empty and that another container should be brought on line. In one embodiment, data logging of chemical usage can be provided since the chemical in the reservoir(s) is continuously and accurately weighed by load cell(s) which give an input signal to the PLC or other logic device which outputs real time, accurate information as to the amount of chemical available in the reservoir. The load cell is an inherently safe sensing device since failure is indicated by an abnormally large reading or an immediate zero reading, both of which cause the PLC

or other logic device to trigger an alarm. The invention can also prevent bubbles that occur during a supply container switching operation from passing through to the output chemical line, can provide constant, non-varying pressure dispense with multiple supply containers, can refill itself by vacuum or by pumping liquid to refill the reservoir or refill with different chemicals at precise ratios and mix them before transferring the mixture to the buffer reservoir, which may be important for time dependent, very reactive chemistries.

The invention can provide precise flow control of fluids, chemistries, and compound mixtures utilizing pressure reservoirs fitted with valves, tubing, weight sensors (load cells), and a control system. The invention can also monitor and control volumetric level replenishment utilizing pressure reservoirs fitted with valves, tubing, weight sensors, and a control system. The invention can also replace the commonly used methodologies to control precise flow, such as manually set throttle valves and flow meters. The invention when fitted with the pinch valve can control very precise low flow rate.

WHAT IS CLAIMED:

1. A chemical delivery system, comprising:

a main reservoir in fluid communication with one or more inlet fill valves, an inlet pressure valve, and a main reservoir outlet valve;

a buffer reservoir in fluid communication with a buffer reservoir inlet valve and a buffer outlet valve;

a line connecting the main reservoir outlet valve to the buffer reservoir inlet valve;

a load cell for monitoring the weight of a chemical in the buffer reservoir and generating analog signals that are converted to digital signals indicative of the weight of the chemical in the buffer reservoir;

a proportional valve block including a buffer control inlet valve and a buffer control outlet valve that adjusts the pressure to the buffer reservoir;

a programmable logic controller receiving the digital signals and generating control signals to the proportional valve block to achieve a desired chemical flow rate.

2. The system of claim 1, further comprising a load cell for monitoring the weight of the chemical in the main reservoir and generating analog signals that are converted to digital signals indicative of the weight of the chemical in the main reservoir.

3. The system of claim 2, wherein the one or more inlet fill valves includes a gross fill valve and a fine fill valve, and wherein the programmable logic controller sends a signal to open the gross fill valve until the main reservoir has almost sufficient chemical, and another signal to the chatter the fine fill valve until the main reservoir has the precise amount of chemical required.

4. The system of claim 2, wherein the programmable logic controller sends control signals to each of the one or more inlet fill valves sequentially so as to admit chemicals sequentially into the main reservoir so that the load cell of the main reservoir can weigh each chemical accurately.

5. The system of claim 4, further comprising a mixer assembly including a motor, and a shaft and an impeller associated with the main reservoir, wherein the programmable logic controller sends control signals to engage the motor, rotate the shaft and impeller which stirs the chemicals admitted into the main reservoir.

6. The system of claim 4, further comprising a mixer assembly including a motor, and a shaft and an impeller associated with the buffer reservoir, wherein the programmable logic controller sends control signals to engage the motor, rotate the shaft and impeller which continues to stir the mixture from the main reservoir that is admitted into the buffer reservoir.

7. The system of claim 1, further comprising a pinch valve in fluid communication and downstream of the buffer outlet valve, wherein the programmable logic controller sends control signals to the fully open the pinch valve to allow full flow during a flush sequence and then return to a more closed determined set point.

8. The system of claim 1, further comprising an inert gas supply that is in communication with the main reservoir and the buffer reservoir.

9. The system of claim 8, wherein the inert gas supply is passed through an inert gas humidifier so that the gas is humidified with the liquid in the inert gas humidifier.

10. The system of claim 8 or 9, wherein the chemical being delivered from the system is a chemical mechanical polishing formulation whose primary component is de-ionized water and the inert gas is nitrogen.

11. A method of liquid chemical delivery at low flow rates in a system comprising a multi-reservoir load cell assembly, including a main reservoir, a buffer reservoir, each reservoir having at least one load cell and a mixer, and a logic device, comprising:

isolating the main reservoir from the buffer reservoir;

reducing pressure in the main reservoir;

adding liquid chemical components sequentially into the main reservoir;

weighing each liquid chemical component by the multi-reservoir load cell assembly;

mixing the chemical components into a mixture;

supplying the main reservoir with an inert gas;

transporting mixture from the main reservoir to the buffer reservoir; and

transporting the mixture from the buffer reservoir through a pinch valve.

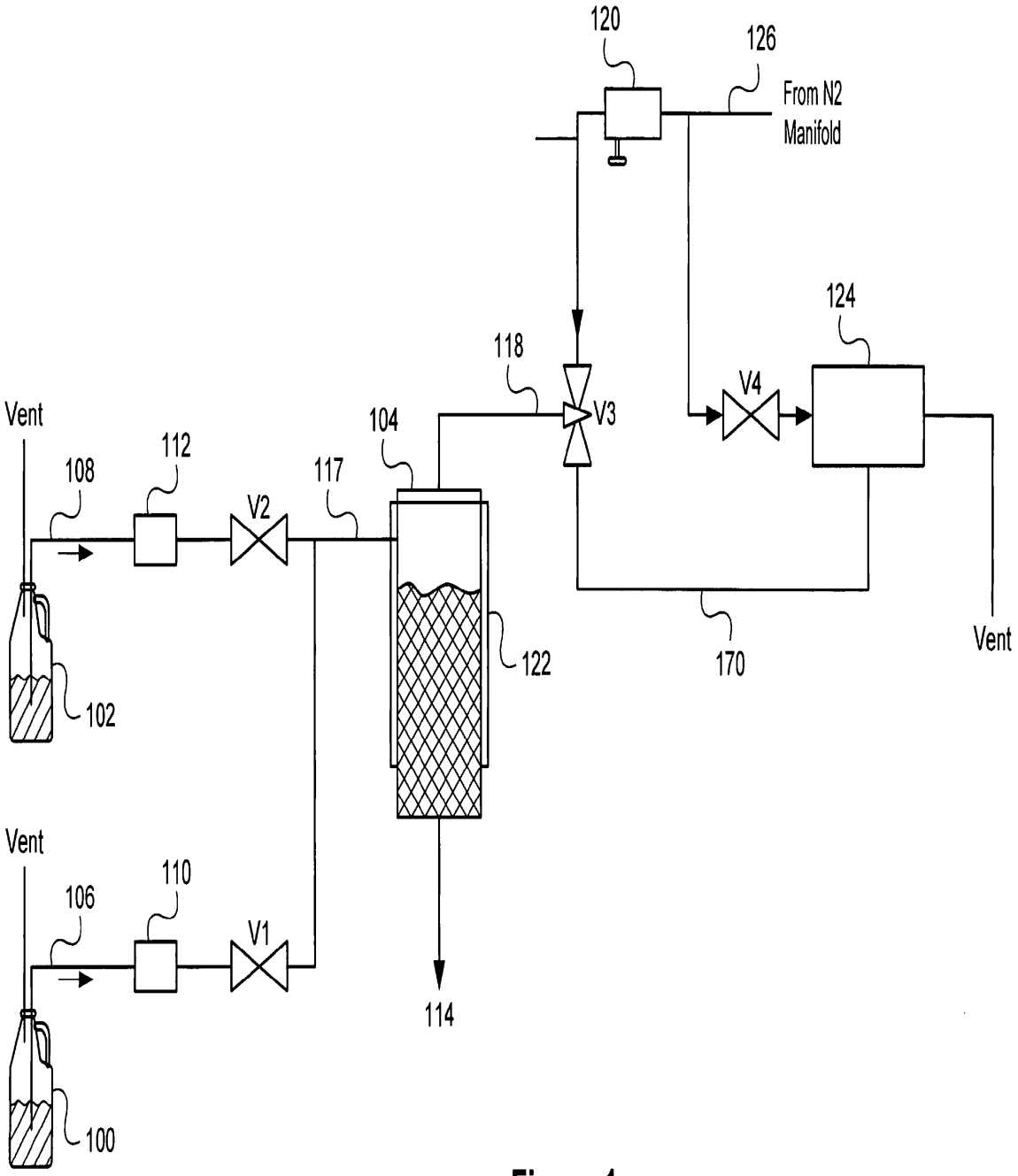

120
126
From N2
Manifold
124
118
V4
V3
104
Vent
108
112
117
V2
122
102
170
Vent
Vent
106
110
V1
114
100

Figure 1

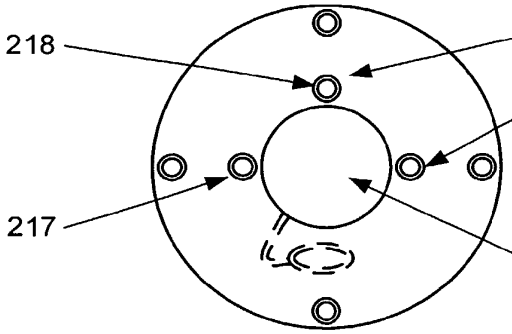


Figure 2B

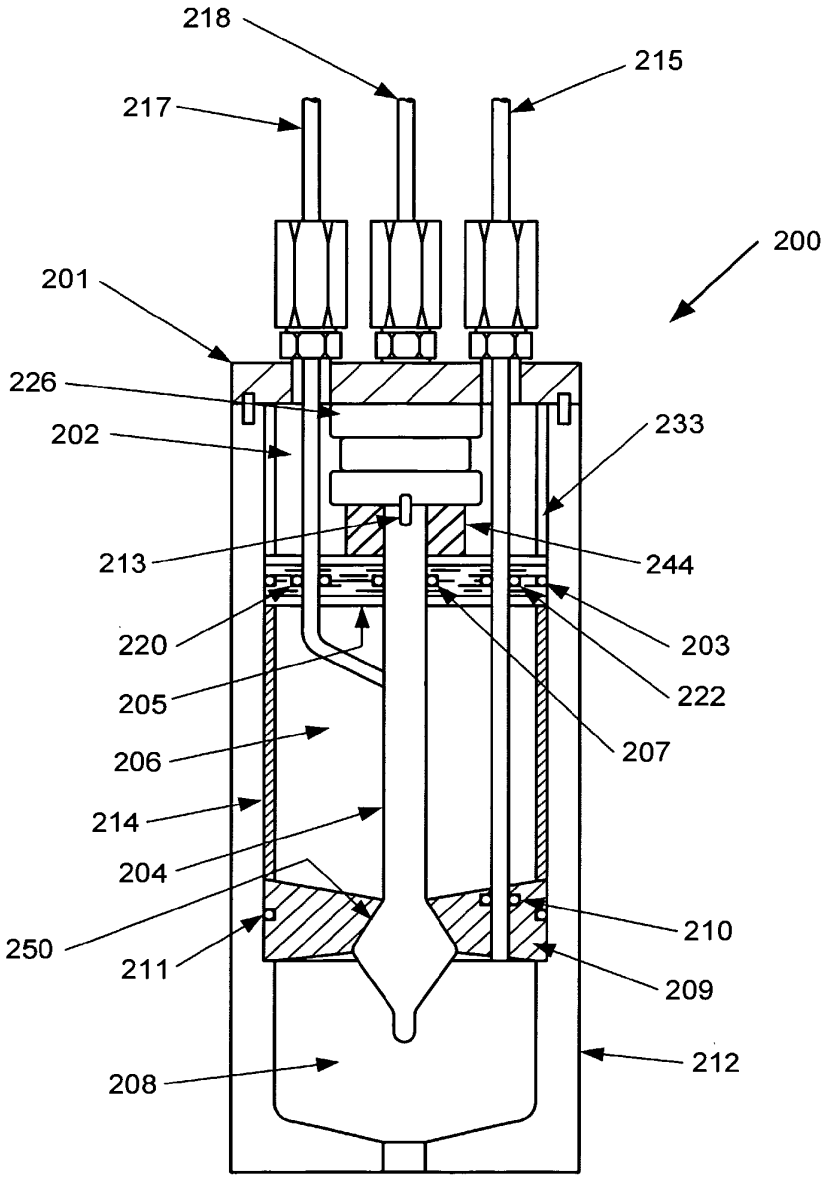


Figure 2A

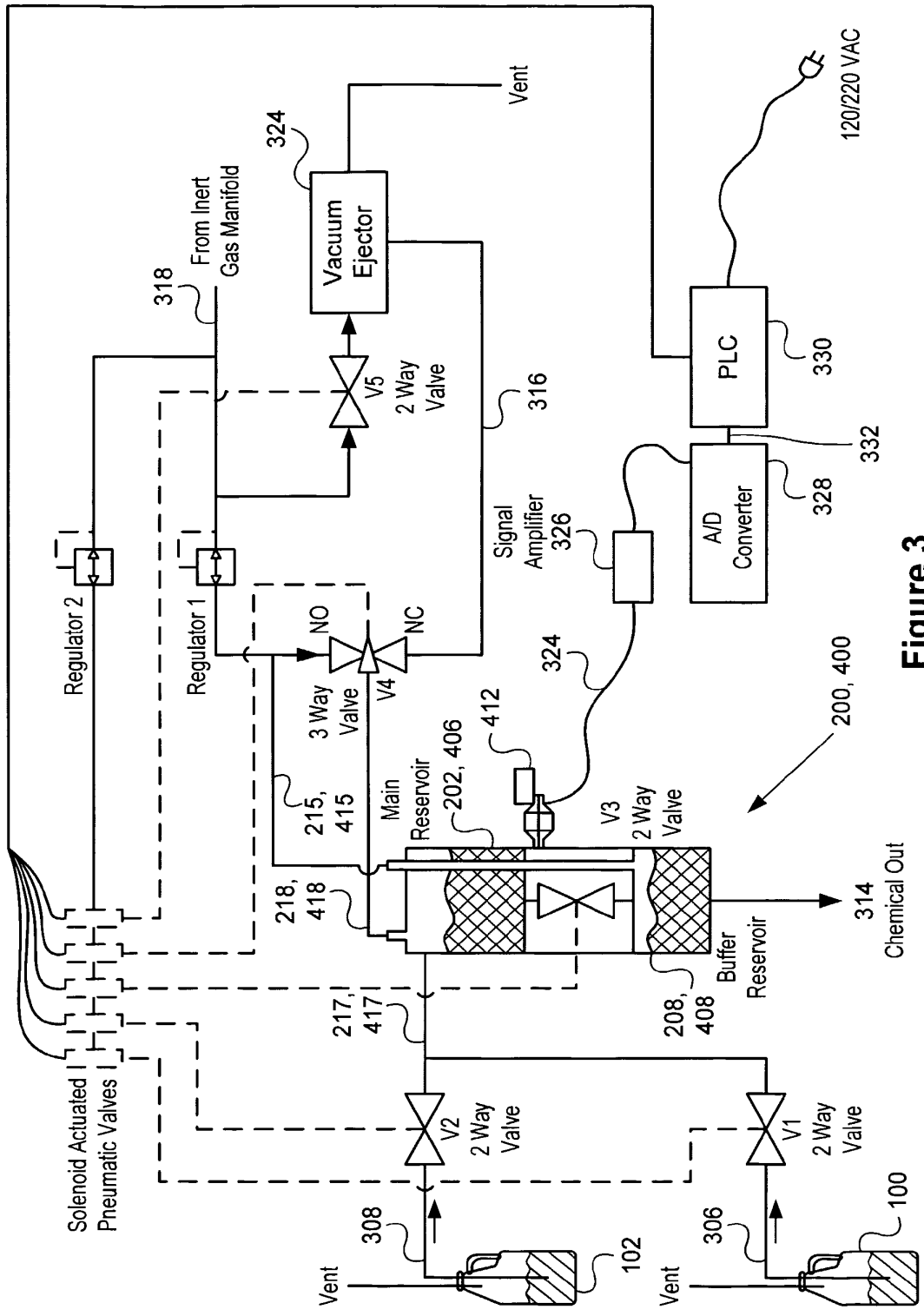

120/220 VAC
Vent
324
Vacuum Ejector
From Inert Gas Manifold
318
V5 2 Way Valve
316
PLC
330
332
A/D Converter
328
Signal Amplifier 326
Regulator 2
Regulator 1
NO
NC
3 Way Valve V4
324
412
200, 400
215, 415
Main Reservoir 202, 406
V3 2 Way Valve
218, 418
314 Chemical Out
Buffer Reservoir
208, 408
217, 417
Solenoid Actuated Pneumatic Valves
V2 2 Way Valve
V1 2 Way Valve
308
306
100
Vent
Vent
102

Figure 3

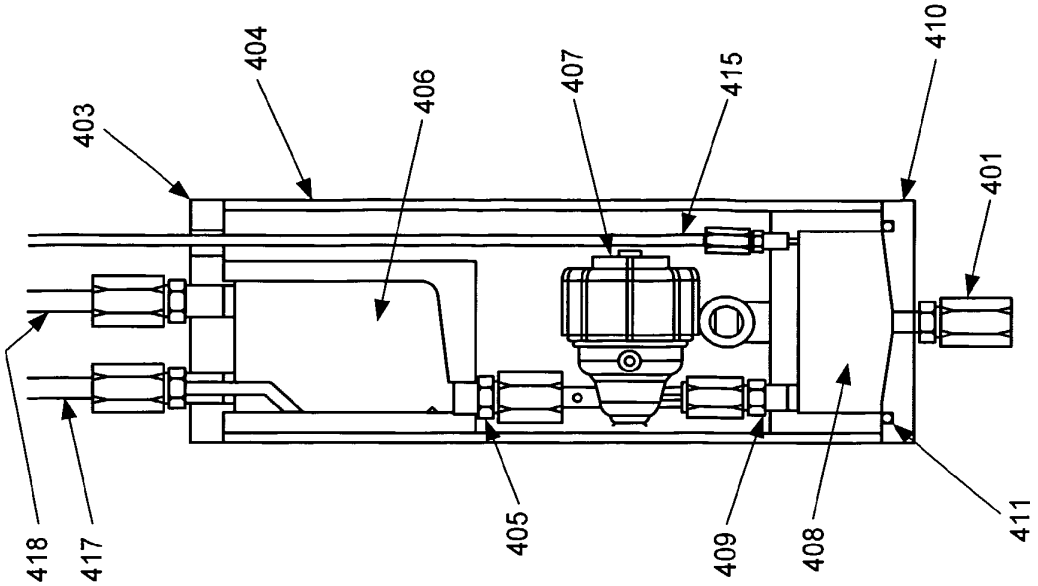


Figure 4A

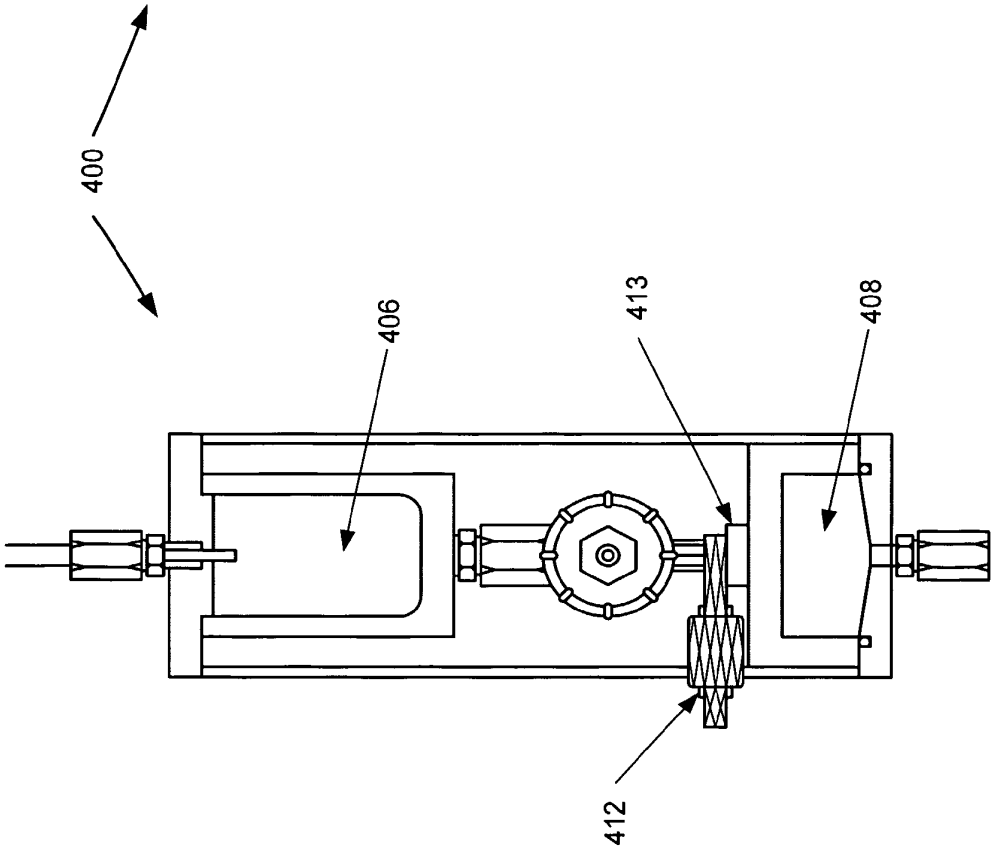


Figure 4B

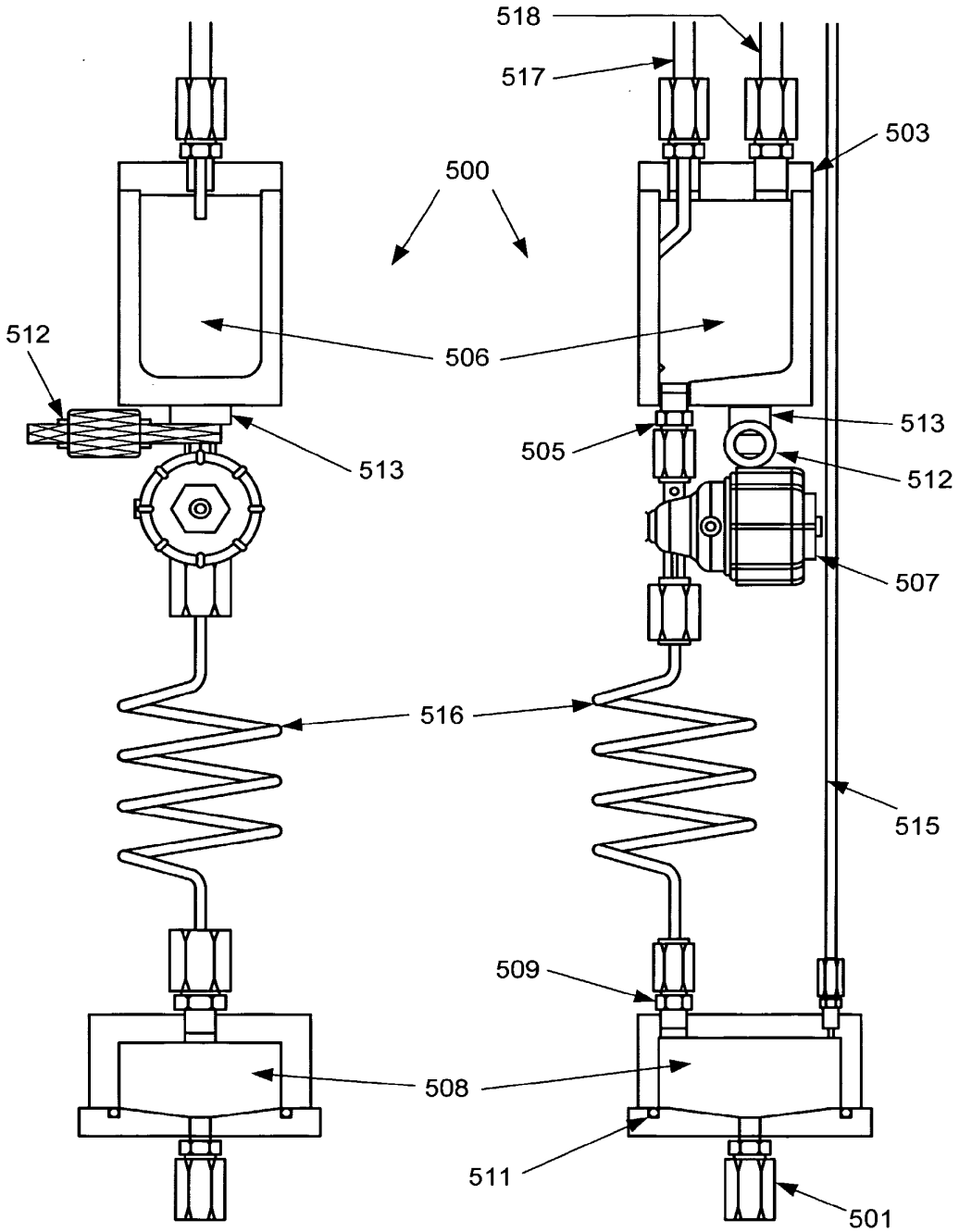


Figure 5B Figure 5A

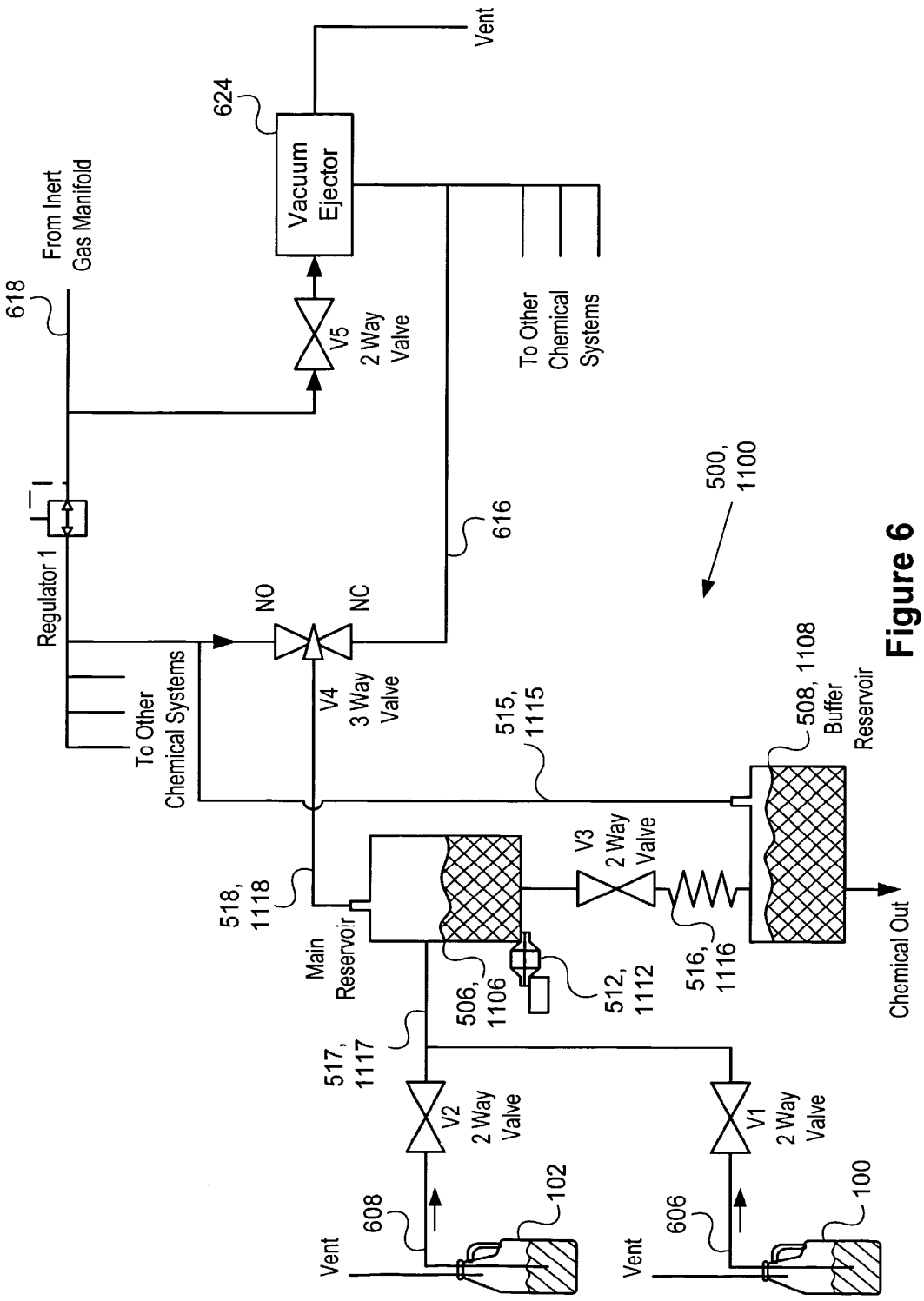

Vent
624
Vacuum Ejector
From Inert Gas Manifold
618
V5 2 Way Valve
To Other Chemical Systems
500, 1100
616
Regulator 1
NO
NC
V4 3 Way Valve
To Other Chemical Systems
515, 1115
508, 1108 Buffer Reservoir
V3 2 Way Valve
518, 1118
Main Reservoir
506, 1106
512, 1112
516, 1116
Chemical Out
517, 1117
V2 2 Way Valve
V1 2 Way Valve
608
102
606
100
Vent
Vent

Figure 6

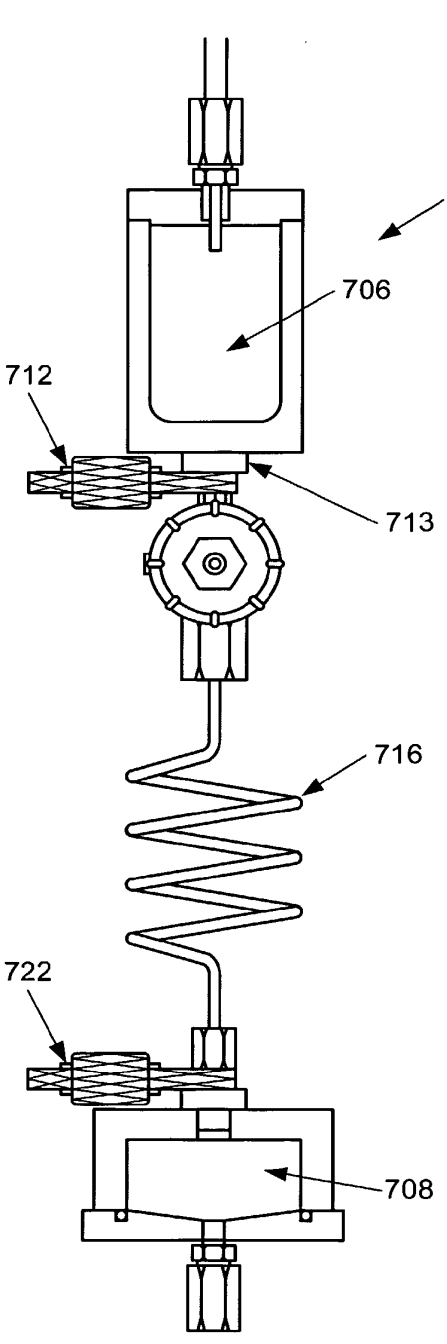


Figure 7B

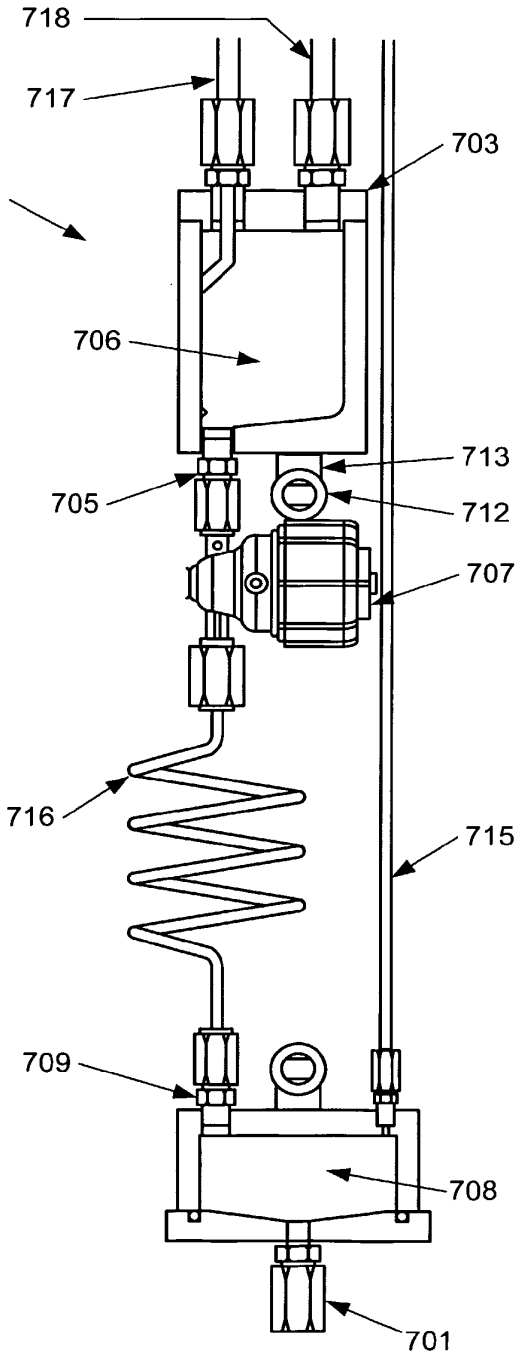


Figure 7A

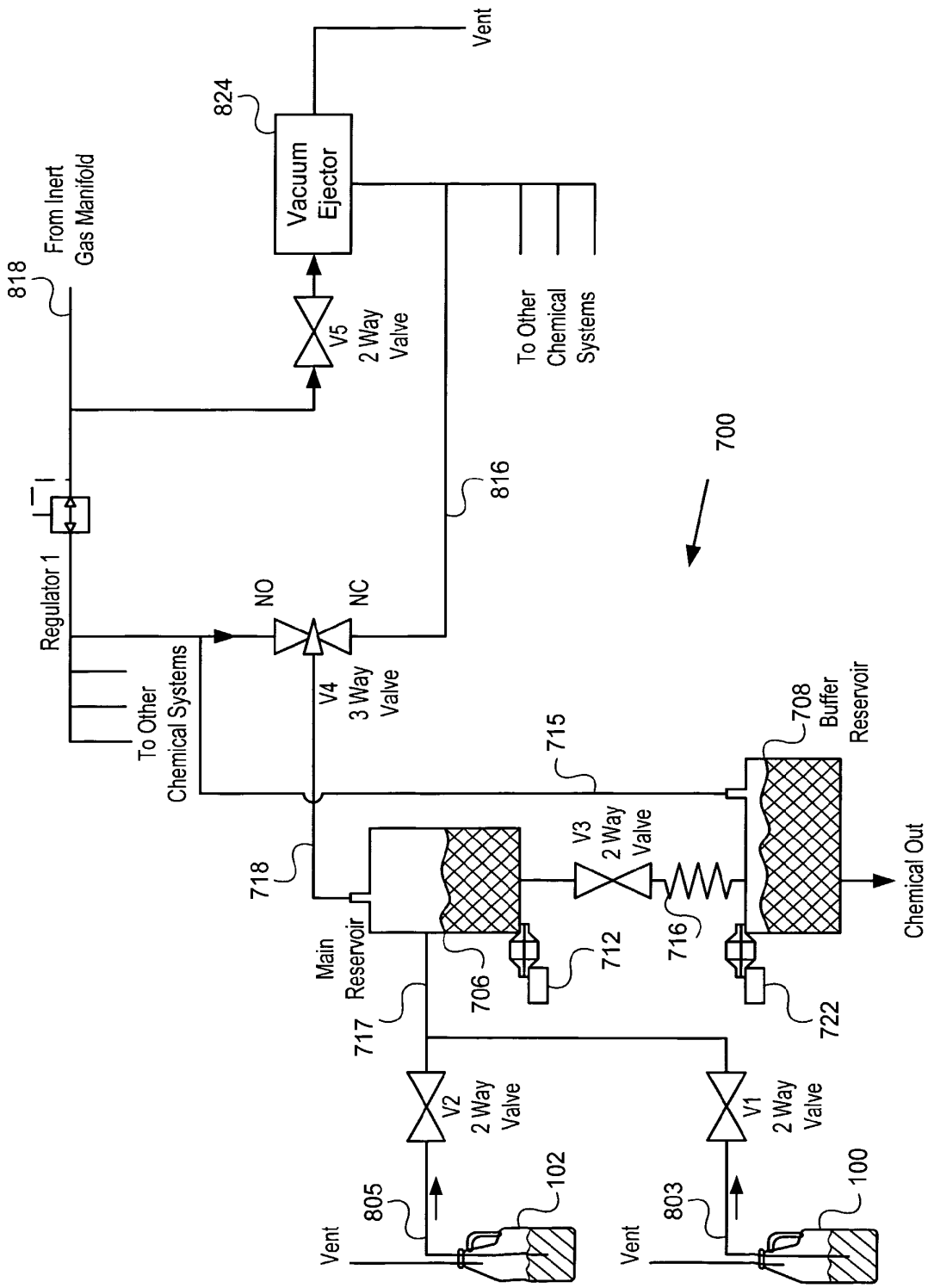

Vent
824
Vacuum Ejector
From Inert Gas Manifold
818
V5 2 Way Valve
To Other Chemical Systems
700
816
Regulator 1
NO
NC
V4 3 Way Valve
To Other Chemical Systems
715
708 Buffer Reservoir
718
V3 2 Way Valve
Chemical Out
Main Reservoir
706
712
716
722
717
V2 2 Way Valve
V1 2 Way Valve
805
102
803
100
Vent
Vent

Figure 8

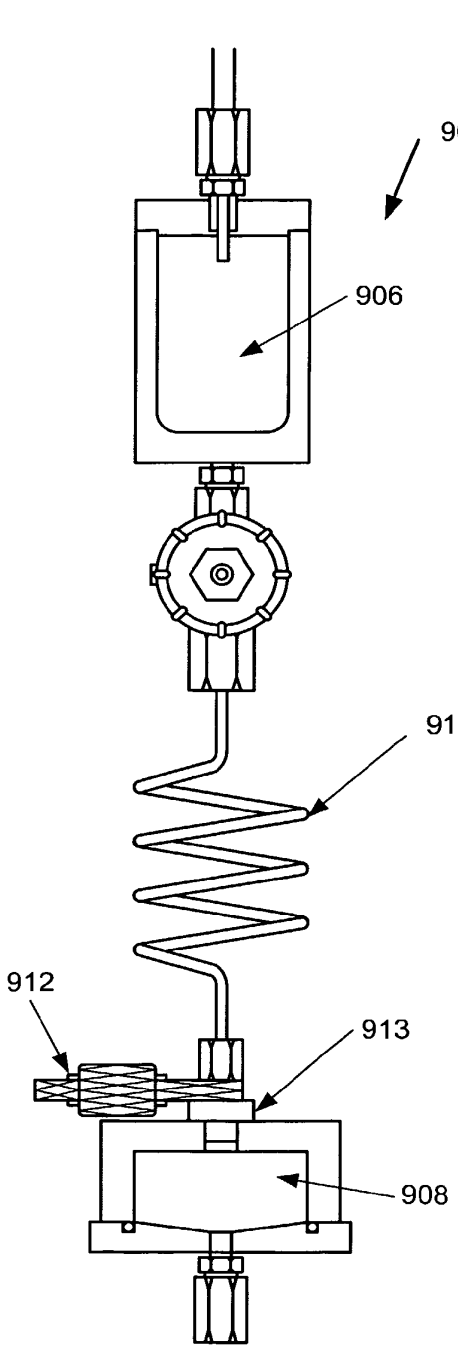


Figure 9B

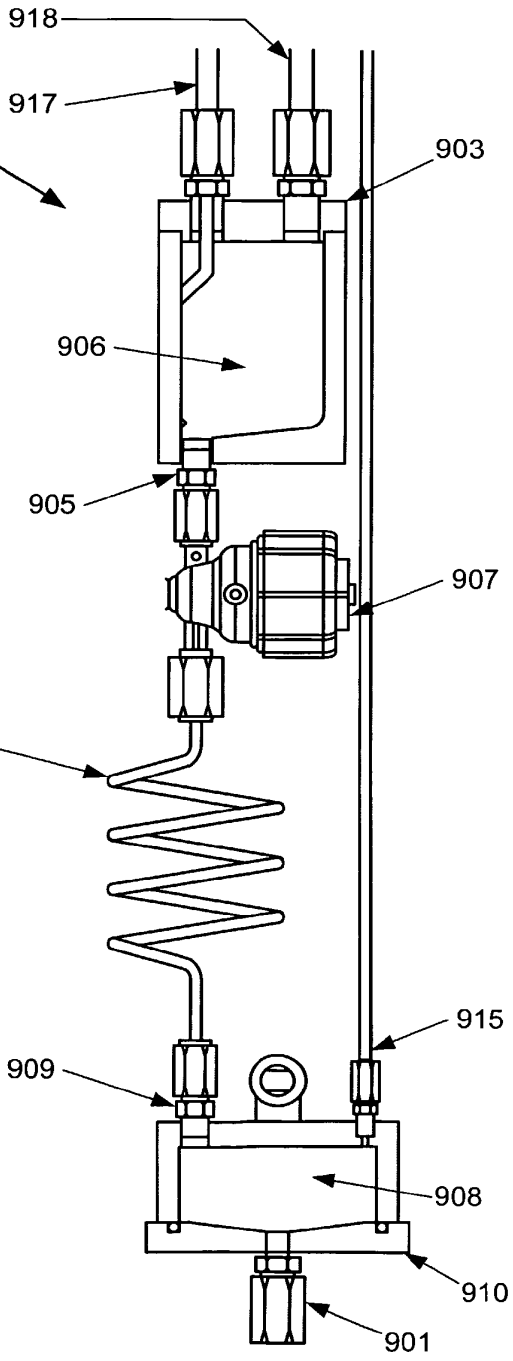


Figure 9A

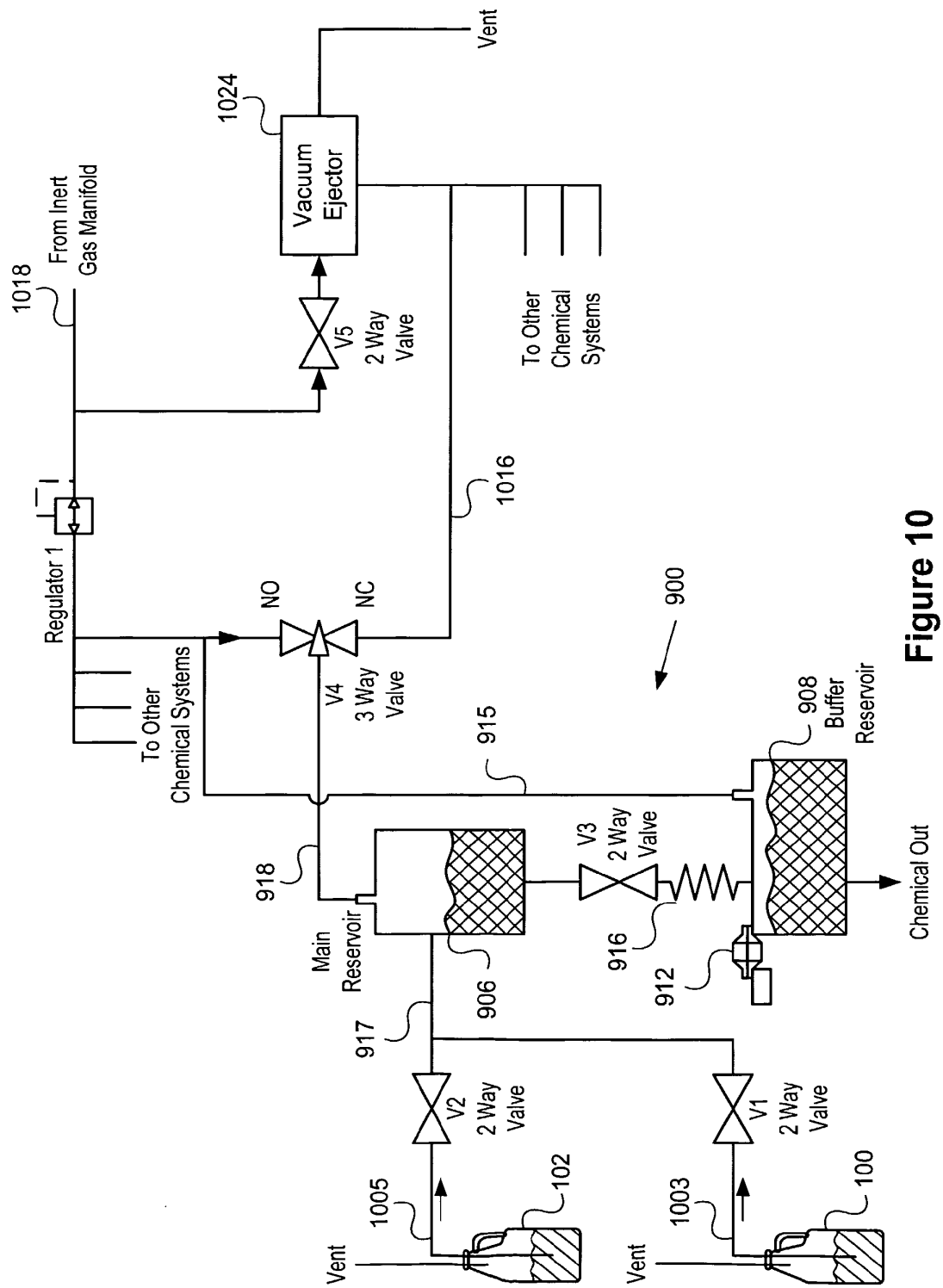

Vent
1024
Vacuum Ejector
From Inert Gas Manifold
1018
V5 2 Way Valve
To Other Chemical Systems
1016
Regulator 1
NO
NC
900
To Other Chemical Systems
V4 3 Way Valve
915
908 Buffer Reservoir
V3 2 Way Valve
918
Chemical Out
Main Reservoir
916
906
912
917
V2 2 Way Valve
V1 2 Way Valve
1005
102
1003
100
Vent
Vent

Figure 10

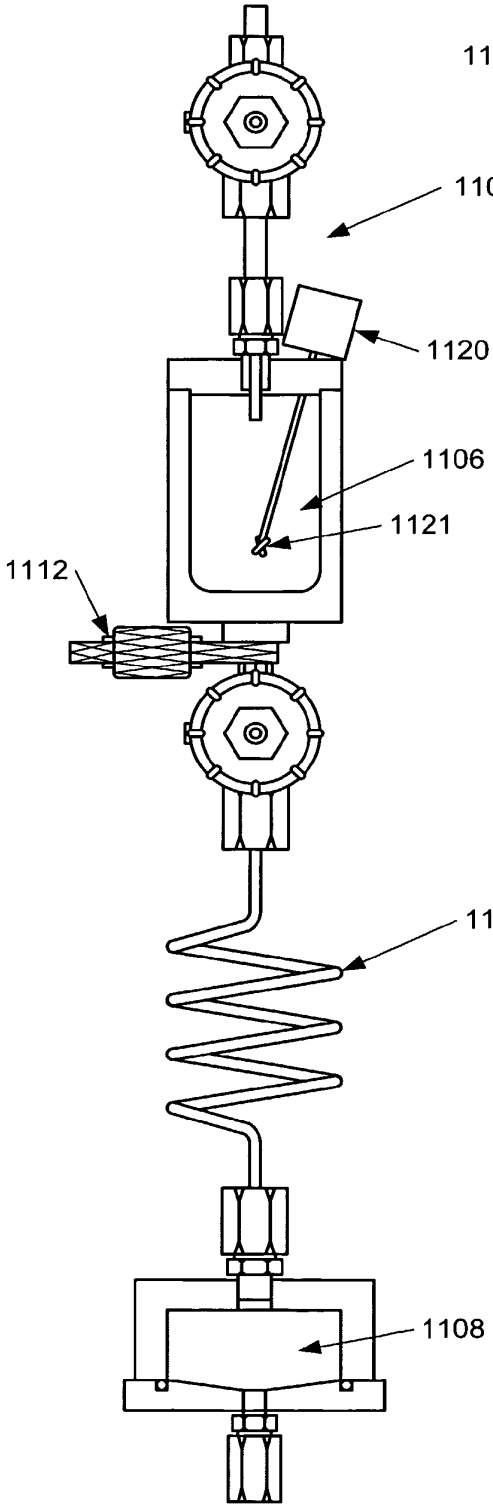


Figure 11B

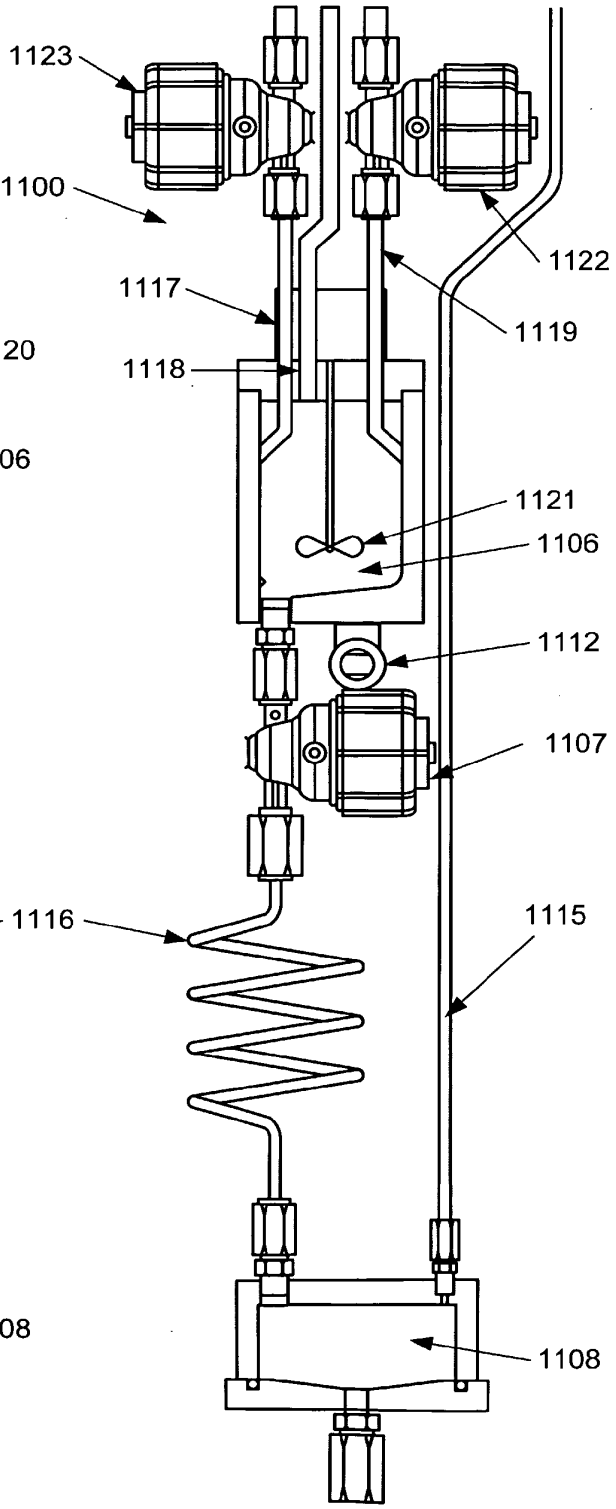


Figure 11A

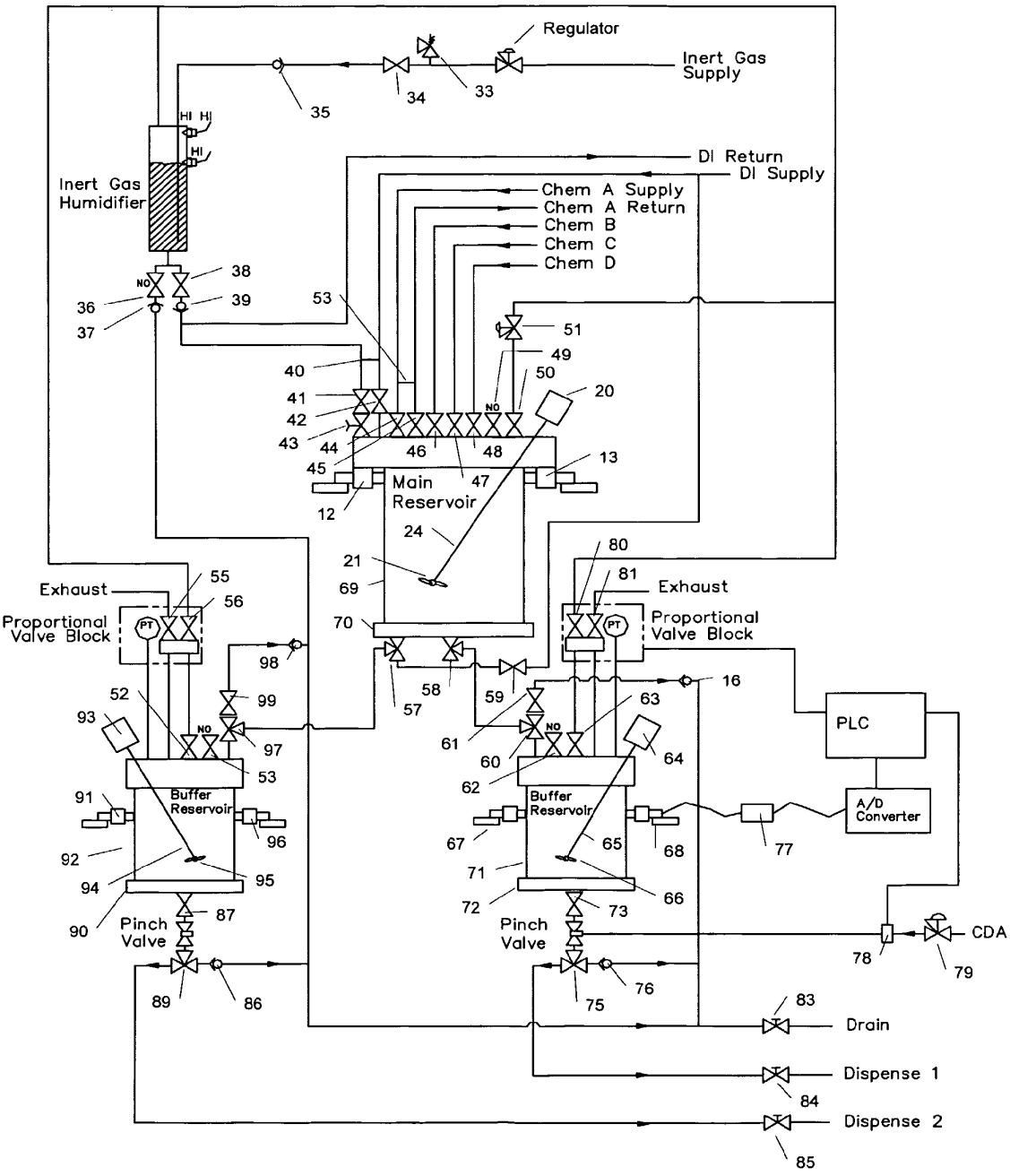

Regulator
Inert Gas Supply
Inert Gas Humidifier
DI Return
DI Supply
Chem A Supply
Chem A Return
Chem B
Chem C
Chem D
Main Reservoir
Exhaust
Proportional Valve Block
Buffer Reservoir
Pinch Valve
PLC
A/D Converter
CDA
Drain
Dispense 1
Dispense 2

Figure 12

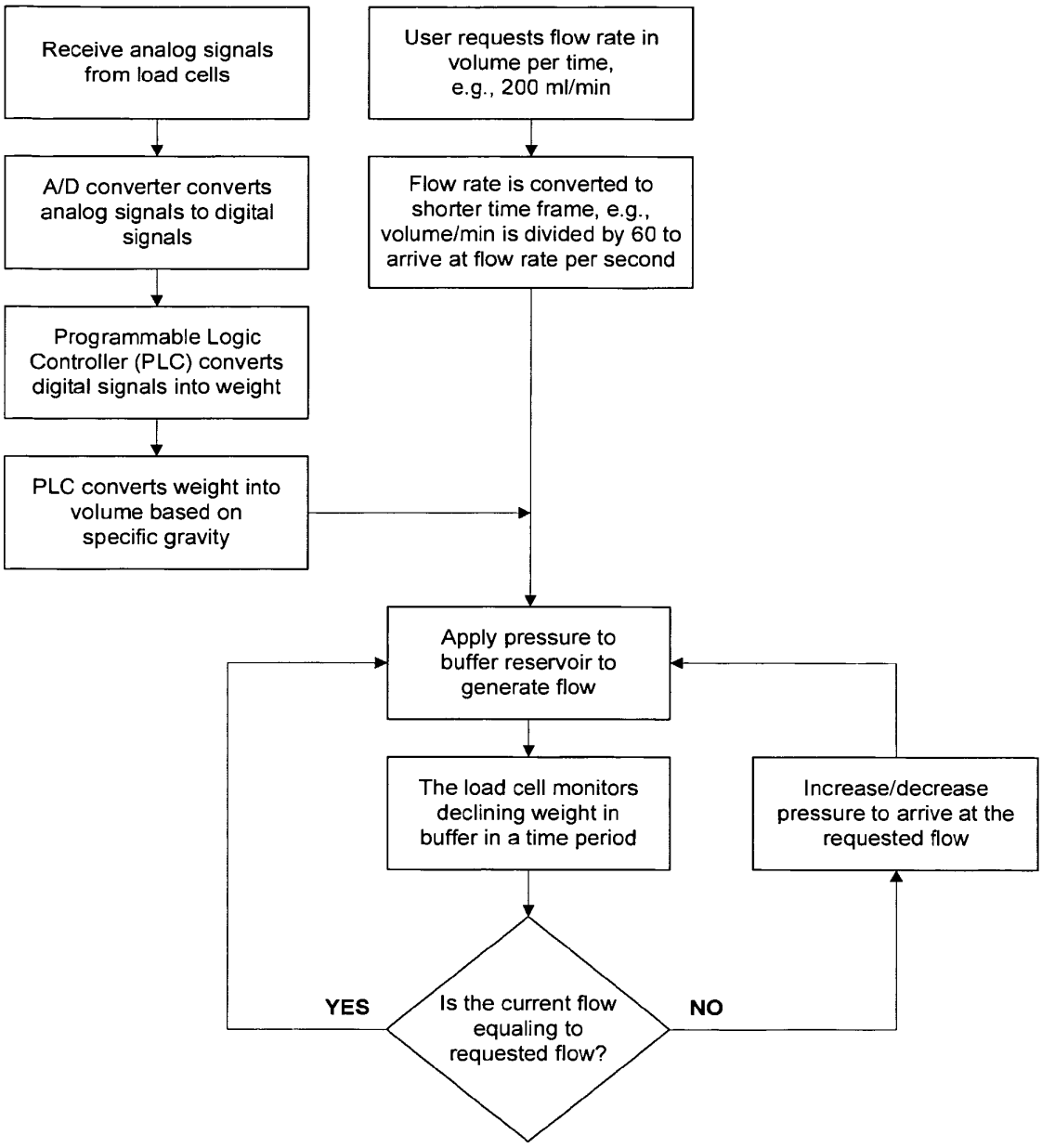

Receive analog signals from load cells
A/D converter converts analog signals to digital signals
Programmable Logic Controller (PLC) converts digital signals into weight
PLC converts weight into volume based on specific gravity
User requests flow rate in volume per time, e.g., 200 ml/min
Flow rate is converted to shorter time frame, e.g., volume/min is divided by 60 to arrive at flow rate per second
Apply pressure to buffer reservoir to generate flow
The load cell monitors declining weight in buffer in a time period
Is the current flow equaling to requested flow?
YES
NO
Increase/decrease pressure to arrive at the requested flow

Figure 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/14233

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : B67D 5/08
US CL : 222/001, 053, 056, 145.6
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 222/001, 053, 056,058, 145.1, 145.5, 145.6; 137/403, 408

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,098,843 A (SOBERANIS et al.) 08 August 2000 (08.08.2000), abstract.	1-11
A	US 6,269,975 B2 (SOBERANIS et al.) 07 August 2001 (07.08.2001), abstract.	1-11
A	US 6,340,098 B2 (SOBERANIS et al.) 22 January 2002 (22.01.2002), abstract.	1-11

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

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Kenneth Bomberg Telephone No. 703-308-0861

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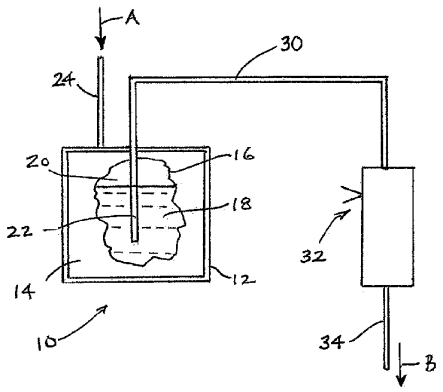
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(54) Title: LINER-BASED LIQUID STORAGE AND DISPENSING SYSTEMS WITH EMPTY DETECTION CAPABILITY



(57) Abstract: Fluid supply systems for storage and dispensing of chemical reagents and compositions, e.g., high purity liquid reagents and chemical mechanical polishing compositions used to manufacture microelectronic device products, having capability for detection of an empty or near-empty condition when the contained liquid is at or approaching depletion during dispensing operation. Fluid delivery systems employing empty detect arrangements are described, including pressure transducer monitoring of dispensed material intermediate the supply package and a servo-hydraulic dispense pump, or monitoring of dispenser chamber replenishment times in a dispenser being replenished on a cyclic schedule to flow material from the dispenser to a downstream tool utilizing the dispensed material.

WO 2006/116572 A2

LINER-BASED LIQUID STORAGE AND DISPENSING SYSTEMS WITH EMPTY DETECTION CAPABILITY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to U.S. Provisional Patent Application 60/674,578 filed April 25, 2005 in the names of Glenn M. Tom, John Kingery, Kevin O'Dougherty, Kirk Mikkelsen and Michelle Alberg for "ZERO HEAD SPACE/MINIMAL HEAD SPACE LINER-BASED LIQUID STORAGE AND DISPENSING SYSTEMS ADAPTED FOR PRESSURE DISPENSING," and U.S. Provisional Application 60/761,608 filed on January 24, 2006 in the names of Glenn M. Tom, et al. for "MATERIAL STORAGE AND DISPENSING PACKAGES AND METHODS," as well as U.S. Provisional Patent Application 60/674,579 filed April 25, 2005 in the names of Minna Hovinen, John Kingery, Glenn M. Tom, Kevin O'Dougherty, Kirk Mikkelsen, Donald Ware and Peter Van Buskirk for "LINER-BASED LIQUID STORAGE AND DISPENSING SYSTEMS WITH EMPTY DETECTION CAPABILITY," and U.S. Provisional Patent Application 60/674,577 filed on April 25, 2005 in the names of Weihua Wang, David Bernhard, Thomas H. Baum, Greg Mlynar and Minna Hovinen for "APPARATUS AND PROCESS FOR STORAGE AND DISPENSING OF CHEMICAL REAGENTS AND COMPOSITIONS." The disclosures of all such provisional applications are hereby incorporated herein by reference in their respective entireties.

FIELD OF THE INVENTION

[0002] The present invention relates to liner-based liquid containment systems for storage and dispensing of chemical reagents and compositions, e.g., high purity liquid reagents and chemical mechanical polishing compositions used in the manufacture of microelectronic device products, having capability for empty detection when the contained liquid is at or approaching depletion during dispensing operation.

DESCRIPTION OF THE RELATED ART

[0003] In many industrial applications, chemical reagents and compositions are required to be supplied in a high purity state, and specialized packaging has been developed to ensure that the supplied material is maintained in a pure and suitable form, throughout the package fill, storage, transport, and ultimate dispensing operations.

[0004] In the field of microelectronic device manufacturing, the need for suitable packaging is particularly compelling for a wide variety of liquids and liquid-containing compositions, since any contaminants in the packaged material, and/or any ingress of environmental contaminants to the contained material in the package, can adversely affect the microelectronic device products that are manufactured with such liquids or liquid-containing compositions, rendering the microelectronic device products deficient or even useless for their intended use.

[0005] As a result of these considerations, many types of high-purity packaging have been developed for liquids and liquid-containing compositions used in microelectronic device manufacturing, such as photoresists, etchants, chemical vapor deposition reagents, solvents, wafer and tool cleaning formulations, chemical mechanical polishing compositions, etc.

[0006] One type of high-purity packaging that has come into such usage includes a rigid outer pack containing a liquid or liquid-based composition in a flexible liner or bag that is secured in position in the rigid outer pack by retaining structure such as a lid or cover. Such packaging is commonly referred to as "bag-in-box" packaging. The rigid outer pack of the packaging may for example be formed of a high-density polyethylene or other polymer or metal, and the liner may be provided as a pre-cleaned, sterile collapsible bag of a polymeric film material, such as polytetrafluoroethylene (PTFE), low-density polyethylene, PTFE-based multilaminates, polyurethane, or the like, selected to be inert to the contained liquid or liquid-based material to be contained in the liner. Packaging of such type is commercially available under the trademark NOWPAK from ATMI, Inc. (Danbury, CT, USA).

[0007] In the dispensing operation involving such liner packaging of liquids and liquid-based compositions, the liquid is dispensed from the liner by connecting a dispensing assembly including a dip tube to a port of the liner, with the dip tube immersed in the contained liquid. After the dispensing assembly has been thus coupled to the liner, fluid pressure is applied on the exterior surface of the liner, so that it progressively collapses and forces liquid through the dispensing assembly for discharge to associated flow circuitry for flow to an end-use site.

[0008] It has been established that the provision of a minimal, and preferably zero, head space in the liner package is advantageous in order to suppress generation of particles and microbubbles in the liquid or liquid-based composition.

[0009] Additionally, in the storage and dispensing of liquids and liquid-based compositions from liner packages, it is desirable to manage the dispensing operation so that the depletion or approach to depletion of the dispensed material is detected so that termination of a downstream operation, or switchover to a fresh package of material, is able to be timely effected. Reliability in end-stage monitoring of the dispensing operation, and particularly in detection of an empty or approaching empty condition, therefore enables optimum utilization of liner packages, and is a desired objective for design and implementation of such packaging.

SUMMARY OF THE INVENTION

[0010] The present invention relates to packaging apparatus and process for the storage and dispensing of liquids and liquid-based compositions.

[0011] In one aspect, the invention relates to a fluid storage and dispensing system, comprising:

a vessel having an interior volume;

a liner in said interior volume, arranged to contain a liquid medium in a zero or near-zero head space conformation;

a dispensing assembly adapted for engagement with the vessel, to withdraw liquid medium from the liner during dispensing operation; and

an integrated flowmeter arranged to monitor the liquid medium withdrawn from the liner during dispensing operation, and to generate an output correlative of an empty or near-empty condition upon occurrence of same.

[0012] In another aspect, the invention relates to a liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in said interior volume, arranged to contain a liquid medium in a zero or near-zero head space conformation;

a dispensing assembly adapted for engagement with the vessel, to withdraw (or deliver) liquid medium from the liner during dispensing operation;

flow circuitry coupled with the dispensing assembly and arranged for flow therethrough of liquid medium during the dispensing operation;

such flow circuitry including an in-line portion and an optional branch portion;

a secondary volume of liquid medium arranged for dispensing so that dispensing of the secondary volume does not occur until a primary volume of liquid medium has been fully dispensed, wherein such primary volume includes at least part of the liquid medium in the liner, and the secondary volume is constituted by one or more of:

(i) a part of the liquid medium in the liner other than liquid medium constituting the primary volume, when the primary volume comprises less than all liquid medium in the liner;

(ii) an in-line volume of liquid medium in or communicating with the in-line portion of the flow circuitry; and

(iii) a branch volume of liquid medium in or communicating with the branch portion of the flow circuitry; and

an empty detector arranged to monitor said dispensing operation and generate an empty detect output due to an empty or near-empty condition when said secondary volume dispensing is initiated after the primary volume of liquid medium has been dispensed.

[0013] A further aspect of the invention relates to a liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in said interior volume, arranged to contain a liquid medium overlaid by a head space;

a reservoir barometrically coupled in fluid communication with the head space and liquid medium in the liner, and arranged to contain liquid medium overlaid by gas to define a liquid level in the reservoir; and

an empty detector arranged to monitor liquid level in the reservoir and generate an empty detect output when liquid level in the reservoir changes due to an empty or near-empty condition of the liner.

[0014] Another aspect of the invention relates to a liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in the interior volume, arranged to contain a liquid medium overlaid by a head space;

a phase separator;

a dispense line coupling the liner in fluid communication with the phase separator;

a liquid medium flow line coupled with the phase separator to discharge liquid medium therefrom;

a reservoir positioned above the phase separator, arranged to contain liquid medium defining a liquid medium level in the reservoir;

an overhead line joining the phase separator in fluid flow communication with the reservoir;

a first level sensor arranged to detect a first liquid medium level in the reservoir at which the reservoir contains a predetermined amount of reserve liquid medium;

a second level sensor in said overhead line, arranged to detect a second liquid medium level in the overhead line during dispensing of said reserve liquid medium;

a first flow control valve in said overhead line, between said second level sensor and said reservoir, arranged to be open for filling of the reservoir during dispensing of liquid medium from the liner, and to close upon detection of the first liquid medium level by the first level sensor;

a pressure detection actuator in the dispense line, operatively arranged to detect an empty or near-empty condition of the liner subsequent to closure of the first flow control valve in the overhead line, and upon detection of the empty or near-empty condition of the liner to open the first flow control valve for dispensing of the reserve liquid medium through the phase separator and liquid medium flow line.

[0015] A further aspect of the invention relates to a liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in the interior volume, arranged to contain a liquid medium overlaid by a head space;

a reservoir, arranged to contain liquid medium defining a liquid medium level in the reservoir;

a dispense line coupling the liner in fluid communication with the reservoir;

a liquid medium flow line coupled with the reservoir to discharge liquid medium therefrom;

a first level sensor arranged to detect a first liquid medium level in the reservoir;

a second level sensor arranged to detect a second liquid medium level in the reservoir, wherein said second medium level in the reservoir is higher than the first medium level in the reservoir;

a gas communication line coupling the reservoir to (i) an ambient environment of the reservoir by a vent line joining the gas communication line in fluid communication with the ambient environment, and, optionally, (ii). a source of pressurization gas, operatively arranged for pressure-assisted dispensing of reserve liquid medium from the reservoir, by a pressurization line joining the gas communication line in fluid communication with the source of pressurization gas, the vent line having a first fluid communication control valve therein, and second pressurization line having a second fluid communication flow control valve therein, wherein the first fluid communication control valve is operatively coupled with the second level sensor to be open and accommodate filling of the reservoir to the second liquid medium level, and to close when the second liquid medium level has been reached, for subsequent dispensing of liquid medium from the liner though the dispense line and reservoir to the liquid medium flow line, in dispensing operation; and

a pressure detection actuator in the dispense line, operatively arranged to detect an empty or near-empty condition of the liner, and upon detection of said empty or near-empty condition of the liner to open one of the first and second fluid communication control valves for continued dispensing of liquid medium from the reservoir after the empty condition has been detected.

[0016] A further aspect of the invention relates to a liner package dispensing system, comprising:

a vessel having a first interior volume;

a first liner in said first interior volume, arranged to contain a first volume of liquid medium overlaid by a first head space;

a venting path adapted to vent head space gas from the first head space;

an empty detect reservoir having a second interior volume;

a second liner in the second interior volume, arranged to contain a second volume of the liquid medium overlaid by a second head space;

a source of pressurizing gas;

a first conduit coupled to the source of pressurizing gas and arranged to flow pressurizing gas into the vessel to exert pressure on the first liner therein;

a dispensing assembly adapted for engagement with the vessel, to dispense liquid medium from the first liner when pressure is exerted on the first liner by the pressurizing gas source during dispensing operation;

a second conduit interconnecting the dispensing assembly and the empty detect reservoir, to deliver dispensed liquid medium to the empty detect reservoir;

a third conduit coupled to a same or different source of pressurizing gas and arranged to flow pressurizing gas into the empty detect reservoir to exert pressure on the second liner therein;

a second vent conduit communicating with the second interior volume of the empty detect reservoir and arranged to vent head space gas from the second head space;

a fourth conduit coupled in dispensing communication with the second liner in the empty detect reservoir and arranged to discharge liquid medium therefrom;

a first flow control valve in said first conduit;

a second flow control valve in said first vent conduit;

a third flow control valve in said second conduit;

a fourth flow control valve in said second vent conduit;

a fifth flow control valve in said third conduit;

a sixth flow control valve in said fourth conduit;

a first level indicator arranged to detect presence of liquid medium in said first vent conduit;

a second level indicator arranged to detect presence of liquid medium in said second vent conduit;

a third level indicator arranged to detect presence of liquid medium in the second liner; and

a controller arranged to conduct a dispensing operation including the steps of:

opening the first and second flow control valves to vent gas from the first head space;

flowing pressurizing gas into the vessel to exert pressure on the first liner, to effect pressure dispensing of liquid medium;

closing the second flow control valve when the first level indicator senses presence of liquid medium in the first vent conduit;

opening the third and fourth flow control valves to flow liquid medium from the first liner through the dispensing assembly and second conduit to the second liner in the empty detect reservoir, and to vent the second head space through the second vent conduit;

closing the fourth flow control valve when the second level indicator senses presence of liquid medium in the second vent conduit;

opening the fifth flow control valve;

flowing pressurizing gas into the empty detect reservoir to exert a predetermined pressure on the second liner that is less than pressure exerted on the first liner;

opening the sixth flow control valve and dispensing liquid medium from the second liner to the fourth conduit until pressure in the second liner decreases due to an empty or near-empty condition in the first liner;

closing the third and first flow control valves when the third level indicator detects a liquid medium level in said second liner indicative of the empty or near-empty condition; and

after occurrence of the empty or near-empty condition in the first liner, continuing dispensing of liquid medium from the second liner.

[0017] A still further aspect of the invention relates to a liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in the interior volume, arranged to contain a liquid medium;

a dispensing assembly adapted for engagement with the vessel, to withdraw liquid medium from the liner during dispensing operation; and

a sensor arranged to detect a dispensing-related condition, and to generate a correlative output indicative of the condition.

[0018] In another aspect, the invention relates to a fluid storage and dispensing method, comprising:

providing a vessel having an interior volume and a liner in the interior volume, containing a liquid medium in a zero or near-zero head space conformation;

dispensing liquid medium from the liner; and

monitoring the liquid medium withdrawn from the liner during dispensing with an integrated flowmeter, and generating an output from the integrated flowmeter that is correlative of an empty or near-empty condition upon occurrence of same.

[0019] Another aspect of the invention relates to a system for manufacturing microelectronic devices including one or more of the containers of the invention and one or more subsystems for applying materials contained in such containers to such microelectronic devices.

[0020] A further aspect of the invention relates to a method of making a product containing a microelectronic device comprising applying one or more materials from one or more of the containers to the microelectronic device and incorporating such device into such product.

[0021] Yet another aspect of the invention relates to improved microelectronic devices made using the containers of the invention and having reduced defects.

[0022] Additional aspects of the invention relate to fluid dispensing systems and methods of types corresponding to those illustratively identified above, but lacking the liner feature described above.

[0023] A further aspect of the invention relates to a material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a dispensed material-utilizing tool, and the dispense line has operatively disposed therein a servo-hydraulic dispense pump, and an empty detect pressure transducer between the package and the pump operatively arranged to provide an output indicative of approach to an empty state of the package.

[0024] Yet another aspect of the invention relates to a material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a dispensed material-utilizing tool, and the dispense line is coupled to a dispenser arranged to receive resist on a cyclic replenishment schedule from said package, for flow to the tool, and a monitor adapted to detect an increase in time required for replenishment of the dispenser indicative of approach to an empty state of the package and to responsively provide an output of said approach.

[0025] In another aspect, the invention relates to a method of supplying material, comprising delivery of said material by pressure dispensing same from a liner in a material storage and dispensing package to a material-utilizing tool, said delivery including pumping of material from the package to the tool, and monitoring pressure of the dispensed material upstream of the pump to determine occurrence of a progressively increasingly rapid decline of pressure thereof, as indicative of onset of exhaustion of material in the package.

[0026] In still another aspect, the invention relates to a method of supplying material, comprising delivery of said material by pressure dispensing same from a liner in a material storage and dispensing package to a material-utilizing tool, said delivery including flow of material from the package to a dispenser arranged to receive resist on a cyclic replenishment schedule from said package, for flow to the tool, monitoring replenishment time for the cup, and responsively generating an output upon detection of a progressively more rapid increase of time required for replenishment of the dispenser, as indicative of onset of exhaustion of material in the package.

[0027] In a further aspect, the invention relates to a pressure-dispense system, comprising a vessel enclosing an interior volume, a liner disposed in the interior volume and adapted to hold material therein for pressure dispensing, and a pressure assembly adapted to apply exterior fluid pressure on the liner for the pressure dispensing, wherein the pressure-dispense system includes a secondary volume for said material, with such secondary volume constituting a sub-volume of the liner having a different pressurizing requirement than that required for pressure-dispensing of material from a main volume of the liner not including such sub-volume. The pressure assembly includes a fluid pressurizing drive train adapted to deliver pressurized fluid

into the interior volume to apply pressure on the liner, during dispensing of material from the main volume and during dispensing of material from the secondary volume, that maintains dispensed material at a same pressure throughout the dispensing from the main volume and the secondary volume.

[0028] Another aspect of the invention relates to a microelectronic product manufacturing apparatus, comprising a pressure-dispense system as described above, and a microelectronic product manufacturing tool, coupled with the pressure-dispense system to receive said dispensed material therefrom.

[0029] Still another aspect of the invention relates to a method of supplying a material, comprising: providing a pressure-dispense system as described above; actuating the pressure assembly for dispensing; dispensing material from the main volume of the liner; and thereafter dispensing material from the secondary volume of the liner; wherein material is dispensed at a same pressure throughout the dispensing from the main volume of the liner and dispensing from the secondary volume of the liner.

[0030] A further aspect of the invention relates to a method of manufacturing a microelectronic product, comprising supplying such material by a method as described above, and utilizing material from such dispensing in a microelectronic product manufacturing process.

[0031] Other aspects, features and embodiments of the invention will be more fully apparent from the ensuing disclosure and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. 1 is a schematic representation of a liner package dispensing system with an empty detect sensor arranged to monitor the liquid medium dispensing operation.

[0033] FIG. 2 is a schematic representation of a liner package dispensing system with primary and secondary volumes of liquid medium arranged so that dispensing of the secondary volume does not occur until the primary volume of liquid medium has been fully exhausted, and with the dispensing of secondary volume liquid medium triggering an empty detect sensor arranged to monitor the liquid medium dispensing operation.

[0034] FIGS. 3-5 are alternative reservoir assemblies useful for empty detect monitoring of liner packages during dispensing operation.

[0035] FIG. 6 is a schematic representation of a reservoir empty detect system according to another embodiment.

[0036] FIG. 7 is a schematic representation of a reservoir empty detect system according to yet another embodiment.

[0037] FIG. 8 is a schematic representation of a liner package and reservoir empty detect system in a specific embodiment.

[0038] FIG. 9 is a schematic representation of a dispense system, including a liner-based pressure dispensing supply vessel integrated with a servo-hydraulic dispense pump and utilizing an empty detect pressure transducer, to determine the onset of pressure droop as an indicator of approach to an empty condition requiring change-out of the supply vessel.

[0039] FIG. 10 is a qualitative graph of the supply package outlet pressure as a function of dispensed material volume, for a material delivery system according to one embodiment of the invention.

[0040] FIG. 11 is a schematic representation of a wafer coating system comprising a pressure dispense supply vessel having a dispense line interconnecting the package to a dispenser unit, according to another embodiment of the invention.

[0041] FIG. 12 is a qualitative graph of the relationship of the time-to-replenish for the dispenser unit (identified as "CRD") in a material delivery system of a type as shown in FIG. 11.

[0042] FIG. 13 is a schematic illustration of a COT (spin coat subsystem) module of a type as employed in the material delivery system of FIG. 11.

[0043] FIG. 14 is a graph of time-to-replenish dispenser at respective elevation-corrected pressures, as a function of the volume of dispensed resist material, in milliliters, for a COT module of the type as employed in the material delivery system of FIG. 11.

DETAILED DESCRIPTION OF THE INVENTION, AND PREFERRED EMBODIMENTS THEREOF

[0044] The present invention relates to liquid containment systems for storage and dispensing of chemical reagents and compositions of widely varied character. Although the invention is hereafter described primarily with reference to storage and dispensing of liquid or liquid-containing compositions for use in the manufacture of microelectronic device products, it will be appreciated that the utility of the invention is not thus limited, but rather the invention extends to and encompasses a wide variety of other applications and contained materials.

[0045] Although the invention is discussed hereinafter with reference to specific embodiments including various liner-based packages and containers, it will be appreciated that various of such embodiments, e.g., as directed to pressure-dispense arrangements or other features of the invention, may be practiced in liner-less package and container systems.

[0046] The present invention relates in various aspects to liquid containment systems for storage and dispensing of chemical reagents and compositions, e.g., high purity liquid reagents and chemical mechanical polishing compositions used in the manufacture of microelectronic

device products, having capability for empty detection when the contained liquid is at or approaching depletion during dispensing operation.

[0047] The term "microelectronic device" as used herein refers to resist-coated semiconductor substrates, flat-panel displays, thin-film recording heads, microelectromechanical systems (MEMS), and other advanced microelectronic components. The microelectronic device may include patterned and/or blanketed silicon wafers, flat-panel display substrates or polymer, e.g., fluoropolymer substrates. Further, the microelectronic device may include mesoporous or microporous inorganic solids.

[0048] In liner packaging of liquids and liquid-containing compositions (hereafter referred to as liquid media), it is desirable to minimize the head space of the liquid medium in the liner. The head space is the volume of gas overlying the liquid medium in the liner.

[0049] The liner-based liquid media containment systems of the present invention have particular utility in application to liquid media used in the manufacture of microelectronic device products. Additionally, such systems have utility in numerous other applications, including medical and pharmaceutical products, building and construction materials, food products, etc., where liquid media or liquid materials require packaging.

[0050] As used herein, the term "zero head space" in reference to fluid in a liner means that the liner is totally filled with liquid medium, and that there is no volume of gas overlying liquid medium in the liner.

[0051] Correspondingly, the term "near zero head space" as used herein in reference to fluid in a liner means that the liner is substantially completely filled with liquid medium except for a very small volume of gas overlying liquid medium in the liner, e.g., the volume of gas is less than 5% of the total volume of fluid in the liner, preferably being less than 3% of the total volume of fluid, more preferably less than 2% of the total volume of fluid and most preferably, being less than 1% of the total volume of fluid (or, expressed another way, the volume of liquid in the liner is greater than 95% of the total volume of the liner, preferably being more than 97% of such total volume, more preferably more than 98% of such total volume, and most preferably more than 99% of such total volume).

[0052] The greater the volume of the head space, the greater the likelihood that the overlying gas will become entrained and/or solubilized in the liquid medium, since the liquid medium will be subjected to sloshing, splashing and translation in the liner, as well as impact of the liner against the rigid surrounding container during transportation of the package. This circumstance will in turn result in the formation of bubbles, microbubbles, and particulates in the liquid medium, which degrade the liquid medium, and render it potentially unsuitable for its intended purpose. For this reason, head space is desired to be minimized and preferably eliminated (i.e., in a zero or near-zero head space conformation) with complete filling of the interior volume of the liner with liquid medium.

[0053] In instances where head space is present in the liner, and a dip tube coupled with a dispense head is used as a dispensing assembly engageable with the liner package, the end of the dispensing operation is readily determinable by the entrance of gas bubble(s) to the dip tube, indicating that the liquid medium in the liner is depleted and only the remaining gas originally overlying the liquid medium is able to flow through the dip tube and remainder of the dispensing assembly.

[0054] Where zero or near-zero head space conformations are employed, however, it is not possible to utilize such ingress of gas into the dip tube to detect an empty or near-empty condition.

[0055] As used herein, the term "empty" in reference to liquid medium in a liner or other vessel, means that the liner or other vessel is fully depleted of liquid medium therein. The term "near-empty" as used herein, in reference to liquid medium in a liner or other vessel, means that the liner or other vessel is substantially completely depleted of liquid medium therein, e.g., the volume of liquid medium remaining in the liner or other vessel is less than 5% of the total volume of the liner or other vessel, preferably being less than 3% by volume, more preferably less than 2% by volume, and most preferably less than 1% by volume, of the total volume of the liner or other vessel. The terms "empty detect" and "empty detection" refer to the detecting of an empty or near-empty condition in a liner or vessel, and the term "empty detector" refers to an apparatus that is employed for determination of such condition. It will be appreciated that the proximity to total depletion of the liquid medium that is able to be sensed by such detectors will in practice vary depending on the specific apparatus employed and its sensitivity, calibration, etc., and that one of skill in the art can readily determine an appropriate detector for a given liquid medium dispensing system without undue effort, based on the disclosure herein.

[0056] There is significant diminution of flow toward the end of the dispensing operation in zero or near-zero head space packages, as the liquid medium in the liner approaches depletion. For example, in an exemplary commercial 4-liter bag-in-box liner package containing polyethyleneglycol methyl ether acetate (PGMEA), a 20% reduction in flow rate of the liquid is measurable at the 99% dispense point, in relation to the flow rate during earlier stages of the dispense operation.

[0057] The present invention in one aspect takes advantage of such diminution of flow rate at the approach to liquid medium depletion in zero or near-zero head space conformations of liner packages, to detect empty or near-empty conditions, by flowing the dispensed liquid medium through an integrated flowmeter. Integrated flowmeters thus can be used to monitor the liquid dispensing rate, and to provide an output indicative of the diminution of the flow rate at the approach to empty condition, so that the depleted liner package is taken off dispensing operation in favor of a fresh package containing liquid medium for continued dispensing at the

desired flow rate. Such integrated flowmeter usage thus resolves a potential flow rate problem in applications in which any reduction in the set point flow rate is not acceptable.

[0058] Integrated flowmeters are commercially available, and a suitable type of such flowmeter is readily determinable within the skill of the art based on the disclosure herein. In one embodiment, the integrated flowmeter is an electronic output integrated flowmeter, providing an empty-detect output signal that can be processed by associated monitoring and control equipment. For example, the liner package may be accessorized with an RFID tag, e.g., on the liner itself, or on the rigid overpack within which the liner is reposed. The RFID tag may include an RF antenna for communication of information from the tag to a process controller querying the tag. The electronic output integrated flowmeter arranged to monitor the dispensed liquid medium flow rate can therefore feed an empty-detect signal to the RFID tag on the package, so that the process controller receives a corresponding empty warning signal correlative of the depletion or approach to depletion of the liquid medium from the liner package, and automatic switchover to a new package is effected, or the dispensing operation is otherwise terminated from the exhausted package.

[0059] Alternatively, the electronic output integrated flowmeter could be arranged to send a control signal correlative of approach to depletion of the liquid medium directly to the process controller for the same purpose.

[0060] FIG. 1 is a schematic representation of an illustrative liner package dispensing system with an empty detect sensor arranged to monitor the liquid medium dispensing operation.

[0061] The liner package dispensing system as illustrated includes a liner package 10 including a rigid overpack 12 defining an interior volume 14 in which is disposed a flexible, collapsible liner 16 holding liquid medium 18. Overlying the liquid medium 18 is a head space 20 comprising gas. Joined to the overpack 12, in fluid communication with the interior volume 14 therein, is a pressurizing gas feed tube 24. The gas feed tube 24 is in turn coupled to a source of pressurizing gas (source not shown in FIG. 1), by which pressurizing gas is flowed into the gas feed tube 24 in the direction indicated by arrow A.

[0062] The introduced gas from gas feed tube 24 enters the interior volume 14 and exerts pressure on the exterior surface of the liner 16, to thereby effect collapsing of the liner and pressure dispensing of the liquid medium 18 therefrom.

[0063] The dispensing of the liquid medium 18 is facilitated by the dip tube 22 extending into the rigid overpack 12 and the liner 16 (e.g., through a port structure of the liner, not shown for ease of description in FIG. 1). The dip tube 22 is open at its lower end, and liquid medium 18 from the (interior of the) liner flows under the impetus of the applied pressure of the pressurizing gas on the liner, through dip tube 22, and flow line 30, connected to the dip tube,

to the liquid medium discharge line 34 containing empty detect sensor 32 therein. Liquid medium is discharged from the discharge line 34 in the direction indicated by arrow B.

[0064] In lieu of the introduction to the interior volume 14 of the pressurizing gas, external pressure can be applied to the liner by hydraulic or mechanical means, to effect dispensing of the liquid medium from the liner.

[0065] As dispensing of the liquid medium proceeds, the liner 16 progressively collapses, until the liquid is depleted. At this juncture, gas from the head space 20 in the liner, and gas, rather than liquid medium, flows through the dip tube 22, flow line 30 and liquid medium discharge line 34. The passage of gas rather than liquid medium through the empty detect sensor 32 triggers the detection of the empty or near-empty condition of the liner by such sensor.

[0066] Such empty detect sensor can operate by various modalities to detect the ingress of gas into the liquid medium dispensing flow circuitry. For example, the empty detect sensor can employ optical sensing of the fluid passing through an inline transparent tube or reservoir of suitable material, e.g., a fluoroplastic polymer, such as a polymer of tetrafluoroethylene and perfluorovinylether (PFA), or alternatively a capacitive electrical effect in a sensor arrangement including such PFA tube or reservoir.

[0067] Although the foregoing arrangement for empty detect operation is effective for determining when the liner has become exhausted of liquid, it relies on the presence of gas in a head space overlying the liquid medium in the liner. Where the liner is fully filled with the liquid medium in a zero head space conformation, there is no gas to determine the end point of liquid medium supply from the liner.

[0068] FIG. 2 is a schematic representation of a zero or near-zero head space liner package dispensing system with primary and secondary volumes of liquid medium arranged so that dispensing of the secondary volume does not occur until the primary volume of liquid medium has been fully exhausted, and with the dispensing of secondary volume liquid medium triggering an empty detect sensor arranged to monitor the liquid medium dispensing operation.

[0069] As illustrated in FIG. 2, the liner package dispensing system as illustrated includes a liner package 10 including a rigid overpack 12 defining an interior volume 14 in which is disposed a flexible, collapsible liner 16 holding liquid medium 18. There is no head space in the liner, but the liner includes, in addition to a primary volume of liquid medium therein, a secondary volume illustrated schematically as being within the solid line 40. The secondary volume of liquid medium is the same type of liquid medium as in the primary volume in the liner, the only difference being that the secondary volume is arranged so that it is not accessed until the dispensing of the primary volume of the liquid medium is completed. The secondary volume may be a partitioned space in the liner that is internal to the primary volume in the liner.

[0070] Alternatively, the secondary volume may be disposed in-line in flow line 30, shown schematically as secondary volume 42, or the secondary volume may be branched from the flow line 30, as shown by the secondary volume 46 being disposed in tee-line 48. The in-line secondary volume 42 is preferred to the branched secondary volume 46, due to the difficulties of turning over and purging the dead end such that fresh lot liquid medium is supplied to the downstream process. The internal secondary volume 40 is most preferred and has the advantage that it requires reduced dispense train components and lower cost than the provision of secondary volumes 42 and/or 46, and the internal secondary volume 40 provides fresh secondary volume of high purity liquid medium each cycle.

[0071] In the FIG. 2 system, joined to the overpack 12, in fluid communication with the interior volume 14 therein, is a pressurizing gas feed tube 24. The gas feed tube 24 is in turn coupled to a source of pressurizing gas (source not shown in FIG. 2), by which pressurizing gas is flowed into the gas feed tube 24 in the direction indicated by arrow B.

[0072] The introduced gas from gas feed tube 24 enters the interior volume 14 and exerts pressure on the exterior surface of the liner 16, to thereby effect collapsing of the liner and pressure dispensing of the liquid medium 18 therefrom.

[0073] The dispensing of the liquid medium 18 is facilitated by the dip tube 22 extending into the rigid overpack 12 and the liner 16 (e.g., through a port structure of the liner, not shown for ease of description in FIG. 2). The dip tube 22 is open at its lower end, and liquid medium 18 from the liner flows under the impetus of the applied pressure of the pressurizing gas on the liner, through dip tube 22, and flow line 30, connected to the dip tube, to the liquid medium discharge line 34. Liquid medium is discharged from the discharge line 34 in the direction indicated by arrow A.

[0074] The inline exterior secondary volume 42 is disposed in, or in communication with, flow line 30 and is shown as having compressive force being exerted thereon, schematically depicted by arrow C. The branched secondary volume 46 is in, or in communication with, the tee-line 48, e.g., coupled to the extremity of such branch line, and is shown as having compressive force being exerted thereon, schematically depicted by arrow D.

[0075] If the secondary volume of liquid medium is partitioned internally of the liner in relation to the primary volume of liquid medium in the liner, the force exerted on the liner 16 by the pressurizing gas introduced in gas feed line 24 is adequate to effect dispensing of the internal secondary volume liquid medium. However, if the secondary volume is external of the liner package, in a corresponding secondary volume liner, the secondary volume liner must have additional compressive force exerted thereon, such as by separate application of a pressurizing gas, or by hydraulic or mechanical application of compressive force thereon.

