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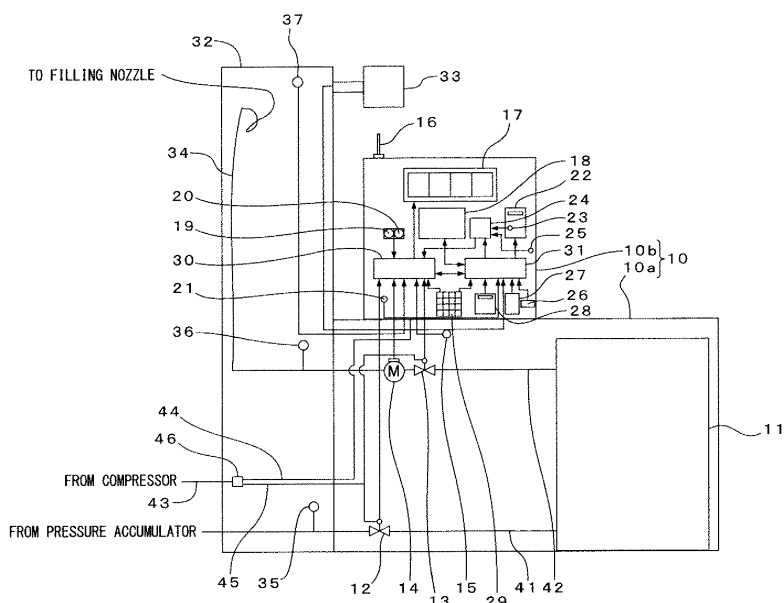
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(54) **GAS FILLING DEVICE**

(57) To provide a safety and compact gas filling device with a display unit having a high degree of freedom in design. A gas filling device 2 characterized by comprising: a filling unit 10a having a filling mechanism for transporting a gas from a gas supply source while measuring flow rate of the gas, a hose unit 32 having a filling hose 34 connected to a gas outlet pipe 42 of the gas filling mechanism and a filling nozzle attached to a tip of

the filling hose; and a display unit 10b for displaying filling data measured by the filling mechanism, wherein the display unit has an internal pressure explosion-proof structure. A monitoring device 24 for monitoring an internal pressure of the display unit is mounted, and the monitoring device interrupts a power source of the gas filling device when the internal pressure of the display unit changes.

[Fig. 2]



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a gas filling device for filling gas to in-vehicle tanks of CNG automobiles, fuel-cell vehicles, hydrogen automobiles and so on that use CNG, hydrogen gas and others as fuels.

[0002] As vehicles for coping with environmental problems in recent years, CNG automobiles, fuel-cell vehicles, hydrogen automobiles and so on that use CNG (Compressed Natural Gas), hydrogen gas and others as fuel have been developed actively. In order to promote spread of such vehicles traveling with the above gas fuels, devices for stably and efficiently filling the gas fuels to in-vehicle tanks of such vehicles become necessary. Then, the present applicant proposed a gas filling device for efficiently filling gas fuels to in-vehicle tanks of vehicles in Japanese Patent Publication No. 2014-109350.

[0003] The content of Japanese Patent Publication 2014-109350 is incorporated herein by reference in its entirety.

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004] Hydrogen gas, which is a combustible gas, has a remarkably wide explosion limit, and generation of sparks due to static electricity or the like will cause explosion with a high probability, so that electrical devices in a display unit that is used under an environment where combustible gas is filled adopts an explosion-proof structure to prevent combustible gas from catching fire even if sparks or the like generate in the unit.

[0005] The explosion-proof structure is adopted, even if combustible gas explodes in the structure, to bear the pressure of the explosion and to prevent outer combustible gas from catching fire, so that it is effective to prevent accident caused by the explosion. But, since each electrical device is accommodated in an explosion-proof case, the display unit becomes large, which may spoil a degree of freedom in design.

[0006] Further, in order to promote spread of hydrogen stations, utilization of self-type gas filling devices has been considered recently through revisions of the Ministerial Ordinance and the Operational Safety Ordinance, so that it is desired to develop safety and compact gas filling devices.

[0007] Then, the present invention has been made in consideration of the above problems in the conventional art, and the object thereof is to provide a safety and compact gas filling device with a display unit having a high degree of freedom in design.

Means of Solving the Problems

[0008] To achieve the above object, a gas filling device according to the present invention is characterized by comprising: a filling unit having a filling mechanism for transporting a gas from a gas supply source while measuring flow rate of the gas, a hose unit having a filling hose connected to a gas outlet pipe of the gas filling mechanism and a filling nozzle attached to a tip of the filling hose; and a display unit for displaying filling data measured by the filling mechanism, wherein the display unit has an internal pressure explosion-proof structure.