[0076] The design and implementation of the secondary volumes must ensure that the secondary volumes do not begin collapsing until the primary volume of liquid medium is

FAS 2004 - Page 459

completely exhausted. This can be accomplished, for example, by making the secondary volume collapsing force greater than the primary volume collapsing force. The collapsing force on the secondary volume of liquid medium can be applied in a "push" (active compressive force on the secondary volume of liquid medium) or "pull" (extraction or drawing of liquid medium from the secondary volume, e.g., by use of a downstream pump, venturi, or the like) manner.

[0077] The secondary volume of liquid medium can be contained in a liner of polymeric film similar to the liner containing the primary volume of liquid medium, or the secondary volume of liquid medium may be contained in a restricted region by bellows, diaphragms or collapsing tubes, or by other suitable structure ensuring that the primary volume of liquid medium is first exhausted before any secondary volume liquid medium is dispensed. The specific arrangement of secondary volume restriction is readily determinable based on the disclosure herein, and considerations of cost, flow-through effectiveness, occurrence of dead zones in the flow path, etc.

[0078] As the primary volume of liquid medium is completely exhausted during the dispensing operation, the secondary volume of liquid medium assumes responsibility for supplying liquid medium to the downstream process or other locus of use of the dispensed liquid medium. Upon this changeover, from the inventory of primary volume liquid medium to the secondary volume of the liquid medium, the empty-detect detector in the dispensing system must detect this change.

[0079] In general, the detection of the beginning of the secondary volume dispensing can be detected in any suitable manner, by a detector disposed in the flow path (not shown in FIG. 2) or otherwise arranged to effect the detection. Illustrative examples of useful detection schemes include, without limitation: a pressure transducer arranged to detect pressure decay in the flow of primary volume liquid medium to the downstream point of use; a load change associated with the use of "push" and "pull" elements in the system, as the increased load of dispensing the more restricted secondary volume of liquid medium is detected; flow measurement, if the secondary volume is disposed in a branched tee-line; and/or measurement of the displacement of the secondary volume of liquid medium. Specific devices that can be used in such detection schemes variously include: electronic pressure transducers; thermal or other flow sensors; current load monitors; capacitive, inductive, Hall effect, or optic displacement elements; etc.

[0080] In one specific embodiment, the secondary volume of liquid medium may be provided in a second liner package with an independent and lower compressive force requirement for the pressurizing gas used to dispense the secondary volume liquid medium, in contrast to the compressive force required to effect dispensing of liquid medium from the primary volume of liquid medium in a first liner package.

[0081] In one specific embodiment, the liner package utilizes a flexible member that is welded to the liner, in which the flexible member is stiffer in character than the liner film of which the liner is constructed. The flexible member is configured such that it forms a restricted sub-volume of the liquid medium within the liner, e.g., as a packet structure in the interior volume of the liner, which flexes to release the liquid medium in the packet. The flexible member thereby creates a small pressure drop, e.g., of 1-3 psig magnitude, but functions to dispense a fairly well-defined amount of the liquid medium.

[0082] A pressure transducer or pump torque (measured by amperage drawn by the pump) then can be employed to detect the pressure drop in the liquid medium dispense line. If the liner package itself is used as the pump, by the imposition of pressure on the exterior surface of the liner to compress and collapse the liner and force liquid medium to be expelled from the liner, then the flexible member in the liner will cause an increase in the drive train pressure that is required to maintain the dispense line pressure.

[0083] In other words, the amount of the compressive force exerted on the liner by a drive train, e.g., compression gas delivery flow circuitry, which may for example include an air compressor, or a fluid pump applying gas compression on the liner, will need to increase in order to overcome the additional incremental pressure drop that is associated with the flexible member, when the liner otherwise becomes empty, in order to maintain the same pressure (as during earlier dispensing from the bulk volume of liquid medium in the liner) in the dispense line that is coupled to the package.

[0084] An empty detect alarm can be actuated in response to the change in differential pressure between the drive train pressure and the dispense line pressure that occurs when the bulk liquid medium is exhausted from the interior volume of the liner, and the drive train pressure then is increased to maintain the desired pressure and flow rate of dispensed liquid medium from the restricted sub-volume defined by the flexible member.

[0085] The flexible member defining the restricted sub-volume in the interior volume of the liner can be of any suitable form. In one embodiment, the flexible member is provided as a "V"-shaped sheet element that is welded, e.g., by ultrasonic welding, solvent welding or in other suitable manner, to an edge (bottom, side or top edge) of the liner, with each side of the "V"-shaped sheet element welded to each side of the liner. In another embodiment, the flexible member is provided in the form of a flat or slightly curved rectangular member that is welded to a flat section of the liner. In still another embodiment, the flexible member is configured as a disc-shaped member that is welded to a flat portion of the liner, e.g., a portion near the middle of the liner.

[0086] Thus, the invention contemplates a pressure-dispense system, comprising a vessel enclosing an interior volume, a liner disposed in the interior volume and adapted to hold material therein for pressure dispensing, and a pressure assembly adapted to apply exterior fluid

pressure on the liner for the pressure dispensing, wherein the pressure-dispense system includes a secondary volume for said material, with such secondary volume constituting a sub-volume of the liner having a different pressurizing requirement than that required for pressure-dispensing of material from a main volume of the liner not including such sub-volume. The pressure assembly includes a fluid pressurizing drive train adapted to deliver pressurized fluid into the interior volume to apply pressure on the liner, during dispensing of material from the main volume and during dispensing of material from the secondary volume, that maintains dispensed material at a same pressure throughout the dispensing from the main volume and the secondary volume.

[0087] The fluid pressurizing drive train includes, in one embodiment, flow circuitry including an air compressor or fluid pump adapted to maintain a same pressure throughout the dispensing from the main volume and the secondary volume.

[0088] The liner in use contains a material of appropriate character for the intended application, e.g., a material for manufacturing a microelectronic product. The pressure-dispense system described above can be provided as a part of a microelectronic product manufacturing apparatus, in combination with a microelectronic product manufacturing tool that is coupled with the pressure-dispense system to receive the dispensed material therefrom.

[0089] The pressure-dispense system described above can be used in a method of supplying a material, in which the pressure assembly is actuated, followed by dispensing material first from the main volume of the liner, and thereafter from the secondary volume of the liner, with the material being dispensed at a same pressure throughout the dispensing from the main volume of the liner and dispensing from the secondary volume of the liner. The dispensed material may for example comprise a material for manufacturing a microelectronic product, whereby the material may be dispensed as described, and utilized in a microelectronic product manufacturing process.

[0090] In another embodiment, an empty detect system for a liner package includes a modified barometer to provide a reservoir for liquid utilized for wafer processing in microelectronic device manufacturing operations. In such arrangement, the liner package has head space in the liner, from which head space gas can be extracted to provide a miminum head space in the liner package. The head space, having a volume that may for example be on the order of 100-150 milliliters, is vented to a reservoir vessel for level detection, to provide capability for sensing of the empty-detect condition of the liner package when the liquid medium inventory in the liner has reached, or is approaching, a depleted state.

[0091] The reservoir used in such empty detect systems can be of any suitable type, such as one of the alternative forms shown in FIGS. 3-5, wherein corresponding parts and features are numbered correspondingly in the respective drawings.

[0092] Referring to FIG. 3, the reservoir system 60 is arranged to receive liquid medium from the liner package in feed line 64, entering the reservoir 62 to form therein a liquid medium volume 66, with excess gas from the feed line 64 forming the gas space 70 from which the excess gas may be vented off, in vent line 76 containing a flow control valve 78 therein.

[0093] From the reservoir, the liquid medium from volume 66 may be discharged in line 72 containing flow control valve 74 therein, and passed to the downstream use facility or location, e.g., a microelectronic device manufacturing facility.

[0094] For monitoring for the occurrence of an empty or near-empty condition, the vent valve 78 and the liquid medium flow valve 74 are closed, and dispense pressure is applied to the exterior surface of the liner in the liner package, to cause head space gas from the liner to be forced to the top region of the reservoir 62. When the liquid medium has been fully expelled from the liner, the gas in the top region of the reservoir 62 is under pressure and can affect pressure dispensing of the liquid medium from the reservoir to the downstream process to complete the feeding of the liquid medium without cessation of flow.

[0095] During the dispensing of the liquid medium from the reservoir to the downstream process, another fresh liner package containing an inventory of liquid medium can be coupled to the flow circuitry in the liquid medium dispensing system, or otherwise be "changed in" for renewed liner package dispensing.

[0096] The amount of the liquid medium that is dispensed from the reservoir 62 during the "running dry" of the liner package is indicated as the cross-hatched volume 68 in FIG. 3. As this make-up amount of liquid medium (volume 68) is dispensed to the downstream process, the falling level of such liquid medium will be detected by level detect unit 80. The level detect unit 80 may incorporate level sensor elements of any suitable type, e.g., infrared level sensors or capacitive sensors, and the empty or near-empty condition sensed by the detect unit 80 may cause the detect unit to actuate a suitable alarm, send a control signal to an auto-changeover system for switch-in of a new liner package for dispensing, or take other appropriate action.

[0097] The reservoir system of FIG. 3 is deployed in the process flow line and functions both as a surge tank or hold-up vessel that supplies liquid medium when the liner package has been depleted of material to be dispensed, as well as a level detect installation that serves to provide appropriate warning or corrective action even when head space is present in the liner of the liner package.

[0098] In the FIG. 4 reservoir system, the structure of the reservoir is the same as that shown in FIG. 3, except that the reservoir at its intermediate portion has a reduced diameter section 82 for level detect sensing, with the reduced diameter section being flanked by the frustoconical transition sections 84 and 86 as illustrated.

[0099] The detection system 60 shown in FIG. 5 is of the same conformation as the detection system in FIG. 4, except that the reduced diameter section 82 is of an elongated

character in relation to the length of such section in the detection system of FIG. 4, and the reduced diameter section 82 in the FIG. 5 system has a flow restriction 90 at its lower end, as shown.

[00100] The three reservoir empty detect systems of FIGS. 3-5 are designed to minimize the incorporation of dissolved gases in the liquid medium being dispensed, since any dissolved gases can later appear as bubbles. The empty detect systems of FIGS. 4 and 5 have a reduced diameter intermediate section 82 to limit the diffusion of gases into the liquid medium being dispensed. The system of FIG. 5 demonstrates the provision of a longer barrier to gas incorporation (i.e., the system of FIG. 5 provides a long path for disengagement of gas from the liquid medium). As another variant, the reservoir could be formed as an upper gas section and a lower liquid section, interconnected by a long coil of tubing to provide good isolation between the respective gas and liquid sections of the reservoir.

[00101] The FIG. 5 reservoir provides a trap for extraneous bubbles that may be expelled by the liner after the initial discharge of the head space gas from the liner package. If bubbles were to rise up through the reduced diameter intermediate section of the reservoir, such bubble movement could result in significant convective mixing of the reservoir, which would hasten the uptake of gas by the liquid medium. During the initial transfer of head space gas, the increasing pressure will force the gas up to the top section of the reservoir.

[00102] FIG. 6 is a schematic representation of a reservoir empty detect system according to another embodiment, and addresses the pressurization of the reservoir during normal dispense. The previously described barometric reservoir arrangements of FIGS. 3-5 leave the liquid medium in the reservoir under pressure for the whole dispense time. This liquid medium gets mixed into the lower reservoir and bubbles could be subsequently dispensed with the liquid medium. The FIG. 6 system stores the reserve liquid medium at atmospheric pressure in the reservoir.

[00103] The liner package and reservoir system 100 of FIG. 6 includes the liner package 116 as schematically shown coupled to the dispense line 118 containing check or valve upstream of a pressure switch or transducer. From the pressure switch or transducer, the liquid medium and headspace gas flows in line 112 to the phase separator, with the gases being vented through the check valve, phase separator, reservoir 102, and valves V3 and (if present) V1. When the liquid medium pushes up to Level Sensor 1, valve V3 is closed and the reserve amount of the liquid medium is saved.

[00104] The reservoir 102 has coupled thereto a gas discharge line 106 which in turn is joined to vent line 110 (to Vent) having valve V1 therein, and to branch line 108 (to N2) containing valve V2 therein. The reservoir 102 is positioned above the phase separator, and the phase separator at an upper portion thereof is coupled in fluid flow communication with the overlying reservoir by overhead line 104 having Level Sensor 2 and valve V3 therein. The

phase separator in turn is coupled at a lower portion thereof to a liquid medium flow line containing valve V4 therein.

[00105] When the liner package is ready to dispense liquid medium to the downstream process, valve V4 is opened, and flow initiated. Errant bubbles are trapped by the Phase Separator, as the liquid medium continues to be dispensed. When the liner package 116 is empty, the pressure in the dispense line will drop and the pressure switch/transducer will be actuated. Valve V3 then will open, and liquid medium will be fed from the reservoir to the dispense train. When the liquid level drops to Level Sensor 2, valves V3 and V4 will close and the liner package 116 will then need to be changed.

[00106] Due to the presence of the check valve/valve in line 118, the liner package 116 can be taken offline when the Level Sensor 1 is actuated and the liner package changed out while the downstream process is fed from the reserve liquid medium in the reservoir.

[00107] Valves V1 and V2 are optional components of the system, which can simply be operated with the reservoir being open to atmospheric venting. Nonetheless, from a safety perspective and the objective of minimizing the evaporation of solvent, where the liquid medium is or contains volatile material, V1 is preferably used and is open during the filling of the reservoir. When the reservoir is filled to Level Sensor 1, V1 will close. Upon actuation of the pressure switch or transducer in line 118, indicating that the liner package is empty, valve V3 opens and valve V1 opens allowing reserve liquid medium to be used. Alternatively, if pressure dispensing is required, valve V2 will open instead of valve V1.

[00108] If valve V1 is used during the dispensing of liquid medium from the reservoir, there is the possibility that the pressure in a downstream pump will create bubbles from the resulting negative pressure condition. Pressurizing using valve V2 instead of valve V1 addresses such negative pressure issue. Dissolved gases may be present in the liquid medium coming from the reserve supply in the reservoir, but due to the short operational time involved, such effect should be minimal or absent.

[00109] FIG. 7 is a schematic representation of a reservoir empty detect system according to yet another embodiment. The liner package is not shown in FIG. 7 but may comprise a liner package of a type commercially available from ATMI, Inc. (Danbury, CT, USA) under the trademark PDMPak, which is coupled to the liquid medium feed line 126 ("from PDMPak"). Feed line 126 contains a Check or other type of Valve, and downstream of such valve is a Pressure Switch or Transducer.

[00110] The feed line 126 is coupled to a reservoir 122 having Level Sensor 2 at an upper portion thereof, and a Level Sensor 1 at a lower portion thereof. The lower portion of the reservoir is connected to a discharge line 124 having flow control valve V3 therein. At its upper end, the reservoir is coupled to line 128, which in turn is joined to branch line 130

containing valve V1 therein (to Vent), as well as to branch line 132 containing valve V2 therein (to N2).

[00111] At start up of the FIG. 7 system, the head space gas from the liner package is forced through the Check Valve/Valve up through the reservoir 122 and out lines 128 and 130, V1 being open. When liquid starts to flow to the reservoir, initiating fill thereof, the liquid level rises and when it reaches Level Sensor 2, valve V1 closes. The system then is ready to dispense to the downstream process facility, such as a microelectronic device manufacturing tool. It is to be noted that the Level Sensor 2 could alternatively be located in line 128, thereby allowing the reservoir to be completely full of chemical and further minimize gas entrainment. When the liner package reaches an empty condition, the pressure starts to decline, and such pressure drop actuates the Pressure Switch. The user has a choice to set the opening of either valve V1 or valve V2 at this stage of operation. If valve V1 is selected and is opened, then the pressure in the system will drop from the dispense pressure to atmospheric pressure. If valve V2 is selected and is opened, then the pressure in the reservoir will rise to the supply pressure of the nitrogen gas used in the system as a pressurizing gas for the liner package dispensing operation.

[00112] In the FIG. 7 system, the user has the ability to deliver liquid medium between Level Sensor 1 and Level Sensor 2.

[00113] When Level Sensor 1 is actuated, the liner package should be changed out and the dispense operation should be terminated.

[00114] The presence of the Check Valve in line 126 allows the user to remove and change out the liner package when Level Sensor 2 is actuated, thereby limiting the down time of the downstream liquid medium-utilizing process.

[00115] FIG. 8 is a schematic representation of a liner package and reservoir empty or near empty detect system 200 in a specific embodiment. This embodiment allows for pressure dispensing and level detection without dispense gas (pressurizing gas) coming into contact with the liquid medium.

[00116] The FIG. 8 system uses a "bag/bellows in bottle" type liner package as the Empty Detect Vessel, and is arranged for empty detect monitoring of the liner package and pressure dispensing of reserve liquid medium to the downstream process facility, without the application of dispense gas directly to the liquid medium.

[00117] At startup of the FIG. 8 system, valves V1 and V2 open to vent gas from the head space of the liner package 200 comprising vessel 202 containing liner 204 and coupled via cap 208 with a dispensing assembly including dip tube 206. Pressurizing gas (N2) is introduced by pressurizing gas feed line 210 into the interior volume of vessel 202, to exert pressure on the liner therein, and effect pressure dispensing of liquid medium.

[00118] The liner package in the system of FIG. 8 can be of any suitable type. A vessel of the type commercially available from ATMI, Inc. (Danbury, CT, USA) under the trademark NOWPAK, having a 4-liter liquid medium capacity, and a 3-port probe design, is illustratively shown.

[00119] When Level Indicator 1 senses liquid, valve V2 closes, which terminates flow of head space gas out of valve V2. Valves V3 and V4 then open, allowing liquid medium to enter the Empty Detect Vessel 226 via liquid medium transfer line 220. The Empty Detect Vessel is designed with a through port configuration that allows gas to escape through valve V4 and vent line 222.

[00120] Once Level Indicator 2 senses the presence of liquid (Level Indicator 3 being arranged for actuation prior to actuation of Level Indicator 2), valve V4 closes, thereby terminating the flow of liquid medium through such vent valve. After a short delay, valve V5 opens, thereby allowing the introduction of pressurizing gas (N2), to supply pressure to the interior volume of the Empty Detect Vessel. This supply pressure for the Empty Detect Vessel is set for slightly lower than the supply pressure applied to the interior volume of the liner package. By such arrangement, as long as liquid medium is in the liner package, liquid medium will be dispensed from the liner package, rather than from the Empty Detect Vessel 226.

[00121] Once the desired pressure is achieved by flow of pressurizing gas through valve V5, valve V6 opens to supply liquid medium in liquid medium discharge line 228 to the downstream process tool 250. The downstream process tool 250 can be of any suitable type, e.g., a microelectronic device manufacturing tool comprising a deposition chamber for deposition of photoresist on a semiconductor substrate, an ion implant tool for ion implantation of a semiconductor substrate, a chemical vapor deposition tool receiving an organometallic reagent for deposition of metal on a flat panel display substrate, etc. Eventually, the liquid medium in the liner package feeding the tool is fully consumed. When this occurs, the pressure inside the Empty Detect Vessel drops. The dispense pressure from nitrogen gas flowed through valve V5 takes over and continues the dispensing of liquid medium from the Empty Detect Vessel to the downstream process.

[00122] Level Indicator 3 is actuated when dispensing from the Empty Detect Vessel occurs, indicating that the liner package needs to be replaced. Valves V3 and V1 will close when Level Indicator 3 is actuated, thereby allowing the liner package to be changed safely while the downstream process is operating on the reserve liquid medium supply from the Empty Detect Vessel. The Empty Detect Vessel is designed to have a minimum liquid medium reserve, so that the Empty Detect Vessel can supply enough liquid medium for continued operation, e.g., in one specific embodiment, in a sufficient quantity to dispense microelectronic

device manufacturing reagent to 2 boat loads of wafers (i.e., two lots of wafers (= 50 wafers)). Once the liner package is changed out, the liquid medium dispensing process is repeated.

[00123] The Empty Detect Vessel can be configured and operated in any suitable manner. In one embodiment, the Empty Detect Vessel is constructed with a collapsible membrane that can be pressurized without applying direct pressure to the liquid medium, thus avoiding saturating the liquid medium with bubble-forming gas.

[00124] Other pressurizing structures that may be employed to avoid contacting the pressurizing gas with the liquid medium include bags, bellows, collapsilble tubes, and the like.

[00125] Another alternative construction employs a tube, with a floating ball that allows for the pressurization of the Empty Detect Vessel, while simultaneously accommodating the separation of the pressurizing gas from the liquid medium. As a variation of this approach, a plunger or piston could be used to similar effect, in applications in which such moving parts can be accommodated without adverse effect on the desired purity requirements for the liquid being dispensed.

[00126] In yet another embodiment, the invention contemplates ultra-high purity packaging with integral sensors, to increase the functionality of the packaging, e.g., to improve the knowledge of the contents of packaging such as liner packages, during their storage, transport and subsequent use, as well as to link information from the packaging to centralized IT systems for factory automation/control, thereby achieving decreased cost-of-ownership and increased production efficiency, and enhancing cost accounting efficiency of packaging and packaged products.

[00127] Sensors used for such purpose may employ passive radio frequency identification (RFID) technology, the term passive denoting technology that uses no batteries for power, but instead uses RF power in the interrogating RF signal. Electrical power in this signal, which may also contain information, is received by an antenna. Simple circuitry processes the sensed electrical signal to rectify it, e.g., by diode circuitry, and to store it, e.g., by use of capacitive circuitry, so that after a suitable integration time the processed signal is available to wake up and operate the passive RFID chip.

[00128] Passive RFID, while useful for read-only or read-write non-volatile memory operations, in various packaging applications of the invention, can also be utilized in sensors, particularly if the sensed data density required is low enough to be satisfied by the power limitations in the passive approach. A variety of passive RFID protocols are available, including ISO 14443 (types A, B and C), operating at 13.56 MHz, and the EPC Gen-2, operating around 900 MHz.

[00129] Sensors useful in the broad practice of the present invention include, without limitation, liquid or solid level sensors, and sensors of material properties.

[00130] Level sensors can be of various types, including gravity sensors. When a bag-in-box package is utilized, such as the package commercially available from ATMI, Inc. (Danbury, CT, USA) under the trademark NOWPAK, the liner walls are typically unsupported and the entire liner hangs freely from a dispense nozzle. In such conformation, the amount of stress and resulting mechanical deformation (strain) on the dispense nozzle physical supports can be measured by a sensor, to determine the amount of material left in the liner. This measurement can for example be a low-accuracy measurement, with 1/8 gradations of total liner volume, similar to an automobile fuel gauge, and with the sensor being zero-set at the factory. To improve sensitivity in specific embodiments of such sensor usage, the dispense nozzle could be fabricated from specific material at specific material thickness, on which a strain gauge can be mounted, to measure strain, e.g., using a Wheatstone bridge resistance array, with one or more of the legs fabricated to be strain-sensitive.

[00131] Since strain depends on temperature, a simultaneous temperature measurement can be conducted by a thermal sensor to correct for temperature effects. A combined strain-gauge/temperature sensor can be embodied as a battery powered, hardwired sensor, to determine the weight of material in the liner package, via deformation of the mounting flange in the dispense section of the package. A liner package level sensor of this type can also be hardwired for power and communication, and/or it can be adapted for wireless communication, with either battery power (e.g., as an active RFID) or with a passive RFID sensor. In instances where the sensor is placed on the disposable liner mounted on the dispense nozzle, such passive RFID scheme provides a low-cost, easily implemented material inventory sensor. Wireless sensors of this type can be implemented in an integrated manner with respect to antenna/reader components of materials tracking systems, or they may be independently implemented.

[00132] Alternatively, a strain sensor can be deployed on the tool (downstream process) side of the dispense nozzle, to measure the weight of the material-containing liner that is attached to the tool, using the same or similar hardware and hardwired (data and power) interfaces.

[00133] The invention contemplates usage of level sensors in bag-in-can or bag-in-bag liner packaging applications. In these cases removal of the liquid medium from the liner packaging can be achieved or assisted by pumping pressurized fluid (either gas or liquid) into the intermediate space inside the can or outer bag, to bear compressively on the exterior surface of the liner, so that the liner collapses and causes the liquid medium therein to be discharged. Since the outer containment vessel in such package arrangements has a fixed volume, the volume of the intermediate space (between the liner and the outer containment vessel) provides a direct indication of the amount of material left in the liner.

[00134] In one embodiment, the volume of this intermediate space is sensed by 1) temporarily closing the outlet or a downstream conducting line from the liner, 2) delivering a

known quantity of gas into the intermediate space in the bag-in-can or the bag-in-bag package, and 3) measuring the pressure increase resulting from this incremental pulse of material into the intermediate space in the package. This sensor arrangement is preferably hardwired, with a module affixed to the outside of the outer containment vessel at the point of entry of the pressurizing fluid. This arrangement is particularly advantageous when there is a significant differential between the compressibility of the liner contents and the pressurizing fluid, e.g., between a liquid medium as the contained material in the liner, and a pressurizing gas.

[00135] With respect to materials property sensors, various properties of the liquid medium in the liner can be utilized for material property monitoring, in order to optimize the downstream process utilization of such liquid medium, to reject liquid medium that has become degraded, to salvage liquid medium beyond its nominal shelf life, to check and ensure accuracy of material packaging, etc.

[00136] In such applications, the materials property sensor can be of any suitable type, e.g., a hardwired microsensor, wireless battery-powered microsensor, or passive sensor integrated into the ultra-high purity disposable liner packaging, or in other disposable components of the product packaging.

[00137] Integration of passive RFID sensors directly into the liner packaging permits the accurate observation and tracking of material properties in an efficient and cost-effective manner.

[00138] The present invention in a specific aspect includes the use of fluid analysis sensors-on-a-chip that are integrated into the dispense nozzle or the liner packaging, e.g., via a hardwired power-data interface, to monitor a material in a high purity disposable package during use.

[00139] The invention therefore broadly contemplates the deployment in the packaging of sensors of various types, including for example (i) thermal sensors for monitoring equilibration of the product and its packaging after installation in a storage, transport or installation environment, (ii) electrochemical sensors for monitoring product shelf life, such as by analyzing organics or inorganic, or by-products formed *in situ* as a result of aging, environmental contamination, pH changes, gas permeation, etc., and (iii) optical scattering sensors, for monitoring homogeneity and mixing/mixedness of product compositions in package product applications.

[00140] The invention additionally contemplates delivery systems for material using liner-based packages for pressure dispensing, and systems for material delivery in which exhaustion of a supply package is readily detected.

[00141] In one embodiment, the invention provides a material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a

dispensed material-utilizing tool, and the dispense line has operatively disposed therein a servo-hydraulic dispense pump, and an empty detect pressure transducer between the package and the pump operatively arranged to provide an output indicative of approach to an empty state of the package.

[00142] The system may further include a reservoir gas separator and vent assembly disposed in the dispense line between the package and the servo-hydraulic dispense pump. Optionally, the system may also include a filter disposed in the dispense line between the reservoir gas separator and vent assembly and the pump, and an air-operated sequencing valve assembly (atmospheric valve/sequencing valve, or AV/SV, assembly) in the dispense line downstream of the pump.

[00143] The liner may suitably contain a chemical reagent, such as a photoresist or other material usefully employed for manufacture of microelectronic products, e.g., semiconductor devices and flat panel displays.

[00144] In the above-described system, the pressure transducer can be operatively coupled to a controller for isolating the package to enable change-out thereof on the approach to an empty state of the package.

[00145] Another embodiment of the invention relates to a material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a dispensed material-utilizing tool, and the dispense line is coupled to a dispenser arranged to receive resist on a cyclic replenishment schedule from said package, for flow to the tool, and a monitor adapted to detect an increase in time required for replenishment of the dispenser indicative of approach to an empty state of the package and to responsively provide an output of such approach.

[00146] The dispenser in such embodiment can include a pump, such as a pneumatic pump, a hydraulic pump, etc., wherein there is variation in elevation of different ones of the cups in the spin coat subsystem, and wherein the filling of the chamber of the dispenser (pump) assembly is elevation corrected. As used in such context, the term "cup" refers to a chamber (pump chamber) that has a wafer spinning position and is associated with a dispense arm and nozzle, spinner motor, and wafer chuck. The dispenser system can include a reservoir gas separator and vent assembly in a dispense line between the package and the dispenser. A filter may be provided in the dispense line between the reservoir gas separator and vent assembly and the dispenser, and an AV/SV valve assembly can be provided in the dispense line downstream of the dispenser. The AV/SV valve assembly includes an air-operated automatic valve (as the on/off AV portion of the assembly) and a suction-back valve (as the SV portion of the assembly), in which the SV portion reverse displaces volume so that the dispensed material is

sucked up slightly into the nozzle, such that the meniscus does not drip on the wafer after coating.

[00147] The liner may suitably contain a chemical reagent, such as a photoresist or other material usefully employed for manufacture of microelectronic products, e.g., semiconductor devices and flat panel displays.

[00148] In the above-described system, the monitor can be operatively coupled to a controller for isolating the package to enable change-out thereof on the approach to an empty state of the package, and/or the monitor can be adapted for effecting other action in the system, such as a process control function.

[00149] In another aspect, the invention relates to a liner-based material storage and dispensing package for direct pressure-dispensing of material such as photoresist. The package is advantageously arranged for removal of headspace gas prior to dispensing, in order to achieve a zero or near-zero headspace condition, and thereby avoid generation of microbubbles in the packaged material to be dispensed.

[00150] By way of specific example, in semiconductor manufacturing facilities, such liner-based photoresist storage and dispensing package may be integrated with servo-hydraulic coupled dispense pumps for delivery of photoresist to the semiconductor wafer coating tool.

[00151] In dispensing systems of such type, the dispense pressure can be monitored by a transducer, and a progressively increasingly rapid drop in such pressure, as an empty condition of the dispensing vessel is approached, termed a "droop,"can be used as a process parameter to determine when change-out of the supply package is necessary.

[00152] A dispense system 300 of such type is schematically shown in FIG. 9, including a liner-based pressure dispensing supply vessel 302 integrated with a servo-hydraulic dispense pump including a servo piston motor 308 and a hydraulic fluid coupling 310. The system utilizes an empty detect pressure transducer 306, to determine the onset of pressure droop as an indicator of the approach-to-empty condition necessitating change-out of the supply vessel.

[00153] The servo-hydraulic dispense pump is disposed in the dispense line 312, being provided with an upstream flow control valve 314, and a downstream flow control valve 316. The dispense line 312 further contains a reservoir gas separator 320. A vent line 322 is coupled to the reservoir gas separator 320 and contains a flow control valve 324 therein, to accommodate the venting of the reservoir.

[00154] Downstream of the reservoir gas separator 320 is a filter 326. The filter is in turn positioned upstream of the servo-hydraulic dispense pump in the dispense line 312. Also disposed in the dispense line 312 is an air-operated sequencing valve 328 (atmospheric valve/sequencing valve, or AV/SV), as a valve tandem providing on/off back-suction to facilitate both dispensing and replenishment modes of operation in the delivery of the photoresist to the wafer 330.

[00155] In the FIG. 9 system, the pump diaphragm in the servo-hydraulic dispense pump is the driver in both dispense and replenish modes. The time of the dispense and replenish is a pump operational parameter. Onset of the empty condition of the supply package 302 is detected by the transducer 306, and the empty condition is selected as a predetermined pressure droop as the empty condition is approached. A qualitative graph of the supply package outlet pressure as a function of dispensed material volume is set out in FIG. 10 hereof.

[00156] Although the above-described approach of utilizing an empty detect pressure transducer for determining onset of an empty condition in the photoresist supply vessel is in general reliable, transducers are relatively expensive, and do not monitor all aspects of the operational condition of the dispense train.

[00157] The invention therefore contemplates, in one embodiment thereof, the provision of a liner-based material storage and dispensing package for direct pressure-dispensing of material such as photoresist, integrated with a dispenser unit, e.g., of a type as described in US Patent 6,319,317 to Hideyuki Takamori, the disclosure which hereby is incorporated herein by reference, in its entirety.

[00158] FIG. 11 is a schematic representation of a wafer coating system 400, comprising a pressure dispense supply vessel 402 having dispense line 412 coupled thereto. Disposed in the dispense line 412 is a dispenser (pump) unit including a pneumatic coupling section 410. The dispenser unit is coupled to a replenish vent line containing a three-way valve 444 therein, so that the dispenser unit can be vented through such valve, when it is in the open position, through discharge line 446. Also coupled to three-way valve 444, by feed line 448, is an electro-pneumatic regulator 450. The dispenser unit includes a replenish home position sensor 452.

[00159] The FIG. 11 system is otherwise configured as described in connection with FIG. 9 hereof, with a reservoir gas separator 420 in dispense line 412, coupled to vent line 422 having flow control valve 424 therein. The reservoir gas separator 420 is upstream of filter 426. The dispenser unit has respective upstream and downstream flow control valves 414 and 416 associated therewith, e.g., as integral components of the dispenser unit, and an AV/SV tandem valve 428 is disposed in dispense line 412, upstream of the wafer 430.

[00160] In the FIG. 11 system, the pump diaphragm is the driver only in the dispense operation. In the replenish mode, the pressure-dispensing package is the driver, and the dispenser diaphragm is a follower, with the replenish time being a function of the package pressure, resist viscosity, dispenser elevation with respect to the supply package, filter selection, dispenser dispense volume, filter loading, dispense line geometry and flow restrictions. The time required to replenish the dispenser unit is an early indication of the approach-to-empty condition of the supply vessel, in an inverse relationship to the empty-onset pressure droop.

[00161] The empty condition is selected as a predetermined vessel time-to-replenish for each cup elevation of the wafer cup module of the resist coating unit ("COT"), with accompanying selection of the other parameters identified above. A qualitative graph of the relationship of the time-to-replenish for the dispenser unit is shown in FIG. 12.

[00162] The system arrangement shown in FIG. 11 avoids the need for an expensive pressure transducer and provides an indication of the character of the replenish operation.

[00163] FIG. 13 is a schematic illustration of a COT module commercially available from Tokyo Electron Ltd. (Tokyo, Japan) under the trademark LITHIUS II, containing five wafer cups (Cup 1, Cup 2, Cup 3, Cup 4 and Cup 5). Each line A_1-A_5 on the COT module represents the constant dispense distance and elevation from the dispenser to the respective wafer cup. Each line B_1-B_4 represents the variable elevation as a function of the supply vessel to dispenser location. The COT module is shown as containing two pressure dispense packages 500 and 502, which are adapted to be used in sequence, so that as supply package 500 approaches exhaustion, it can be switched out, with fresh supply package 502, then being placed into dispensing service.

[00164] Each line A_1-A_5 represents a unique replenish time for the associated dispenser. As shown in the COT module elevation, each level represents 0.5 m (4.898 kPa, 0.710 psi) for a resist density of 1 g per milliliter.

[00165] Each COT module has a working drive pressure above the elevation, as a pressure that will linearly correlate under laminar flow conditions to the dispenser fill time. The ratio of replenish time to elevation-subtracted drive pressure was found to be a constant, thereby demonstrating the agreement of the empirical data to elevation-corrected drive potential. With all other factors being equal, e.g., filter loading, dispense line length, viscosity, filter selection, the dispenser's dispense volume to replenish, dispense line conformation, etc., the time to replenish is fixed at each cup level, and an increase in time reflects the onset of the supply vessel empty condition.

[00166] The end-of-dispense empty detect capability in the above-described system relies on the fact that for each cup level, the time-to-replenish will rise in proportion to the fraction of supply package pressure droop compared to the elevation-corrected drive pressure.

[00167] FIG. 14 is a graph of time-to-replenish dispenser at respective elevation-corrected pressures, as a function of the volume of dispensed resist material, in milliliters, for the COT module schematically illustrated in FIG. 13.

[00168] It is to be noted in the FIG. 14 graph that the replenish time ramps upwardly more quickly at higher cup elevations due to the supply package droop being larger percentage of elevation-corrected drive pressure under such conditions.

[00169] While the invention has been has been described herein in reference to specific aspects, features and illustrative embodiments of the invention, it will be appreciated that the utility of the invention is not thus limited, but rather extends to and encompasses numerous other variations, modifications and alternative embodiments, as will suggest themselves to those of ordinary skill in the field of the present invention, based on the disclosure herein. Correspondingly, the invention as hereinafter claimed is intended to be broadly construed and interpreted, as including all such variations, modifications and alternative embodiments, within its spirit and scope.

THE CLAIMS

What is claimed is:

1. A fluid storage and dispensing system, comprising:
a vessel having an interior volume;
a liner in said interior volume, arranged to contain a liquid medium in a zero or near zero head space conformation;
a dispensing assembly adapted for engagement with the vessel, to withdraw liquid medium from the liner during dispensing operation; and
an integrated flowmeter arranged to monitor the liquid medium withdrawn from the liner during dispensing operation, and to generate an output correlative of an empty-detect condition upon occurrence of same.

2. The fluid storage and dispensing system of claim 1, wherein the integrated flowmeter monitors the liquid medium dispensing rate and generates said output in response to a substantial diminution of flow rate of the liquid medium as said empty-detect condition.

3. The fluid storage and dispensing system of claim 1, wherein the integrated flowmeter comprises an electronic output integrated flowmeter.

4. The fluid storage and dispensing system of claim 3, further comprising an RF-responsive controller adapted to terminate the dispensing operation in response to received information that an empty-detect condition has occurred, and an RFID tag on at least one of the liner and the vessel, wherein said RFID tag includes an RF antenna arranged to communicate information from the RFID tag to the controller, and said electronic output integrated flowmeter is arranged to feed said output to said RFID tag, whereby the generation of said output indicative of said empty-detect condition is communicated to said RFID tag and corresponding information indicative of said empty-detect condition is transmitted by said RF antenna to said RF-responsive controller to terminate the dispensing operation upon occurrence of the empty-detect condition.

5. The fluid storage and dispensing system of claim 4, wherein the RF-responsive controller is adapted to effect a change-over from said vessel and liner, to a second vessel and liner for continued dispensing operation.

6. The fluid storage and dispensing system of claim 3, further comprising a controller adapted to receive said output from the electronic output integrated flowmeter, and to responsively terminate the dispensing operation.

7. The fluid storage and dispensing system of claim 6, wherein the controller is adapted to effect a change-over from said vessel and liner, to a second vessel and liner for continued dispensing operation.

8. A liner package dispensing system, comprising:
a vessel having an interior volume;
a liner in said interior volume, arranged to contain a liquid medium in a zero or near zero head space conformation;
a dispensing assembly adapted for engagement with the vessel, to withdraw liquid medium from the liner during dispensing operation;
flow circuitry coupled with the dispensing assembly and arranged for flow therethrough of liquid medium during the dispensing operation;
said flow circuitry including an in-line portion and an optional branch portion;
a secondary volume of liquid medium arranged for dispensing so that dispensing of the secondary volume does not occur until a primary volume of liquid medium has been fully dispensed, wherein said primary volume includes at least part of said liquid medium in said liner, and said secondary volume is constituted by one or more of:
(i) a part of said liquid medium in said liner other than liquid medium constituting said primary volume, when said primary volume comprises less than all liquid medium in said liner;
(ii) an in-line volume of liquid medium in or communicating with said in-line portion of said flow circuitry; and
(iii) a branch volume of liquid medium in or communicating with said branch portion of said flow circuitry; and
an empty detector arranged to monitor said dispensing operation and generate an empty-detect output when said secondary volume dispensing is initiated after the primary volume of liquid medium has been dispensed.

9. The liner package dispensing system of claim 8, wherein the secondary volume of liquid medium is a partitioned region in the liner.

10. The liner package dispensing system of claim 8, further comprising a pressurizing gas supply arranged to apply compressive gas pressure on the liner to mediate dispensing of liquid medium during said dispensing operation.

11. The liner package dispensing system of claim 8, wherein the dispensing assembly comprises a dispense head coupled with a dip tube, and the dip tube is adapted for flow therethrough of liquid medium from the liner during said dispensing operation.

12. The liner package dispensing system of claim 8, further comprising a pressurized gas supply arranged for mediating pressure dispensing of liquid medium from at least one of said primary and secondary volumes of liquid medium.

13. The liner package dispensing system of claim 8, further comprising a pump coupled to the flow circuitry.

14. The liner package dispensing system of claim 8, wherein the secondary volume of liquid medium is contained in a liner of polymeric film.

15. The liner package dispensing system of claim 8, wherein the secondary volume of liquid medium is contained in a restricted region in the liner.

16. The liner package dispensing system of claim 8, wherein the restricted region in the liner is formed by a restriction structure selected from the group consisting of bellows, diaphragms and collapsing tubes.

17. The liner package dispensing system of claim 8, wherein said empty detector performs a detection scheme selected from the group consisting of: detection of pressure decay in the flow of primary volume liquid medium through the flow circuitry; detection of a load change incident to an increased load of dispensing the secondary volume of liquid medium in relation to load of dispensing the primary volume of liquid medium; flow measurement when the secondary volume is constituted by a branch volume of liquid medium in or communicating with said branch portion of said flow circuitry; and measurement of displacement of the secondary volume of liquid medium during dispensing operation.

18. The liner package dispensing system of claim 8, wherein the secondary volume of liquid medium is contained in a second liner, and each of the primary and secondary volumes of

liquid medium is pressure-dispensed from its respective liner by a compressive force of gas exerted thereon.

19. The liner package dispensing system of claim 18, wherein said empty detector performs a detection scheme based on a different compressive force required for dispensing the secondary volume of liquid medium, in relation to compressive force required for dispensing the primary volume of liquid medium.

20. The liner package dispensing system of claim 8, wherein said secondary volume is constituted by a restricted sub-volume in said liner bounded by a flexible member secured to the liner and formed of a material that is stiffer than material of construction of said liner.

21. The liner package dispensing system of claim 20, wherein the flexible member is welded to the liner.

22. The liner package dispensing system of claim 20, wherein the flexible member comprises a V-shaped sheet element that is welded to an edge of the liner, with each side of the V-shaped sheet element welded to each side of the liner.

23. The liner package dispensing system of claim 20, wherein the flexible member comprises a flat or slightly curved rectangular member that is welded to a flat section of the liner.

24. The liner package dispensing system of claim 20, wherein the flexible member comprises a disc-shaped member that is welded to a flat portion of the liner.

25. The liner package dispensing system of claim 24, wherein the flat portion of the liner comprises a portion near the middle of the liner.

26. The liner package dispensing system of claim 8, wherein said secondary volume is constituted by a restricted sub-volume in said liner bounded by a flexible member that flexes to release liquid medium from the restricted sub-volume after the primary volume of liquid medium has been dispensed.

27. The liner package dispensing system of claim 8, wherein said empty detector is arranged to detect pressure drop in the dispensed liquid medium and responsively generate said empty-detect output.

28. The liner package dispensing system of claim 27, wherein said empty detector comprises a pressure transducer.

29. The liner package dispensing system of claim 8, further comprising an electrically powered pump for pumping of liquid medium during dispensing thereof, and wherein said empty detector is arranged to monitor amperage drawn by said pump to generate said empty-detect output when said amperage changes upon initiation of dispensing of liquid medium from the secondary volume.

30. The liner package dispensing system of claim 8, wherein the dispensing system further comprises a drive train arranged to generate pressure for pressure dispensing of the primary and secondary volumes of liquid medium, and wherein said empty detector is arranged to detect a change in drive train pressure required to maintain a predetermined pressure during transition from dispensing of liquid medium from said primary volume to said secondary volume.

31. A liner package dispensing system, comprising:
a vessel having an interior volume;
a liner in said interior volume, arranged to contain a liquid medium overlaid by a head space;
a reservoir barometrically coupled in fluid communication with the head space and liquid medium in said liner, and arranged to contain liquid medium overlaid by gas to define a liquid level in the reservoir; and
an empty detector arranged to monitor liquid level in the reservoir and generate an empty-detect output when liquid level in the reservoir changes due to an empty condition of the liner.

32. The liner package dispensing system of claim 31, wherein the reservoir is coupled in fluid communication with the head space and liquid medium in said liner, by a feed line therebetween.

33. The liner package dispensing system of claim 31, wherein the reservoir is of vertically elongate form, with an upper part adapted to contain said gas and a lower part adapted to contain said liquid medium overlaid by gas, with a vent line coupled to said upper part and a liquid discharge line connected to said lower part.

34. The liner package dispensing system of claim 33, wherein the vent line and liquid discharge line are valved with flow control valves.

35. The liner package dispensing system of claim 34, wherein said flow control valves are arranged to be closed when dispense pressure is applied to the liner, to thereby cause head space gas from the liner to be forced to the upper portion of the reservoir to overlie liquid medium therein, whereby when liquid medium has been fully dispensed from the liner, the gas in the upper portion of the reservoir is pressurized for effecting pressure dispensing of liquid medium from the reservoir for continued dispensing of liquid medium after exhaustion of liquid medium from the liner.

36. The liner package dispensing system of claim 35, wherein said reservoir is arranged for said continued dispensing of liquid medium for a time sufficient to switch a second vessel containing a second liner into dispensing operation.

37. The liner package dispensing system of claim 31, wherein the empty detector actuates an alarm as said empty-detect output.

38. The liner package dispensing system of claim 31, wherein the empty detector comprises a level sensor element selected from the group consisting of infrared level sensors and capacitive sensors.

39. The liner package dispensing system of claim 36, further comprising an auto-changeover apparatus arranged for actuation by the empty-detect output of the empty detector, to switch-in a fresh liner package during said time sufficient to switch a second vessel containing a second liner into dispensing operation.

40. The liner package dispensing system of claim 31, wherein the reservoir has a vertically elongate form, and at an intermediate portion of its length has a reduced diameter section for level detect sensing by the level detector.

41. The liner package dispensing system of claim 40, wherein the intermediate portion of the reservoir includes a flow restriction therein.

42. The liner package dispensing system of claim 40, wherein the intermediate portion of the reservoir comprises coiled tubing.

43. A liner package dispensing system, comprising:
a vessel having an interior volume;
a liner in said interior volume, arranged to contain a liquid medium overlaid by a head space;

a phase separator;
a dispense line coupling the liner in fluid communication with said phase separator;
a liquid medium flow line coupled with the phase separator to discharge liquid medium therefrom;
a reservoir positioned above the phase separator, arranged to contain liquid medium defining a liquid medium level in the reservoir;
an overhead line joining the phase separator in fluid flow communication with the reservoir;
a first level sensor arranged to detect a first liquid medium level in the reservoir at which the reservoir contains a predetermined amount of reserve liquid medium;
a second level sensor in said overhead line, arranged to detect a second liquid medium level in the overhead line during dispensing of said reserve liquid medium;
a first flow control valve in said overhead line, between said second level sensor and said reservoir, arranged to be open for filling of the reservoir during dispensing of liquid medium from the liner, and to close upon detection of the first liquid medium level by the first level sensor;
a pressure detection actuator in the dispense line, operatively arranged to detect an empty or near-empty condition of the liner subsequent to closure of said first flow control valve in said overhead line, and upon detection of said empty or near-empty condition of the liner to open said first flow control valve for dispensing of said reserve liquid medium through the phase separator and liquid medium flow line.

44. The liner package dispensing system of claim 43, wherein the dispense line contains a check valve accommodating flow of liquid medium from the liner to the phase separator.

45. The liner package dispensing system of claim 43, wherein the reservoir is ventable to the ambient environment of the system.

46. The liner package dispensing system of claim 43, wherein the reservoir is coupled to a source of pressurization gas, operatively arranged for pressure-assisted dispensing of reserve liquid medium from said reservoir.

47. The liner package dispensing system of claim 43, wherein a second flow control valve is disposed in the liquid medium flow line and arranged to be open during dispensing of liquid medium from the liner and during dispensing of reserve liquid medium from the reservoir.

48. The liner package dispensing system of claim 47, wherein the second flow control valve is operatively coupled with the second level sensor, to close when the second level sensor detects

a second liquid medium level in the overhead line during dispensing of said reserve liquid medium.

49. The liner package dispensing system of claim 48, wherein the first flow control valve is operatively coupled with the second level sensor, to close when the second level sensor detects a second liquid medium level in the overhead line during dispensing of said reserve liquid medium.

50. A liner package dispensing system, comprising:
a vessel having an interior volume;
a liner in said interior volume, arranged to contain a liquid medium overlaid by a head space;
a reservoir, arranged to contain liquid medium defining a liquid medium level in the reservoir;
a dispense line coupling the liner in fluid communication with said reservoir;
a liquid medium flow line coupled with the reservoir to discharge liquid medium therefrom;
a first level sensor arranged to detect a first liquid medium level in the reservoir;
a second level sensor arranged to detect a second liquid medium level in the reservoir, wherein said second medium level in the reservoir is higher than said first medium level in the reservoir;
a gas communication line coupling the reservoir to (i) an ambient environment of the reservoir by a vent line joining the gas communication line in fluid communication with said ambient environment, and, optionally, (ii) a source of pressurization gas, operatively arranged for pressure-assisted dispensing of reserve liquid medium from said reservoir, by a pressurization line joining the gas communication line in fluid communication with the source of pressurization gas, said vent line having a first fluid communication control valve therein, and second pressurization line having a second fluid communication flow control valve therein, wherein the first fluid communication control valve is operatively coupled with the second level sensor to be open and accommodate filling of the reservoir to said second liquid medium level, and to close when said second liquid medium level has been reached, for subsequent dispensing of liquid medium from the liner though the dispense line and reservoir to the liquid medium flow line, in dispensing operation; and
a pressure detection actuator in the dispense line, operatively arranged to detect an empty or near-empty condition of the liner, and upon detection of said empty or near-empty condition of the liner to open one of said first and second fluid communication control valves for continued dispensing of liquid medium from the reservoir after said empty or near-empty condition has been detected.

51. The liner package dispensing system of claim 50, further comprising a flow control valve in the liquid medium flow line, wherein said first level sensor is operatively arranged with (i) said

open one of said first and second fluid communication control valves, and (ii) said flow control valve, to close said open one of said first and second fluid communication control valves and said flow control valve when said first level sensor has detected said first liquid medium level in the reservoir.

52. The liner package dispensing system of claim 50, wherein the dispense line contains a check valve accommodating flow of liquid medium from the liner to the reservoir.

53. A liner package dispensing system, comprising:
a vessel having a first interior volume;
a first liner in said first interior volume, arranged to contain a first volume of liquid medium overlaid by a first head space;
a venting path adapted to vent head space gas from the first head space;
an empty detect reservoir having a second interior volume;
a second liner in said second interior volume, arranged to contain a second volume of said liquid medium overlaid by a second head space;
a source of pressurizing gas;
a first conduit coupled to said source of pressurizing gas and arranged to flow pressurizing gas into the vessel to exert pressure on the first liner therein;
a dispensing assembly adapted for engagement with the vessel, to dispense liquid medium from the first liner when pressure is exerted on the first liner by the pressurizing gas source during dispensing operation;
a second conduit interconnecting the dispensing assembly and the empty detect reservoir, to deliver dispensed liquid medium to the empty detect reservoir;
a third conduit coupled to a same or different source of pressurizing gas and arranged to flow pressurizing gas into the empty detect reservoir to exert pressure on the second liner therein;
a second vent conduit communicating with the second interior volume of the empty detect reservoir and arranged to vent head space gas from said second head space;
a fourth conduit coupled in dispensing communication with the second liner in the empty detect reservoir and arranged to discharge liquid medium therefrom;
a first flow control valve in said first conduit;
a second flow control valve in said first vent conduit;
a third flow control valve in said second conduit;
a fourth flow control valve in said second vent conduit;
a fifth flow control valve in said third conduit;
a sixth flow control valve in said fourth conduit;
a first level indicator arranged to detect presence of liquid medium in said first vent conduit;

a second level indicator arranged to detect presence of liquid medium in said second vent conduit;

a third level indicator arranged to detect presence of liquid medium in the second liner; and

a controller arranged to conduct a dispensing operation including the steps of:

opening the first and second flow control valves to vent gas from the first head space;

flowing pressurizing gas into the vessel to exert pressure on the first liner, to effect pressure dispensing of liquid medium;

closing the second flow control valve when the first level indicator senses presence of liquid medium in the first vent conduit;

opening the third and fourth flow control valves to flow liquid medium from the first liner through the dispensing assembly and second conduit to the second liner in the empty detect reservoir, and to vent the second head space through the second vent conduit;

closing the fourth flow control valve when the second level indicator senses presence of liquid medium in the second vent conduit;

opening the fifth flow control valve;

flowing pressurizing gas into the empty detect reservoir to exert a predetermined pressure on the second liner that is less than pressure exerted on the first liner;

opening the sixth flow control valve and dispensing liquid medium from the second liner to the fourth conduit until pressure in the second liner decreases due to an empty condition in said first liner;

closing the third and first flow control valves when the third level indicator detects a liquid medium level in said second liner indicative of said empty condition; and

after occurrence of said empty condition in said first liner, continuing dispensing of liquid medium from said second liner.

54. A liner package dispensing system, comprising:

a vessel having an interior volume;

a liner in said interior volume, arranged to contain a liquid medium;

a dispensing assembly adapted for engagement with the vessel, to withdraw liquid medium from the liner during dispensing operation; and

a sensor arranged to detect a dispensing-related condition, and to generate a correlative output indicative of said condition.

55. The liner package dispensing system of claim 54, wherein the sensor senses a dispensing-related condition selected from the group consisting of liquid level, material properties, strain on the dispensing assembly deriving from liquid medium in said liner, displacement of the liner during dispensing, volume of space in the vessel outside the liner, temperature, pressure, flow

rate of dispensed liquid medium, weight of liquid medium in the liner, and liquid medium homogeneity.

56. The liner package dispensing system of claim 54, further comprising a source of pressurized gas, arranged for flow of pressurized gas into the vessel for exerting exterior pressure on the liner.

57. The liner package dispensing system of claim 54, wherein said sensor comprises a passive RFID sensor.

58. The liner package dispensing system of claim 57, wherein the passive RFID sensor is characterized by an operating protocol selected from the group consisting of ISO 14443 (types A, B and C) and EPC Gen-2.

59. The liner package dispensing system of claim 54, wherein the dispensing assembly includes a dispense nozzle, and the liner is suspended from the dispense nozzle.

60. The liner package dispensing system of claim 59, wherein the sensor detects strain on the dispense nozzle.

61. The liner package dispensing system of claim 60, wherein said sensor output comprises a fill gauge with visual indicia of fill state of the liner.

62. The liner package dispensing system of claim 60, wherein the sensor comprises a strain gauge.

63. The liner package dispensing system of claim 60, wherein the sensor also detects temperature.

64. The liner package dispensing system of claim 63, wherein the system includes a mounting flange for mounting of the liner, and wherein said sensor is arranged to determine weight of liquid medium in the liner, by detecting deformation of the mounting flange.

65. The liner package dispensing system of claim 54, wherein the sensor is adapted to detect a pressure pulse on the liner in the vessel, and said sensor output comprises volume of the liquid medium in the liner.

66. The liner package dispensing system of claim 54, wherein the sensor is a hardwired microsensor, wireless battery-powered microsensor, or passive sensor integrated in the system, or in a component or subassembly thereof.

67. The liner package dispensing system of claim 54, wherein the sensor comprises a fluid analysis sensor-on-a-chip.

68. The liner package dispensing system of claim 67, wherein the dispensing assembly includes a dispense nozzle, and the sensor is integrated in the dispense nozzle with a hardwired power-data interface, to monitor the liquid medium during dispensing thereof.

69. The liner package dispensing system of claim 54, wherein the sensor is of a type selected from the group consisting of: thermal sensors for monitoring equilibration of the liquid medium and its packaging after installation in a storage, transport or installation environment; electrochemical sensors for monitoring shelf life of the liquid medium; and optical scattering sensors, for monitoring homogeneity and mixing/mixedness of the liquid medium.

70. A fluid storage and dispensing method, comprising:
providing a vessel having an interior volume and a liner in said interior volume, containing a liquid medium in a zero or near zero head space conformation;
dispensing liquid medium from the liner; and
monitoring the liquid medium withdrawn from the liner during dispensing with an integrated flowmeter, and generating an output from said integrated flowmeter that is correlative of an empty-detect condition upon occurrence of same.

71. The method of claim 70, wherein the integrated flowmeter monitors the liquid medium dispensing rate and generates said output in response to a substantial diminution of flow rate of the liquid medium as said empty-detect condition.

72. The method of claim 70, wherein the integrated flowmeter comprises an electronic output integrated flowmeter.

73. The method of claim 72, further comprising deploying an RF-responsive controller adapted to terminate the dispensing operation in response to received information that an empty-detect condition has occurred, and mounting an RFID tag on at least one of the liner and the vessel, wherein said RFID tag includes an RF antenna arranged to communicate information from the RFID tag to the controller, and feeding said output from said electronic output integrated

flowmeter to said RFID tag, whereby the generation of said output indicative of said empty-detect condition is communicated to said RFID tag and corresponding information indicative of said empty-detect condition is transmitted by said RF antenna to said RF-responsive controller to terminate the dispensing operation upon occurrence of the empty-detect condition.

74. The method of claim 73, wherein the RF-responsive controller is adapted to effect a change-over from said vessel and liner, to a second vessel and liner for continued dispensing operation.

75. The method of claim 72, further comprising operating a controller to receive said output from the electronic output integrated flowmeter, and to responsively terminate the dispensing operation.

76. The method of claim 75, wherein the controller is adapted to effect a change-over from said vessel and liner, to a second vessel and liner for continued dispensing operation.

77. A liquid medium dispensing method, comprising:
providing a liner package dispensing system as claimed in claim 8, containing a liquid medium in the liner in a zero or near zero head space conformation;
dispensing primary volume liquid medium from the liner in the vessel and flowing such primary volume liquid medium though the dispensing circuitry;
detecting when the primary volume liquid medium has been fully dispensed; and
thereupon initiating dispensing of secondary volume liquid medium.

78. The method of claim 77, wherein the secondary volume of liquid medium is a partitioned region in the liner.

79. The method of claim 77, further comprising applying compressive gas pressure on the liner to mediate dispensing of liquid medium during said dispensing of primary volume liquid medium.

80. The method of claim 77, wherein the dispensing comprises use of a dispensing assembly including a dispense head coupled with a dip tube, and the dip tube is adapted to extend into liquid medium in the liner during said dispensing operation.

81. The method of claim 77, further comprising pressure dispensing liquid medium from at least one of said primary and secondary volumes of liquid medium.

82. The method of claim 77, wherein the secondary volume of liquid medium is contained in a liner of polymeric film.

83. The method of claim 77, wherein the secondary volume of liquid medium is contained in a restricted region in the liner.

84. The method of claim 77, wherein the restricted region in the liner is formed by a restriction structure selected from the group consisting of bellows, diaphragms, collapsing tubes, plungers and pistons.

85. The method of claim 77, wherein said detecting when the primary volume liquid medium has been fully dispensed, comprises performing a detecting operation including a step selected from the group consisting of: detecting pressure decay in the flow of primary volume liquid medium through the flow circuitry; detecting a load change incident to an increased load of dispensing the secondary volume of liquid medium in relation to load of dispensing the primary volume of liquid medium; measuring flow when the secondary volume is constituted by a branch volume of liquid medium in or communicating with said branch portion of said flow circuitry; and measuring displacement of the secondary volume of liquid medium during dispensing.

86. The method of claim 77, wherein the secondary volume of liquid medium is contained in a second liner, and each of the primary and secondary volumes of liquid medium is pressure-dispensed from its respective liner by a compressive force of gas exerted thereon.

87. The method of claim 86, wherein said detecting when the primary volume liquid medium has been fully dispensed, comprises performing a detection scheme based on a different compressive force required for dispensing the secondary volume of liquid medium, in relation to compressive force required for dispensing the primary volume of liquid medium.

88. The method of claim 77, wherein said secondary volume is constituted by a restricted sub-volume in said liner bounded by a flexible member secured to the liner and formed of a material that is stiffer than material of construction of said liner.

89. The method of claim 88, wherein the flexible member is welded to the liner.

FAS 2004 - Page 489

90. The method of claim 88, wherein the flexible member comprises a V-shaped sheet element that is welded to an edge of the liner, with each side of the V-shaped sheet element welded to each side of the liner.

91. The method of claim 88, wherein the flexible member comprises a flat or slightly curved rectangular member that is welded to a flat section of the liner.

92. The method of claim 88, wherein the flexible member comprises a disc-shaped member that is welded to a flat portion of the liner.

93. The method of claim 92, wherein the flat portion of the liner comprises a portion near the middle of the liner.

94. The method of claim 77, wherein said secondary volume is constituted by a restricted sub-volume in said liner bounded by a flexible member that flexes to release liquid medium from the restricted sub-volume after the primary volume of liquid medium has been dispensed.

95. The method of claim 77, wherein said empty detector is arranged to detect pressure drop in the dispensed liquid medium and responsively generate said empty-detect output.

96. The method of claim 95, wherein said empty detector comprises a pressure transducer.

97. The method of claim 77, further comprising operating an electrically powered pump for pumping of liquid medium during dispensing thereof, and monitoring amperage drawn by said pump to generate said empty-detect output when said amperage changes upon initiation of dispensing of liquid medium from the secondary volume.

98. The method of claim 77, further comprising operating a drive train to generate pressure for pressure dispensing of the primary and secondary volumes of liquid medium, and detecting a change in drive train pressure required to maintain a predetermined pressure during transition from dispensing of liquid medium from said primary volume to said secondary volume.

99. A liquid medium dispensing method, comprising:
providing a liner package dispensing system as claimed in claim 31, containing a liquid medium in the liner overlaid by a head space;
dispensing liquid medium from the liner in the vessel and flowing such liquid medium to the reservoir;

monitoring liquid level in the reservoir; and
generating an empty-detect output when liquid level in the reservoir changes due to an empty condition of the liner.

100. The method of claim 99, wherein the reservoir is of vertically elongate form, with an upper part adapted to contain said gas and a lower part adapted to contain said liquid medium overlaid by gas, with a vent line coupled to said upper part and a liquid discharge line connected to said lower part.

101. The method of claim 100, wherein the vent line and liquid discharge line are valved with flow control valves.

102. The method of claim 101, comprising closing said flow control valves when dispense pressure is applied to the liner, to thereby cause head space gas from the liner to be forced to the upper portion of the reservoir to overlie liquid medium therein, whereby when liquid medium has been fully dispensed from the liner, the gas in the upper portion of the reservoir is pressurized for effecting pressure dispensing of liquid medium from the reservoir for continued dispensing of liquid medium after exhaustion of liquid medium from the liner.

103. The method of claim 102, wherein said reservoir is arranged for said continued dispensing of liquid medium for a time sufficient to switch a second vessel containing a second liner into dispensing operation.

104. The method of claim 99, comprising actuating an alarm as said empty-detect output.

105. The method of claim 99, comprising use of a level sensor element selected from the group consisting of infrared level sensors and capacitive sensors.

106. The method of claim 103, further comprising switching-in a fresh liner package during said time sufficient to switch a second vessel containing a second liner into dispensing operation.

107. The method of claim 99, wherein the reservoir has a vertically elongate form, and at an intermediate portion of its length has a reduced diameter section for level detect sensing.

108. The method of claim 107, wherein the intermediate portion of the reservoir includes a flow restriction therein.

109. The method of claim 108, wherein the intermediate portion of the reservoir comprises coiled tubing.

110. A liquid medium dispensing method, comprising:
providing a liner package dispensing system as claimed in claim 43, containing a liquid medium in the liner overlaid by a head space;
filling the reservoir with liquid medium from the liner to establish an amount of reserve liquid medium therein; and
dispensing liquid medium from the reservoir after liquid medium has been fully dispensed from the liner.

111. A liquid medium-supplied manufacturing system, comprising:
a manufacturing tool adapted to utilize a liquid medium; and
a liquid medium source joined in flow communication with the manufacturing tool, to dispense the liquid medium thereto;
wherein the liquid medium source comprises a source selected from the group consisting of:

(A) a fluid storage and dispensing system as claimed in claim 1, wherein said liner contains said liquid medium;
(B) a liner package dispensing system as claimed in claim 8, wherein said liner contains said liquid medium;
(C) a liner package dispensing system as claimed in claim 31, wherein said liner contains said liquid medium;
(D) a liner package dispensing system as claimed in claim 42, wherein said liner contains said liquid medium;
(E) a liner package dispensing system as claimed in claim 50, wherein said liner contains said liquid medium;
(F) a liner package dispensing system as claimed in claim 53, wherein said liner contains said liquid medium; and
(G) a liner package dispensing system as claimed in claim 54, wherein said liner contains said liquid medium.

112. The liquid medium-supplied manufacturing system of claim 111, wherein the manufacturing tool comprises a microelectronic device manufacturing tool.

113. The liquid medium-supplied manufacturing system of claim 112, wherein the microelectronic device manufacturing tool comprises a tool selected from the group consisting of: deposition tools and ion implant tools.

114. The liquid medium-supplied manufacturing system of claim 111, wherein the liquid medium comprises a microelectronic device manufacturing reagent.

115. The liquid medium-supplied manufacturing system of claim 114, wherein said microelectronic device manufacturing reagent comprises a reagent selected from the group consisting of photoresists, etchants, chemical vapor deposition reagents, solvents, wafer and tool cleaning formulations, and chemical mechanical polishing compositions.

116. A method of manufacturing a product by a process involving utilization of a liquid medium, said method comprising supplying said liquid medium to said process from a liner-based source, wherein said liner-based source is selected from the group consisting of:

(A) a fluid storage and dispensing system as claimed in claim 1, wherein said liner contains said liquid medium;

(B) a liner package dispensing system as claimed in claim 8, wherein said liner contains said liquid medium;

(C) a liner package dispensing system as claimed in claim 31, wherein said liner contains said liquid medium;

(D) a liner package dispensing system as claimed in claim 42, wherein said liner contains said liquid medium;

(E) a liner package dispensing system as claimed in claim 50, wherein said liner contains said liquid medium;

(F) a liner package dispensing system as claimed in claim 53, wherein said liner contains said liquid medium; and

(G) a liner package dispensing system as claimed in claim 54, wherein said liner contains said liquid medium.

117. The method of claim 114, wherein said liquid medium comprises a microelectronic device manufacturing reagent.

118. The method of claim 115, wherein said microelectronic device manufacturing reagent comprises a reagent selected from the group consisting of photoresists, etchants, chemical vapor deposition reagents, solvents, wafer and tool cleaning formulations, and chemical mechanical polishing compositions.

119. A material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a dispensed material-utilizing tool, and the dispense line has operatively disposed therein a servo-hydraulic dispense pump, and an empty detect pressure transducer between the package and the pump operatively arranged to provide an output indicative of approach to an empty state of the package.

120. The system of claim 119, further comprising a reservoir gas separator and vent assembly disposed in said dispense line between the package and the servo-hydraulic dispense pump.

121. The system of claim 120, further comprising a filter disposed in the dispense line between the reservoir gas separator and vent assembly and the pump.

122. The system of claim 121, further comprising an AV/SV valve assembly in the dispense line downstream of the pump.

123. The system of claim 119, wherein the liner contains a semiconductor manufacturing reagent.

124. The system of claim 119, wherein the liner contains a photoresist.

125. The system of claim 119, wherein the pressure transducer is operatively coupled to a controller for isolating the package to enable change-out thereof on said approach to an empty state of the package.

126. A material dispensing system including a material storage and dispensing package containing a liner therein, adapted to hold a material for pressure-dispensing thereof, wherein the package is coupled by a dispense line to a dispensed material-utilizing tool, and the dispense line is coupled to a dispenser arranged to receive resist on a cyclic replenishment schedule from said package, for flow to the tool, and a monitor adapted to detect an increase in time required for replenishment of the dispenser indicative of approach to an empty state of the package and to responsively provide an output of said approach.

127. The system of claim 126, wherein the dispenser comprises a pump.

128. The system of claim 127, wherein the replenishment of the dispenser is elevation-corrected.

129. The system of claim 126, further comprising a reservoir gas separator and vent assembly disposed in said dispense line between the package and the dispenser.

130. The system of claim 129, further comprising a filter disposed in the dispense line between the reservoir gas separator and vent assembly and the dispenser.

131. The system of claim 130, further comprising an AV/SV valve assembly in the dispense line downstream of the dispenser.

132. The system of claim 126, wherein the liner contains a semiconductor manufacturing reagent.

133. The system of claim 126, wherein the liner contains a photoresist.

134. The system of claim 126, wherein the monitor is operatively coupled to a controller for isolating the package to enable change-out thereof on said approach to an empty state of the package.

135. A method of supplying material, comprising delivery of said material by pressure dispensing same from a liner in a material storage and dispensing package to a material-utilizing tool, said delivery including pumping of material from the package to the tool, and monitoring pressure of the dispensed material upstream of the pump to determine occurrence of a progressively more rapid decline of pressure thereof, as indicative of onset of exhaustion of material in the package.

136. The method of claim 135, wherein the liner contains a semiconductor manufacturing reagent.

137. The method of claim 135, wherein the liner contains a photoresist.

138. The method of claim 135, further comprising isolating said package from delivery of said material, upon said occurrence, and changing out the isolated package to introduce a fresh material storage and dispensing package for said delivery.

139. A method of supplying material, comprising delivery of said material by pressure dispensing same from a liner in a material storage and dispensing package to a material-utilizing tool, said delivery including flow of material from the package to a dispenser arranged to receive resist on a cyclic replenishment schedule from said package, for flow to the tool, monitoring replenishment time for the dispenser, and responsively generating an output upon detection of a progressively more rapid increase of time required for replenishment of the dispenser, as indicative of onset of exhaustion of material in the package.

140. The method of claim 139, wherein the liner contains a semiconductor manufacturing reagent.

141. The method of claim 139, wherein the liner contains a photoresist.

142. The method of claim 139, further comprising isolating said package from delivery of said material, upon said detection, and changing out the isolated package to introduce a fresh material storage and dispensing package for said delivery.

143. A pressure-dispense system, comprising a vessel enclosing an interior volume, a liner disposed in the interior volume and adapted to hold material therein for pressure dispensing, and a pressure assembly adapted to apply exterior fluid pressure on the liner for said pressure dispensing, wherein the pressure-dispense system includes a secondary volume for said material, said secondary volume constituting a sub-volume of the liner having a different pressurizing requirement than that required for pressure-dispensing of material from a main volume of the liner not including said sub-volume, and wherein the pressure assembly includes a fluid pressurizing drive train adapted to deliver pressurized fluid into the interior volume to apply pressure on the liner, during dispensing of material from the main volume and during dispensing of material from the secondary volume, that maintains dispensed material at a same pressure throughout said dispensing from the main volume and the secondary volume.

144. The system of claim 143, wherein the fluid pressurizing drive train comprises flow circuitry including an air compressor or fluid pump adapted to maintain said same pressure throughout said dispensing from the main volume and the secondary volume.

145. The system of claim 143, wherein said liner contains a material for manufacturing a microelectronic product.

146. A microelectronic product manufacturing apparatus, comprising a pressure-dispense system as claimed in claim 143, and a microelectronic product manufacturing tool, coupled with the pressure-dispense system to receive said dispensed material therefrom.

147. A method of supplying a material, comprising: providing a pressure-dispense system as claimed in claim 143; actuating the pressure assembly for dispensing; dispensing material from the main volume of the liner; and thereafter dispensing material from the secondary volume of the liner; wherein material is dispensed at a same pressure throughout the dispensing from the main volume of the liner and dispensing from the secondary volume of the liner.

148. The method of claim 147, wherein the dispensed material comprises a material for manufacturing a microelectronic product.

149. A method of manufacturing a microelectronic product, comprising supplying said material by a method as claimed in claim 148, and utilizing material from said dispensing in a microelectronic product manufacturing process.

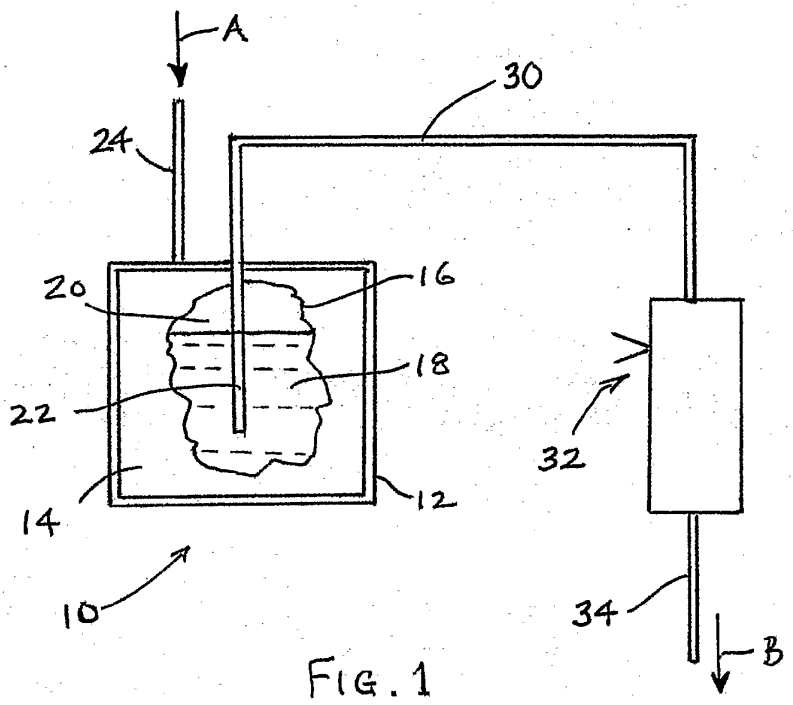


FIG. 1

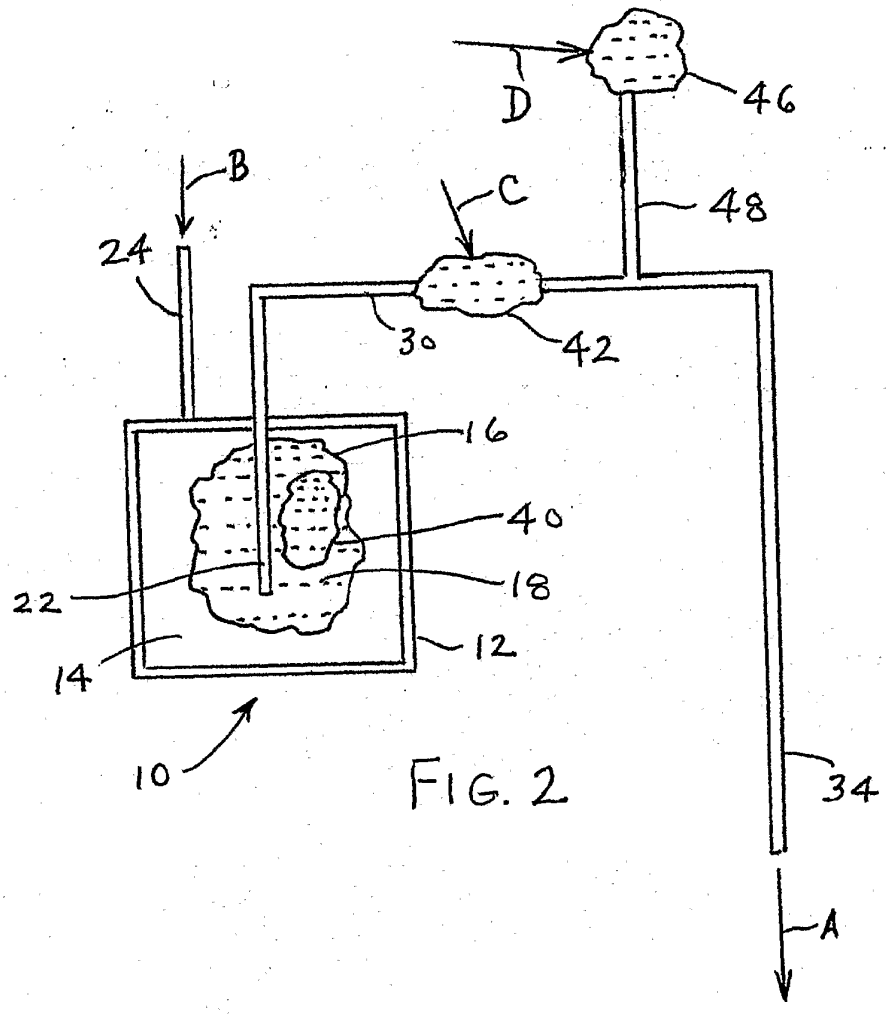


FIG. 2

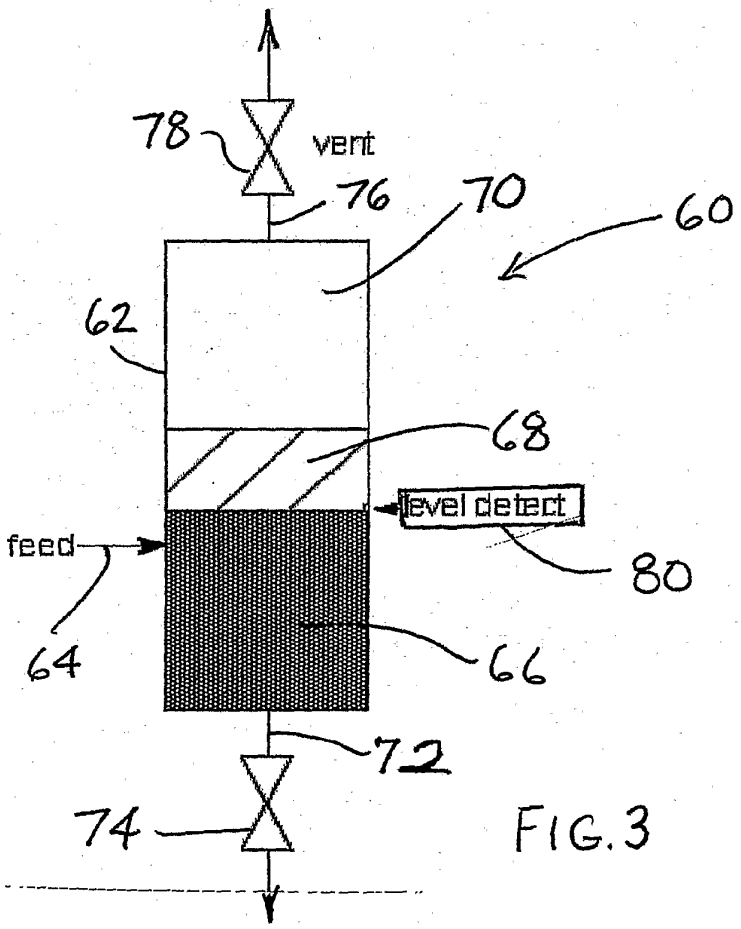


FIG. 3

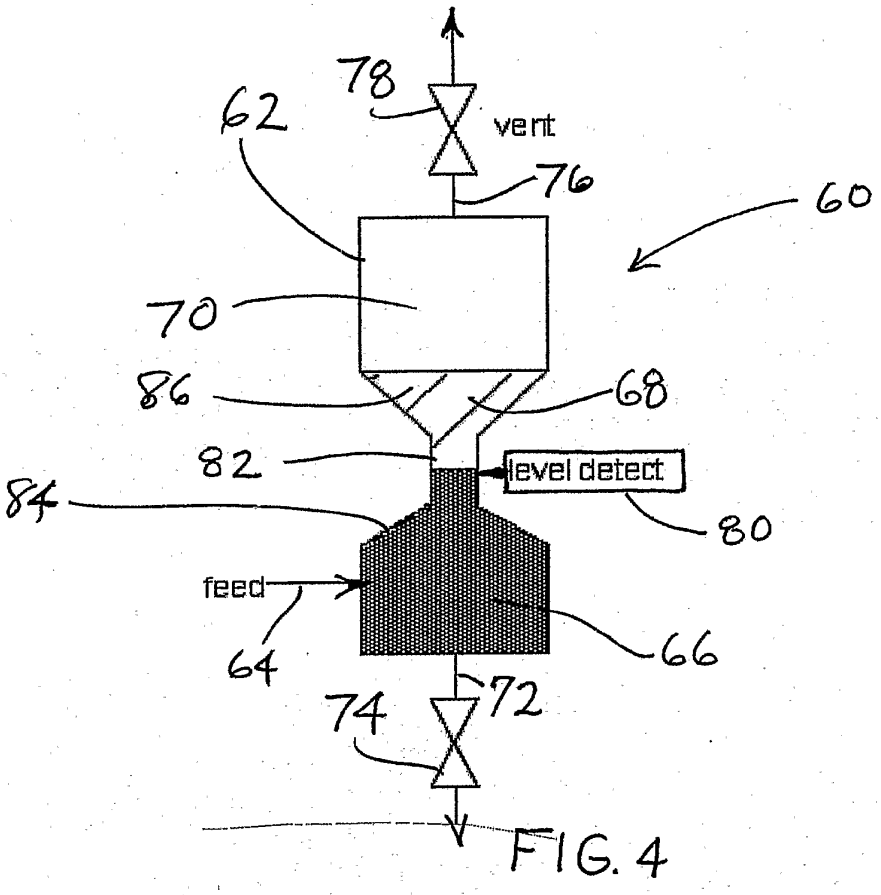


FIG. 4

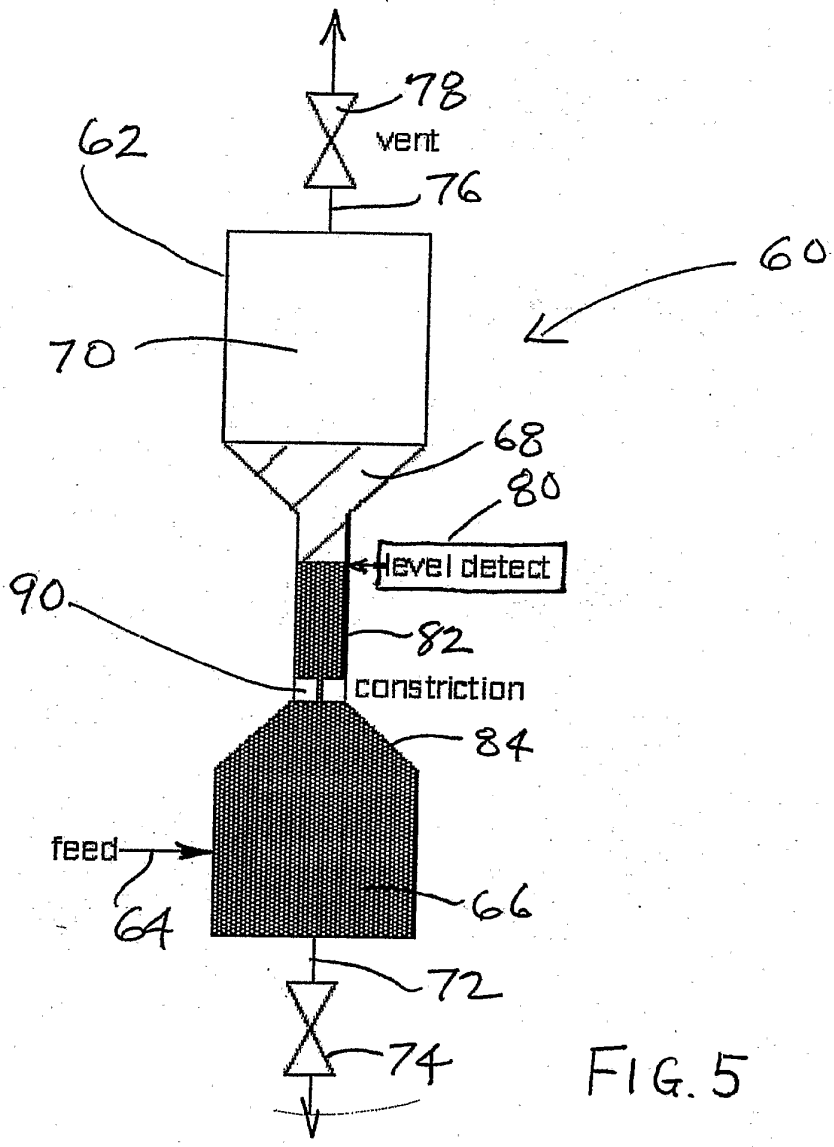

78
vent
62
76
60
70
68
80
level detect
90
82
constriction
84
feed
64
66
72
74

FIG. 5

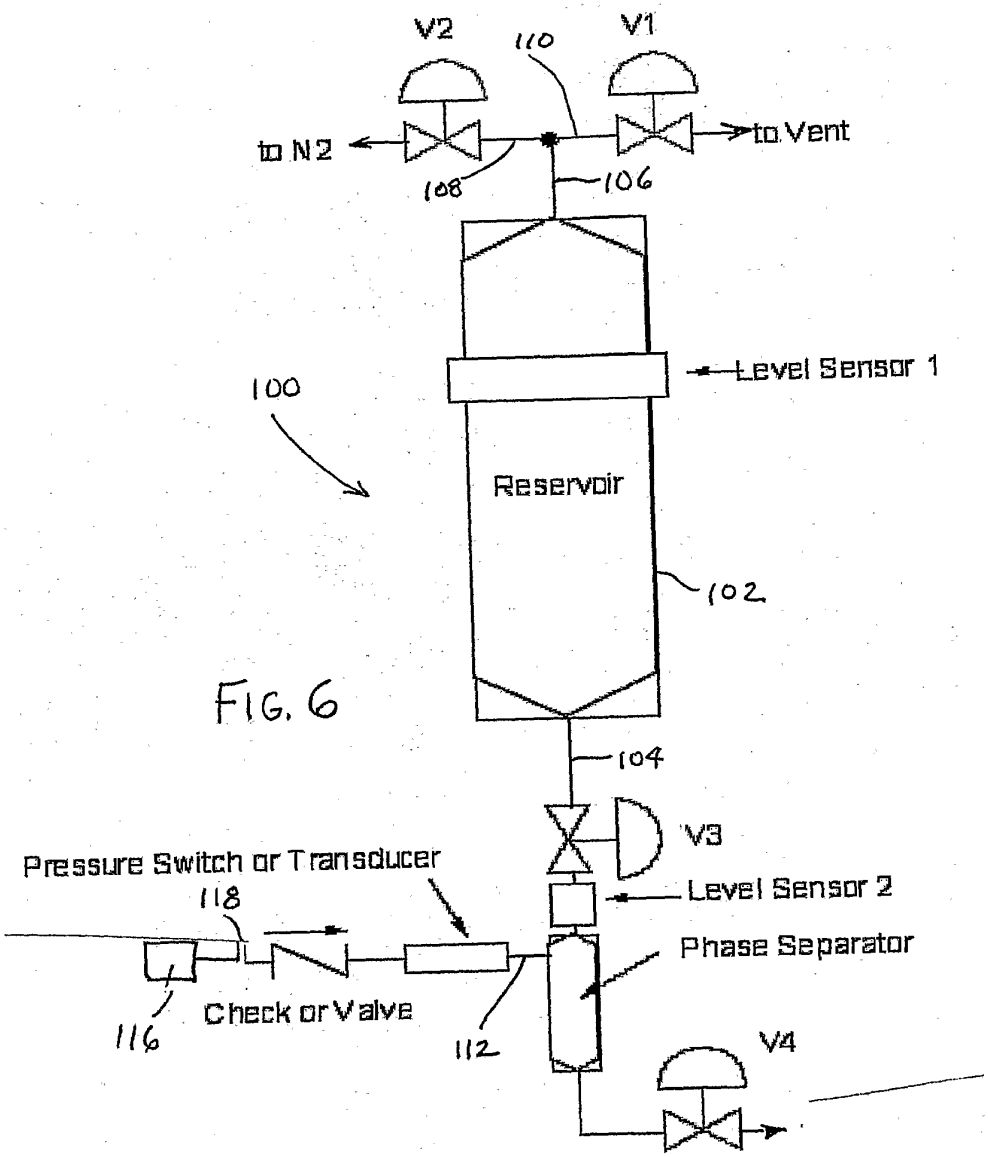

V2
110
V1
to N2
to Vent
108
106
Level Sensor 1
100
Reservoir
102
104
V3
Pressure Switch or Transducer
118
Level Sensor 2
Phase Separator
Check or Valve
116
112
V4

FIG. 6

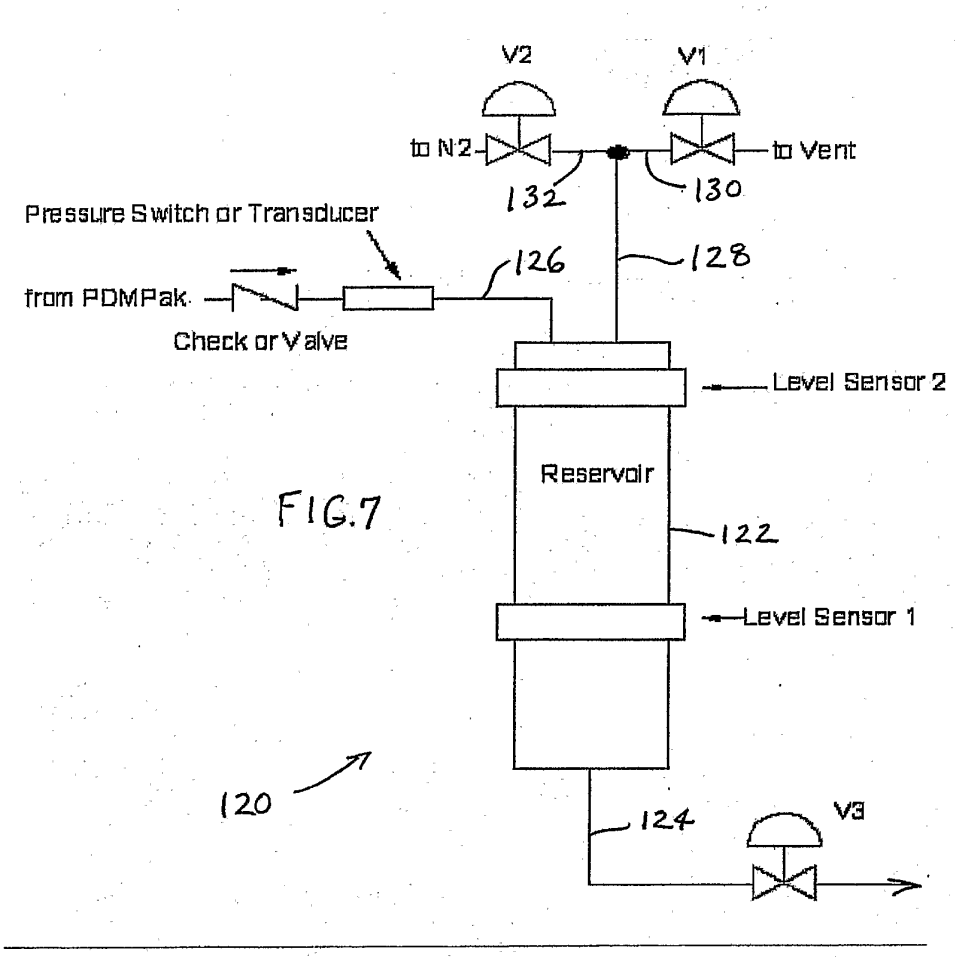

V2
V1
to N2
to Vent
132
130
Pressure Switch or Transducer
126
128
from PDMPak
Check or Valve
Level Sensor 2
Reservoir
122
Level Sensor 1
120
124
V3

FIG.7

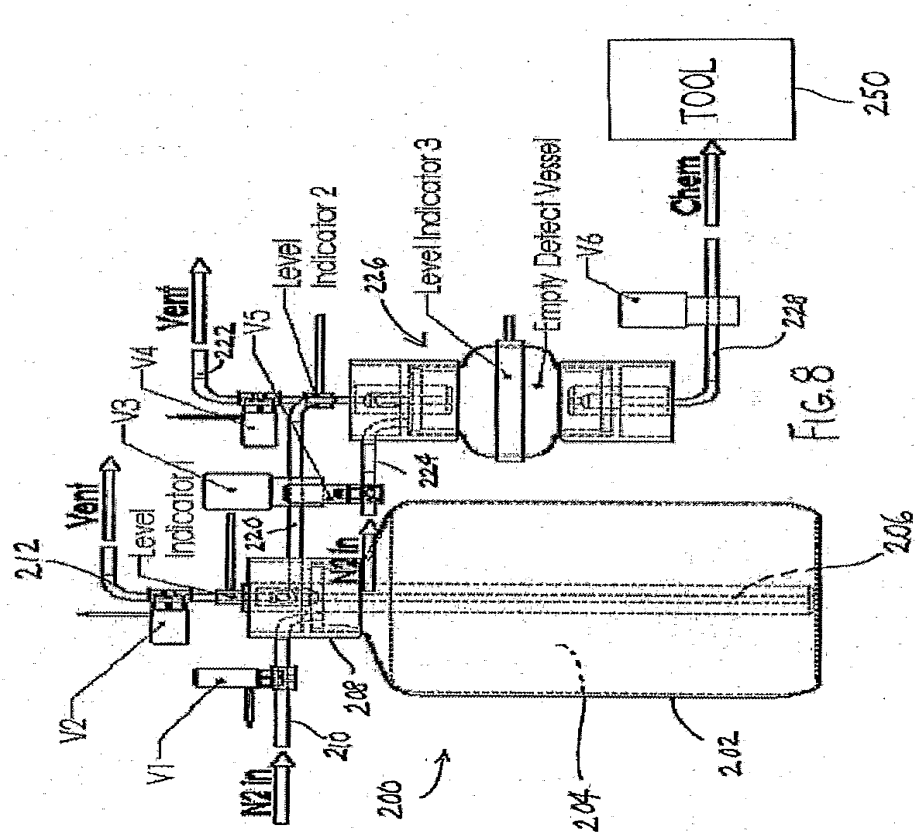


FIG.8

FAS 2004 - Page 505

FIG. 9

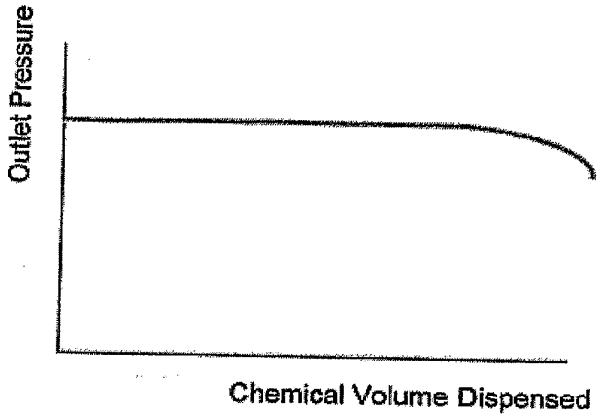


FIG. 10

400
444
446
450
448
424
410
422
452
428
420
402
426
414
416
412
430

FIG. 11

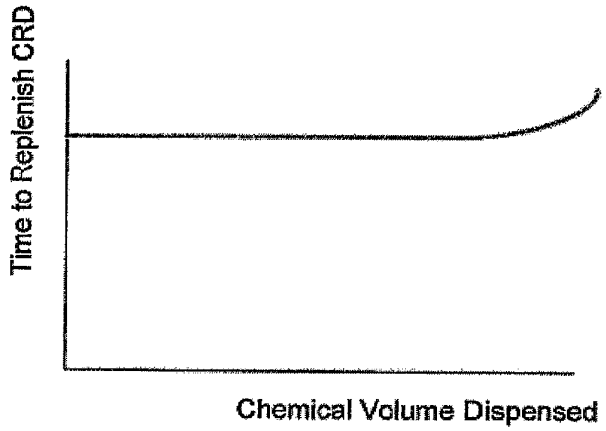


FIG. 12

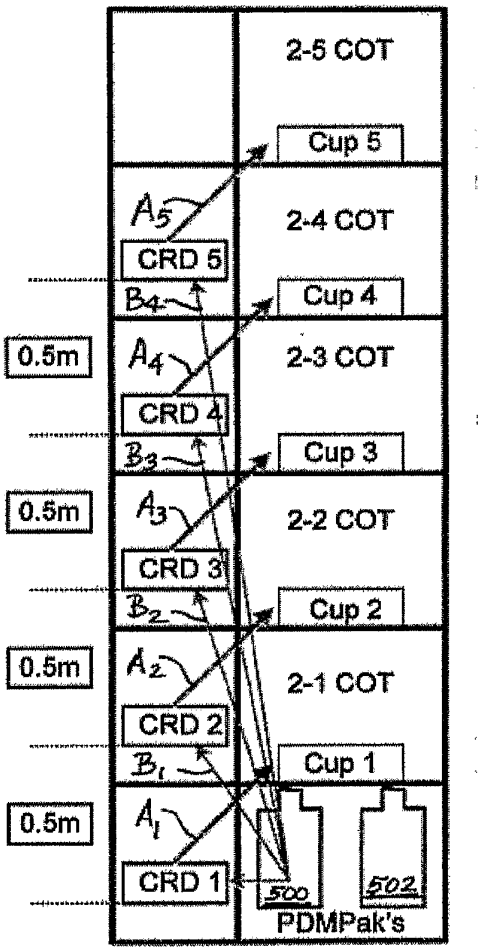

2-5 COT
Cup 5
A5
2-4 COT
CRD 5
B4
Cup 4
0.5m
A4
2-3 COT
CRD 4
B3
Cup 3
0.5m
A3
2-2 COT
CRD 3
B2
Cup 2
0.5m
A2
2-1 COT
CRD 2
B1
Cup 1
0.5m
A1
CRD 1
500
502
PDMPak's

FIG. 13

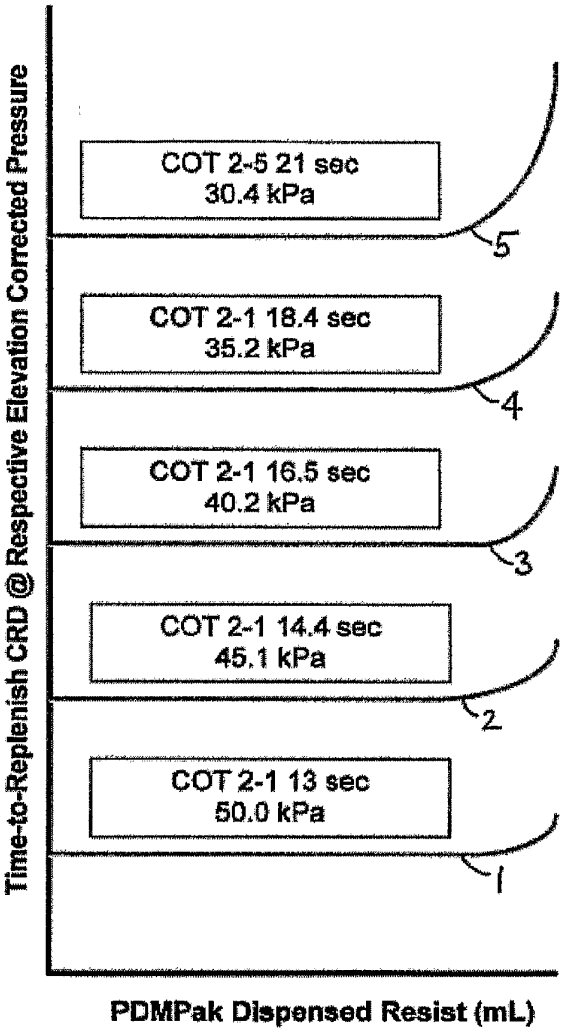

Time-to-Replenish CRD @ Respective Elevation Corrected Pressure
COT 2-5 21 sec
30.4 kPa
5
COT 2-1 18.4 sec
35.2 kPa
4
COT 2-1 16.5 sec
40.2 kPa
3
COT 2-1 14.4 sec
45.1 kPa
2
COT 2-1 13 sec
50.0 kPa
1
PDMPak Dispensed Resist (mL)

FIG. 14

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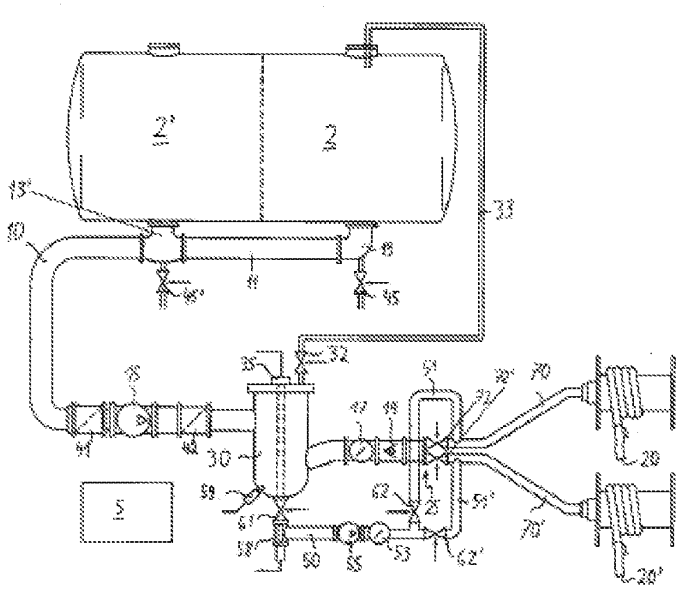
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(54) Title: METHOD AND DEVICE FOR DISPENSING A FLUID FROM A TANK

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(57) **Abstract:** The invention relates to a method for dispensing a fluid from at least one tank (2), in which the fluid is conveyed out of the tank by a conveying pipe (10) and dispensed, wherein the quantity of dispensed fluid is measured, at the end of the dispensing operation the conveying pipe is shut off by means of a tank shutting-off device (13), and, subsequently, residual fluid located on that side of the tank shutting-off device which faces away from the tank is removed from the conveying pipe and likewise dispensed, wherein the quantity of dispensed residual fluid is measured. The invention furthermore relates to a device for dispensing a fluid from at least one tank (2).

Method and Device for Dispensing a Fluid from a Tank

The invention relates to a method and a device for dispensing a fluid, in particular a measured amount of fluid, from at least one tank.

When dispensing mineral oil products such as, for example heating oil, to the end customer a measuring device that meets the legal calibration must be used as a rule which allows on the one hand a precisely calibrated measuring of the flowthrough volume and on the other hand prevents inclusions of air, in particular air bubbles, from being mixed into the product to be dispensed. A device with a measuring device designed to this end is described, for example, in EP 0 855 576 A1.

According to the teaching of EP 0 855 576 A1 the liquid is dispensed via a pipeline from a tank, wherein a pump and a meter are provided on the pipeline. Furthermore, a degassing container as well as a gas bubble sensor are provided on the pipeline upstream from the meter. In order to avoid that entrained gas penetrates with the liquid in the meter, in the device according to EP 0 855 576 A1 the bubble component can be measured by the gas bubble sensor and the pump performance can be controlled in a corresponding manner. If an excessive entrance of air occurs, in particular at the conclusion of the dispensing, the pump can be stopped, wherein it can be provided that only so much product remains in the degassing container that it is ensured that no gas passes into the meter. Therefore, at the end of the dispensing a residual volume of the product remains in the pipeline.

If a partial delivery is performed with the device according to EP 0 855 576 A1, that is, the tank is not completely emptied, the entire pipeline system including the components arranged on it as well as complete hoses arranged on it remain filled with the corresponding product at the end of the dispensing.

In the typical tank vehicle the residual volume contained at the end of the dispensing in the pipeline system is typically up to 30 l.

If a change of product is carried out after the conclusion of the dispensing, for example by switching to a differently filled tank chamber, the residual volume contained in the pipeline can cause mixings of and contaminants in the subsequently dispensed product. In particular in the case of expensive heating oils and diesel fuels with a different sulfur content and with biosynthetic additives, such contaminants caused by residual volume amounts are, however, to be avoided.

DE 197 33 715 C1 teaches a method for the dispensing of liquid from a tank truck containing several chambers substantially by gravity. According to the teaching of DE 197 33 715 C1, at the end of the dispensing a bottom valve of the tank is closed and the dispensing line is ventilated for the residual emptying. During this residual emptying the electronic registration of the meter signals of a driving slide meter or of a turbine meter which is provided for determining the dispensed amount of liquid is stopped. The volume of liquid dispensed during the residual emptying is taken into account in that a previously determined value is added to the volumetric value previously added in an electronic control device. However, in particular when air inclusions are present in the conduction system this procedure cannot be sufficiently precise as regards the legal calibration requirements.

It is known from DE 198 21 559 A1 to press out the liquid volume contained in the dispensing hose of a dispensing pump at the end of the dispensing.

DE 100 46 921 C1 and US 5, 505, 335 describe a procedure in which at the end of the dispensing, residual fluid contained in the line is returned into the tank.

The invention has the **problem** of indicating a method and a device for the dispensing of a fluid which ensure a high purity of the product with great accuracy during the determination of the dispensed amount of fluid.

This problem is solved by a method for the dispensing of a fluid from at least one tank with the features of Claim 1 and a device for the dispensing of a fluid from at least one tank with the features of Claim 9. Preferred exemplary embodiments are indicated in the dependent claims.

The method of the invention provides that the fluid is transported by a transportation line from the tank and is dispensed, wherein the amount of the dispensed fluid is measured, at the end of the dispensing the transportation line is blocked by a tank blocking device, in particular by a bottom valve, and subsequently residual fluid present on the side of the tank blocking device facing away from the tank is removed from the transportation line and is also dispensed, wherein the amount of the dispensed residual fluid is measured.

A basic concept of the invention can be seen in that a residual amount of fluid contained in the transportation line after the conclusion of the delivery, which can also be designated as the carry-over volume, is not pumped into intermediate tanks or back into the tank but rather is delivered to the customer. A measuring of the fluid amount is carried out here even in the dispensing of the amount of residual fluid so that the legal calibration requirements are satisfied. Therefore, according to the invention the transportation line system is emptied after the dispensing so that the danger of a mixing with residual fluid is reduced, during which a measuring of the dispensed amount is carried out during the entire dispensing procedure including the dispensing of the residual fluid.

An additional pump and/or an additional measuring system for the volume is/are preferably used during the dispensing of the residual fluid which differ from the pump or from the measuring system which are used in the initial dispensing of fluid with an opened tank blocking device. The tank blocking device of the invention can be, for example a valve, a slide or a flap which is arranged in the course of the line of the transportation line. In particular, it is a bottom valve of the tank. The fluid can be in particular a liquid, preferably a fuel. If several tanks are provided, preferably individual tank chambers of an entire tank are concerned. The transportation of the fluid and/or of the residual fluid can basically take place only by the action of gravity but also takes place preferably by pump action.

The measuring of the amount of the dispensed fluid and/or of the dispensed residual fluid advantageously takes place by a flow-through measuring device, for example, an impeller meter or turbine meter. However, even other measuring methods and measuring devices are basically possible.

According to the invention it can be provided that the dispensing of fluid in the first phase is stopped upon reaching a predetermined dispensed amount and that the tank blocking device is closed. Alternatively, it can also be provided that the gas amount in the transportation line is measured and that the first phase of the dispensing of fluid is concluded as a function of the measured results. According to the invention it is especially advantageous that the dispensing of fluid is stopped at the dispensed the amount which corresponds to a theoretical value minus the previously determined correction value, and that the residual fluid is then dispensed. This can avoid an overfilling of the container into which the fluid is being dispensed. The correction value preferably corresponds to a maximum value which corresponds to a complete filling with fluid of the transportation line side facing away from the tank, that is, without the inclusion of air.

It is basically possible to dispense the residual fluid through the same line path through which the fluid is also dispensed in the first dispensing phase before the blocking of the tank blocking device. However, it is especially advantageous that the residual fluid is dispensed through a residue removal line which branches off from the transportation line and which empties again at a location further distanced from the tank back into the transportation line. This makes it possible to very largely prevent the appearance of mixtures due to residual fluid amounts in dead spaces of the residue removal line. If the residue removal line empties back into the transportation line at a downstream location of it, it is possible during the entire dispensing procedure to dispense from one and the same dispensing opening, which is an especially simple procedure.

An especially rapid and effective removal of residue from the transportation line can be achieved in that the residual fluid is transported by a residue removal pump device arranged on the residue removal line. Another pump device is suitably arranged on the transportation line which serves to pump the fluid in the first phase before the blocking of the tank blocking device. The residue removal pump device is suitably operated as a function of the status of the fluid.

According to the invention it can furthermore be provided that the amount of the fluid dispensed before the blocking of the tank blocking device and the amount of the dispensed residual fluid are determined by different measuring devices. It can be taken into account here that in the case of dispensing residual fluid, lesser volumetric currents frequently occur than is the case with the preceding dispensing of fluid. It can also be taken into account that the residual fluid possibly has a comparatively high amount of gas inclusions. The two measuring devices are preferably connected in parallel by line technology, wherein during the dispensing of fluid a first line with the first measuring device is flowed through and during the

dispensing of residual fluid a second line with the second measuring device is flowed through. The second line is preferably smaller in diameter than the first line.

According to the invention it is advantageous that the dispensed amount of residual fluid is determined by a residual removal flow-through device arranged on the residual removal line.

The residual fluid is suitably removed at least one dead space of the transportation line and/or at a lower vertex of the transportation line from the latter. The residual fluid is preferably conducted out of the transportation line to a gas separator arranged on the transportation line. Such a gas separator is advantageously arranged on the side, facing the tank, of a flow-through measuring device for the fluid provided in the transportation line in order to keep inclusions of gas away from this measuring device. Such a gas separator, which also can be designated as a gas measuring preventer, frequently comprises a dead space for the fluid on the bottom side.

An especially simple operation is given in that the fluid dispensed before the blocking of the tank blocking device and the residual fluid are dispensed via the same dispensing opening. However, the line paths for the dispensing of the fluid and for the dispensing of the residual fluid preferably differ from one another at least in sections.

The invention can provide that the fluid is dispensed via at least one complete hose. Several complete hoses are suitably made available for different products. It can be provided that the fluid and especially also the residual fluid are supplied after being combined to another complete hose. Additionally or alternatively, a fluid dispensing via at least one empty hose can also be provided.

A device according to the invention is constructed with a transportation line which is connected to the tank on its one end by a tank blocking device, in particular a bottom valve, and which comprises on its other end at least one dispensing opening, means for removing and dispensing residual fluid which is located after the blocking of the tank blocking device on the side, facing away from the tank, of the tank blocking device in the transportation line, and means for measuring the amount of the dispensed residual fluid.

The device according to the invention can be used in particular for carrying out the method of the invention, as a result of which the advantages described in this connection can be achieved. The features described in conjunction with the method according to the invention can also be used with the device according to the invention and also the features described in conjunction with the device according to the invention can be used in the method according to the invention.

The means for removing and dispensing residual fluid is advantageously designed in such a manner that the residual fluid as well as the fluid in the first dispensing phase are dispensed through the dispensing opening.

An especially thorough removal of residue from the transportation line can be achieved according to the invention in that the means for removing and dispensing residual fluid comprises a residual removal line which branches off from the transportation line and preferably empties back into the transportation line at a location further removed from the tank. The residual removal line advantageously branches off from the transportation line at least one dead space, in particular at a lower vertex point of the transportation line. The residual removal line is preferably designed for a lesser volume flow in comparison to the transportation line, in particular it is designed with a smaller diameter.

According to the invention it is advantageous that in addition to the means for measuring the amount of the dispensed residual fluid, means for measuring the amount of the fluid dispensed before the blocking of the tank blocking device is also provided. The means for measuring are advantageously all signal-connected to an evaluation device which in particular comprises a summing member for the two measured values. The evaluation device can be part of a control which controls pump devices and/or blocking device of the device.

According to the invention it is furthermore advantageous that a gas separator is arranged on the transportation line. This makes it possible that the dispensed amount of fluid can be measured especially precisely. If a gas separator is provided, it is advantageous that the residue removal line branches off on the gas separator, especially at a bottom area of the gas separator. A dead space for the fluid can be formed in the bottom area of such a gas separator. The gas separator can in particular have an area in the transportation line which area has an enlarged cross section.

According to the invention even several residue removal lines can be provided and/or the residue removal line can comprise several supply lines which branch off from the transportation line at different positions, in particular at different dead spaces.

The transportation of the fluid can basically take place when the tank blocking device is open solely be the action of gravity. However, it is especially advantageous that a main pump device is provided on the transportation line. This can achieve an especially high dispensing performance in the first dispensing phase.

In order to determine the amount of fluid dispensed in the first dispensing phase it is furthermore advantageous that a main flowthrough measuring device is provided on the transportation line. However, even other devices for determining the dispensed the amount of fluid are conceivable such as, for example, a balance arranged on the tank.

For an especially rapid and reliable residue removal it is advantageous that a residue removal pump device is provided on the residue removal line. It is furthermore advantageous that a residue removal flow-through device is arranged on the residue removal line. In particular, the means for measuring the amount of the dispensed residual fluid comprises the residue removal flow-through measuring device. The pump performance of the residue removal pump device is preferably less than the pump performance of the main pump device.

The flow-through measuring devices can be in particular turbine meters or impeller meters.

It is advantageous in the course of the transportation line that the tank is followed at first by the main pump device then by the gas separator and finally by the main flowthrough measuring device.

An especially high precision in the determining of the dispensed the amount of residual fluid can be achieved in that in particular in the residue removal line a level recorder is provided and that a control is preferably provided which is designed to control the residue removal pump device as a function of the level determined by the level recorder. This level recorder can be constructed in particular as a sensor displaying empty. It is possible by means of this level sensor to prevent that the residue removal flow-through device is loaded with too high a gas component or that the residue removal line runs entirely empty. Since as a rule

a residual fluid volume remains in the residue removal line, it is advantageous that it is constructed with a small cross section, in particular with a cross section smaller than the transport line.

The reliability of the invention can be increased in that at least one blocking device is provided on the residue removal line. The at least one blocking device can advantageously be activated by the control. At least one blocking device is advantageously provided on the branching and also on the emptying of the residue removal line out of and into the transportation line so that the residue removal line can be separated using flow technology on the inlet side as well as on the outlet side from the transportation line during the first dispensing phase, that is, the phase in which the tank blocking device is open. A blocking device is advantageously provided on the residue removal line on both sides of the residue removal flowthrough measuring device and/or of the residue removal pump device. If several dispensing openings are provided for different products, it can be advantageous to provide each dispensing opening with its own blocking device on the outlet side on the residue removal line.

Furthermore, it is advantageous according to the invention that the residue removal line branches off from the transportation line on the side, facing the tank, of the main flowthrough measuring device and empties on the side, facing away from the tank, of the main flowthrough measuring device back into the transportation line. In this case the residue removal line forms a bypass line which goes around the main flowthrough measuring device. The main flowthrough measuring device is preferably emptied during the removal of residue.

Furthermore, it can be provided according to the invention that a blocking device, in particular a non-return valve is provided on the transport line, in particular in the area of the main flowthrough measuring device and in particular on its side facing

away from the tank. This blocking device is provided according to the invention on the side of the tank blocking device which side faces away from the tank. An area of the transport line which was removed of residue can be separated from an area of the transport line which was not removed of residue by this blocking device. This makes it possible according to the invention to operate with complete hoses. It is preferably provided that the residue removal line branches out of the transport line on the one side of the blocking device and empties back into the transport line on the other side of the blocking device. If a blocking device is provided, the control is advantageously designed to close this blocking device during the dispensing of the residual fluid. A non-return valve can assume this function without an external control. The non-return valve is advantageously designed in such a manner that it blocks during a flow of fluid directed into the tank.

In order to prevent that an amount of fluid is counted twice, in the first dispensing phase and also in the removal of residue, the blocking device is advantageously arranged in the direct vicinity of the main flowthrough measuring device, preferably on its side facing away from the tank. The non-return valve can also be constructed as a pressure retaining valve.

According to the invention it is preferred that several tanks are provided and that the transportation line comprises a collector line to which each tank is connected by a tank blocking device. The tanks can be in particular tank chambers of an entire tank. The invention is advantageously provided for a tank truck.

In particular when several tanks are provided which are to be loaded with different fluids, it can be advantageous that the transportation line comprises several dispensing lines on which at least one dispensing opening is provided, and that a distributor is provided in the transportation line with which the fluid can be purposefully distributed into the different dispensing lines. The distributor

preferably directly follows the blocking device arranged in the transportation line so that a residual volume provided downstream from the blocking device which was not removed is held as small as possible.

If several dispensing lines are provided, it is advantageous for an especially slight mixing that the residue removal line branches into several partial lines which empty into different dispensing lines. Each partial line can be provided with its own blocking device at the branching.

The invention can provide that the transportation line comprises at least one dispensing line constructed as a complete hose.

In order to allow an especially simple and rapid removal of residue, it is advantageous that at least one line ventilation device, in particular a ventilation valve, is provided in the transportation line, especially in the area of the tank blocking device, with which valve the transportation line can be ventilated on the tank side during the dispensing of residual fluid.

A gas amount sensor for the adjusting of the pump performance of the main pump device by the control as a function of the gas component is preferably provided in the transportation line.

The invention is described in detail in the following using preferred exemplary embodiment schematically shown in the drawings. In the drawings:

Fig. 1 shows a schematic view of a device according to the invention for dispensing a fluid for carrying out the method of the invention in accordance with a first embodiment;

Fig. 2 shows a detailed view of a device according to the invention in the area of the distributor in the area of the dispensing line side according to a second embodiment;

Fig. 3 shows a top view of the device in fig. 2 in direction A; and

Fig. 4 shows a side view of the device in fig. 2 along the section plane B-B.

Elements with the same operation are characterized in all figures with the same reference numerals.

Fig. 1 shows a first embodiment of a device according to the invention. The device comprises two tanks 2, 2' which form tank chambers of an entire tank. A tank blocking device 13, 13' constructed as a bottom valve is provided on each of the two tanks 2, 2'. The tanks 2, 2' can be emptied into a collector line 11 provided on the input side of a transportation line 10 via these bottom valves.

A main pump device 15 for transporting the fluid from the two tanks 2, 2' is provided in the transportation line 10. A filter 41, 42 is arranged on both sides of the main pump device 15 in the transport line 10. In the course of the transport line 10 the main pump device 15 with the second filter 42 is followed by a gas separator 30 which comprises a vertically running wall section which is constructed in comparison to the surrounding transport line 10 with a greater inner cross section, in particular with a greater inside diameter.

The gas separator 30 is followed in the transportation line 10 by a main flowthrough measuring device 17 constructed, for example, as a turbine meter which is directly followed for its part by a blocking device constructed as a non-return valve 19. The gas separator 30 serves to minimize a loading of the main flowthrough measuring device 17 with gas. The non-return valve 19 is followed by a distributor 25 which divides the transportation line cross section into, for

example, two separate dispensing lines 70, 70' which are constructed toward the end as complete hoses and each comprise a dispensing opening 20, 20'. On the input side of the two dispensing lines 70, 70' in the area of the distributor 25 the two dispensing lines 70, 70' each have a blocking device 72, 72'. More than two dispensing lines can also be provided, wherein the number of dispensing openings and blocking devices can then be increased in a corresponding manner.

A dead space is formed in the bottom area of the gas separator 30 which cannot be pumped out by the transportation line 10 entering in and out of it. A residue removal line 50 branches off in this bottom area of the gas separator 30 from the transportation line 10 via a blocking device 61. This residue removal line 50 branches, for example, into two partial lines 51, 51' which empty downstream from the non-return valve 19 into the two dispensing lines 70, 70'. At least one partial line is preferably provided per dispensing line. A residue removal pump device 55 and a residue removal flowthrough measuring device 53, which is constructed, for example, as a turbine meter, are arranged in the residue removal line 50. Furthermore, a level recorder 58 is provided on the tank side of the residue removal flowthrough measuring device 53. A blocking device 62, 62' is provided behind the branching of the residue removal line 50 in each of the two partial lines 51, 51' of the residue removal line 50.

If a given amount of fluid of, for example 3000 l is to be dispensed from the tank 2 by the device, the following procedure according to an exemplary embodiment of the invention can be used:

At first, the transportation line 10 is filled in that the tank blocking device 13 is opened, wherein the second tank blocking device 13' is switched to passage. Furthermore, a ventilation valve 32 provided on the cover side on the gas separator 30 is opened which has a line connection via a ventilating line 33, for example, to

the tank 2 or also to the environment. As a result the transportation line 10 can be filled with fluid up to the non-return valve 19.

In addition to the ventilation valve 32, even other ventilation valves which are not shown can also be provided which have a line connection with the environment or with the other tank 2'.

In order to show the level of the transportation line 10, a measuring probe 35 is provided on this line. This measuring probe 35 is constructed in the present exemplary embodiment as an electronic dipstick which is arranged in the gas separator 30, which can also be designated as a gas measuring preventer. As soon as it is determined by the measuring probe 35 that sufficient product is present in the line system 10 for dispensing bubble-free product into the dispensing lines 70, 70' and their complete hoses, the ventilation valve 32 is closed. Alternatively, a time-lapse control can also be provided.

During the initial filling of the transport line 10 the blocking device 61, which can also be designated as a residue removal valve, as well as the blocking devices 62, 62' and 72, 72' are closed.

If the transportation line 10 is filled, the blocking device 72 or the blocking device 72', depending on the prior hose filling, is opened and the main pump device 15 is started. The main flowthrough measuring device 17 detects the amount flowing through, which is substantially free of bubbles on account of the gas separator 30 connected in front. The control 5 designed as a computer controls the main pump device 15 in such a manner that the transport procedure is stopped in time before the desired theoretical value for the dispensing. In particular, a stop can be made at a dispensing volume which corresponds to the theoretical volume minus the

volume of the transportation line 10, in the present example at a pipe volume of 30 l at a value of 2970 l.

The dispensing lines 70, 70' are already filled with the product of the particular complete hose, which can take place, for example upon the first starting up of the system.

Subsequently, the tank blocking device 13 is closed. In the embodiment shown, in which the partial lines 51, 51' of the residue removal line 50 empty on the side facing away from the tank, that is, downstream from the blocking devices 72, 72', into the transportation line, even these two blocking devices 72, 72' are closed.

The residue removal will now begin. To this end the tank blocking device 13 is ventilated by a ventilation valve 45. Another ventilation valve is provided on the second tank blocking device 13' of the second tank 2'. Furthermore, the blocking device 61 provided on the inlet side of the residue removal line 50 as well as, corresponding to the previously used dispensing line 70 or 70', the blocking device 62 on the outlet side or the outlet-side blocking device 62' of the residual removal line 30 are opened. The outlet-side blocking devices 62, 62' can also be designated as selection valves.

After the opening of the blocking devices 61 and 62 and 62' the residue removal pump device 55 is started and pumps the products to be removed via the residue removal flowthrough measuring device 53 into the injection position of the particular dispensing device 70 or 70'. A level recorder 58 which can also be designated as an empty indicator sensor, monitors the product flow in the residue removal line 50 for the entrance of air. As soon as an entrance of air is detected, the residue removal pump device 55 is stopped or lowered.

In addition to or alternatively to the level recorder 58 in the residue removal line 50, a level recorder 59 can also be provided for the same purpose on the gas separator 30. This level recorder 59 allows a time-delayed reaction and pump control. The signal of the level recorder 58 can, on the other hand, be taken as an absolute cutoff criterion in order to ensure that no gas can penetrate into the feedline for the residue removal pump device 55.

If a running empty of the residue removal line 50 is shown by the recorder 58 or 59, the open blocking device of the two blocking devices 62, 62' is closed. The amount of fluid measured by the residue removal flowthrough measuring device 53 is added to the amount of fluid measured by the main flowthrough measuring device 17. Therefore, the amount supplied and to be paid is, for example, 3000 l or, depending on the gas content in the transportation line 10, in particular in the gas separator 30, at the beginning of the removal of residue somewhat less.

Subsequently, the ventilation valve 45 is closed again and another dispensing procedure can be started with a residue-free system.

The control of the gas separator 30 can preferably take place by the measuring probe 35 constructed as a dipstick and which indicates the level in the gas separator 30. The measured signal of the measuring probe 35 can also be used to control the residue removal procedure, in particular to control the residue removal pump device 55, since the level in the gas separator 30 can be continuously determined with it, which significantly simplifies the pump control. If the measuring probe 35 is used for the pump control, the level recorder 58 and/or 59 can optionally be eliminated.

It should be taking into account that the residue removal system in the schematic figure 1 is shown with exaggerated proportions for the sake of clarity. The inside

volume of the residue removal device, in particular the residue removal line 50, should be selected to be as small as possible in order to minimize a contamination of the product.

The residual volume remaining in the system can be further reduced by the further development of the distributor 25 and associated valve blocks shown in the fig. 2 to 4 in which the dead volumes are reduced.

The distributor 25 shown in the fig. 2 to 4 makes the distribution of the product possible with reduced mixing. In contrast to the exemplary embodiment of fig. 1, in the exemplary embodiment shown in fig. 2 to 4 the residue removal line 50 does not branch until directly in front of the distributor 25, that is, the blocking devices 62, 62' arranged in the partial lines 51, 51' border directly on the distributor 25. On the one hand the transportation line 10 branches into the two dispensing lines 70, 70' in the distributor 25 of fig. 2 to 4. In addition, the two partial lines 51, 51' of the residue removal line 50 also empty into the separate dispensing lines 70, 70' in the distributor 25. In contrast to the exemplary embodiment in fig. 1 the partial lines 51, 51' empty on the side of the blocking devices 72, 72' facing the tank into the dispensing lines 70, 70'. The blocking devices 72, 72' directly follow the distributor 25.

In the exemplary embodiment shown in fig. 2 to 4 sensors 80, 80' are arranged in the residue removal line 50 upstream from their branching, which serve to detect a signal from the residue removal pump device 55 and/or the residue removal flowthrough measuring device 53. The residue removal pump device 55 and/or the residue removal flowthrough measuring device 53 can be constructed, for example, as turbine wheel meters or impeller wheel meters (with a 90° phase shift).

The blocking devices 62, 62' and 72, 72' are controlled in a simultaneous and associated manner, that is, for example, the blocking device 62, 72 are open and the blocking devices 62' and 72' are closed.

The flowthrough measuring devices of the invention can be constructed in particular as driving slide meters.

CLAIMS

1. A method for dispensing a fluid from at least one tank (2) in which

- the fluid is transported and dispensed via a transportation line (10) from the tank (2), wherein the amount of the dispensed fluid is measured,
- at the end of the dispensing the transportation line (10) is blocked by a tank blocking device (13) in particular a bottom valve, and
- subsequently residual fluid present on the side of the tank blocking device (13) facing away from the tank is removed from the transportation line (10) and is also dispensed, wherein the amount of the dispensed residual fluid is measured.

2. The method according to Claim 1,
characterized in that
the residual fluid is dispensed through a residue removal line (50) which branches off from the transportation line (10) and which empties again at a location further distanced from the tank (2) back into the transportation line (10).

3. The method according to one of the previous claims,
characterized in that
the residual fluid is transported by a residue removal pump device (55) arranged on the residue removal line (50).

4. The method according to one of the previous claims,
characterized in that
the amount of the fluid dispensed before the blocking of the tank blocking device (13) and the amount of the dispensed residual fluid are determined by different measuring devices.

5. The method according to one of the previous claims,
characterized in that
the dispensed amount of residual fluid is determined by a residual removal flow-through device (53) arranged on the residual removal line (50).

6. The method according to one of the previous claims,
characterized in that
the residual fluid is conducted out of the transportation line (10) to a gas separator (30) arranged on the transportation line (10).

7. The method according to one of the previous claims,
characterized in that
the fluid dispensed before the blocking of the tank blocking device (13)and the residual fluid are dispensed via the same dispensing opening (20).

8. The method according to one of the previous claims,
characterized in that
the fluid is dispensed via at least one complete hose.

9. A device for dispensing a fluid from at least one tank (2), in particular for carrying out the method according to one of the previous claims, with

- a transportation line (10) which is connected to the tank (2) on its one end by a tank blocking device (13), in particular a bottom valve, and which comprises on its other end at least one dispensing opening (20),
- means for removing and dispensing residual fluid which is located after the blocking of the tank blocking device (13) on the side, facing away from the tank, of the tank blocking device (13) in the transportation line (10), and
- means for measuring the amount of the dispensed residual fluid.

10. The device according to Claim 9,
characterized in that
the means for removing and dispensing residual fluid comprises a residual removal line (50) which branches off from the transportation line (10) and empties back into the transportation line (10) at a location further removed from the tank (2).

11. The device according to one of the previous claims,
characterized in that
a gas separator (30) is arranged on the transportation line (10), and
that the residue removal line (50) branches off in particular in the gas separator (30).

12. The device according to one of the previous claims,
characterized in that
a main pump device (15) and/or a main flowthrough measuring device (17) is/are provided on the transportation line.

13. The device according to one of Claims 10 to 12,
characterized in that
a residue removal pump device (55) and/or a residue removal flowthrough measuring device (53) is/are arranged in the residue removal line 50.

14. The device according to one of Claims 10 to 13,
characterized in that
a level recorder (58) is provided in the residue removal line (50) and
that a control (5) is preferably provided which is designed to control the residue removal pump device (55) as a function of the level determined by the level recorder (58).

15. The device according to one of Claims 10 to 14,
characterized in that
at least one blocking device (61, 62) is provided on the residue removal line (50).

16. The device according to one of Claims 12 to 15,
characterized in that
that the residue removal line (50) branches off from the transportation line (10) on the side, facing the tank, of the main flowthrough measuring device (17) and empties on the side, facing away from the tank, of the main flowthrough measuring device (17) back into the transportation line (10).

17. The device according to one of the previous claims,
characterized in that
a blocking device, in particular a non-return valve (19) is provided on the transport line (10), in particular in the area of the main flowthrough measuring device (17) and in particular on its side facing away from the tank.

18. The device according to one of the previous claims,
characterized in that
several tanks (2) are provided and that the transportation line (10) comprises a collector line (11) to which the tanks (2) are connected by a tank blocking device (13).

19. The device according to one of the previous claims,
characterized in that
the transportation line (10) comprises several dispensing lines (70) on which at least one dispensing opening is provided (20),
that a distributor (25) is provided in the transportation line (10) with which the fluid can be purposefully distributed into the different dispensing lines (70), and

that the residue removal line (50) branches into several partial lines (51) which empty into different dispensing lines (70).

20. The device according to one of Claims 10 to 19,
characterized in that
the transportation line (10) comprises at least one dispensing line (70) constructed as a complete hose.

Fig. 1

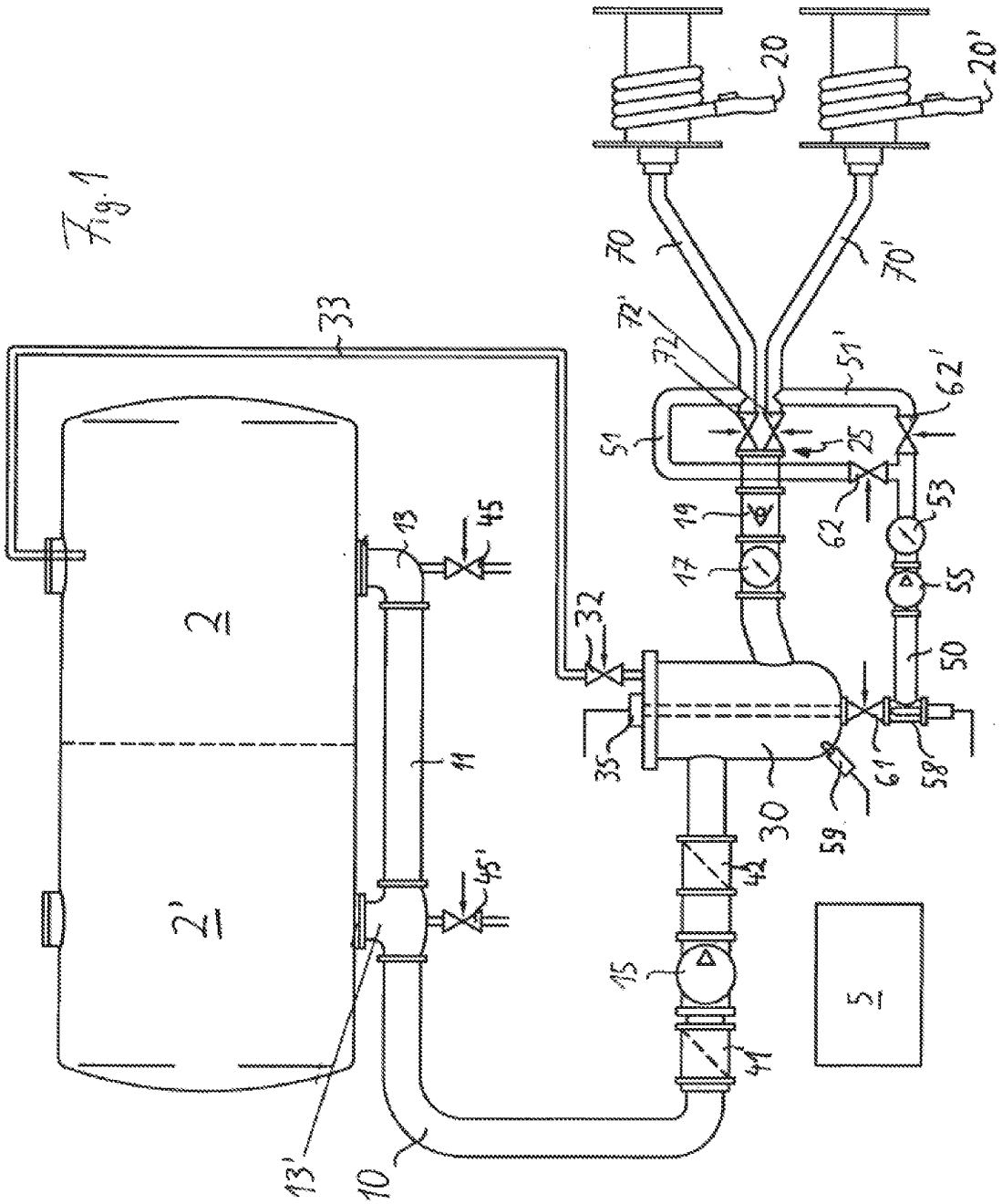

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17
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2'
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41
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5
13'
10

Fig. 2

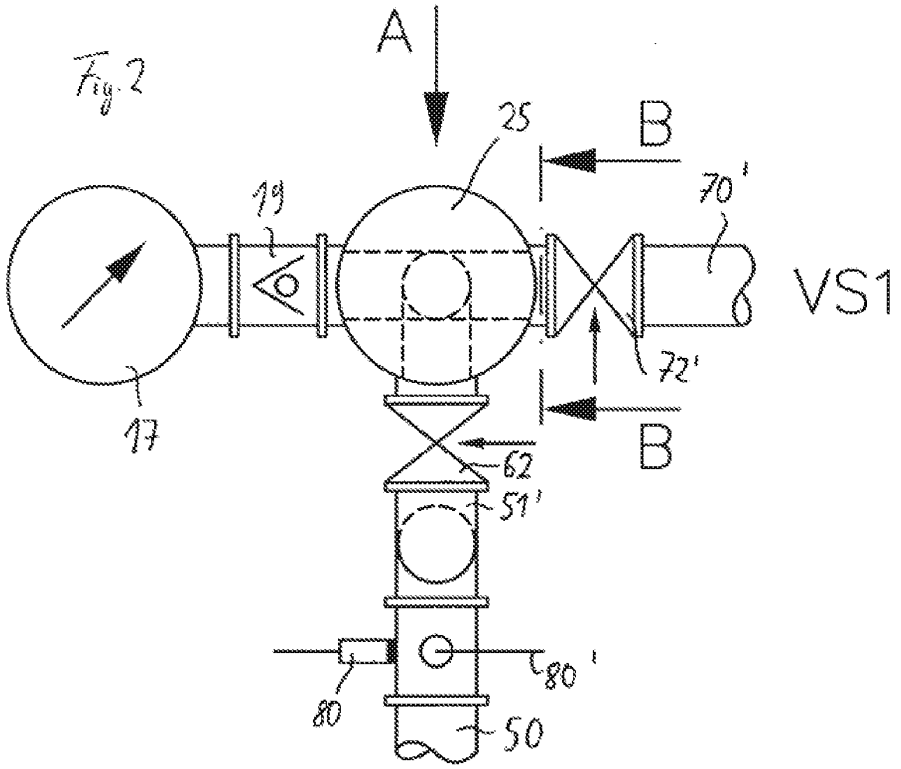


Fig. 3

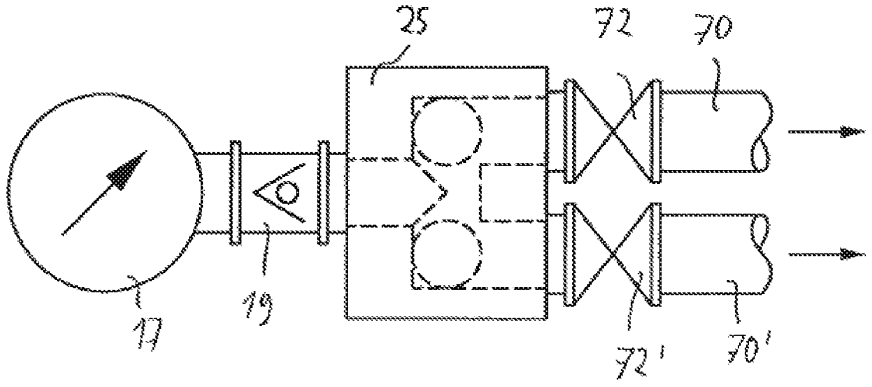
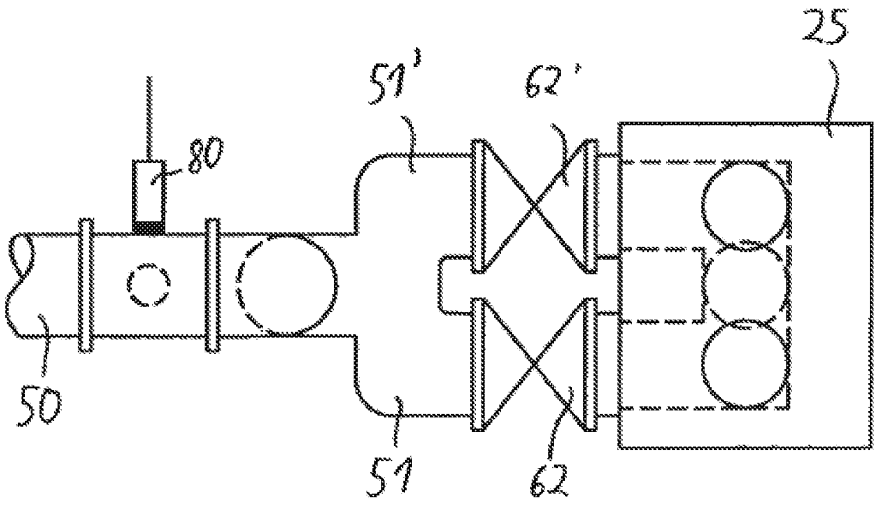


Fig 4



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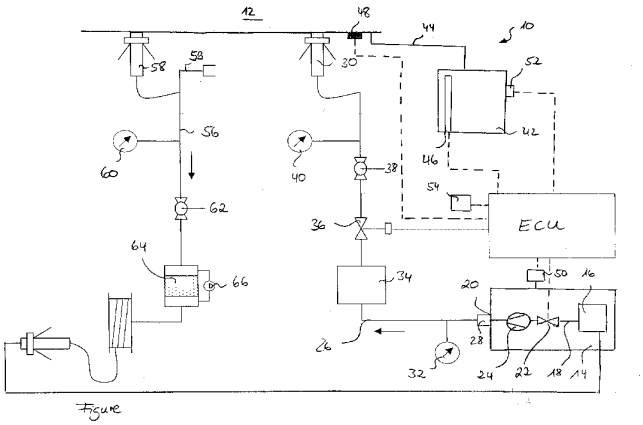
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(54) **Title:** APPARATUS AND METHOD FOR TESTING AN AIRCRAFT TANK SYSTEM



Figure

(57) **Abstract:** An apparatus (10) for testing an aircraft tank system (12) comprises a fuel supply device (14) including a fuel reservoir (16), a fuel supply line (18) for supplying fuel from the fuel reservoir (16) to a fuel outlet (20) of the fuel supply device (14), and a first isolation valve (22) disposed in the fuel supply line (18). The apparatus (10) further comprises a fuel transfer line (26) for transferring fuel from the fuel outlet (20) of the fuel supply device (14) to the aircraft tank system (12) and a second isolation valve (36) disposed in the fuel transfer line (26). An electronic control unit (ECU) of the apparatus (10) is adapted to control the first isolation valve (22) and the second isolation valve (36) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, in response to a test parameter signal provided to the electronic control unit (ECU).

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Apparatus and method for testing an aircraft tank system

The invention is directed to an apparatus and a method for testing an aircraft tank system.

During final assembly of an aircraft a test has to be performed on the aircraft tank system so as to ensure a proper operation of the aircraft tank system control equipment, in particular a fuel level control device. Furthermore, the test serves to discover leakages in the tank system. The aircraft tank system test involves the supply of a predefined volume of fuel from a fuel reservoir to the tank system. For safety reasons, an apparatus for testing an aircraft tank system typically comprises an emergency shut-off device which allows to interrupt the test upon occurrence of a safety critical situation, e.g. an excess pressure in one of the aircraft tanks to be tested. Additionally, the supply of fuel from the fuel reservoir usually is controlled by means of a dead man's device. The dead man's device serves to immediately interrupt the fuel supply from the fuel reservoir, if an operator fails to push a respective dead man's button, e.g. at regular time intervals or continuously, so as to generate a confirmation command for the continuation of the fuel supply from the fuel reservoir.

An aircraft tank system test might be quite time consuming and in some cases takes up to eight hours. The operation of a dead man's device for such a long time is very uncomfortable for an operator. Furthermore, there is the risk that the operator, e.g. due to a lack of concentration, mistakenly fails to push the dead man's button, so that a test is inadvertently interrupted.

The present invention is directed to the problem to provide an apparatus and a method which allow to reliably perform an aircraft tank system test and to simultaneously ensure an enhanced safety during the test.

To solve the above problem, an inventive apparatus for testing an aircraft tank system comprises a fuel supply device including a fuel reservoir and a fuel supply line which at a first end is connected to the fuel reservoir and which at a second end is connected to a fuel outlet of the fuel supply device and thus serves to supply fuel from the fuel reservoir to the fuel outlet of the fuel supply device. A first isolation valve which forms an integral part of the fuel supply device is disposed in the fuel

supply line. In its open state the first isolation valve allows the supply of fuel from the fuel reservoir to the fuel outlet of the fuel supply device and in its closed state the first isolation valve interrupts the supply of fuel from the fuel reservoir to the fuel outlet of the fuel supply device. The fuel supply device might be a stationary device but preferably is a mobile device, for example a fuelling vehicle. Additionally, the fuel supply device might comprise a fuel pump which serves to deliver fuel from the fuel reservoir.

The inventive device for testing an aircraft tank system further comprises a fuel transfer line which at a first end is connected to the fuel outlet of the fuel supply device and which at a second end is connectable to the aircraft tank system and thus serves to transfer fuel from the fuel outlet of the fuel supply device to the aircraft tank system. A second isolation valve is disposed in the fuel transfer line. In its open state the second isolation valve allows the transfer of fuel from the fuel outlet of the fuel supply device to the aircraft tank system and in its closed state the second isolation valve interrupts the supply of the fuel from the fuel outlet of the fuel supply device to the aircraft tank system.

An electronic control unit of the inventive apparatus is adapted to control the first isolation valve and the second isolation valve so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, in response to a test parameter signal provided to the electronic control unit. In other words, the electronic control unit controls both, the first and the second isolation valve so as to close the first and the second isolation valve and thus interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if the electronic control unit receives a respective test parameter signal. The first isolation valve of the fuel supply device thus is integrated in the control circuit of the electronic control unit.

As a result, in the inventive apparatus for testing an aircraft tank system a dead man's device for controlling an interruption of the fuel supply from the fuel supply device can be omitted. The apparatus thus is comfortable to operate for an operator. Furthermore, the overall safety during performing an aircraft tank system test can be enhanced, since the electronic control unit in response to a respective test parameter signal simultaneously controls the first and the second isolation valve so as to intermediately interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively.

The electronic control unit of the inventive apparatus might further be adapted to control the fuel pump of the fuel supply device so as to stop the delivery of fuel from the fuel reservoir in response to a respective test parameter signal provided to the electronic control unit. Alternatively, it is, however, also possible not to integrate the fuel pump in the control circuit of the electronic control unit. If the first isolation valve is closed in response to a respective command from the electronic control unit while the fuel pump operation continues, the operating modus of the fuel pump changes to an idling operation modus.

Preferably, for enhanced safety, at least one of the first and the second isolation valve of the inventive apparatus for testing an aircraft tank system is a pneumatically operated valve.

In a preferred embodiment the inventive apparatus further comprises a pressure sensor for sensing a pressure within the aircraft tank system and for providing a test parameter signal indicative of the pressure within the aircraft tank system. Preferably, the pressure sensor is adapted to be removably connected to a water drain valve provided on the aircraft tank system. For example, the pressure sensor might be adapted to be removably disposed within a housing of a water drain valve provided on the aircraft tank system. Alternatively, the pressure sensor can be connected to an outer part of the water drain valve. The water drain valve usually is disposed at the bottom of the aircraft tank system and accessible from outside the aircraft to allow the removal of condensation water from the aircraft tank system. By providing a pressure sensor which might be inserted into the housing of the water drain valve after simply removing the water drain valve body, the pressure sensor can easily be installed from outside the aircraft. An installation of the pressure sensor inside the aircraft tank system thus can be omitted. Since the water drain valve usually is disposed at the lowest point of the tank system, positioning the sensor within the housing of this valve, also allows a particular reliable and exact measuring of the pressure within the tank system.

The inventive apparatus might comprise a plurality of pressure sensors which serve to sense the pressure within the individual tanks of the aircraft tank system, i.e. the wing tanks, the center tank and the auxiliary center tanks of the aircraft. The pressure sensors which might be disposed in housings of water drain valves of the indi-

vidual tanks provide test parameter signals indicative of the pressure within the individual tanks of the aircraft tank system to the electronic control unit.

The electronic control unit might be adapted to control the first isolation valve and the second isolation valve so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if the pressure within the aircraft tank system sensed by means of the pressure sensor(s) exceeds a predetermined limit. The inventive apparatus then reliably ensures that the pressure within the aircraft tank system during fuelling the tank system upon performing an aircraft tank system test does not exceed the predetermined limit. As a result, the overall safety during performing the test can be significantly enhanced. Furthermore, damages to the tank system and the aircraft due to excess fuel pressure within the aircraft tank system can be avoided.

The inventive apparatus might further comprise an overflow reservoir which might be connected to the aircraft tank system during performing the aircraft tank system test for receiving overflowing fuel from the aircraft tank system. Typically, an aircraft tank system control equipment comprises a fuel level control device which might be adapted to automatically interrupt the supply of fuel to the aircraft tank system, if a fuel level sensing device for sensing the fuel level in the aircraft tank system indicates that the aircraft tanks are full. During performing an aircraft tank system test the proper operation of the fuel level control device has to be tested. In case of a malfunction of the fuel level control device, i.e. in case the supply of fuel to the aircraft tank system is not interrupted, although the aircraft tanks are already full, the overflow reservoir receives fuel overflowing from the aircraft tank system. Furthermore, an overflow test can be performed, during which the supply of fuel to the aircraft tank system is intentionally continued, although the aircraft tanks are already full.

In the inventive apparatus for testing an aircraft tank system a level sensor might be provided for sensing a fuel level in the overflow reservoir and for providing a test parameter signal indicative of the fuel level in the overflow reservoir. Preferably, a plurality of overflow reservoirs is provided for receiving overflowing fuel from the individual tanks of the aircraft tank system. Each overflow reservoir might be provided with a level sensor for sensing the fuel level in the overflow reservoir and for providing a test parameter signal indicative of the fuel level in the overflow reservoir.

Preferably the electronic control unit of the inventive apparatus is adapted to control the first isolation valve and the second isolation valve so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if the fuel level in the overflow reservoir sensed by means of the level sensor exceeds a predetermined limit. In other words, in the inventive apparatus the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line is interrupted, if the overflow reservoir(s) is/are full.

Preferably, the inventive apparatus further comprises at least one manually operable emergency shut-off button which upon actuation provides a test parameter signal indicative of a control request of an operator. The apparatus might be provided with a plurality of manually operable emergency shut-off buttons associated to the fuel supply device, a stationary or mobile test station comprising the fuel transfer line and the second isolation valve and each of the overflow reservoirs.

The electronic control unit of the inventive apparatus might be adapted to control the first isolation valve and the second isolation valve so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, in response to the test parameter signal provided by the emergency shut-off button. In other words, the electronic control unit controls the first and the second isolation valve so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if an operator manually pushes an emergency shut-off button provided on the inventive apparatus.

An inventive method for testing an aircraft tank system comprises the steps of supplying fuel from a fuel reservoir to a fuel outlet of a fuel supply device via a fuel supply line and transferring fuel from the fuel outlet of the fuel supply device to the aircraft tank system via a fuel transfer line. A first isolation valve disposed in the fuel supply line and a second isolation valve disposed in the fuel transfer line are controlled by means of an electronic control unit so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, in response to a test parameter signal provided to the electronic control unit.

Preferably the inventive method further comprises the steps of sensing a pressure within the aircraft tank system and providing a test parameter signal indicative of the pressure within the aircraft tank system by means of a pressure sensor. The first

isolation valve and the second isolation valve preferably are controlled by means of the electronic control unit so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if the pressure within the aircraft tank system sensed by means of the pressure sensor exceeds a predetermined limit.

The inventive method for testing an aircraft tank system might further comprise the steps of sensing a fuel level in an overflow reservoir for receiving overflowing fuel from the aircraft tank system and providing a test parameter signal indicative of the fuel level in the overflow reservoir by means of level sensor. The first isolation valve and the second isolation valve may be controlled by means of the electronic control unit so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, if the fuel level within the overflow reservoir sensed by means of the level sensor exceeds a predetermined limit.

Preferably, the inventive method further comprises the steps of providing at least one manually operable emergency shut-off button which upon actuation provides a test parameter signal indicative of a control request of an operator. The first isolation valve and the second isolation valve may be controlled by means of the electronic control unit so as to interrupt the supply of fuel through the fuel supply line and the transfer of fuel through the fuel transfer line, respectively, in response to the test parameter signal provided by the emergency shut-off button.

The present invention now is explained in detail with reference to the schematic drawing showing a preferred embodiment of an inventive apparatus for testing an aircraft tank system.

An apparatus 10 for testing an aircraft tank system 12 comprises a fuel supply device 14 in the form of a fuelling vehicle which includes a fuel reservoir 16. The fuel supply reservoir 16 is connected to a first end of a fuel supply line 18. A second end of the fuel supply line 18 is connected to a fuel outlet 20 of the fuel supply device 14.

A first isolation valve 22 is disposed in the fuel supply line 18 which in its closed state interrupts the supply of fuel from the fuel reservoir 16 to the fuel outlet 20 of the fuel supply device 14. To the contrary, in its open state the first isolation valve 22 allows fuel to be supplied from the fuel reservoir 16 to the fuel outlet 20 of the fuel

supply device 14. A fuel pump 24 disposed in the fuel supply line 18 downstream of the first isolation valve 22 serves to deliver fuel from the fuel reservoir 16.

The fuel outlet 20 of the fuel supply device 14 is connected to a first end of a fuel transfer line 26 via an appropriate coupling member 28. For performing an aircraft tank system test, a second end of the fuel transfer line 26 is connected to the aircraft tank system 12 via a coupling member 30. A first pressure gauge 32 is disposed in the fuel transfer line 26 for sensing the pressure within the fuel transfer line 26. Downstream of the first pressure gauge 32 a counting device 34 is disposed in the fuel transfer line 26 which serves to measure the mass, the density and the temperature of the fuel flowing through the fuel transfer line 26.

A second isolation valve 36 is disposed in the fuel transfer line 26 downstream of the counting device 34. The second isolation valve 32, like the first isolation valve 22, is a pneumatically operated valve. In its closed state the second isolation valve 36 interrupts the supply of fuel from the fuel outlet 20 of the fuel supply device 14 to the aircraft tank system 12, whereas the second isolation valve 36 in its open state allows fuel to be supplied from the fuel outlet 20 of the fuel supply device 14 to the aircraft tank system 12.

A fuel supply valve 38 is disposed in the fuel transfer line 26 downstream of the second isolation valve 36. The fuel supply valve serves to regulate the flow of fuel through the fuel transfer line 26. A second pressure gauge 40 is disposed in the fuel transfer line 26 downstream of the fuel supply valve 38 for sensing the pressure within the fuel transfer line 26 downstream of the fuel supply valve 38.

An overflow reservoir 42 is connected to the aircraft tank system 12 via an overflow line 44 which serves to receive overflowing fuel from the aircraft tank system in case excess fuel is supplied to the aircraft tank system 12, although the aircraft tanks 12 are already full. A level sensor 46 is provided in the overflow reservoir 42 to sense the fuel level in the overflow reservoir 42.

A pressure sensor 48 serves to measure the pressure within the aircraft tank system 12. The pressure sensor 48 is removably disposed within a housing of a water drain valve provided on the aircraft tank system 12. The water drain valve is disposed at a bottom of the aircraft tank system 12 and accessible from outside the aircraft. The

pressure sensor 48 thus can be inserted into the housing of the water drain valve after removing the water drain valve body.

Furthermore, emergency shut-off buttons 50, 52, 54 are provided on the fuel supply device 14, the overflow reservoir 42 and a mobile test station comprising the fuel transfer line 26, the first and the second pressure gauges 32, 40, the counting device 34, the second isolation valve 36 and the fuel supply valve 38.

The emergency shut-off buttons 50, 52, 54 each provide a test parameter signal to an electronic control unit ECU which indicates a control request, i.e. a shut-off request of an operator. Furthermore, test parameters signals indicative of the fuel level in the overflow reservoir are provided to the electronic control unit ECU by the fuel level sensor 46. Finally, the electronic control unit ECU receives test parameter signals indicative of the pressure within the aircraft tank system 12 from the pressure sensor 48.

The apparatus 10 for testing an aircraft tank system 12 further comprises a fuel discharge line 56 which is connected to the aircraft tank system 12 by means of a coupling member 58. The fuel discharge line 56 is connected to a vent line 59 which can be connected to the coupling member 30 at the second end of the fuel supply line 18. This arrangement allows to circulate fuel from the fuel supply line 18 directly to the fuel discharge line 56 without an aircraft tank system 12 being connected between the fuel supply line 18 and the fuel discharge line 56, e.g. to purge of the fuel supply line 18. A third pressure gauge 60 is disposed in the fuel discharge line 56 for measuring the fuel pressure within the fuel discharge line 56.

The discharge of fuel from the aircraft tank system 12 via the fuel discharge line 56 is controlled by means of a fuel discharge valve 62. In its closed state the fuel discharge valve 62 interrupts the discharge of fuel from the aircraft tank system 12 through the fuel discharge line 56, whereas the fuel discharge valve 62 in its open state allows fuel to be discharged from the aircraft tank system 12 through the fuel discharge line 56. The fuel discharge line 56 is connected to the fuel reservoir 16 of the fuel supply device 14. This permits defuelling of the aircraft tank system independent of the pump 24 of the fuel supply device 14. The fuel discharged via the fuel discharge line 56 after performing an aircraft tank system test thus can be reused for further tests.

A filter 64 is disposed in the fuel discharge line 56 downstream of the fuel discharge valve 62. The filter 64 is provided with a differential pressure sensing device 66 so as to detect choking or other malfunctions of the filter 64. The filter 64 serves to prevent particulate impurities within the fuel discharged from the aircraft tank system 12 to be introduced into the fuel reservoir 16 of the fuel supply device 14.

For performing an aircraft tank system test the second end of the fuel transfer line 26 is connected to the aircraft tank system 12 via the coupling member 30. The fuel supply valve 38 is manually brought into its open state to allow the supply of fuel from the fuel supply device 14 to the aircraft tank system 12. The pump of the fuel supply device 14 then is operated and fuel is delivered from the fuel reservoir 16 to the aircraft tank system 12.

During fuelling the aircraft tank system 12 the pressure within the aircraft tank system 12 is continuously sensed by means of the pressure sensor 48. Furthermore, the level sensor 46 continuously senses the fuel level in the overflow reservoir 42.

In case signals provided from the pressure sensor 48 to the electronic control unit ECU indicate that the pressure within the aircraft tank system 12 exceeds a predetermined limit, the electronic control unit ECU controls the first isolation valve 22 disposed in the fuel supply line 18 and the second isolation valve 36 disposed in the fuel transfer line 26 so as to intermediately interrupt the supply of fuel through the fuel supply line 18 and the transfer of fuel through the fuel transfer line 26, respectively. The supply of fuel from the fuel reservoir 16 of the fuel supply device 18 to the aircraft tank system 12 thus is reliably interrupted.

Similarly, the electronic control unit ECU controls the first isolation valve 22 and the second isolation valve 36 so as to interrupt the supply of fuel through the fuel supply line 18 and the transfer of fuel through the fuel transfer line 26, respectively, if a signal provided by the level sensor 46 to the electronic control unit ECU indicates that the overflow reservoir 42 is full.

Finally, the electronic control unit ECU controls the first isolation valve 22 and the second isolation valve 36 so as to interrupt the supply of fuel through the fuel supply line 18 and the transfer of fuel through the fuel transfer line 26, respectively, if any one of the emergency shut-off buttons 50, 52, 54 is manually actuated by an operator.

For defuelling the aircraft tank system 12, the fuel discharge line 56 is connected to the aircraft tank system 12 via the coupling member 58. Thereafter, the fuel discharge valve 62 is manually brought into its open state so that fuel can be discharged from the aircraft tank system 12 via the fuel discharge line 56 and reintroduced into the fuel reservoir 16 of the fuel supply device 14.

1759

Claims

1. Apparatus (10) for testing an aircraft tank system (12), which comprises:
- a fuel supply device (14) including a fuel reservoir (16), a fuel supply line (18) for supplying fuel from the fuel reservoir (16) to a fuel outlet (20) of the fuel supply device (14), and a first isolation valve (22) disposed in the fuel supply line (18),
- a fuel transfer line (26) for transferring fuel from the fuel outlet (20) of the fuel supply device (14) to the aircraft tank system (12),
- a second isolation valve (36) disposed in the fuel transfer line (26), and
- an electronic control unit (ECU) which is adapted to control the first isolation valve (22) and the second isolation valve (36) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, in response to a test parameter signal provided to the electronic control unit (ECU).

2. Apparatus according to claim 1, wherein at least one of the first and the second isolation valve (22, 36) is a pneumatically operated valve.

3. Apparatus according to claim 1 or 2, further comprising a pressure sensor (48) for sensing a pressure within the aircraft tank system (12) and for providing a test parameter signal indicative of the pressure within the aircraft tank system (12), wherein the electronic control unit (ECU) is adapted to control the first isolation valve (22) and the second isolation valve (36) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, if the pressure within the aircraft tank system (12) sensed by means of the pressure sensor (48) exceeds a predetermined limit.

4. Apparatus according to any of claims 1 to 3, further comprising an overflow reservoir (42) for receiving overflowing fuel from the aircraft tank system (12) and a level sensor (46) for sensing a fuel level within the overflow reservoir (42) and for providing a test parameter signal indicative of the fuel level in the overflow reservoir (42), wherein the electronic control unit (ECU) is adapted to control the first isolation valve (22) and the second isolation valve (36) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, if the fuel level within the overflow reservoir (42) sensed by

means of the level sensor (46) exceeds a predetermined limit.

5. Apparatus according to any one of claims 1 to 4, further comprising at least one manually operable emergency shut-off button (50, 52, 54) which upon actuation provides a test parameter signal indicative of a control request of an operator, wherein the electronic control unit (ECU) is adapted to control the first isolation valve (22) and the second isolation valve (36) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, in response to the test parameter signal provided by the emergency shut-off button (50, 52, 54).

6. Method for testing an aircraft tank system (12), which comprises the steps of:
- supplying fuel from a fuel reservoir (16) to a fuel outlet (20) of a fuel supply device (14) via a fuel supply line (18),
- transferring fuel from the fuel outlet (20) of the fuel supply device (14) to the aircraft tank system (12) via a fuel transfer line (26), and
- controlling a first isolation valve (22) disposed in the fuel supply line (18) and a second isolation valve (36) disposed in the fuel transfer line (26) by means of an electronic control unit (ECU) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, in response to a test parameter signal provided to the electronic control unit (ECU).

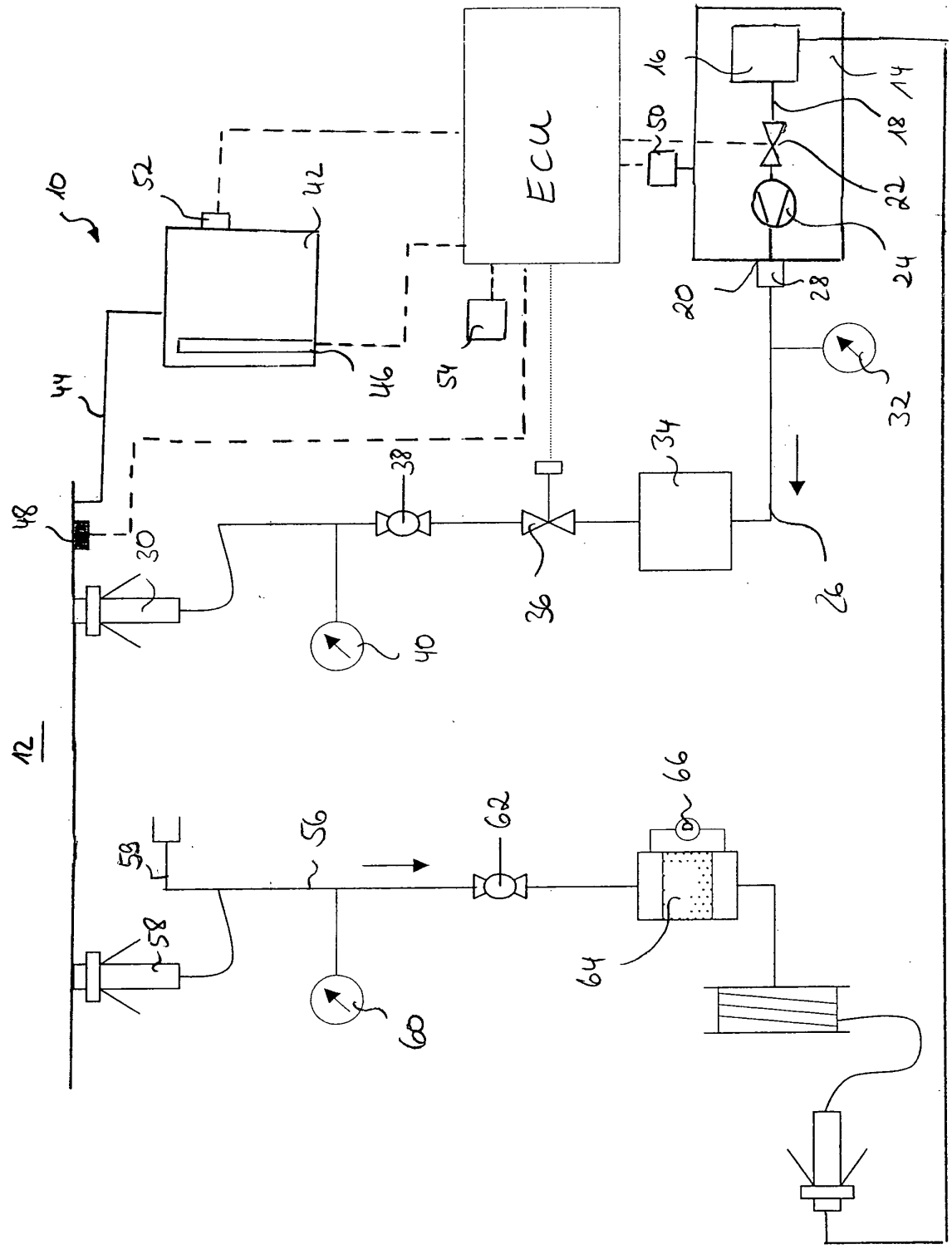
7. Method according to claim 6, further comprising the steps of:
- sensing a pressure within the aircraft tank system (12) and providing a test parameter signal indicative of the pressure within the aircraft tank system (12) by means of a pressure sensor (48), and
- controlling the first isolation valve (22) and the second isolation valve (36) by means of the electronic control unit (ECU) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, if the pressure within the aircraft tank system (12) sensed by means of the pressure sensor (48) exceeds a predetermined limit.

8. Method according to claim 6 or 7, further comprising the steps of:
- sensing a fuel level in an overflow reservoir (42) for receiving overflowing fuel from the aircraft tank system (12) and providing a test parameter signal indicative of the fuel level in the overflow reservoir (42) by means of a level sensor (46), and

- controlling the first isolation valve (22) and the second isolation valve (36) by means of the electronic control unit (ECU) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, if the fuel level within the overflow reservoir (42) sensed by means of the level sensor (46) exceeds a predetermined limit.

9. Method according to any one of claims 6 to 8, further comprising the steps of:
- providing at least one manually operable emergency shut-off button (50, 52, 54) which upon actuation provides a test parameter signal indicative of a control request of an operator, and
- controlling the first isolation valve (22) and the second isolation valve (36) by means of the electronic control unit (ECU) so as to interrupt the supply of fuel through the fuel supply line (18) and the transfer of fuel through the fuel transfer line (26), respectively, in response to the test parameter signal provided by the emergency shut-off button (50, 52, 54).

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ECU
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Figure

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/010379

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64D37/16 B64F1/28 B64F5/00

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)
B64F B64D F02M G01M

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 440 317 B1 (KOETHE TERENCE LEE [US]) 27 August 2002 (2002-08-27) column 5, line 13 - line 23 column 12, line 19 - line 24; figures 1,8	1,6
A	US 6 234 224 B1 (SCHULTZ JR ROBERT L [US]) 22 May 2001 (2001-05-22) column 2, line 31 - line 41; figure 1	1,6
A	US 6 327 898 B1 (HARRIS ROBERT S [US]) 11 December 2001 (2001-12-11) abstract; figure 2	1,6
A	DE 100 28 157 A1 (JAGUAR CARS [GB]) 18 January 2001 (2001-01-18) abstract; figure 1	1,6

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2008	02/09/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kaysan, Rainer

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/010379

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 100 06 186 C1 (BOSCH GMBH ROBERT [DE]) 13 June 2001 (2001-06-13) column 3, line 22 - line 53	1,6
A	DE 29 30 340 A1 (MESSERSCHMITT BOELKOW BLOHM) 19 February 1981 (1981-02-19) page 6, line 10 - line 16; figure 1	1,6

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2007/010379

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6440317 B1	27-08-2002	NONE	
US 6234224 B1	22-05-2001	NONE	
US 6327898 B1	11-12-2001	NONE	
DE 10028157 A1	18-01-2001	GB 2354331 A	21-03-2001
		US 6164123 A	26-12-2000
DE 10006186 C1	13-06-2001	WO 0159287 A1	16-08-2001
		EP 1169565 A1	09-01-2002
		JP 2003522938 T	29-07-2003
		US 2002157654 A1	31-10-2002
DE 2930340 A1	19-02-1981	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

Electronic Patent Application Fee Transmittal

Application Number:	15290304
Filing Date:	11-Oct-2016
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Filer:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1

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($)
Extension - 2 months with $0 paid	1252	1	600	600
Miscellaneous:				
		Total in USD ($)		**600**

Electronic Acknowledgement Receipt	
EFS ID:	31774630
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz
Filer Authorized By:	
Attorney Docket Number:	67846-006PUS1
Receipt Date:	13-FEB-2018
Filing Date:	11-OCT-2016
Time Stamp:	12:03:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$600
RAM confirmation Number	021318INTEFSW00010015501482
Deposit Account	501482
Authorized User	Andrea DeHart
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Amendment_2_13_17.pdf	36960 66440fe0e3773de2b43ff86f4dba058a5abaeb72	yes	7
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	5	
	Applicant Arguments/Remarks Made in an Amendment		6	7	
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	US_IDS_Form_SB_08a_2_13_18.pdf	613874 0127cab912e1c6619bd214d7aee4be6db22bee05	no	7
Warnings:					
Information:					
3	Foreign Reference	DE20106400U1.pdf	1113817 451b7b7a2ad09faeff3664858c3f4028417139e9	no	26
Warnings:					
Information:					
4	Foreign Reference	DE102006026025A1.pdf	656257 bd99bb69c7d0c833d81748728d24a29d3013017b	no	12
Warnings:					
Information:					
5	Foreign Reference	EP0161042A2.pdf	1470083 404e5ceff016b8cd005d1716d5ba312a792502d7	no	29

Warnings:					
Information:					
6	Foreign Reference	EP0433041A2.pdf	813574 7e45ceac684c78d4f551a1fad7ebbbd7a154e910	no	15
Warnings:					
Information:					
7	Foreign Reference	DE1147397B_English.pdf	6301515 aac70d338ebf042636956b06c17a72282de8fc15	no	15
Warnings:					
Information:					
8	Foreign Reference	DE10309307A1_English.pdf	9297499 1d1ea3969e1cfb32181006323ef4dbf8237b4871	no	25
Warnings:					
Information:					
9	Foreign Reference	DE102006038652A1_English.pdf	386887 ae3a9c86738ad3de259ce9ce498e6dfebec6cd65	no	12
Warnings:					
Information:					
10	Foreign Reference	JP1992062289.pdf	606992 ab5345c87eb1cb50d76632ab268ae3915ccff74d	no	10
Warnings:					
Information:					
11	Foreign Reference	JP2003002400.pdf	988837 1f87b3baae6dd8796a252012317a10e1623d8d130	no	40
Warnings:					
Information:					
12	Foreign Reference	RU28347.pdf	2478203 eb3c5e62ae2104956000dd7ffb73fe8cde4a56dc	no	44
Warnings:					
Information:					

13	Foreign Reference	JP2007182242.pdf	1629528 fdb39e7c5d2c6e3335ba5408051c18551f6adccb	no	12
Warnings:					
Information:					
14	Foreign Reference	JP2008265843.pdf	397338 28db42a34102cff5944b5c9b6d44aa146376fc26	no	12
Warnings:					
Information:					
15	Foreign Reference	RU91135.pdf	201907 dca7a590601a3c2c7666e7b8aeb9460c6bf803e7	no	10
Warnings:					
Information:					
16	Foreign Reference	RU2452668.pdf	549940 44067ebcd3381d06ef9f6ad0575ca640af3cf5f6	no	16
Warnings:					
Information:					
17	Foreign Reference	SU949644.pdf	5939112 5d74c206d27e246db0bee61e5bf963187483d33b	no	8
Warnings:					
Information:					
18	Foreign Reference	WO0177006A1_English.pdf	12967576 1c61568677fa20a63ef7ed4ed0604a54f09ea5aa	no	32
Warnings:					
Information:					
19	Foreign Reference	WO03029721A1.pdf	1386184 fac8f55e80c1b5c9fcb4c906eb83d9ab7eb3c725	no	36
Warnings:					
Information:					

20	Foreign Reference	WO03093118A1.pdf	1665078 46dbaba75974a92e39b650281727fdf1da227590	no	43
Warnings:					
Information:					
21	Foreign Reference	WO2006116572A2.pdf	3338215 878f65f5403205e7c16bb1d47850620a0049d043	no	68
Warnings:					
Information:					
22	Foreign Reference	WO2007087849A1_English.pdf	12901933 efb54f8776fe780bdc7f2e953eeb7df6bc7c6767	no	29
Warnings:					
Information:					
23	Foreign Reference	WO2009068065A1.pdf	480445 efa3ddfd3190b210f3a73723f884c26d98c3b5b2	no	18
Warnings:					
Information:					
24	Non Patent Literature	SAE_2014.pdf	417110 b075b9b87e088960653d2a10fc9e48b42725de66	no	5
Warnings:					
Information:					
25	Non Patent Literature	Nisselki_1986.pdf	10074729 ec22de3427454f77d70028a204c7c02a5f85f394	no	8
Warnings:					
Information:					
26	Fee Worksheet (SB06)	fee-info.pdf	31168 3c9dc15741bc5a703ba64c97449ec2bac56768f7	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	76744761		

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Rickey Dean Shock
Serial No.:	15/290,304
Filed:	October 11, 2016
Examiner:	Arnett, Nicolas Allen
Group Art Unit:	3753
Confirmation No.:	3315
For:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

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

AMENDMENT

This paper is responsive to the Office Action dated September 13, 2017. Please amend the application as follows.

IN THE CLAIMS

Please amend the claims as follows.

1. (CANCELLED)

2. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 1~~claim 18, wherein each of the sensor communication lines is routed in ~~the respective~~ a different one of the hoses.

3. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 1~~claim 18, wherein each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

4. (CANCELLED)

5. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 4~~claim 18, further comprising a plurality of connectors, each of the connectors being mounted on a respective different one of the reels and each of the connectors receiving a respective different one of the sensor communication lines.

6. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 4~~claim 18, wherein each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

7. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 1~~claim 18, wherein each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

8. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 1~~claim 18, wherein each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

9. (CURRENTLY AMENDED) The distribution station as recited in ~~claim 1~~claim 18, further comprising a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

10. (ORIGINAL) The distribution station as recited in claim 9, wherein controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

11. (CANCELLED)

12. (CANCELLED)

13. (CURRENTLY AMENDED) A mobile distribution station comprising a pump, a manifold, a plurality of hoses, a plurality of reels, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves between the manifold and the reels, a plurality of fuel level sensors in the fuel caps, and a controller, the controller configured to operate the pump and valves responsive to ~~a low fuel threshold~~the fuel level sensors ~~to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses~~, wherein the fuel level sensors are hard-wired through the ~~hoses~~ reels to the controller.

14. (ORIGINAL) The mobile distribution station as recited in claim 13, wherein each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

15. (CANCELLED)

16. (CURRENTLY AMENDED) The mobile distribution station as recited in ~~claim 15~~claim 13, wherein the fuel level sensors are hard-wired through spindles of the reels.

17. (CURRENTLY AMENDED) The mobile distribution station as recited in claim 16, wherein each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors~~each of the fuel level sensors is detachably connectable with the controller~~.

18. (NEW) A distribution station comprising:

a mobile trailer;

a pump on the trailer;

a manifold on the trailer and in fluid communication with the pump;

a plurality of hoses;

a plurality of reels, each said hose in fluid communication with the manifold through a different one of the reels,

a plurality of valves, each said valve situated between the manifold and a respective different one of the reels;

a plurality of fluid level sensors, each said fluid level sensor connectable to an end of a different one of the hoses; and

a plurality of sensor communication lines, each said sensor communication line connected with a respective different one of the fluid level sensors, and each said sensor communication line being routed through a respective different one of the reels.

19. (NEW) The distribution station as recited in claim 18, further comprising a plurality of connectors, each of the connectors being mounted on a respective different one of the reels, and each of the connectors receiving a respective different one of the sensor communication lines.

20. (NEW) The distribution station as recited in claim 19, wherein each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

21. (NEW) The distribution station as recited in claim 20, wherein each of the sensor communication lines includes a wire bundle.

22. (NEW) The distribution station as recited in claim 20, further comprising a controller configured to operate the pump and valves responsive to the fuel level sensors.

23. (NEW) The distribution station as recited in claim 22, wherein at least a portion of the sensor communication lines converge to a communication junction block prior to the controller.

24. (NEW) The distribution station as recited in claim 18, wherein each said sensor communication line is routed in a different one of the hoses, extends from an end of the respective hose, and has a connector that is detachably connectable with a respective one of the fluid level sensors.

25. (NEW) The distribution station as recited in claim 24, wherein the fluid level sensors are guided wave radar sensors.

REMARKS

Claims 2, 3, 5-9, 13, 16, and 17 are amended. Claims 1, 4, 11, 12, and 15 are cancelled. Claims 18-25 are new. Accordingly, claims 2, 3, 5-10, 13, 14, and 16-25 are pending.

Double Patenting

If all issues are deemed resolved, Applicant will promptly review the then-pending claims to ensure that a terminal disclaimer is warranted and, if so, will file a Terminal Disclaimer. Accordingly, if the Examiner agrees this case is otherwise in condition for allowance, the Examiner is urged to telephone Applicant's representative.

Obviousness Rejection

Independent claim 18 recites, "each said sensor communication line being routed through a respective different one of the reels." Independent claim 13 recites, "the fuel level sensors are hard-wired through the reels to the controller."

It is respectfully submitted that neither Van Vliet nor Griffiths teach or suggest the above features. Van Vliet discloses that "The control station or controller 56 … is responsive to signals supplied from each fuel level sensor 54 through respective communication channels, wired or wireless…" (see 4:36-39). However, Van Vliet (and also Griffiths) is silent as to a sensor communication line being routed or hard-wired through a reel. And even if a communication line were routed in a hose in Van Vliet as modified by the examiner, the references completely lack any details about routing a sensor communication line through a reel. Indeed, the reels in Van Vliet appear to be optional and merely for storage, not routing (see 6:55-56, "Hoses from the outlets 22 may be stored on reels 30 mounted on two or more shelves within the trailer 14" (emphasis provided)). Accordingly, Applicant submits that the rejections should be withdrawn.

No fees are due; however, if fees are now or ever due the Commissioner is authorized to charge Deposit Account No. **50-1482** in the name of Carlson, Gaskey & Olds, P.C. for any additional fees or credit the account for any overpayment.

Respectfully submitted,

CARLSON, GASKEY & OLDS, P.C.

/Matthew L. Koziarz/

Matthew L. Koziarz
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400 W. Maple, Suite 350
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Telephone: (248) 988-8360

Dated: February 13, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1	3315

26096 7590 09/13/2017

CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

EXAMINER	
ARNETT, NICOLAS ALLEN	

ART UNIT	PAPER NUMBER
3753	

NOTIFICATION DATE	DELIVERY MODE
09/13/2017	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):

ptodocket@cgolaw.com
cgolaw@yahoo.com

Office Action Summary	Application No. 15/290,304	Applicant(s) SHOCK, RICKY DEAN	
	Examiner NICOLAS A. ARNETT	Art Unit 3753	AIA (First Inventor to File) Status Yes

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

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10/11/16*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-17* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-17* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *4/5/17* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *no date required*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Claim Interpretation

2. The following is a quotation of 35 U.S.C. 112(f):

> (f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

3. Use of the word “means” (or “step for”) in a claim with functional language creates a rebuttable presumption that the claim element is to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is invoked is rebutted when the function is recited with sufficient structure, material, or acts within the claim itself to entirely perform the recited function.

Absence of the word “means” (or “step for”) in a claim creates a rebuttable presumption that the claim element **is not** to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f)

(pre-AIA 35 U.S.C. 112, sixth paragraph) is not invoked is rebutted when the claim element recites function but fails to recite sufficiently definite structure, material or acts to perform that function.

Claim elements in this application that use the word "means" (or "step for") are presumed to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action. Similarly, claim elements that do not use the word "means" (or "step for") are presumed not to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action.

Double Patenting

4. A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process... may obtain a patent therefor..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the claims that are directed to the same invention so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

5. Claims 1-17 are provisionally rejected under 35 U.S.C. 101 as claiming the same invention as that of claims 1-17 of copending Application No. 15/673730. The claims of

both applications are identical. This is a provisional statutory double patenting rejection since the claims directed to the same invention have not in fact been patented.

Claim Rejections - 35 USC § 103

6. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

7. 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, 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.

8. Claims 1-17 are rejected under 35 U.S.C. 103 as being unpatentable over US Patent Application Publication 2011/0197988 to Van Vliet et al. (Van Vliet) in view of UK Patent Application Publication 2485832 to Griffiths (Griffiths). The Griffiths reference was cited by applicant on an IDS and a copy thereof provided. Therefore, a copy of the reference has not been included with this office action.

Regarding claim 1, Van Vliet discloses a distribution station (14) comprising: a mobile trailer (see [0014]); a pump (32, 34) on the mobile trailer; a manifold (36, 38) on the mobile trailer and fluidly connected with the pump (Fig. 1); a plurality of hoses (hoses 24) connected with the manifold; a plurality of valves (58) on the mobile trailer,

each of the valves situated between the manifold and a respective different one of the hoses (Fig. 1); a plurality of fluid level sensors (54), each of the fluid level sensors being associated a respective different one of the hoses ([0017]-[0018]); and a plurality of sensor communication lines (the wires coupling the sensor to the controller in the wired embodiment; see [0018]), each of the sensor communication lines being connected or connectable with a respective different one of the fluid level sensors. Van Vliet does not disclose each of the sensor communication lines being routed with a respective different one of the hoses. Griffiths teaches a fluid supply system having a hose (2) and a communication line (10) routed with the hose such that a single coupling provides both fluid and data communication. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to have routed the wires of Van Vliet with the hoses as taught by Griffiths such that a single coupling provides both fluid and data communication.

Regarding claim 2, Griffiths further teaches each of the sensor communication lines is routed in the respective different one of the hoses (Fig. 1).

Regarding claim 3, Griffiths further teaches the hose includes a tube and a sleeve that circumscribes the tube, and the sensor communication line is routed in the hose between the tube and the sleeve (in the embodiment where the lines are routed in the walls of the hose; see page 24).

Regarding claim 4, Van Vliet further discloses a plurality of reels (30) on the mobile trailer, each of the hoses being wound on a respective one of the reels (Fig. 1), and each of the sensor communication lines being routed through a respective different

one of the reels (as modified about such that the lines are routed with the hoses, it is inherent that the lines are then routed through the reels as well; the hoses are routed through the reels and the communication lines follow the same route).

Regarding claim 5, Van Vliet discloses a plurality of connectors (the connectors that couple outlets 22 to hoses 24), each of the connectors being mounted on a respective different one of the reels and each of the connectors receiving a respective different one of the sensor communication lines.

Regarding claim 6, Van Vliet further discloses each of the reels includes a respective spindle (inherent to a reel). Van Vliet as modified by Griffiths does not disclose each of the sensor communication lines is routed through a respective different one of the spindles. However, as set forth above, it is inherent that the communication lines are routed through the reels as the hoses are routed through the reels. Further, as a reel requires only a small number of parts (e.g. a spindle, a spool and a base), routing the lines through the spindles would be obvious to try as it requires only choosing from a finite number of identifiable and predictable solutions with a reasonable expectation of success.

Regarding claim 7, Van Vliet discloses each of the sensor communication lines includes a respective connector (the connector by which the wire connects to the sensor) that is detachably connectable with a respective different one of the fluid level sensors (the wires are able to be detached from the sensors).

Regarding claim 8, Van Vliet discloses each of the fluid level sensors is integrated with a respective fuel cap (26) that includes a port that is detachably connectable with a respective different one of the hoses (see Figs. 2-3).

Regarding claim 9, Van Vliet further discloses a controller (56) on the mobile trailer, and each of the sensor communication lines is connected with the controller ([0018]).

Regarding claim 10, Van Vliet discloses the controller is operable to open and close the plurality of valves responsive to a fuel level threshold (in the embodiment where valves 58 are automatically operable valves controlled by the controller in response to the fuel level; see [0020]-[0023]).

Regarding claim 11, Van Vliet discloses a plurality of reels (30) on the mobile trailer, each of the hoses being wound on a respective one of the reels, and each of the sensor communication lines being routed through a respective different one of the reels (as modified about such that the lines are routed with the hoses, it is inherent that the lines are then routed through the reels as well; the hoses are routed through the reels and the communication lines follow the same route). Van Vliet does not disclose each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve. Griffiths teaches the hose includes a tube and a sleeve that circumscribes the tube, and the sensor communication line is routed in the hose between the tube and the sleeve (in the embodiment where the lines are routed in the walls of the hose; see page 24). It would have been obvious to one of ordinary skill

in the art before the effective filing date of the claimed invention to have used a hose having a tube and a sleeve with the wire routed therein as taught by Griffiths in the device of Van Vliet such that the communication lines are protected from both the fluid in the hose and the exterior environment.

Regarding claim 12, Van Vliet discloses each of the reels includes a respective spindle (inherent). Van Vliet as modified by Griffiths does not disclose each of the sensor communication lines is routed through a respective different one of the spindles. However, as set forth above, it is inherent that the communication lines are routed through the reels as the hoses are routed through the reels. Further, as a reel requires only a small number of parts (e.g. a spindle, a spool and a base), routing the lines through the spindles would be obvious to try as it requires only choosing from a finite number of identifiable and predictable solutions with a reasonable expectation of success.

Regarding claim 13, Van Vliet discloses a mobile distribution station (14) comprising a pump (32, 34), a manifold (36, 38), a plurality of hoses (24), a plurality of detachably connectable fuel caps (26) connected or connectable with the hoses, a plurality of valves (58), a plurality of fuel level sensors (54), and a controller (56), the controller configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses (Fig. 1; [0020]-[0023]) and wires connecting the sensors to the controller (in the wired embodiment; see [0018]). Van Vliet does not disclose the wires are routed through the hoses. Griffiths teaches a fluid supply system having a hose (2) and a

communication line (10) routed with the hose such that a single coupling provides both fluid and data communication. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to have routed the wires of Van Vliet with the hoses as taught by Griffiths such that a single coupling provides both fluid and data communication.

Regarding claim 14, Griffiths further teaches the hose includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hose between the tube and the sleeve (in the embodiment where the lines are routed in the walls of the hose; see page 24).

Regarding claim 15, Griffiths discloses a plurality of reels (30) on which the hoses are wound, and the fuel level sensors are hard-wired through the reels (as modified about such that the lines are routed with the hoses, it is inherent that the lines are then routed through the reels as well; the hoses are routed through the reels and the communication lines follow the same route).

Regarding claim 16, Van Vliet further discloses each of the reels includes a respective spindle (inherent to a reel). Van Vliet as modified by Griffiths does not disclose each of the sensor communication lines is routed through a respective different one of the spindles. However, as set forth above, it is inherent that the communication lines are routed through the reels as the hoses are routed through the reels. Further, as a reel requires only a small number of parts (e.g. a spindle, a spool and a base), routing the lines through the spindles would be obvious to try as it requires only choosing from

a finite number of identifiable and predictable solutions with a reasonable expectation of success.