[0009] In the present invention, as an explosion-proof structure for the display unit is adopted an internal pressure explosion-proof structure, so that it is possible to downsize the device in comparison to flameproof structure while securing safety, and degree of freedom in design of the display unit can be increased.

[0010] The gas filling device may further comprise a monitoring device for monitoring an internal pressure of the display unit, and the monitoring device interrupts a power source of the gas filling device when the internal pressure of the display unit changes. With this, inflow of the combustible gas into the display unit can be detected rapidly to prevent explosion.

[0011] Further, the gas filling device may further comprise: an openable display panel disposed so as to oppose a display in the display unit; an openable printer cover disposed so as to oppose a printer; sensors for detecting opening/closing conditions of the display panel and the printer cover, and a filling control device for stopping filling from the filling mechanism when the sensors detect opening of the display panel or/and the printer cover. With this, maintenances of the display and the printer can be carried out with ease while securing safety.

[0012] The display unit can include a storing device for storing filling times and filling amount of the gas by the filling mechanism. The data on filling stored can effectively be used for maintenance of the gas filling device, for instance, expendables such as hoses and nozzles can be exchanged before expiry date based on the data.

[0013] A gas detector for detecting leakage of the gas from the filling mechanism at an upper portion in the filling unit can be mounted, and the gas detector can interrupt a power source of the gas filling device when detecting the gas leakage. With this, leakage of combustible gas in the filling unit can be detected to prevent explosion.

[0014] A camera can be arranged on the display unit, and the camera can functions as identifier reading means when filling amount from the filling mechanism is set, and functions as a monitoring camera when the filling is not performed. With this camera, it becomes possible to read barcode or the like for settlement discount and to perform remote monitoring, resulting in improved convenience.

Effects of the Invention

[0015] As described above, with the present invention,

it is possible to provide a safety and compact gas filling device with a display unit having a high degree of freedom in design.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a schematic view showing a gas filling system to which a gas filling device according to the present invention is adapted;

Figure 2 shows an overall construction of a gas filling device according to an embodiment of the present invention;

Figure 3 is a flowchart for explaining motion of the gas filling system shown in Fig. 1; and

Figure 4 is a flowchart for explaining a part of the motion of the gas filling system shown in Fig. 3 in detail.

MODE FOR CARRYING OUT THE INVENTION

[0017] Next, an embodiment of the present invention will be explained with reference to drawings in detail. In the below explanations, a gas filling device of the present invention is a hydrogen gas filling device and the hydrogen gas is filled in a hydrogen gas vehicle as an example.

[0018] At first, a gas filling system to which a gas filling device according to the present invention is adapted will be explained roughly with reference to Fig. 1. This gas filling system 1 includes gas filling devices 2 (2A, 2B); a POS terminal (point-of-sale terminal, hereinafter abbreviated as "POS") 4 and a remote monitoring server 5 communicating with the gas filling devices 2 through a relay unit 3; a supervisory PC 6 and a portable terminal 7 connected to the remote monitoring server 5; a back facility 8 directly communicating with the gas filling devices 2; and a settlement center 9 communicating with the filling devices 2 directly or through the relay unit 3.

[0019] The relay unit 3 is connected to each of the gas filling devices 2A, 2B through a cable (SSLAN). This relay unit 3 may be mounted to each of the gas filling devices 2 or one relay unit 3 may be mounted to the gas filling system 1 and the relay unit 3 and each of the gas filling devices 2A, 2B may be connected with each other through cables.

[0020] The remote monitoring server 5 is wirelessly connected to the relay unit 3 and receives filling data such as filling amount and filling price of hydrogen gas (hereinafter referred to as "gas") by the gas filling devices 2 from the gas filling device 2 through the relay unit 3 and stores them. In addition, the remote monitoring server 5 stores information on maintenance inputted by a worker of the gas filling system 1. For instance, the filling data are grasped by the supervisory PC 6 that is connected to the remote monitoring server 5, and the information on maintenance can be transmitted to the portable terminal 7 that is connected to the remote monitoring server

5.

[0021] The back facility 8 is mounted to control devices such as the gas filling device 2 of the overall gas filling system 1 while monitoring the devices. In addition, the settlement center 9 is mounted to deal with credit card payment by an user of the gas filling system 1 (hereinafter referred to as merely "user").

[0022] Figure 2 shows an embodiment of the gas filling device according to an embodiment of the present invention, and the gas filling device 2 is composed of a main body unit 10 and a hose unit 32.