Regarding claim 17, Van Vliet further discloses each of the fuel level sensors is detachably connectable with the controller (the sensors can be detached from the controller).

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The cited documents disclose additional fluid distribution devices which are related to applicant's disclosure and claimed invention.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NICOLAS A. ARNETT whose telephone number is (571)270-5062. The examiner can normally be reached on Monday - Thursday 7:00 AM to 4:00 PM EST; Friday 12:30 PM to 4:30 PM EST.

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, Mary E. McManmon can be reached on (571) 272-6007. 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 http://pair-direct.uspto.gov. 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.

/NICOLAS A ARNETT/
Primary Examiner, Art Unit 3753
September 8, 2017

Notice of References Cited	Application/Control No. 15/290,304	Applicant(s)/Patent Under Reexamination SHOCK, RICKY DEAN	
	Examiner NICOLAS A. ARNETT	Art Unit 3753	Page 1 of 1

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*	B	US-6,745,801 B1	06-2004	Cohen; Joseph Perry	C01B3/00	141/18
*	C	US-2004/0163731 A1	08-2004	Eichelberger, Donald Paul	B60S5/02	141/284
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	Q					
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NON-PATENT DOCUMENTS

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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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	Art Unit
	NICOLAS A ARNETT	3753

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

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

CLAIM		DATE								
Final	Original	09/08/2017								
	1	✓								
	2	✓								
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	15	✓								
	16	✓								
	17	✓								

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Shock
Art Unit	
Examiner Name	
Attorney Docket Number	67846-006PUS1

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2516150		1950-07-25	Samiran	
	2	2769572		1956-11-06	Harman et al.	
	3	2777461		1957-01-15	Wildhaber	
	4	3028010		1962-04-03	Headrick	
	5	3136295		1964-06-09	Gramo	
	6	3547141		1970-12-15	Alexander	
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	First Named Inventor	Shock
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	Application Number	
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	Art Unit	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
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	First Named Inventor	Shock
	Art Unit	
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	Attorney Docket Number	67846-006PUS1

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	4	20160076533		2016-03-17	Moffitt, Jr.	

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	Attorney Docket Number	67846-006PUS1

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Oilfield Business: Technologies. Frac Shack Inc. introduces world's first Bi-Fuel Distribution Unit for hydraulic fracturing industry. Texas Oil & Gas: The National Magazine for Oil & Gas in Texas. Vol. 4, Issue 2. 2015. p. 27.	
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	Examiner Name	
	Attorney Docket Number	67846-006PUS1

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EXAMINER SIGNATURE

Examiner Signature	/NICOLAS A ARNETT/	Date Considered	09/08/2017

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

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	
	Filing Date	
	First Named Inventor	Shock
	Art Unit	
	Examiner Name	
	Attorney Docket Number	67846-006PUS1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew L. Koziarz/	Date (YYYY-MM-DD)	2016-10-11
Name/Print	Matthew L. Koziarz	Registration Number	53154

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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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CONFIRMATION NO. 3315

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/290,304	10/11/2016 RULE	141	3753	67846-006PUS1

APPLICANTS
Fuel Automation Station, LLC, Birmingham, MI;

INVENTORS
Ricky Dean Shock, Victoria, TX;

**** CONTINUING DATA ***************************

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
10/20/2016

Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☑ No		TX	18	17	2
Verified and Acknowledged	/NICOLAS ALLEN ARNETT/ Examiner's Signature	Initials				

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400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009
UNITED STATES

TITLE

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
1600	No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15290304	SHOCK, RICKY DEAN
	Examiner	Art Unit
	NICOLAS A ARNETT	3753

CPC- SEARCHED		
Symbol	Date	Examiner
B67D 7/465, 40, 845, 04	9/8/2017	NAA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
141	94-95, 231	9/8/2017	NAA

* 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
Text search of the classifications indicated above	9/8/2017	NAA
Searched East: (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT)	9/8/2017	NAA
Inventor search Conducted, limited with text: (USPAT, USPGPUB)	9/8/2017	NAA
Applicant search Conducted, limited with text: (USPAT, USPGPUB)	9/8/2017	NAA
Google text search conducted	9/8/2017	NAA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/NICOLAS A ARNETT/ Primary Examiner.Art Unit 3753

EAST Search History

EAST Search History (Prior Art)

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Electronic Acknowledgement Receipt	
EFS ID:	27177263
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	11-OCT-2016
Filing Date:	
Time Stamp:	14:13:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$5740
RAM confirmation Number	101216INTEFSW00000606501482
Deposit Account	501482
Authorized User	Andrea DeHart
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)	

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Filer:	Matthew L. Koziarz/Andrea DeHart
Attorney Docket Number:	67846-006PUS1

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	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140

Adjustment Date: 04/20/2017 ENTRETA1 00000066 5814OC 15200304
10:12/2016 INTERSW 4803.00 CR
DA FC:1617

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CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM MI 48009

MAILED
APR 12 2017
OFFICE OF PETITIONS

Doc Code: TRACK1.DENY

Decision Dismissing Request for Prioritized Examination (Track I)	Application No.: 15/290,304

1. THE REQUEST FILED October 11, 2016 IS **DISMISSED** BECAUSE:

A. ☐ The application is not a utility application under 35 U.S.C. 111(a) filed by EFS-Web or a plant application under 35 U.S.C. 111(a) filed by paper:
   i. ☐ The application is a utility application that was not filed by EFS-Web.
   ii. ☐ The application is neither a utility application nor a plant application, but rather is a _____, which is excluded from the Track I program.

B. ☐ The request was not filed with the application or on the same date the application was filed.

C. ☐ One or more of the following fees were not filed with the application or on the same date the application was filed:
   i. ☐ Basic filing fee, as set forth in 37 CFR 1.16(a), or for a plant application, 37 CFR 1.16(c).
   ii. ☐ Search fee, as set forth in 37 CFR 1.16(k), or for a plant application, 37 CFR 1.16(m).
   iii. ☐ Examination fee, as set forth in 37 CFR 1.16(o), or for a plant application, 37 CFR 1.16(q).
   iv. ☐ Publication fee, as set forth in 37 CFR 1.18(d).
   v. ☐ Track I processing fee, as set forth in 37 CFR 1.17(i).
   vi. ☐ Track I prioritized examination fee, as set forth in 37 CFR 1.17(c).

D. ☐ The executed inventor's oath or declaration, **or** an application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) was not filed with the application or on the same date the application was filed.

E. ☐ The application contains or has been amended to contain:
   i. ☐ More than four independent claims.
   ii. ☐ More than thirty total claims.
   iii. ☐ One or more multiple dependent claims.

F. ☐ The Track I program has exceeded its limit of 10,000 requests for the current fiscal year.

☒ Other: Applicants obtained an extension of time on April 5, 2017, which disqualifies the application from participation in the Prioritized Examination, Track 1, Program.

2. CONCLUSION

☐ **ALL of the above defect(s) consist only of one or more of items E (i-iii). Applicant is hereby accorded a non-extendable ONE MONTH time period from the mailing date of this Decision to (1) correct the subject defect(s) and (2) file a petition under 37 CFR 1.181 requesting reconsideration of prioritized examination. If no such petition is timely filed, the application will not undergo prioritized examination.**

-OR-

☒ **The application will not undergo prioritized examination, because the request was not accompanied by all of the required items or an extension of time was obtained before the Request was decided.**

Telephone inquiries with regard to this decision should be directed to Brian W. Brown at 571-272-5338.

/Brian W. Brown/
[*Signature*]

Petitions Examiner, Office of Petitions
(Title)

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/290,304

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/290,304	10/11/2016	1711	1600	67846-006PUS1	17	2

CONFIRMATION NO. 3315

UPDATED FILING RECEIPT

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

OC000000090448400

Date Mailed: 04/07/2017

Receipt is acknowledged of this non-provisional 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 APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Ricky Dean Shock, Victoria, TX;

Applicant(s)

Fuel Automation Station, LLC, Birmingham, MI;

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/20/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/290,304**

Projected Publication Date: 04/12/2018

Non-Publication Request: No

Early Publication Request: No

Title

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

Preliminary Class

134

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Ricky Dean Shock
Serial No.:	15/290,304
Filed:	October 11, 2016
Group Art Unit:	1711
Examiner:	Unknown
Confirmation No.:	3315
Title:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

This paper is responsive to the Notice dated February 28, 2107. The Notice requires a substitute specification with a proper description of the drawings. This requirement appears to stem from Figure 9 and Figure 10, which are too large to properly fit on a page. Figure 9 is thus presented in sub-sections 9A, 9B, 9C, 9D, 9E, and 9F and Figure 10 is presented in sub-sections 10A, 10B, 10C, 10D, 10E, 10F, 10G, and 10H. The sub-sections 9A, 9B, 9C, 9D, 9E, and 9F as well as sub-sections 10A, 10B, 10C, 10D, 10E, 10F, 10G, and 10H were not described. The specification is amended herewith to insert such description. No new matter has been added, and Applicant respectfully requests examination on the merits.

Respectfully submitted,

/Matthew L. Koziarz /
Matthew L. Koziarz, Reg. No. 53,154
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(248) 988-8360

Dated: April 5, 2017

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 ~~illustrates~~ is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9A, Figure 9B, Figure 9C, Figure 9D, Figure 9E, and Figure 9F. The sub-

sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 ~~illustrates~~ is another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 10 is divided into sub-sections, indicated as Figure 10A, Figure 10B, Figure 10C, Figure 10D, Figure 10E, Figure 10F, Figure 10G, and Figure 10H. The sub-sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator

system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52 includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are

to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed.

For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and

electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture. In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A

longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for

purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control

purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may

additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely

intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to

change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds, sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a

portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

FAS 2004 - Page 632

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9A, Figure 9B, Figure 9C, Figure 9D, Figure 9E, and Figure 9F. The sub-sections show the

details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 is another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 10 is divided into sub-sections, indicated as Figure 10A, Figure 10B, Figure 10C, Figure 10D, Figure 10E, Figure 10F, Figure 10G, and Figure 10H. The sub-sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator

system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52 includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are

to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed.

For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and

electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture. In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A

longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for

purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control

purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may

additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely

intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to

change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds, sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a

portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

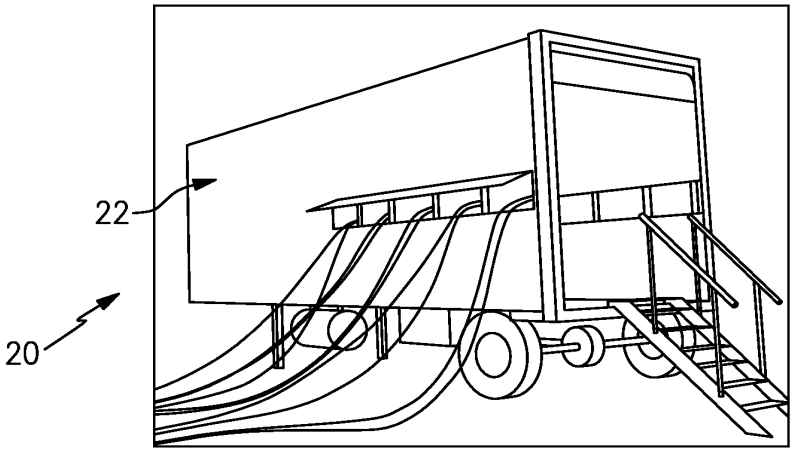

22
20

FIG.1

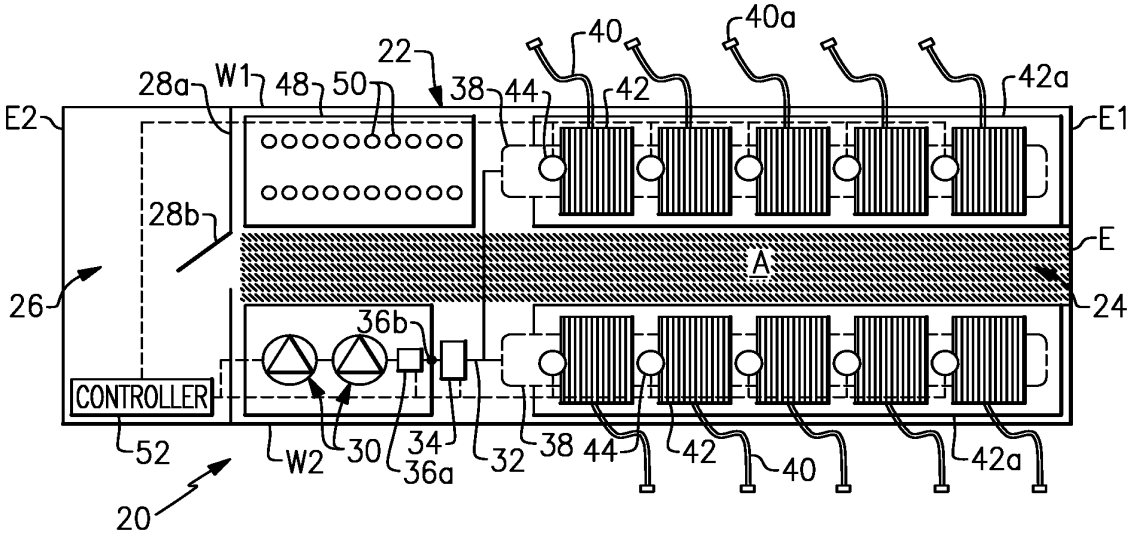

22
40
40a
28a
W1
48
50
38
44
42
42a
E2
E1
28b
E
A
26
24
36b
CONTROLLER
52
W2
30
34
36a
32
38
44
42
40
42a
20

FIG.2

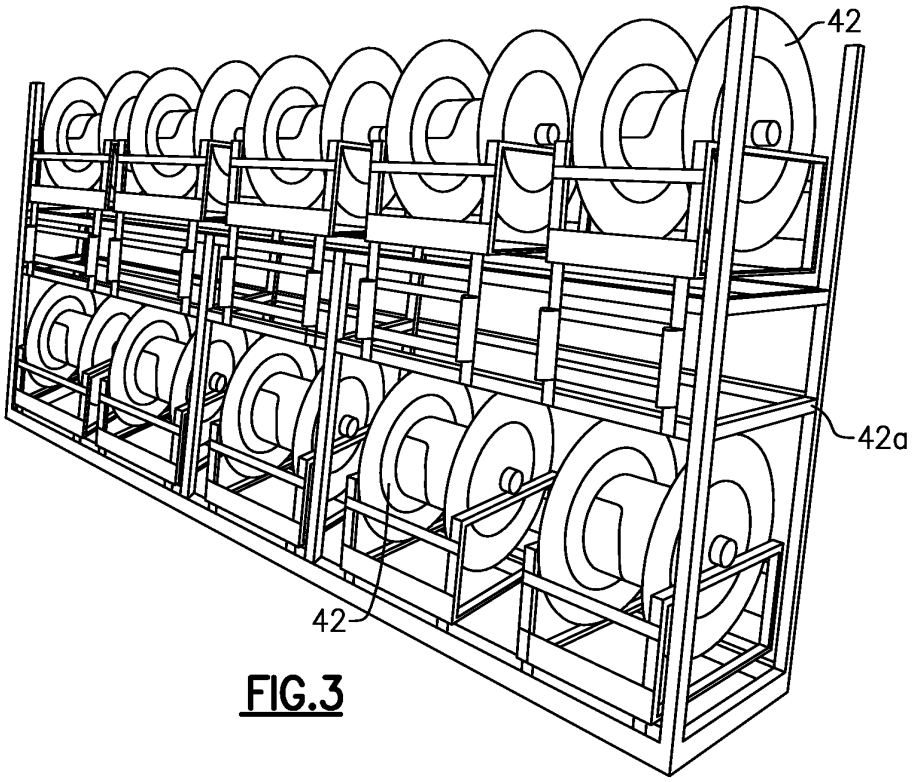


FIG.3

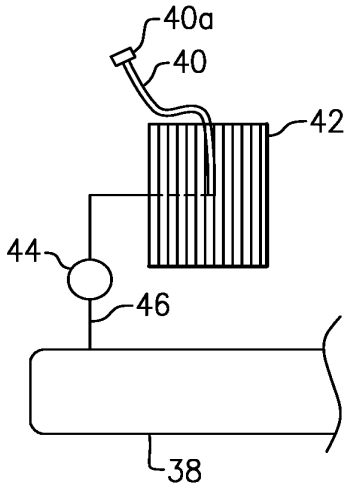


FIG.4

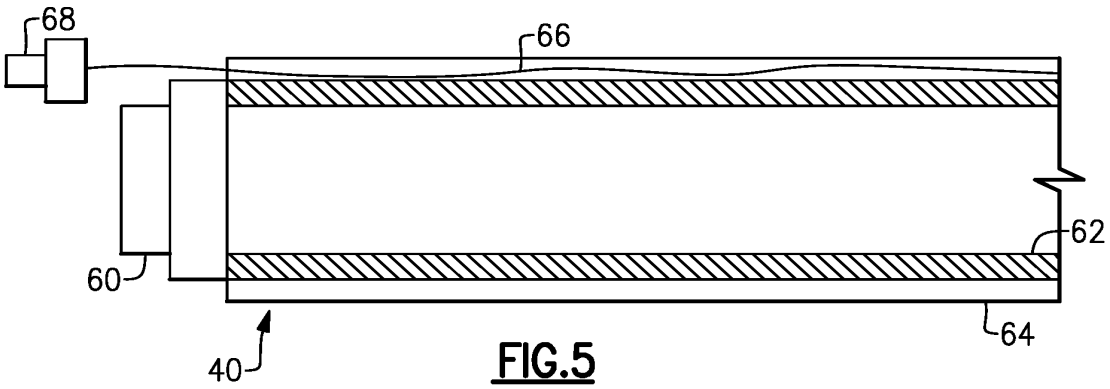


FIG.5

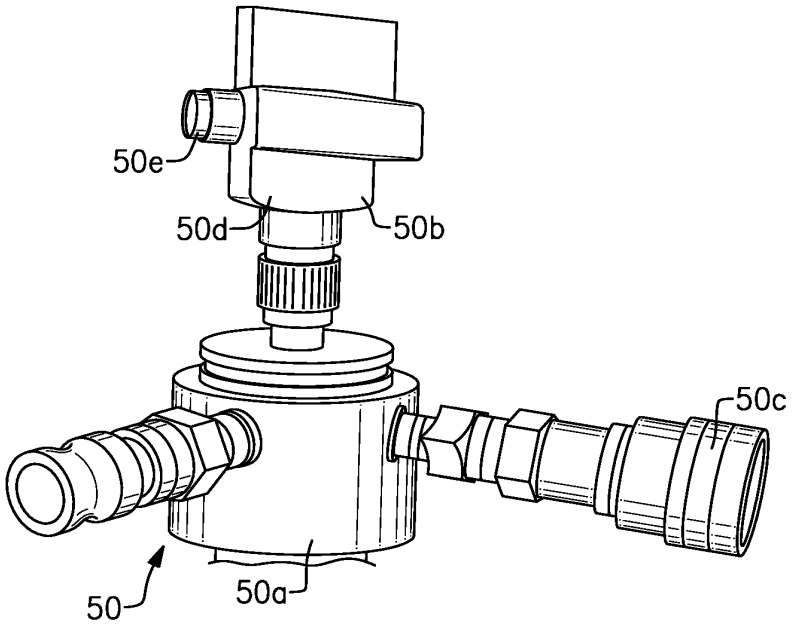


FIG.6

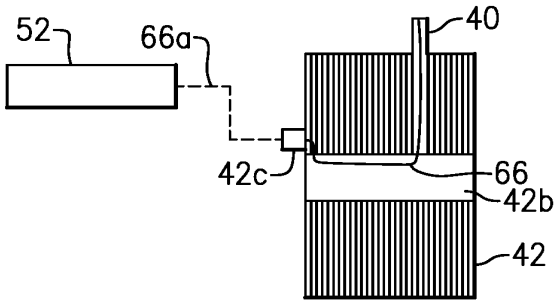


FIG.7

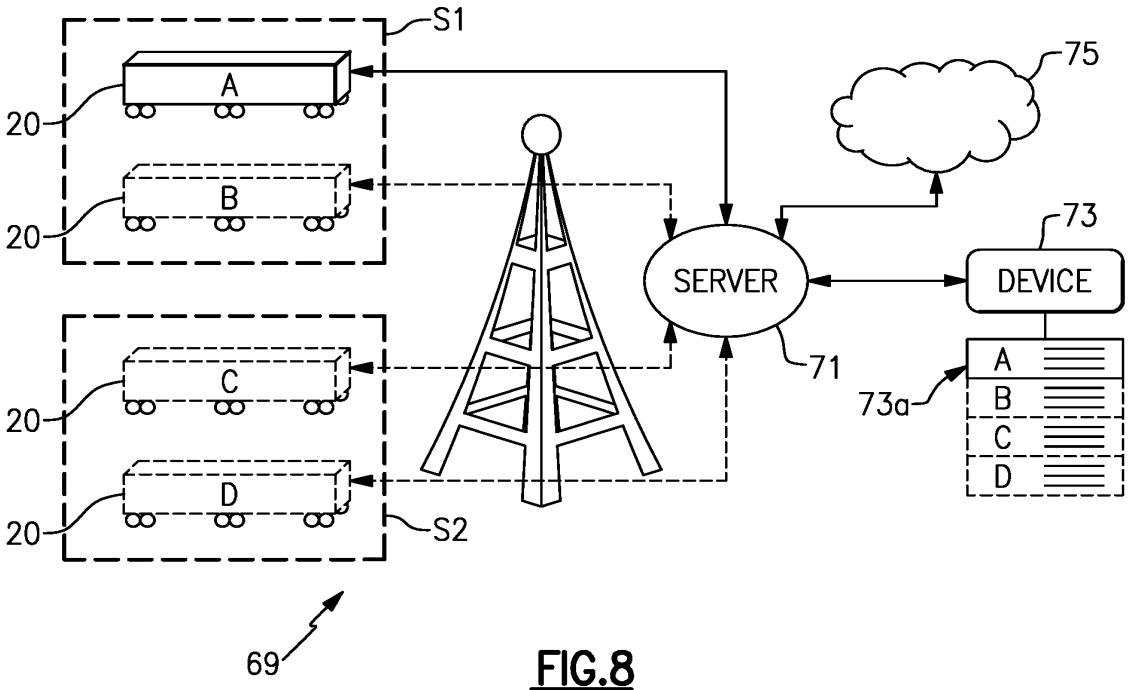


FIG.8

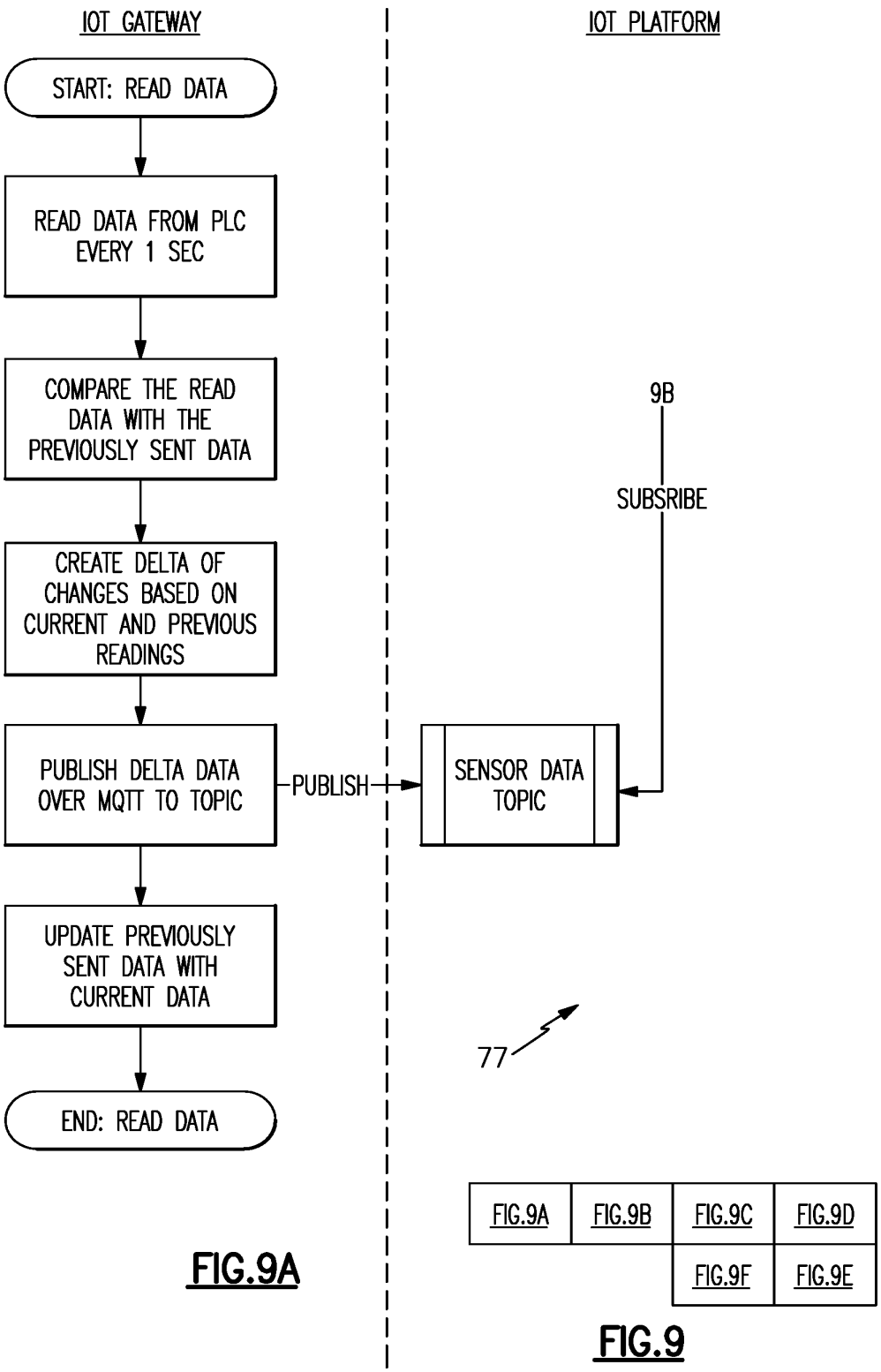


FIG.9A

FIG.9A	FIG.9B	FIG.9C	FIG.9D
		FIG.9F	FIG.9E

FIG.9

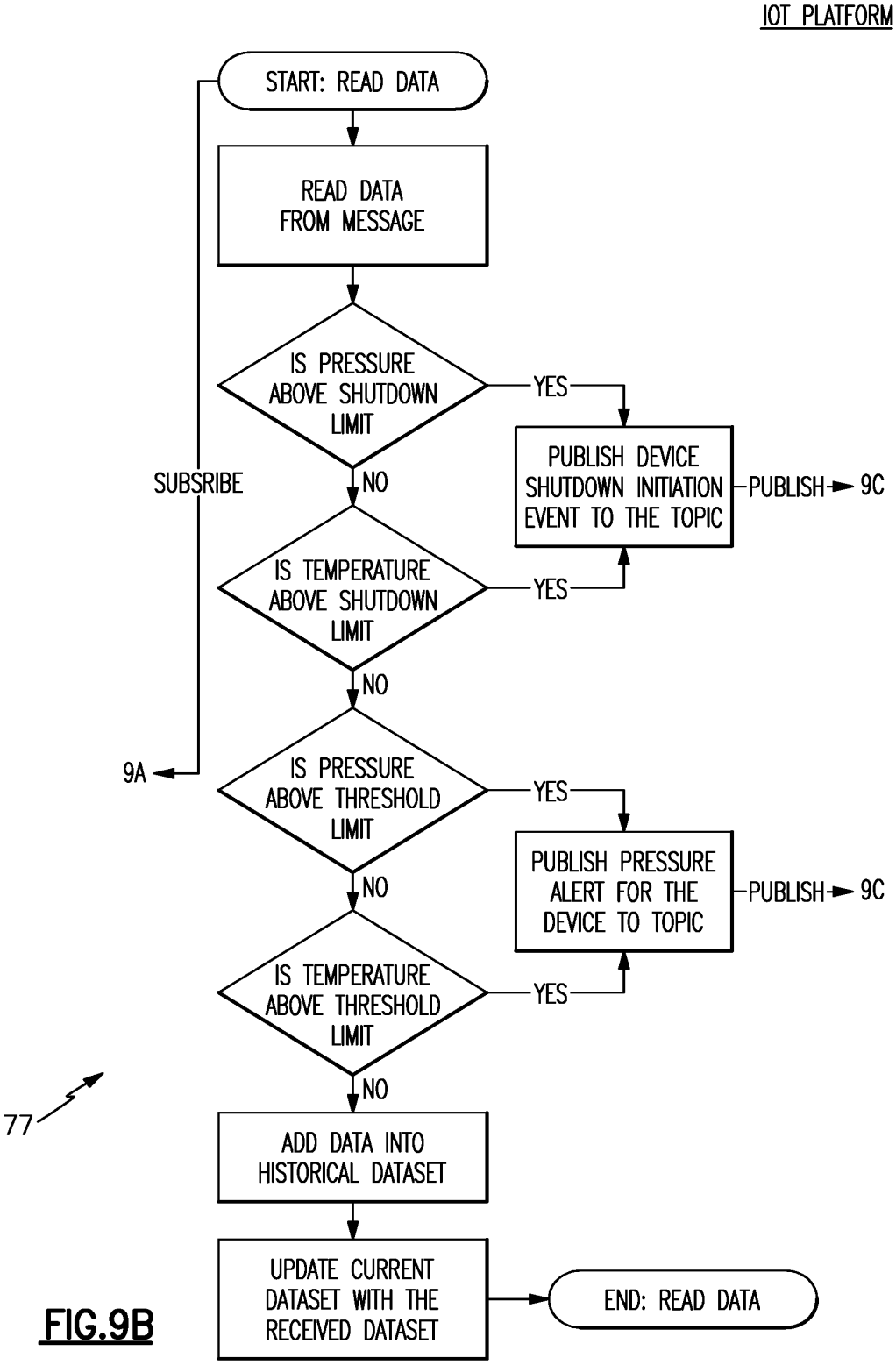

IOT PLATFORM
START: READ DATA
READ DATA FROM MESSAGE
IS PRESSURE ABOVE SHUTDOWN LIMIT
YES
PUBLISH DEVICE SHUTDOWN INITIATION EVENT TO THE TOPIC
PUBLISH
9C
SUBSRIBE
NO
IS TEMPERATURE ABOVE SHUTDOWN LIMIT
YES
NO
9A
IS PRESSURE ABOVE THRESHOLD LIMIT
YES
PUBLISH PRESSURE ALERT FOR THE DEVICE TO TOPIC
PUBLISH
9C
NO
IS TEMPERATURE ABOVE THRESHOLD LIMIT
YES
NO
77
ADD DATA INTO HISTORICAL DATASET
UPDATE CURRENT DATASET WITH THE RECEIVED DATASET
END: READ DATA

FIG.9B

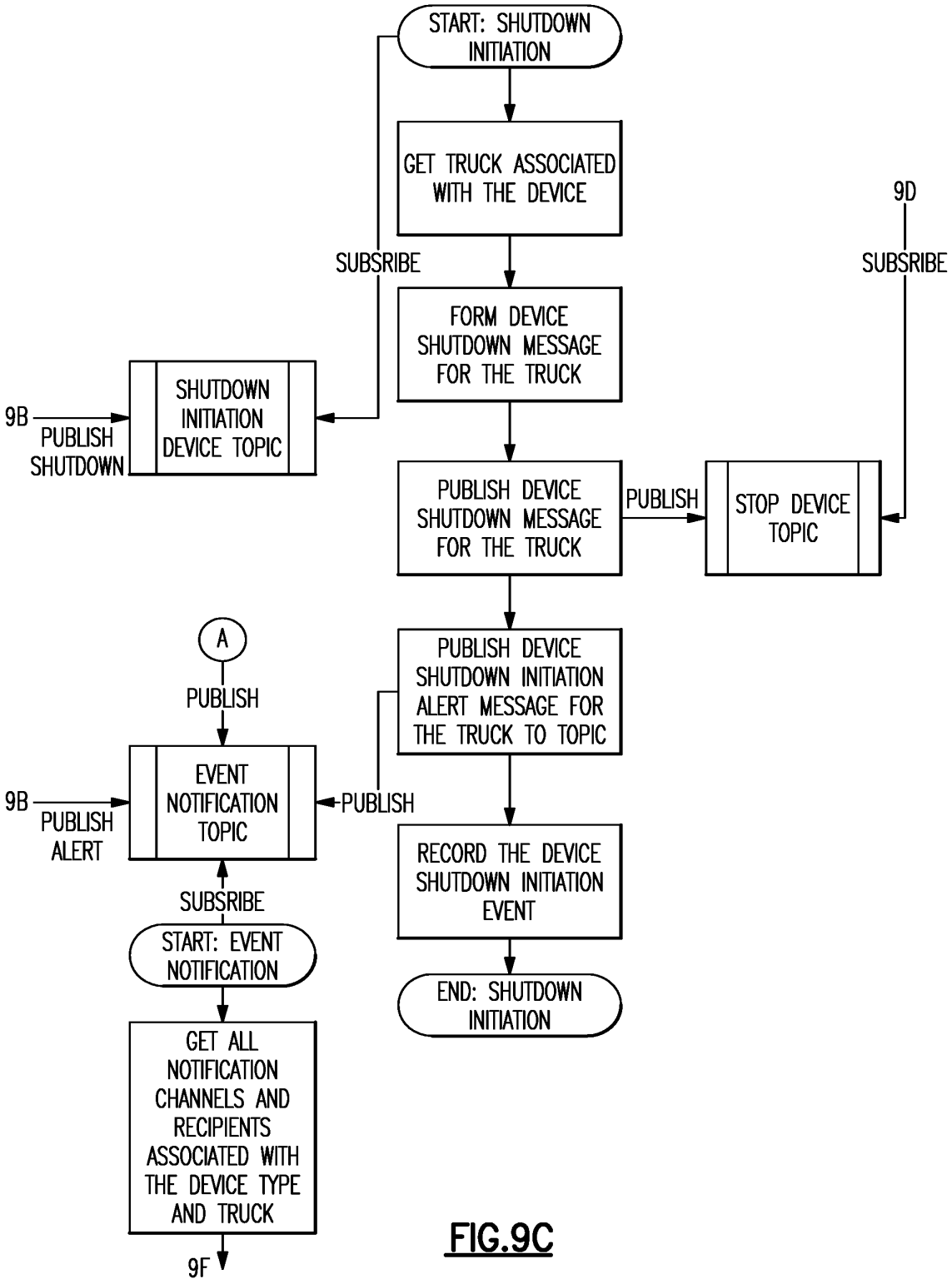

START: SHUTDOWN INITIATION
GET TRUCK ASSOCIATED WITH THE DEVICE
SUBSRIBE
FORM DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
9B
PUBLISH SHUTDOWN
SHUTDOWN INITIATION DEVICE TOPIC
PUBLISH DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
PUBLISH
STOP DEVICE TOPIC
9D
SUBSRIBE
A
PUBLISH
PUBLISH DEVICE SHUTDOWN INITIATION ALERT MESSAGE FOR THE TRUCK TO TOPIC
9B
PUBLISH ALERT
EVENT NOTIFICATION TOPIC
PUBLISH
SUBSRIBE
START: EVENT NOTIFICATION
RECORD THE DEVICE SHUTDOWN INITIATION EVENT
END: SHUTDOWN INITIATION
GET ALL NOTIFICATION CHANNELS AND RECIPIENTS ASSOCIATED WITH THE DEVICE TYPE AND TRUCK
9F

FIG.9C

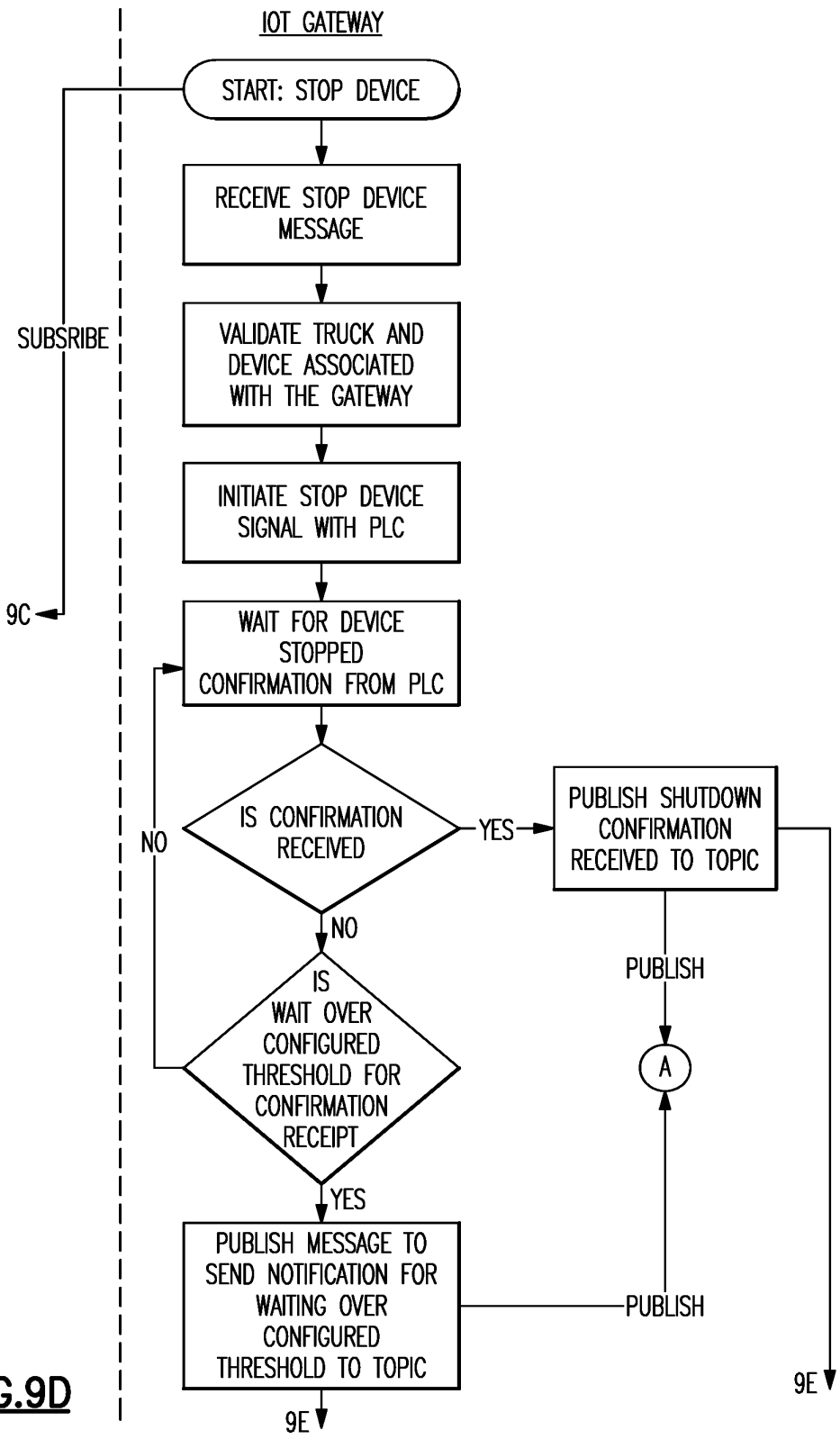

IOT GATEWAY
START: STOP DEVICE
RECEIVE STOP DEVICE MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE STOP DEVICE SIGNAL WITH PLC
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
NO
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
SUBSRIBE
9C
9E
9E

FIG.9D

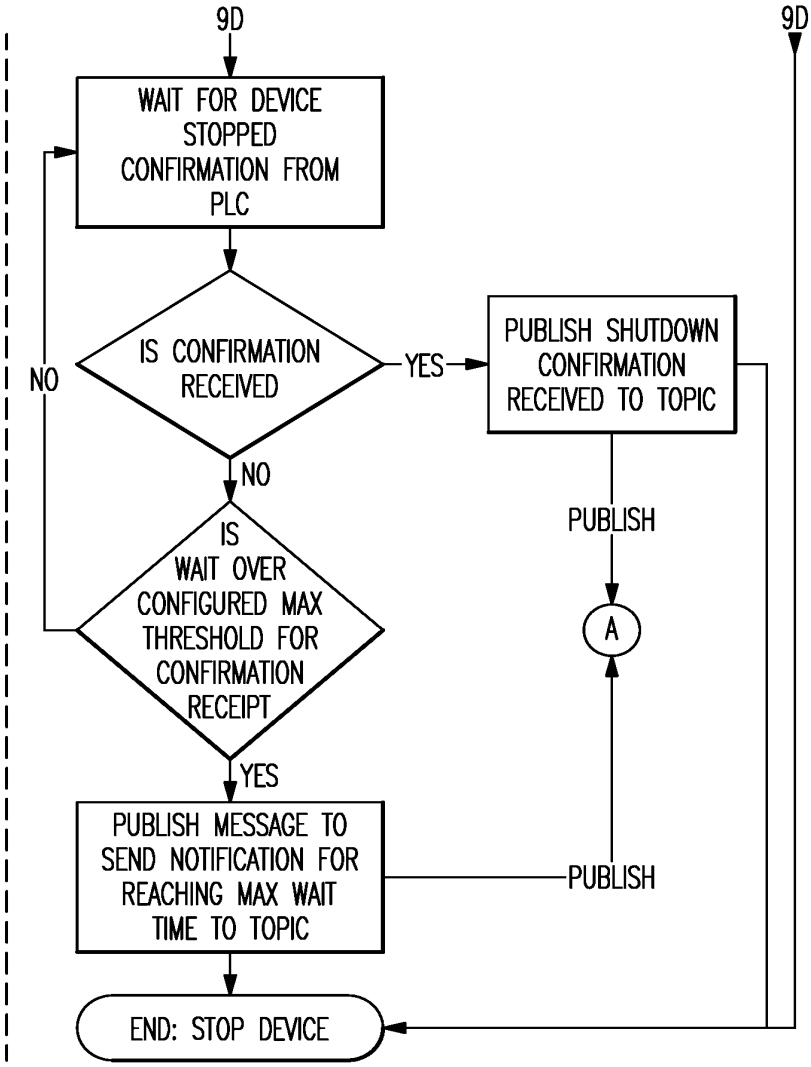

9D
9D
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
NO
PUBLISH
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
A
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: STOP DEVICE

FIG.9E

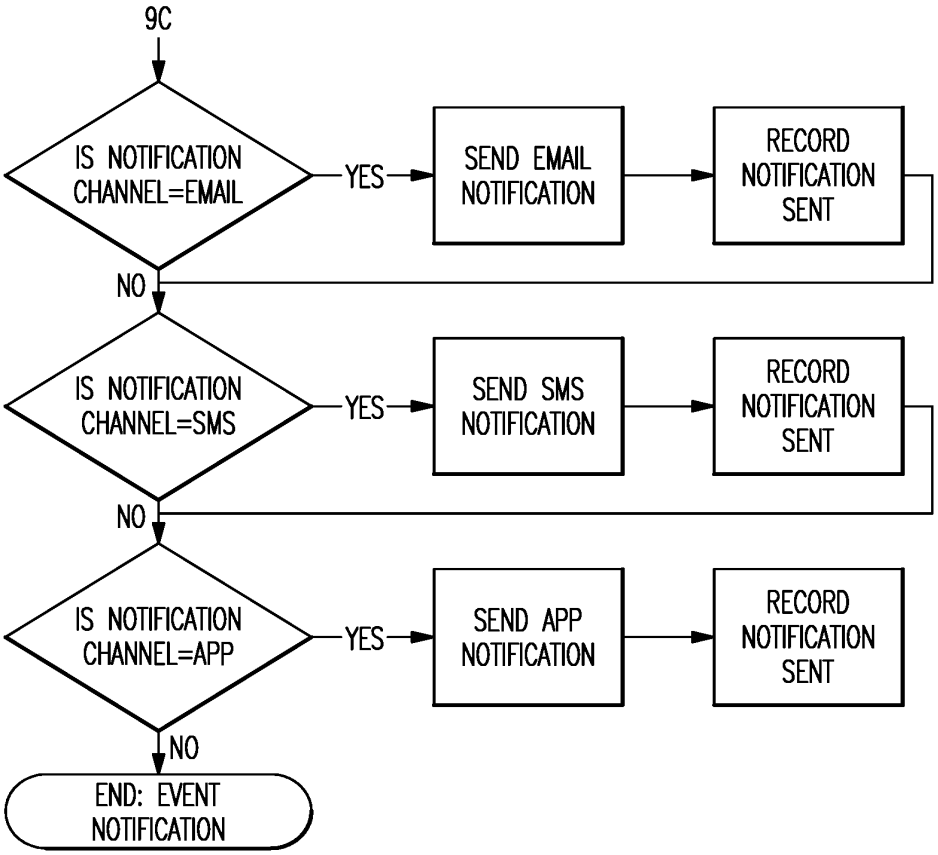

9C
IS NOTIFICATION CHANNEL=EMAIL
YES
SEND EMAIL NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=SMS
YES
SEND SMS NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=APP
YES
SEND APP NOTIFICATION
RECORD NOTIFICATION SENT
NO
END: EVENT NOTIFICATION

FIG.9F

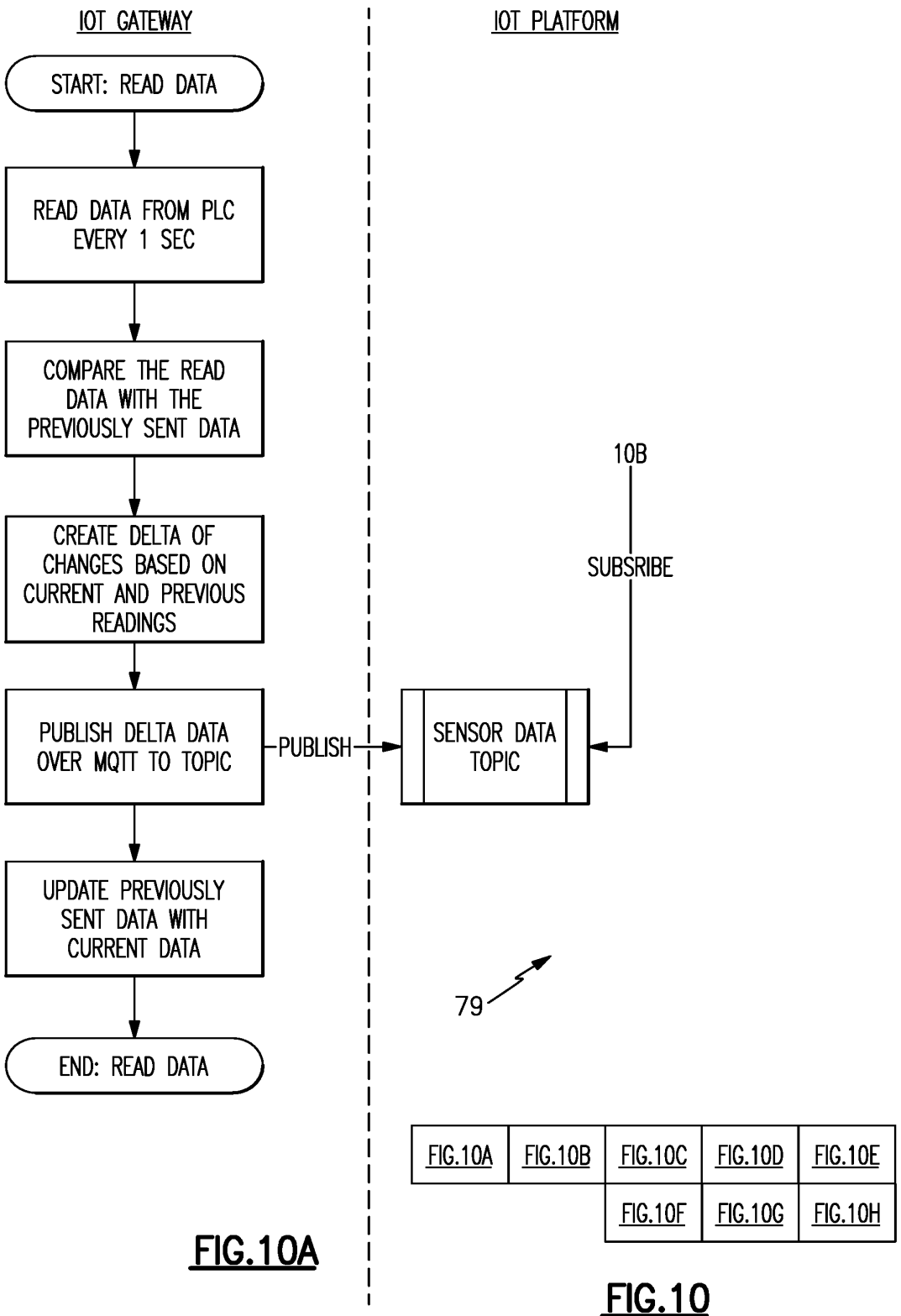


FIG.10A

FIG.10A	FIG.10B	FIG.10C	FIG.10D	FIG.10E
		FIG.10F	FIG.10G	FIG.10H

FIG.10

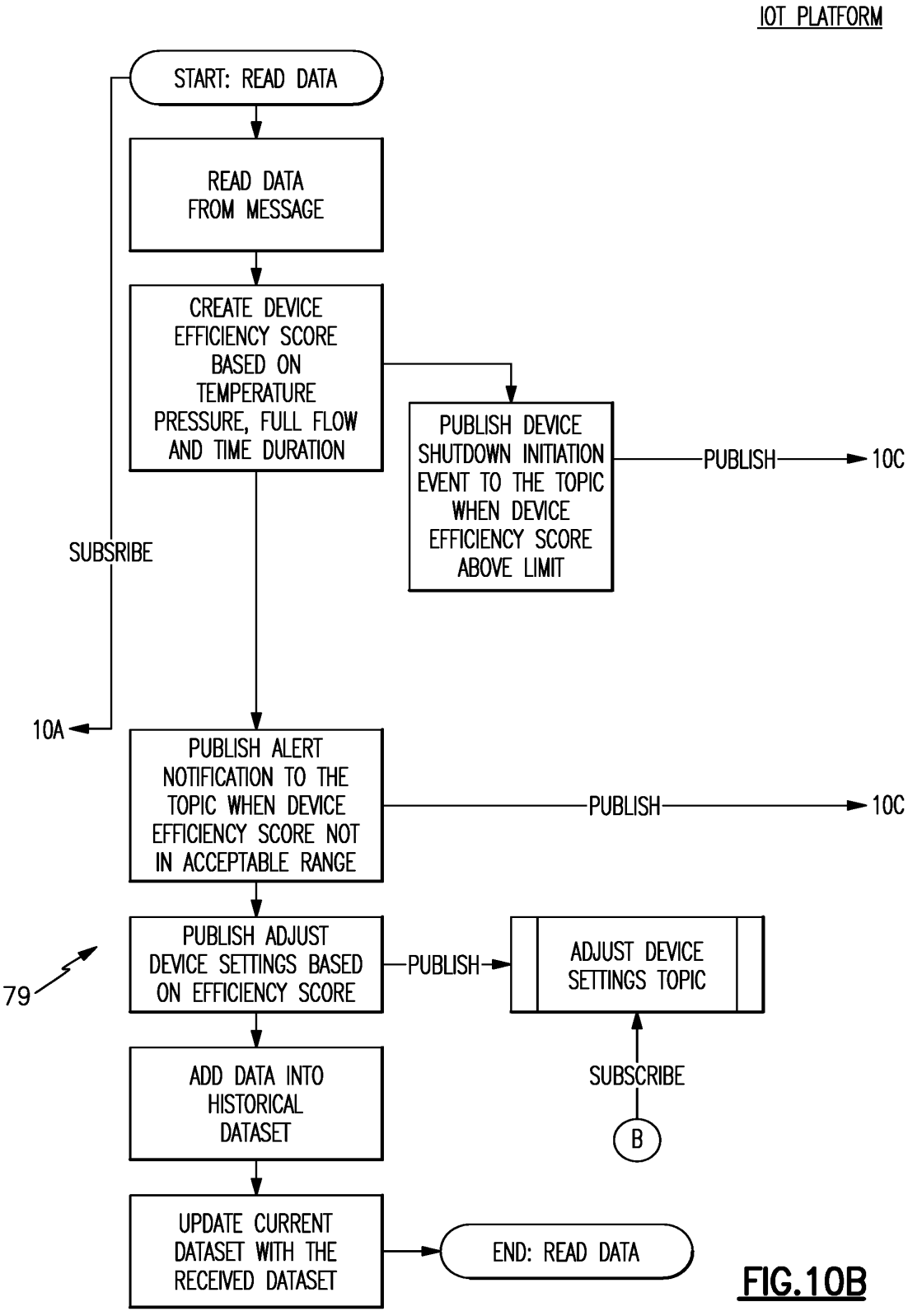

IOT PLATFORM
START: READ DATA
READ DATA FROM MESSAGE
CREATE DEVICE EFFICIENCY SCORE BASED ON TEMPERATURE PRESSURE, FULL FLOW AND TIME DURATION
PUBLISH DEVICE SHUTDOWN INITIATION EVENT TO THE TOPIC WHEN DEVICE EFFICIENCY SCORE ABOVE LIMIT
PUBLISH
10C
SUBSRIBE
10A
PUBLISH ALERT NOTIFICATION TO THE TOPIC WHEN DEVICE EFFICIENCY SCORE NOT IN ACCEPTABLE RANGE
PUBLISH
10C
79
PUBLISH ADJUST DEVICE SETTINGS BASED ON EFFICIENCY SCORE
PUBLISH
ADJUST DEVICE SETTINGS TOPIC
SUBSCRIBE
B
ADD DATA INTO HISTORICAL DATASET
UPDATE CURRENT DATASET WITH THE RECEIVED DATASET
END: READ DATA

FIG.10B

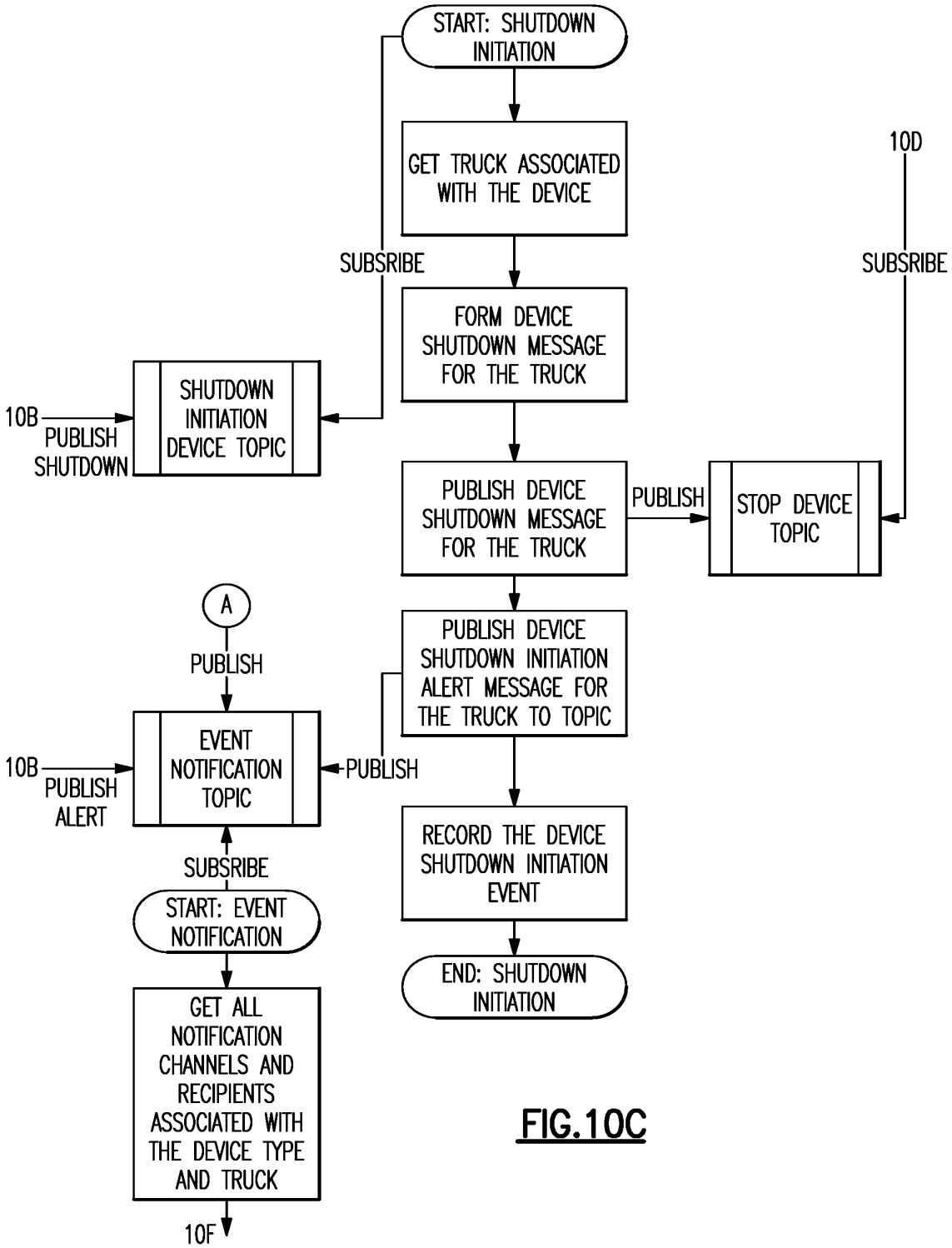

START: SHUTDOWN INITIATION
GET TRUCK ASSOCIATED WITH THE DEVICE
SUBSRIBE
FORM DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
10B
PUBLISH SHUTDOWN
SHUTDOWN INITIATION DEVICE TOPIC
PUBLISH DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
PUBLISH
STOP DEVICE TOPIC
10D
SUBSRIBE
A
PUBLISH
PUBLISH DEVICE SHUTDOWN INITIATION ALERT MESSAGE FOR THE TRUCK TO TOPIC
10B
PUBLISH ALERT
EVENT NOTIFICATION TOPIC
PUBLISH
RECORD THE DEVICE SHUTDOWN INITIATION EVENT
SUBSRIBE
START: EVENT NOTIFICATION
END: SHUTDOWN INITIATION
GET ALL NOTIFICATION CHANNELS AND RECIPIENTS ASSOCIATED WITH THE DEVICE TYPE AND TRUCK
10F

FIG.10C

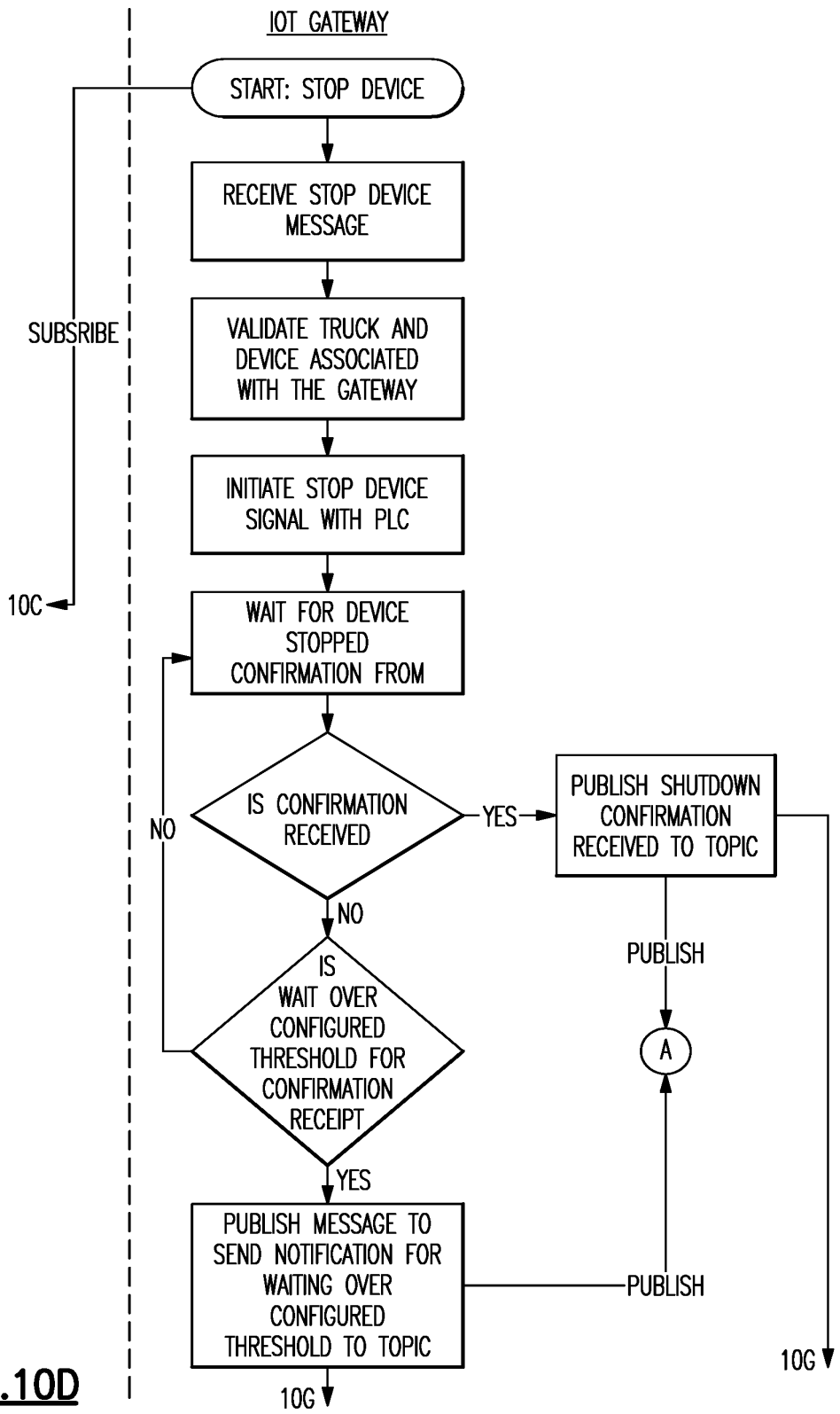

IOT GATEWAY
START: STOP DEVICE
RECEIVE STOP DEVICE MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE STOP DEVICE SIGNAL WITH PLC
WAIT FOR DEVICE STOPPED CONFIRMATION FROM
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
NO
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
SUBSRIBE
10C
10G
10G

FIG.10D

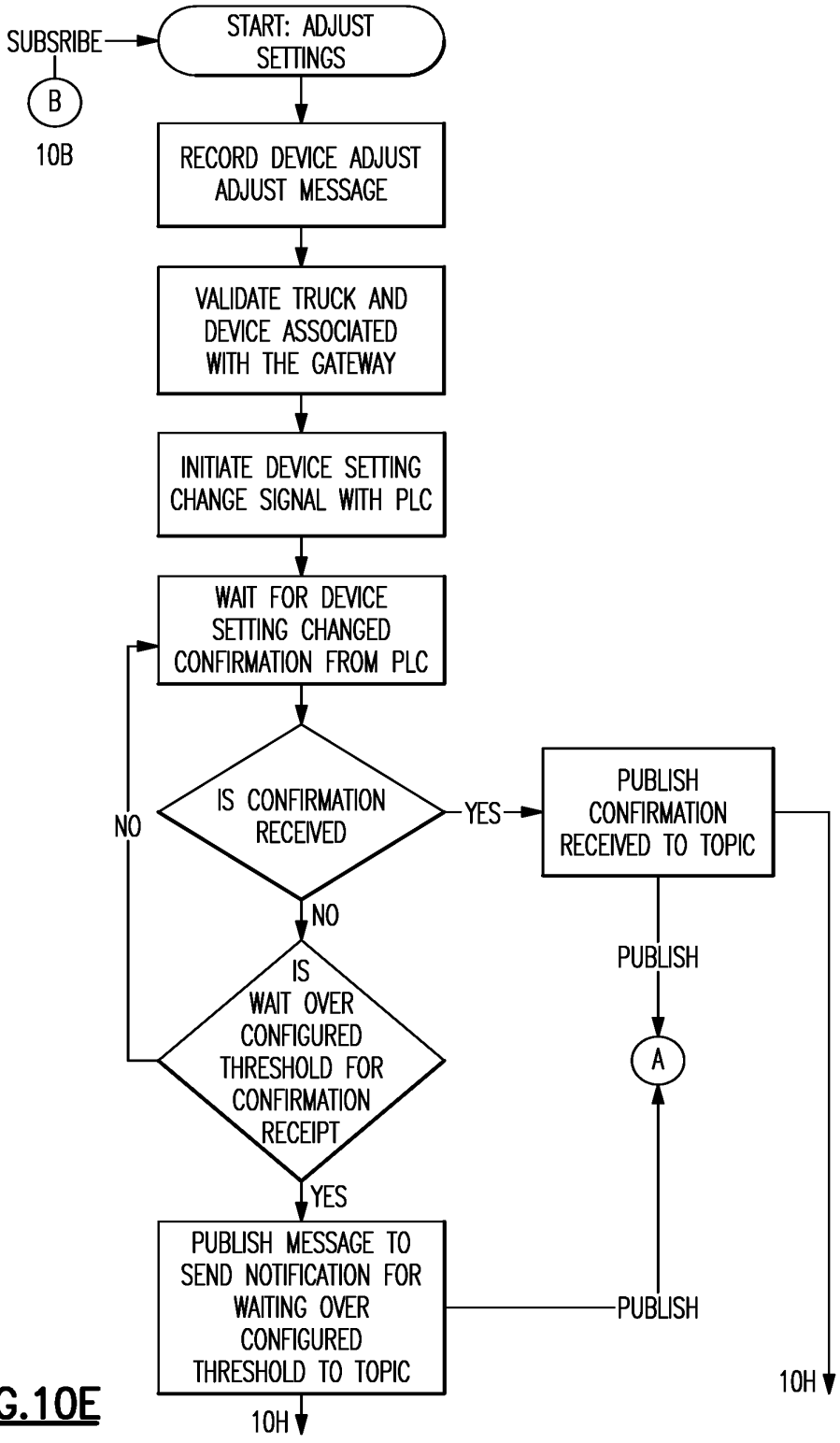

SUBSRIBE
B
10B
START: ADJUST SETTINGS
RECORD DEVICE ADJUST ADJUST MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE DEVICE SETTING CHANGE SIGNAL WITH PLC
WAIT FOR DEVICE SETTING CHANGED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
NO
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
10H
10H

FIG.10E

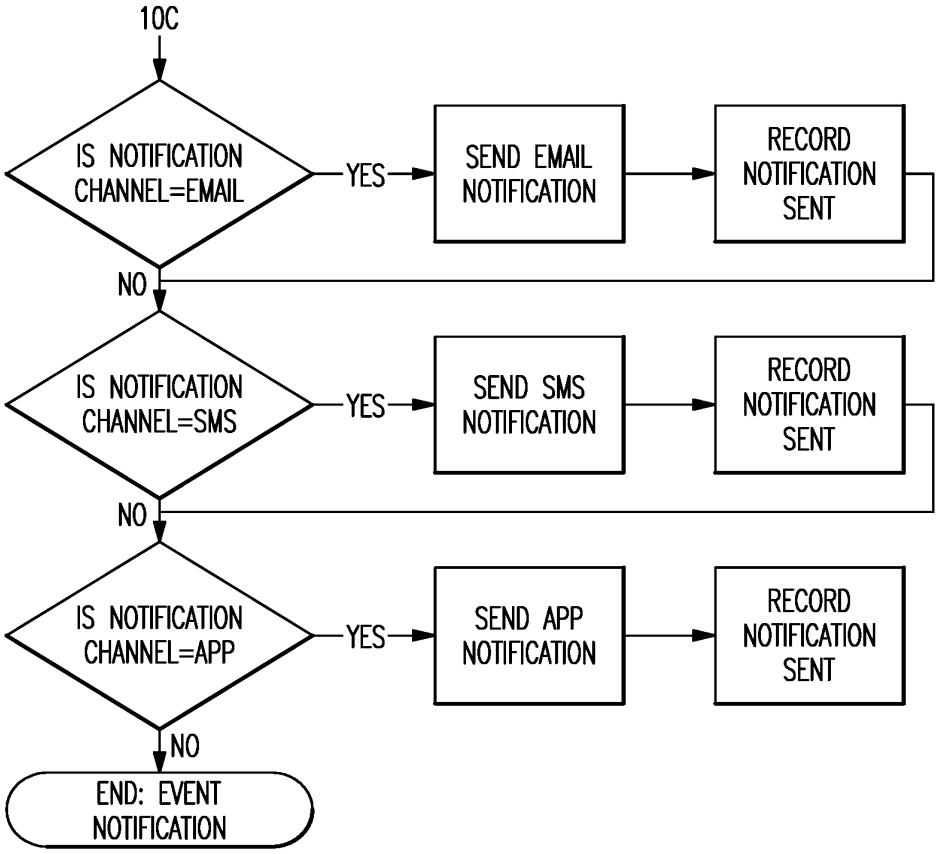

10C
IS NOTIFICATION CHANNEL=EMAIL
YES
SEND EMAIL NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=SMS
YES
SEND SMS NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=APP
YES
SEND APP NOTIFICATION
RECORD NOTIFICATION SENT
NO
END: EVENT NOTIFICATION

FIG.10F

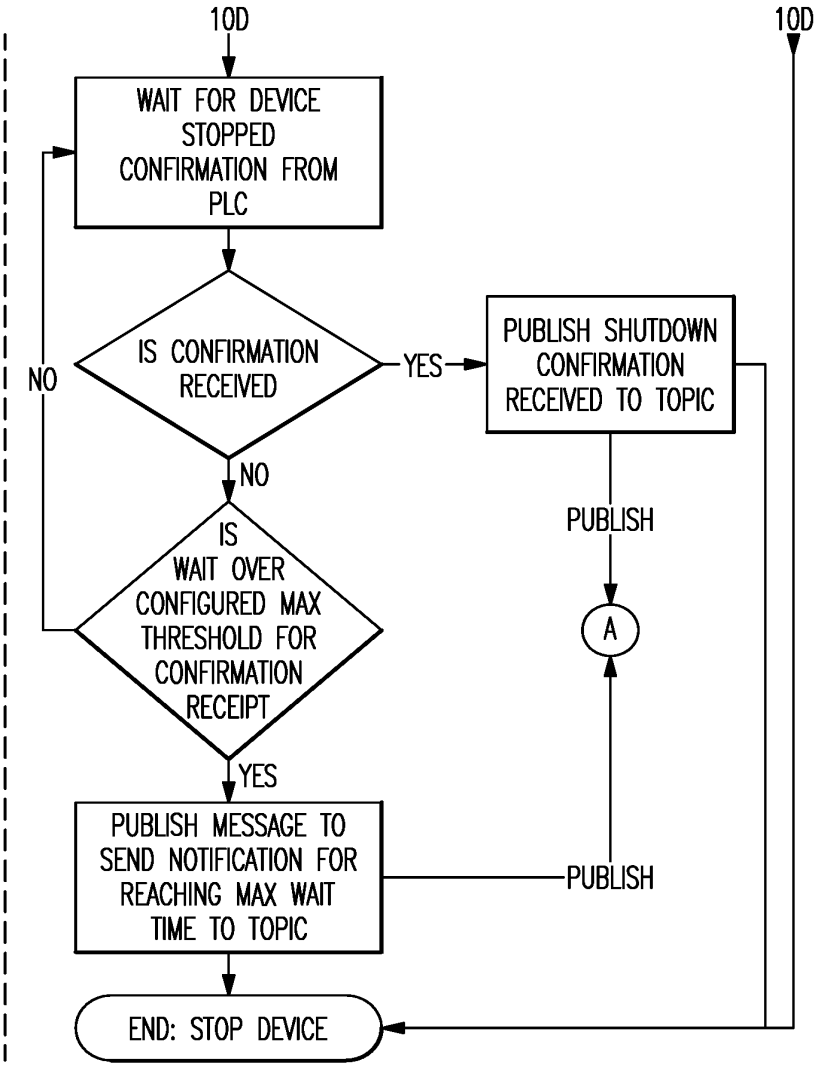

10D
10D
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
NO
PUBLISH
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
A
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: STOP DEVICE

FIG.10G

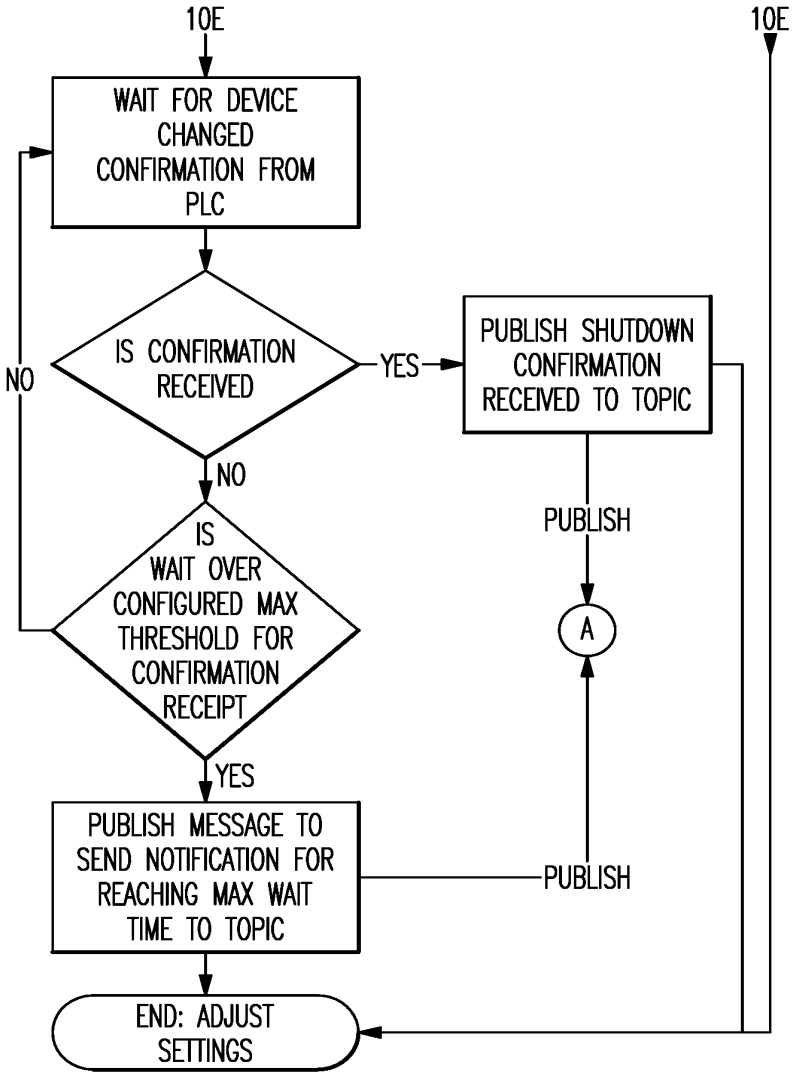

10E
10E
WAIT FOR DEVICE CHANGED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
NO
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
A
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: ADJUST SETTINGS

FIG.10H

Electronic Patent Application Fee Transmittal

Application Number:	15290304
Filing Date:	23-Feb-2017
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Filer:	Matthew L. Koziarz/Andrea DeHart
Attorney Docket Number:	67846-006PUS1

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($)
Extension - 4 months with $0 paid	1254	1	2200	2200
Miscellaneous:				
		Total in USD ($)		**2200**

Electronic Acknowledgement Receipt	
EFS ID:	28841172
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	05-APR-2017
Filing Date:	23-FEB-2017
Time Stamp:	15:10:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$2200
RAM confirmation Number	040617INTEFSW00001501501482
Deposit Account	501482
Authorized User	Andrea DeHart
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Response_CorrectedApplicationPapers_4_5_17.pdf	14757 19ca3a3816576bc921b257187ace57ce7b1b7b98	no	1
Warnings:					
Information:					
2	Specification	Corrected_Specification_Redline_4_5_16.pdf	127165 b977c5c731ec1bde76f8bd1d311b9da49c49a3fd	no	18
Warnings:					
Information:					
3	Specification	Corrected_Specification_Clean_4_5_16.pdf	126640 8cf92042d3e60ae92b1d0e3bf77718b6f2e91fef	no	18
Warnings:					
Information:					
4	Drawings-only black and white line drawings	006PUS1_FormalDrawings.pdf	1030063 f7b84497d47d06daed64ad1ea8a09eaaf008bce6	no	18
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	31277 15b2789a64e5e320b328d680d2439e717d9c3cf2	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1329902		

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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/290,304

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/290,304	02/23/2017	Ricky Dean Shock	67846-006PUS1

CONFIRMATION NO. 3315

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

FORMALITIES LETTER

OC000000089488686

Date Mailed: 02/28/2017

NOTICE OF INCOMPLETE REPLY (NONPROVISIONAL)

Filing Date Granted

The U.S. Patent and Trademark Office has received your reply on 02/23/2017 to the Notice to File Missing Parts (Notice) mailed 10/24/2016 and it has been entered into the nonprovisional application. The reply, however, does not include the following items required in the Notice. A complete reply must be timely filed to prevent ABANDONMENT of the above-identified application. Replies should be mailed to: Mail Stop Missing Parts, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

Applicant is given **TWO MONTHS** from the date of the Notice to File Missing Parts (Notice) mailed 10/24/2016 within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

Items Required to Avoid Abandonment:

The required items noted below SHOULD be filed along with any items required above. The filing date of this nonprovisional application will be the date of receipt of the items required above.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The application contains drawings and the specification contains a brief description of the drawings. However, the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(7) and/or a drawing(s) has not been labeled in accordance with 37 CFR 1.84(u)(1). If each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.), then the drawing(s) must be relabeled in accordance with 37 CFR 1.84(u)(1). In addition, if the brief description of the several views of the drawings does not refer to the figure(s) as properly labeled, then the specification must be amended to correspond to the figure(s) as properly labeled and a substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
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Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/kgebremichael/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Ricky Dean Shock
Serial No.:	15/290,304
Filed:	October 11, 2016
Group Art Unit:	1711
Examiner:	Unknown
Confirmation No.:	3315
Title:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

This paper is responsive to the Notice dated December 23, 2016. The Notice requires a substitute specification with a proper description of the drawings. This requirement appears to stem from Figure 9 and Figure 10, which are too large to properly fit on a page. Figure 9 is thus presented in sub-sections 9A, 9B, 9C, 9D, 9E, and 9F and Figure 10 is presented in sub-sections 10A, 10B, 10C, 10D, 10E, 10F, 10G, and 10H. The sub-sections 9A, 9B, 9C, 9D, 9E, and 9F as well as sub-sections 10A, 10B, 10C, 10D, 10E, 10F, 10G, and 10H were not described. The specification is amended herewith to insert such description. No new matter has been added, and Applicant respectfully requests examination on the merits.

Respectfully submitted,

/Matthew L. Koziarz /
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Dated: February 23, 2017

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 ~~illustrates~~ is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9A, Figure 9B, Figure 9C, Figure 9D, Figure 9E, and Figure 9F. The sub-

sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 ~~illustrates~~ is another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 10 is divided into sub-sections, indicated as Figure 10A, Figure 10B, Figure 10C, Figure 10D, Figure 10E, Figure 10F, Figure 10G, and Figure 10H. The sub-sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator

system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52 includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are

to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed.

For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and

electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture. In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A

longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for

purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control

purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may

additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely

intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to

change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds, sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a

portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

FAS 2004 - Page 695

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9A, Figure 9B, Figure 9C, Figure 9D, Figure 9E, and Figure 9F. The sub-sections show the

details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 is another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 10 is divided into sub-sections, indicated as Figure 10A, Figure 10B, Figure 10C, Figure 10D, Figure 10E, Figure 10F, Figure 10G, and Figure 10H. The sub-sections show the details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator

system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52 includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are

to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed.

For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and

electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture. In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A

longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for

purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control

purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may

additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely

FAS 2004 - Page 709

intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to

change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds, sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a

portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

FAS 2004 - Page 713

Electronic Acknowledgement Receipt

EFS ID:	28436418
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
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Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Response_CorrectedApplicationPapers_2_23_17.pdf	14756 a6cff40620f994edd68bd5d4a6310bc1f48cbe78	no	1

Warnings:

Information:					
2	Specification	Corrected_Specification_Redline_2_23_17.pdf	127175 6eb923e6b7645355b721bc37cc5e21c477a01a6c	no	18
Warnings:					
Information:					
3	Specification	Corrected_Specification_Clean_2_23_17.pdf	126547 3b60aac17d572430649ec7c0cf669977222e1d3d	no	18
Warnings:					
Information:					
			Total Files Size (in bytes):	268478	

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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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/290,304

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1

CONFIRMATION NO. 3315

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

FORMALITIES LETTER

OC000000088051326

Date Mailed: 12/23/2016

NOTICE OF INCOMPLETE REPLY (NONPROVISIONAL)

Filing Date Granted

The U.S. Patent and Trademark Office has received your reply on 12/19/2016 to the Notice to File Missing Parts (Notice) mailed 10/24/2016 and it has been entered into the nonprovisional application. The reply, however, does not include the following items required in the Notice. A complete reply must be timely filed to prevent ABANDONMENT of the above-identified application. Replies should be mailed to: Mail Stop Missing Parts, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450.

Applicant is given **TWO MONTHS** from the date of the Notice to File Missing Parts (Notice) mailed 10/24/2016 within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

Items Required to Avoid Abandonment:

The required items noted below SHOULD be filed along with any items required above. The filing date of this nonprovisional application will be the date of receipt of the items required above.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application contains drawings, but the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

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Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/hsarwari/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Ricky Dean Shock
Serial No.:	15/290,304
Filed:	October 11, 2016
Group Art Unit:	1711
Examiner:	Unknown
Confirmation No.:	3315
Title:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

This paper is responsive to the Notice dated October 24, 2016. The Notice requires a substitute specification with a proper description of the drawings. This requirement appears to stem from Figure 9, which is too large to properly fit on a page. Figure 9 was thus presented in sub-sections 9-1, 9-2, 9-3, 9-4, 9-5, and 9-6. The sub-sections 9-1, 9-2, 9-3, 9-4, 9-5, and 9-6 were not described. The specification is amended herewith to insert such description. No new matter has been added, and Applicant respectfully requests examination on the merits.

Respectfully submitted,

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Dated: December 19, 2016

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9-1, Figure 9-2, Figure 9-3, Figure 9-4, Figure 9-5, and Figure 9-6. The sub-sections show the

details of the workflow logic diagram and, where appropriate, linking arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 illustrates another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52

includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is

otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed. For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a

daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture.

In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one

or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via

the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as

the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar

to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds,

sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 ~~illustrates~~ is a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations. The size of the diagram exceeds what can be shown on a page. Therefore, Figure 9 is divided into sub-sections, indicated as Figure 9-1, Figure 9-2, Figure 9-3, Figure 9-4, Figure 9-5, and Figure 9-6. The sub-sections show the details of the workflow logic diagram and, where appropriate, linking

arrows to adjacent sub-sections. The relative location of the sub-sections to each other is also shown.

[0029] Figure 10 illustrates another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52

includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation. The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is

otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller 52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed. For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a

daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture.

In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one

or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via

the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as

the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar

to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds,

sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

Electronic Acknowledgement Receipt

EFS ID:	27826640
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	19-DEC-2016
Filing Date:	11-OCT-2016
Time Stamp:	11:33:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Response_CorrectedApplicationPapers.pdf	14500 007372d2095f1b7dcefcd99c87ff262aa265df0d	no	1

Warnings:

Information:					
2	Specification	Corrected_Specification_clean.pdf	125807 124c04a01b596a618290acca2af342473685 1754	no	18
Warnings:					
Information:					
3	Specification	Corrected_Specification_Redline.pdf	126246 3c138e37dc85529df7f33faa9b93b654d170 febb	no	18
Warnings:					
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			Total Files Size (in bytes):	266553	

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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
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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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/290,304	10/11/2016	Ricky Dean Shock	67846-006PUS1

CONFIRMATION NO. 3315

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

FORMALITIES LETTER

OC000000086655352

Date Mailed: 10/24/2016

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application contains drawings, but the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

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If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/afessehaye/

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/290,304

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/290,304	10/11/2016	1711	1600	67846-006PUS1	17	2

CONFIRMATION NO. 3315

FILING RECEIPT

26096
CARLSON, GASKEY & OLDS, P.C.
400 WEST MAPLE ROAD
SUITE 350
BIRMINGHAM, MI 48009

OC000000088853351

Date Mailed: 10/24/2016

Receipt is acknowledged of this non-provisional 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 APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Ricky Dean Shock, Victoria, TX;

Applicant(s)

Fuel Automation Station, LLC, Birmingham, MI;

Power of Attorney: None

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/20/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/290,304**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

Preliminary Class

134

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Ricky Dean Shock	Nonprovisional Application Number (if known):	
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES		

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 /Matthew L. Koziarz/	Date 2016-10-11
Name (Print/Typed) Matthew L. Koziarz	Practitioner Registration Number 53154

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.

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ricky	Dean	Shock	

Residence Information (Select One) ● US Residency ○ Non US Residency ○ Active US Military Service

City	Victoria	State/Province	TX	Country of Residence	US

Mailing Address of Inventor:

Address 1	84 Hill Creek Lane
Address 2	

City	Victoria	State/Province	TX
Postal Code	77905	Country	US

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	26096		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES		
Attorney Docket Number	67846-006PUS1	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	18	Suggested Figure for Publication (if any)	1

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

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

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			

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			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Fuel Automation Station, LLC

Mailing Address Information For Applicant:

Address 1	335 E. Maple		
Address 2			
City	Birmingham	**State/Province**	MI
Country	US	Postal Code	48009
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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

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.

Remove

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	67846-006PUS1
	Application Number	
Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES	

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MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

BACKGROUND

[0001] Hydraulic fracturing (also known as fracking) is a well-stimulation process that utilizes pressurized liquids to fracture rock formations. Pumps and other equipment used for hydraulic fracturing typically operate at the surface of the well site. The equipment may operate until refueling is needed, at which time the equipment may be shut-down for refueling. Shut-downs are costly and reduce efficiency. More preferably, to avoid shut-downs fuel is replenished in a hot-refueling operation while the equipment continues to run. This permits fracking operations to proceed continuously. However, hot-refueling can be difficult to reliably sustain for the duration of the fracking operation.

SUMMARY

[0002] A distribution station according to an example of the present disclosure includes a mobile trailer, a pump on the mobile trailer, and a manifold on the mobile trailer fluidly connected with the pump. A plurality of hoses are connected with the manifold, and there are a plurality of valves on the mobile trailer. Each of the valves is situated between the manifold and a respective different one of the hoses. Fluid level sensors are associated with a respective different ones of the hoses. A plurality of sensor communication lines are connected or connectable with a respective different ones of the fluid level sensors. Each of the sensor communication lines is routed with a respective different one of the hoses.

[0003] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines is routed in the respective different one of the hoses.

[0004] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

[0005] A further embodiment of any of the foregoing embodiments includes a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0006] A further embodiment of any of the foregoing embodiments includes a plurality of connectors. Each of the connectors are mounted on a respective different one of

the reels and each of the connectors receiving a respective different one of the sensor communication lines.

[0007] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0008] In a further embodiment of any of the foregoing embodiments, each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

[0009] In a further embodiment of any of the foregoing embodiments, each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

[0010] A further embodiment of any of the foregoing embodiments includes a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

[0011] In a further embodiment of any of the foregoing embodiments, controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

[0012] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer. Each of the hoses are wound on a respective one of the reels, and each of the sensor communication lines are routed through a respective different one of the reels.

[0013] In a further embodiment of any of the foregoing embodiments, each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

[0014] A mobile distribution station according to an example of the present disclosure includes a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller. The controller is configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses. The fuel level sensors are hard-wired through the hoses to the controller.

[0015] In a further embodiment of any of the foregoing embodiments, each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

[0016] The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

[0017] In a further embodiment of any of the foregoing embodiments, the fuel level sensors are hard-wired through spindles of the reels.

[0018] In a further embodiment of any of the foregoing embodiments, each of the fuel level sensors is detachably connectable with the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

[0020] Figure 1 illustrates an example mobile distribution station.

[0021] Figure 2 illustrates an internal layout of a mobile distribution station.

[0022] Figure 3 illustrates an isolated view of hose reels on a support rack used in a mobile distribution station.

[0023] Figure 4 illustrates an example of a connection between a manifold, a control valve, and a reel.

[0024] Figure 5 illustrates a sectioned view of an example hose for a mobile distribution station.

[0025] Figure 6 illustrates an example of an integrated cap sensor for a mobile distribution station.

[0026] Figure 7 illustrates an example of the routing of a sensor communication line through a reel in a mobile distribution station.

[0027] Figure 8 illustrates a system that can be used to remotely monitor and manage one or more mobile distribution stations.

[0028] Figure 9 illustrates a workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations.

[0029] Figure 10 illustrates another workflow logic diagram that represents an example of a method for managing one or more mobile distribution stations.

DETAILED DESCRIPTION

[0030] Figure 1 illustrates a mobile distribution station 20 and Figure 2 illustrates an internal layout of the station 20. As will be described, the station 20 may serve in a "hot-refueling" capacity to distribute fuel to multiple pieces of equipment while the equipment is running, such as fracking equipment at a well site. As will be appreciated, the station 20 is not limited to applications for fracking or for delivering fuel. The examples herein may be presented with respect to fuel delivery, but the station 20 may be used in mobile delivery of other fluids, in other gas/petroleum recovery operations, or in other operations where mobile refueling or fluid delivery will be of benefit.

[0031] In this example, the station 20 includes a mobile trailer 22. Generally, the mobile trailer 22 is elongated and has first and second opposed trailer side walls W1 and W2 that join first and second opposed trailer end walls E1 and E2. Most typically, the trailer 22 will also have a closed top (not shown). The mobile trailer 22 may have wheels that permit the mobile trailer 22 to be moved by a vehicle from site to site to service different hot-refueling operations. In this example, the mobile trailer 22 has two compartments. A first compartment 24 includes the physical components for distributing fuel, such as diesel fuel, and a second compartment 26 serves as an isolated control room for managing and monitoring fuel distribution. The compartments 24/26 are separated by an inside wall 28a that has an inside door 28b.

[0032] The first compartment 24 includes one or more pumps 30. Fuel may be provided to the one or more pumps 30 from an external fuel source, such as a tanker truck on the site. On the trailer 22, the one or more pumps 30 are fluidly connected via a fuel line 32 with a high precision register 34 for metering fuel. The fuel line 32 may include, but is not limited to, hard piping. In this example, the fuel line 32 includes a filtration and air eliminator system 36a and one or more sensors 36b. Although optional, the system 36a is beneficial in many implementations, to remove foreign particles and air from the fuel prior to delivery to the equipment. The one or more sensors 36b may include a temperature sensor, a pressure sensor, or a combination thereof, which assist in fuel distribution management.

[0033] The fuel line 32 is connected with one or more manifolds 38. In the illustrated example, the station 20 includes two manifolds 38 that arranged on opposed sides of the compartment 24. As an example, the manifolds 38 are elongated tubes that are generally larger in diameter than the fuel line 32 and that have at least one inlet and multiple outlets. Each hose 40 is wound, at least initially, on a reel 42 that is rotatable to extend or retract the

hose 40 externally through one or more windows of the trailer 22. Each reel 42 may have an associated motor to mechanically extend and retract the hose 40.

[0034] As shown in an isolated view in Figure 3, the reels 42 are mounted on a support rack 42a. In this example, the support rack 42a is configured with upper and lower rows of reels 42. Each row has five reels 42 such that each support rack 42a provides ten reels 42 and thus ten hoses 40. There are two support racks 42a (Figure 2) arranged on opposed sides of the first compartment 24, with an aisle (A) that runs between the support racks 42a from an outside door E to the inside door 28b. The station 20 therefore provides twenty hoses 40 in the illustrated arrangement, with ten hoses 40 provided on each side of the station 20. As will be appreciated, fewer or additional reels and hoses may be used in alternative examples.

[0035] As shown in a representative example in Figure 4, each hose 40 is connected to a respective one of the reels 42 and a respective one of a plurality of control valves 44. For example, a secondary fuel line 46 leads from the manifold 38 to the reel 42. The control valve 44 is in the secondary fuel line 46. The control valve 44 is moveable between open and closed positions to selectively permit fuel flow from the manifold 38 to the reel 42 and the hose 40. For example, the control valve 44 is a powered valve, such as a solenoid valve.

[0036] In the illustrated example, the first compartment 24 also includes a sensor support rack 48. The sensor support rack 48 holds integrated fuel cap sensors 50 (when not in use), or at least portions thereof. When in use, each integrated fuel cap sensor 50 is temporarily affixed to a piece of equipment (i.e., the fuel tank of the equipment) that is subject to the hot-refueling operation. Each hose 40 may include a connector end 40a and each integrated fuel cap sensor 50 may have a corresponding mating connector to facilitate rapid connection and disconnection of the hose 40 with the integrated fuel cap sensor 50. For example, the connector end 40a and mating connector on the integrated fuel cap sensor 50 form a hydraulic quick-connect.

[0037] At least the control valves 44, pump or pumps 30, sensor or sensors 36b, and register 34 are in communication with a controller 52 located in the second compartment 26. As an example, the controller 52 includes software, hardware, or both that is configured to carry out any of the functions described herein. In one further example, the controller 52 includes a programmable logic controller with a touch-screen for user input and display of status data. For example, the screen may simultaneously show multiple fluid levels of the equipment that is being serviced.

[0038] When in operation, the integrated fuel cap sensors 50 are mounted on respective fuel tanks of the pieces of equipment that are subject to the hot-refueling operation.

The hoses 40 are connected to the respective integrated fuel cap sensors 50. Each integrated fuel cap sensor 50 generates signals that are indicative of the fuel level in the fuel tank of the piece of equipment on which the integrated fuel cap sensor 50 is mounted. The signals are communicated to the controller 52.

[0039] The controller 52 interprets the signals and determines the fuel level for each fuel tank of each piece of equipment. In response to a fuel level that falls below a lower threshold, the controller 52 opens the control valve 44 associated with the hose 40 to that fuel tank and activates the pump or pumps 30. The pump or pumps 30 provide fuel flow into the manifolds 38 and through the open control valve 44 and reel 42 such that fuel is provided through the respective hose 40 and integrated fuel cap sensor 50 into the fuel tank. The lower threshold may correspond to an empty fuel level of the fuel tank, but more typically the lower threshold will be a level above the empty level to reduce the potential that the equipment completely runs out of fuel and shuts down. The controller 52 can also be programmed with a failsafe measure related to the operation of the fuel cap sensors 50. As an example, once a control valve 44 is open, if the controller 52 does not detect a change in fuel level from the fuel cap sensor 50 associated with the control valve 44 within a preset time period, the controller 52 shuts the pump 30 off and closes the control valve 44. Thus, if a hose 40 were to rupture, spillage of fuel is limited to the volume of fuel in the hose 40. For instance, the preset time period may be three seconds, six seconds, ten seconds, or fifteen seconds, which may limit spillage to approximately fifteen gallons for a given size of hose.

[0040] The controller 52 also determines when the fuel level in the fuel tank reaches an upper threshold. The upper threshold may correspond to a full fuel level of the fuel tank, but more typically the upper threshold will be a level below the full level to reduce the potential for overflow. In response to reaching the upper threshold, the controller 52 closes the respective control valve 44 and ceases the pump or pumps 30. If other control valves 44 are open or are to be opened, the pump or pumps 30 may remain on. The controller 52 can also be programmed with an electronic stop failsafe measure to prevent over-filling. As an example, once an upper threshold is reached on a first tank and the control valve 44 is closed, but the pump 30 is otherwise to remain on to fill other tanks, if the fuel level continues to rise in the first tank, the controller 52 shuts the pump 30 off.

[0041] Multiple control valves 44 may be open at one time, to provide fuel to multiple fuel tanks at one time. Alternatively, if there is demand for fuel from two or more fuel tanks, the controller 52 may sequentially open the control valves 44 such that the tanks are refueled sequentially. For instance, upon completion of refueling of one fuel tank, the controller

52 closes the control valve 44 of the hose 40 associated with that tank and then opens the next control valve 44 to begin refueling the next fuel tank. Sequential refueling may facilitate maintaining internal pressure in the manifold and fuel line 32 above a desired or preset pressure threshold to more rapidly deliver fuel. Similarly, the controller 52 may limit the number of control valves 44 that are open at any one instance in order to maintain the internal pressure in the manifold and fuel line 32 above a desired or preset threshold. The controller 52 may perform the functions above while in an automated operating mode. Additionally, the controller 52 may have a manual mode in which a user can control at least some functions through the PLC, such as starting and stopped the pump 30 and opening and closing control valves 44. For example, manual mode may be used at the beginning of a job when initially filling tanks to levels at which the fuel cap sensors 50 can detect fuel and/or during a job if a fuel cap sensor 50 becomes inoperable. Of course, operating in manual mode may deactivate some automated functions, such as filling at the low threshold or stopping at the high threshold.

[0042] In addition to the use of the sensor signals to determine fuel level, or even as an alternative to use of the sensor signals, the refueling may be time-based. For instance, the fuel consumption of a given piece of equipment may be known such that the fuel tank reaches the lower threshold at known time intervals. The controller 52 is operable to refuel the fuel tank at the time intervals rather than on the basis of the sensor signals, although sensor signals may also be used to verify fuel level.

[0043] The controller 52 also tracks the amount of fuel provided to the fuel tanks. For instance, the register 34 precisely measures the amount of fuel provided from the pump or pumps 30. As an example, the register 34 is an electronic register and has a resolution of about 0.1 gallons. The register 34 communicates measurement data to the controller 52. The controller 52 can thus determine the total amount of fuel used to very precise levels. The controller 52 may also be configured to provide outputs of the total amount of fuel consumed. For instance, a user may program the controller 52 to provide outputs at desired intervals, such as by worker shifts or daily, weekly, or monthly periods. The outputs may also be used to generate invoices for the amount of fuel used. As an example, the controller 52 may provide a daily output of fuel use and trigger the generation of an invoice that corresponds to the daily fuel use, thereby enabling almost instantaneous invoicing.

[0044] In a further example, the integrated fuel cap sensors 50 are each hard-wired to the controller 52. The term "hard-wired" or variations thereof refers to a wired connection between two components that serves for electronic communication there between, which here is a sensor and a controller. The hard-wiring may facilitate providing more reliable signals from

the integrated fuel cap sensors 50. For instance, the many pieces of equipment, vehicles, workers, etc. at a site may communicate using wireless devices. The wireless signals may interfere with each other and, therefore, degrade communication reliability. Hard-wiring the integrated fuel cap sensors 50 to the controller 52 facilitates reduction in interference and thus enhances reliability.

[0045] In general, hard-wiring in a hot-refueling environment presents several challenges. For example, a site has many workers walking about and typically is located on rough terrain. Thus, as will be described below, each integrated fuel cap sensor 50 is hard-wired through the associated hose 40 to the controller 52.

[0046] Figure 5 illustrates a representative portion of one of the hoses 40 and, specifically, the end of the hose 40 that will be located at the fuel tank of the equipment being refueled. In this example, the hose 40 includes a connector 60 at the end for detachably connecting the hose 40 to the integrated fuel cap sensors 50. The hose 40 is formed of a tube 62 and a sleeve 64 that circumscribes the tube 62. As an example, the tube 62 may be a flexible elastomeric tube and the sleeve 64 may be a flexible fabric sleeve. The sleeve 64 is generally loosely arranged around the tube 62, although the sleeve 64 may closely fit on the tube 62 to prevent substantial slipping of the sleeve 64 relative to the tube 62 during use and handling. Optionally, to further prevent slipping and/or to secure the sleeve 64, bands may be tightened around the hose 40. As an example, one or more steel or stainless steel bands can be provided at least near the ends of the hose 40.

[0047] A plurality of sensor communication lines 66 (one shown) are routed with or in the respective hoses 40. For instance, each line 66 may include a wire, a wire bundle, and/or multiple wires or wire bundles. In one further example, the line 66 is a low milli-amp intrinsic safety wiring, which serves as a protection feature for reducing the concern for operating electrical equipment in the presence of fuel by limiting the amount of thermal and electrical energy available for ignition. In this example, the line 66 is routed through the hose 40 between (radially) the tube 62 and the sleeve 64. The sleeve 64 thus serves to secure and protect the line 66, and the sleeve 64 may limit spill and spewing if there is a hose 40 rupture. In particular, since the line 66 is secured in the hose 40, the line 66 does not present a tripping concern for workers. Moreover, in rough terrain environments where there are stones, sand, and other objects that could damage the line 66 if it were free, the sleeve 64 shields the line 66 from direct contact with such objects. In further examples, the line 66 may be embedded or partially embedded in the tube 62 or the sleeve 64.

[0048] In this example, the line 66 extends out from the end of the hose 40 and includes a connector 68 that is detachably connectable with a respective one of the integrated fuel cap sensors 50. For example, Figure 6 illustrates a representative example of one of the integrated fuel cap sensors 50. The integrated fuel cap sensor 50 includes a cap portion 50a and a level sensor portion 50b. The cap portion 50a is detachably connectable with a port of a fuel tank. The cap portion 50a includes a connector port 50c, which is detachably connectable with the connector 60 of the hose 40. The sensor portion 50b includes a sensor 50d and a sensor port 50e that is detachably connectable with the connector 68 of the line 66. The fuel cap sensor 50 may also include a vent port that attaches to a drain hose, to drain any overflow into a containment bucket and/or reduce air pressure build-up in a fuel tank. Thus, a user may first mount the cap portion 50a on the fuel tank of the equipment, followed by connecting the hose 40 to the port 50c and connecting the line 66 to the port 50e.

[0049] The sensor 50d may be any type of sensor that is capable of detecting fluid or fuel level in a tank. In one example, the sensor 50d is a guided wave radar sensor. A guided wave radar sensor may include a transmitter/sensor that emits radar waves, most typically radio frequency waves, down a probe. A sheath may be provided around the probe. For example, the sheath may be a metal alloy (e.g., stainless steel or aluminum) or polymer tube that surrounds the probe. One or more bushings may be provided between the probe and the sheth, to separate the probe from the sheath. The sheath shields the probe from contact by external objects, the walls of a fuel tank, or other components in a fuel tank, which might otherwise increase the potential for faulty sensor readings. The probe serves as a guide for the radar waves. The radar waves reflect off of the surface of the fuel and the reflected radar waves are received into the transmitter/sensor. A sensor controller determines the "time of flight" of the radar waves, i.e., how long it takes from emission of the radar waves for the radar waves to reflect back to the transmitter/sensor. Based on the time, the sensor controller, or the controller 52 if the sensor controller does not have the capability, determines the distance that the radar waves travel. A longer distance thus indicates a lower fuel level (farther away) and a shorter distance indicates a higher fuel level (closer).

[0050] The line 66 routes through the hose 40 and back to the reel 42 in the trailer 22. For example, the line 66 is also routed or hard-wired through the reel 42 to the controller 52. Figure 7 illustrates a representative example of the routing in the reel 42. In this example, the reel 42 includes a spindle 42b about which the reel is rotatable. The spindle 42b may be hollow, and the line 66 may be routed through the spindle 42b. The reel 42 may also include a

connector 42c mounted thereon. The connector 42c receives the line 66 and serves as a port for connection with another line 66a to the controller 52.

[0051] The lines 66a may converge to one or more communication junction blocks or "bricks" prior to the controller 52. The communication junction blocks may serve to facilitate the relay of the signals back to the controller 52. The communication junction blocks may alternatively or additionally serve to facilitate identification of the lines 66, and thus the signals, with respect to which of the hoses a particular line 66 is associated with. For instance, a group of communication junction blocks may have unique identifiers and the lines 66 into a particular communication junction block may be associated with identifiers. A signal relayed into the controller 52 may thus be associated with the identifiers of the communication junction blocks and a particular line 66 of that communication junction block in order to identify which hose 40 the signal is to be associated with. The valves 44 may also communicate with the controller 52 in a similar manner through the communication junction blocks.

[0052] As can be appreciated from the examples herein, the station 20 permits continuous hot-refueling with enhanced reliability. While there might generally be a tendency to choose wireless sensor communication for convenience, a hard-wired approach mitigates the potential for signal interference that can arise with wireless. Moreover, by hard-wiring the sensors through the hoses to the controller, wired communication lines are protected from exposure and do not pose additional concerns for workers on a site.

[0053] Figure 8 illustrates a system 69 for remotely monitoring and/or managing at least one mobile distribution station 20 (A). It is to be appreciated that the system 69 may include additional mobile distribution stations, shown in phantom at 20 (B), 20 (C), and 20 (D) (collectively mobile distribution stations 20), for example. The mobile distribution stations 20 may be located at a single work site or located across several different work sites S1 and S2. Each mobile distribution station 20 is in communication with one or more servers 71 that are remotely located from the mobile distribution stations 20 and work sites S1/S2. In most implementations, the communication will be wireless.

[0054] The server 71 may include hardware, software, or both that is configured to perform the functions described herein. The server 71 may also be in communication with one or more electronic devices 73. The electronic device 73 is external of or remote from the mobile fuel distribution stations 20. For example, the electronic device 73 may be, but is not limited to, a computer, such as a desktop or laptop computer, a cellular device, or tablet device. The electronic device 73 may communicate and interact in the system 69 via data connectivity,

which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0055] The electronic device 73 may include a display 73a, such as an electronic screen, that is configured to display the fuel operating parameter data of each of the mobile distribution stations 20. As an example, the electronic device 73 may display in real-time the operating parameter data of each of the mobile distribution stations 20 in the system 69 to permit remote monitoring and management control of the mobile distribution stations 20. For instance, the operating parameter data may include fuel temperature, fuel pressure, fuel flow, total amount of fuel distributed, operational settings (e.g., low and high fuel level thresholds), or other parameters.

[0056] The server 71 may also be in communication with one or more cloud-based devices 75. The cloud-based device 75 may include one or more servers and a memory for communicating with and storing information from the server 71.

[0057] The server 71 is configured to communicate with the mobile distribution stations 20. Most typically, the server 71 will communicate with the controller 52 of the mobile distribution station 20. In this regard, the controller 52 of each mobile distribution station 20 may be include hardware, software, or both that is configured for external communication with the server 71. For example, each controller 52 may communicate and interact in the system 69 via data connectivity, which may involve internet connectivity, cellular connectivity, software, mobile application, or combinations of these.

[0058] The server 71 is configured to receive operating parameter data from the mobile distribution stations 20. The operating parameter data may include or represent physical measurements of operating conditions of the mobile distribution station 20, status information of the mobile distribution station 20, setting information of the mobile distribution station 20, or other information associated with control or management of the operation of the mobile distribution station 20.

[0059] For example, the server 71 utilizes the information to monitor and auto-manage the mobile distribution station 20. The monitoring and auto-management may be for purposes of identifying potential risk conditions that may require shutdown or alert, purposes of intelligently enhancing operation, or purposes of reading fuel or fluid levels in real-time via the sensors 50. As an example, the server 71 may utilize the information to monitor or display fuel or fluid levels, or determine whether the fuel operating parameter data is within a preset limit and send a control action in response to the operating parameter data being outside the preset limit. As will described in further detail below, the control action may be a shutdown

instruction to the mobile fuel distribution stations 20, an adjustment instruction to the mobile fuel distribution stations 20, or an alert to the electronic device 73.

[0060] Figure 9 illustrates a workflow logic diagram of an example control method 77 which can be implemented with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. In general, the illustrated method 77 can be used to provide a shutdown instruction or an alert if operating parameter data of one or more mobile distribution stations 20 is outside of a preset limit. For instance, if fuel pressure or fuel temperature in one of the mobile distribution stations 20 exceeds one or more limits, the method 77 shuts down the mobile distribution station 20 and/or sends an alert so that appropriate action can, if needed, be taken in response to the situation. In particular, in hot-refueling implementations, the ability to automatically shut down or to provide a remote alert may facilitate enhancement of reliable and safe operation.

[0061] Referring to Figure 9, one or more current or instantaneous operating parameters are read (i.e., by the controller 52). An operating parameter may include, but is not limited to, fuel temperature and fuel pressure. Other parameters may additionally or alternatively be used, such as pump speed or power and fuel flow. Parameters may be first order parameters based on first order readings from sensor signals, or second order parameters that are derived or calculated from first order parameters or first order sensor signals. For instance, temperature is a first order parameter and direct detection of temperature to produce signals representative of temperature constitute first order sensor signals. The product of temperature and pressure, for example, is a second order parameter that is based on first order sensor signals of each of temperature and pressure. As will be appreciated, there may be additional types of second order parameters based on temperature, pressure, power, flow, etc., which may or may not be weighted in a calculation of a second order parameter.

[0062] In this example, the current operating parameter is compared with a prior operating parameter stored in memory in the controller 52. A difference in the current operating parameter and the prior operating parameter is calculated to produce a change (delta) value in the operating parameter. The change value is used as the operating parameter data for control purposes in the method 77. The operating parameter data thus represents the change in the operating parameter from the prior reading to the current reading. Use of the change value as the operating parameter data serves to reduce the amount of data that is to be sent in connection with the method 77. For example, the actual operating parameter values may be larger than the change values and may thus require more memory and bandwidth to send than the change values. The change values are sampled and calculated at a predesignated interval rate. In this

example, the interval rate is once per second. Each operating parameter is stored in memory for use as the next "prior" operating parameter for comparison with a subsequent "new" operating parameter reading. The controller 52 may be programmed to perform the above steps. As will be appreciated, the steps above achieve data efficiency, and actual values could alternatively or additionally be used if memory and bandwidth permit.

[0063] Each operating parameter data reading (i.e., change value) is published or sent via IoT (Internet of Things) Gateway to an IoT Platform, which may be implemented fully or partially on the server 71 and cloud device 75. The operating parameter data may also contain additional information, such as but not limited to, metadata with time stamp information and identification of the individual mobile distribution station 20. In this example, the operating parameter data of interest is associated with fuel pressure and fuel temperature. In the method 77, the operating parameter data for fuel temperature and fuel pressure are compared to, respectively, a preset fuel temperature shutdown limit and a preset fuel pressure shutdown limit. The shutdown limits may be temperature and pressure limits corresponding to rated limits of the pump 30, fuel line 32, and manifold 38, for example.

[0064] If the temperature or pressure are outside of the preset fuel temperature or pressure shutdown limits, the method 77 initiates a shutdown event. In this example, the shutdown event includes identifying the particular mobile distribution station 20 associated with the temperature or pressure that is outside of the preset limit, forming a shutdown instruction message, and publishing or sending the shutdown instruction message via the IoT Gateway to the corresponding identified mobile distribution station 20.

[0065] Upon receiving the shutdown instruction message, the controller 52 of the identified mobile distribution station 20 validates and executes the shutdown instruction. For instance, shutdown may include shutting off the pump 30 and closing all of the control valves 44. In this example, the method 77 includes a timing feature that waits for confirmation of shutdown. Confirmation may be generated by the controller 52 performing an electronic check of whether the pump 30 is off and the control valves 44 are closed. Confirmation may additionally or alternatively involve manual feedback via input into the controller 52 by a worker at the identified mobile distribution station 20.

[0066] Once shutdown is confirmed by the controller 52, confirmation of shutdown is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of shutdown by a maximum preset time threshold, a non-confirmation of shutdown is published or sent for subsequent issuance of an alert.

[0067] If the temperature and/or pressure is not outside of the preset fuel temperature or pressure shutdown limits, the method 77 in this example continues to determine whether the fuel temperature and fuel pressure with are, respectively, outside of a preset fuel temperature threshold limit and a preset fuel pressure threshold limit. The threshold limits will typically be preset at levels which indicate a potential for shutdown conditions. For example, the threshold limits may be intermediate temperature or pressure levels which, if exceeded, may indicate an upward trend in temperature or pressure toward the shutdown limits. In one example, the threshold limits are rate of change thresholds. For instance, a change value in temperature and/or pressure that exceeds a corresponding threshold change limit may be indicative that temperature and/or pressure is rapidly elevating toward the shutdown condition.

[0068] In response to the temperature and/or pressure being outside of the preset fuel temperature or pressure threshold limits, the method 77 initiates an alert event. In this example, the alert event includes initiating an event notification. In the event notification, the method 77 conducts a lookup of notification channels and then issues an alert via one or more selected notification channels, such as an alert on the display 73a. As an example, the notification channels may be selected by user preferences and may include alerts by email, SMS (short message service), and/or mobile device app notification (e.g., banners, badges, home screen alerts, etc.). The event notification is also used for alerts of confirmation and non-confirmation of shutdown. The method 77 thus provides capability to nearly instantaneously issue an alert that can be immediately and readily viewed in real-time on the electronic device 73 so that appropriate action, if needed, can be taken. In one example, such actions may include adjustment of operation settings of the mobile distribution station 20, which may be communicated and implemented via the system 69 from the electronic device 73 to the mobile distribution station 20.

[0069] Figure 10 illustrates a workflow logic diagram of an example control management method 79 which can be implemented with the method 77 and with the system 69 or with other configurations of one or more mobile distribution stations 20 and one or more servers. For example, the method 79 is used to identify shutdown conditions and/or remotely intelligently auto-manage operation of one or more mobile distribution stations 20. The initial portion of the method 79 with respect to generating operating parameters data may be similar to the method 77; however, the method 79 uses the operating parameter data to calculate an efficiency score and identify shutdown conditions or other actions to be taken in response to the efficiency score. For example, the efficiency score is a second order parameter and is a calculation based on multiple fuel operating parameters selected from fuel temperature, fuel

pressure, fuel flow, and time. The efficiency score is then compared to an efficiency score shutdown limit. If the calculated efficiency score exceeds the limit, the method 79 initiates the shutdown event as described above. As an example, the efficiency score is the product of a safety score multiplied by one or more of a temperature score, a pressure score, a flow rate score, a tank level score, or the sum of two or more of these scores. For instance, the efficiency score is as shown in Equation I below.

[0070] Equation I:

[0071] Efficiency Score = Safety Score x (Temperature Score + Pressure Score + Flow Rate Score + Tank Level Score).

[0072] In one example, the safety score is a product of a safety factor and logic values of one or zero for each of the temperature score, the pressure score, the flow rate score, and the tank level score. Thus, if any of the temperature score, the pressure score, the flow rate score, or the tank level score fails, resulting in a logic value of zero, the efficiency score will be zero. In response to an efficiency score of zero, the method 79 initiates the shutdown event as described above. The logic values are assigned according to whether the given parameter is within a predetermined minimum/maximum range. If the parameter is within the range, the logic value is one and if the parameter is outside of the range, the value is zero. As an example, the safety score may be determined by:

[0073] Safety Score = (Safety Check Positive Response/Total Safety Checks) * (IF (Temperature Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Pressure Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Flow Rate Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)) * (IF (Tank Inventory Reading between MIN LIMIT and MAX LIMIT) THEN 1 ELSE 0)),

[0074] wherein

[0075] Temperature Score = (((Temperature Reading – Min Limit)/ Temperature Reading) + ((Max Limit + Temperature Reading)/ Temperature Reading)))/2,

[0076] Pressure Score = (((Pressure Reading – Min Limit)/ Pressure Reading) + ((Max Limit + Pressure Reading)/ Pressure Reading)))/2,

[0077] Flow Rate Score = (((Flow Rate Reading – Min Limit)/ Flow Rate Reading) + ((Max Limit + Flow Rate Reading)/ Flow Rate Reading)))/2, and

[0078] Tank Level Score = (((Tank Level Reading – Min Limit)/ Tank Level Reading) + ((Max Limit + Tank Level Reading)/ Tank Level Reading)))/2.

[0079] In one example, the safety factor includes a calculation based on safety checks of a mobile distribution station 20. For instance, the safety factor is the quotient of

positive or passing safety checks divided by the total number of safety check made. A safety check may involve periodic validation of multiple parameters or conditions on the site of a station 20 and/or in the station 20. As examples, the safety check may include validation that electrical power supply is fully functional (e.g., a generator), validation of oil levels (e.g., in a generator), validation of whether there are any work obstructions at the site, etc. Thus, each safety check may involve validation of a set of parameters and conditions. If validation passes, the safety check is positive and if validation does not pass the safety check is negative. As an example, if 5 safety checks are conducted for a station 20 and four of the checks pass and one does not pass, the safety factor is equal to four divided by five, or 0.8.

[0080] The method 79 also uses the efficiency score to actively intelligently auto-manage operation of one or more of the mobile distribution stations 20. For example, the efficiency score is compared in the method 79 with an efficiency score threshold limit or efficiency score range. If the efficiency score is outside of the limit or range, the method 79 initiates an adjustment event to adjust settings of the operating parameters of the mobile distribution station 20. For example, pumping rate or power may be changed to increase or decrease fuel pressure. In further examples in the table below, preset actions are taken in response to efficiency scores within preset ranges.

Efficiency Score	Action
<= 1	SHUTDOWN
>1 AND <= 2	ALERT
>2 AND <= 3	ADJUST SETTINGS
>3 AND <= 4	NO ACTION

[0081] The adjustment event may include forming an adjustment instruction message and publishing or sending the adjustment instruction message to the mobile distribution station 20 via the IoT Gateway. Upon receiving the adjustment instruction message the controller 52 of the mobile distribution station 20 validates and executes the message. The message constitutes a control action to change one or more of the operating parameters to move the efficiency score within the limit or range. As an example, pumping rate is changed to change fuel pressure. Other parameters may additionally or alternatively be adjusted to change the fuel efficiency score, such as but not limited to, fuel tank upper and lower thresholds, sequence of opening/closing control valves 44, and number of control valves 44 that may be open at one time. Thus, once implemented, the method 79 can serve to auto-adjust operation of one or more of the mobile distribution stations 20, without human intervention, to achieve enhanced or optimize fuel distribution.

[0082] In one example, a rate of fuel consumption of one or more pieces of the equipment may be calculated, and the upper and/or lower fuel level threshold settings are changed in response to the calculated rate of fuel consumption. For instance, if consumption is lower or higher than a given fuel level threshold setting warrants, the fuel level threshold setting is responsively auto-adjusted up or down for more efficient operation. For a low consumption rate, there may be a downward adjustment of the lower fuel level threshold, since there is lower likelihood that the low consumption rate will lead to a fully empty condition in the equipment. Similarly, for a high consumption rate, there may be an upward adjustment of the lower fuel level threshold, since there is higher likelihood that the high consumption rate will lead to a fully empty condition in the equipment. Thus, the mobile distribution station 20 can be operated more efficiently and safely by distributing fuel at proper times to ensure filling the equipment with desired safety margins.

[0083] Similar to the shutdown instruction message described above, the method 79 may include a timing feature that waits for confirmation of adjustment. Once adjustment is confirmed by the controller 52, confirmation of adjustment is published or sent via the Iot Gateway to the IoT Platform for subsequent issuance of an alert. If there is no confirmation of adjustment by a maximum preset time threshold, a non-confirmation of adjustment is published or sent for subsequent issuance of an alert. In further examples, the method 79 may exclude use of the efficiency score for purposes of shutdown or for purposes of intelligent auto-management. That is, the method 79 may employ the efficiency score for only one or the other of shutdown or intelligent auto-management.

[0084] Additionally or alternatively, the system 69 with one or more mobile distribution stations 20 and one or more servers may be used for centralized, intelligent auto-filling. For example, fuel levels may be tracked in real-time or near real-time. When a fuel level associated with one of the stations 20 reaches the lower threshold, described above, an instruction may be sent via the system 69 to active the pump 30 and open the appropriate control valve 44. Moreover, the system 69 can ensure that there is minimal or zero delay time from the time of identifying the low threshold to the time that filling begins. Thus, at least a portion of the functionality of the controllers 52 may be remotely and centrally based in the server of the system 69.

[0085] Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the

portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

[0086] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

CLAIMS

What is claimed is:

1. A distribution station comprising:

a mobile trailer;

a pump on the mobile trailer;

a manifold on the mobile trailer and fluidly connected with the pump;

a plurality of hoses connected with the manifold;

a plurality of valves on the mobile trailer, each of the valves situated between the manifold and a respective different one of the hoses;

a plurality of fluid level sensors, each of the fluid level sensors being associated a respective different one of the hoses; and

a plurality of sensor communication lines, each of the sensor communication lines being connected or connectable with a respective different one of the fluid level sensors, and each of the sensor communication lines being routed with a respective different one of the hoses.

2. The distribution station as recited in claim 1, wherein each of the sensor communication lines is routed in the respective different one of the hoses.

3. The distribution station as recited in claim 1, wherein each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve.

4. The distribution station as recited in claim 1, further comprising a plurality of reels on the mobile trailer, each of the hoses being wound on a respective one of the reels, and each of the sensor communication lines being routed through a respective different one of the reels.

5. The distribution station as recited in claim 4, further comprising a plurality of connectors, each of the connectors being mounted on a respective different one of the reels and each of the connectors receiving a respective different one of the sensor communication lines.

6. The distribution station as recited in claim 4, wherein each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

7. The distribution station as recited in claim 1, wherein each of the sensor communication lines includes a respective connector that is detachably connectable with a respective different one of the fluid level sensors.

8. The distribution station as recited in claim 1, wherein each of the fluid level sensors is integrated with a respective fuel cap that includes a port that is detachably connectable with a respective different one of the hoses.

9. The distribution station as recited in claim 1, further comprising a controller on the mobile trailer, and each of the sensor communication lines is connected with the controller.

10. The distribution station as recited in claim 9, wherein controller is operable to open and close the plurality of valves responsive to a fuel level threshold.

11. The distribution station as recited in claim 1, wherein each of the hoses includes a tube and a sleeve that circumscribes the tube, and each of the sensor communication lines is routed in the respective different one of the hoses between the tube and the sleeve, and further comprising a plurality of reels on the mobile trailer, each of the hoses being wound on a respective one of the reels, and each of the sensor communication lines being routed through a respective different one of the reels.

12. The distribution station as recited in claim 11, wherein each of the reels includes a respective spindle, and each of the sensor communication lines is routed through a respective different one of the spindles.

13. A mobile distribution station comprising a pump, a manifold, a plurality of hoses, a plurality of detachably connectable fuel caps connected or connectable with the hoses, a plurality of valves, a plurality of fuel level sensors, and a controller, the controller configured to operate the pump responsive to a low fuel threshold to provide fuel to the manifold, from the manifold to the valves, and from the valves through the hoses, wherein the fuel level sensors are hard-wired through the hoses to the controller.

14. The mobile distribution station as recited in claim 13, wherein each of the hoses includes a tube and a sleeve circumscribing the tube, and the fuel level sensors are hard-wired through the hoses between the tubes and the sleeves.

15. The mobile distribution station as recited in claim 14, further comprising a plurality of reels on which the hoses are wound, and the fuel level sensors are hard-wired through the reels.

16. The mobile distribution station as recited in claim 15, wherein the fuel level sensors are hard-wired through spindles of the reels.

17. The mobile distribution station as recited in claim 16, wherein each of the fuel level sensors is detachably connectable with the controller.

MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

ABSTRACT

A distribution station includes a mobile trailer, a pump on the mobile trailer, a manifold on the mobile trailer and fluidly connected with the pump, a plurality of hoses connected with the manifold, a plurality of valves, each of the valves situated between the manifold and a respective one of the hoses, a plurality of fluid level sensors, each of the fluid level sensors being situated at an end of a respective one of the hoses, and a plurality of sensor communication lines. Each of the sensor communication lines is connected or connectable with a respective one of the fluid level sensors. Each of the sensor communication lines is routed with a respective one of the hoses.

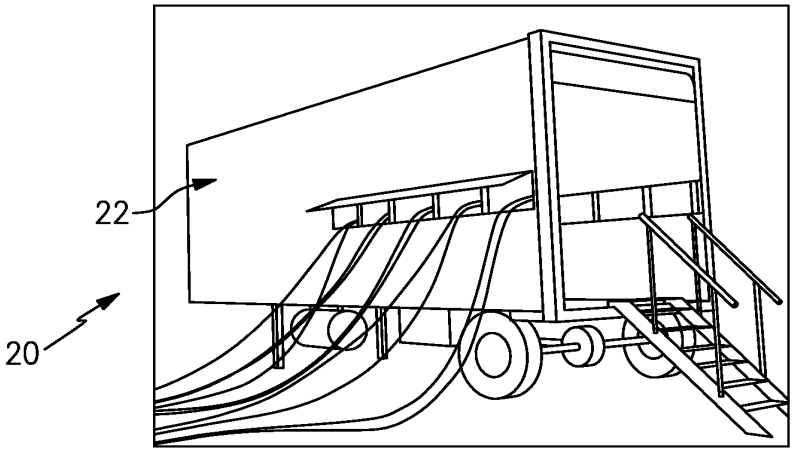

22
20

FIG.1

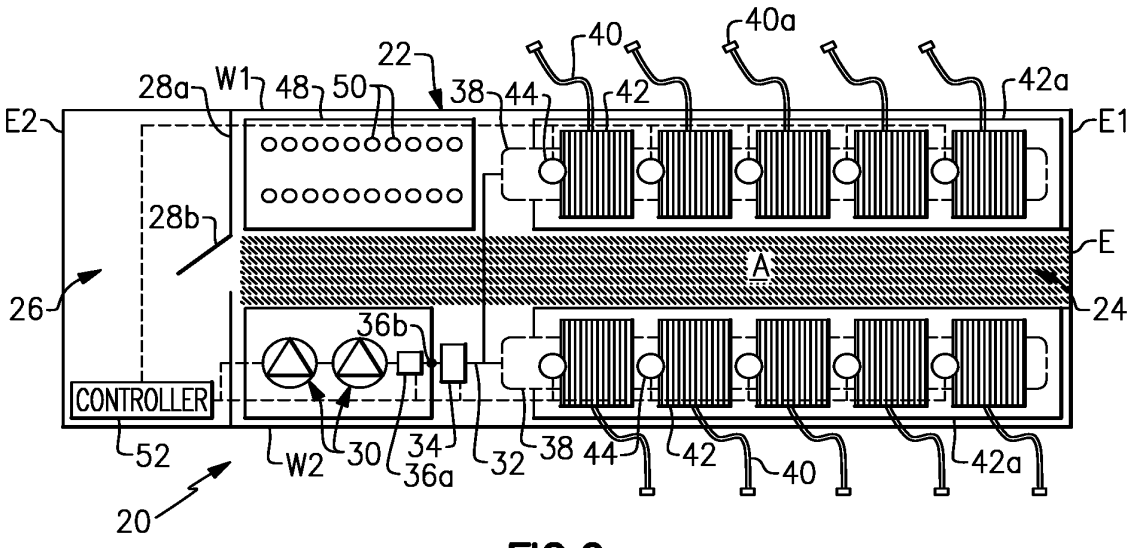

22
40
40a
28a
W1
48
50
38
44
42
42a
E2
E1
28b
E
A
26
24
36b
CONTROLLER
52
W2
30
34
36a
32
38
44
42
40
42a
20

FIG.2

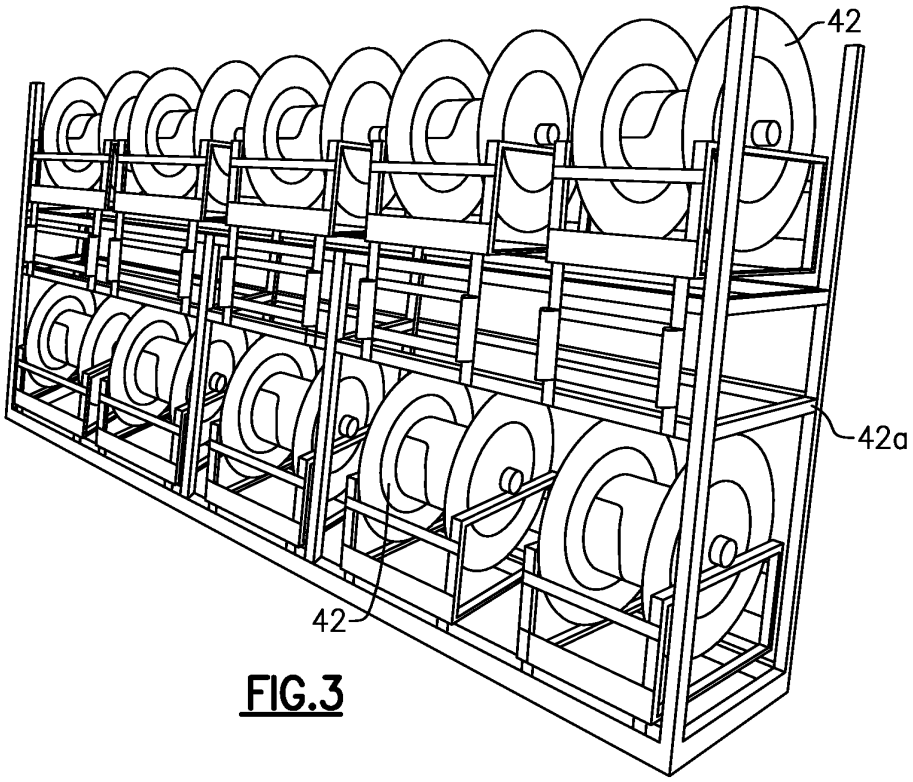


FIG.3

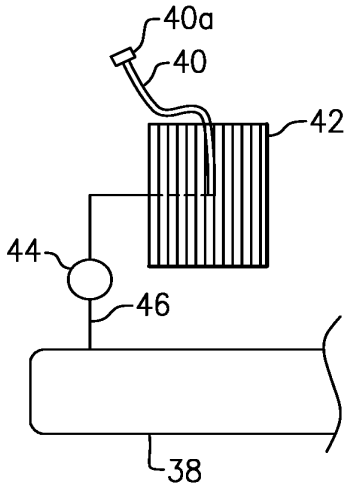


FIG.4

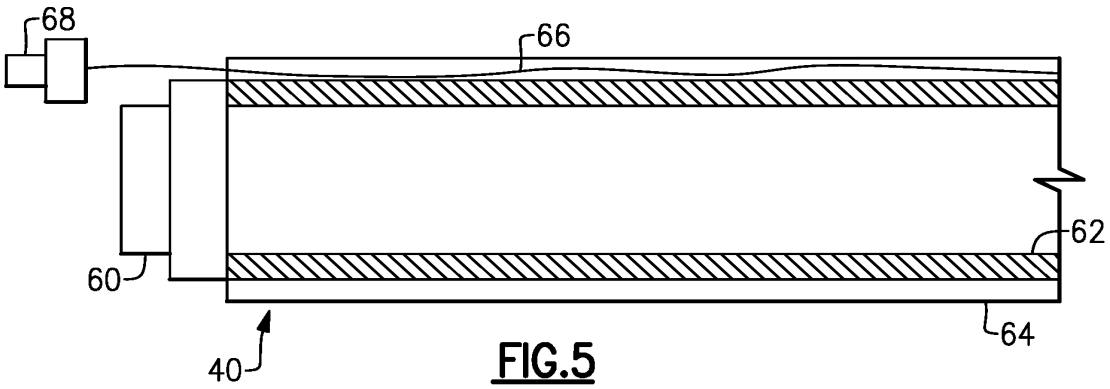


FIG.5

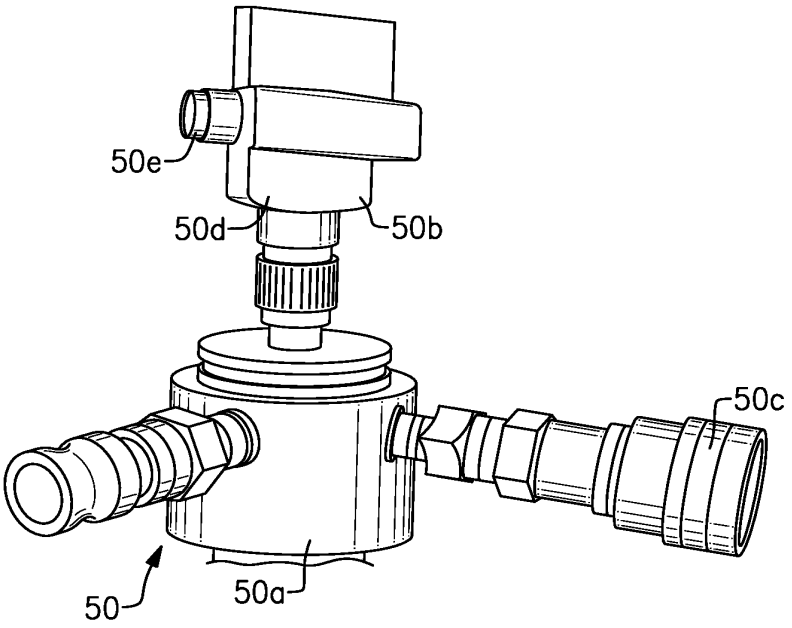


FIG.6

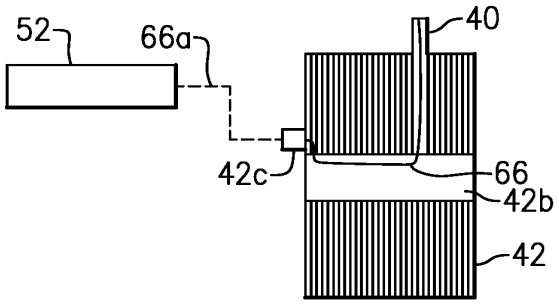


FIG.7

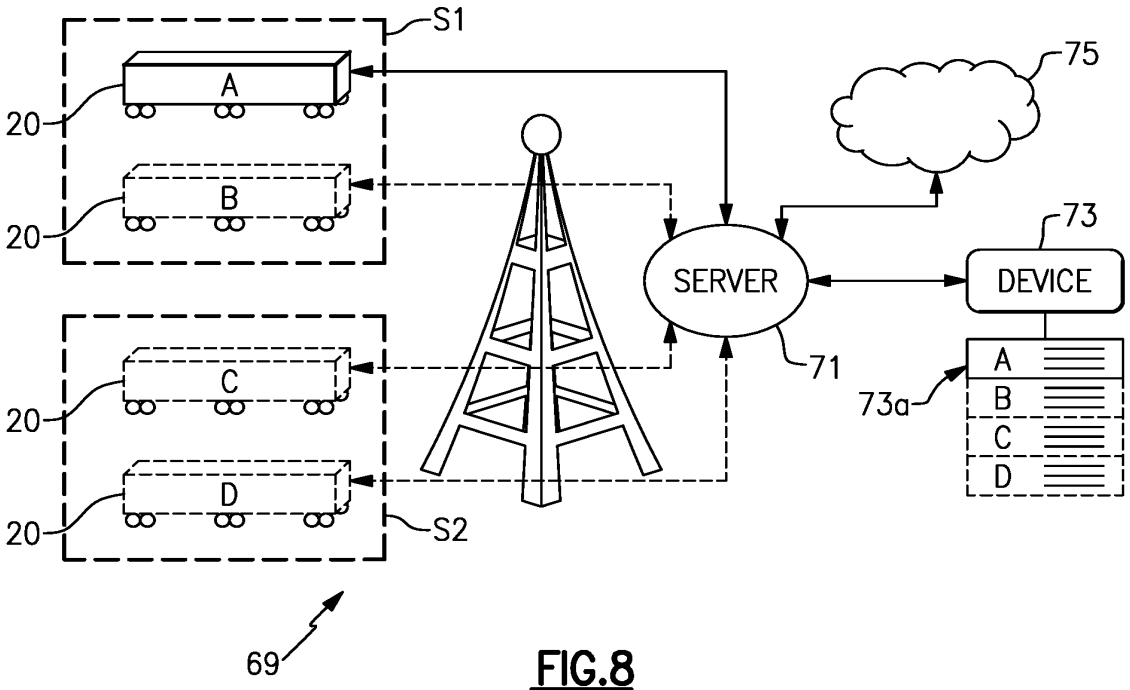


FIG.8

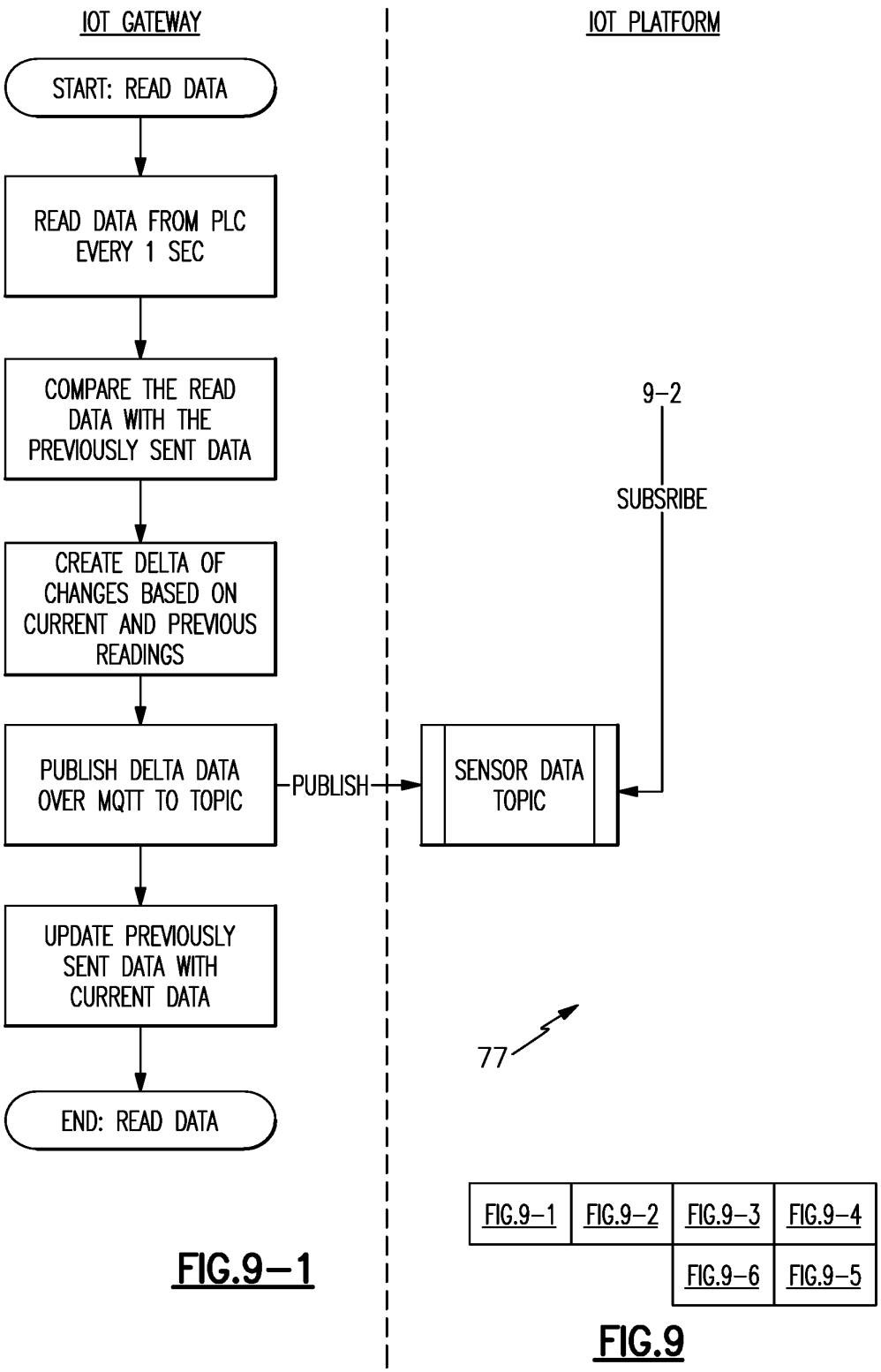


FIG.9-1

FIG.9-1	FIG.9-2	FIG.9-3	FIG.9-4
		FIG.9-6	FIG.9-5

FIG.9

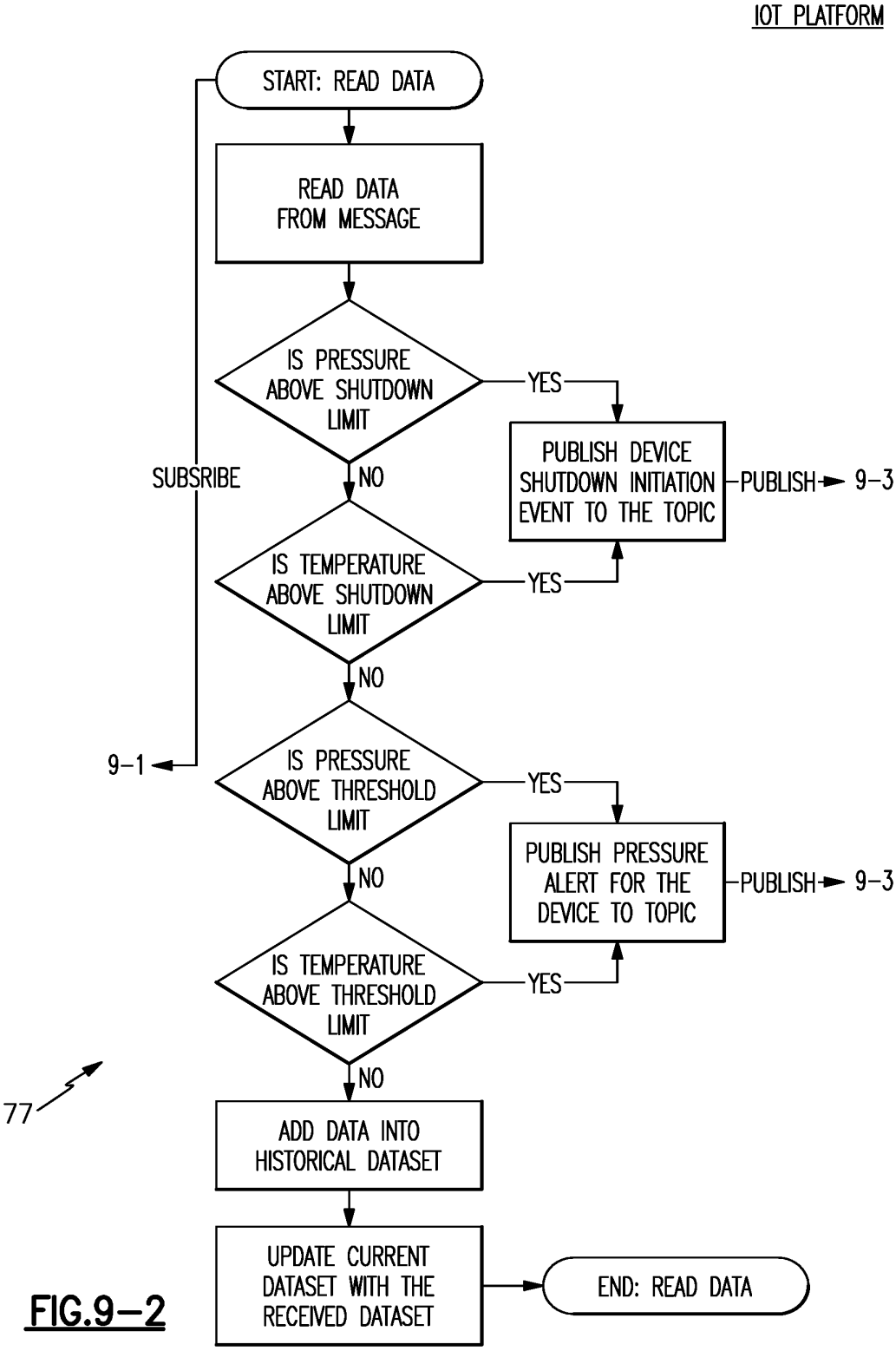

IOT PLATFORM
START: READ DATA
READ DATA FROM MESSAGE
IS PRESSURE ABOVE SHUTDOWN LIMIT
YES
PUBLISH DEVICE SHUTDOWN INITIATION EVENT TO THE TOPIC
PUBLISH
9-3
SUBSRIBE
NO
IS TEMPERATURE ABOVE SHUTDOWN LIMIT
YES
NO
9-1
IS PRESSURE ABOVE THRESHOLD LIMIT
YES
PUBLISH PRESSURE ALERT FOR THE DEVICE TO TOPIC
PUBLISH
9-3
NO
IS TEMPERATURE ABOVE THRESHOLD LIMIT
YES
NO
77
ADD DATA INTO HISTORICAL DATASET
UPDATE CURRENT DATASET WITH THE RECEIVED DATASET
END: READ DATA

FIG.9–2

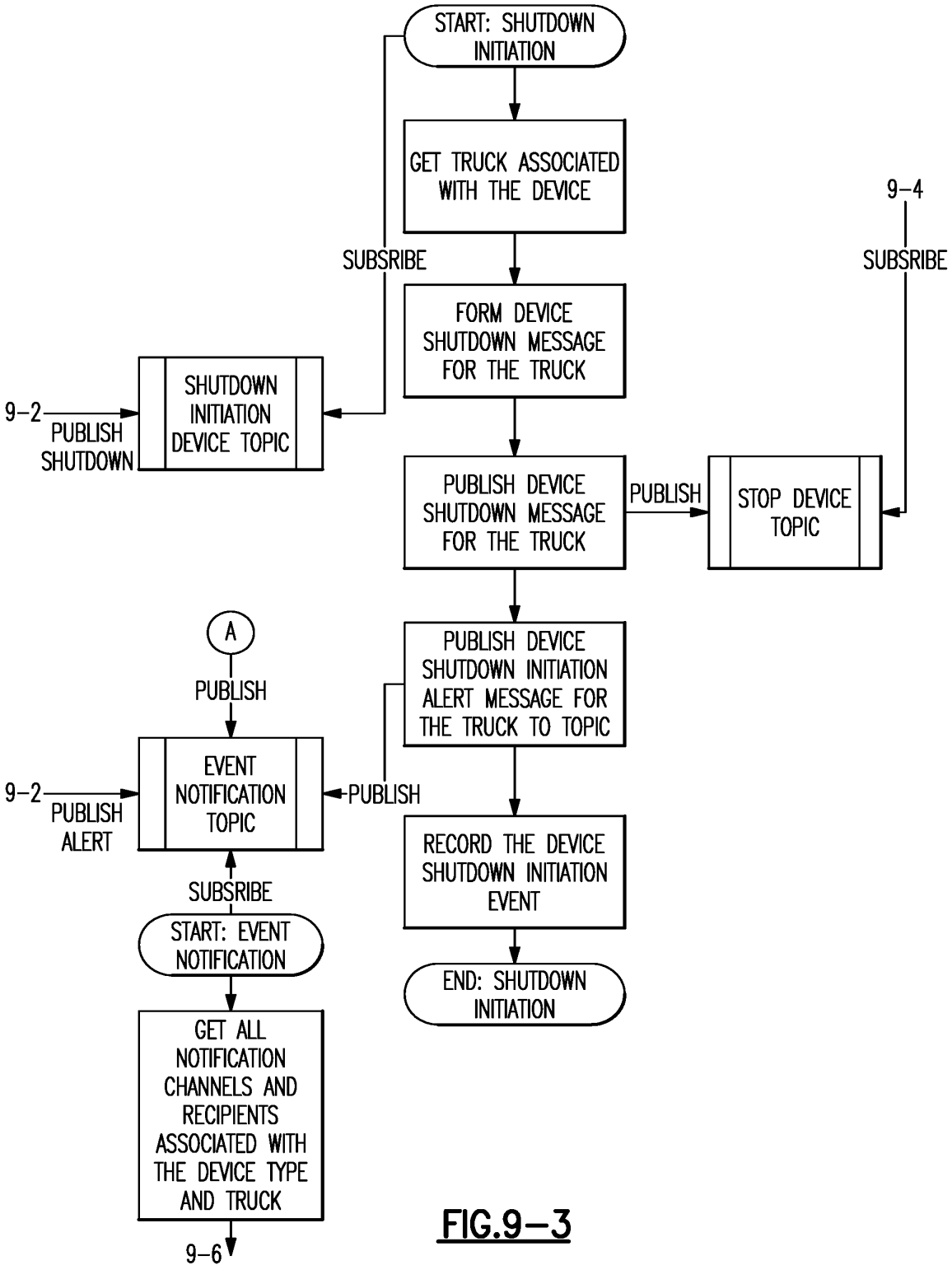

START: SHUTDOWN INITIATION
GET TRUCK ASSOCIATED WITH THE DEVICE
SUBSRIBE
FORM DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
9-2
PUBLISH SHUTDOWN
SHUTDOWN INITIATION DEVICE TOPIC
9-4
SUBSRIBE
PUBLISH DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
PUBLISH
STOP DEVICE TOPIC
A
PUBLISH
PUBLISH DEVICE SHUTDOWN INITIATION ALERT MESSAGE FOR THE TRUCK TO TOPIC
9-2
PUBLISH ALERT
EVENT NOTIFICATION TOPIC
PUBLISH
SUBSRIBE
START: EVENT NOTIFICATION
RECORD THE DEVICE SHUTDOWN INITIATION EVENT
END: SHUTDOWN INITIATION
GET ALL NOTIFICATION CHANNELS AND RECIPIENTS ASSOCIATED WITH THE DEVICE TYPE AND TRUCK
9-6

FIG.9-3

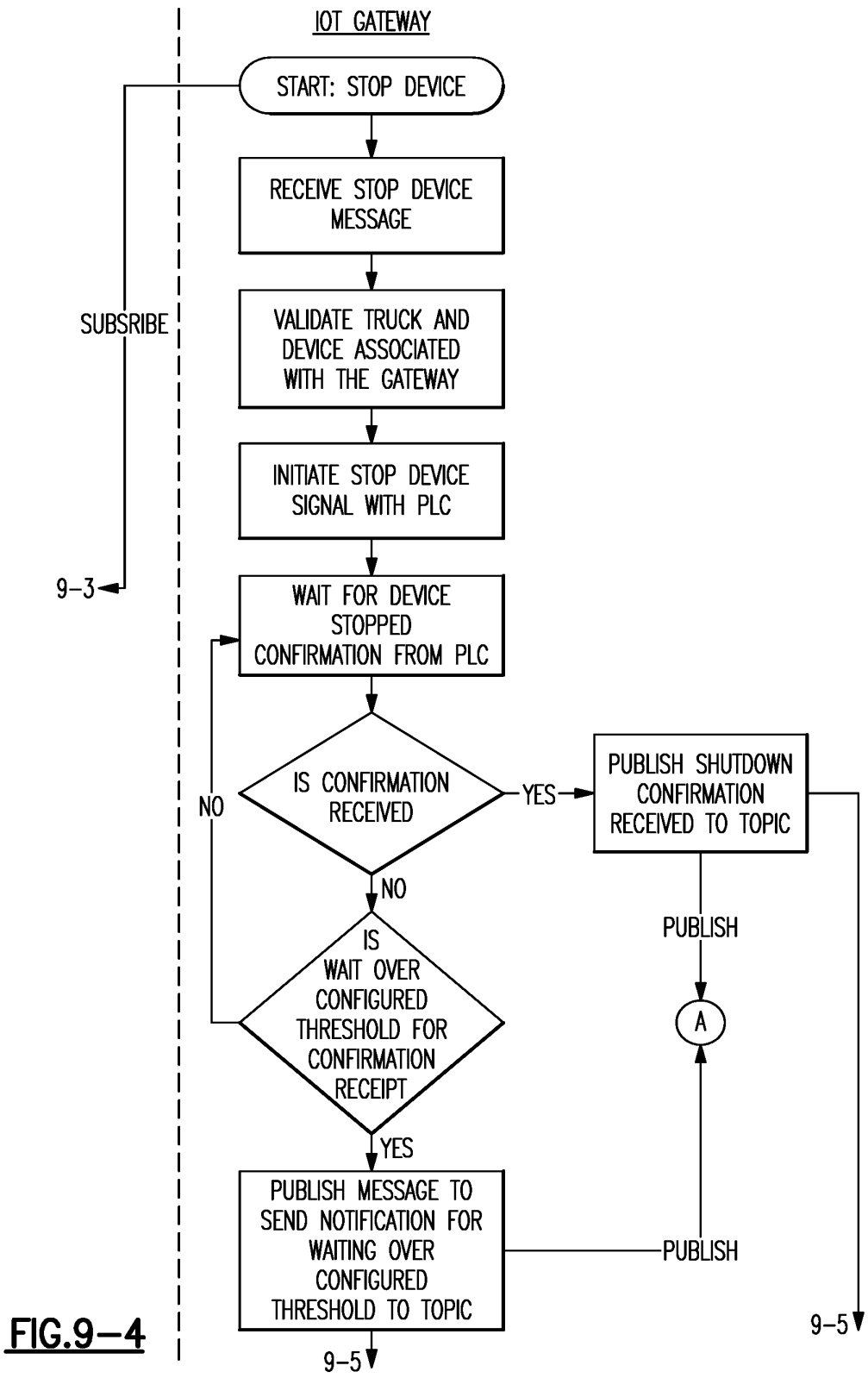

IOT GATEWAY
START: STOP DEVICE
RECEIVE STOP DEVICE MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE STOP DEVICE SIGNAL WITH PLC
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
NO
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
SUBSRIBE
9-3
9-5
9-5

FIG.9-4

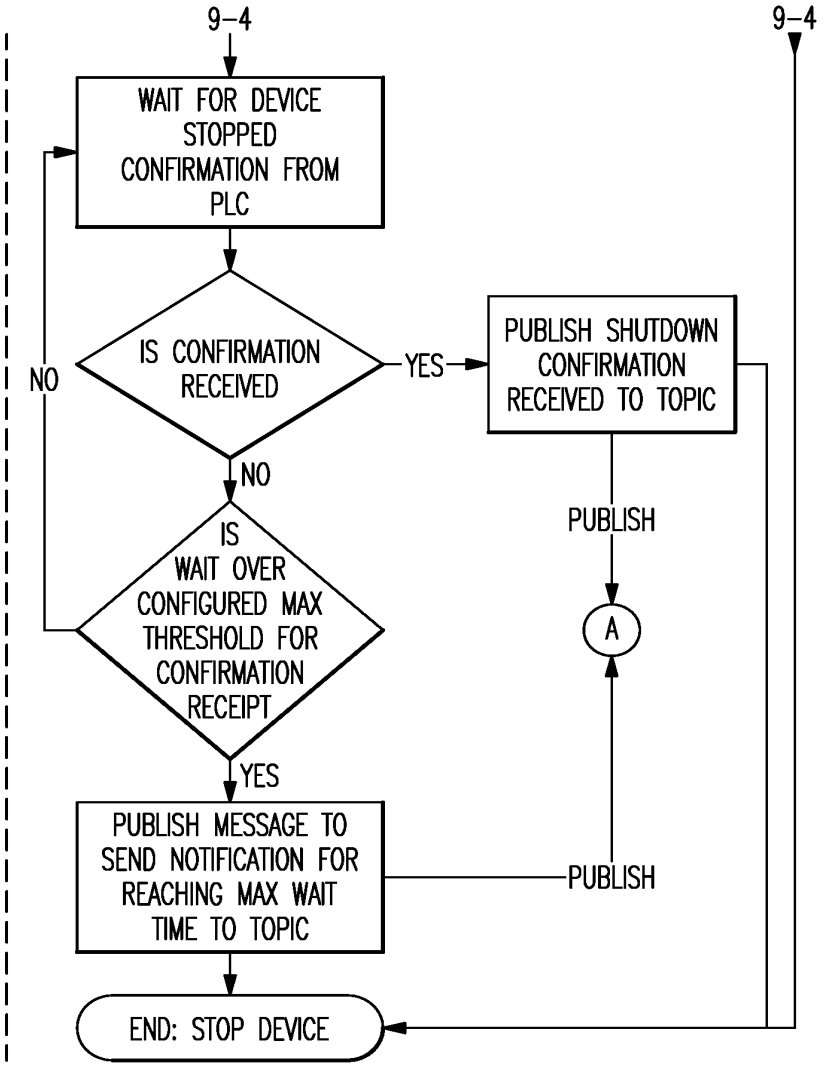

9-4
9-4
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
NO
PUBLISH
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
A
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: STOP DEVICE

FIG.9-5

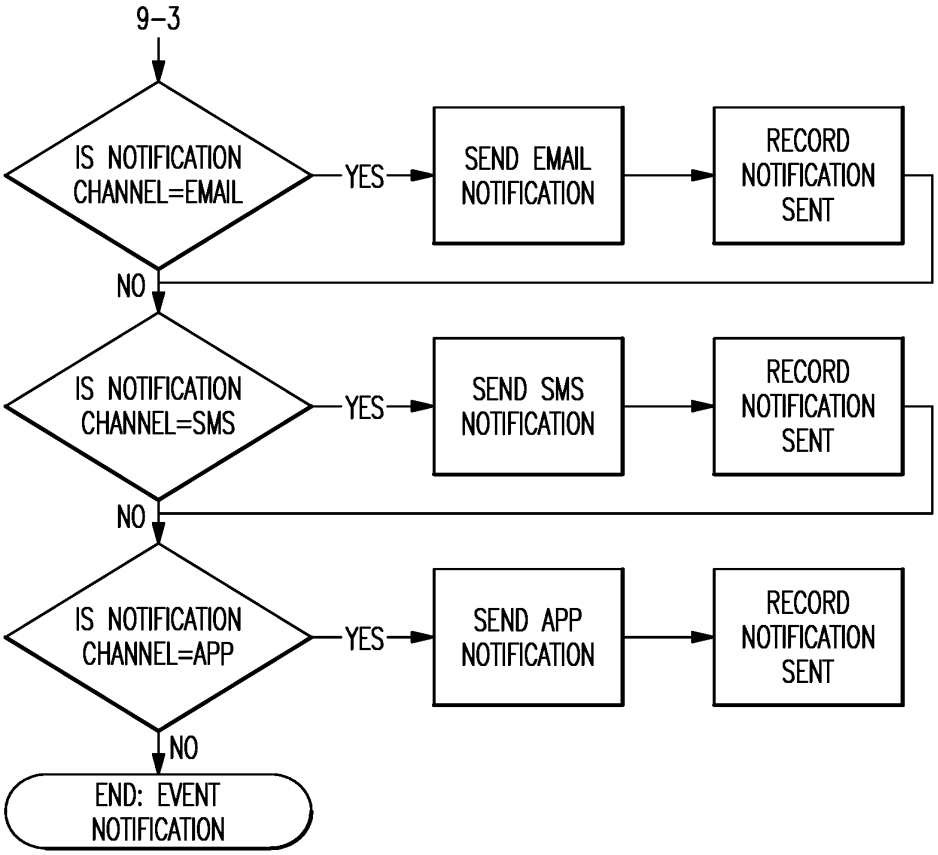

9-3
IS NOTIFICATION CHANNEL=EMAIL
YES
SEND EMAIL NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=SMS
YES
SEND SMS NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=APP
YES
SEND APP NOTIFICATION
RECORD NOTIFICATION SENT
NO
END: EVENT NOTIFICATION

FIG.9-6

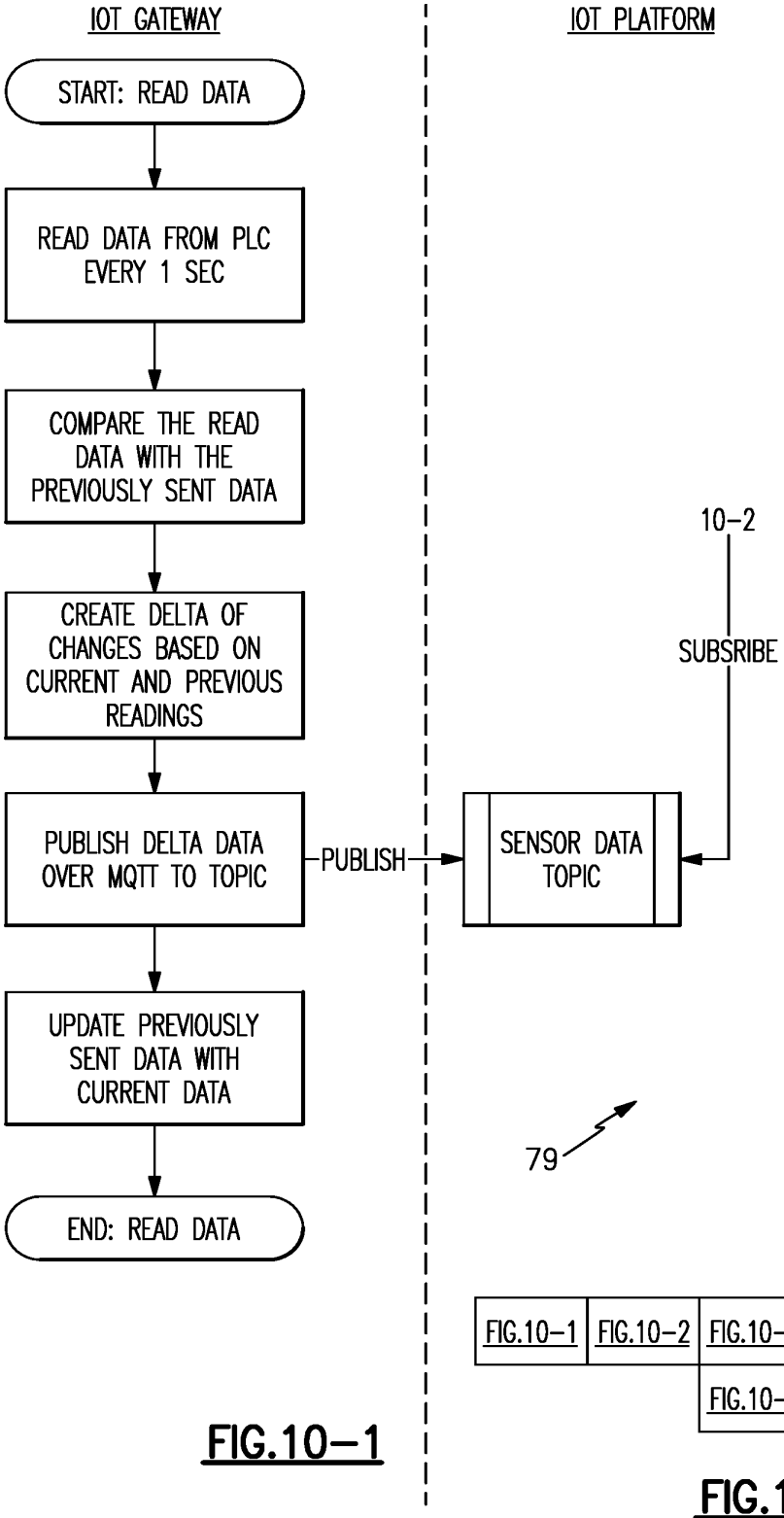


FIG.10-1

FIG.10-1	FIG.10-2	FIG.10-3	FIG.10-4	FIG.10-5
		FIG.10-6	FIG.10-7	FIG.10-8

FIG.10

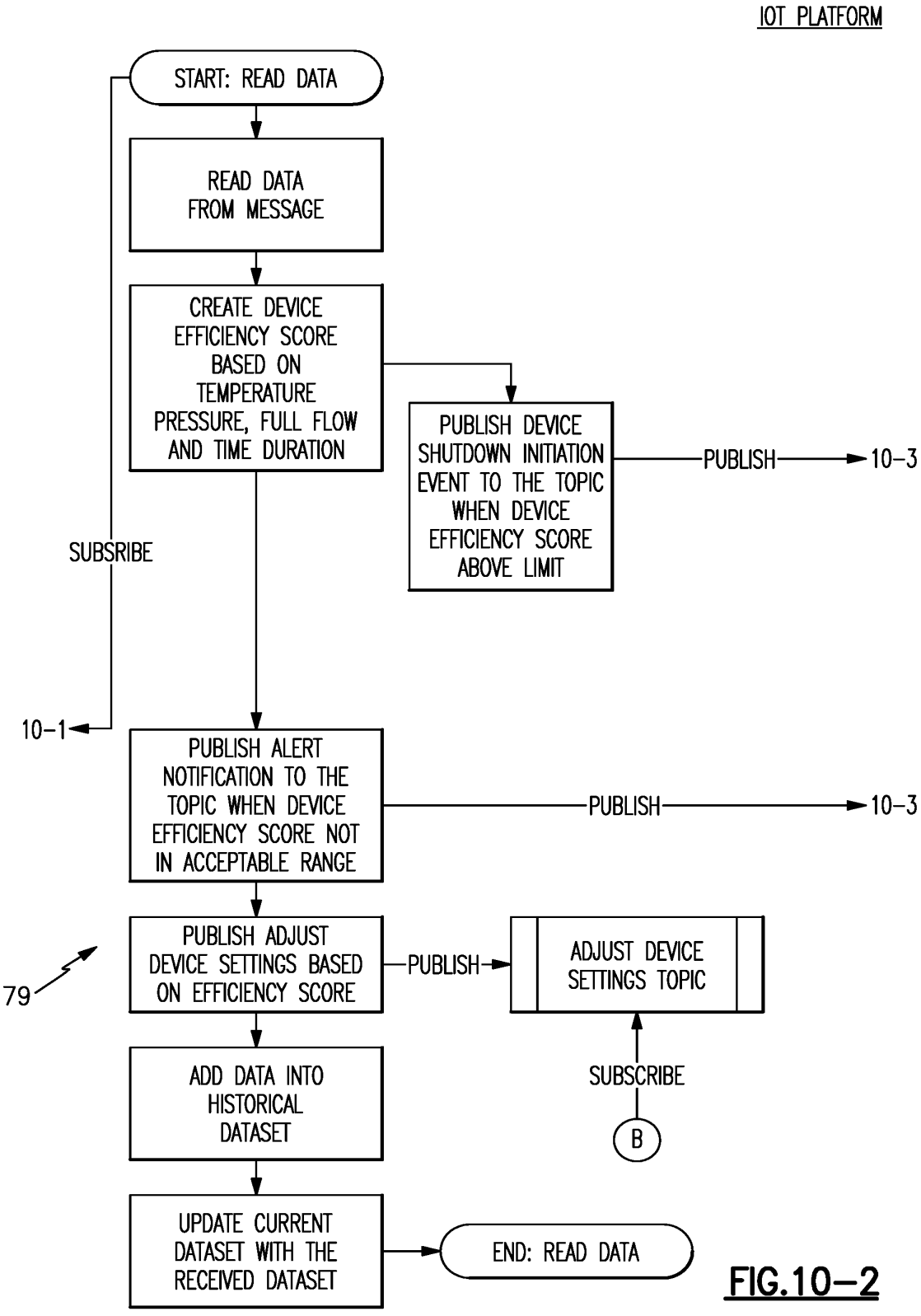

IOT PLATFORM
START: READ DATA
READ DATA FROM MESSAGE
CREATE DEVICE EFFICIENCY SCORE BASED ON TEMPERATURE PRESSURE, FULL FLOW AND TIME DURATION
PUBLISH DEVICE SHUTDOWN INITIATION EVENT TO THE TOPIC WHEN DEVICE EFFICIENCY SCORE ABOVE LIMIT
PUBLISH
10-3
SUBSRIBE
10-1
PUBLISH ALERT NOTIFICATION TO THE TOPIC WHEN DEVICE EFFICIENCY SCORE NOT IN ACCEPTABLE RANGE
PUBLISH
10-3
79
PUBLISH ADJUST DEVICE SETTINGS BASED ON EFFICIENCY SCORE
PUBLISH
ADJUST DEVICE SETTINGS TOPIC
SUBSCRIBE
B
ADD DATA INTO HISTORICAL DATASET
UPDATE CURRENT DATASET WITH THE RECEIVED DATASET
END: READ DATA

FIG.10-2

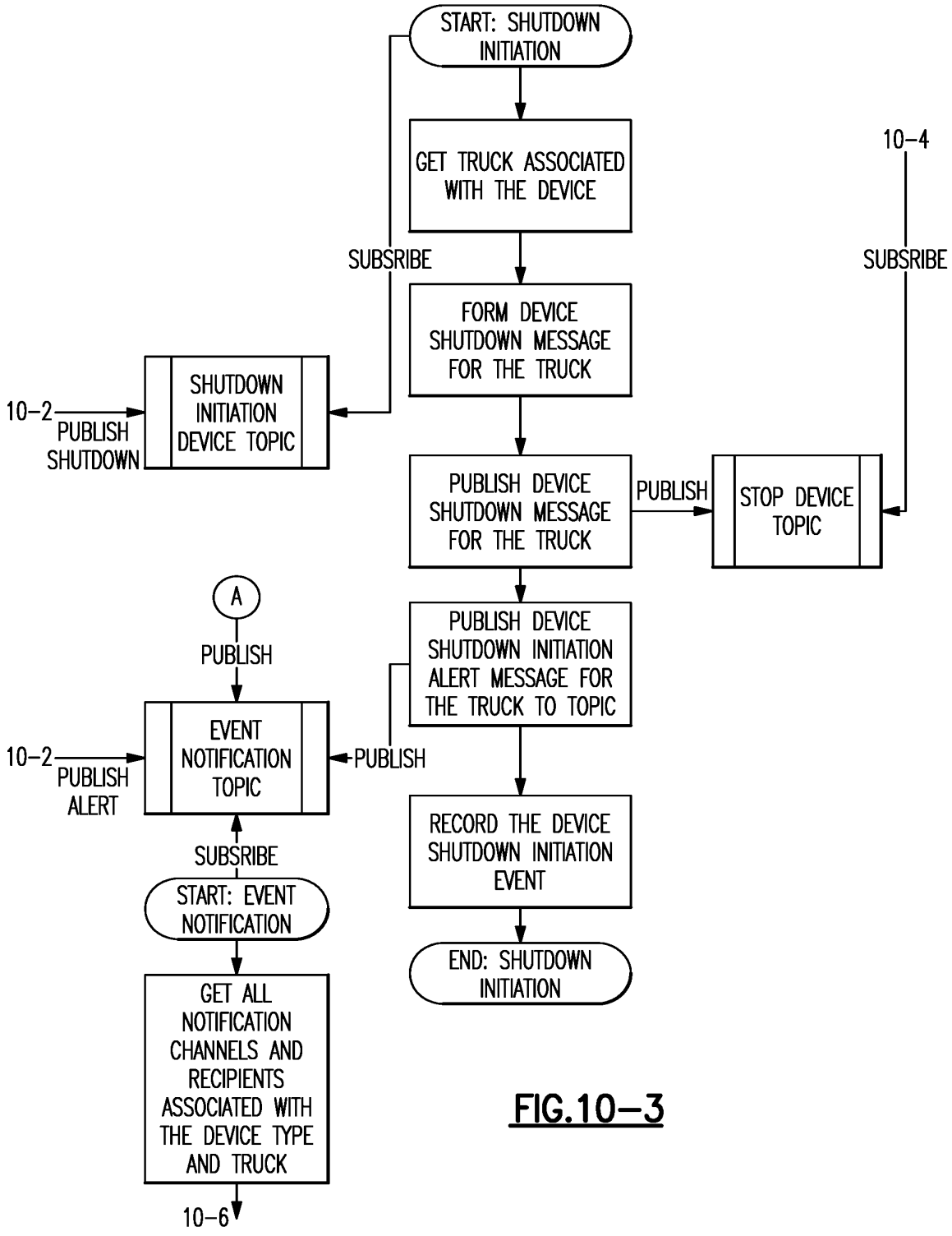

START: SHUTDOWN INITIATION
GET TRUCK ASSOCIATED WITH THE DEVICE
FORM DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
PUBLISH DEVICE SHUTDOWN MESSAGE FOR THE TRUCK
PUBLISH DEVICE SHUTDOWN INITIATION ALERT MESSAGE FOR THE TRUCK TO TOPIC
RECORD THE DEVICE SHUTDOWN INITIATION EVENT
END: SHUTDOWN INITIATION
SUBSRIBE
10-2
PUBLISH
SHUTDOWN
SHUTDOWN INITIATION DEVICE TOPIC
PUBLISH
STOP DEVICE TOPIC
10-4
SUBSRIBE
A
PUBLISH
10-2
PUBLISH
ALERT
EVENT NOTIFICATION TOPIC
PUBLISH
SUBSRIBE
START: EVENT NOTIFICATION
GET ALL NOTIFICATION CHANNELS AND RECIPIENTS ASSOCIATED WITH THE DEVICE TYPE AND TRUCK
10-6

FIG.10-3

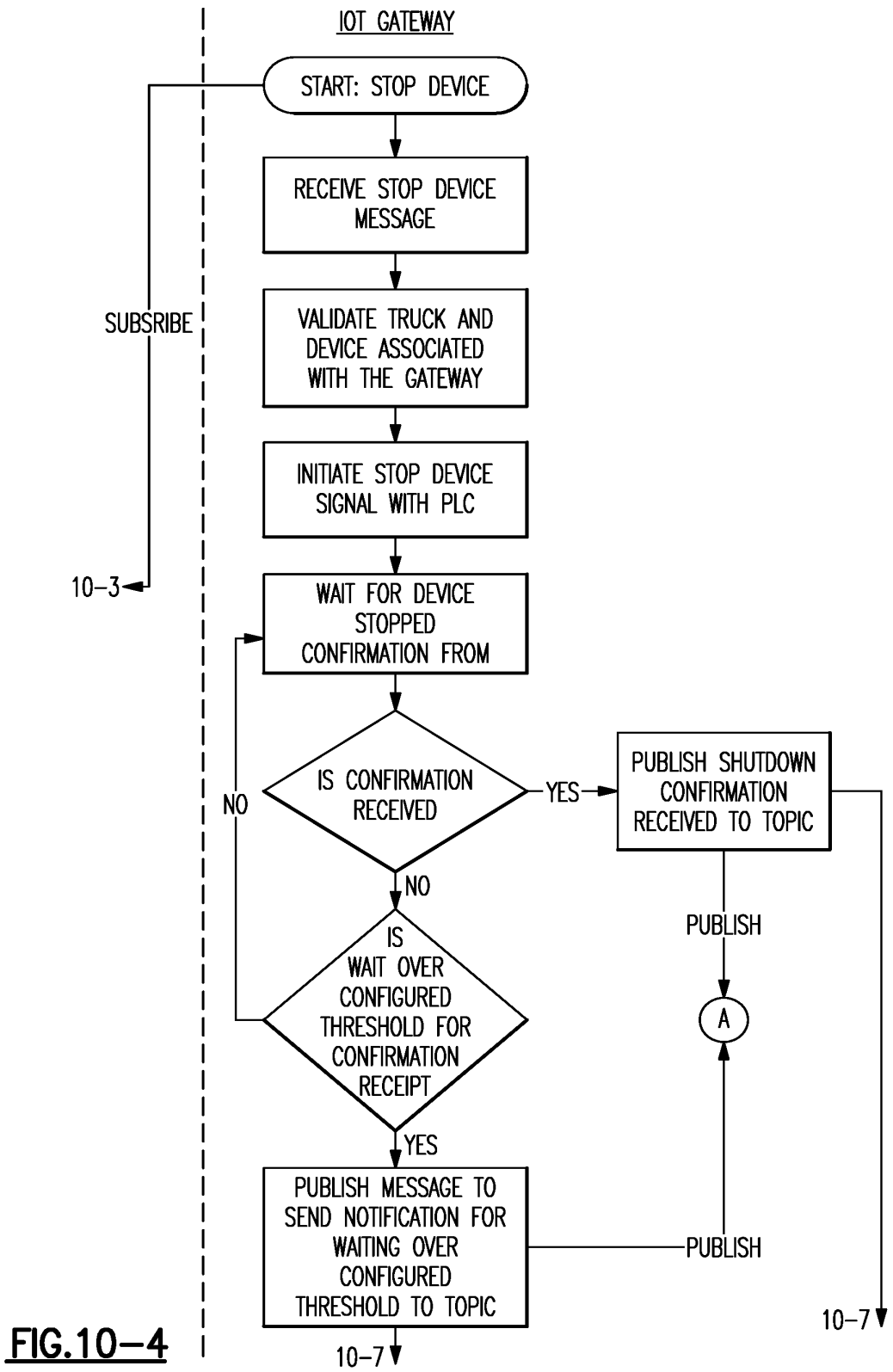

IOT GATEWAY
START: STOP DEVICE
RECEIVE STOP DEVICE MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE STOP DEVICE SIGNAL WITH PLC
WAIT FOR DEVICE STOPPED CONFIRMATION FROM
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
NO
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
SUBSRIBE
10-3
10-7
10-7

FIG.10-4

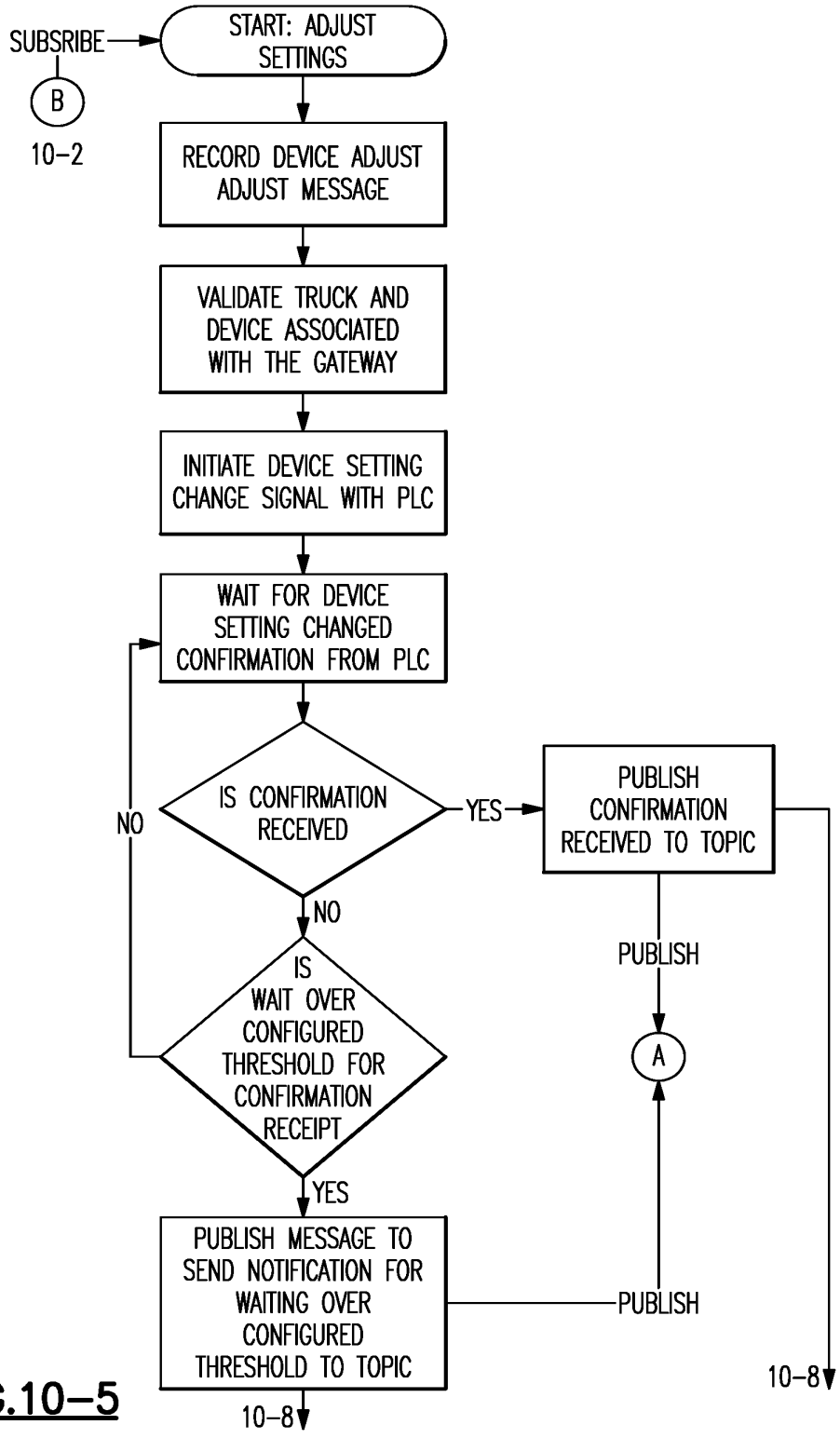

SUBSRIBE
B
10-2
START: ADJUST SETTINGS
RECORD DEVICE ADJUST ADJUST MESSAGE
VALIDATE TRUCK AND DEVICE ASSOCIATED WITH THE GATEWAY
INITIATE DEVICE SETTING CHANGE SIGNAL WITH PLC
WAIT FOR DEVICE SETTING CHANGED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
NO
IS WAIT OVER CONFIGURED THRESHOLD FOR CONFIRMATION RECEIPT
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR WAITING OVER CONFIGURED THRESHOLD TO TOPIC
PUBLISH
10-8
10-8

FIG.10-5

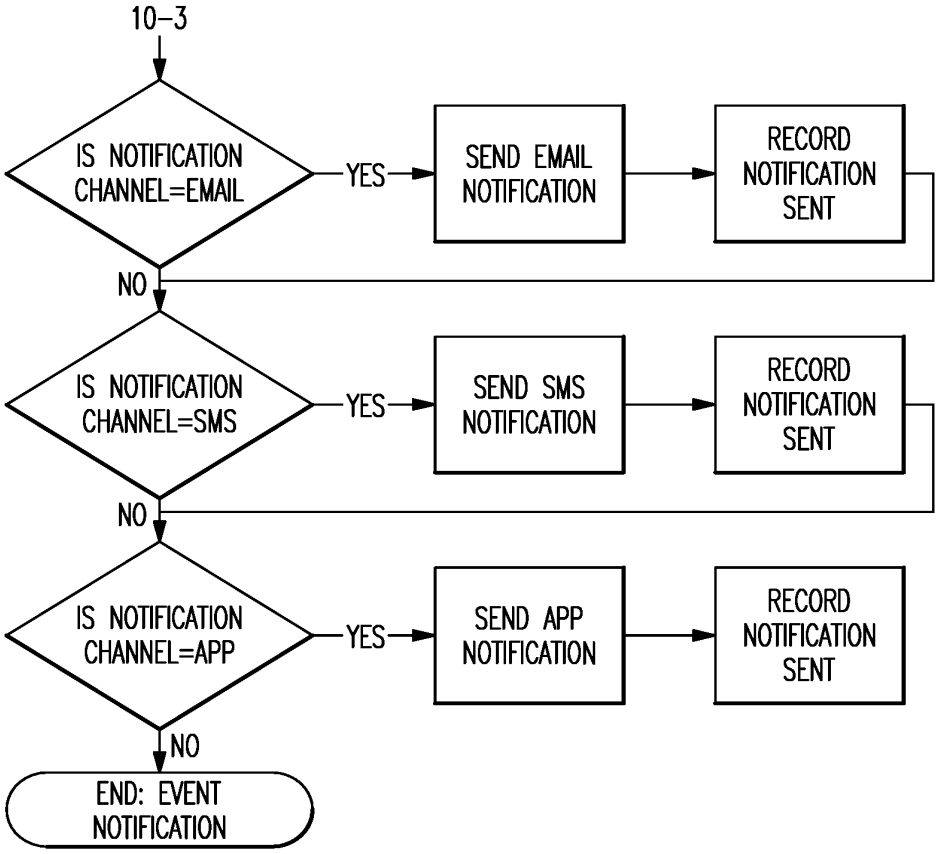

10-3
IS NOTIFICATION CHANNEL=EMAIL
YES
SEND EMAIL NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=SMS
YES
SEND SMS NOTIFICATION
RECORD NOTIFICATION SENT
NO
IS NOTIFICATION CHANNEL=APP
YES
SEND APP NOTIFICATION
RECORD NOTIFICATION SENT
NO
END: EVENT NOTIFICATION

FIG.10-6

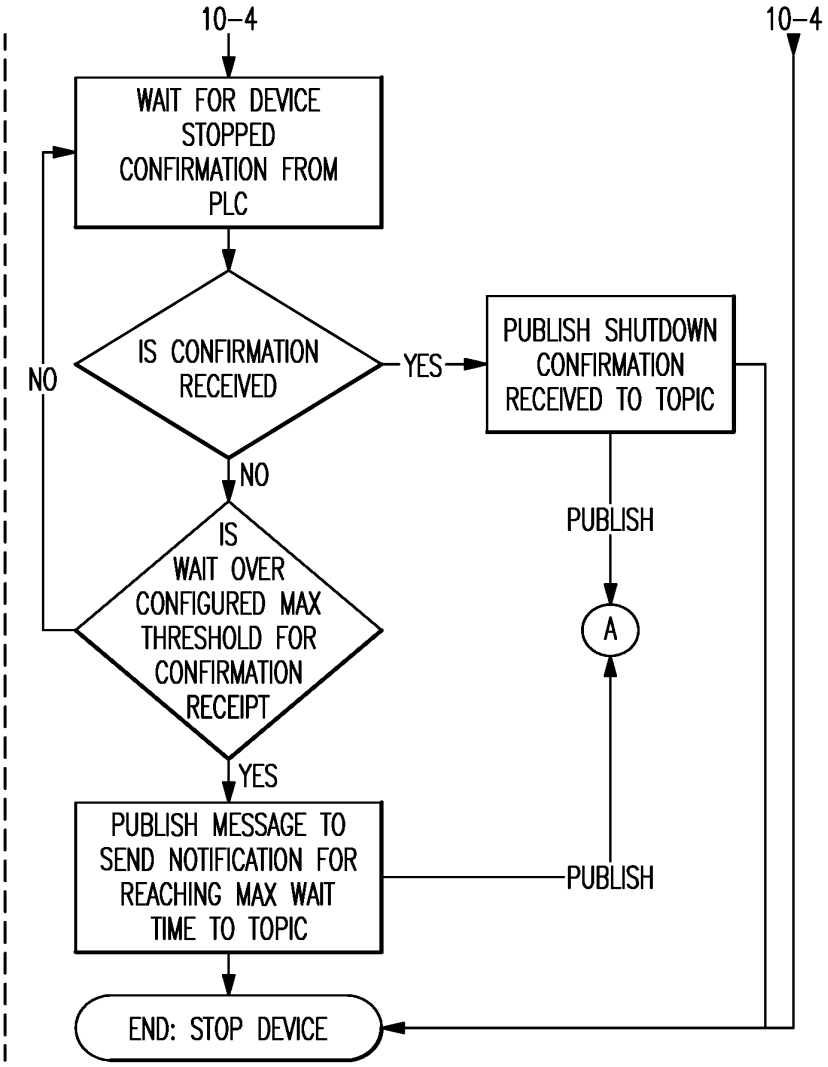

10-4
10-4
WAIT FOR DEVICE STOPPED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
A
NO
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: STOP DEVICE

FIG.10-7

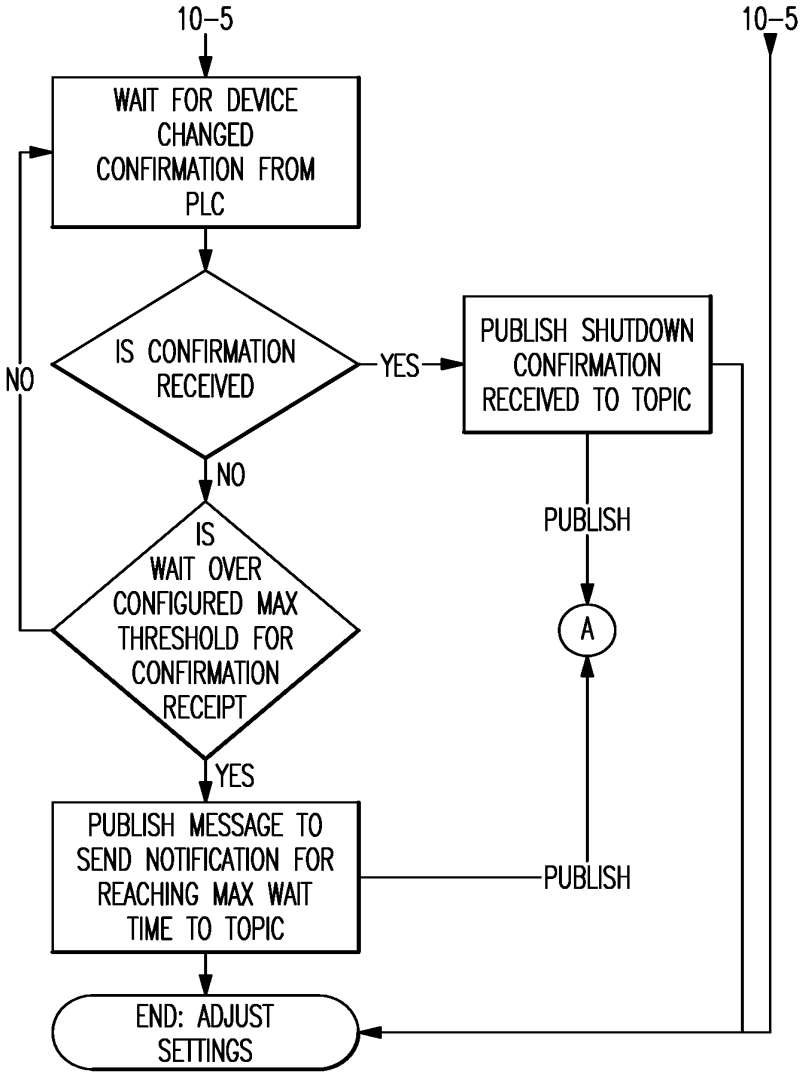

10–5
10–5
WAIT FOR DEVICE CHANGED CONFIRMATION FROM PLC
IS CONFIRMATION RECEIVED
YES
NO
PUBLISH SHUTDOWN CONFIRMATION RECEIVED TO TOPIC
PUBLISH
NO
IS WAIT OVER CONFIGURED MAX THRESHOLD FOR CONFIRMATION RECEIPT
A
YES
PUBLISH MESSAGE TO SEND NOTIFICATION FOR REACHING MAX WAIT TIME TO TOPIC
PUBLISH
END: ADJUST SETTINGS

FIG.10–8

PTO/SB/08a (01-10)
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Application Number	
Filing Date	
First Named Inventor	Shock
Art Unit	
Examiner Name	
Attorney Docket Number	67846-006PUS1

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	2516150		1950-07-25	Samiran	
	2	2769572		1956-11-06	Harman et al.	
	3	2777461		1957-01-15	Wildhaber	
	4	3028010		1962-04-03	Headrick	
	5	3136295		1964-06-09	Gramo	
	6	3547141		1970-12-15	Alexander	
	7	3618643		1971-11-09	Thomson	
	8	4139019		1979-02-13	Bresie et al.	