[0023] The main body unit 10 is composed of a filling unit 10a having a filling mechanism for transporting a gas from an accumulator not shown as a gas supply source while measuring flow rate of the gas, and a cooling device 11 for cooling a gas supplied through a gas transporting pipe 41, and a display unit 10b mounted on a ceiling portion of the filling unit 10a and displaying gas filling amount and so on.

[0024] The filling unit 10a is provided with; a master valve 12 mounted on the gas transporting pipe 41; a flow control valve 13 and a flow meter 14, mounted on a gas transporting pipe 42, for controlling and measuring gas flow rate from the cooling device 11 to a filling hose 34; a gas detector 15 for interrupting a power source of the gas filling device 2 when detecting gas leakage from the filling mechanism; and so on. Especially, the gas detector 15 prevents explosion when detecting leakage of combustible gas in the filling unit 10a.

[0025] The cooling device 11 cools a gas supplied from the accumulator with coolant such as liquid nitrogen, fluorocarbon and carbon dioxide, which are accumulated therein.

[0026] The display unit 10b is provided with; an antenna 16 for telephone network functioning as a part of the relay unit 3; a display 17 for displaying flow rate of the gas flowing from the gas transportation pipe 42 to the filling hose 34, which is supply amount of the gas from a filling nozzle described below to a fuel tank of an automobile; a touch display 18; start/finish switches (hereinafter "switches" are abbreviated as "SWs") 19, 20 depressed when starting/finishing filling; a vehicle detector 21 for detecting approach of a vehicle; a printer 22 for printing a receipt and others; a printer cover closing SW 23; a pressure control device 24; a display panel closing SW 25; a camera 26; an IC tag reader 27; a card reader 28; a keyboard 29; a filling control device 30 for controlling the filling mechanism; and a setting control device 31 for control on setting for filling. The remote monitoring server 5 receives filling data from the gas filling device 2 through the antenna 16 for telephone network.

[0027] To this display unit 10b is adopted an internal pressure explosion-proof structure, and in the display unit 10b is filled an incombustible gas that is fed from a compressor not shown through a gas transportation pipe 43, a three-way valve 46 and a gas transportation pipe 44. This incombustible gas is the same as that is used for driving the flow control valve 13 through a gas transpor-

tation pipe 45, and clean air can be used for the gas.

[0028] In addition, the display unit 10b is provided with an openable panel, which is an overall front face of the display unit 10b except for the printer 22, for maintenance and so on. The display panel closing SW 25 outputs an ON signal when the panel of the display unit 10b is closed.

[0029] The vehicle detector 21 detects a vehicle approaching the gas filling device 2 to transmit a detection signal to the setting control device 31.

[0030] On the front face of the printer 22 is mounted an openable cover not shown for supplying rolled paper and so on. The printer cover closing SW 23 outputs an ON signal when the cover of the printer 22 is closed.

[0031] The pressure control device 24 functions as a monitoring device that monitors internal pressure of the display unit 10b and outputs a control signal for forcibly terminate gas filling when the internal pressure of the display unit 10b is changed to the filling control device 30, and as described below, the pressure control device 24 leads the changed internal pressure of the display unit 10b to the setting pressure.

[0032] The camera 26 functions as a barcode reader or the like in setting for filling with the setting control device 31 to make discount in settlement possible, and functions as a monitoring camera in other occasions to perform remote monitoring at an office or the like where the gas filling system 1 is installed.

[0033] The IC tag reader 27 reads an IC tag in a vehicle and outputs setting for filling registered in the IC tag to the setting control device 31. The card reader 28 is mounted to read a credit card of a user and performs settlement while exchanging information with the settlement center 9.

[0034] To the filling control device 30 are inputted ON/OFF signals from a nozzle switch not shown mounted to a nozzle hook not shown of a filling nozzle, signals from a pulse transmitter of a flow meter not shown, and signals from measuring devices, and control signals are outputted to the master valve 12, the flow control valve 13 and others from the filling control device 30.

[0035] To the setting control device 31 are inputted filling setting signals and so on from the touch display 18, the IC tag reader 27 and the keyboard 29, and control signals are outputted to the filling control device 30 and the printer 22 from the setting control device 31.

[0036] The hose unit 32 is provided with: a vehicle tag reader 33 for reading a tag of a vehicle; the filling hose 34 connected to the gas transportation pipe 42, which is an outlet pipe of the filling mechanism, in the filling unit 10a; a filling nozzle attached to a tip portion of the filling hose 34; pressure gages 35, 36 detecting internal pressures of the gas transportation pipes 41, 42 respectively; a gas detector 37 for detecting gas leakage; and so on.