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	Filing Date	
	First Named Inventor	Shock
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	Examiner Name	
	Attorney Docket Number	67846-006PUS1

	9	4591115		1986-05-27	DeCarlo	
	10	4930665		1990-06-05	Devine	
	11	5406988		1995-04-18	Hopkins	
	12	5454408		1995-10-03	DiBella et al.	
	13	5503199		1996-04-02	Whitley, II et al.	
	14	5538051		1996-07-23	Brown et al.	
	15	5708424		1998-01-13	Orlando et al.	
	16	5884675		1999-12-23	Krasnov	
	17	6206056		2001-03-27	Lagache	
	18	6564615		2003-05-20	Carter	
	19	6651706		2003-11-25	Litt	

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	Examiner Name	
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	20	6697705		2004-02-24	Johnson et al.	
	21	6755225		2004-06-29	Niedwiecki et al.	
	22	6761194		2004-07-13	Blong	
	23	6786245		2004-09-07	Eichelberger et al.	
	24	7063276		2006-06-20	Newton	
	25	7106026		2006-09-12	Moore	
	26	7353808		2008-04-08	Kakoo	
	27	7415995		2008-08-26	Plummer et al.	
	28	7458543		2008-12-02	Cutler et al.	
	29	7568507		2009-08-04	Farese et al.	
	30	7602143		2009-12-13	Capizzo	

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	Attorney Docket Number	67846-006PUS1

	31	7628182		2009-12-08	Poulter	
	32	7938151		2011-05-10	Hockner	
	33	9346662		2016-05-24	Van Vliet et al.	
	34	9371830		2016-06-21	Moffitt, Jr.	
	35	9371831		2016-06-21	Moffitt, Jr.	

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	1	20070079891		2007-04-12	Farese et al.	
	2	20070164031		2007-07-19	Holz	
	3	20070181212		2007-08-09	Fell	
	4	20160076533		2016-03-17	Moffitt, Jr.	

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	1	0177006	WO		2001-10-18	BARTEC COMPONENTEN & SYST GMBH		
	2	2006005686	WO		2006-01-19	SECURITY & ELECTRONIC TECHNOLOGIES GMBH		
	3	2008083830	WO		2008-07-17	SECURITY & ELECTRONIC TECHNOLOGIES GMBH		
	4	2009026607	WO		2009-03-05	BANLAW PIPELINE PTY LTD		
	5	2485832	GB		2012-05-30	GRIFFITHS, Joseph Anthony BRITANNIA 2000 LIMITED		

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	1	Oilfield Business: Technologies. Frac Shack Inc. introduces world's first Bi-Fuel Distribution Unit for hydraulic fracturing industry. Texas Oil & Gas: The National Magazine for Oil & Gas in Texas. Vol. 4, Issue 2. 2015. p. 27.	
	2	Frac Shack International. Publications & Endorsements. Retrieved August 23, 2016 from: http://www.fracshack.com	
	3	Frac Shack International. Technology. Retrieved August 23, 2016 from: http://www.fracshack.com	

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	Filing Date	
	First Named Inventor	Shock
	Art Unit	
	Examiner Name	
	Attorney Docket Number	67846-006PUS1

	4	Frac Shack International. Design Benefits. Retrieved August 23, 2016 from: http://www.fracshack.com	
	5	Frac Shack International. Publications & Endorsements. Retrieved August 23, 2016 from: http://www.fracshack.com	
	6	Frac Shack International. Service. Retrieved August 23, 2016 from: http://www.fracshack.com	
	7	Frac Shack International. Frac Shack Series- Series A. Retrieved August 23, 2016 from: http://www.fracshack.com	
	8	Frac Shack International. Frac Shack Series- Series B. Retrieved August 23, 2016 from: http://www.fracshack.com	
	9	Frac Shack International. Frac Shack Series- Series C. Retrieved August 23, 2016 from: http://www.fracshack.com	
	10	Frac Shack International. Frac Shack Series- Series D. Retrieved August 23, 2016 from: http://www.fracshack.com	
	11	Frac Shack International. Frac Shack Series- Series E. Retrieved August 23, 2016 from: http://www.fracshack.com	
	12	Frac Shack International. Frac Shack Series- Series EG. Retrieved August 23, 2016 from: http://www.fracshack.com	
	13	Mann Tek. Dry Disconnect Couplings. Retrieved July 22, 2016 from: http://www.manntek.com/products/drydisconnectcouplings p. 1-4	
	14	Mann Tek. Dry Aviation Couplings. Retrieved July 22, 2016 from: http://www.manntek.com/products/dryaviationcouplings p. 1-4	

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	Application Number	
	Filing Date	
	First Named Inventor	Shock
	Art Unit	
	Examiner Name	
	Attorney Docket Number	67846-006PUS1

	15	Water, J. (2013). Better Safe than Sorry: Frac Shack a welcome addition to the oil patch. January 2, 2013. Retrieved August 23, 2016 from: http://www.pipelinenewsnorth.ca/better-safe-than-sorry-1.1123066	

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	Attorney Docket Number	67846-006PUS1

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew L. Koziarz/	Date (YYYY-MM-DD)	2016-10-11
Name/Print	Matthew L. Koziarz	Registration Number	53154

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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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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.

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(12) UK Patent Application (19) GB (11) 2485832 (13) A

(43) Date of A Publication 30.05.2012

(21) Application No: 1020096.2

(22) Date of Filing: 26.11.2010

(71) Applicant(s):
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(72) Inventor(s):
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John Swatton
Mike Kelly
Ralph Jones

(74) Agent and/or Address for Service:
Venner Shipley LLP
200 Aldersgate, LONDON, EC1A 4HD, United Kingdom

(51) INT CL:
F16L 11/127 (2006.01) ***F16L 25/01*** (2006.01)
F16L 37/407 (2006.01) ***H01R 13/00*** (2006.01)

(56) Documents Cited:
EP 1901382 A2 **EP 1127583 A2**
EP 0337055 A2 **DE 002333620 A1**
DE 002212656 A1 **US 5810048 A1**
US 20040025682 A1 **US 20020135179 A1**

(58) Field of Search:
INT CL **F16L, H01R**
Other: **EPODOC, WPI**

(54) Title of the Invention: **A fluid supply and data communication system and couplings for use in such a system**
Abstract Title: **A combined fluid coupling and data communication connection**

(57) A combined fluid supply and data communication conduit comprising a fluid supply duct / pipe 2, a data communication cable / wire 10 within the pipe, at least one end of the duct having a coupling 5 comprising a fluid tight valve 8 which is closed when the coupling is uncoupled (shown) and opened when the coupling is coupled, wherein the coupling comprises a data connection terminal 12 connected to the cable. The data cable may be an electrical wire for providing audio / radio link, or may be an optic fibre cable for a camera link, amongst others. The data terminals may be concentric, spring mounted, etc. Contactless RF induction coupling may alternatively be used to transmit data for safety reasons (fig. 7). Preferably air is fed in the pipe to a user on an oil-platform. Other independent claims relate to mating components of a releasable combined fluid supply and communications coupling, a retro-fit data communication connector and a retro-fitted adaptor.

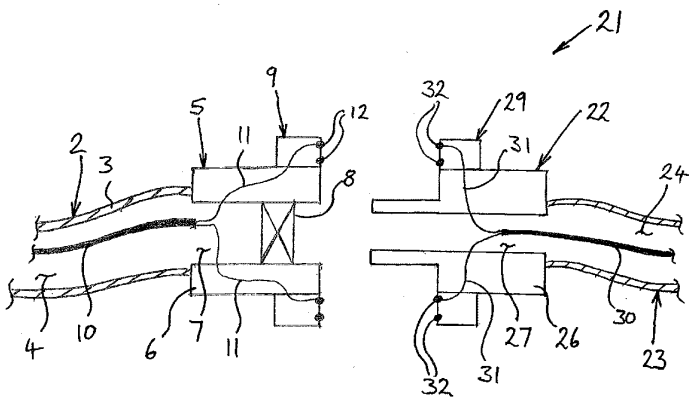


FIGURE 2

GB 2485832 A

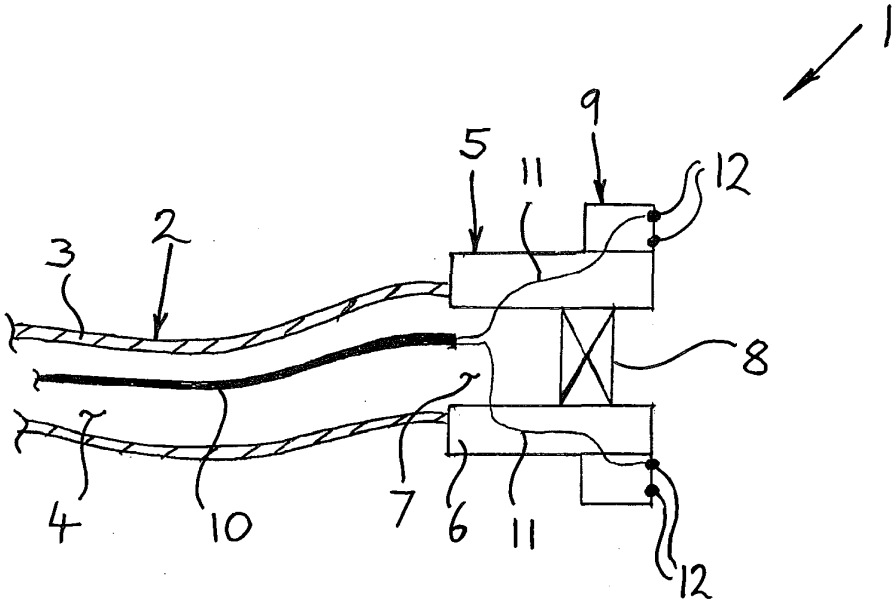


FIGURE 1

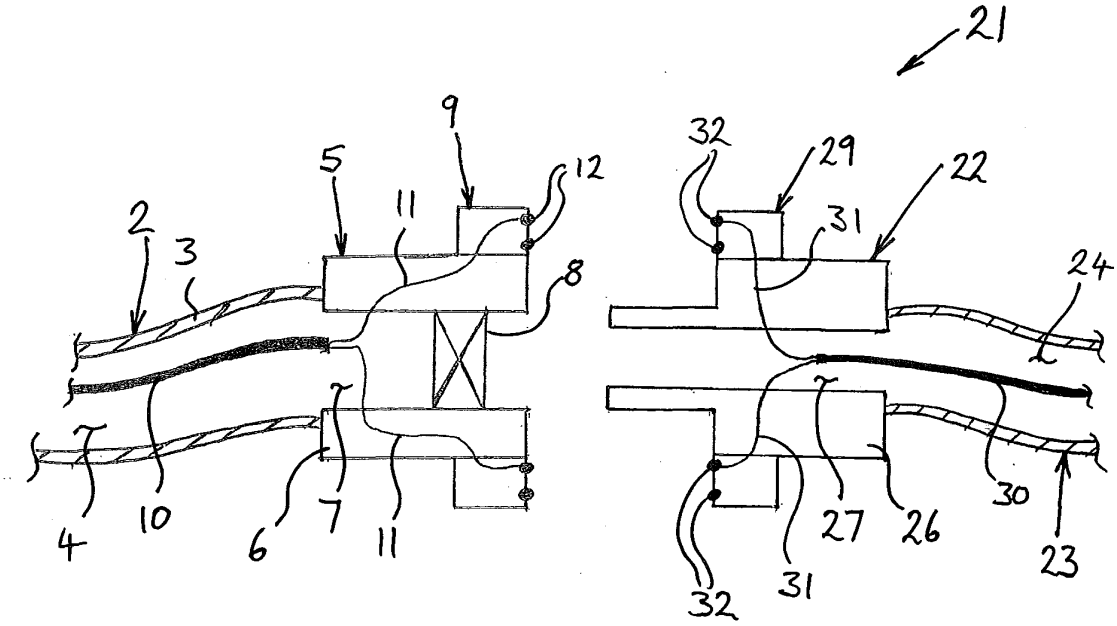


FIGURE 2

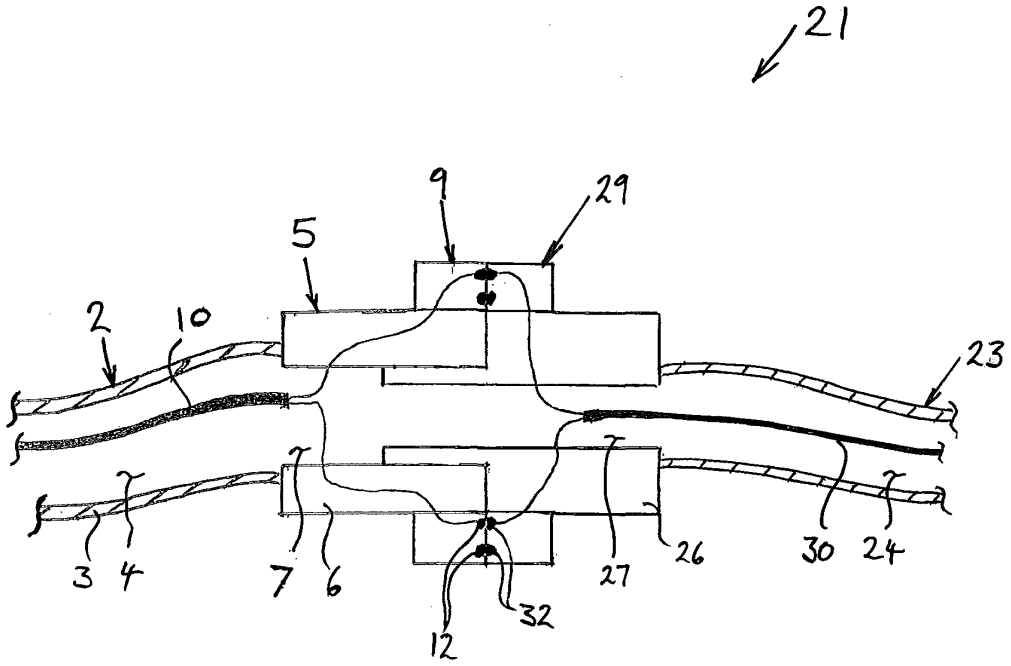


FIGURE 3

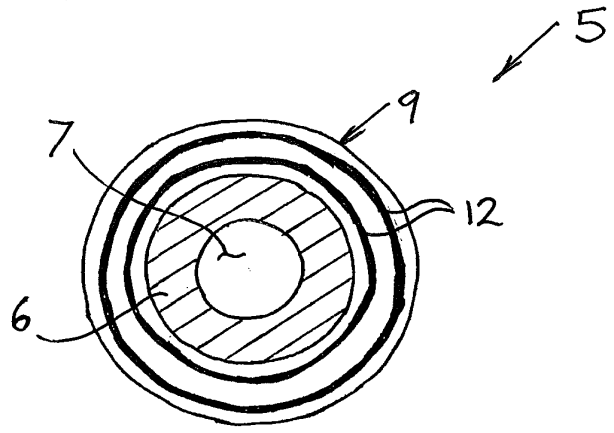


FIGURE 4A

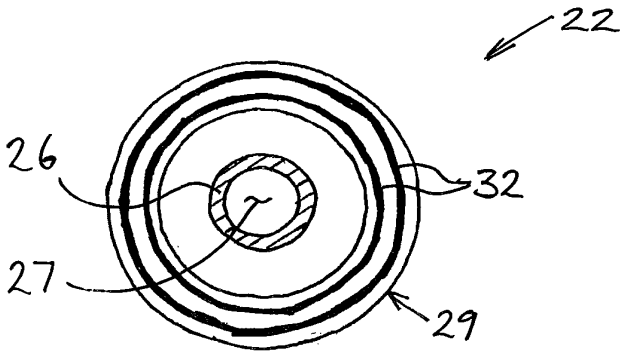


FIGURE 4B

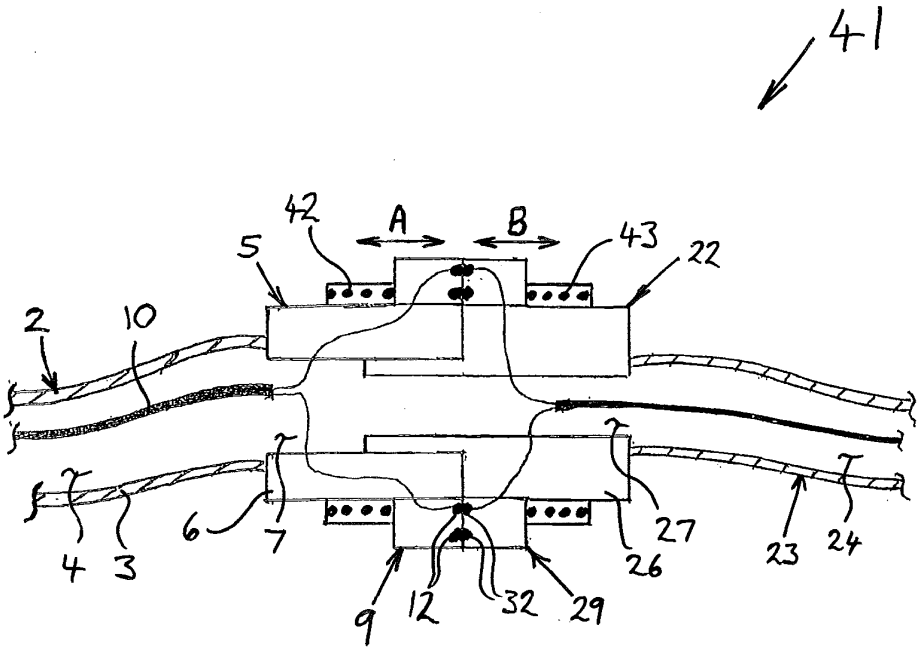


FIGURE 5

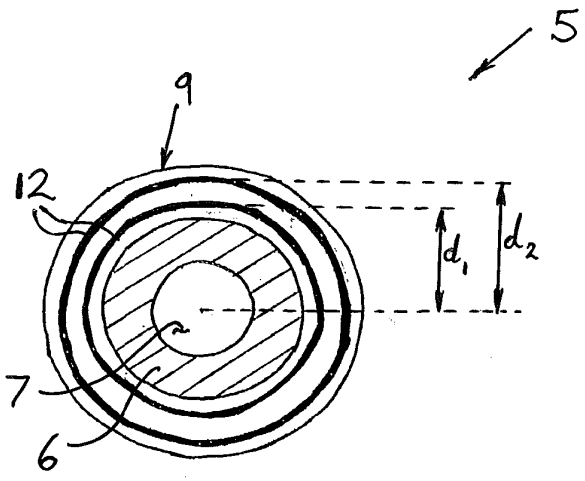


FIGURE 6A

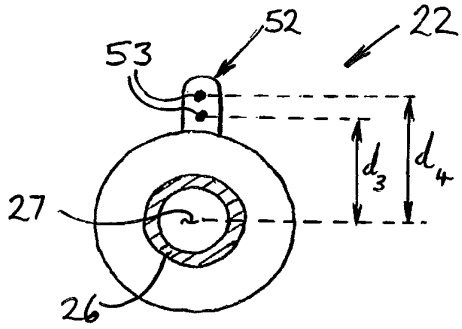


FIGURE 6B

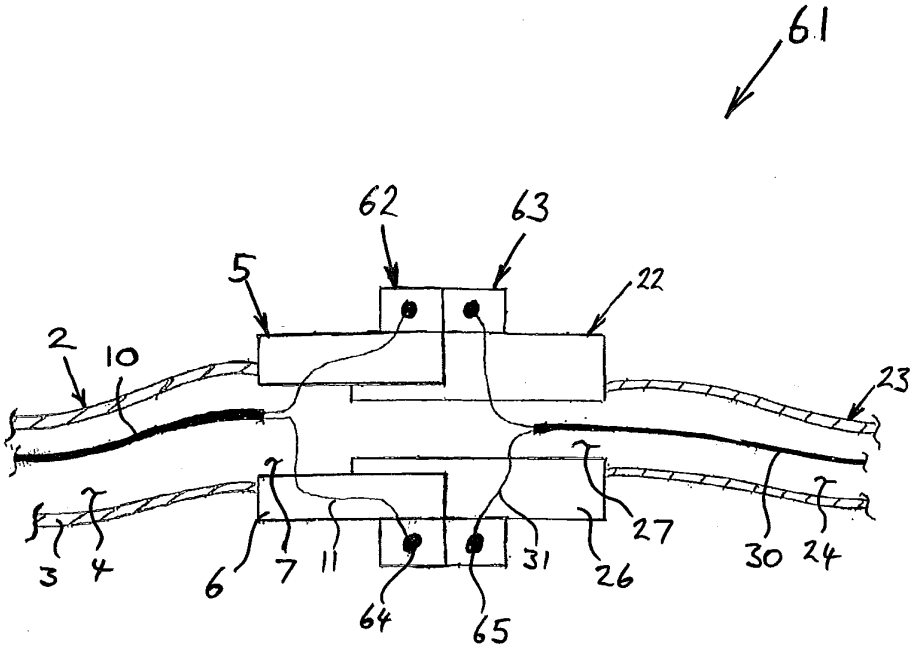


FIGURE 7

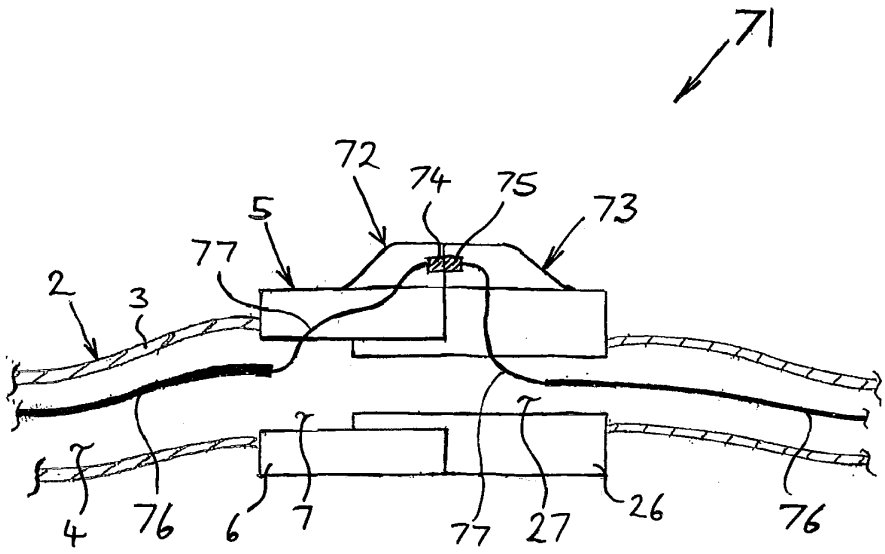


FIGURE 8

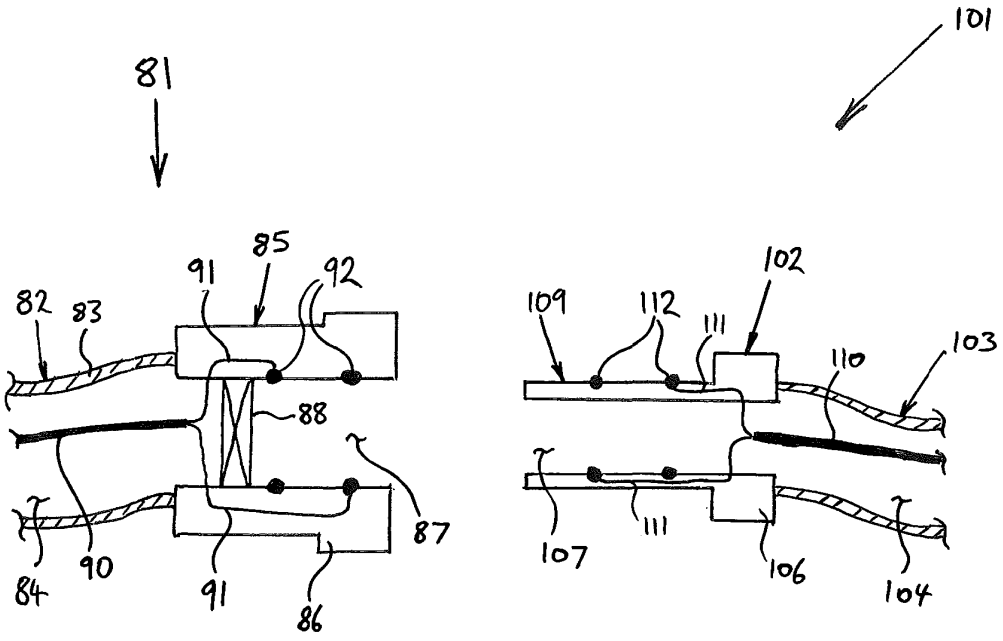

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FIGURE 9

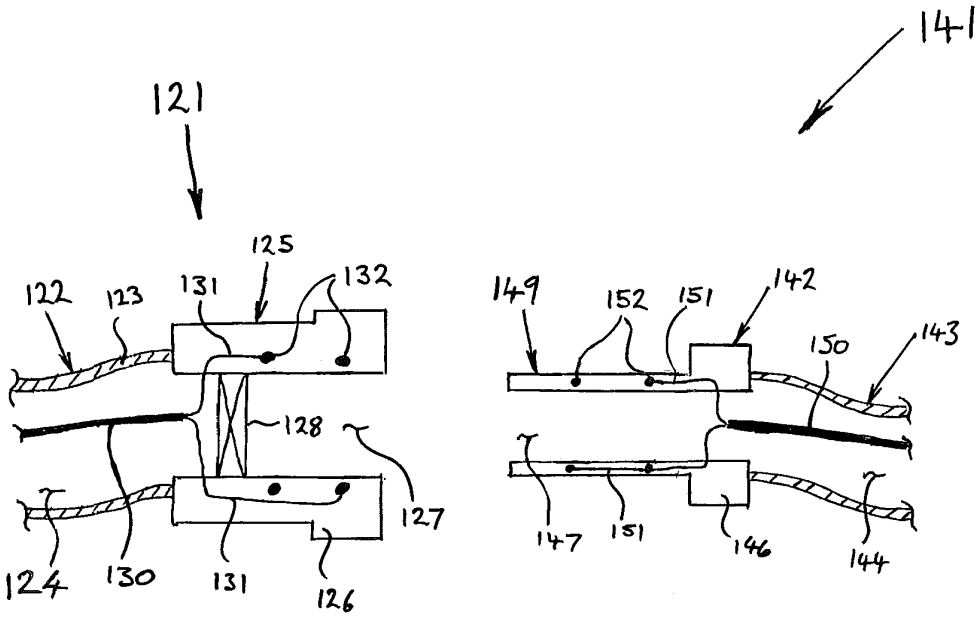

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FIGURE 10

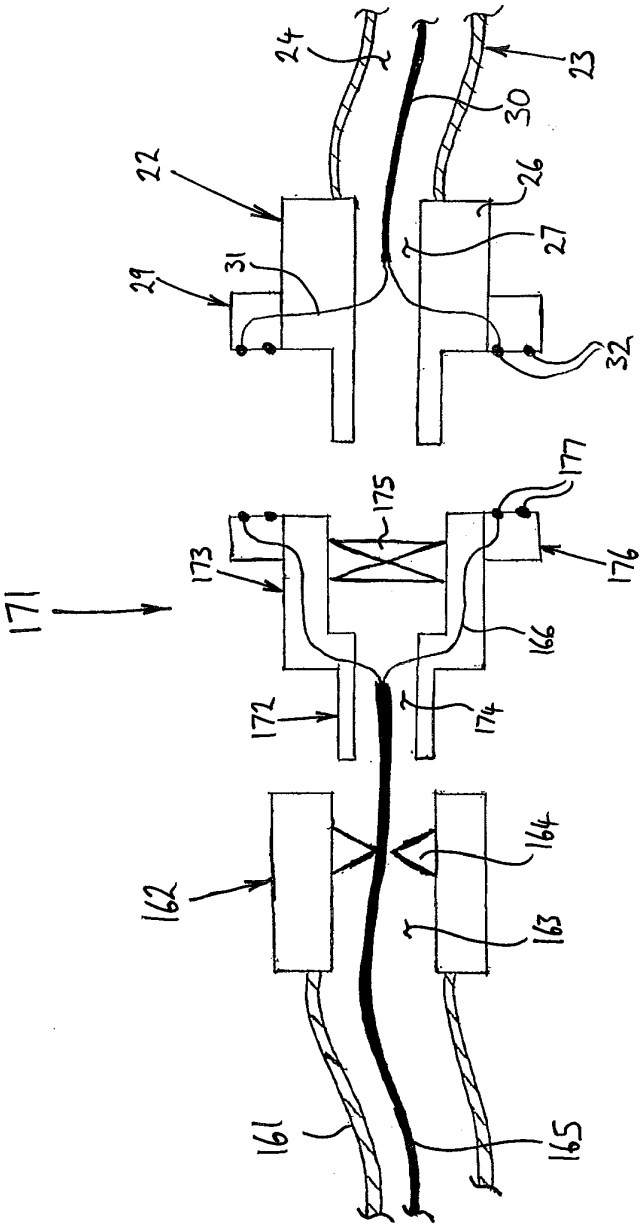

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FIGURE 11

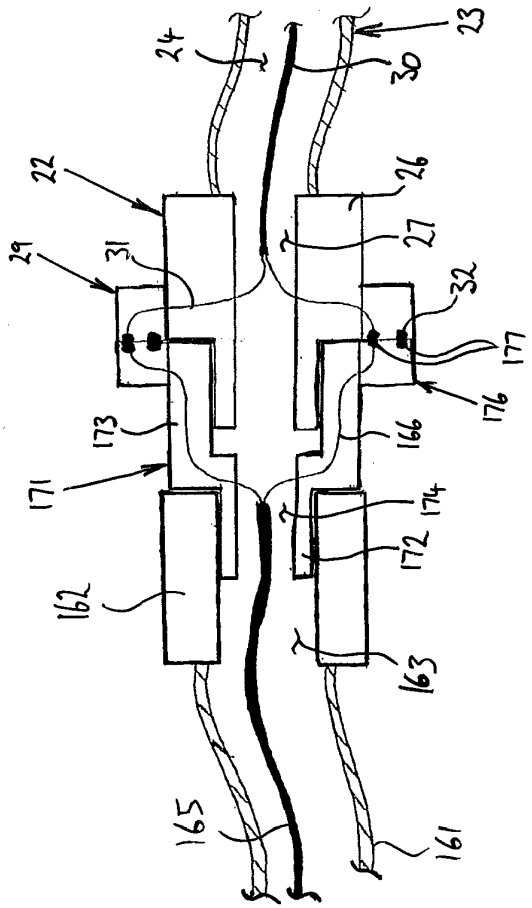

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FIGURE 12

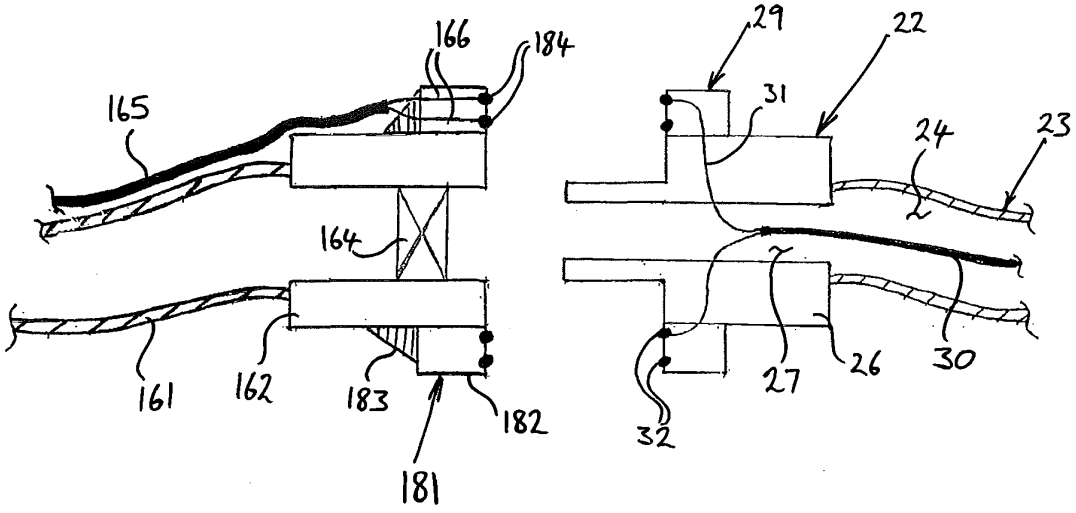


FIGURE 13

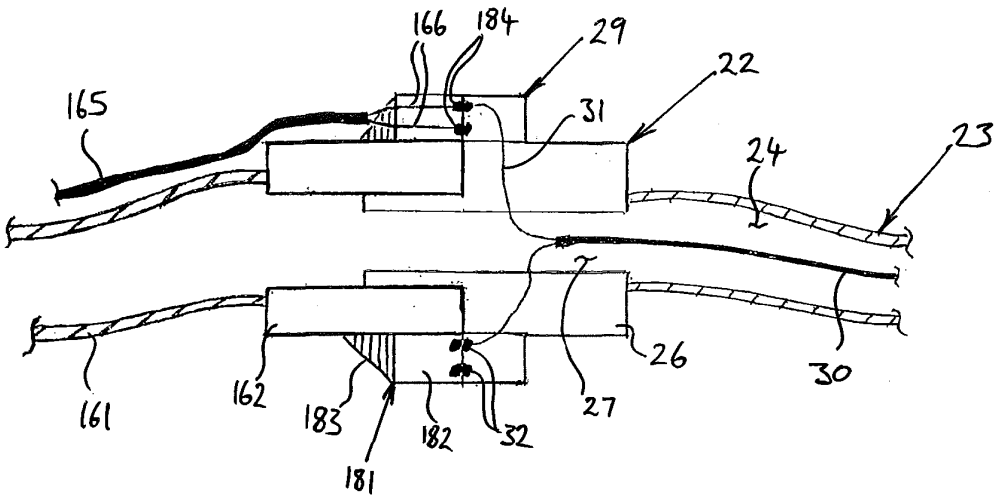


FIGURE 14

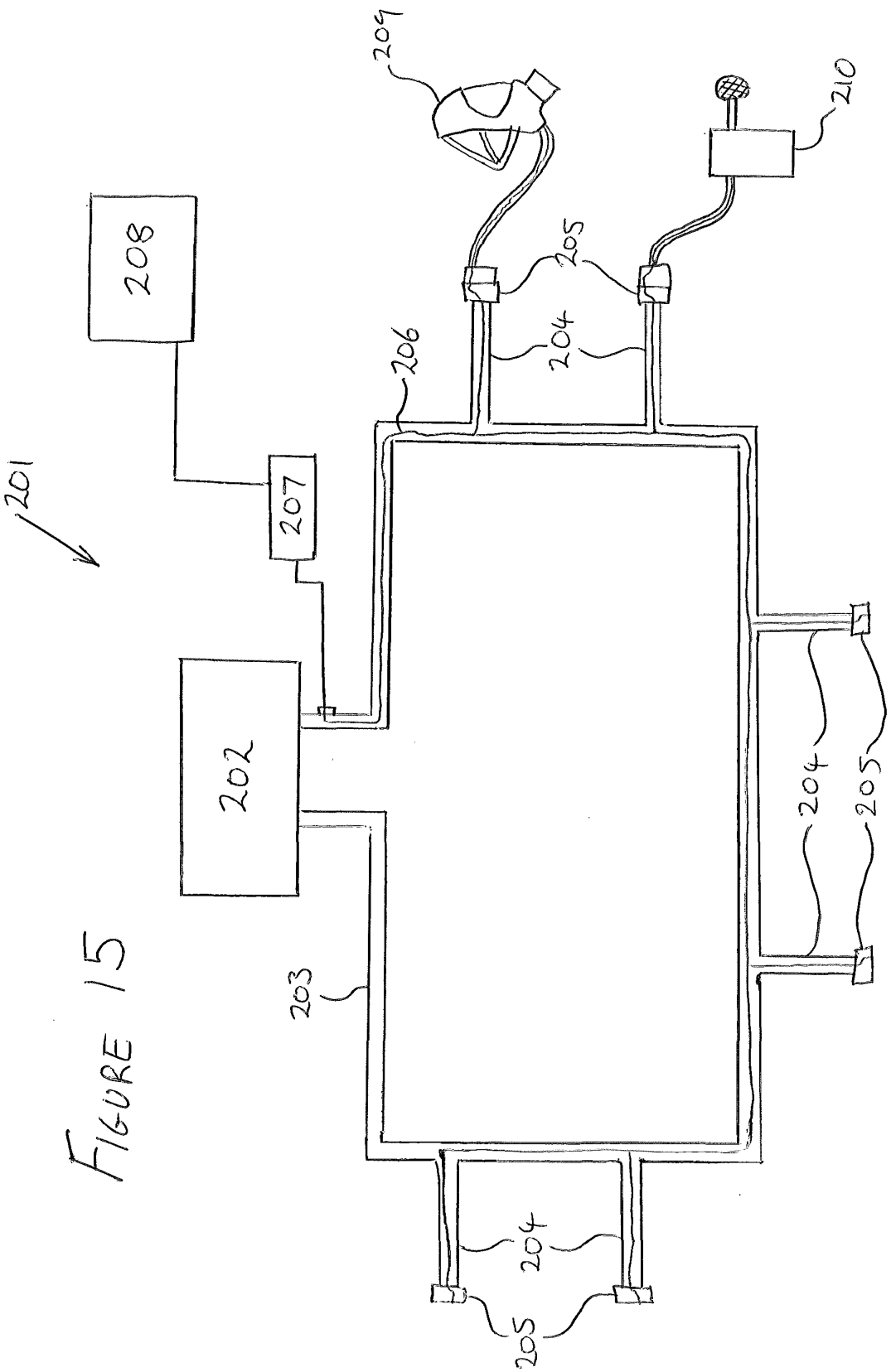


FIGURE 15

A Fluid Supply and Data Communication System and Couplings for use in such a System.

Description

The present invention relates to a combined system for fluid supply and data communication, and to couplings for use with such a system, as well as couplings for retrofitting to existing fluid supply systems to create such a combined fluid supply and data communication system.

There are various situations where it is necessary to supply fluid from one place to another, or from a source to individual outlets, and also communicate data between those places or source/outlet. One such situation is on off-shore drilling platforms or oil refinery facilities. These facilities are provided with a closed breathable air supply conduit network comprising a mains air supply ring extending around the whole facility through which filtered breathable air is pumped. A plurality of branch lines extend off the main ring, usually in the form of flexible air hoses, which terminate in a valve coupling. Workers on the facilities are required to wear breathing apparatuses at all times. These breathing apparatuses, or 'respirators', also known as 'working sets', include their own self-contained compressed air supply bottles. However, these bottles are only capable of providing 10 – 15 minutes of breathable air supply and are intended solely for emergency evacuation purposes, not for normal day-to-day operational use. At all other times, the worker is required to connect their respirator to one of the branch lines of the mains air supply ring by means of a connector configured to mate with the valve coupling on the end of the branch line air hoses. Connection of the respirator to the valve coupling opens the valve and allows air to flow from the air hose to the worker's respirator. Such fluid couplings are known, for example, sliding ring couplings commonly used in pressurised air supply connections.

When a worker in the above-described facility wishes to move around the room or area he is in, the hose can be extended, for example on a tensioned reel, to allow a finite range of freedom up to the maximum hose extension. If the worker wishes to

move beyond that finite range, he moves to the next air hose location, disconnects his respirator from the first air hose which auto-recoils back onto the tensioned reel, and the worker re-connects his respirator to a second air hose at the new location. The facilities are provided with a sufficient number of branch air lines located such that a user can work anywhere on the facility and always have his respirator connected to an air hose for the supply of breathable air thereto.

It will be appreciated that by use of the above air supply system, breathable air can be supplied to workers at any location on the facility in question. However, as well as an air supply, it is also necessary for various data to be communicated between workers, or between a worker and a communication hub or control centre. For example, a worker may be wearing a body-mounted or respirator-mounted video camera so that supervisors can monitor the worker's operation and actions, the signal from which will need to be transmitted to a communication hub/control centre. To provide such data communication, it is necessary to have a separate data communication network on the facility for the worker to connect to. For example, the worker may need to connect a video feed connection from a person-mounted video camera to a video feed network. However, there may well be additional data to be communicated from the worker to a communication hub or control centre, such as a signal from a health-monitoring device worn by the worker, e.g. heart-rate monitor, breathing monitor or other vital statistics monitor. Also, it may be necessary for a control centre to convey information to a worker – for example, if a supervisor identifies a hazardous situation via a fixed CCTV camera in an area near the worker, the supervisor would need to warn the worker to evacuate the area or take certain corrective actions to deal with the hazard. This would require an audio signal to be transmitted from the control centre to an earpiece in the worker's respirator or a headset and for a two-way conversation, the worker would also need an audio signal to be transmitted from a microphone on his person or in the respirator to the control centre. All of the above functional features result in the need for additional connection(s) between the worker and a separate data/communication network, and so more connections for the workers to have between themselves and the facility, and more data communication networks that the facility must have installed therein. This results in a complex arrangement of

personal support systems to which the worker must be connected, which are cumbersome and obstructive for the worker and are complex and expensive to install and maintain on the facility. In normal day-to-day operations, this is a time consuming inconvenience but in an emergency situation, it means that the worker has a lot of equipment connections which are to be uncoupled before he can evacuate the facility.

In addition to all of the above, in potentially explosive working environments such as oil drilling platforms or oil refineries, all electrical equipment and their connections/couplings must be intrinsically safe – that is, there must be no risk of sparks or over-heating of electrical components which may have the potential to cause ignition of a hazardous atmosphere.

It is therefore an object of the present invention to provide a fluid supply and data communication system, and a coupling therefor, which substantially alleviates or overcomes the problems mentioned above.

Accordingly, the present invention provides a combined fluid supply and data communication conduit comprising an enclosed fluid supply duct having at least two distal open ends, and a data communication cable extending within the fluid supply duct, at least one of the distal open ends of the fluid supply duct including a coupling comprising a fluid-tight valve configured to seal closed said at least one distal open end of the fluid supply duct when the coupling is in an un-coupled state and, configured to remain open to allow fluid to pass therethrough when in a coupled state, the coupling further including a data connection terminal connected to the data communication cable within the fluid supply duct and configured to connect to a corresponding terminal of a corresponding coupling to allow combined fluid and data communication through the conduit via said coupling in a coupled state thereof.

The present invention also provides A combined fluid supply and data communication coupling comprising a first part having a hollow bore and a valve therein and a first data communication terminal for connection to a first data

communication cable, and a second part having a hollow bore and a second data communication terminal for connection to a second data communication cable, the first and second parts being configured to be releasably coupled to each other such that, when in a coupled state, the valve is open and the hollow bore of the first and second parts are in sealed fluid communication to allow fluid to pass therethrough and the first and second data communication terminals are in contact to allow a data signal to pass from one terminal to the other terminal, and when the first and second parts are in an un-coupled state, the valve is closed to prevent fluid flow therethrough and the data communication terminals are out of contact with each other to prevent data signals passing therebetween.

The present invention also provides a data communication connector for retro-fitting to a conventional fluid supply coupling, the connector comprising a mounting portion configured to securely attach the connector to a fluid supply duct or fluid supply coupling, and a data coupling portion configured to be connected to a data communication cable and, in use, to be in contact with a corresponding data coupling portion of a combined fluid supply and data communication coupling for data signals to be transmitted between the data coupling portions.

The present invention also provides a combined fluid supply and data communication adaptor for retro-fitting to a conventional fluid supply coupling, the adaptor comprising a main body portion having a hollow bore, and a data coupling portion configured to be connected to a data communication cable and, in use, to be in contact with a corresponding data coupling portion of a combined fluid supply and data communication coupling for data signals to be transmitted between the data coupling portions.

The present invention also provides a combined fluid supply and data communication network comprising a main fluid supply duct coupled at one end to a source of fluid and having a plurality of branch lines in fluid communication therewith, at least one branch line including a coupling at one end thereof including a valve to seal the branch line closed in an un-coupled state, the network further comprising a plurality of data communication cables extending within the main fluid

supply duct and branch lines, at least one cable connected to a communications control unit and at least one cable connected to the at least one coupling at a terminal formed on the at least one coupling, the network configured to simultaneously provide fluid to a fluid-compatible equipment when coupled to the at least one coupling, and to transmit data signals between the communication control unit and an electrical device connected to the terminal on the at least one coupling.

Preferred and/or optional features of the above embodiments of the invention are set out in the claims hereafter.

Embodiments of the present invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic cross-sectional view of a combined fluid supply and data communication conduit according to a first embodiment of the invention;
Figure 2 shows a schematic cross-sectional view of a combined fluid supply and data communication coupling, in an un-coupled state, according to a second embodiment of the invention;
Figure 3 shows a schematic cross-sectional view of the combined fluid supply and data communication coupling shown in Figure 2, but in a coupled state;
Figure 4A shows an end view of a female part of the combined fluid supply and data communication coupling of Figure 2;
Figure 4B shows an end view of a male part of the fluid supply and data communication coupling of Figure 2;
Figure 5 shows a schematic cross-sectional view of an alternative combined fluid supply and data communication coupling of a third embodiment of the invention in a coupled state;
Figure 6A shows an end view of a female part of a further alternative combined fluid supply and data communication coupling of a fourth embodiment of the invention;
Figure 6B shows an end view of a male part of the combined fluid supply and data communication coupling of the fourth embodiment of the invention;

Figure 7 shows a schematic cross-sectional view of a further alternative combined fluid supply and data communication coupling of a fifth embodiment of the invention in a coupled state;

Figure 8 shows a schematic cross-sectional view of a further alternative combined fluid supply and data communication coupling of a sixth embodiment of the invention in a coupled state;

Figure 9 shows a schematic cross-sectional view of a combined fluid supply and data communication conduit according to a seventh embodiment of the invention and also a schematic cross-sectional view of a combined fluid supply and data communication coupling, in an un-coupled state, according to an eighth embodiment of the invention;

Figure 10 shows a schematic cross-sectional view of a combined fluid supply and data communication conduit according to a ninth embodiment of the invention and also a schematic cross-sectional view of a combined fluid supply and data communication coupling, in an un-coupled state, according to a tenth embodiment of the invention;

Figure 11 shows a schematic cross-sectional view of a retro-fit adaptor coupling of an eleventh embodiment of the invention in an un-coupled state with a conventional fluid supply coupling and a male coupling part of a combined fluid supply and data communication coupling of the second embodiment of the invention;

Figure 12 shows a schematic cross-sectional view of the retro-fit adaptor of Figure 11 in a coupled state with a conventional fluid supply coupling and a male coupling part of a combined fluid supply and data communication coupling of the second embodiment of the invention;

Figure 13 shows a retro-fit coupling of a twelfth embodiment of the invention mounted to a conventional fluid supply coupling which is in an un-coupled state with a male coupling part of a combined fluid supply and data communication coupling of the second embodiment of the invention;

Figure 14 shows the retro-fit coupling of Figure 13 mounted to a conventional fluid supply coupling which is in an un-coupled state with a male coupling part of a combined fluid supply and data communication coupling of the second embodiment of the invention; and

Figure 15 shows a schematic system diagram of a combined fluid supply and data communication network of a thirteenth embodiment of the invention.

Referring now to Figure 1, a combined fluid supply and data communication conduit 1 according to a first embodiment of the invention is shown, and comprises a fluid supply duct 2 in the form of an enclosed flexible hose having an outer peripheral wall 3 defining a central bore 4. A fluid coupling 5 is provided at one distal end of the fluid supply duct 2 and comprises a main body portion 6 having a hollow bore 7 in fluid communication with the central bore 4 of the fluid supply duct 2. The fluid coupling includes a valve 8 which closes the central bore 7 of the fluid coupling 5 when the fluid coupling 5 is in a disconnected or 'uncoupled' state, preventing fluid from flowing out of the fluid supply duct 2 through the fluid coupling 5.

The main body portion 6 of the fluid coupling 5 includes a data coupling portion 9 around the perimeter of the distal end of the body portion 6. A data communication cable 10 is disposed within the bore 4 of the fluid supply duct 2 and includes data communication elements 11 which are connected to terminals 12 in the data coupling portion 9.

The fluid coupling 5 is a first part of a two-part fluid coupling and comprises a female coupling which is configured to connect with a corresponding male coupling to provide a combined fluid supply and data communication coupling 21 which comprises a second embodiment of the invention and is shown in Figure 2. The features of the female part of the coupling 5 already described above with reference to the combined fluid supply and data communication conduit 1 of the first embodiment of the invention retain the same reference numerals. The combined fluid supply and data communication coupling 21 also comprises a male coupling 22 comprising a main body portion 26 having a hollow bore 27 which, in use, would be in fluid communication with a bore 24 of a fluid supply duct 23, such as an enclosed flexible hose. The male coupling 22 also includes a data coupling portion 29 around the perimeter of the distal end of the body portion 26 remote from the fluid supply duct 23 which includes terminals 32 configured to be connected to data

communication elements 31 of a data communication cable 30 which would be disposed within the bore 24 of the fluid supply duct 23.

In the embodiment shown, the data coupling portions 9, 29 of the male and female couplings 5, 22 comprise annular elements extending around the respective main body portions 6, 26, and the terminals 12, 32 are exposed metal contact rings, as shown more clearly in Figures 4A and 4B, which are concentric about the central axis of the bores 7, 27 of the main body portion 6, 26. It will be appreciated that in the un-coupled state shown in Figure 2, the terminals 12, 32 are spaced from each other and so not capable of transmitting data signals between each other. Also in this un-coupled state, the valve 8 in the female coupling 5 is closed and so fluid is prevented from flowing through the bore 7 of the coupling 5 and therefore to/from the fluid supply duct 2.

In the coupled state of the fluid supply and data communication coupling shown in Figure 3, the male coupling part 22 is fully inserted into the female part 5 and locked thereto by a conventional known locking means (not shown). In this coupled state, the terminals 12 of the data coupling portion 9 of the female coupling 5 are in contact with the terminals 32 of the data coupling portion 29 of the male coupling 22 and so data signals care be transmitted between the data cable 10 in the fluid supply duct 2 on the female coupling side and the data cable 30 in the fluid supply duct 23 on the male coupling side. Also in this coupled state, the distal end of the male coupling 22 is engaged with and opens the valve 8 of the female coupling 5, thereby rendering the hollow bores 7, 27 of the female and male couplings 5, 22, and therefore the fluid supply ducts 2, 23, in fluid communication.

It will be appreciated that the terminals 12, 32 of the data coupling portions 9, 29 are concentric and symmetrical about the central axis of the female/male couplings 5, 22 respectively. Accordingly, the terminals 12, 32 will always make contact with each other as the female and male couplings 5, 22 are connected into the coupled state, irrespective of the orientation of each coupling 5, 22 about its respective central axis.

In order to ensure a consistent and secure connection between the data coupling portions, it is intended within the scope of the invention that the data coupling portions may be biased towards the distal end of each coupling so that, in a coupled state, the terminals 12, 32 of each coupling 5, 22 are biased into contact with each other. Such an embodiment is shown in Figure 5, which shows an alternative combined fluid supply and data communication coupling 41 of a third embodiment of the invention, in which corresponding features to the combined fluid supply and data communication coupling of the second embodiment of the invention shown in Figures 2 – 4A retain the same reference numerals and description thereof will not be repeated for sake of brevity.

The alternative combined fluid supply and data communication coupling of the third embodiment of the invention differs from that of the second embodiment of the invention in that the data coupling portions 9, 29 are not fixed to the respective main body portions 6, 26 of the couplings 5, 22 but instead are axially slidable thereon about the central axis of the bore 7, 27 of each coupling 5, 22, in a direction shown by arrows A and B respectively. Furthermore, each data coupling portion 9, 29 includes a biasing element in the form of a spring 42, 43 configured to bias the respective data coupling portion 9, 29 toward the other data coupling portion 9, 29 so that in a coupled state of the combined fluid supply and data communication coupling 41, the terminals 12, 32 of each are pushed into contact with each other. This ensures a data connection is maintained even if the coupling 41 is subject to shocks or other physical disruption.

In the second the third embodiments of the invention shown and described above, both data coupling portions include annular terminals 12, 32. However, an alternative configuration of combined fluid supply and data communication coupling 51 of a fourth embodiment of the invention is shown in Figures 6A and 6B, which are end views of the female and male coupling portions 5,22 respectively. Similar features to those of the combined fluid supply and data communication couplings of the second and third embodiments of the invention retain the same reference numerals and description thereof will not be repeated for sake of brevity. The combined fluid supply and data communication coupling 51 of the fourth

embodiment of the invention differs from those of the second and third embodiments of the invention in that the data coupling 52 on the male coupling 22 is not an annular element like on the female coupling 5 but instead is an elongate element extending radially relative to the central axis of the bore 27 of the male coupling 22. Also, the data coupling 52 includes terminals 53 which are point contacts rather than annular contacts. However, the position of the point contacts 53 in a radial direction relative to the central axis of the bore 27 of the male coupling 22 corresponds to the position of the annular terminals 12 in a radial direction relative to the central axis of the bore 7 of the female coupling 5. Referring to Figures 6A and 6B, this is shown by dimensions $d_1 = d_3$ and dimensions $d_2 = d_4$. Therefore, upon coupling together of the female and male couplings 5, 22, the terminals 12, 53 are aligned and in contact to allow data signals to be transmitted therebetween, and also, as with the second and third embodiments of the invention, the terminals 12, 53 will always make contact with each other as the female and male couplings 5, 22 are connected into the coupled state, irrespective of the orientation of each coupling 5, 22 about its respective central axis.

Although not shown in Figures 6A and 6B, the data couplings 9, 52 may be axially slidable on the main body portions 6, 26 and spring biased into a contact position to provide a more secure and reliable connection, as per the third embodiment of the invention shown in Figure 5 and described above.

The data couplings of the combined fluid supply and data communication couplings of the second to fourth embodiments of the invention described above all include terminals which are exposed and make direct contact with each other in the coupled state of the couplings to enable data signal transmission through them. However, it is intended that alternative configurations of data couplings are to be encompassed within the scope of the invention other than direct contact data couplings. One such alternative is shown in Figure 7 which shows a combined fluid supply and data communication coupling 61 of a fifth embodiment of the invention. Features identical to those of the second embodiment of the invention shown in Figures 2 – 4B retain the same reference numerals and description thereof will not be repeated.

The combined fluid supply and data communication coupling 61 of the fifth embodiment of the invention differs from that of the second embodiment of the invention in that the main body portions 6, 26 of the female and male couplings 5, 22 include modified data coupling portions 62, 63. Each data coupling portion 62, 63 is an annular member with a looped induction element 64, 65 embedded within the body of the annular member and so not exposed on the outside surface of the data coupling 62, 63. Each looped induction element 64, 65 is connected to data communication elements 11, 31 of a respective data communication cable 10, 30.

In use, the male and female couplings 5, 22 are connected together by the male coupling part 22 being is fully inserted into the female part 5 and locked thereto by a conventional known locking means (not shown). In this coupled state, the two data coupling portions 62, 63 are in direct contact with each other. However, as the induction elements 64, 65 are embedded within in each data coupling 62, 63, they are not in direct contact with each other. Nevertheless, data signals are able to be transmitted between the data couplings 62, 63 by inductive RF coupling. This would require one of the data communication cables 10, 30 to provide power to one of the induction coils 64, 65, and this could be provided by a battery or other suitable power source.

Although not shown in Figure 7, the male and female couplings 5, 22 could include additional means to secure the inductive connection between the two data couplings 62, 63. For example, the data couplings 62, 63 may be slidable on the respective main body portions 6, 26, as with the third embodiment of the invention shown in Figure 5, and include a biasing means such as a spring to bias the data couplings 62, 63 into contact with each other in the coupled state of the female and male couplings 5, 22. Alternatively, or in addition, the data couplings 62, 63 may include one or more magnets embedded therein to attract the data couplings 62, 63 together to further secure them together in the coupled state. Indeed, any of the data coupling portions of the first to fourth embodiments of the invention may also include magnets therein to further secure them together in the coupled state. It will be appreciated that such measures help to maintain the integrity of the data communication link should the coupling 61 be subjected to physical shocks.

In all embodiments of the invention so far described, data coupling portions have included terminals or induction coils connected to data communication elements of a data communication cable. Such terminals/induction coils would typically be required to be connected to a metallic electrical conductor, and so the data communication elements would be a copper element or similar such electrically conductive element. However, it is intended that alternative data coupling means may be used in a combined fluid supply and data communication coupling within the scope of the invention. Such an alternative is shown in Figure 8 which shows a combined fluid supply and data communication coupling 71 of a sixth embodiment of the invention. Features identical to those of the second embodiment of the invention shown in Figures 2 – 4B retain the same reference numerals and description thereof will not be repeated. The combined fluid supply and data communication coupling 71 of the sixth embodiment of the invention differs from that of the second embodiment of the invention in that the main body portion 6, 26 of the female and male couplings 5, 22 includes modified data coupling portions 72, 73. Each data coupling portion 72, 73 is an elongate lug extending from the outer surface of the respective main body portion 6, 26 in a radial direction relative to the central axis of the bore 7, 27 of the female/male couplings 5, 22, respectively. Each data coupling portion 72, 73 includes an interface element 74, 75. Instead of each of the data coupling portions 72, 73 being connected to an electrically conductive data communication cable as with the previous embodiments, each interface element 74, 75 is an optical connector connected to a remote end of an optical fibre 77 of a fibre-optic data communication cable 76.

In use, the male and female couplings 5, 22 are connected together by the male coupling part 22 being is fully inserted into the female part 5 and locked thereto by a conventional known locking means (not shown). In this coupled state, the two data coupling portions 72, 73 are in direct contact with each other and are configured such that, when aligned, the interface elements 74, 75 of each data coupling 72, 73, are in direct contact with each other. This establishes an optical connection and enables data signals to be transmitted between the data couplings

72, 73 and thereby between the respective fibre-optic data communication cables 76.

It will be appreciated that with the sixth embodiment of the invention described above, the correct alignment of the two interface elements 74, 75 is essential to create an effective data communication link. Therefore, the data coupling portions 72, 73 may be configured with cooperating elements to ensure an exact engagement and alignment with one another in the coupled state. Also, they may be provided with spring biasing means and/or magnetic elements as described above with reference to the fifth embodiment of the invention to ensure the integrity of the data communication link should the coupling 71 be subjected to physical shocks.

A further alternative configuration of a combined fluid supply and data communication conduit 81 of a seventh embodiment of the invention is shown in Figure 9 and comprises a fluid supply duct 82 in the form of an enclosed flexible hose having an outer peripheral wall 83 defining a central bore 84. A fluid coupling 85 is provided at one distal end of the fluid supply duct 82 and comprises a main body portion 86 having a hollow bore 87 in fluid communication with the central bore 84 of the fluid supply duct 82. The fluid coupling includes a valve 88 which closes the central bore 87 of the fluid coupling 85 when the fluid coupling 85 is in a disconnected or 'uncoupled' state, preventing fluid from flowing out of the fluid supply duct 82 through the fluid coupling 85.

The combined fluid supply and data communication conduit 81of the seventh embodiment of the invention differs from that of the first embodiment of the invention in the configuration of its data coupling portion 89, wherein the main body portion 86 includes a pair of annular terminals 92 on the inside wall of the hollow bore 87 which are spaced in an axial direction of the bore 87. A data communication cable 90 is disposed within the bore 84 of the fluid supply duct 82 and includes data communication elements 91 which are connected to the terminals 92.

The fluid coupling 85 is a first part of a two-part fluid coupling and comprises a female coupling which is configured to connect with a corresponding male coupling to provide a combined fluid supply and data communication coupling 101 which comprises an eighth embodiment of the invention and is also shown in Figure 9. The features of the female part of the coupling 85 already described above with reference to the combined fluid supply and data communication conduit 81 of the seventh embodiment of the invention retain the same reference numerals. The combined fluid supply and data communication coupling 101 also comprises a male coupling 102 comprising a main body portion 106 having a hollow bore 107 which, in use, would be in fluid communication with a bore 104 of a fluid supply duct 103, such as an enclosed flexible hose. The male coupling 102 includes an elongate data coupling portion 109 comprising a pair of annular terminals 112 around the outer perimeter of the data coupling portion 109 and which are spaced in an axial direction thereof. The terminals 112 are configured to be connected to data communication elements 111 of a data communication cable 110 which would be disposed within the bore 104 of the fluid supply duct 103.

It will be appreciated that in the un-coupled state shown in Figure 9, the terminals 92, 112 are spaced from each other and so not capable of transmitting data signals between each other. Also in this un-coupled state, the valve 88 in the female coupling 85 is closed and so fluid is prevented from flowing through the bore 87 of the coupling 85 and therefore to/from the fluid supply duct 82.

In a coupled state (not shown) of the fluid supply and data communication coupling 101, the data coupling portion 109 of the male coupling part 102 is fully inserted into the female part 85 and locked thereto by a conventional known locking means (not shown). In this coupled state, the terminals 92 of the data coupling portion 89 of the female coupling 85 are aligned with and in contact with the terminals 112 of the data coupling portion 109 of the male coupling 102 and so data signals can be transmitted between the data cable 90 in the fluid supply duct 82 on the female coupling side and the data cable 110 in the fluid supply duct 103 on the male coupling side. Also in this coupled state, the distal end of the male coupling 102 is engaged with and opens the valve 88 of the female coupling 85, thereby rendering

the hollow bores 87, 107 of the female and male couplings 85, 102, and therefore the fluid supply ducts 82, 103, in fluid communication.

It will be appreciated that the terminals 92, 112 of the data coupling portions 89, 109 are symmetrical about the central axis of the female/male couplings 85, 102 respectively. Accordingly, the terminals 92, 112 will always make contact with each other as the female and male couplings 85, 102 are connected into the coupled state, irrespective of the orientation of each coupling 85, 102 about its respective central axis.

A further alternative configuration of a combined fluid supply and data communication conduit 121 of a ninth embodiment of the invention is shown in Figure 10 and is similar in configuration to the conduit of the seventh embodiment of the invention shown in Figure 9 and similarly comprises a fluid supply duct 122 having an outer peripheral wall 123 defining a central bore 124, a fluid coupling 125 at one distal end of the fluid supply duct 122 comprising a main body portion 126 having a hollow bore 127 in fluid communication with the central bore 124 of the fluid supply duct 122, and a valve 128 which is closed in a disconnected or 'uncoupled' state of the fluid coupling 125.

The combined fluid supply and data communication conduit 121of the ninth embodiment of the invention differs from that of the seventh embodiment of the invention in that annular terminals 92 on the inside wall of the hollow bore 87 spaced in an axial direction of the bore 87 are omitted and instead a pair of annualr induction elements 132 are embedded in the body portion 126 of the coupling 125. A data communication cable 130 is disposed within the bore 124 of the fluid supply duct 122 and includes data communication elements 131 which are connected to the induction elements 132.

The fluid coupling 125 is a first part of a two-part fluid coupling and comprises a female coupling which is configured to connect with a corresponding male coupling to provide a combined fluid supply and data communication coupling 141 which comprises a tenth embodiment of the invention and is also shown in Figure 10.

The features of the female part of the coupling 125 already described above with reference to the combined fluid supply and data communication conduit 121 of the ninth embodiment of the invention retain the same reference numerals. The combined fluid supply and data communication coupling 141 also comprises a male coupling 142 comprising a main body portion 146 having a hollow bore 147 which, in use, would be in fluid communication with a bore 144 of a fluid supply duct 143, such as an enclosed flexible hose. The male coupling 142 includes an elongate data coupling portion 149 comprising a pair of annular induction elements 152 embedded therein and spaced from the surface, and which are spaced in an axial direction of the data coupling portion 149. The induction elements 152 are configured to be connected to data communication elements 151 of a data communication cable 150 which would be disposed within the bore 144 of the fluid supply duct 143.

It will be appreciated that in the un-coupled state shown in Figure 10, the induction elements 132, 152 are spaced from each other and so not capable of transmitting data signals between each other. Also in this un-coupled state, the valve 128 in the female coupling 125 is closed and so fluid is prevented from flowing through the bore 127 of the coupling 125 and therefore to/from the fluid supply duct 122.

In a coupled state (not shown) of the fluid supply and data communication coupling 121, the data coupling portion 149 of the male coupling part 142 is fully inserted into the female part 125 and locked thereto by a conventional known locking means (not shown). In this coupled state, as the induction elements 132, 152 are embedded within in each coupling 125, 142, they are not in direct contact with each other. Nevertheless, data signals are able to be transmitted between the male/female couplings 125, 142 by inductive RF coupling and so data signals can be transmitted between the data cable 130 in the fluid supply duct 122 on the female coupling side and the data cable 150 in the fluid supply duct 143 on the male coupling side. This would require one of the data communication cables 130, 150 to provide power to one of the induction elements 132, 152 and this could be provided by a battery or other suitable power source.

Also in this coupled state, the distal end of the male coupling 142 is engaged with and opens the valve 128 of the female coupling 125, thereby rendering the hollow bores 127, 147 of the female and male couplings 125, 142, and therefore the fluid supply ducts 122, 143, in fluid communication.

As with the terminals of the seventh/eighth embodiments of the invention, the induction elements 132, 152 are symmetrical about the central axis of the female/male couplings 125, 142 respectively and so will always be aligned with each other as the female and male couplings 125, 142 are connected into the coupled state, irrespective of the orientation of each coupling 125, 142 about its respective central axis.

All of the couplings described above are intended to be 'intrinsically safe' and so could be suitable for use in environments such as off-shore drilling platforms, as described above. The contact-type couplings of the first to fourth, seventh and eighth embodiments of the invention may utilise sufficiently low electrical energy that there is no risk of spark between them or any chance of ignition of an explosive atmosphere which may surround the couplings. The inductive data coupling and the fibre-optic data coupling of the fifth, sixth, ninth and tenth embodiments of the invention have no physically touching contacts and so are inherently intrinsically safe and suitable for use in the hazardous environments described above.

Furthermore, in all cases, the data communication cables are housed within the enclosed fluid supply ducts and so are not exposed to any hazardous external environments, thereby further rendering the conduit and couplings of the invention intrinsically safe. It should be noted, however, that the invention is not intended to be limited to couplings/conduits in which a data coupling portion forms in intrinsically safe connection, as the couplings/conduits of the invention may be equally suitable for use in neutral or non-hazardous/non-explosive environments. Aside from the safety element, the conduit and couplings of the invention are also much more convenient and less cumbersome than conventional systems as both breathable air supply and data communication can be provided to the worker from the facility with a single, convenient coupling and conduit.

Although all embodiments of the invention shown and described above show the respective data communication cables as being disposed within the bores of the fluid supply ducts, it is intended within the scope of the invention that the data communication cables may alternatively be embedded within the walls of the fluid supply ducts, in a dedicated unitary fluid supply and data communication ducting.

Although various couplings and conduits of the invention have been shown and described above, modifications to these exemplary embodiments are intended to fall within the scope of the invention. For example, although each embodiment shows two terminals or two induction elements in each coupling part, only one or more than two terminals/induction elements may be provided. Also, the embodiments show specific configurations of data connection terminals/induction elements in combination with the fluid coupling portions, but various other configurations of data communication coupling means in combination with fluid coupling portions, are intended to fall within the scope of the invention.

The embodiments of the invention so far shown and described comprise conduits and couplings suitable for installation in the type of facilities mentioned above where hazardous/explosive environments may exist, such as oil drilling platforms. However, such existing facilities will already have a network of air supply lines including flexible air hoses with valve couplings thereon, but will not have an integrated data communication system with the air supply network. Therefore, the present invention also provides a solution to retro-fit data communication apparatus and couplings to existing fluid supply equipment to provide combined fluid supply and data communication conduits, couplings and overall system.

A retro-fit adaptor coupling of an eleventh embodiment of the invention is shown in Figure 11 in an uncoupled state, together with a conventional fluid supply pipe 161 and a coupling 162 attached to one end thereof. The conventional coupling 162 is a female coupling which includes has a central bore 163 a valve 164 configured to close the bore 163 when the coupling 162 is in a disconnected state. One method of adapting an existing fluid supply system to be a combined fluid supply and data

communication system is to feed data supply cables 165 through all existing fluid supply pipes of the system and centrally connect them to a data control system, data bus or similar unit. Once the data supply cables 165 are installed within the existing fluid supply pipes, they may be connected to a coupling of the invention (such as described above and shown in Figures 1 – 9) which replaces the existing fluid coupling 162 on the end of the fluid supply pipes. Alternatively, an adaptor coupling 171 as shown in Figure 11 may be fitted to the existing fluid coupling 162. In the latter case, the data supply cable 165 would feed through the existing fluid coupling 162 and through the valve 164, thereby holding the valve in an open position at all times whether the fluid coupling 162 is in a coupled or un-coupled state.

The adaptor coupling 171 comprises a male portion 172 and a female portion 173 and has a hollow bore 174 extending therethrough. A valve 175 is disposed in the bore 174. The adaptor also includes a data coupling portion 176 including terminals 177.

As the valve 164 of the existing fluid coupling 162 is held open by the data communication cable 165, air is free to escape from the fluid supply pipe therethrough. However, the adaptor coupling 171 is fitted to the fluid coupling 162 with the male portion 172 received in the bore 163 of the fluid coupling and locked in place by conventional fluid coupling securing means (not shown). Data communication elements 166 of the data communication cable 165 are connected to the terminals 177 of the data coupling portion 176. The valve 175 of the adaptor coupling 171 is closed when no further combined fluid and data supply coupling is connected thereto and so prevents air from the fluid supply pipe 161 from escaping.

In use, a male coupling 22 part of a combined fluid supply and data communication coupling of the invention can be connected to the adaptor coupling 171. Such a male coupling part 22 is shown in Figure 11 in the un-coupled state with the adaptor coupling 171 and is the same as the male coupling part of the second embodiment of the invention shown in Figures 2 and 3, the features of which retain the same reference numerals and description of its features will not be repeated again to avoid repetition.

The fluid coupling 162, adaptor coupling 171 and male coupling part 22 are shown in the connected/coupled state in Figure 12. The male coupling part 22 is inserted into the female part 173 of the adaptor coupling 171 and locked thereto by a conventional known locking means (not shown). In this coupled state, the terminals 177 of the data coupling portion 176 of the adaptor coupling 171 are in contact with the terminals 32 of the data coupling portion 29 of the male coupling part 22 and so data signals care be transmitted between the data cable 165 in the fluid supply duct 161 on the existing fluid coupling 162 side and the data cable 30 in the fluid supply duct 23 on the male coupling part side. Also in this coupled state, the distal end of the male coupling part 22 is engaged with and opens the valve 175 of the adaptor coupling 171, thereby rendering the fluid supply ducts 161, 23 in fluid communication.

Although the adaptor coupling 171 shown in Figures 11 and 12 and described above includes data coupling portions similar to those of the second embodiment of the invention, it will be appreciated that any alternative data coupling means shown and described previously could alternatively be used in an adaptor coupling within the scope of the invention, such as biased data coupling portions, inductive data couplings, fibre optic data couplings, magnetic data coupling securing means, etc. Also, all portions shown as male may be female, and vice versa, within the scope of the invenition.

An alternative retro-fit coupling 181 of a twelfth embodiment of the invention is shown in Figure 13 in an uncoupled state. In this embodiment, the retro-fit coupling 181 is fitted to a conventional fluid coupling 162 attached to one end of a conventional fluid supply pipe 161, as shown in Figure 11 and described above. Like features retain the same reference numerals. Unlike the retrofit adaptor coupling 171 shown in Figures 11 and 12, the data communication cable 165 to be retro-fitted to the existing fluid supply system is not fed into the existing fluid supply pipes 161, but remains on the outside thereof and may be secured thereto by conventional means (not shown). The retro-fit coupling 181 is secured to the existing fluid coupling 162 and comprises a data coupling portion 182 and a

mounting means 183. The data coupling portion 182 includes terminals 184 which are connected to the data communication elements 166 of the data communication cable 165. The mounting means may comprise any suitable means within the scope of the invention, for example, a clamp, bracket, adhesive, weld etc.

Upon fitment of the retro-fit coupling 181 to the fluid coupling 162, a first part (female part in this case) of a combined fluid supply and data communication coupling is formed. This is then capable of connecting to a corresponding (male) coupling part 22 of a combined fluid supply and data communication coupling, as shown in Figure 13. The male coupling part 22 is the same as that of the second embodiment of the invention shown in Figures 2 and 3, the features of which retain the same reference numerals.

In the coupled state, the male coupling part 22 is inserted into the fluid coupling 162 and locked thereto by a conventional known locking means (not shown). In this coupled state, the terminals 185 of the data coupling portion 182 of the retro-fit coupling 181 are in contact with the terminals 32 of the data coupling portion 29 of the male coupling part 22 and so data signals care be transmitted between the data cable 165 which is external of the fluid supply duct 161 on the existing fluid coupling 162 side and the data cable 30 in the fluid supply duct 23 on the male coupling part side, enabling data to be transmitted to/from a data control system, data bus or similar unit. Also in this coupled state, the distal end of the male coupling part 22 is engaged with and opens the valve 164 of the fluid coupling 162, thereby rendering the fluid supply ducts 161, 23 in fluid communication.

As mentioned above with the adaptor coupling 171 shown in Figures 11 and 12, although the data coupling portion 182 is similar to those of the second embodiment of the invention, it will be appreciated that any alternative data coupling means shown and described previously could alternatively be used in a retro-fit coupling within the scope of the invention, such as biased data coupling portions (possibly including slidably moveable mounting means for the data coupling portion 182), inductive data couplings, fibre optic data couplings, magnetic data coupling securing means, etc.

The present invention also provides a combined fluid supply and data communication network 201 which is shown schematically in Figure 15. The network comprises an air supply source 202 (e.g. pump, filter, etc.) fluidly coupled to a mains air supply ring 203. Such a ring would extend around a facility such as an oil drilling platform, oil refinery, etc. Branch air lines 204 extend off the main ring 203 and terminate in combined fluid supply and data communication couplings 205 (of any form as described above) for individual workers to connect their respirators/working sets 209 to, as described above. A network of data communication cables 206 extend from a data bus 207 into the mains air ring 203 and into each branch air line 204, each terminating in one of the combined fluid supply and data communication couplings 205. A data control centre 208 is connected to the data bus 207.

In use, a worker can connect his working set 209 to a combined fluid supply and data communication coupling 205 of the network 201 and receive breathable air through the branch air line 204. Simultaneously, any equipment he is wearing or operating on his person, which would be connected to the respirator's combined fluid supply and data communication coupling portion, would be connected to the data communication cable 206 in the network via the combined fluid supply and data communication coupling 205 on the end of the branch air line 204.

Using the above system, data from a user's equipment can be fed to the data bus 207 and received by a data control centre 208. Likewise, the data control centre can transmit data to individual workers connected to the network and to equipment they may have on their person or be coupled to.

Examples of equipment that a worker may couple to the combined fluid supply and data communication network in the above manner may include audio equipment, such as microphones and headsets to allow communication between the worker and a control centre, video equipment, for example a head-mounted camera worn by the worker, health/vital statistic monitoring equipment such as breathing/hearth-rate monitor to be relayed to the data control centre to monitor each individual worker's

health. Also, workers may be provided with locator means such as GPS devices which could relay their position via the combined fluid supply and data communication network to the control centre.

In order to provide an intrinsically safe system, it is preferable that the combined fluid supply and data communication network is passive, and power to transmit data signals can come from the equipment coupled to the system via the combined fluid supply and data communication couplings 205, such as battery power provided with the audio/video/health-monitoring equipment, etc.

As well as personnel mounted equipment, the combined fluid supply and data communication network of the invention can be used to connect only equipment thereto. For example, an air-quality monitor 210 may include a coupling compatible with the combined fluid supply and data communication coupling 205 on the end of the branch air line 205 to form a data coupling therewith. Although the equipment may likely not need an air supply, it can utilise only the data communication function of the network to feed information from areas on the facility, such as air-quality, to detect toxic/explosive gases in the air, back to the data control centre.

Although the above exemplary combined fluid supply and data communication network of the invention is shown and described as an air-supply network, the invention is not limited to such a specific fluid supply, and any other fluid supply system may be included. For example, a combined fluid supply and data communication network of the invention may provide fuel such as gas or liquid fuel such as petrol/diesel/aviation fuel to branch-line supply pipes, which may simultaneously connect to equipment such as pumping equipment, vehicle fuel tank fill level monitoring equipment, vehicle temperature monitoring equipment, fluid volume transfer monitoring equipment, etc. Again, in such use, it would be much by preference that the data communication coupling portion is intrinsically safe to avoid accidents/explosions of any combustible/explosive fluids, in use.

Also, although the exemplary combined fluid supply and data communication network of the invention shown and described above shows the data

communication cables disposed within the fluid supply pipes, they may alternatively be disposed on the outside of the fluid supply pipes (as shown in the embodiments in Figures 13 and 14), or alternatively, may be embedded within the walls of the fluid supply pipes.

5

Claims

1. A combined fluid supply and data communication conduit comprising an enclosed fluid supply duct having at least two distal open ends, and a data communication cable extending within the fluid supply duct, at least one of the distal open ends of the fluid supply duct including a coupling comprising a fluid-tight valve configured to seal closed said at least one distal open end of the fluid supply duct when the coupling is in an un-coupled state and, configured to remain open to allow fluid to pass therethrough when in a coupled state, the coupling further including a data connection terminal connected to the data communication cable within the fluid supply duct and configured to connect to a corresponding terminal of a corresponding coupling to allow combined fluid and data communication through the conduit via said coupling in a coupled state thereof.

2. A conduit according to claim 1 wherein the data connection terminal includes at least one induction element connected to the data communication cable and which is configured to make an inductive data connection with a corresponding induction element of a corresponding coupling when placed adjacent thereto.

3. A conduit according to claim 2 wherein the induction element comprises a loop of conductive material embedded in the body of the data connection terminal.

4. A conduit according to claim 1 wherein the data connection terminal includes at least one exposed electrical contact connected to the data communication cable.

5. A conduit according to any of claims 2 to 4 wherein the at least one induction element/electrical contact is an annular member.

6. A conduit according to claim 5 comprising a plurality of concentric induction elements/electrical contacts.

7. A conduit according to claim 1 wherein the data connection terminal includes at least one optical connector and the data communication cable comprises an optical fibre connected to the optical connector, the optical connector being configured to make an optical data link with a corresponding optical connector of a corresponding coupling when placed adjacent thereto.

8. A conduit according to any preceding claim wherein the coupling further comprises a magnet configured to hold the data connection terminal in contact with a corresponding data connection terminal of a corresponding coupling when placed adjacent thereto in a coupled state of the coupling.

9. A conduit according to any preceding claim wherein the coupling comprises a main body portion and the data connection terminal is disposed on an outer periphery of the main body portion.

10. A conduit according to claim 9 wherein the data connection terminal is slidably mounted on the main body portion.

11. A conduit according to claim 10 wherein the data connection terminal is biased towards a distal end of the coupling.

12. A conduit according to any preceding claim wherein the fluid supply duct defines a central bore and the data communication cable is disposed in the central bore of the fluid supply duct.

13. A conduit according to any of claim 1 to 11 wherein the fluid supply duct comprises a peripheral wall defining a central bore and the data communication cable is disposed within the peripheral wall of the fluid supply duct.

14. A combined fluid supply and data communication coupling comprising a first part having a hollow bore and a valve therein and a first data communication terminal for connection to a first data communication cable, and a second part having a hollow bore and a second data communication terminal for connection to a

second data communication cable, the first and second parts being configured to be releasably coupled to each other such that, when in a coupled state, the valve is open and the hollow bore of the first and second parts are in sealed fluid communication to allow fluid to pass therethrough and the first and second data communication terminals are in contact to allow a data signal to pass from one terminal to the other terminal, and when the first and second parts are in an un-coupled state, the valve is closed to prevent fluid flow therethrough and the data communication terminals are out of contact with each other to prevent data signals passing therebetween.

15. A coupling according to claim 14 wherein the first and second data connection terminals each include at least one induction element connected to the first and second data communication cables, respectively, and which are configured to make an inductive data connection with each other when adjacent to each other in the coupled state of the coupling.

16. A coupling according to claim 15 wherein the induction elements each comprise a loop of conductive material embedded in the body of the respective first and second data connection terminals.

17. A coupling according to claim 14 wherein the first and second data connection terminals each include at least one exposed electrical contact connected to the respective first and second data communication cable.

18. A coupling according to any of claims 15 to 17 wherein each of the at least one first and second induction elements/electrical contacts is an annular member.

19. A coupling according to claim 18 comprising a plurality of concentric first and second induction elements/electrical contacts.

20. A coupling according to claim 14 wherein the first and second data connection terminals each include at least one optical connector and the first and second data communication cables each comprise an optical fibre connected to the

respective first and second optical connector, the first and second optical connectors being configured to make an optical data link with each other when placed adjacent to each other in the coupled state of the coupling.

21. A coupling according to any of claims 14 – 20 further comprising a magnet configured to hold the first and second data connection terminals in contact with each other when placed adjacent to each other in a coupled state of the coupling.

22. A coupling according to any of claims 14 – 21 wherein the first and second coupling parts each comprise a main body portion and each of the first and second data connection terminals are disposed on an outer periphery of the respective main body portions.

23. A coupling according to claim 22 wherein at least one of the first and second data connection terminals is slidably mounted on the respective main body portion.

24. A coupling according to claim 23 wherein the at least one slidably mounted data connection terminal is biased towards the other of the data connection terminals in a coupled state of the coupling.

25. A coupling according to any of claims 14 – 24 wherein at least one of the first and second coupling parts is connected to an enclosed fluid supply duct, and a data communication cable extends within the at least one fluid supply duct, the respective first and/or second data connection terminals being connected to the respective data communication cable within the respective fluid supply duct.

26. A coupling according to claim 25 wherein the at least one fluid supply duct defines a central bore and the at least one data communication cable is disposed in the central bore of the at least one fluid supply duct.

27. A coupling according to claim 25 wherein the at least one fluid supply duct comprises a peripheral wall defining a central bore and the at least one data

communication cable is disposed within the peripheral wall of the at least one fluid supply duct

28. A data communication connector for retro-fitting to a conventional fluid supply coupling, the connector comprising a mounting portion configured to securely attach the connector to a fluid supply duct or fluid supply coupling, and a data coupling portion configured to be connected to a data communication cable and, in use, to be in contact with a corresponding data coupling portion of a combined fluid supply and data communication coupling for data signals to be transmitted between the data coupling portions.

29. A connector according to claim 28 wherein the data coupling portion includes at least one induction element to be connected to a data communication cable and which is configured to make an inductive data connection with a corresponding induction element of a combined fluid supply and data communication coupling when placed adjacent thereto.

30. A connector according to claim 29 wherein the induction element comprises a loop of conductive material embedded in the body of the data coupling portion.

31. A connector according to claim 28 wherein the data coupling portion includes at least one exposed electrical contact to be connected to a data communication cable.

32. A connector according to any of claims 29 to 31 wherein the at least one induction element/electrical contact is an annular member.

33. A connector according to claim 32 comprising a plurality of concentric induction elements/electrical contacts.

34. A connector according to claim 28 wherein the data coupling portion includes at least one optical connector to be connected to an optical fibre of a data communication cable, the optical connector being configured to make an optical

data link with a corresponding optical connector of a combined fluid supply and data communication coupling when placed adjacent thereto.

35. A connector according to any of claims 28 – 34 configured to be mounted on an outer periphery of a substantially cylindrical conventional fluid supply coupling.

36. A combined fluid supply and data communication adaptor for retro-fitting to a conventional fluid supply coupling, the adaptor comprising a main body portion having a hollow bore, and a data coupling portion configured to be connected to a data communication cable and, in use, to be in contact with a corresponding data coupling portion of a combined fluid supply and data communication coupling for data signals to be transmitted between the data coupling portions.

37. An adaptor according to claim 36 wherein the hollow bore comprises a valve operable to prevent or permit fluid flow through the hollow bore.

38. An adaptor according to claim 37 wherein the main body portion comprises a first part configured to couple with a conventional fluid supply valve and a second portion configured to couple with a combined fluid supply and data communication coupling.

39. An adaptor according to claim 38 wherein the first portion comprises a male portion configured to be received in a conventional female fluid supply coupling and the second portion comprises a female portion configured to receive a male portion of a combined fluid supply and data communication coupling.

40. An adaptor according to any of claims 36 – 39 wherein the data coupling portion includes at least one induction element to be connected to a data communication cable and which is configured to make an inductive data connection with a corresponding induction element of a combined fluid supply and data communication coupling when placed adjacent thereto.

41. An adaptor according to claim 40 wherein the induction element comprises a loop of conductive material embedded in the body of the data coupling portion.

42. A connector according to any of claims 36 – 39 wherein the data coupling portion includes at least one exposed electrical contact to be connected to a data communication cable.

43. A connector according to any of claims 40 – 42 wherein the at least one induction element/electrical contact is an annular member.

44. A connector according to claim 43 comprising a plurality of concentric induction elements/electrical contacts.

45. A connector according to any of claims 36 – 39 wherein the data coupling portion includes at least one optical connector to be connected to an optical fibre of a data communication cable, the optical connector being configured to make an optical data link with a corresponding optical connector of a combined fluid supply and data communication coupling when placed adjacent thereto.

46. A combined fluid supply and data communication network comprising a main fluid supply duct coupled at one end to a source of fluid and having a plurality of branch lines in fluid communication therewith, at least one branch line including a coupling at one end thereof including a valve to seal the branch line closed in an un-coupled state, the network further comprising a plurality of data communication cables extending within the main fluid supply duct and branch lines, at least one cable connected to a communications control unit and at least one cable connected to the at least one coupling at a terminal formed on the at least one coupling, the network configured to simultaneously provide fluid to a fluid-compatible equipment when coupled to the at least one coupling, and to transmit data signals between the communication control unit and an electrical device connected to the terminal on the at least one coupling.

47. A network according to claim 46 wherein the source of fluid is a source of compressed breathable air and the network is configured to provide breathable air to breathing equipment coupled to the at least one coupling.

48. A network according to claim 46 or claim 47 wherein a data bus is connected between the communications control unit and the data communication cable(s).

49. A network according to any of claims 46 – 48 wherein the network is a passive network and power to transmit data signals between an electrical device connected to the terminal on the at least one coupling and the communications control unit is to be provided by a power source on the electrical device.

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Claims searched:	1-13	**Date of search:**	25 August 2011

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-13	DE2333620 A1 (Kernforschung); see air and telephone line quick-release connector with valve, and wiring located within air duct
X	1-13	DE2212656 A1 (Kernforschung); see air and telephone line quick-release connector with valve, and wiring located within air duct
X	1-13	US5810048 A1 (Zeiner); see figure 6-9 relating to electrical wiring and fibre optic cables in fluid connectors with valve
X	1-13	EP1901382 A2 (Yamaha); note various electrical coupling connections in the fluid coupling with valve
A	-	US2002/135179 A1 (Schlumberger); discusses inductive coupling in fluid connectors
A	-	EP0337055 A2 (Teikoku); see electrical terminals of connectors in figures 1 and 2
A	-	US2004/025682 A1 (Festo); see light guides in fluid coupler
A	-	EP1127583 A2 (Siemens); see electrical contacts of fluid coupler in figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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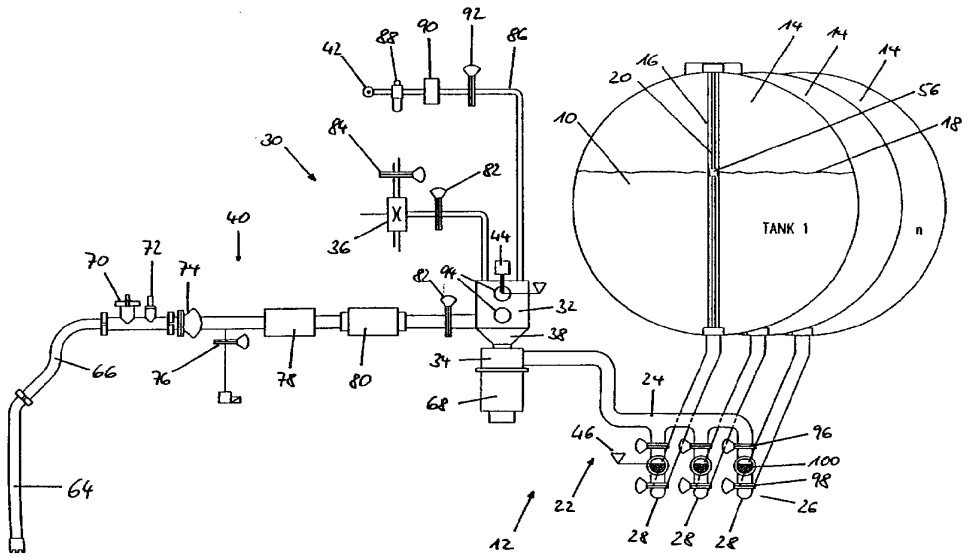
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(54) Title: DEVICE AND METHOD FOR TRANSPORTING A MEDIUM

(54) Bezeichnung: VORRICHTUNG UND VERFAHREN ZUR FÖRDERUNG EINES MEDIUMS



(57) Abstract: The invention relates to a device for transporting a medium (10), comprising a conduit assembly (12) which allows several tanks (14) to be filled and/or drained and comprising fill-level gauges (16), located essentially in the interior of the tanks (14), for determining the position of at least one limiting surface (18) of the medium (10) in the tanks. The invention also relates to a method for transporting a medium (10) by means of a conduit assembly (12), whereby the fill level in several tanks (14) is measured by fill-level gauges (16).

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(57) Zusammenfassung: Die Erfindung betrifft eine Vorrichtung zur Förderung eines Mediums (10) mit einer Leitungseinrichtung (12), wobei über die Leitungseinrichtung (12) mehrere Tanks (14) befüllbar und/oder entleerbar sind, Füllpegelmesseinrichtungen (16) im wesentlichen im Inneren der Tanks (14) zur Bestimmung der Position mindestens einer Grenzfläche (18) des Mediums (10) in den Tanks vorgesehen sind. Die Erfindung betrifft ferner ein Verfahren zur Förderung eines Mediums (10), bei dem das Medium über eine Leitungseinrichtung (12) transportiert wird, wobei die Füllpegel in mehreren Tanks (14) von Füllpegelmesseinrichtungen (16) gemessen werden.

Vorrichtung und Verfahren zur Förderung eines Mediums

Die Erfindung betrifft eine Vorrichtung zur Förderung eines Mediums nach dem Oberbegriff des Anspruchs 1. Die Erfindung betrifft ferner ein Verfahren zur Förderung eines Mediums nach dem Oberbegriff des Anspruchs 18.

Gattungsgemäße Vorrichtungen und gattungsgemäße Verfahren werden beispielsweise in der Milchwirtschaft oder beim Vertrieb von Treibstoffen verwendet.

Im Bereich der Milchwirtschaft fährt ein Tankwagen regelmäßig bestimmte Milcherzeuger an und entnimmt die dort zum Beispiel im Laufe eines Tages angefallene Milch aus einem oder mehreren Vorratsbehältern. Bei dieser Milchannahme ist es wichtig, dass die entnommene Menge Milch genau gemessen und registriert wird, da auf dieser Grundlage eine spätere Abrechnung zwischen dem Erzeuger und dem Abnehmer erfolgt. Diese Messung der Milchmenge unterliegt dem Eichrecht, welches vorschreibt, wie die Messung zu erfolgen hat und welche Genauigkeiten eingehalten werden müssen (DIN 19217).

Eine Möglichkeit zur Durchführung einer Messung, welche dem Eichrecht genügt, besteht in der Verwendung von Durchflusszählern, wobei allerdings sicherzustellen ist, dass Luft-

beimengungen, die beim Ansaugen der Milch insbesondere zu Beginn und am Ende des Annahmevorgangs zwangsweise entstehen, nicht in das Durchflussmessgerät gelangen und dort zu Messfehlern führen. Derartige Luftbeimengungen werden durch das Einfügen von Gasmessverhütern und Gasabscheidern vermieden, welche auch als Luftabscheider bezeichnet werden. Grundsätzlich sind Luftabscheider als Zwischenbehälter zwischen dem zu befüllenden Tank und dem Entnahmebehälter angeordnet. Die zu fördernde Milch verbleibt eine Weile in dem Luftabscheider, so dass sich Lufteinschlüsse in der Milch zurückbilden können. Erst dann wird die Milch beispielsweise durch einen Durchflusszähler in den zu befüllenden Tank geleitet, um eine der Eichpflicht genügende Mengenbestimmung durchzuführen.

Aus dem Einsatz von Luftabscheidern ergeben sich jedoch einige Nachteile. Zum einen wird die Gesamtapparatur aufwendig, da es sich bei den Gasabscheidern und den Gasmessverhütern um komplizierte mechanische Gebilde mit großem Volumen und großem Gewicht handelt; dies hat eine Reduzierung des zulässigen Zuladegewichts bei den Sammelfahrzeugen zur Folge. Weiterhin sind die Luftabscheider stets nur für eine begrenzte Durchflussmenge zugelassen, was die gesamte Saugleistung des Sammelfahrzeuges begrenzt.

In der DE 198 39 112.9 wurde bereits eine Anordnung beschrieben, welche ohne den Einsatz von Luftabscheidern auskommt. Die Entbehrlichkeit der Luftabscheider beruht insbesondere darauf, dass in dem zu befüllenden Tank eine hochgenaue Volumenbestimmung durch Einsatz einer Füllpegelmesseinrichtung erfolgt. Es ist daher nicht mehr unbedingt erforderlich, eine Mengenbestimmung bei der strömenden Flüssigkeit durchzuführen, so dass auch die oben besprochenen Messfehler aufgrund von Lufteinschlüssen vermieden werden.

Da der Tank gleichzeitig als Luftabscheider wirkt, kann mit einer hochgenauen Füllpegelmesseinrichtung der Eichpflicht genügt werden.

Ein weiterer mit den Luftabscheidern in Verbindung stehender Nachteil ist zu nennen. Grundsätzlich soll bei der Milchannahme verhindert werden, dass sich unterschiedliche Partien der Rohmilch miteinander vermischen. Dies gewinnt gerade in jüngster Zeit zunehmend an Bedeutung, da das Qualitätsbewusstsein der Verbraucher immer mehr steigt. Beispielsweise wollen die Verbraucher von Biomilch sich darauf verlassen können, dass ihre Milch nicht zusammen mit herkömmlicher Rohmilch vermengt bzw. vermischt wird. Aber auch sonst wird die Milch in unterschiedlichste Qualitätsstufen unterteilt - derzeit unterscheidet man bis zu neun Qualitätsstufen. Arbeitet man nun mit Luftabscheidern, um der erforderlichen Eichpflicht zu genügen, so ist unmittelbar ersichtlich, dass ein großer Aufwand zu treiben ist, um eine Vermischung von Milch verschiedener Qualitätsstufen zu vermeiden. Ohne eine aufwendige Förder- und Leitungstechnik würde es zu Vermischungen der aktuell entnommenen Milch mit Milch aus einem vorangehenden Entnahmevorgang (Haftmilch) im Luftabscheider kommen.

Aus der gattungsbildenden DE 197 50 950 A1 ist ein Sicherungssystem für eine aus mehreren Tanks bestehende Tankanordnung bekannt, mit der das durch eine Leitungseinrichtung erfolgende Befüllen und/oder Entleeren der Tanks kontrolliert werden kann. Zur Bestimmung der Füllmenge in den Tanks ist ferner im Inneren jedes Tanks eine Füllpegelmesseinrichtung zur Bestimmung der Position mindestens einer Grenzfläche des Mediums im Tank vorgesehen.

Es ist nun **Aufgabe** der Erfindung, eine Vorrichtung bzw. ein Verfahren zur Förderung eines Mediums zu schaffen, bei der bzw. durch das eine Befüllung eines von mehreren Tanks mit einem sich von den in die anderen Tanks zu füllenden Medien unterscheidenden Medium ohne großen Aufwand und bei Gewährleistung allenfalls geringer Vermischung des einzufüllenden Mediums mit den anderen Medien möglich ist.

Diese Aufgabe wird durch eine Vorrichtung mit den Merkmalen des Anspruchs 1 bzw. durch ein Verfahren mit den Merkmalen des Anspruchs 18 gelöst.

Die Erfindung baut auf der gattungsgemäßen Vorrichtung dadurch auf, dass über die Leitungseinrichtung mehrere Tanks befüllbar und/oder entleerbar sind, dass Füllpegelmesseinrichtungen im Wesentlichen im Inneren der Tanks zur Bestimmung der Position mindestens einer Grenzfläche des Mediums in den Tanks vorgesehen sind. Auf diese Weise ist es möglich, eine der Eichpflicht genügende Volumenbestimmung durchzuführen. Weiterhin kann die Rohmilch entsprechend den unterschiedlichen Qualitätsstufen beim Annahmevorgang ohne Kontamination getrennt werden.

Zu diesem Zweck weist die erfindungsgemäße Leitungseinrichtung eine Verteilereinrichtung mit einer Primärseite und einer Sekundärseite auf, wobei die Sekundärseite einzelne, mit den Tanks in Verbindung stehende, absperrbare Verteilerwege aufweist. Diese Verteilereinrichtung dient der die Qualität der Milch sichernden Trennung von Milch unterschiedlicher Qualitätsstufen, beispielsweise der Trennung von herkömmlicher Rohmilch und Biomilch.

Ferner weist die Verteilereinrichtung Füllstandmesseinrichtungen auf, welche den Verteilerwegen zugeordnet sind. Über

die Füllstandmesseinrichtungen wird die Förderleistung des Mediums überwacht. Ferner dienen die Füllstandmesseinrichtungen in der Verteilereinrichtung der Bereitstellung eines Ausgangssignals bei der Vorbereitung des Systems für die Milchannahme in den nächsten Tank, nämlich dann, wenn die Milch in ausreichendem Maße aus dem Annahmesystem verdrängt wurde.

Die Vorrichtung ist preiswerter und leichter aufgrund der Entbehrlichkeit der Luftabscheider. Ferner nimmt sie weniger Platz ein. Da die Saugleistung nicht durch einen Luftabscheider begrenzt wird, kann eine höhere Förderleistung bereitgestellt werden.

Bevorzugt steht die Primärseite mit einer Ansaugeinrichtung in Verbindung. Diese Ansaugeinrichtung dient der Förderung der Milch aus einem von dem Lieferanten bereitgestellten Behälter.

Die Ansaugeinrichtung weist vorteilhafterweise einen ersten Ansaugbehälter, eine Kreiselpumpe und einen Ejektor auf. Über den Ejektor, welcher nach dem Prinzip einer Wasserstrahlpumpe arbeitet, kann ein Unterdruck in dem Ansaugbehälter erzeugt werden. Durch diesen Unterdruck wird zumindest ein Verteilerweg der Verteilereinrichtung bis zu einem vorbestimmten Füllstand befüllt. Nachfolgend übernimmt die Kreiselpumpe die Förderung, wobei der als Vakuumpumpe arbeitende Ejektor nur bei Bedarf optional zugestellt werden kann. Ob ein solcher Bedarf vorliegt, wird vorzugsweise in der Verteilereinrichtung durch Füllstandmessung ermittelt.

In dem Ansaugbereich der Kreiselpumpe ist vorteilhafterweise ein Strudelbrecher angeordnet. Dieser vermindert die Menge der in die Kreiselpumpe eintretenden Luft, welche an-

sonsten den Wirkungsgrad der Kreiselpumpe erheblich vermindern könnte.

Es ist nützlich, wenn die Ansaugeinrichtung mit einer Zuleitung verbindbar ist. Diese Zuleitung verbindet die Ansaugeinrichtung mit dem Behälter des Lieferanten. Die Ansaugeinrichtung ist jedoch nicht zwingend mit einer Zuleitung verbunden, was insbesondere im Hinblick auf die unten beschriebene Abgabe der Milch aus den Tanks zu erklären ist.

Weiterhin ist es bevorzugt, wenn die Ansaugeinrichtung mit einem Druckluftanschluss verbindbar ist. Über diesen kann bei der Beendigung der Milchannahme in einen bestimmten Tank Druckluft zugeführt werden, welche die restliche Milch aus dem Ansaugsystem entfernt; somit steht die Anlage für die Annahme von Milch in einen weiteren Tank zur Verfügung.

Die Ansaugeinrichtung weist vorzugsweise eine Füllstandmesseinrichtung auf. Ein Ausgangssignal dieser Füllstandmesseinrichtung lässt beispielsweise erkennen, dass die Ansaugarbeit des Ejektors von der Kreiselpumpe übernommen werden kann.

Es ist bevorzugt, dass zwischen der Ansaugeinrichtung und der Primärseite der Verteilereinrichtung eine Abgabeöffnung vorgesehen ist und dass die mit den Tanks in Verbindung stehenden Verteilerwege auf der Sekundärseite der Verteilereinrichtung über eine Umpumpleitung mit der Ansaugvorrichtung in Verbindung stehen. Diese Anordnung der erfindungsgemäßen Vorrichtung dient der selektiven Abgabe der Milch aus einem ausgewählten Tank über den Ansaugbehälter. Dies hat den Vorteil, dass dieselben Komponenten, welche schon bei der Annahme der Milch verwendet wurden, bei-

spielsweise der Ansaugbehälter und der Ejektor, für die Abgabe der Milch genutzt werden können.

Bei einer anderen bevorzugten Ausführungsform der Erfindung umfasst die Ansaugeinrichtung eine Impellerpumpe. Impellerpumpen sind selbstansaugend, wodurch sich das System vereinfacht. Weiterhin sind Impellerpumpen preiswert, was nochmals Vorteile mit sich bringt. Im Vergleich zu dem System mit Vakuumpumpe und Kreiselpumpe ist allerdings zu bemerken, dass die Milch weniger schonend angenommen wird; ferner ist die Saugleistung geringer als bei dem System mit Kreiselpumpe und separater Vakuumpumpe. Man wird je nach der gewünschten Anwendung die Vor- und Nachteile der Ausführungsform gegeneinander abwägen und das entsprechende System zum Einsatz bringen.

Bei dieser Ausführungsform ist es besonders bevorzugt, dass für jeden Tank eine Ansaugvorrichtung, insbesondere eine Impellerpumpe vorgesehen ist. Damit wird eine Vermischung der unterschiedlichen Annahmepartien in der Ansaugeinrichtung vermieden.

Eine weitere Ausführungsform der Erfindung arbeitet darüber, dass in den Tanks ein erster Unterdruck erzeugbar ist. Durch den Unterdruck in den Tanks wird das flüssige Produkt beim Öffnen eines entsprechenden Ventils in den Tank hineingesaugt. Eine Vermischung der Milch in einer Ansaugvorrichtung wird also auch hierdurch wirkungsvoll vermieden.

Besonders vorteilhaft ist bei dieser Ausführungsform, wenn mit dem Tank ein zweiter Ansaugbehälter verbindbar ist, in dem ein zweiter Unterdruck erzeugbar ist, wobei der erste Unterdruck unabhängig von dem zweiten Unterdruck erzeugbar

ist. Diese Anordnung hat den Vorteil, dass zunächst ein relativ kleiner Ansaugbehälter evakuiert wird, während der Tank seinen bereits erzeugten Unterdruck in seinem großen Volumen aufrechterhält. Erst wenn der Ansaugbehälter gefüllt ist, was durch einen Sensor detektiert werden kann, wird über die Betätigung von Ventilen das Produkt von dem Ansaugbehälter in den Tank befördert. Durch die Tatsache, dass der erste Unterdruck in dem Tank unabhängig von dem zweiten Unterdruck in dem Ansaugbehälter erzeugt wird, wird verhindert, dass durch Lufteinfall zu Beginn oder am Ende der Annahme ein vorzeitiger Druckanstieg in dem Tank entsteht; ein solcher hätte zur Folge, dass das große Tankvolumen daraufhin neu evakuiert werden müsste.

Bei der Ausführungsform mit Ansaugbehälter ist besonders zu bevorzugen, dass das Volumen des zweiten Ansaugbehälters mindestens so groß ist, wie das Volumen des Ansaugsystems. Der Ansaugbehälter kann somit die gesamte Milch annehmen, welche sich in dem Ansaugsystem (Schlauch plus Verrohrung) befindet. Auch dies ist im Hinblick auf die Vermeidung der Vermischung aufeinanderfolgender Annahmepartien nützlich.

Besonders vorteilhaft ist die erfindungsgemäße Vorrichtung, wenn die Füllpegelmesseinrichtung einen nach dem magnetostriktiven Prinzip arbeitenden, mit einer Rechenvorrichtung gekoppelten, transsonaren Wegaufnehmer aufweist, der mit dem Peilstab und mindestens einem Schwimmer ausgestattet ist, wobei der Schwimmer mit mindestens einem Magneten ausgestattet ist. Das magnetostriktive Prinzip beruht auf dem Phänomen, dass zwei sich kreuzende Magnetfelder eine Verformung des Metalls, in dem diese gebündelt sind, hervorrufen. Gibt man nun in den Peilstab einen Erregerstromimpuls, so resultiert daraus ein bezüglich des Peilstabes axialsymmetrisches Erregermagnetfeld. Dieses wechselwirkt

mit den kreuzenden Magnetfeldern der Schwimmermagnete, wodurch eine kurzzeitige Deformation und ein daraus entstehender Ultraschallimpuls in dem als Wellenleiter wirkenden Peilstab erzeugt wird. Aus der Laufzeit des Ultraschallimpulses durch den Peilstab bis zu einem vorzugsweise am Peilstab endseitig angeordneten Empfänger lässt sich in Kenntnis der Schallgeschwindigkeit in dem Wellenleiter auf die Position der Magnete und somit des Schwimmers rückschließen. Durch die derart ausgestattete Vorrichtung ist es möglich, die Position des Schwimmers bis zu einer Größenordnung von < 10 µm zu messen. Transsonare Wegaufnehmer sind ferner langzeitstabil und erfüllen somit die strengen gesetzlichen Vorschriften hinsichtlich der Eichung und der Messgenauigkeit.

Vorzugsweise ist eine Steuereinrichtung vorgesehen, welche die Förderung des Mediums in Abhängigkeit der Messsignale der Füllpegelmesseinrichtung der Tanks und/oder der Füllstandmesseinrichtungen der Verteilereinrichtung und/oder der Füllstandmesseinrichtung der Ausgangseinrichtung steuert. Mit einem oder mehreren dieser Parameter ist unter Verwendung einer Steuereinrichtung eine zuverlässige Automatisierung der Milchannahme bzw. der Abgabe der Milch möglich, wobei sich insbesondere eine unerwünschte Vermischung vermeiden lässt.

Ebenso kann vorteilhaft sein, dass mindestens ein Drucksensor und/oder mindestens ein Temperatursensor und/oder mindestens eine Volumenstrommesseinrichtung vorgesehen sind, während Ausgangssignale der Steuereinrichtung als Eingangssignale zuführbar sind. Mit diesen weiteren Parametern lässt sich die Qualitätssicherung bei der Milchannahme bzw. der Milchabgabe weiter verbessern.

Es kann vorteilhaft sein, dass die Verbindungen der Leitungseinrichtung mit anderen Systemkomponenten mit Leseeinrichtung und codierten Einrichtungen (TAGs) ausgestattet sind, so dass über eine Steuerung die korrekte Zuordnung der Komponenten überprüfbar ist. Beispielsweise kann so sichergestellt werden, dass eine Milchannahme oder Abgabe nur erfolgt, wenn sämtliche Systemkomponenten korrekt verbunden sind.

Bei dem erfindungsgemäßen Verfahren, wie es in Anspruch 18 definiert ist, wird zur Befüllung einer der Tanks das Medium in einen mit dem zu befüllenden Tank verbundenen Verteilerweg einer Verteilereinrichtung der Leitungseinrichtung gefördert. Gegen Ende der Befüllung wird gemeinsam mit dem Medium auch Luft in die Leitungseinrichtung gefördert. Durch Erfassen des Füllstandes in der Verteilereinrichtung wird die Befüllung so lange fortgesetzt, bis der erfasste Füllstand unter ein vorgegebenes Niveau fällt. Sobald dies auftritt, wird der geöffnete Verteilerweg zur Beendigung der Befüllung geschlossen. Auf diese Weise wird erreicht, dass die Leitungseinrichtung bis zu dem gesperrten Verteilerweg von Mediumresten frei ist. Gleichzeitig enthält der gesperrte Verteilerweg zwischen der Sperrstelle und dem Tank ein definiertes Volumen, so dass das in den Tank gefüllte Gesamtvolumen des Mediums problemlos und sehr genau berechnet werden kann.

Das Verfahren ist besonders dadurch vorteilhaft, dass ein Tank ausgewählt wird, welcher mit dem Medium zu befüllen ist, dass in einer Ansaugeinrichtung ein Unterdruck zur Befüllung der Leitungseinrichtung erzeugt wird, dass in der Ansaugeinrichtung ein Füllstand ermittelt wird und dass in Abhängigkeit des ermittelten Füllstandes die Förderung des Mediums durch die Leitungseinrichtung in den ausgewählten

Tank beginnt und die Erzeugung des Unterdrucks beendet wird. Somit wird sichergestellt, dass die Füllstandermittlung in der Ansaugeinrichtung als Kriterium für den Verfahrensablauf dienen kann, insbesondere auch für die Bestimmung der Beendigung der Befüllung. Dass die Befüllung beendet werden soll, zeigt sich daran, dass der Füllstand in der Ansaugeinrichtung unter einen vorbestimmten Wert fällt.

Vorzugsweise wird nach der Befüllung des ausgewählten Tanks mindestens ein weiterer Tank befüllt. Dies ist möglich, da mit der Füllstandermittlung, insbesondere nach einem Austreiben der Milch aus dem Annahmesystem durch Druckluft, sichergestellt ist, dass das Annahmesystem hinreichend von Milchresten der vorangehenden Annahme befreit ist.

Vorzugsweise wird nach der Erzeugung des Unterdruckes in der Ansaugeinrichtung eine Kreiselpumpe zur Förderung des Mediums betrieben. Eine solche Kombination von Vakuumpumpe, zum Beispiel unter Einsatz eines Ejektors, und einer Kreiselpumpe ermöglicht eine große Förderleistung; ferner wird hierdurch eine schonende Förderung der Milch erreicht.

Besonders bevorzugt ist, dass die den Unterdruck erzeugende Vakuumpumpe unterstützend zu der Kreiselpumpe betrieben wird, wenn der in der Ansaugeinrichtung ermittelte Füllstand unter ein vorgegebenes Niveau fällt. Fällt beispielsweise der in der Ansaugeinrichtung ermittelte Füllstand unter das vorbestimmte Niveau, so kann dies an einer unzureichenden Förderleistung der Kreiselpumpe liegen. In dem Fall kann automatisch veranlasst werden, dass die Vakuumpumpe in Betrieb genommen wird, so dass der Füllstand in dem jeweiligen Verteilerweg wieder sein Sollniveau erreicht.

In diesem Zusammenhang ist es besonders bevorzugt, dass die Inbetriebnahme der Kreiselpumpe und/oder die unterstützende Inbetriebnahme der Vakuumpumpe und/oder die Beendigung der Befüllung eines Tanks auch in Abhängigkeit des ermittelten Füllstandes in der Verteilereinrichtung gesteuert wird bzw. werden. Die Füllstandermittlung in der Verteilereinrichtung dient also gleichzeitig der Steuerung mehrerer Vorgänge während des Verfahrensablaufes.

Vorzugsweise werden vor der Befüllung eines weiteren Tanks Reste des Mediums von der Vakuumpumpe abgesaugt. Dies unterstützt, dass bei der nächsten Milchannahme keine unerwünschte Vermischung mit Restmilch aus einer vorangehenden Milchannahme auftritt.

In diesem Zusammenhang ist es auch nützlich, dass vor der Befüllung eines weiteren Tanks Druckluft in das System eingespeist wird, bis in der Verteilereinrichtung ein vorbestimmter Füllstand erreicht ist. Wiederum wird also der Füllstand in der Verteilereinrichtung zur Steuerung eines Vorganges während des erfindungsgemäßen Verfahrens verwendet.

Vorzugsweise wird das Medium aus dem Tank abgegeben, indem ein Tank ausgewählt wird, mindestens ein Teil des Mediums über eine Umpumpleitung in einen Ansaugbehälter gedrückt wird und das Medium aus dem Ansaugbehälter durch eine zwischen dem Ansaugbehälter und der Verteilereinrichtung angeordneten Abgabeöffnung abgegeben wird. Somit wird auch bei der Abgabe der Milch sichergestellt, dass keine Vermischung auftritt. Besonders vorteilhaft ist dabei, dass Systemkomponenten zum Einsatz kommen, welche schon bei der Annahme der Milch nützlich waren.

Ferner kann vorteilhaft sein, wenn in einem Tank ein erster Unterdruck erzeugt wird, so dass der Tank mit dem geförderten Medium befüllt wird. Bei diesem Verfahren ist eine zusätzliche Ansaugvorrichtung entbehrlich, so dass auch naturgemäß eine Vermischung in einer solchen Ansaugvorrichtung nicht auftreten kann.

In diesem Zusammenhang kann es besonders nützlich sein, dass in einem zweiten Ansaugbehälter, welcher mit dem Tank in Verbindung steht, ein zweiter Unterdruck unabhängig von dem ersten Unterdruck erzeugt wird, wobei zunächst der zweite Ansaugbehälter und danach der Tank mit dem geförderten Medium befüllt werden. Dies hat den Vorteil, dass zunächst der relativ kleine Ansaugbehälter evakuiert wird, während der großvolumige Tank seinen bereits erzeugten Unterdruck aufrechterhält. Erst wenn der Ansaugbehälter gefüllt ist, was beispielsweise durch einen Sensor detektiert werden kann, wird durch eine Umschaltung von Ventilen und den Unterdruck im Tank das Produkt, vorzugsweise durch ein Rückschlagventil, in den Tank befördert. Indem der Unterdruck in dem Ansaugbehälter unabhängig von dem Unterdruck im Tank erzeugt wird, wird verhindert, dass ein Lufteinfall zu Beginn oder am Ende der Annahme zu einem vorzeitigen Druckanstieg im Tank führt. Dies hätte zur Folge, dass das große Tankvolumen neu evakuiert werden müsste.

Der Erfindung liegt die überraschende Erkenntnis zugrunde, dass es möglich ist, sowohl den strengen Eichvorschriften als auch den Qualitätsanforderungen genügt werden kann. Dies wird einerseits durch eine hochpräzise Volumenbestimmung innerhalb eines Tanks durch eine Füllpegelmesseinrichtung erreicht, was zusätzliche Luftabscheider entbehrlich macht. Ferner kann die Qualität der Milch auf diese Weise gesichert werden. Die erfindungsgemäße Vorrichtung ist im

Vergleich zu den Vorrichtungen des Standes der Technik preiswerter und leichter; sie nimmt weniger Platz ein, und sie ist in der Lage eine höhere Leistung zu erbringen. Die Vorrichtung ermöglicht es, ohne erheblich vergrößerten apparativen Aufwand Milch mit zahlreichen unterschiedlichen Qualitätsniveaus anzunehmen. Beim Stand der Technik war es erforderlich für jede Qualitätsstufe einen separaten Luftabscheider zu verwenden; bei der Erfindung ist lediglich eine entsprechende Anzahl von Tanks und eine demgemäße Auslegung des Leitungssystems erforderlich.

Die Erfindung wird nun mit Bezug auf die begleitenden Zeichnungen anhand von Ausführungsformen beispielhaft beschrieben.

Fig. 1 zeigt eine erste Ausführungsform einer erfindungsgemäßen Vorrichtung;

Fig. 2 zeigt einen Ausschnitt der Vorrichtung aus Fig. 1 mit einer Erweiterung;

Fig. 3 zeigt eine zweite Ausführungsform einer erfindungsgemäßen Vorrichtung;

Fig. 4 zeigt einen Ausschnitt der Vorrichtung aus Fig. 3 mit einer Erweiterung;

Fig. 5 zeigt eine erste Tankanordnung, welche im Rahmen der Erfindung einsetzbar ist;

Fig. 6 zeigt eine zweite Tankanordnung, welche im Rahmen der Erfindung einsetzbar ist;

Fig. 7 zeigt eine dritte Tankanordnung, welche im Rahmen der Erfindung einsetzbar ist;

Fig. 8 zeigt eine spezielle Ausführungsform einer Verteilereinrichtung, welche im Rahmen der Erfindung einsetzbar ist.

Fig. 1 zeigt eine erste Ausführungsform einer erfindungsgemäßen Vorrichtung. Eine Mehrzahl mit einem Medium 10 gefüllter oder befüllbarer Tanks 14 ist mit einer Leitungseinrichtung 12 verbunden. Innerhalb der Tanks 14 sind Füllpegelmesseinrichtungen 16 vorgesehen. Die Füllpegelmesseinrichtungen 16 umfassen einen Peilstab 20 und einen Schwimmer 56, so dass mit der Füllpegelmesseinrichtung 16 eine Grenzfläche 18 des Mediums 10 messbar ist. Die Leitungseinrichtung 12 umfasst eine Ansauglanze 64, einen Ansaugschlauch 66 und eine Zuleitung 40 zu einer Ansaugeinrichtung 30 mit einem Ansaugbehälter 32. Der Ansaugbehälter 32 steht über einen Strudelbrecher 38 mit einer Kreiselpumpe 34 in Verbindung, welche von einem Antriebsmotor 68 antreibbar ist. Die Kreiselpumpe 34 ist mit der Primärseite 24 einer Verteilereinrichtung 22 verbunden. Die Sekundärseite 26 der Verteilereinrichtung 22 mündet über Verteilerwege 28, von denen hier beispielhaft drei Stück dargestellt sind, in die Tanks 14.

Die Zuleitung 40 zu dem Ansaugbehälter 32 ist mit weiteren Komponenten versehen: einem Vakuumschalter 70, einem Temperaturfühler 72, einem Scheibenventil 74, einem Milch-Prüf-Ring-Ventil (MPR-Ventil) 76, einem Volumenstrommesser 78, einem Online-Probenehmer 80 sowie einem weiteren Scheibenventil 82. An dem Ansaugbehälter 32 ist ein Ejektor 36 über ein Ventil 83 angeordnet. Der Ejektor 36 ist mit einem Druckluftventil 84 ausgestattet. Ferner steht der Ansaugbe-

hälter 32 mit einem Druckluftanschluss 42 in Verbindung. Eine Druckluftleitung 86 ist mit einem Druckluftreduzierer 88, einem Filter 90 (z.B. 200 µm) und einem Absperrventil 92 ausgestattet. Der Ansaugbehälter 32 ist mit einer Füllstandmesseinrichtung 44 und mit Schaugläsern 94 versehen. Auch die Verteilereinrichtung 22 ist auf ihren verschiedenen Verteilwegen 28 mit Füllstandmesseinrichtungen 46 ausgestattet. Die Verteilereinrichtung 22 ist sowohl auf ihrer Primärseite als auch auf ihrer Sekundärseite 26 mit Scheibenventilen 96, 98 ausgestattet. Ferner sind Schaugläser 100 vorgesehen.

Bei einer Milchannahme funktioniert die erfindungsgemäße Vorrichtung beispielsweise wie folgt. Zu Beginn der Annahme wird auf der Grundlage der anzunehmenden Milchqualität (Vorgabe) der entsprechende Tank 14 (Tanksegment) gewählt. Zu diesem Zweck wird das entsprechende Ventil 96 an der Verteilereinrichtung 22 geöffnet. Ein (nicht gezeigtes) Rückschlagventil verhindert das Rückströmen von Milch, welche sich eventuell bereits in dem Tank 14 befindet. Daraufhin wird in dem Ansaugbehälter 32 ein Unterdruck erzeugt. Dies erfolgt über den Ejektor 36 in Verbindung mit dem Ventil 82 und dem Druckluftventil 84. Im Prinzip kann der Ejektor 36 durch eine andersartige Vakuumpumpe ersetzt werden. Wenn der Unterdruck einen gewissen Wert erreicht hat beginnt die Förderung der Milch. Zu diesem Zeitpunkt sind das Scheibenventil 74 und das Ventil 82 geöffnet. Der Vakuumschalter 70 detektiert den Unterdruck. Über die Ansauglanze 64 und den flexiblen Ansaugschlauch 66 wird die Milch am Temperaturfühler 72 vorbei gefördert. Der Temperaturfühler 72 dient einer zusätzlichen Qualitätssicherung. Danach gelangt die Milch in den Volumenstrommesser 78, in dem der aktuelle Volumenstrom ermittelt wird. Aus den Werten des Volumenstrommessers 78 (Geschwindigkeit und Füllgrad) wird

durch eine nicht dargestellten Steuereinheit zusammen mit beliebigen anderen Werten der Online-Probenehmer 80 angesteuert. Die Probe wird in eine (nicht dargestellte) Probenflasche abgefüllt; auch dies dient der Qualitätssicherung. Sobald die Milch in dem Ansaugbehälter 32 das mit einem Dreieck gekennzeichnete Niveau erreicht hat, wird der Antriebsmotor 68 der Kreiselpumpe 34 aktiviert, und die Kreiselpumpe 34 drängt die Milch in eine Leitung, welche zur Primärseite 24 der Verteilereinrichtung 22 führt. Um sicherzustellen, dass die Sogwirkung der Kreiselpumpe 34 keinen Trichter (Paraboloiden) zieht, ist im Einströmbereich der Kreiselpumpe 34 ein Strudelbrecher 38 angebracht. Eventuell eintretende Luft würde zwar die Messung des Milchvolumens nicht verfälschen, da die Milch im Tank 14 ausreichende Zeit zum Ausgasen hat; eine Entlüftung empfiehlt sich jedoch, um den Wirkungsgrad der Kreiselpumpe 34 zu verbessern bzw. aufrechtzuerhalten. Sobald die Kreiselpumpe 38 läuft, kann die Vakuumpumpe bzw. der Ejektor 12 abgeschaltet werden, da die Kreiselpumpe 32 nun für die Förderung der Milch sorgt. Lediglich wenn das Niveau im Ansaugbehälter 32 unter das mit einem Dreieck gekennzeichnete vorbestimmte Niveau abfällt, was an den Schaugläsern 94 zu beobachten ist, greift der Ejektor 36 unterstützend ein. Dieser Niveaunachweis erfolgt über die Füllstandmesseinrichtung 44 in dem Ansaugbehälter 32. Gegen Ende des Annahmevorgangs wird Luft mitangesaugt, das Niveau im Ansaugbehälter 32 fällt, und der Ejektor 36 saugt das Ansaugsystem von Milchresten frei. Zusätzlich ist in der beschriebenen Ausführungsform ein Milch-Prüf-Ring-Ventil 76 (MPR-Ventil) vorgesehen, welches sicherstellt, dass keine neue Annahme gestartet werden kann, bevor die laufende Annahme abgeschlossen ist. Dies geschieht dadurch, dass das MPR-Ventil 76 öffnet und somit das Ansaugsystem mit Luft flutet. Nachfolgend wird das Ventil 82, welches als Rückschlag-Absperr-

ventil ausgelegt sein kann, geschlossen, woraufhin das System leer gedrückt wird. Dieses Leerdrücken des Systems erfolgt durch die Anwendung von Druckluft, welche am Druckluftanschluss 42 angelegt wird und so in den Ansaugbehälter 32 gelangt. Die Druckluft wird über einen Druckluftreduzierer 88 mit Filter und Wasser-Öl-Abscheider und ein Absperrventil 92 geleitet und dabei auf einen Druck reduziert, welcher für das System ungefährlich ist. Dieser Druck ist aber so groß, dass er die Milch in den höchsten Tank 14 befördern kann. Der Tank 14 ist zu diesem Zeitpunkt belüftet. Ein Feinfilter 90 stellt sicher, dass die lebensmittelrechtlichen Anforderungen eingehalten werden (200 µm). Die Milch wird solange aus dem Ansaugbehälter verdrängt, bis das mit einem Dreieck gekennzeichnete Niveau in der Verteilereinrichtung 22 erreicht ist. Dies wird durch die Füllstandmesseinrichtung 46 nachgewiesen. Da die Leitungseinrichtung 12 bzw. die Verteilereinrichtung 22 in diesem Bereich geringe Querschnitte aufweist, wird der Messfehler minimiert. Die Füllstandsmesseinrichtung 46 kann in der Praxis ein Niveauschalter sein, aber auch eine stetig messende Einrichtung, insbesondere eine Peilstabeinrichtung.

Die Verrohrung des Systems ist strömungstechnisch so gestaltet, dass keine Siphons oder Vertiefungen vorhanden sind. Auf diese Weise wird sichergestellt, dass die Milch selbstständig abfließt. Somit ist die verbleibende Haftmilchmenge gering, und bei der nächsten Annahme findet nur eine minimale Kontamination statt.

Im Hinblick auf die Volumenbestimmung der angenommenen Milch ist zu bemerken, dass das Volumen zwischen dem mit einem Dreieck gekennzeichneten Übergabeniveau der Verteilereinrichtung 22 und dem Tank 14 für die Berechnung des Gesamtvolumens addiert werden muss.

Fig. 2 zeigt einen Ausschnitt der in Fig. 1 dargestellten Vorrichtung. Allerdings weist die dargestellte Vorrichtung zusätzliche Komponenten auf, welche bei der Abgabe von Milch aus den Tanks zum Einsatz kommen. Gleiche Bezugszeichen verweisen auf gleiche Komponenten.

Zusätzlich ist an der Sekundärseite der Verteilereinrichtung 22 eine Umpumpleitung 50 über die Scheibenventile 98 angeschlossen. Diese Umpumpleitung führt über ein Umpumpscheibenventil 104 zum Ansaugbehälter 32. Ferner ist die Umpumpleitung 50 mit einem Entrestventil 110 versehen. Zwischen der Kreiselpumpe 34 und der Primärseite 24 der Verteilereinrichtung 22 ist ein Abgabescheibenventil 106 angeordnet. Zwischen diesem Abgabescheibenventil 106 und der Kreiselpumpe 34 befindet sich eine als Ventil ausgelegte Abgabeöffnung 48. Im Bereich der Abgabeöffnung 48 ist zusätzlich ein Füllstandmesser 108 vorgesehen.

Bei der Milchabgabe aus einem Tank 14 funktioniert die Vorrichtung wie folgt. Das Ventil 82 ist anfänglich geschlossen, und das System ist leergedrückt. Das Leerdrücken hat beispielsweise nach einer vorangehenden Milchannahme stattgefunden. Nun wird der gewünschte Tank 14 (Tanksegment) ausgewählt, indem das entsprechende Ventil 98 geöffnet wird. Ebenso wird das Umpumpscheibenventil 104 geöffnet. Die Milch wird nun über die Schwerkraft in den Ansaugbehälter 32 gedrückt oder über einen Unterdruck von dem Ejektor 36 bzw. einer beliebigen Vakuumpumpe angesaugt. Das Ventil 106 ist zu diesem Zeitpunkt bereits geschlossen. Das Ventil der Abgabeöffnung 48 wird geöffnet. Daraufhin wird die Kreiselpumpe 34 aktiviert. Folglich wird die Milch über die Abgabeöffnung 48 abgegeben.

Findet eine Teilabgabe der Milch statt, so wird nur die entstandene Niveaudifferenz in dem entsprechenden Tanksegment über die Füllpegelmesseinrichtung 16 ermittelt und entsprechend volumenmäßig umgerechnet.

Bei einer vollständigen Entleerung des Tanks 14 sind, je nach Vorgeschichte (Teilabgabe) die zusätzlichen Volumina, beispielsweise das Volumen der Umpumpleitung 50, zu verrechnen. Das letzte Teilvolumen vom gezeigten Füllstand in der Verteilereinrichtung 22 bis zum Rückschlagventil 102 wird durch einen kurzen Druckstoß befördert, wobei das Scheibenventil 96 und das Abgabescheibenventil 106 geöffnet sind, während das Ventil der Abgabeöffnung 48 geschlossen ist. Folglich wird das letzte Teilvolumen in den Bereich gedrückt, welcher zu dem Tank 14 führt, sowie in das Volumen der Umpumpleitung 50. Der jeweilige Sensor 46 weist diesen Zustand nach. Anschließend wird das Teilvolumen durch Unterdruck in den Ansaugbehälter 32 befördert. Zum Abschluss der Abgabe wird das System leergedrückt - das Abgabescheibenventil 106 ist geschlossen, das Ventil der Abgabeöffnung 48 ist geöffnet. Dieses Leerdrücken erfolgt, bis der Sensor 108 anspricht. Insgesamt wurde auf diese Weise eine volumenmäßig erfasste Abgabe ohne wesentliche Kontamination durchgeführt.

Ebenso ist es möglich, eine Schwerkraftabladung durchzuführen. Dabei führt das jeweilige Ventil 98 direkt in den zu befüllenden Behälter.

Auch Kombinationen des Umpumpverfahrens und der Schwerkraftabladung sind selbstverständlich denkbar.

Fig. 3 zeigt eine andere Ausführungsform einer erfindungsgemäßen Vorrichtung. Vergleichbare Komponenten sind mit den

gleichen Bezugszeichen gekennzeichnet. Die Besonderheit an dieser Ausführungsform besteht darin, dass als Ansaugeinrichtung 30 eine Impellerpumpe 52 vorgesehen ist. Die Impellerpumpe 52 ist über ein Ventil 114 mit der Primärseite 24 der Verteilereinrichtung 22 verbunden. Von dem Ventil 114 stromabwärts in Richtung Verteilereinrichtung 22 gesehen, kann zusätzlich ein Druckluftanschluss 42 vorgesehen sein. Da dieser optional ist, ist er vorliegend mit unterbrochenen Linien dargestellt.

Da die Impellerpumpe 52 selbstansaugend ist, vereinfacht sich das System erheblich. Beispielsweise ist keine zusätzliche Vakuumpumpe, zum Beispiel als Ejektor ausgelegt, vorgesehen. Jedoch wird die Milch durch die Impellerpumpe 52 nicht so schonend aufgenommen, wie dies zum Beispiel durch die Kombination Vakuumpumpe/Kreiselpumpe der in Fig. 1 dargestellten Ausführungsform geschieht; ferner bringt eine Impellerpumpe 52 nicht dieselbe Leistung wie die Kombination Vakuumpumpe/Kreiselpumpe gemäß Fig. 1. Als Vorteil der Impellerpumpe 52 ist jedoch noch zu nennen, dass sie eine preiswertere Lösung darstellt.

Die Impellerpumpe 52 saugt die Milch an und drückt sie bei geöffnetem Ventil 114 in den ausgewählten Tank 14. Wenn der Vakuumschalter 70 anspricht, wird die Impellerpumpe 52 für eine bestimmte Zeit weiterbetrieben, damit die Restmilch aus dem Ansaugsystem entfernt wird. Daraufhin wird die Impellerpumpe 52 abgeschaltet, und das Ventil 114 wird geschlossen. Das Ventil 92 wird geöffnet, während das Ventil 112 geschlossen bleibt. Hierdurch wird die im Rohrsystem verbliebene Milch bis auf das mit einem Dreieck gekennzeichnete Niveau in der Verteilereinrichtung 22 gedrückt. Nachfolgend wird das Ventil 92 geschlossen, und das Rohrsystem wird über das Ventil 112 entlüftet. Die Leitung,

welche den Druckluftanschluss 42 mit der Leitungseinrichtung 12 verbindet, kann durch ein (nicht dargestelltes) Ventil vor dem Eindringen von Milch geschützt werden; hierdurch vereinfacht sich die Reinigung der Anlage.

Sowohl bei der Ausführungsform gemäß Fig. 3 als auch bei der Ausführungsform gemäß Fig. 1 kann es unter Umständen nützlich sein, jede Leitung mit einer eigenen Pumpe zu versehen. Dies bietet sich insbesondere bei Impellerpumpen 52 an, da diese nur schwer vollständig zu entleeren sind. Reste in der Impellerpumpe 52 würden jedoch zu einer Kontamination führen.

In Fig. 4 ist ein Teil der in Fig. 3 gezeigten Vorrichtung dargestellt, welche mit derjenigen in Fig. 3 vergleichbar ist. Gleiche Komponenten sind mit gleichen Bezugszeichen gekennzeichnet.

Zusätzliche Komponenten dienen dazu, mit dem System eine Abgabe durchzuführen, wobei diese Komponenten im wesentlichen denjenigen aus Fig. 2 entsprechen. Auch hier sind gleiche Bezugszeichen für ähnliche Komponenten verwendet. Die Vorgänge zur Abgabe der Milch über die Abgabeöffnung 48 sind mit denjenigen in Fig. 2 vergleichbar, so dass eine erneute Beschreibung nicht erforderlich ist.

In Fig. 5 ist eine Vorrichtung dargestellt, welche im Rahmen der Erfindung vorteilhaft einsetzbar ist. Wiederum ist ein Tank 14 gezeigt, welcher mit einem Medium 10, beispielsweise Milch gefüllt ist. Das Medium 10 hat eine Grenzfläche 18, welche durch die Füllpegelmesseinrichtung 16 mit ihrem Peilstab 20 gemessen wird. An dem Tank 14 ist eine Leitungseinrichtung 12 angeschlossen. An dieser sind

ein Ansaugschlauch 118, eine Kupplung 120, ein Ventil 122 und ein Sensor 124 angeordnet.

Die Vorrichtung gemäß Fig. 5 wird mit einem in dem Tank 14 erzeugten Unterdruck betrieben. Bei dieser Vorrichtung wirken sich die Vorteile der Füllpegelmesseinrichtung 16 mit Peilstab 20 besonders deutlich aus. Bei Tanks 14, welche mit Unterdruck arbeiten, wird der ganze Tank bis zu einem gewissen Unterdruck evakuiert. Der minimale Druck ist dabei durch die Formstabilität des Tanks bestimmt. Durch diesen Unterdruck wird dann das Flüssigprodukt bei Öffnen des entsprechenden Ventils 122 in den Tank 14 hineingesaugt. Dabei entstehen besonders geringe Kontaminationen. Bei der in Fig. 5 dargestellten Ausführungsform findet die Befüllung und die Abgabe an derselben Seite des Tanks 14 statt. Das System ist beispielhaft ohne Probenahme dargestellt, was im Ausland nach wie vor häufig gefragt ist. Über den flexiblen Ansaugschlauch 118, der über eine Kupplung 120 mit dem Befüll-Abgabe-Stutzen verbunden ist, gelangt das Produkt nach dem Öffnen des Ventils 122 in den Tank 14. Die Füllpegelmesseinrichtung 16 mit ihrem Peilstab 20 kann neben der Volumenbestimmung auch als Überfüllsicherung dienen. Um bei einer volumenmäßig erfassten Abgabe sicherzustellen, dass auch die ganze Leitungseinrichtung 12 entleert ist, ist ein Sensor 124 vorgesehen.

Fig. 6 zeigt eine weitere Vorrichtung, welche im Rahmen der vorliegenden Erfindung vorteilhaft einsetzbar ist. Auch hier handelt es sich um ein Unterdrucksystem. Im Unterschied zu Fig. 5 findet hier jedoch die Befüllung des Tanks 14 von oben statt, während die Abgabe an der Unterseite des Tanks 14 erfolgt. Die Leitungseinrichtung 12 auf der Befüllseite weist ein Ventil 128 auf, ebenso wie die Lei-

tungseinrichtung 12 auf der Abgabeseite ein Ventil 122 aufweist.

Fig. 7 ist eine erweiterte Variante der Ausführungsform gemäß Fig. 6. Zusätzlich ist hier ein Ansaugbehälter 54 vorgesehen. Diese Anordnung hat den Vorteil, dass zunächst der relativ kleine Ansaugbehälter 54 evakuiert wird, während der Tank 14 seinen bereits erzeugten Unterdruck aufrechterhält. Erst wenn der Ansaugbehälter 54 gefüllt ist, was durch den Sensor 130 detektiert wird, wird das Ventil 128 geschlossen, und das Ventil 122 wird geöffnet. Durch den Unterdruck im Tank 14 wird das Produkt durch das Rückschlagventil 132 in den Tank 14 befördert. Dabei ist es besonders vorteilhaft, wenn der Unterdruck im Ansaugbehälter 54 nicht mit dem Unterdruck im Tank 14 verbunden ist. Dadurch wird verhindert, dass ein Lufteinfall zum Beginn oder am Ende der Annahme zu einem vorzeitigen Druckanstieg im Tank 14 führt; denn sollte dies eintreten, so müsste das große Volumen des Tanks 14 erneut evakuiert werden. Der Ansaugbehälter 54 ist so dimensioniert, dass er das Volumen des Ansaugsystems aufnehmen kann.

In Fig. 8 ist eine Verteilereinrichtung 22 dargestellt, welche im Rahmen der vorliegenden Erfindung vorteilhaft eingesetzt werden kann. An den Verbindungen zwischen den Schläuchen 134 und den jeweiligen Leitungen 136, 138 sind Leseeinrichtungen 58 und codierte Einrichtungen 60 (TAGs) angeordnet. Die Leseeinrichtungen 58 sind in der Lage, den Code der TAGs 60 zu lesen und das Ergebnis einer Steuerung 62 einzugeben. Die Übertragung von den Leseeinrichtungen 58 kann über eine feste Verkabelung oder über eine Fernübertragungseinrichtung 140 erfolgen. Letztere kann beispielsweise Funk- oder Infrarotsignale aussenden. Ferner kann in dem System eine Überfüllsicherung 142 angeordnet sein. Das

System kann nun so ausgelegt sein, dass die Ventile 146 zu den Tanks 14 nur dann von der Steuerung zum Öffnen freigegeben werden, wenn von den Leseeinrichtungen 58 die richtigen von den TAGs 60 gelesenen Codes bzw. die entsprechenden Lesesignale übertragen werden. Dies erhöht die Sicherheit bei der Milchannahme, da so ein unbeabsichtigtes Vermischen durch ein falsches Anschließen verhindert wird. Um zusätzlich beispielsweise Manipulationen entgegenzutreten, können die Verbindungen zwischen den Leitungen und den Schläuchen durch eine Plombe 144 versiegelt sein.

Sofern eine mechanische Plombe vorgesehen ist und angebracht ist, könnten die TAGs und TAG-Reader landseitig entfallen.

Die in der vorstehenden Beschreibung, in der Zeichnung sowie in den Ansprüchen offenbarten Merkmale der Erfindung können sowohl einzeln als auch in beliebiger Kombination für die Verwirklichung der Erfindung wesentlich sein.

Ansprüche

1. Vorrichtung zur Förderung eines Mediums, mit einer Leitungseinrichtung (12), über die mehrere Tanks (14) befüllbar und/oder entleerbar sind, und mit einer Füllpegelmesseinrichtung (16) im Inneren jedes Tanks (14) zur Bestimmung der Position mindestens einer Grenzfläche (18) des Mediums (10) in dem Tank (14),
dadurch g e k e n n z e i c h n e t,
- dass die Leitungseinrichtung (12) eine Verteilereinrichtung (22) mit einer Primärseite (24) und einer Sekundärseite (26) aufweist,
- dass die Sekundärseite (26) einzelne, mit den Tanks (14) in Verbindung stehende, absperrbare Verteilerwege (28) aufweist und
- dass jedem Verteilerweg (28) eine Füllstandsmesseinrichtung (46) zum Messen des Füllstandes in der Verteilereinrichtung (22) zugeordnet ist.

2. Vorrichtung nach Anspruch 1,
dadurch g e k e n n z e i c h n e t,
dass die Primärseite (24) der Verteilereinrichtung (22) mit einer Ansaugeinrichtung (30) in Verbindung steht.

3. Vorrichtung nach Anspruch 2,
dadurch g e k e n n z e i c h n e t,

dass die Ansaugeinrichtung (30) einen ersten Ansaugbehälter (32), eine Kreiselpumpe (34) und einen Ejektor (36) aufweist.

4. Vorrichtung nach Anspruch 3,
dadurch g e k e n n z e i c h n e t,
dass im Ansaugbereich der Kreiselpumpe (34) ein Strudelbrecher (38) angeordnet ist.

5. Vorrichtung nach einem der Ansprüche 2 bis 4,
dadurch g e k e n n z e i c h n e t,
dass die Ansaugeinrichtung (30) mit einer Zuleitung (40) verbindbar ist.

6. Vorrichtung nach einem der Ansprüche 2 bis 5,
dadurch g e k e n n z e i c h n e t,
dass die Ansaugeinrichtung (30) mit einem Druckluftanschluss (42) verbindbar ist.

7. Vorrichtung nach einem der Ansprüche 2 bis 6,
dadurch g e k e n n z e i c h n e t,
dass die Ansaugeinrichtung (30) eine Füllstandmesseinrichtung (44) aufweist.

8. Vorrichtung nach einem der Ansprüche 2 bis 7,
dadurch g e k e n n z e i c h n e t,
- dass zwischen der Ansaugeinrichtung (30) und der Primärseite (24) der Verteilereinrichtung (22) eine Abgabeöffnung (48) vorgesehen ist und
- dass die mit den Tanks (14) in Verbindung stehenden Verteilerwege (28) auf der Sekundärseite (26) der Verteilereinrichtung (22) über eine Umpumpleitung (50) mit der Ansaugvorrichtung (30) in Verbindung stehen.

9. Vorrichtung nach einem der Ansprüche 2 bis 8, dadurch g e k e n n z e i c h n e t, dass die Ansaugeinrichtung (30) eine Impellerpumpe (52) umfasst.

10. Vorrichtung nach Anspruch 1, dadurch g e k e n n z e i c h n e t, dass für jeden Tank (14) eine Ansaugeinrichtung (30), insbesondere eine Impellerpumpe (52) vorgesehen ist.

11. Vorrichtung nach Anspruch 1, dadurch g e k e n n z e i c h n e t, dass in zumindest einem der Tanks (14) ein erster Unterdruck erzeugbar ist.

12. Vorrichtung nach Anspruch 11, dadurch g e k e n n z e i c h n e t, dass mit dem Tank (14) ein zweiter Ansaugbehälter (54) verbindbar ist, indem ein zweiter Unterdruck erzeugbar ist, wobei der erste Unterdruck unabhängig von dem zweiten Unterdruck erzeugbar ist.

13. Vorrichtung nach Anspruch 12, dadurch g e k e n n z e i c h n e t, dass das Volumen des zweiten Ansaugbehälters (54) mindestens so groß ist wie das Volumen des restlichen Ansaugsystems.

14. Vorrichtung nach einem der vorangehenden Ansprüche, dadurch g e k e n n z e i c h n e t,
- dass als Füllpegelmesseinrichtung (16) ein nach dem magnetostriktiven Prinzip arbeitender, mit einer Rechenvorrichtung gekoppelter, transsonarer Wegaufneh-

mer mit mindestens einem Peilstab (20) und mindestens einem Schwimmer (56) vorgesehen ist und

- dass der Schwimmer (56) mit mindestens einem Magneten versehen ist.

15. Vorrichtung nach einem der vorangehenden Ansprüche, dadurch g e k e n n z e i c h n e t, dass eine Steuereinrichtung vorgesehen ist, welche die Förderung des Mediums (10) in Abhängigkeit der Messsignale der Füllpegelmesseinrichtungen (16) der Tanks (14) und/oder der Füllstandmesseinrichtungen (46) der Verteilereinrichtung (22) und/oder der Füllstandmesseinrichtung (44) der Ansaugeinrichtung (30) steuert.

16. Vorrichtung nach Anspruch 15, dadurch g e k e n n z e i c h n e t, dass mindestens ein Drucksensor und/oder mindestens ein Temperaturfühler (72) und/oder mindestens eine Volumenstrommesseinrichtung (48) vorgesehen sind, deren Ausgangssignale der Steuereinrichtung als Eingangssignale zuführbar sind.

17. Vorrichtung nach einem der vorangehenden Ansprüche, dadurch g e k e n n z e i c h n e t, dass die Verbindungen der Leitungseinrichtung (12) mit anderen Systemkomponenten mit Leseeinrichtungen (58) und codierten Einrichtungen (60) (TAGs) ausgestattet sind, so dass über eine Steuerung die korrekte Zuordnung der Komponenten überprüfbar ist.

18. Verfahren zur Förderung eines Mediums (10), bei dem das Medium über eine Leitungseinrichtung (12) in Tanks (14) gefördert wird und bei dem die Füllpegel in den Tanks

(14) von Füllpegelmesseinrichtungen (16) gemessen werden,
dadurch g e k e n n z e i c h n e t,
- dass das Medium (10) zur Befüllung einer der Tanks (4) in eine Verteilereinrichtung (22) der Leitungseinrichtung (12) gefördert wird, wobei die Verteilereinrichtung (22) für jeden Tank (14) einen mit diesem in Verbindung stehenden Verteilerweg (28) aufweist,
- dass ein Tank (14) ausgewählt wird, welcher mit dem Medium (10) zu befüllen ist,
- dass der Verteilerweg (28) des zu befüllenden Tanks (14) geöffnet wird,
- dass zumindest während der Befüllung des Tanks (14) der Füllstand in der Verteilereinrichtung (22) erfasst wird und
- dass in Abhängigkeit von dem in der Verteilereinrichtung (22) erfassten Füllstand der geöffnete Verteilerweg (28) zur Beendigung der Befüllung geschlossen wird.

19. Verfahren nach Anspruch 18,
dadurch g e k e n n z e i c h n e t,
- dass in einer Ansaugeinrichtung (30) ein Unterdruck zur Befüllung der Leitungseinrichtung (12) erzeugt wird,
- dass in der Ansaugeinrichtung (30) ein Füllstand ermittelt wird und
- dass in Abhängigkeit des ermittelten Füllstandes die Förderung des Mediums (10) durch die Leitungseinrichtung (12) in den ausgewählten Tank (14) beginnt und die Erzeugung des Unterdrucks beendet wird.

20. Verfahren nach Anspruch 18 oder 19,
dadurch g e k e n n z e i c h n e t,

dass nach der Befüllung des ausgewählten Tanks (14) mindestens ein weiterer Tank (14) befüllt wird.

21. Verfahren nach einem der Ansprüche 18 bis 20, dadurch g e k e n n z e i c h n e t, dass nach der Erzeugung des Unterdruckes in der Ansaugeinrichtung (30) eine Kreiselpumpe (34) zur Förderung des Mediums (10) betrieben wird.

22. Verfahren nach Anspruch 21, dadurch g e k e n n z e i c h n e t, dass eine zur Erzeugung des Unterdrucks dienende Vakuumpumpe (36) unterstützend zu der Kreiselpumpe (34) betrieben wird, wenn der in der Ansaugeinrichtung (30) ermittelte Füllstand unter ein vorgegebenes Niveau fällt.

23. Verfahren nach Anspruch 21 oder 22, dadurch g e k e n n z e i c h n e t, dass die Inbetriebnahme der Kreiselpumpe (34) und/oder die unterstützende Inbetriebnahme der Vakuumpumpe (36) auch in Abhängigkeit des ermittelten Füllstandes in der Verteilereinrichtung (22) gesteuert werden bzw. wird.

24. Verfahren nach einem der Ansprüche 18 bis 23, dadurch g e k e n n z e i c h n e t, dass vor der Befüllung eines weiteren Tanks (14) Reste des Mediums (10) von der Vakuumpumpe abgesaugt werden.

25. Verfahren nach einem der Ansprüche 18 bis 23, dadurch g e k e n n z e i c h n e t, dass vor der Befüllung eines weiteren Tanks (14) Druckluft in das System eingespeist wird, bis in der Vertei-

lereinrichtung (22) ein vorbestimmter Füllstand erreicht ist.

26. Verfahren nach einem der Ansprüche 18 bis 25, dadurch g e k e n n z e i c h n e t, dass das Medium (10) aus einem Tank (14) abgegeben wird, indem
- ein Tank (14) ausgewählt wird,
- mindestens ein Teil des Mediums (10) über eine Umpumpleitung (50) in einen Ansaugbehälter (32) gedrückt wird und
- das Medium (10) aus dem Ansaugbehälter (32) durch eine zwischen dem Ansaugbehälter (32) und der Verteilereinrichtung (22) angeordnete Abgabeöffnung (48) abgegeben wird.

27. Verfahren nach einem der Ansprüche 18 bis 26, dadurch g e k e n n z e i c h n e t, dass in einem Tank (14) ein erster Unterdruck erzeugt wird, so dass der Tank (14) mit dem geförderten Medium (10) befüllt wird.

28. Verfahren nach Anspruch 27, dadurch g e k e n n z e i c h n e t, dass in einem zweiten Ansaugbehälter (54), welcher mit dem Tank (14) in Verbindung steht, ein zweiter Unterdruck unabhängig von dem ersten Unterdruck erzeugt wird, wobei zunächst der zweite Ansaugbehälter (54) und danach der Tank (14) mit dem geförderten Medium (10) befüllt wird.

Fig. 1

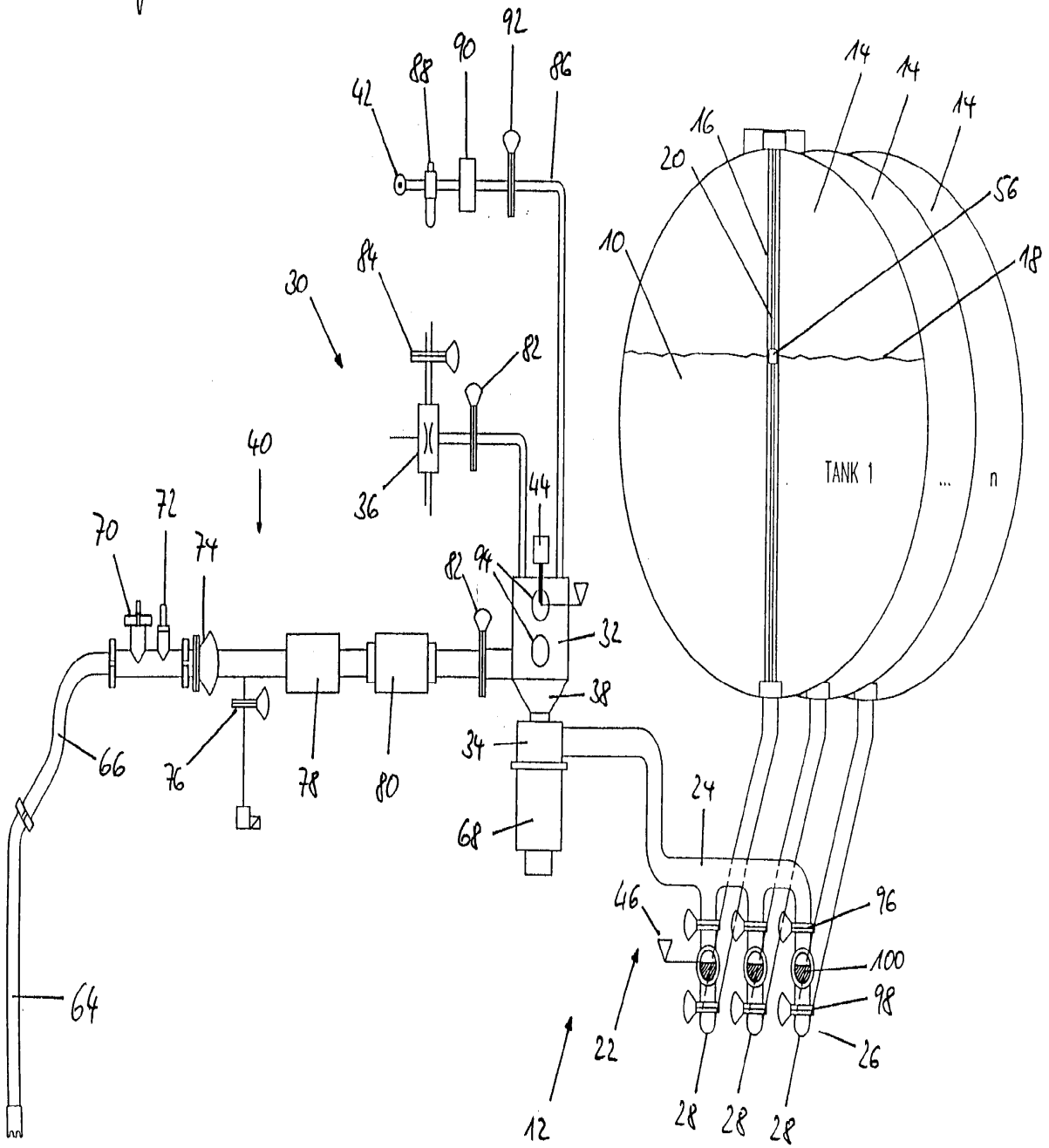

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Fig. 2

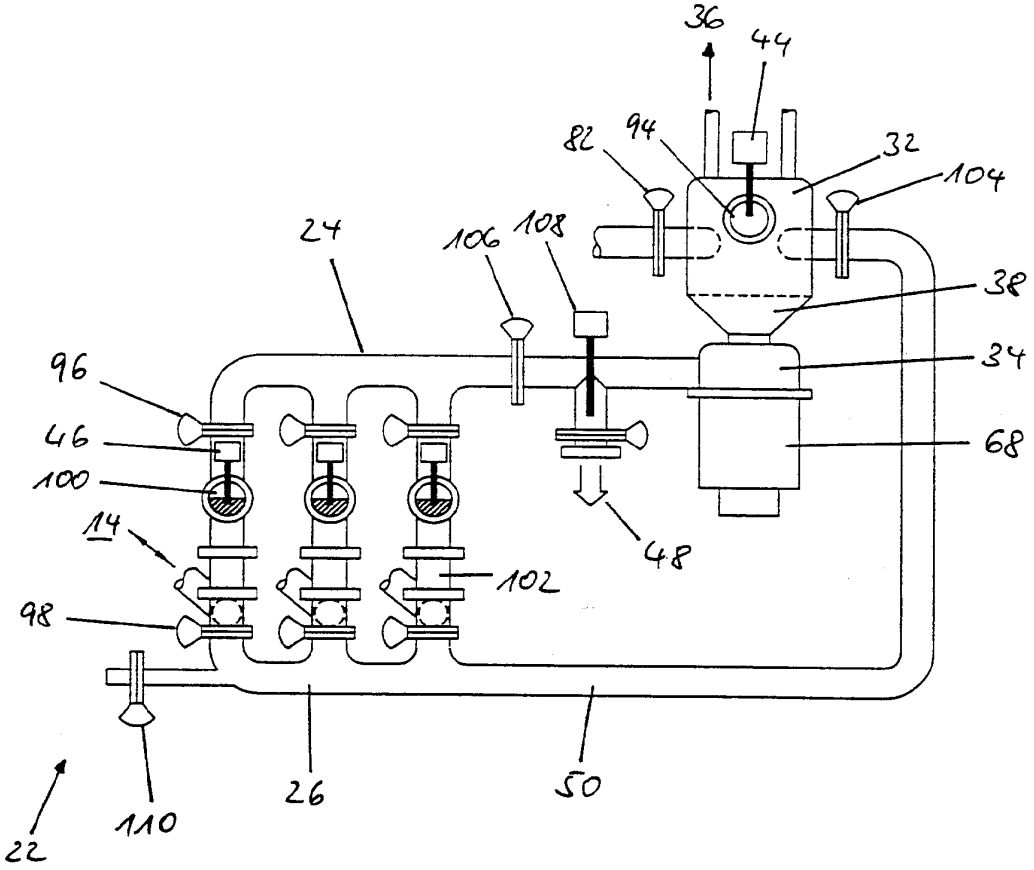

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Fig.3

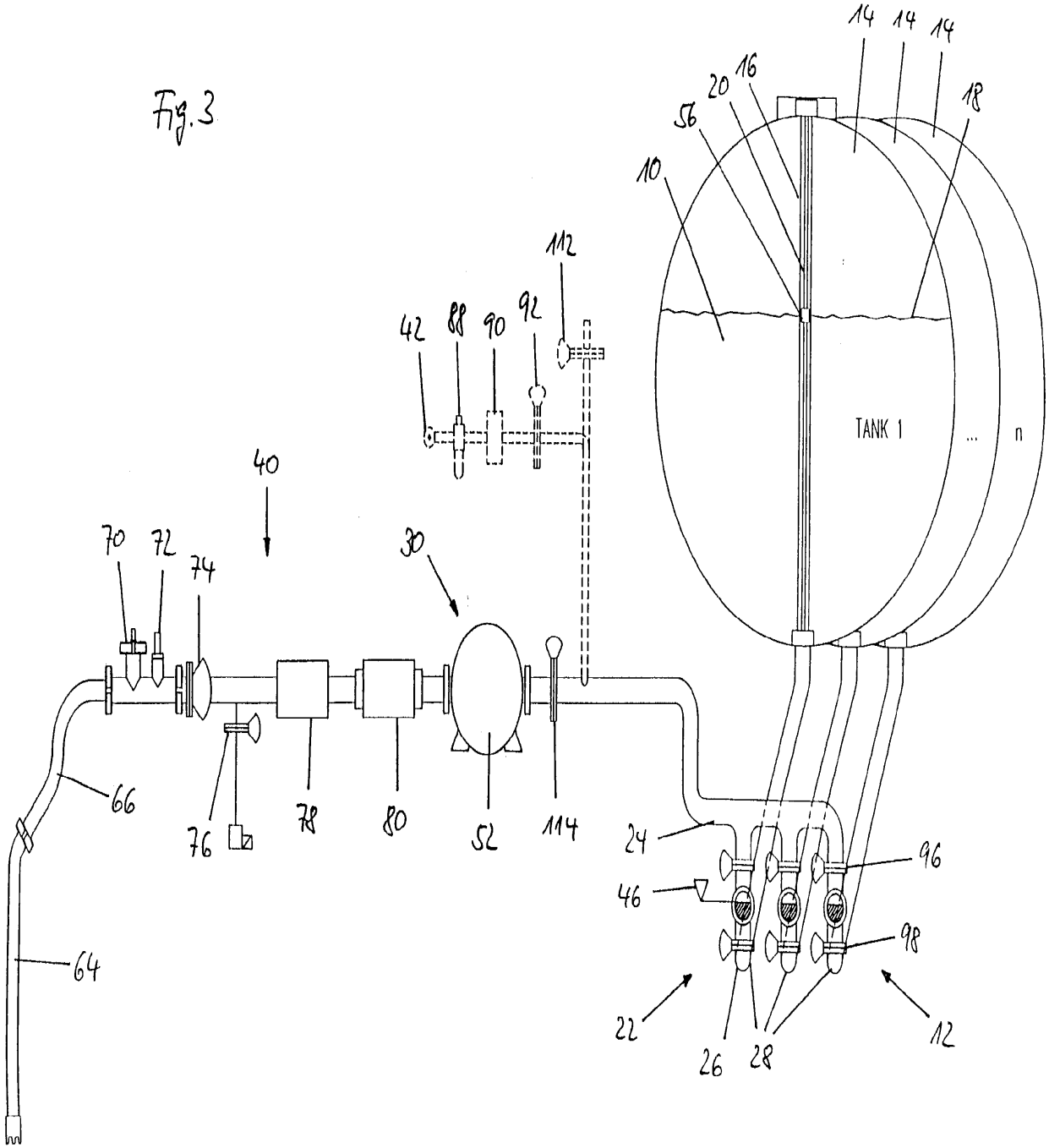

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Fig. 4

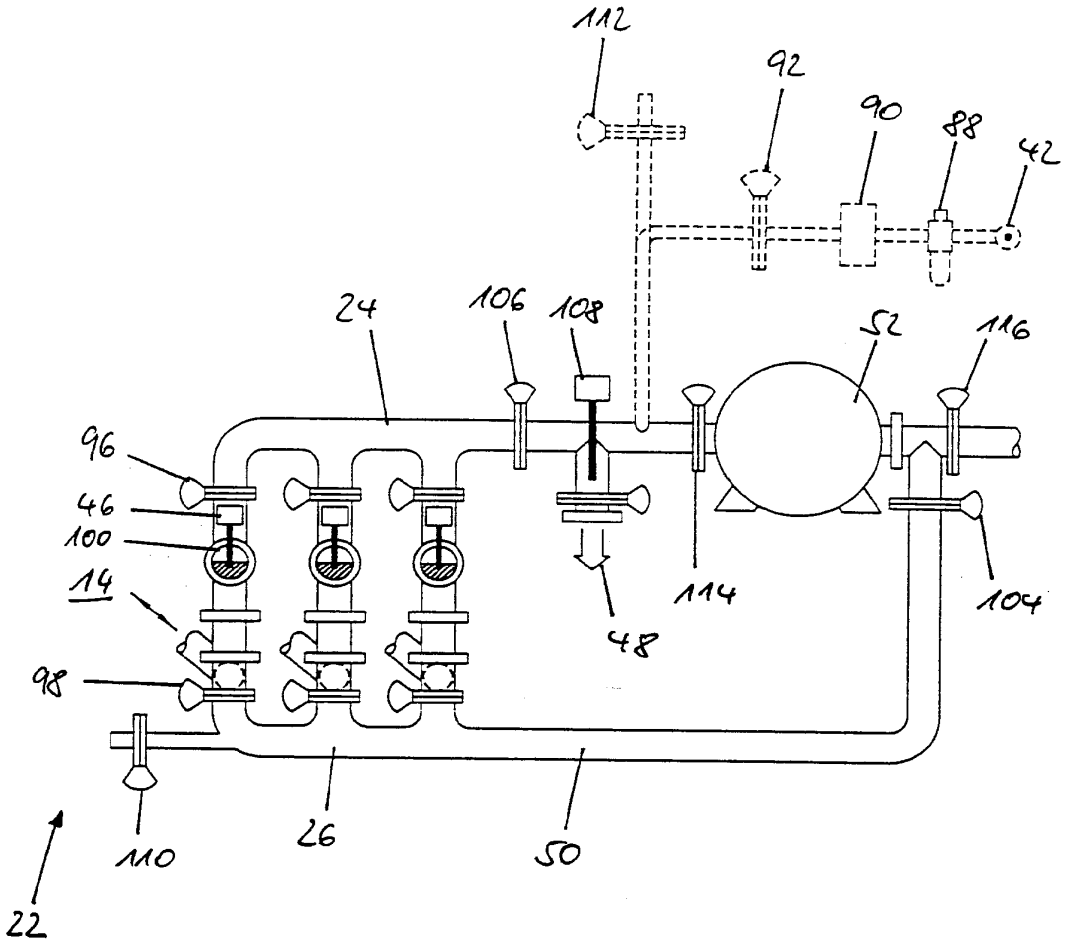

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Fig. 5

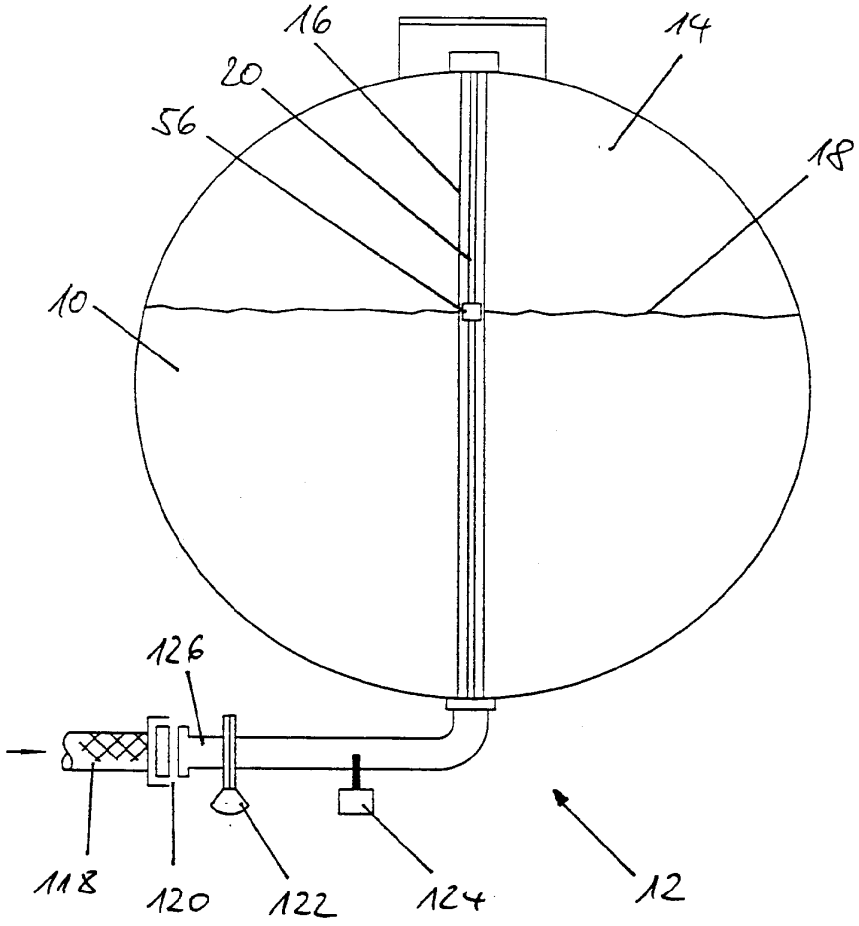


Fig. 6

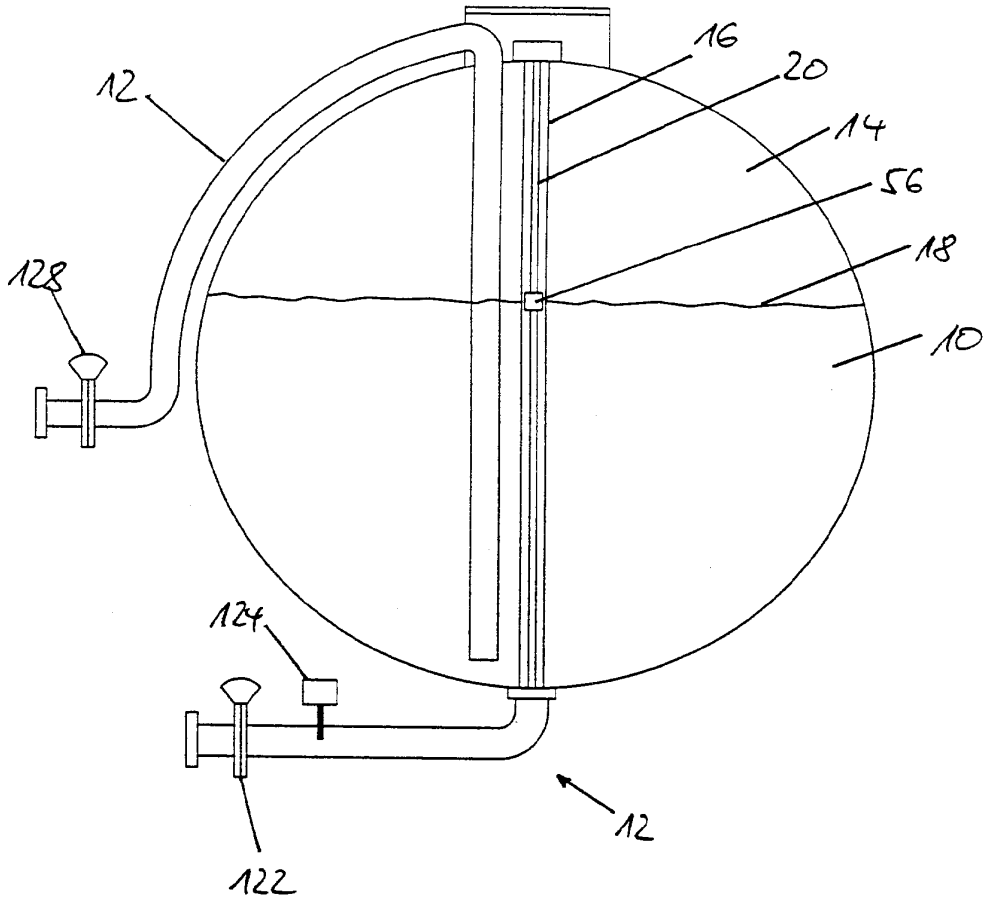


Fig. 7

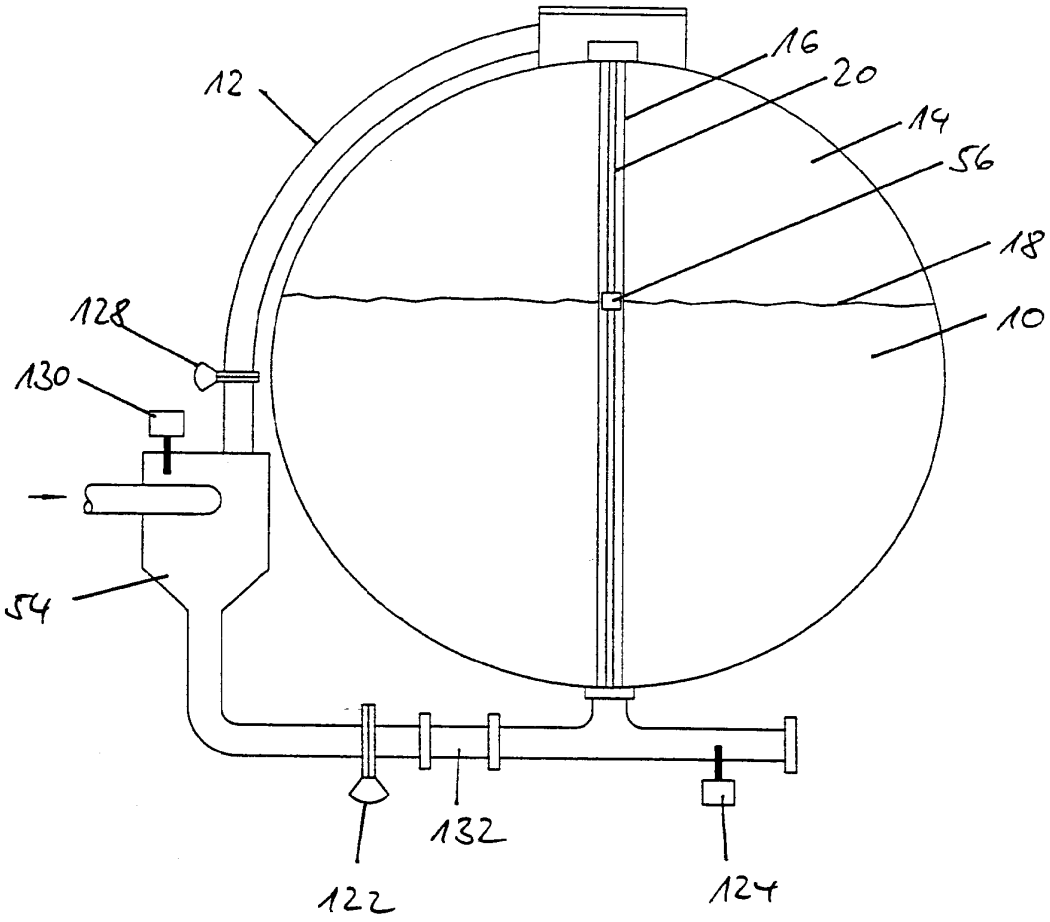
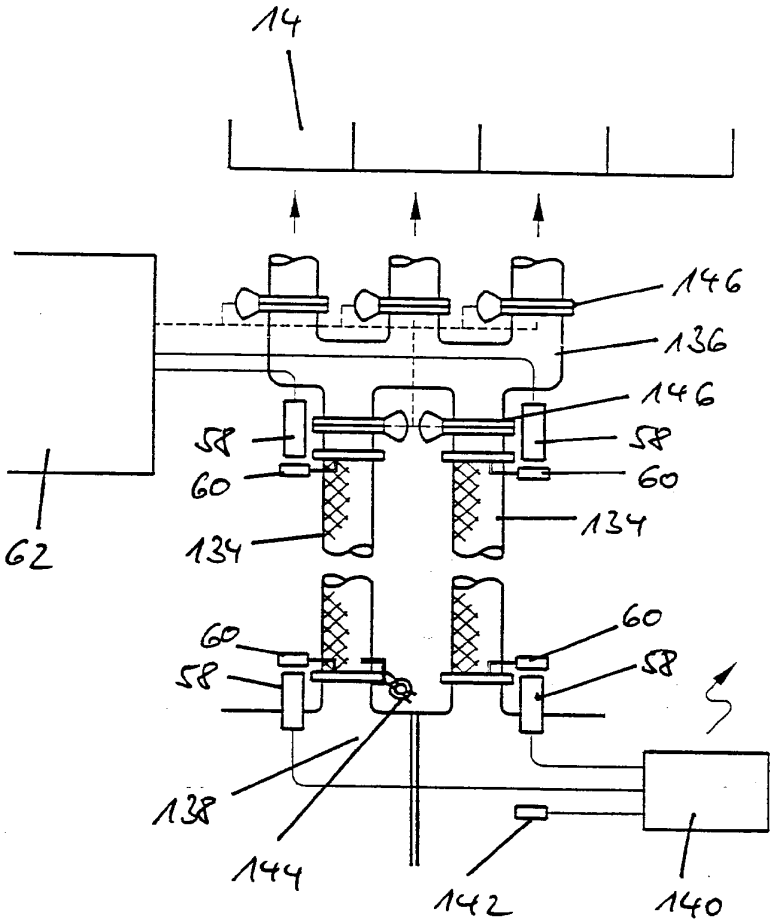


Fig. 8



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/03915

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B67D5/02 B67D5/33 B67D5/58

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 7 B67D

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 799 833 A (GREEN THOMAS S ET AL) 1 September 1998 (1998-09-01)	1
A	column 3, line 15 - line 16 column 3, line 35 figure 1	18

Y	DE 198 39 112 A (BARTEC COMPONENTEN & SYST GMBH) 9 March 2000 (2000-03-09) cited in the application column 6, line 43 - line 46	1

A	EP 0 258 811 A (HACKMAN AB OY) 9 March 1988 (1988-03-09) column 2, line 18 - line 21 column 2, line 44 - line 53 column 4, line 1 - line 6 figure 1	1,18

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[X] Further documents are listed in the continuation of box C.

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2001	17/07/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040. Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Martínez Navarro, A.

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FAS 2004 - Page 915

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 01/03915

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 4 601 409 A (DIREGOLO JOSEPH A) 22 July 1986 (1986-07-22) ---	
A	WO 99 65094 A (FITTER JOHAN CHRISTIAAN) 16 December 1999 (1999-12-16) -----	

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 01/03915

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5799833 A	01-09-1998	NONE	
DE 19839112 A	09-03-2000	WO 0012972 A	09-03-2000
		EP 1105701 A	13-06-2001
EP 0258811 A	09-03-1988	FI 863533 A	02-03-1988
		PT 85630 A	14-10-1988
US 4601409 A	22-07-1986	JP 1632971 C	20-01-1992
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		JP 61125429 A	13-06-1986
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		EP 1090434 A	11-04-2001

Form PCT/ISA/210 (patent family annex) (July 1992)

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP 01/03915

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7 B67D5/02 B67D5/33 B67D5/58

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B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7 B67D

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
Y	US 5 799 833 A (GREEN THOMAS S ET AL) 1. September 1998 (1998-09-01)	1
A	Spalte 3, Zeile 15 - Zeile 16 Spalte 3, Zeile 35 Abbildung 1	18

Y	DE 198 39 112 A (BARTEC COMPONENTEN & SYST GMBH) 9. März 2000 (2000-03-09) in der Anmeldung erwähnt Spalte 6, Zeile 43 - Zeile 46	1

A	EP 0 258 811 A (HACKMAN AB OY) 9. März 1988 (1988-03-09) Spalte 2, Zeile 18 - Zeile 21 Spalte 2, Zeile 44 - Zeile 53 Spalte 4, Zeile 1 - Zeile 6 Abbildung 1	1,18

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[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

[X] Siehe Anhang Patentfamilie

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"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
10. Juli 2001	17/07/2001

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Martínez Navarro, A.

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Formblatt PCT/ISA/210 (Blatt 2) (Juli 1992)

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP 01/03915

C.(Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	US 4 601 409 A (DIREGOLO JOSEPH A) 22. Juli 1986 (1986-07-22) ---	
A	WO 99 65094 A (FITTER JOHAN CHRISTIAAN) 16. Dezember 1999 (1999-12-16) -----	

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Formblatt PCT/ISA/210 (Fortsetzung von Blatt 2) (Juli 1992)

INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffent. ...ngen, die zur selben Patentfamilie gehören

...rnationales Aktenzeichen
PCT/EP 01/03915

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie	Datum der Veröffentlichung
US 5799833 A	01-09-1998	KEINE	
DE 19839112 A	09-03-2000	WO 0012972 A	09-03-2000
		EP 1105701 A	13-06-2001
EP 0258811 A	09-03-1988	FI 863533 A	02-03-1988
		PT 85630 A	14-10-1988
US 4601409 A	22-07-1986	JP 1632971 C	20-01-1992
		JP 2058973 B	11-12-1990
		JP 61125429 A	13-06-1986
WO 9965094 A	16-12-1999	AU 4053999 A	30-12-1999
		EP 1090434 A	11-04-2001

Formblatt PCT/ISA/210 (Anhang Patentfamilie)(Juli 1992)

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

PCT

(43) Internationales Veröffentlichungsdatum
19. Januar 2006 (19.01.2006)

(10) Internationale Veröffentlichungsnummer
WO 2006/005686 A1

(51) Internationale Patentklassifikation[7]: B60P 3/22, B60S 5/02

(21) Internationales Aktenzeichen: PCT/EP2005/053128

(22) Internationales Anmeldedatum: 1. Juli 2005 (01.07.2005)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
A1207/2004 15. Juli 2004 (15.07.2004) AT

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **SECURITY & ELECTRONIC TECHNOLOGIES GMBH** [AT/AT]; Aumühlweg 3, A-2544 Leobersdorf (AT).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **HÖCKNER, Dagmar** [AT/AT]; Piestingaustrasse 28, A-2483 Ebreichsdorf (AT).

(74) Anwälte: **MÜLLNER, Erwin** usw.; Postfach 159, Weihburggasse 9, A-1014 Wien (AT).

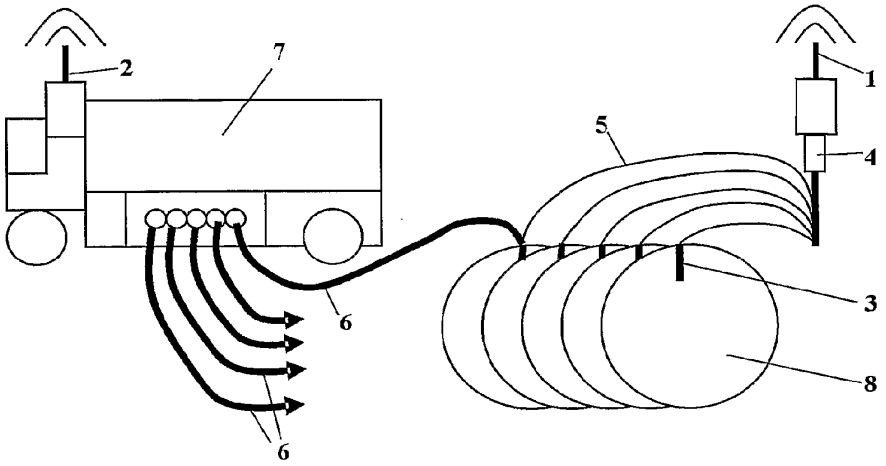
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(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC,

[Fortsetzung auf der nächsten Seite]

(54) Title: SAFETY DEVICE TO PREVENT OVERFILLING

(54) Bezeichnung: MEHRFACHÜBERFÜLLSICHERUNG



(57) Abstract: The invention relates to a device for preventing overfilling of a plurality of fuel tanks (8) at a gasoline station, in the event that fuel tanks are filled simultaneously by multi-chamber tank vehicles (7). The fuel tanks (8) are equipped with filling level threshold indicators (3) linked to a transmitter (1) for wireless transmission of a signal. A receiver (2) mounted in the tank vehicle (7) is provided to control one or several tank valves. In order to ensure safe closure of the tank valves, the filling level threshold indicators (3) of the fuel tanks (8) at the gasoline station are connected each to a signal line (5) leading to a common interface (4). Only one transmitter (1) along with an interrogation control device is provided for connecting to said interface (4) and cooperates with the receiver (2) mounted in the tank vehicle (7). The receiver is connected to a control for receiving address-coded signals from the transmitter (1), said control being connected to an actuating device for selectively disconnecting the tank valves of the tank vehicle (7).

[Fortsetzung auf der nächsten Seite]

WO 2006/005686 A1

NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— *mit internationalem Recherchenbericht*

— *vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eintreffen*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Anordnung zur Überfüllsicherung einer Mehrzahl von Treibstofftanks (8) einer Tankstelle, die gleichzeitig durch Mehrkammer-Tankfahrzeuge (7) befüllt werden, wobei die Treibstofftanks (8) Füllstand-Grenzwertgeber (3) aufweisen, die mit einem Sender (1) zur drahtlosen Übertragung eines Signals verbunden sind, und wobei ein Empfänger (2) am Tankfahrzeug (7) zur Steuerung eines oder mehrerer Tankventile vorgesehen ist. Um eine sichere Abschaltung zu gewährleisten, ist vorgesehen, dass sämtliche Füllstands-Grenzwertgeber (3) der Treibstofftanks (8) an der Tankstelle mit jeweils einer Signalleitung (5) verbunden sind, die zu einer gemeinsamen Schnittstelle (4) führen, und lediglich ein Sender (1) zusammen mit einer Abfrageschaltung zum Anschluss an die Schnittstelle (4) vorgesehen ist, welcher Sender (1) mit einem am Tankfahrzeug (7) angeordneten Empfänger (2) zusammenwirkt, der mit einer Schaltung zum Empfang adresscodierter Signale des Senders (1) verbunden ist, die an eine Steuerung zur selektiven Abschaltung der Tankventile am Tankfahrzeug (7) angeschlossen ist.

Beschreibung

MEHRFACHÜBERFÜLLSICHERUNG

Technisches Umfeld

[001] Die Erfindung bezieht sich auf eine Anordnung zur Überfüllsicherung einer Mehrzahl von Treibstofftanks gemäß dem Oberbegriff des Anspruches 1.

[002] Durch die
DE 20016410 U --.
wurde ein Tankfahrzeug bekannt, das mehrere Kammern aufweist, die mit je einem Ventil versehen sind, das zum Befüllen und Entleeren der entsprechenden Kammer dient. In diesen Kammern ist je ein Füllstandssensor angeordnet, wobei die Füllstandssensoren mit einem Rechner verbunden sind, der die Füll- und Abgabemengen der einzelnen Kammern berechnet. Dabei ist dieser Rechner über eine drahtlose Übertragungsstrecke mit einer Bedieneinheit verbunden, die Anzeige- und Eingabeelemente zur Überwachung und Steuerung zum Befüllen oder Entleeren der Tanks einer Tankstelle aufweist und mit der die erforderlichen Operationen, wie das Ansteuern von Ventilen überwacht werden können.

[003] Bei dieser Lösung ergibt sich jedoch der Nachteil, dass eine Überwachung des Füllstandes nur indirekt erfolgen kann. Dabei hängt aber die Möglichkeit der Vermeidung einer Überfüllung von dem Zusammenspiel der Füllstandsanzeiger mit dem Rechner ab, in dessen Speicher den jeweiligen Kammern bzw. Tanks entsprechende Algorithmen eingegeben sein müssen. Da die Kammern bzw. Tanks eines Tankfahrzeuges meist keine einfachen und leicht berechenbaren Formen aufweisen, ergeben sich dabei meist entsprechende Ungenauigkeiten.

[004] Beim Befüllen von Tanks von Tankstellen ergibt sich immer das Problem, dass ein Überfüllen der meist unterirdisch angelegten Tanks schon aus Umweltschutzgründen vermieden werden muss. Dazu sind meist optische oder Thermistor-Grenzwertgeber vorgesehen, wobei diese beobachtet werden müssen, um dann die weitere Zufuhr von Kraftstoff in die Tanks der Tankstelle zu unterbinden. Dabei ergeben sich aber entsprechende Unsicherheiten.

Offenbarung der Erfindung

Technisches Problem

[005] Ziel der Erfindung ist es, diese Nachteile zu vermeiden und eine Einrichtung der eingangs erwähnten Art vorzuschlagen, bei der beim Befüllen von Tanks einer Tankstelle ein Überfüllen sicher vermieden ist und andererseits die Kapazität der Tanks weitgehend ausgenutzt werden kann.

Technische Lösung

[006] Erfindungsgemäß wird dies bei einer Anordnung der eingangs erwähnten Art durch die kennzeichnenden Merkmale des Anspruches 1 erreicht.

[007] Durch die vorgeschlagenen Maßnahmen kann das Erreichen eines vorgegebenen Füllstandes auf einfache Weise übertragen und ein automatisches Schließen der entsprechenden Zuflussventile eingeleitet werden. Dabei kann jedes Tankfahrzeug einen entsprechenden Empfänger fest eingebaut haben und auch den Sender mitführen. Dieser kann einfach auf die Schnittstelle, eben den Stecker, aufgesteckt und nach Beendigung des Füllvorganges wieder abgenommen werden. Dabei kann aufgrund der Abfrageschaltung das Erreichen des jeweiligen vorgesehenen maximalen Füllstandes eines jeden einzelnen Tanks einer Tankstelle abgefragt werden.

[008] Da der Sender mit einem bestimmten Tankfahrzeug stets mitgeführt werden kann, kann dieser exakt auf die Übertragungsfrequenz des Empfängers abgestimmt werden und es erübrigt sich ein allfälliges Einstellen einer entsprechenden Übertragungsfrequenz auf einen Empfänger.

[009] Durch die Merkmale des Anspruchs 2 ergibt sich der Vorteil, dass eine Überprüfung von Identifizierungscodes auf einfache Weise durchgeführt werden kann.

[010] Durch die Merkmale des Anspruchs 3 ergibt sich der Vorteil, dass das Füllen der Tanks einer Tankstelle praktisch weitgehend automatisiert werden kann. Es genügt dazu, die entsprechenden Schlauchverbindungen herzustellen und den Sender auf der Schnittstelle zu montieren. Nach der Aktivierung des Senders können die entsprechenden Ventile geöffnet werden und der Füllvorgang gestartet werden. Bei Erreichen des vorgesehenen maximalen Füllstandes bewirkt die Übertragung eines vom Füllstand-Grenzwertgeber erzeugten Signals zum Empfänger ein Schließen des entsprechenden Ventils.

Kurze Beschreibung von Zeichnungen

[011] Die Erfindung wird nun an Hand der Zeichnung näher erläutert. Die einzige Figur zeigt schematisch eine erfindungsgemäße Anordnung.

Die beste Art und Weise, die Erfindung auszunutzen

[012] Im Bereich einer nicht näher dargestellten Tankstelle sind in Fig. 1 mehrere Tanks bzw. Treibstofftanks 8 angeordnet. In jedem dieser Tanks 8 ist ein Füllstands-Grenzwertgeber 3 angeordnet, die bei Erreichen eines vorbestimmten Pegels, zweckmäßigerweise des Maximalpegels, in den Tanks 8 ein Signal erzeugen.

[013] Bei diesen Grenzwertgebern 3 kann es sich um bekannte optische Systeme handeln. Bei diesen wird Licht ausgesandt und an einem Glasprisma an der Sonde definiert gebrochen und auf ein lichtempfindliches Element zurückgeworfen. Wird das Prisma von der Flüssigkeit erreicht, so ändert sich der Brechungsindex und es kommt weniger oder gar kein Licht auf das lichtempfindliche Element zurück, wodurch ein Signal

ausgelöst wird.

[014] Diese Füllstands-Grenzwertgeber 3 sind über elektrische Leitungen 5 mit einer Schnittstelle 4 verbunden, die im einfachsten Fall durch einen Stecker gebildet sein kann.

[015] Auf diese Schnittstelle 4 kann ein transportabler Sender 1 aufgesteckt werden, der vorzugsweise mit einer Abfrageschaltung, z.B. einem Multiplexer, versehen sein kann. Dieser Sender 1 wird zweckmäßigerweise mit einem Tankfahrzeug 7 mitgeführt, in dem ein Empfänger 2 eingebaut ist, der mit dem Sender 1 kommunizieren kann.

[016] Beim Befüllen der Tanks 3 werden Schläuche 6 vom Tankfahrzeug 7 zu den Tanks 8 verlegt und an die letzteren angeschlossen.

[017] Nach dem Aktivieren des Senders 1 wird eine drahtlose Kommunikationsverbindung zwischen dem Sender 1 und dem Empfänger 2 aufgebaut. Vorteilhafterweise wird dabei eine Funkverbindung aufgebaut, wobei der Sender 1 und der Empfänger 2, die vorzugsweise als Messumformer aufgebaut sind, aufeinander abgestimmt und kodiert sind. Auf diese Weise wird ausgeschlossen, dass ein anderes System, das sich in der Reichweite des Senders 1 bzw. des Empfängers 2 befindet, Einfluss auf die Verbindung zwischen diesen nehmen kann. Dabei kann das Funkprotokoll digital ausgeführt sein.

[018] Während der Kommunikation zwischen dem Sender 1 und dem Empfänger 2 und einer dem Sender 1 zugeordneten Abfrageschaltung können die einzelnen Füllstands-Grenzwertgeber 3 in den einzelnen Tanks 8 in rascher Folge abgefragt werden und die Informationen an den Sender 1 übertragen werden. Damit es nicht möglich ist, dass sich Sender 1 und/oder Empfänger 2 unterschiedlicher Anordnungen unbeabsichtigt beeinflussen, wird die Kommunikation zwischen Sender 1 und Empfänger 2 einer Anordnung kodiert.

[019] Der Sender 1 ist zweckmäßigerweise mit einer Auswerteschaltung verbunden, die bei Eintreffen eines entsprechenden, das Erreichen des vorgesehenen maximalen Pegelstandes anzeigenden Signals ein den an den betreffenden Tank 8 angeschlossenen Schlauch 6 steuerndes Ventil absperrt.

[020] Dabei kann vorgesehen sein, dass alle Ventile oder nur einzelne, in der Folge des Eintreffens entsprechender, dem maximalen Füllstand entsprechender Signale gesperrt/verschlossen werden.

[021] Die Funkverbindung zwischen dem auf der Schnittstelle 4 montierten Sender 1 und dem in dem Tankfahrzeug 7 mitgeführten Empfänger 2 kann auf einem geeignetem Frequenzband, wie z.B. dem SRD-Band (Short Range Device – ehemals LPD, Low Power Device genannt) erfolgen.

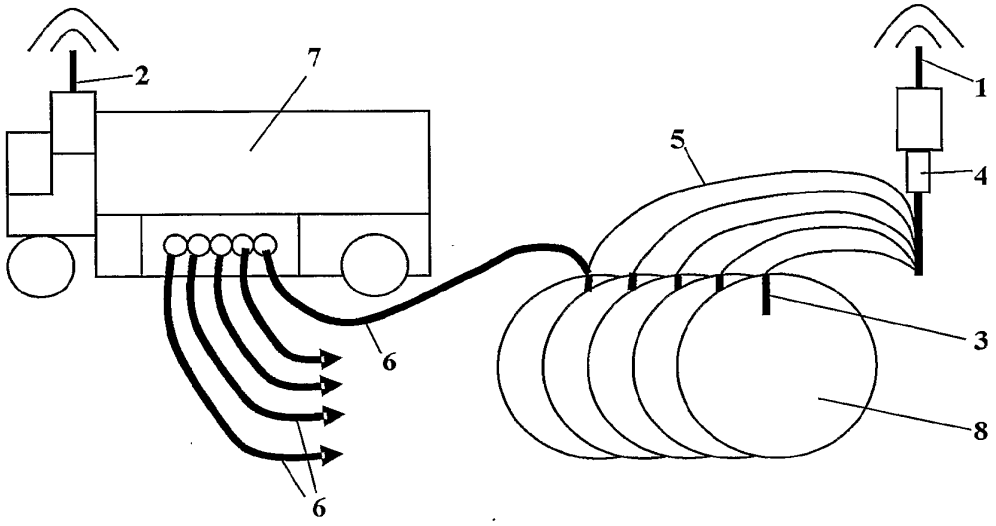
Ansprüche

[001] Anordnung zur Überfüllsicherung einer Mehrzahl von Treibstofftanks (8) einer Tankstelle, die insbesondere gleichzeitig durch Mehrkammer-Tankfahrzeuge (7) befüllt werden und wobei die Treibstofftanks (8) Füllstand-Grenzwertgeber (3), wie z.B. optische oder Thermistor Sonden, aufweisen, die mit einem Sender (1) zur drahtlosen Übertragung eines Signals bei Erreichen des Grenzwertes verbunden sind, und wobei ein Empfänger (2) am Tankfahrzeug (7) zur Steuerung eines Tankventils vorgesehen ist, **dadurch gekennzeichnet,** dass sämtliche Füllstands-Grenzwertgeber (3) der Treibstofftanks (8) an der Tankstelle mit jeweils einer Signalleitung (5) verbunden sind, die zu einer gemeinsamen Schnittstelle (4) in Form eines Steckers führen, dass lediglich ein Sender (1) zusammen mit einer Abfrageschaltung, z.B. einer Multiplexschaltung, zum Anschluss an den Stecker vorgesehen ist, welcher Sender (1) mit einem gemeinsamen, am Tankfahrzeug (7) angeordneten Empfänger (2) zusammenwirkt, der mit einer synchronisierten Multiplexschaltung bzw. einer Schaltung zum Empfang adresscodierter Signale des Senders (1) verbunden ist, die an eine Steuerung zur selektiven Abschaltung der Tankventile am Tankfahrzeug (7) angeschlossen ist.

[002] Anordnung nach Anspruch 1, **dadurch gekennzeichnet,** dass Sender (1) und Empfänger (2) jeweils als Messumformer zur Abgabe, zum Empfang und zur Konkordanzüberprüfung von Identifizierungscodes ausgebildet sind.

[003] Anordnung nach Anspruch 1 oder Anspruch 2, **dadurch gekennzeichnet,** dass der an die Schnittstelle (4) bzw. den Stecker anschließbare Sender (1) bei Anschluss an diesen und bei Anliegen eines Bereitschaftssignals eines jeden Grenzwertgebers (3) selektive Einschaltsignale an den Empfänger am Tankfahrzeug (7) übermittelt, zur selektiven Freigabe des Öffnens der einzelnen Ventile der Kammern des Tankfahrzeuges (7).

[Fig. 001]



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/053128

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60P3/22 B60S5/02

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 7 B60P B60S

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 practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 668 240 A (ALFONS HAAR MASCHINENBAU GMBH & CO) 23 August 1995 (1995-08-23) abstract column 1, lines 26-37 column 5, lines 30-46 figure 1	1-3
A	US 6 224 353 B1 (ISEMAN ZAN) 1 May 2001 (2001-05-01) abstract figure 1	1
A	DE 200 16 410 U1 (INDUSTRIEWERKE SAAR GMBH) 1 February 2001 (2001-02-01) cited in the application abstract paragraph '0005!	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
27 October 2005	07/11/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Christensen, J

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

[redacted]nformation on patent family members

Int[redacted]ional Application No
PCT/EP2005/053128

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0668240 A	23-08-1995	AT 144964 T	15-11-1996
		DE 4404876 C1	18-05-1995
		DK 668240 T3	07-04-1997
		ES 2094663 T3	16-01-1997
		ZA 9500712 A	12-10-1995
US 6224353 B1	01-05-2001	NONE	
DE 20016410 U1	01-02-2001	NONE	

Form PCT/ISA/210 (patent family annex) (January 2004)

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP2005/053128

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 7 B60P3/22 B60S5/02

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 7 B60P B60S

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)
EPO-Internal, WPI Data, PAJ

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie°	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	EP 0 668 240 A (ALFONS HAAR MASCHINENBAU GMBH & CO) 23. August 1995 (1995-08-23) Zusammenfassung Spalte 1, Zeilen 26-37 Spalte 5, Zeilen 30-46 Abbildung 1	1-3
A	US 6 224 353 B1 (ISEMAN ZAN) 1. Mai 2001 (2001-05-01) Zusammenfassung Abbildung 1	1
A	DE 200 16 410 U1 (INDUSTRIEWERKE SAAR GMBH) 1. Februar 2001 (2001-02-01) in der Anmeldung erwähnt Zusammenfassung Absatz '0005!	1

☐ Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

☒ Siehe Anhang Patentfamilie

° Besondere Kategorien von angegebenen Veröffentlichungen :
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Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
27. Oktober 2005	07/11/2005

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Christensen, J

Formblatt PCT/ISA/210 (Blatt 2) (Januar 2004)

INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/EP2005/053128

Im Recherchenbericht angeführtes Patentdokument		Datum der Veröffentlichung	Mitglied(er) der Patentfamilie		Datum der Veröffentlichung
EP 0668240	A	23-08-1995	AT	144964 T	15-11-1996
			DE	4404876 C1	18-05-1995
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			ZA	9500712 A	12-10-1995
US 6224353	B1	01-05-2001	KEINE		
DE 20016410	U1	01-02-2001	KEINE		

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
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PCT

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B67D 5/32 (2006.01) *B60P 3/22* (2006.01)

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21. Dezember 2007 (21.12.2007)

(25) Einreichungssprache: Deutsch

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A 44/2007 9. Januar 2007 (09.01.2007) AT

(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **SECURITY & ELECTRONIC TECHNOLOGIES GMBH** [AT/AT]; Aumühlweg 3, A-2544 Leobersdorf (AT).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **HÖCKNER, Dagmar** [AT/AT]; Piestingaustrasse 28, A-2483 Ebreichsdorf (AT).

(74) Anwälte: **PUCHBERGER, Peter** usw.; PUCHBERGER, BERGER & PARTNER, Reichsratsstrasse 13, A-1010 Wien (AT).

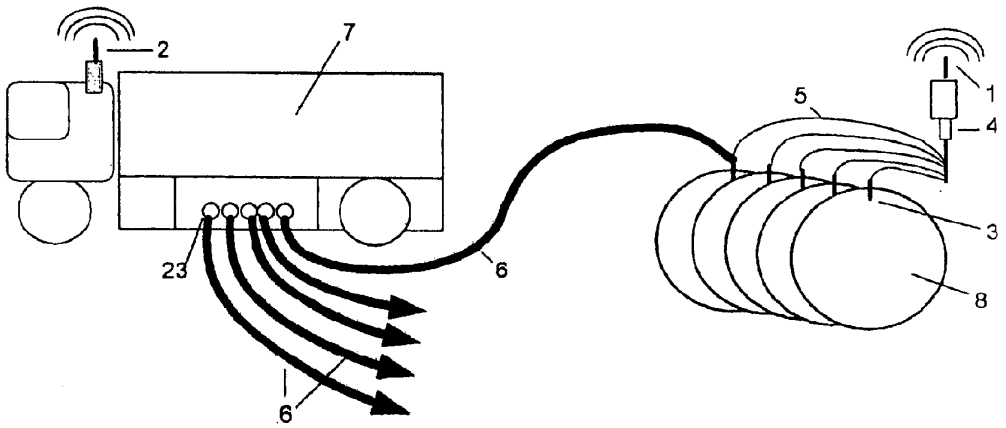
(81) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare nationale Schutzrechtsart)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Bestimmungsstaaten *(soweit nicht anders angegeben, für jede verfügbare regionale Schutzrechtsart)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,

[Fortsetzung auf der nächsten Seite]

(54) Title: ARRANGEMENT FOR SECURING FUEL TANKS AGAINST OVERFLOWING

(54) Bezeichnung: ANORDNUNG ZUR ÜBERFÜLLSICHERUNG VON TREIBSTOFFTANKS



(57) Abstract: The invention relates to an arrangement for securing fuel tanks of a gasoline station from overflowing. Said arrangement is characterized in that the level indicators (3) of the fuel tanks (8) at the gasoline station are connected to a common interface (4) via one respective signal line (5, 25), said interface (4) encompassing a scanning circuit, especially a multiplex circuit. The signal transmitter (1) cooperates with the signal receiver (2) which is arranged on the tank truck (7) and is connected to a synchronized multiplex circuit or a circuit for receiving address-encoded signals of the signal transmitter (1). The circuit is connected to a controller for selectively shutting off the tank valves (23) on the tank truck (7).

(57) Zusammenfassung: Die Erfindung betrifft eine Anordnung zur Überfüllsicherung von Treibstofftanks einer Tankstelle, dadurch gekennzeichnet, dass die Füllstands-Grenzwertgeber (3) der Treibstofftanks (8) an der Tankstelle über jeweils eine Signalleitung (5, 25) mit einer gemeinsamen Schnittstelle (4) verbunden sind, die eine Abfrageschaltung, insbesondere eine Multiplexschaltung aufweist, welcher Signalgeber (1) mit dem am Tankfahrzeug (7) angeordneten Signalempfänger (2) zusammenwirkt, der mit einer synchronisierten Multiplexschaltung bzw einer Schaltung zum Empfang adresscodierter Signale des Signalgebers (1) verbunden ist, die an eine Steuerung zur selektiven Abschaltung der Tankventile (23) am Tankfahrzeug (7) angeschlossen ist.

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ZM, ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Erklärungen gemäß Regel 4.17:

— *hinsichtlich der Berechtigung des Anmelders, ein Patent zu beantragen und zu erhalten (Regel 4.17 Ziffer ii)*

— *Erfindererklärung (Regel 4.17 Ziffer iv)*

Veröffentlicht:

— *ohne internationalen Recherchenbericht und erneut zu veröffentlichen nach Erhalt des Berichts*

Anordnung zur Überfüllsicherung von Treibstofftanks

Die Erfindung bezieht sich auf eine Anordnung zur Überfüllsicherung, bevorzugt einer Mehrzahl von Treibstofftanks gemäß dem Oberbegriff des Anspruches 1. Durch die DE 200 16 410 U1 wurde ein Tankfahrzeug bekannt, das mehrere Kammern aufweist, die mit je einem Auslassventil versehen sind, das zum Befüllen und Entleeren der entsprechenden Kammer dient. In diesen Kammern ist je ein Füllstandssensor angeordnet, wobei die Füllstandssensoren mit einem Rechner verbunden sind, der die Füll- und Abgabemengen der einzelnen Kammern berechnet. Dabei ist dieser Rechner über eine drahtlose Übertragungsstrecke mit einer Bedieneinheit verbunden, die Anzeige- und Eingabeelemente zur Überwachung und Steuerung zum Befüllen oder Entleeren der Tanks einer Tankstelle aufweist und mit der die erforderlichen Operationen, wie das Ansteuern von Ventilen überwacht werden können. Bei dieser Lösung ergibt sich jedoch der Nachteil, dass eine Überwachung des Füllstandes nur indirekt erfolgen kann. Dabei hängt aber die Möglichkeit der Vermeidung einer Überfüllung von dem Zusammenspiel der Füllstandsanzeiger mit dem Rechner ab, in dessen Speicher ein den jeweiligen Kammern bzw Tanks entsprechenden Algorithmen eingegeben sein müssen. Da die Kammern, bzw Tanks eines Tankfahrzeuges meist keine einfachen oder leicht berechenbaren Formen aufweisen ergeben sich dabei meist entsprechende Ungenauigkeiten.

Beim Befüllen von Tanks und Tankstellen ergibt sich immer das Problem, dass ein Überfüllen der meist unterirdisch angelegten Tanks schon aus Umweltschutzgründen vermieden werden muß. Dazu sind meist optische oder Thermistor-Grenzwertgeber oder sonstige Füllstandsmesssysteme vorgesehen, wobei diese beobachtet werden müssen, um dann die weitere Zufuhr von Kraftstoff in die Tanks der Tankstelle zu unterbinden. Dabei ergeben sich aber entsprechende Unsicherheiten.

Ziel der Erfindung ist es, diese Nachteile zu vermeiden und eine Einrichtung der eingangs erwähnten Art vorzuschlagen, bei der beim Befüllen von Tanks einer Tankstelle ein Überfüllen sicher vermieden ist und andererseits die Kapazität der Tanks weitgehend ausgenutzt werden kann. Erfindungsgemäß wird dies bei einer Anordnung der eingangs erwähnten Art durch die kennzeichnenden Merkmale des Anspruches 1 erreicht.

Durch die vorgeschlagenen Maßnahmen kann das Erreichen eines vorgegebenen Füllstandes auf einfache Weise übertragen und ein automatisches Schliessen der

entsprechenden Zuflussventile eingeleitet werden. Dabei kann jedes Tankfahrzeug in einer ersten Ausführungsform einen entsprechenden Empfänger fest eingebaut haben und auch den Sender mitführen. Dieser kann einfach auf die Schnittstelle, eben den Stecker, aufgesteckt und nach Beendigung des Füllvorganges wieder abgenommen werden. Dabei können aufgrund der Abfrageschaltung das Erreichen des jeweiligen vorgesehenen maximalen Füllstandes eines jeden einzelnen Tanks einer Tankstelle abgefragt werden.

Da der Sender mit einem bestimmten Tankfahrzeug stets mitgeführt werden kann, kann dieser exakt auf die Übertragungsfrequenz des Empfängers abgestimmt werden und es erübrigt sich ein allfälliges Einstellen einer entsprechenden Übertragungsfrequenz auf einen Empfänger.

Durch weitere Merkmale der Erfindung ergibt sich der Vorteil, dass eine Überprüfung von Identifizierungscodes auf einfache Weise durchgeführt werden kann. Weiters ergibt sich der Vorteil, dass das Füllen der Tanks einer Tankstelle praktisch weitgehend automatisiert werden kann. Es genügt dazu, die entsprechenden Schlauchverbindungen herzustellen und den Sender auf der Schnittstelle anzubringen. Nach der Aktivierung des Senders können die entsprechenden Ventile geöffnet werden und der Füllvorgang gestartet werden. Bei Erreichen des vorgesehenen maximalen Füllstandes bewirkt die Übertragung eines vom Füllstand-Grenzwertgeber erzeugten Signals zum Empfänger ein Schliessen des entsprechenden Ventils.

In einer weiteren Ausführungsvariante der Erfindung wird statt der drahtlosen Datenübertragung eine Datenleitung von der Elektronik des Tankwagens zur Schnittstelle geführt. Die Schnittstelle befindet sich bevorzugt in oder nahe dem zentralen Füllschacht der Tankstelle, wo auch der vorgeschriebene Erdungsanschluss vorgesehen ist. Weitere Ausführungen zur Aufgabe und Lösung folgen weiter unten bei der Beschreibung der Ausführungsbeispiele.

Die Erfindung wird nun anhand der Zeichnungen näher erläutert, die schematisch eine erfindungsgemäße Anordnung in zwei Ausführungsbeispielen zeigen. Fig. 1 zeigt schematisch eine erste Anwendung der Erfindung und Fig. 2 ein zweites Anwendungsbeispiel. Fig. 3 zeigt ein Detail aus Fig. 2.

Im Bereich einer nicht näher dargestellten Tankstelle sind in Fig. 1 mehrere Tanks, bzw Treibstofftanks 8 angeordnet. In jedem dieser Tanks 8 ist ein Füllstand-

Grenzwertgeber 3 angeordnet, die bei Erreichen eines vorbestimmten Pegels zweckmäßigerweise dem Maximalpegel in den Tanks 8 ein Signal erzeugen.

Bei diesen Grenzwertgebern 3 kann es sich um bekannte optische Systeme handeln. Bei diesen wird Licht ausgesandt und an einem Glasprisma an der Sonde definiert gebrochen und auf ein lichtempfindliches Element zurückgeworfen. Wird das Prisma von der Flüssigkeit erreicht, so ändert sich der Brechungsindex und es kommt weniger oder gar kein Licht auf das lichtempfindliche Element zurück, wodurch ein Signal abgelöst wird.

Diese Füllstands-Grenzwertgeber 3 sind über elektrische Leitungen 5 mit einer Schnittstelle 4 verbunden, die im einfachsten Fall durch einen Stecker gebildet sein kann.

Auf diese Schnittstelle 4 kann ein transportabler Sender 1 aufgesteckt werden, der vorzugsweise mit einer Abfrageschaltung, zB einen Multiplexer versehen sein kann. Dieser Sender 1 wird zweckmäßigerweise mit einem Tankfahrzeug 7 mitgeführt, in dem ein Empfänger 2 eingebaut ist, der mit dem Sender 1 kommunizieren kann.

Beim Befüllen der Tanks 8 werden Produktschläuche 6 vom Tankfahrzeug 7 zu den Tanks 8 verlegt und an die letzteren angeschlossen.

Nach dem Aktivieren des Senders 1 wird eine drahtlose Kommunikationsverbindung zwischen dem Sender 1 und dem Empfänger 2 aufgebaut. Vorteilhafterweise wird dabei eine Funkverbindung aufgebaut, wobei der Sender 1 und der Empfänger 2, die vorzugsweise als Messumformer aufgebaut sind, aufeinander abgestimmt und kodiert sind. Auf diese Weise wird ausgeschlossen, dass ein anderes System, das sich in der Reichweite des Senders 1, bzw des Empfängers 2 befindet, Einfluss auf die Verbindung zwischen diesen nehmen kann. Dabei kann das Funkprotokoll digital ausgeführt sein.

Während der Kommunikation zwischen dem Sender 1 und dem Empfänger 2 und einer dem Sender 1 zugeordneten Abfrageschaltung können die einzelnen Füllstands-Grenzwertgeber 3 in den einzelnen Tanks 8 in rascher Folge abgefragt und die Informationen an den Sender 1 übertragen werden. Damit es nicht möglich ist, dass sich Sender 1 und/oder Empfänger 2 unterschiedlicher Anordnungen unbeabsichtigt beeinflussen, wird die Kommunikation zwischen Sender 1 und Empfänger 2 einer Anordnung kodiert.

Der Sender 1 ist zweckmäßigerweise mit einer Auswerteschaltung verbunden, die bei Eintreffen eines entsprechenden, das Erreichen des vorgesehenen maximalen

Pegelstandes anzeigenden Signals, ein den an den betreffenden Tank 8 angeschlossenen Schlauch 6 steuerndes Tankventil absperrt.
Dabei kann vorgesehen sein, dass alle Tankventile oder nur einzelne, in der Folge des Eintreffens entsprechender, dem maximalen Füllstand entsprechender Signale gesperrt/verschlossen werden.
Die Funkverbindung zwischen dem auf der Schnittstelle 4 montierten Sender 1 und dem in dem Tankfahrzeug 7 mitgeführten Empfängers 2 kann auf einem geeigneten Frequenzband wie zB dem SRD-Band (Short Range Device – ehemals LPD, Low Power Device genannt) erfolgen.

Anhand der Fig. 2 wird nachstehend ein weiteres Ausführungsbeispiel dieser Erfindung anhand einer Tankstelle mit zentralem Füllschacht und Gaspendelanlage beschrieben. Die Datenübertragung zwischen den Füllstands-Grenzwertgebern und dem Tankwagen erfolgt hier nicht drahtlos, sondern über Datenleitungen.

Die dargestellte Tankstelle umfasst fünf Treibstofftanks 8 mit den zugehörigen Füllstands-Grenzwertgebern 3. Die Zuleitungsrohre 20 führen von einem zentralen Füllschacht 9 zu den einzelnen Tanks 8. Jeder Zuleitung ist im Füllschacht ein eigener Anschlussstutzen 27 zugeordnet. Demgemäß ist jedem Anschlussstutzen und dem nachfolgenden Tank ein definiertes Abfüllprodukt zugeordnet wie zB Normalbenzin, Superbenzin, Diesel oder Heizöl.

Der Tankwagen TKW hat je nach ausgelieferten Produkten mehrere Tankabschnitte, aus denen über die TKW-Anschlusskupplungen 22 des Tankwagens und zugeordneten Tankventilen 23 über Produktschläuche 6, das jeweilige Produkt über die Anschlusskupplung und den Anschlussstutzen 27 an die zugehörigen Zuleitungsrohre 20 abgegeben werden kann.

Im Abfüllschacht 9 oder in dessen unmittelbarer Nähe befindet sich die Schnittstelle 4 mit dem Multiplexer 24, zu dem die Datenleitungen 25 der einzelnen Füllstands-Grenzwertgeber 3 geführt sind. An die Schnittstelle 4 ist auch die Datenleitung 26 des Tankwagens TKW anschliessbar.

Die Schnittstelle 4 ist bevorzugt ein mehrpoliger Erdungs- Versorgungs- und Kommunikationsstecker und verbindet die vom TKW führende mehrpolige Erdungs- und

Kommunikationsleitung für die auszutauschenden Grenzwertgeber-Informationen mit dem Multiplexer 24 und der Erdung 10. Die Datenleitung führt am Tankwagen TKW zur Auswert- und Steuerelektronik 15, die die Tankventile 23 steuert. Die von den Tanks 8 zum Multiplexer laufenden Datenleitungen umfassen die PID Leitungen 11, die zu den Produktanschlusskupplungen 21 führen, weiters die PID Leitungen 13, die zu den Gaspendelschlauchkupplungen 14 führen, und die Leitungen 25 zu den Grenzwertgebern 3. Weiters sind in Fig. 2 noch die Gaspendelrohrleitungen 17 eingezeichnet, die zu den Kupplungen 14 im Füllschacht 9 führen.

Zu den Datenleitungen ist zu sagen, dass diese entweder als eigenständige Datenleitungen ausgebildet, oder auch dadurch gebildet sein können, dass die Produktschläuche 6 und auch die Gaspendelschläuche 16 leitfähig und zur Datenübertragung befähigt sind. Gleiches gilt auch für die Datenleitung 26 des Tankwagens, wobei es bereits bekannt war, die Produktschläuche 6 leitend auszustatten, sodass die Produktinformation jedem Schlauch datenmäßig aufgeprägt wird. Damit ist es möglich, dass ein für das Abfüllprodukt charakteristisches Informationssignal jedem Schlauch 6 zugeordnet ist. Dieses PID Informationssignal (Multi-Product-Information-Device PID) wird von einer Steuerelektronik mit einem PID-Signal jedes der Tanks 8 verglichen. Nur dann, wenn die Signale bei der Auswertung ergeben, dass vom Tankwagen das richtige Produkt zum richtigen Tank geleitet wird, werden die Tankventile 23 des TKW freigegeben. Bisher war es allerdings bekannt, je ein PID als Signalgeber pro Tank 8 einzubauen und die Signale zu den Anschlusskupplungen 21 zu leiten. Dies hatte den Nachteil, dass immer dann neue PID's eingebaut werden mußten, wenn ein Tank für ein anderes Produkt verwendet werden sollte.

Bei der vorliegenden Erfindung sind die PID's softwaremäßig im Multiplexer 24 vorgesehen und der Signalvergleich erfolgt über Anschlüsse an den Anschlusskupplungen 21 mit den Signalen über die Schlauchleitungen 6. In gleicher Weise können die richtigen Anschlüsse der Gaspendelschläuche 16 überprüft werden.

Ein weiteres vorteilhaftes Merkmal der Erfindung gemäß Fig. 2 ist, dass die Datenleitung 26 des Tankwagens auch eine Überprüfung vornehmen kann, ob der Tankwagen vorschriftsmäßig geerdet ist. Die Erdung kann durch die Datenleitung 26 selbst erfolgen. Eine Freischaltung der Ventile 23 am TKW soll nur dann erfolgen können, wenn die Elektronik 15 die ordnungsgemäße Erdung feststellt. Weiters ist das

Freischalten der Tankventile 23 nur dann zugelassen, wenn die Grenzwertgeber 3 anzeigen, dass der Tank noch nicht voll ist. Sobald der Grenzwertgeber den Zustand "voll" einnimmt, muß das zugehörige Tankventil am TKW geschlossen werden oder bleiben.

Zufolge dieser erfindungsgemäßen Anordnung ist es möglich, den Füllvorgang vom Tankwagen zu den Produkttanks nach Anschluß der Schläuche 6, 16 und der Datenleitung 26 am zentralen Abfüllschacht 9 praktisch vollautomatisch ablaufen zu lassen. Dies bedeutet eine große Zeitersparnis, vermindert Fehlerquellen und bringt eine erhöhte Sicherheit mit sich.

Die Fig. 3 zeigt schematisch den Multiplexer 24, der in oder am Füllschacht 9 angeordnet ist und sowohl den Multiplexer für die Füllstands-Grenzwertgebersignale als auch die Schaltung für die PID's (Product Identification Devices) 28 aufweist. Zum Multiplexer führen die Leitungen 25, die den Zustand aller Füllstand-Grenzwertgeber 3 (voll oder nicht voll) übermitteln, und der Multiplexer verarbeitet die Signale, sodass sie über eine oder mehrere Kommunikationsleitungen 18 der Schnittstelle 4 übergeben werden können. Mit 19 ist eine Versorgungsleitung bezeichnet, über die die Elektronik wenigstens des Multiplexers mit Strom versorgt werden kann, unabhängig von der belieferten Tankstelle. Die Datenleitung 26 ist ein mehrpoliges Kabel als Verbindung zur Elektronik 15 des TKW und enthält auch dessen Erdungsleitung. Der Ausgang des Multiplexers über die Kommunikationsleitung 18 und die Schnittstelle 4 ergeben funktionsmäßig den Signalgeber 1 der Fig. 1 und die Elektronik 15 des Tankwagens 7 übernimmt die Funktion des Signalempfängers 2 in Fig. 1.

In den Multi-PID 28 führen die Produkt-PID-Leitungen 11, die von den isolierten Kupplungen 21 der Produktleitungen 20 kommen, und weiters die PID-Leitungen 13 von den Gaspedal-Schlauchkupplungen 14.

Die Produktidentifikation über isolierte Kupplungen und leitende Schläuche vom Füllschacht zum TKW ist Stand der Technik und in der Europanorm EN 14116 festgehalten.

Das Multi-PID vereint mehrere PID-Code Generierungen in einem Gerät. Die Informationen sind von einem Installationsbetrieb frei programmierbar, sodass bei der Installation vor Ort die Produkte und ihre Tankzuordnung festgelegt werden kann. Die

einzelnen PID-Leitungen werden vom Gerät an die Befüll- und wenn vorhanden auch an die Gaspendelkupplungen angeschlossen. Wird ein Schlauch an die Produktkupplung (oder wenn vorhanden auch an die Gaspendelkupplung) angeschlossen, wird das Multi-PID über den leitenden Schlauch eigensicher versorgt. Es beginnt die Tank-Daten auf die Versorgung aufzumodulieren (Stand der Technik). Die TKW-Elektronik überprüft die Daten und vergleicht diese mit dem Inhalt der Kammer im TKW, welche mit dem angeschlossenen Schlauch verbunden ist. Stimmen die Produkte überein und ist, falls vorhanden, auch der Gaspendelschlauch richtig angeschlossen, dann wird die Befüllung unter Berücksichtigung der GWG-Information für diesen Tank freigegeben. Somit können viele Tanks gleichzeitig und unabhängig voneinander abgeladen werden.

Der Grenzwertgeber-Multiplexer kann auch unabhängig vom Multi-PID und umgekehrt eingesetzt werden.

Was zuvor für eine KFZ-Tankstelle beschrieben wurde gilt analog auch für alle anderen Tankstellen wie Abfüllanordnungen flüssiger Produkte wie zB Tankterminals für Schiffe, Heizöltankanlagen für Wohn- und Gewerbezwecke oder Abgabestationen von Raffinerien.

Die Tankventile 23 sind zumeist reine Auslassventile, durch die die Flüssigkeiten mittels Schwerkraft austreten. Es kann sich dabei aber auch um Förderpumpen handeln, die die Flüssigkeiten aktiv abgeben wenn sie eingeschaltet sind.

Die Anwendung der erfindungsgemäßen Überfüllsicherung kann auch dann vorteilhaft sein, wenn lediglich ein Tank gefüllt werden soll.

Patentansprüche:

1. Anordnung zur Überfüllsicherung, bevorzugt einer Mehrzahl von Treibstofftanks einer Tankstelle, die insbesondere gleichzeitig durch Mehrkammer-Tankfahrzeuge befüllt werden und wobei die Treibstofftanks Füllstand-Grenzwertgeber wie zB optische oder Thermistor Sonden oder Füllstandsmess-systeme aufweisen, die mit einem Signalgeber zur Übertragung eines Signals bei Erreichen des Grenzwertes verbunden sind und wobei ein Signalempfänger am Tankfahrzeug zur Steuerung der Tankventile vorgesehen ist, dadurch gekennzeichnet, dass die Füllstands-Grenzwertgeber (3) der Treibstofftanks (8) an der Tankstelle über jeweils eine Signalleitung (5, 25) mit einer gemeinsamen Schnittstelle (4) verbunden sind, die eine Abfrageschaltung, insbesondere eine Multiplexschaltung aufweist, welcher Signalgeber (1) mit dem am Tankfahrzeug (7) angeordneten Signalempfänger (2) zusammenwirkt, der mit einer synchronisierten Multiplexschaltung bzw einer Schaltung zum Empfang adresscodierter Signale des Signalgebers (1) verbunden ist, die an eine Steuerung zur selektiven Abschaltung der Tankventile (23) am Tankfahrzeug (7) angeschlossen ist.

2. Anordnung nach Anspruch 1, dadurch gekennzeichnet, dass Signalgeber (1) und Signalempfänger (2) zur drahtlosen Datenübermittlung ausgebildet sind und jeweils als Messumformer zur Abgabe, zum Empfang und zur Konkordanzüberprüfung von Identifizierungscodes eingerichtet sind.

3. Anordnung nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass der an die Schnittstelle (4) angeschlossene oder anschliessbare Signalgeber (1) bei Anschluss an diesen und bei Anliegen eines Bereitschaftssignals eines jeden Grenzwertgebers (3) selektive Einschaltsignale an den Empfänger am Tankfahrzeug (7), zur selektiven Freigabe des Öffnens der einzelnen Tankventile (23) der Kammern des Tankfahrzeuges (7) übermittelt.

4. Anordnung nach Anspruch 1, dadurch gekennzeichnet, dass die Schnittstelle (4) einen mehrpoligen Stecker zum Anschluss einer Datenleitung (26) aufweist, die mit einer Steuerelektronik (15) des Tankwagens verbunden ist.

5. Anordnung nach Anspruch 4, dadurch gekennzeichnet, dass die Datenleitung (26) zusätzlich zur Kommunikationsleitung (18) auch eine Erdungsleitung (19) zur Erdung des Tankwagens aufweist.

6. Anordnung nach Anspruch 5, dadurch gekennzeichnet, dass die Tankventile (23) nur bei Vorliegen eines Erdschlusses des Tankwagens freischaltbar sind.

7. Anordnung nach einem der Ansprüche 4 bis 6, dadurch gekennzeichnet, dass für jeden Tank zumindest eine zugehörige Anschlusskupplung vorgesehen ist, der ein für das Abfüllprodukt charakteristisches Informationssignal (PID-Signal) zugeordnet ist und dass die Tankventile (23) des Tankwagens freischaltbar sind, wenn das PID-Signal der vom Tankwagen kommenden Anschlusskupplung (21) mit jenem des Anschlussstutzens (27) übereinstimmt.

8. Anordnung nach einem der Ansprüche 4 bis 7, dadurch gekennzeichnet, dass die PID-Signale für die Anschlussstutzen (27) von einem programmierbaren Multi-PID (28) bereitgestellt sind.

9. Anordnung nach einem der Ansprüche 4 bis 8, dadurch gekennzeichnet, dass die Anschlussstutzen (27) für die Abfüllprodukte in einem Füllschacht (9) angeordnet sind, und dass im Füllschacht oder in dessen Nähe die Schnittstelle (4) mit einem Stecker, der Multiplexer (24) für die Füllstands-Grenzwertgeber und die PID (28) sowie der Erdungsanschluss (10) vorgesehen sind.

10. Anordnung nach einem der Ansprüche 4 bis 9, dadurch gekennzeichnet, dass jedem Tank (8) ein Füllprodukt-Anschlussstutzen (27) und ein Gaspendelanschlussstutzen (29) zugeordnet ist, und jeder Anschlussstutzen über ein PID-Signal verfügt.

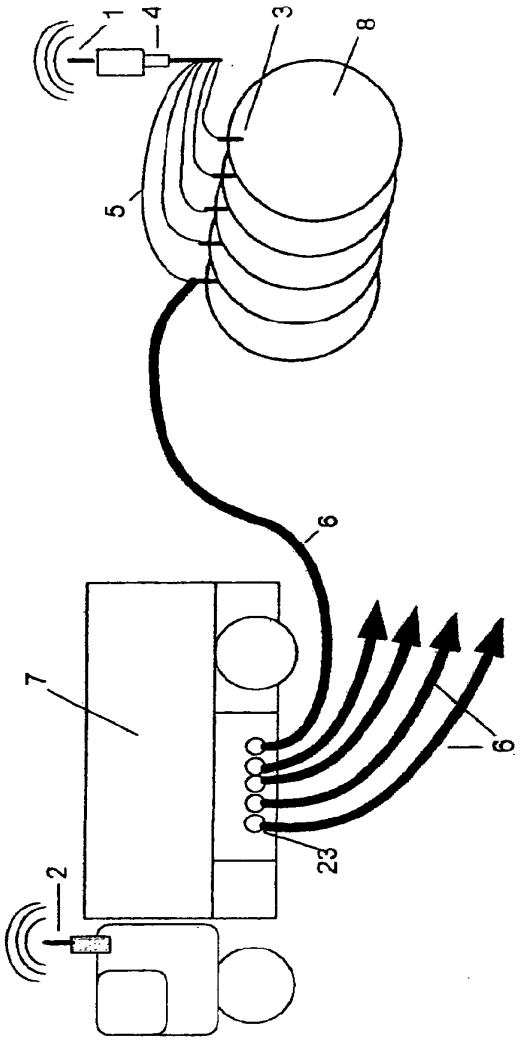


Fig. 1

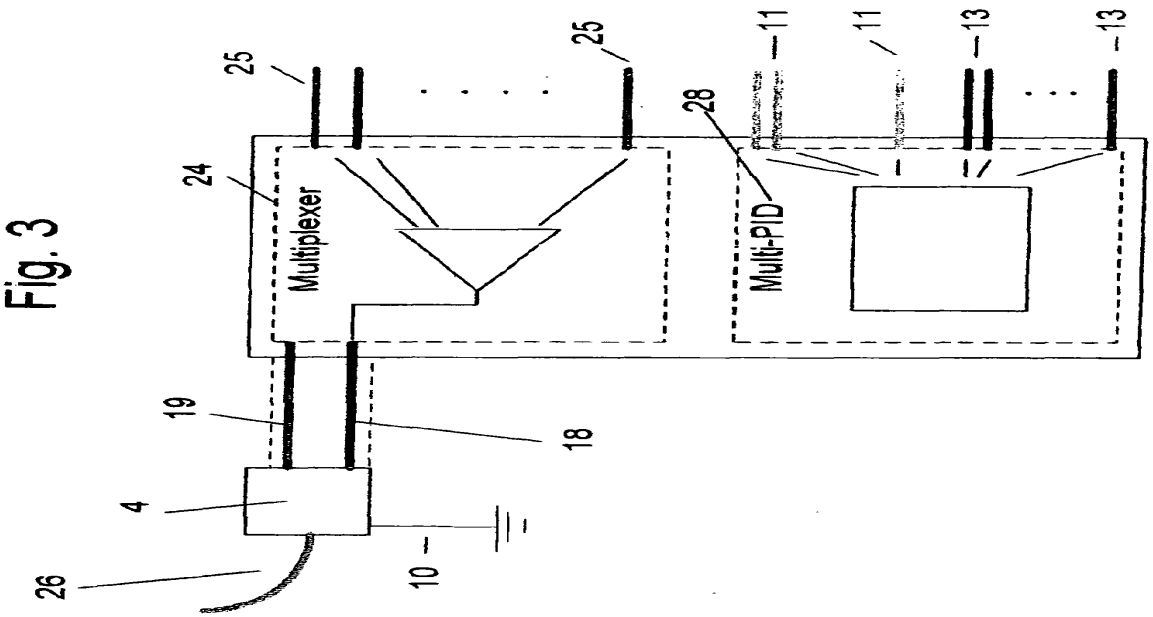
FAS 2004 - Page 943

Fig. 2

ERSATZBLATT (REGEL 26)

FAS 2004 - Page 945

Fig. 3



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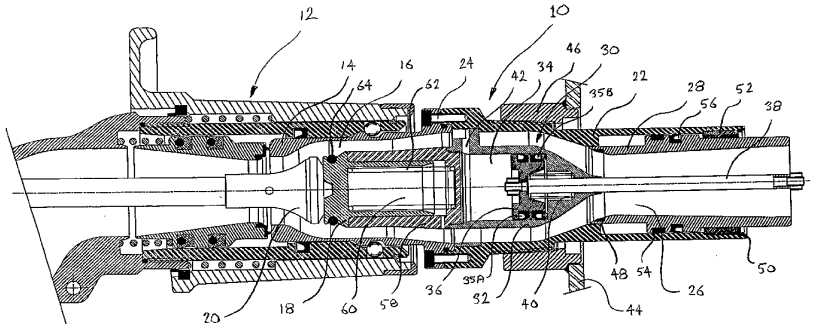


FIGURE 1

(57) Abstract: The present invention relates broadly to a valve assembly (10) being adapted to detachably receive a dry-break refuelling nozzle (12). The valve assembly comprises a receiver body (14) which defines a forward fuel passageway (16) in which a poppet valve member (18) is slidably mounted. The valve assembly (10) also comprises a tail body (22) secured coaxial with the receiver body (14) and defining a rearward fuel passageway (26). the tail body (22) slidably houses a check valve member or diffuser (28) which is driven by a hydraulic actuator or piston assembly (30).

WO 2009/026607 A1

DRY-BREAK FUEL RECEIVER WITH INTEGRAL BACK-FLOW PREVENTION

FIELD OF THE INVENTION

The present invention relates broadly to a valve assembly such as that used in a dry-break refuelling receiver having integral back-flow prevention.

BACKGROUND OF THE INVENTION

The industry standard method of refuelling large diesel powered equipment in the mining, railway, and earthmoving industries has incorporated dry-break fluid couplings designed to transfer diesel fuel from dispensing point into the fuel tank onboard the equipment. This transfer is often done at relatively high flowrates and within a sealed fuel delivery system. The couplings used to engage the dispensing point with the equipment consist of a female coupling typically at the dispensing point – termed the nozzle – and a male coupling onboard the equipment – termed the receiver. The nozzle typically incorporates a manual operation handle (open/closed), and modern nozzles also incorporate an automatic shut-off mechanism. This automatic mechanism is sensitive to fluid pressure passing through the mating nozzle and receiver, and activates at a preset pressure to automatically close the nozzle and hence terminate the transfer of fuel. This pressure generated in the fuel is typically from the pressurisation of the fuel tank, once it is filled.

Large equipment often incorporate fuel tanks of several thousand litre capacity, and are located on the equipment often several metres from ground level. To facilitate refuelling of the equipment from ground level, the fuel receiver is often situated in a position readily accessible to the refuelling operator and is linked to the fuel tank by a length of fixed pipe and/or flexible hose. Access from ground level has obvious occupational safety and time efficiency benefits.

The mechanical engagement of the nozzle and receiver creates wear between mating surfaces and sealing elements (fluid seals). Nozzles are often routinely removed from active use for the purpose of maintenance to replace damaged or otherwise faulty components. Replacing the

receiver installed on equipment is often more difficult, and unless a separate fluid isolation valve exists between the receiver and the tank, the tank must be drained of fuel to a level below the receiver before the receiver can be replaced. This is costly and creates the risk of fuel spillage and subsequent environmental damage.

Drainage of fuel from the fuel tank via the receiver can typically occur in two ways:

(i) The receiver seal is damaged, or the receiver itself suffers impact with another object causing the receiver to fracture; or

(ii) Fuel is pilfered from the tank.

Many thousands of litres of fuel can be lost if no means of back-flow prevention exists between the receiver and the tank.

There are two (2) known fuel receiver products which have an integral back-flow prevention mechanism designed to prevent the drainage of fuel from the tank via the receiver. One such product employs a simple disc style check valve mechanism which is opened by fluid pressure acting directly onto the disc, and is closed by the action of a spring. The front receiver body of the product can be changed out without the need to drain the tank. Another such product is designed so that the second back-flow prevention valve is directly (mechanically) opened by the displacement of the first poppet valve. The principal role of the second valve in this product is to prevent the backflow of fuel during removal (changeout) of the receiver body.

SUMMARY OF THE INVENTION

According to the present invention there is provided a valve assembly comprising:

a poppet valve housing being adapted to provide releasable coupling for a refilling nozzle and including a forward elongated fluid passageway;

a poppet valve member slidably mounted within the poppet valve housing for opening and closure of the forward fluid passageway;

a check valve body connected to the poppet valve housing and including a rearward elongated fluid passageway;

a check valve member movably coupled to the check valve body for opening and closure of the rearward fluid passageway;

a hydraulic actuator located within the check valve body and operatively coupled to the check valve member whereby in operation fluid pressure alone acting on the hydraulic actuator effects movement of the check valve member for the opening of the rearward fluid passageway.

Preferably the check valve member is coupled to the check valve body independent of the poppet valve member.

Preferably the hydraulic actuator comprises a piston assembly including a piston housing secured within the check valve body and having a piston chamber, and a piston head slidably mounted within the piston chamber and connected to the check valve member via a piston rod. More preferably the piston assembly also includes piston biasing means urging the check valve member into seated engagement with the piston housing. Even more preferably the piston housing includes a port into the piston chamber and arranged to provide hydraulic fluid pressure against the piston head and the piston biasing means to force opening of the check valve member.

Preferably the valve assembly also comprises a poppet valve body mounted within the poppet valve housing and including a cylindrical bore for guided and sliding movement of the poppet valve member. More preferably the poppet valve body is secured to the piston housing at its forward end. Even more preferably the valve assembly further comprises poppet valve biasing means housed within the cylindrical bore and arranged to urge the poppet valve member into seated engagement with the poppet valve housing for closure of the forward fluid passageway.

Preferably the check valve member is in the form of a generally cylindrical shaped diffuser. More preferably the diffuser is retained for reciprocating movement within the rearward fluid passageway, via a retaining element. Even more preferably the diffuser is guided for reciprocating movement via an annular bearing and adjacent sealing arrangement.

Generally the valve assembly is adapted for use with a dry-break refuelling nozzle.

BRIEF DESCRIPTION OF THE FIGURES

In order to achieve a better understanding of the nature of the present invention a preferred embodiment of a valve assembly will now be described, by way of example only, with reference to the accompanying drawings in which;

Figures 1 and 2 are cross-sectional views of an embodiment of the valve assembly according to the invention together with a refilling nozzle;

Figures 3 and 4 are cross-sectional views of the valve assembly of Figures 1 and 2 with and without a refilling nozzle respectively;

Figure 5 is a cross-sectional view of the preceding figures together with plan and elevational views.

DETAILED DESCRIPTION OF THE [INVENTION/PREFERRED EMBODIMENT]

As best shown in Figures 1 and 2 there is a valve assembly designated generally as 10 according to one embodiment of the invention and being adapted to receive a re-filling or in this example a refuelling nozzle 12. The refuelling nozzle 12 is of a dry-break configuration such as that described in the applicant's US patent no. 4,919,174 the contents of which are included herein by way of reference.

The valve assembly 10 of this embodiment generally comprises the following components:

1. A poppet valve housing or in this example receiver body 14 which provides for latching of the dry-break refuelling nozzle 12 and defines a forward elongated fluid or fuel passageway 16;

2. A poppet valve member 18 slidably mounted within the receiver body 14 and adapted to be urged open by a nozzle poppet 20 of the refuelling nozzle 12;

3. A check valve body or in this example tail body 22 secured coaxial with the receiver body 14 via a series of screw fasteners such as 24 and defining a rearward elongated fuel passageway 26;

4. A check valve member or in this example cylindrical shaped diffuser 28 slidably housed within the tail body 22;

5. A hydraulic actuator designated generally as 30 located within the tail body 22 and operatively coupled to the diffuser 28 for opening and closure of the rearward fuel passageway 26.

The hydraulic actuator of this embodiment is in the form of a piston assembly 30 including a piston housing 32 securely mounted at an upstream end of the rearward fuel passageway 26. The piston housing defines a piston chamber 34 within which a piston head 36 is slidably mounted. The piston head 36 is connected to the diffuser 28 via a piston connecting rod 38.

The piston assembly 30 of this embodiment includes a pair of piston seals 35A and 35B. The seals 35A and 35B each provide sealing by fluid pressure in both directions, that is the seals 35A and 35B provide a double-acting role. The forward seal 35A retains fluid pressure against the piston head 36 within the forward side of the chamber 34 whilst the rearward seal 35B provides a seal against fluid pressure entering into the forward side of the chamber 34, such as from the fuel tank. The pair of back to back seals 35A and 35B are in the form of U-seals designed to achieve low friction to achieve relatively free travel of the piston 36 within the chamber 34. The pair of seals 35A and 35B could be replaced by a single double-acting piston seal.

The piston assembly 30 also includes biasing means in the form of a compression spring 40 located within the piston chamber 34 about the piston connecting rod 38. The piston spring 40 urges the piston head 36 together with the piston connecting rod 38 and diffuser 28 in a forward direction. Importantly, the piston housing 32 includes a piston chamber port 42 to the piston chamber 34 and arranged to provide hydraulic fluid pressure against the piston head 36 and the biasing force of the spring 40 to force opening of the diffuser 28.

Figures 1 and 2 otherwise illustrate connection of the valve assembly 10 to a fuel tank such as 44 having a receiver socket 46 to which the valve assembly 10 or tail body 22 is screw threaded. The valve assembly 10 of these figures shows both the poppet valve member 18 and the check valve member or diffuser 28 in their open conditions. For ease of reference and

in order to avoid repetition, like components of the assembly 10 of Figure 2 have been designated with the same reference numeral as the corresponding components of Figure 1.

Figures 3 and 4 illustrate the valve assembly 10 of the previous embodiment but with the check valve member or in this case diffuser 28 shown in its closed condition. The valve assembly 10 is otherwise identical in construction to the previous embodiment and corresponding components have been referenced with the same numeral.

The valve assembly 10 of Figures 3 and 4 shows the poppet valve member 18 in its open condition under the cooperating force of the nozzle poppet 20 or some other means. However, in this case depressurisation of the fuel or diesel supply means the fluid pressure force acting within the piston chamber 34 is less than the counter-force of the piston spring 40 which urges the piston 36 together with the check valve member or diffuser 28 into its closed conditions. That is, despite the poppet valve 18 at the forward fluid passageway 16 being opened, the discharge of fuel from the tank 44 is prevented by the check valve member or diffuser 28 being closed.

As shown in Figures 3 and 4 the piston housing 32 is at a downstream end shaped conically and designed to engage or seat with the check valve member or diffuser 28. The diffuser 28 includes a tapered edge at its upstream end which is designed to house a face seal 48 which prevents fluid flow in a reverse direction. In an alternate embodiment the seal 48 may be affixed onto the conical surface of piston housing 32 where it engages the mating tapered face of the diffuser 28.

As best shown in Figure 5 the check valve member or diffuser 28 is arranged for reciprocating movement within the rearward fluid or fuel passageway 26. The diffuser 28 is retained within the check valve body or tail body 22 via a retaining ring 50 and diffuser sleeve 52. The diffuser 28 is guided for reciprocating movement via an annular bearing 54 together with an adjacent diffuser U-seal 56.

The valve assembly 10 of Figure 5 is shown with both the poppet valve member 18 and the check valve member 28 in their closed conditions. The poppet 18 is slidably housed within a poppet valve body 58 which in this example is connected to the piston housing 32. The

poppet valve body 58 includes a cylindrical bore 60 which provides guided reciprocating movement of the poppet 18. The poppet 18 is urged into its closed condition via poppet biasing means in the form of a compression spring 62 located within the cylindrical bore 60. The poppet 18 includes an annular O-ring 64 which seats with an inner surface of the receiver body 14 on closure of the poppet 18.

The general steps involved in operation of the valve assembly 10 of this embodiment are as follows:

1. The refilling or dry-break refuelling nozzle 12 is detachably connected or latched onto the receiver body 14 of the valve assembly 10;

2. The refuelling nozzle 12 is manually opened forcing the nozzle poppet 20 into engagement with the poppet valve member 18 unseating it from the receiver body 14 against the biasing force of the poppet spring 62;

3. The poppet valve member 18 is thus opened allowing fluid to flow through the forward fuel passageway 16 and into the piston chamber 34 via the piston housing port 42;

4. The hydraulic fluid pressure of the fluid or fuel in the piston chamber 34 urges the piston head 36 in a rearward direction against the biasing force of the piston spring 40;

5. The piston head 36 drives the check valve member or diffuser 28 to a rearward position via the action of the piston rod 38;

6. The check valve member or diffuser 28 is thus opened allowing fuel to flow from the forward fluid passageway 16 to the rearward fluid passageway 26 to the fuel tank 44;

7. The refuelling nozzle 12 is either manually or automatically shut off allowing the poppet valve member 18 to return to its closed condition preventing the flow of fuel to the valve assembly 10;

8. The resultant pressure drop of fuel within the piston chamber 34 means that the piston head 36 (as urged by the spring 40) together with the associated diffuser 28 returns to

a forward position for closure of the rearward fluid passageway 26, regardless of whether the front poppet 18 is opened by a nozzle or any other means.

Importantly, and as best shown in Figure 4, if the poppet valve member 18 is depressed open the check valve member 28 will not open unless sufficient fluid pressure is provided within the piston chamber 34. This means that fuel cannot be drained from the tank unless the check valve member 28 is hydraulically actuated. This will be the case whether or not the nozzle 12 is connected and turned ON. This particular design of the valve assembly 10 also prevents manual overriding of this hydraulic actuation insofar as the piston 36 itself and the check valve member or diffuser 28 are effectively inaccessible.

Now that a preferred embodiment of the present invention has been described in some detail it will be apparent to those skilled in the art that the valve assembly has the following advantages:

1. The valve assembly and in particular the check valve which is hydraulically actuated provides no real means of being overridden and thus protects against pilferage of fuel from a tank;

2. The check valve provides a minimal increase in pressure drop which means that the need or temptation for manual overriding of automatic shut-off is not increased where it could otherwise lead to overfilling and create environmental damage, wastage of fuel and possibly structural damage or rupturing of tanks;

3. The valve assembly cannot be forcibly overridden because there is no mechanical link between the poppet valve member and check valve member which is a feature of at least one example of the prior art;

4. The valve assembly has the check valve member "protected" and therefore cannot be overridden by forcing a stiff wire or other element through the open receiver poppet and against the disc style check valve of the prior art; and

5. The valve assembly provides both a poppet valve and check valve each being conveniently in a normally closed state.

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. For example, the hydraulic actuator may vary from the piston assembly described provided it is effectively hydraulically operated and addresses the problems identified by the invention. The hydraulic actuator and/or check valve could be mounted remote from or downstream of the poppet valve member. The check valve member need not be of the diffuser-type provided it effectively provides for opening and closure of the rearward fluid passageway. Although the embodiment described has been installed directly into a tank, the axial discharge of fuel from the check valve lends itself to mounting to a length of pipe or the like. All such variations and modifications are to be considered within the scope of the present invention and nature of which is to be determined from the foregoing description.

CLAIMS

1. A valve assembly comprising:

a poppet valve housing being adapted to provide releasable coupling for a refilling nozzle and including a forward elongated fluid passageway;

a poppet valve member slidably mounted within the poppet valve housing for opening and closure of the forward fluid passageway;

a check valve body connected to the poppet valve housing and including a rearward elongated fluid passageway;

a check valve member movably coupled to the check valve body for opening and closure of the rearward fluid passageway;

a hydraulic actuator located within the check valve body and operatively coupled to the check valve member whereby in operation fluid pressure alone acting on the hydraulic actuator effects movement of the check valve member for the opening of the rearward fluid passageway.

2. A valve assembly as defined in claim 1 wherein the check valve member is coupled to the check valve body independent of the poppet valve member.

3. A valve assembly as defined in either of claims 1 or 2 wherein the hydraulic actuator comprises a piston assembly including a piston housing secured within the check valve body and having a piston chamber, and a piston head slidably mounted within the piston chamber and connected to the check valve member via a piston rod.

4. A valve assembly as defined in claim 3 wherein the piston assembly also includes piston biasing means urging the check valve member into seated engagement with the piston housing.

5. A valve assembly as defined in claim 4 wherein the piston housing includes a port into the piston chamber and arranged to provide hydraulic fluid pressure against the piston head and the piston biasing means to force opening of the check valve member.

6. A valve assembly as defined in any one of the preceding claims also comprising a poppet valve body mounted within the poppet valve housing and including a cylindrical bore for guided and sliding movement of the poppet valve member.

7. A valve assembly as defined in claim 6 wherein the poppet valve body is secured to the piston housing at its forward end.

8. A valve assembly as defined in either of claims 6 or 7 further comprising poppet valve biasing means housed within the cylindrical bore and arranged to urge the poppet valve member into seated engagement with the poppet valve housing for closure of the forward fluid passageway.

9 A valve assembly as defined in any one of the preceding claims wherein the check valve member is in the form of a generally cylindrical shaped diffuser.

10. A valve assembly as defined in claim 9 wherein the diffuser is retained for reciprocating movement within the rearward fluid passageway, via a retaining element.

11. A valve assembly as defined in either of claims 10 or 11 wherein the diffuser is guided for reciprocating movement via an annular bearing and adjacent sealing arrangement.

12. A valve assembly as defined in any one of the preceding claims wherein the valve assembly is adapted for use with a dry-break refuelling nozzle.

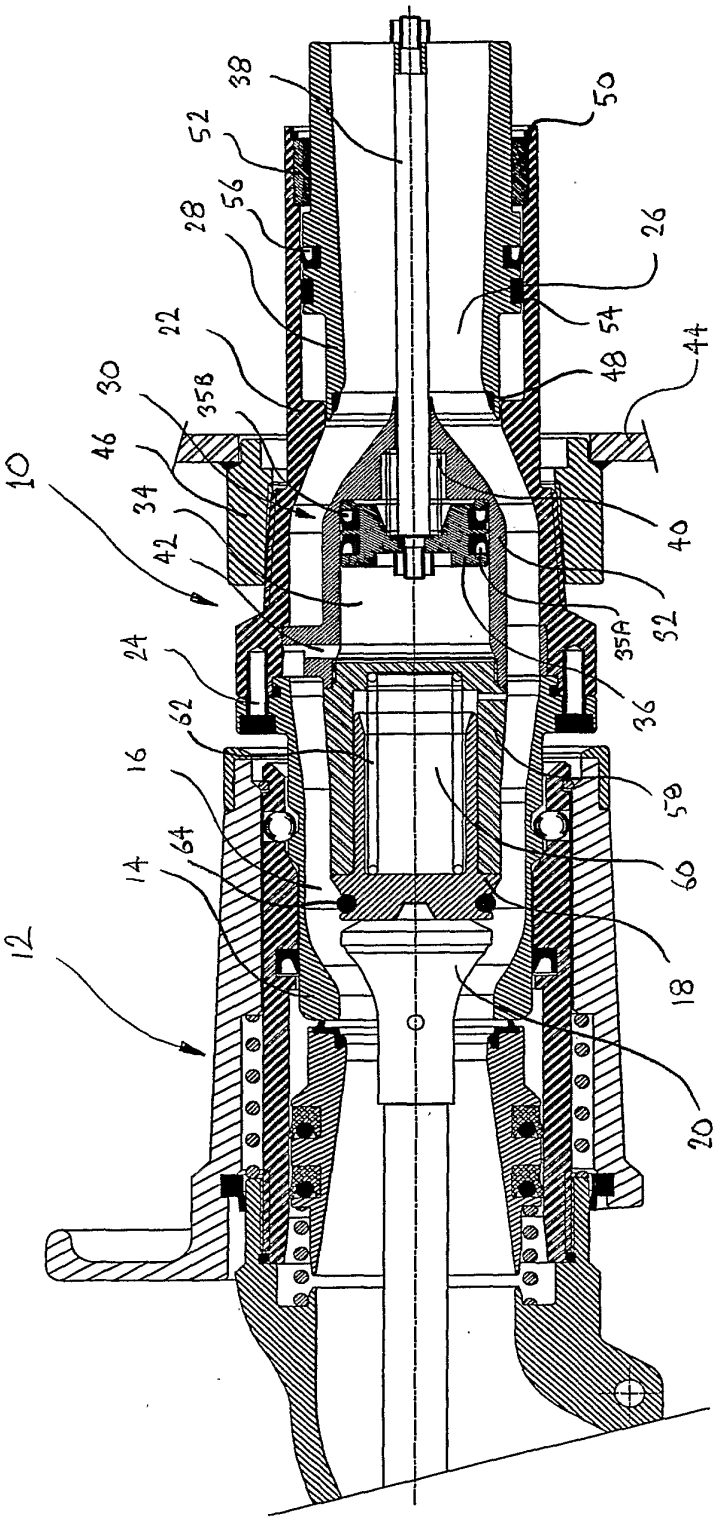

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12
14
16
18
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22
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26
28
30
34
35A
35B
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38
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50
52
54
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58
60
62
64

FIGURE 1

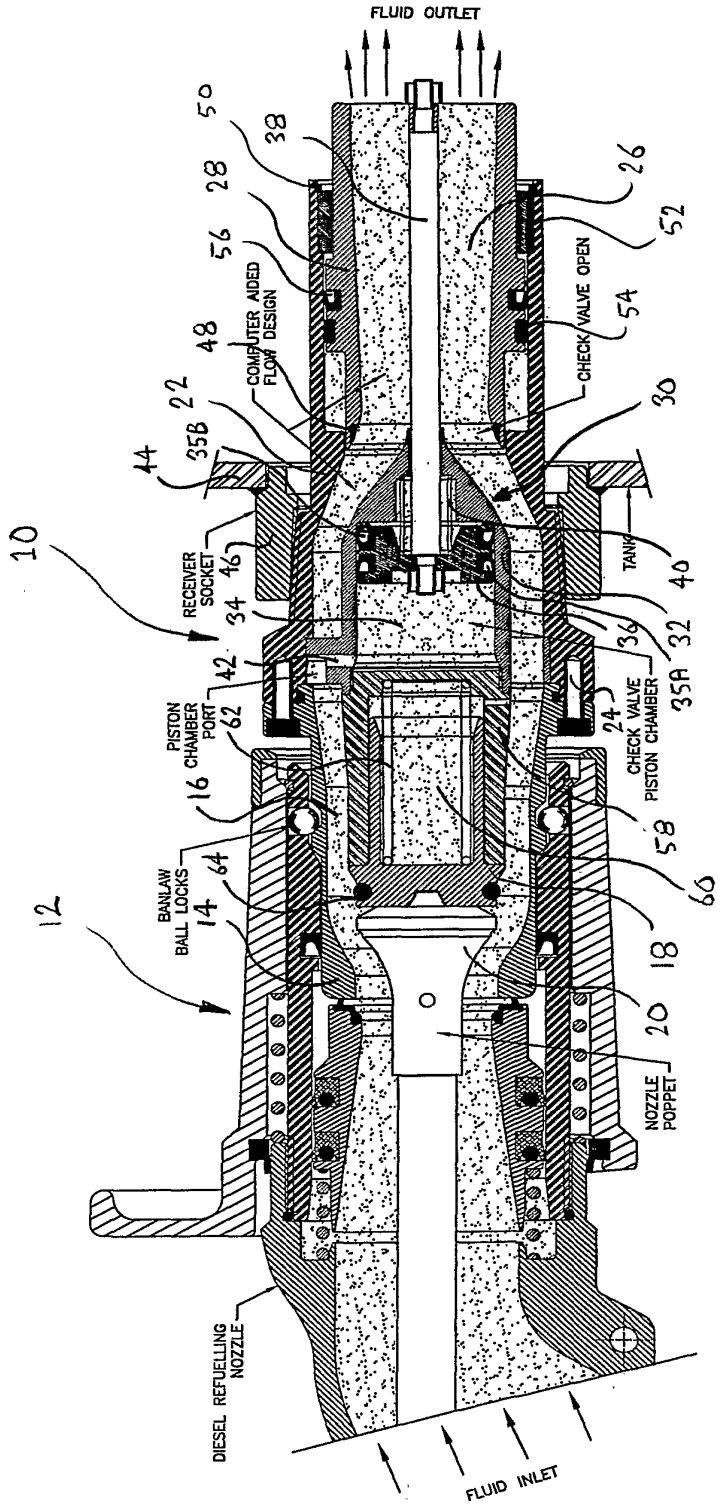

FLUID OUTLET
50
38
28
26
56
52
COMPUTER AIDED FLOW DESIGN
48
CHECK VALVE OPEN
54
22
35B
30
44
10
RECEIVER SOCKET
46
TANK
40
34
36
32
42
35A
PISTON CHAMBER PORT
62
24
CHECK VALVE PISTON CHAMBER
16
58
BANLAW BALL LOCKS
64
66
12
14
18
20
NOZZLE POPPET
DIESEL REFUELLING NOZZLE
FLUID INLET

FIGURE 2

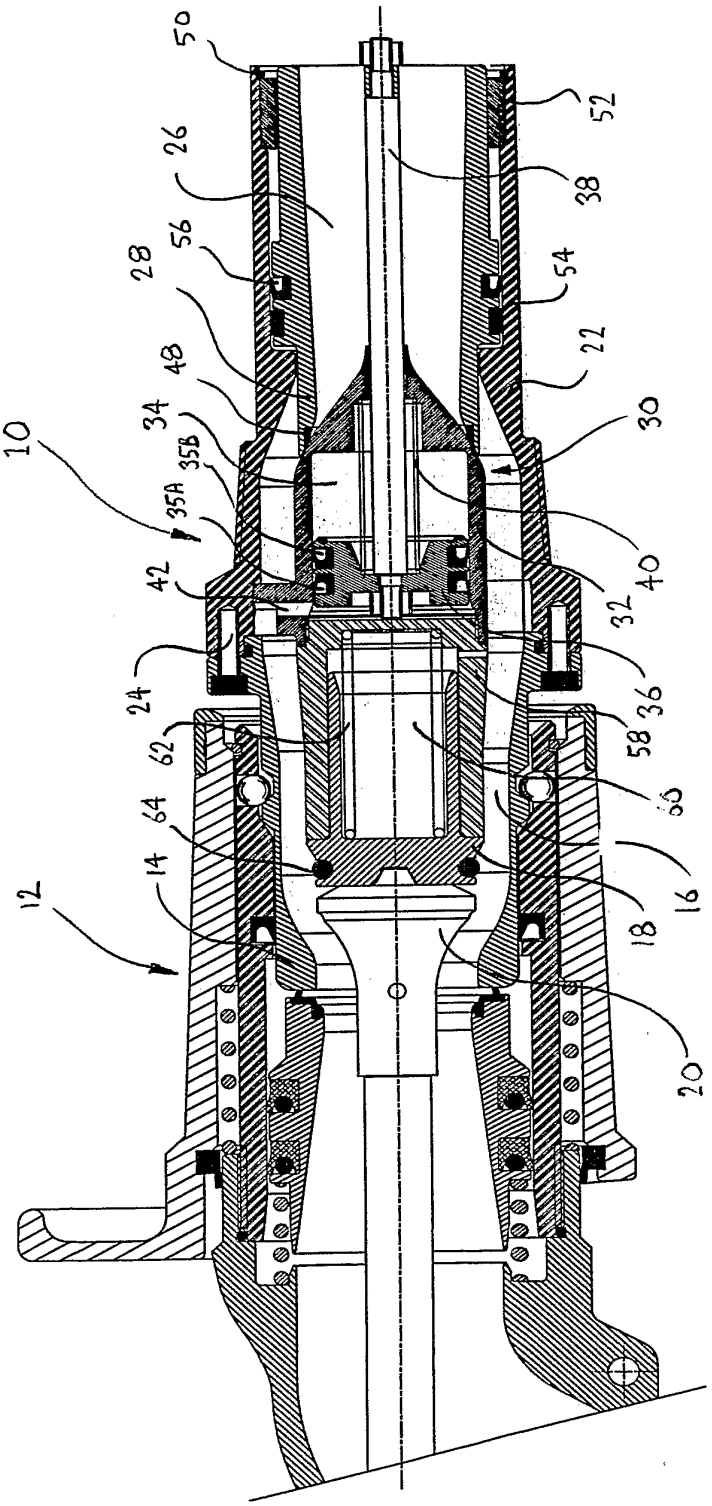

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22
34
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35B
35A
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14
16
12
18
20

FIGURE 3

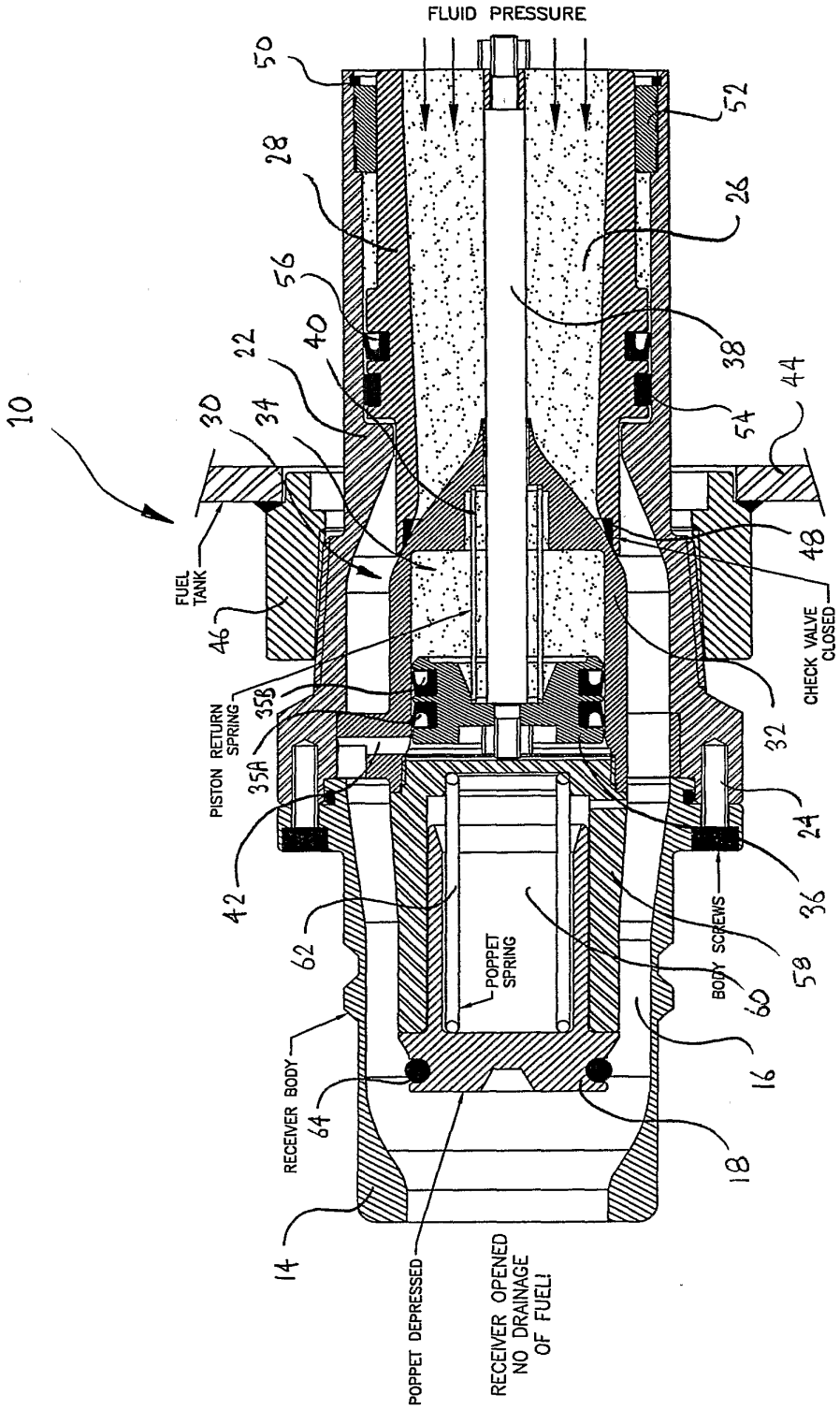

FLUID PRESSURE
10
50
52
28
26
56
40
22
38
30
34
54
44
48
FUEL TANK
46
CHECK VALVE CLOSED
PISTON RETURN SPRING
35B
35A
32
24
42
36
62
POPPET SPRING
BODY SCREWS
58
60
16
RECEIVER BODY
64
18
14
POPPET DEPRESSED
RECEIVER OPENED NO DRAINAGE OF FUEL!

FIGURE 4

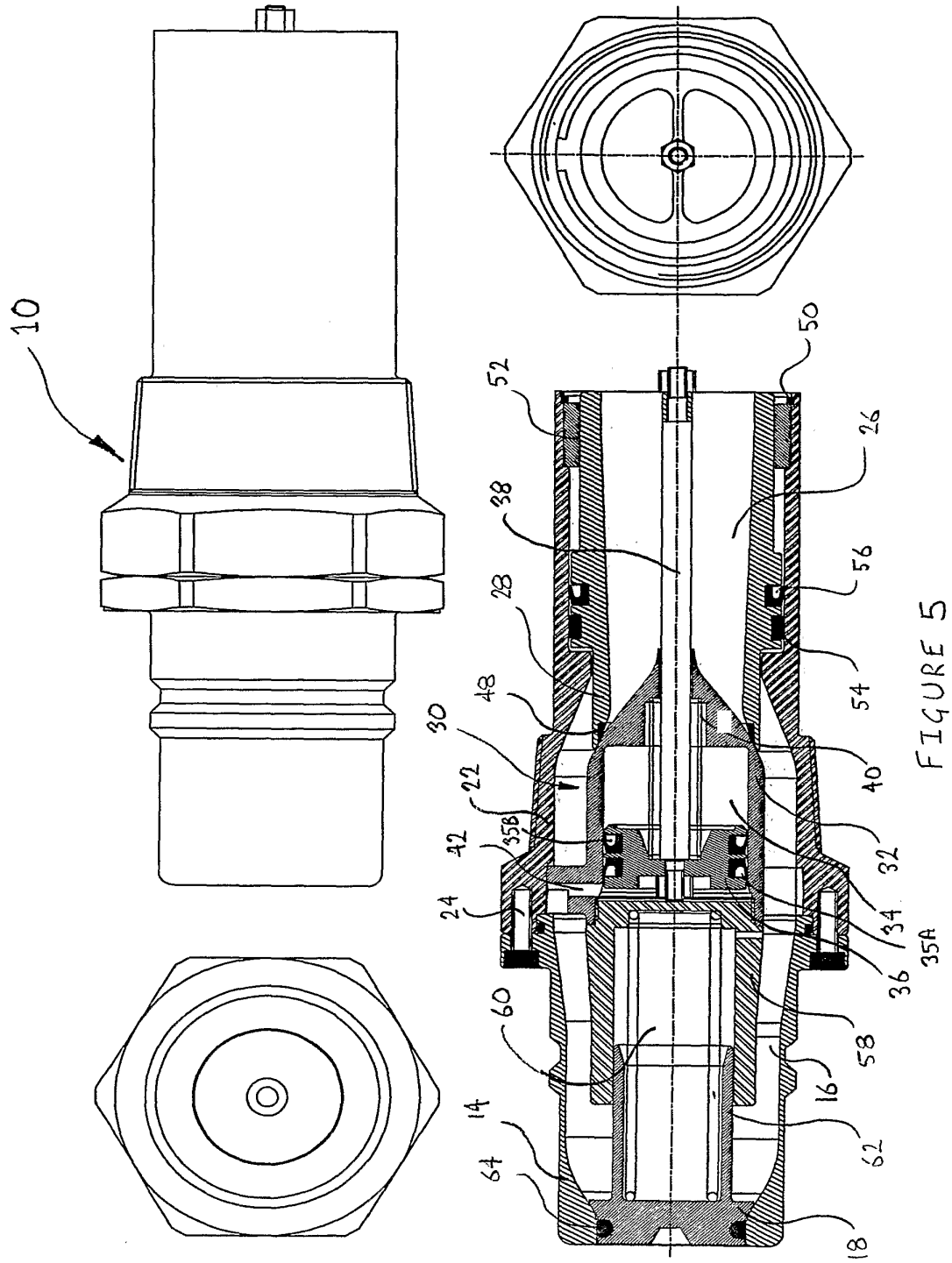

10
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22
35B
42
32
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34
35A
36
60
58
16
14
62
64
18

FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001271

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F16K 21/04 (2006.01) ***F16K 15/18*** (2006.01) ***F16L 37/28*** (2006.01)
B67D 5/377 (2006.01) ***F16K 17/04*** (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI - IPC F16K-, B67D- & keywords (valve, nozzle, poppet, plunger, check, return, fluid, fuel, actuator, control, piston, bias, urge, spring) and like terms; Esp@ce - IPC F16K 21/-, F16L 37/- & keywords (fuel, check, coupling, valve) & like terms; Google Patents & keywords (fuel, coupling, dry break) & like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5813432 A (ELSDON et al) 29 September 1998 Whole of document	1,2,6,7,8,12
A	US 5078170 A (HENRY) 7 January 1992 Whole of document	1, 12
A	US 6672327 B1 (KRYWITSKY) 6 January 2004 Whole of document	1, 12

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 October 2007	19 OCT 2007
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **STEPHEN MARCHANT** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 2533

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2007/001271

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5813432	AU	81019/94	CA	2102569	CA	2175903
		EP	0728120	WO	9512545		
US	5078170		NONE				
US	6672327	CA	2354467	CA	2428072	CA	2431324
		US	6981513	US	7152630	US	2002170596
		US	2003000572	US	2006289062	US	2007039657

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX

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67486-006PUS1

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

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 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Ricky Dean Shock Date (Optional): October 10, 2016

Signature: Ricky Shock

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Filer:	Matthew L. Koziarz/Andrea DeHart
Attorney Docket Number:	67846-006PUS1

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	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4000	4000
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**5740**

Electronic Acknowledgement Receipt	
EFS ID:	27177263
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	11-OCT-2016
Filing Date:	
Time Stamp:	14:13:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$5740
RAM confirmation Number	101216INTEFSW00000606501482
Deposit Account	501482
Authorized User	Andrea DeHart
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	aia0424.pdf	124699 d9e97064d4e966d2f6659b71625c9a0c11dde622	no	2
Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	1793063 52731d83313c1f9f542aba0728af46604b35494b	no	8
Warnings:					
Information:					
3		006PUS1_Application.pdf	137980 b40960e615c9d33f29abbc9a99f06e149d076819	yes	22

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	18
Claims	19	21
Abstract	22	22

Warnings:					
Information:					
4	Drawings-only black and white line drawings	006PUS1_FormalDrawings.pdf	236611 29d4d038d7ca88c0b0d92d5e8ba3126378144ad8	no	18
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	US_IDS_Form_SB_08a_withapp.pdf	614061 c3528841b8cf95db3c4b27284cd3c0bf50150d6f	no	9

Warnings:					
Information:					
6	Non Patent Literature	FrackShack_SeriesE.pdf	291115 0904f27b422214c85368e41f230daa94136cba4b	no	2
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Information:					
7	Non Patent Literature	FrackShack_Service.pdf	295275 3a539ad45909c50822c92a307400b00ebd12c058	no	2
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Information:					
8	Non Patent Literature	FracShack_DesignBenefits.pdf	437528 d497b3b224d34aeb01725af205d074095034dfeb	no	3
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10	Non Patent Literature	FracShack_SeriesA.pdf	291214 69299ddbb4eac1ad43321b0f705da046058bcfd4	no	2
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Information:					
12	Non Patent Literature	FracShack_SeriesC.pdf	287664 0783bfbb92da6d3096b214d47245697d4986cada	no	2
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Information:					

13	Non Patent Literature	FracShack_SeriesD.pdf	289022 36f1fbdccb185bff626c61409d67fb5933bfb2f4	no	2
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14	Non Patent Literature	FracShack_SeriesEG.pdf	295519 38f4343dd5d7cf7568ae988f81c9180570814e96	no	2
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15	Non Patent Literature	FracShack_Welcome.pdf	335305 6a5334b44be940e950220a79e4b3fd6b46e3f688	no	2
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16	Non Patent Literature	FracShak_Technology1.pdf	359723 37107df2b9e7b16a6fe812af52379529d177193d	no	3
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17	Non Patent Literature	Mann_Teknik_AB_DD_Couplings.pdf	232151 fadcd32f2c28032f551ba006877881134900 14b9	no	4
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18	Non Patent Literature	Mann_Teknik_AB_Dry_Aviation_Couplings.pdf	208266 5b690ddb16c524fa560e00520c6a25ef9d9affa5	no	4
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19	Non Patent Literature	TexasOil_2015.pdf	1661589 fa7943b2477c7e12bb574edd867aa8ef3b1687bf	no	2
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20	Non Patent Literature	Waterman_2013.pdf	150176 9724b72ce50a311c345633380bc0118555ad5a49	no	3
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21	Foreign Reference	GB2485832.pdf	1751108 eda34a742ecebec72c433a0156a88a69dadf75e4	no	50
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22	Foreign Reference	WO0177006A1.pdf	1685588 34e27c3142b24917cc5b8d74858ace79bff008d0	no	48
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23	Foreign Reference	WO2006005686A1.pdf	518426 64d31ba12374f19cc0a0f43056ff1fd83c4d4ada	no	11
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24	Foreign Reference	WO2008083830A2.pdf	590566 da37e3e40dd17cc6d6734de845d4edf60fc299d4	no	14
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25	Foreign Reference	WO2009026607.pdf	451842 2cd2ef4a8735889bb97f3b09637a77bd83b8ba6d	no	19
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26	Oath or Declaration filed	Signed_Declaration.pdf	53967 07ace12de3ef6f457b422d064d4c223c5394cb0d	no	1
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27	Fee Worksheet (SB06)	fee-info.pdf	38478 72b32376ee5be19944b50b041c4ed0da17453970	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	14025863	

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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.

Electronic Acknowledgement Receipt

EFS ID:	27177263
Application Number:	15290304
International Application Number:	
Confirmation Number:	3315
Title of Invention:	MOBILE DISTRIBUTION STATION HAVING SENSOR COMMUNICATION LINES ROUTED WITH HOSES
First Named Inventor/Applicant Name:	Ricky Dean Shock
Customer Number:	26096
Filer:	Matthew L. Koziarz/Andrea DeHart
Filer Authorized By:	Matthew L. Koziarz
Attorney Docket Number:	67846-006PUS1
Receipt Date:	11-OCT-2016
Filing Date:	
Time Stamp:	14:13:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$5740
RAM confirmation Number	101216INTEFSW00000606501482
Deposit Account	501482
Authorized User	Andrea DeHart
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	aia0424.pdf	124699 d9e97064d4e966d2f6659b71625c9a0c11dde622	no	2
Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	1793063 52731d83313c1f9f542aba0728af46604b35494b	no	8
Warnings:					
Information:					
3		006PUS1_Application.pdf	137980 b40960e615c9d33f29abbc9a99f06e149d076819	yes	22

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	18
Claims	19	21
Abstract	22	22

Warnings:					
Information:					
4	Drawings-only black and white line drawings	006PUS1_FormalDrawings.pdf	236611 29d4d038d7ca88c0b0d92d5e8ba3126378144ad8	no	18
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Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	US_IDS_Form_SB_08a_withapp.pdf	614061 c3528841b8cf95db3c4b27284cd3c0bf50150d6f	no	9

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6	Non Patent Literature	FrackShack_SeriesE.pdf	291115 0904f27b422214c85368e41f230daa94136cba4b	no	2
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7	Non Patent Literature	FrackShack_Service.pdf	295275 3a539ad45909c50822c92a307400b00ebd12c058	no	2
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8	Non Patent Literature	FracShack_DesignBenefits.pdf	437528 d497b3b224d34aeb01725af205d074095034dfeb	no	3
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9	Non Patent Literature	FracShack_Safety.pdf	603352 de73ad3c804ba146f4e8b4cc5afb026bc53dc8f9	no	3
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10	Non Patent Literature	FracShack_SeriesA.pdf	291214 69299ddbb4eac1ad43321b0f705da046058bcfd4	no	2
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11	Non Patent Literature	FracShack_SeriesB.pdf	291575 f232a411fa5cc2ea86bc6eb2b06b319345e0634a	no	2
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12	Non Patent Literature	FracShack_SeriesC.pdf	287664 0783bfbb92da6d3096b214d47245697d4986cada	no	2
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13	Non Patent Literature	FracShack_SeriesD.pdf	289022 36f1fbdccb185bff626c61409d67fb5933bfb2f4	no	2
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14	Non Patent Literature	FracShack_SeriesEG.pdf	295519 38f4343dd5d7cf7568ae988f81c9180570814e96	no	2
Warnings:					
Information:					
15	Non Patent Literature	FracShack_Welcome.pdf	335305 6a5334b44be940e950220a79e4b3fd6b46e3f688	no	2
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16	Non Patent Literature	FracShak_Technology1.pdf	359723 37107df2b9e7b16a6fe812af52379529d177193d	no	3
Warnings:					
Information:					
17	Non Patent Literature	Mann_Teknik_AB_DD_Couplings.pdf	232151 fadcd32f2c28032f551ba006877881134900 14b9	no	4
Warnings:					
Information:					
18	Non Patent Literature	Mann_Teknik_AB_Dry_Aviation_Couplings.pdf	208266 5b690ddb16c524fa560e00520c6a25ef9d9affa5	no	4
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19	Non Patent Literature	TexasOil_2015.pdf	1661589 fa7943b2477c7e12bb574edd867aa8ef3b1687bf	no	2
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Warnings:					
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21	Foreign Reference	GB2485832.pdf	1751108 eda34a742ecebec72c433a0156a88a69dadf75e4	no	50
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Information:					
22	Foreign Reference	WO0177006A1.pdf	1685588 34e27c3142b24917cc5b8d74858ace79bff008d0	no	48
Warnings:					
Information:					
23	Foreign Reference	WO2006005686A1.pdf	518426 64d31ba12374f19cc0a0f43056ff1fd83c4d4ada	no	11
Warnings:					
Information:					
24	Foreign Reference	WO2008083830A2.pdf	590566 da37e3e40dd17cc6d6734de845d4edf60fc299d4	no	14
Warnings:					
Information:					
25	Foreign Reference	WO2009026607.pdf	451842 2cd2ef4a8735889bb97f3b09637a77bd83b8ba6d	no	19
Warnings:					
Information:					
26	Oath or Declaration filed	Signed_Declaration.pdf	53967 07ace12de3ef6f457b422d064d4c223c5394cb0d	no	1
Warnings:					
Information:					

27	Fee Worksheet (SB06)	fee-info.pdf	38478 72b32376ee5be19944b50b041c4ed0da17453970	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	14025863	

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