[0037] The vehicle tag reader 33 is mounted to confirm whether or not a vehicle is to utilize the gas filling device 2 by reading a tag in the vehicle. This vehicle tag reader 33 has a narrower detecting area than that of the vehicle detector 21 mounted to the display unit 10b. This vehicle

tag reader 33 is disposed on the same line of the vehicle detector 21, and detects approaching of a vehicle and the vehicle tag reader 33 continues to detect the vehicle during filling operation, which allows the actual vehicle conducting filling operation to be recognized and prevents misdetection of other vehicles.

[0038] Next, motion of the gas filling system 1 with the above construction will be explained with reference to Fig. 3 mainly and together with Figs. 1 and 2. In the below explanation, not preset filling for filling a predetermined amount, but usual filling motion, in which filling continues until a customer depresses the finish SW 20, will be explained.

[0039] At first, in Step S1, the setting control device 31 waits until the vehicle detector 21 turns ON. When the vehicle detector 21 turns ON (Step S1; Yes), in Step S2, the vehicle tag reader 33 starts reading a tag in the vehicle, and the tag is read (Step S2; Yes), a setting picture is displayed on the display 17 (in Step S3). On the contrary, in Step S2, when the vehicle tag reader 33 cannot read the tag (Step S2; No), the vehicle is guided so as to approach the gas filling device 2 through notification means or the like (in Step S4), and the procedure returns to Step S2.

[0040] In Step S5, it waits until a user of the gas filling device 2 completes setting for filling through the touch display 18 or the like. When the setting of fueling is finished (Step S5; Yes), in Step S6, it waits until a filling permission signal is inputted in Step S6. When setting for filling is registered in the IC tag of the vehicle in advance, in Step S2 is simultaneously read this setting for filling also when the tag of the vehicle is read, and the Steps S3 and S5 are omitted.

[0041] Next, in the filling control device 30, when the user removes the filling nozzle from the nozzle hook, the nozzle SW turns ON (Step S11; Yes), and the removed filling nozzle is connected to a filling aperture of the fuel tank mounted to the vehicle. Here, to the back facility 8 and the setting control device 31 are outputted the filling permission signals (in Step S12), and in Step S13, it waits until the filling permission signals are inputted.

[0042] In the back facility 8, when the filling permission signal is inputted (Step S31; Yes), in Step S32, safety of each device of the gas filling device 2 is confirmed. When the safety of each device is confirmed (Step S32; Yes), the filling permission signal is outputted to the filling control device 30 (in Step S33), and in Step S34, it waits until the filling finish signal is inputted.

[0043] When to the setting control device 31 is inputted the filling permission request signal (Step S6; Yes), to the filling control device 30 is outputted the filling permission signal, (in Step S7), in Step S8, it waits until the filling finish signal is inputted.

[0044] In the filling control device 30, when filling permission signals are inputted from both of the back facility 8 and the setting control device 31 (Step S13; Yes), in Step S14, it waits until the user depresses the start SW 19, that is, the start SW 19 is turn ON. When the start

SW 19 turns ON (Step S14; Yes), the flow meter 14 returns to zero, and the master valve 12 and the flow control valve 13 are opened (in Step S15).

[0045] Openings of the master valve 12 and the flow control valve 13 cause flow rate pulses to be inputted to the flow meter 14 to fill the gas to the vehicle (in Step S16), and filling amount is measured and displayed on the display 17 (in Step S17).

[0046] During the gas filling, in the steps S18 and S19, internal pressure of the display unit 10b and a detecting signal of the vehicle detector 21 are monitored. When the internal pressure of the display unit 10b changes (Step S18; No), or an OFF signal is outputted from the vehicle detector 21 (Step S19; No), filling operation is immediately ceased.

[0047] In Step S20, when the user depresses the finish SW 20 (Step S20; Yes), or the filling operation is ceased under the above conditions (Steps S18, S19; No), the filling operation is finished, and in step S21 are closed the master valve 12 and the flow control valve 13. After that, in Step S22, it waits until the nozzle SW turns OFF. When the nozzle SW turns OFF (Step S22; Yes), to the setting control device 31, back facility 8 and the remote monitoring server 5 are outputted filling finishing signals (in Step S23), and the motion of the filling control device 30 is finished.

[0048] In the setting control device 31, the filling finish signal is inputted (Step S8; Yes), settlement is performed based on filling amount of the gas, and the result is outputted through printing on a receipt (in Step S9), and the motion of the setting control device 31 is finished.

[0049] On the other hand, in the back facility 8, when the filling finish single is inputted (Step S34; Yes), a flag of corresponding gas filling device 2 is deleted (in Step S35), the motion of the back facility 8 is finished.

[0050] Further, in the remote monitoring server 5, in Step S41, when filling data is inputted together with the filling finish signal (Step S41; Yes), filling data such as filling amount of the gas and filling price are stored (in Step S42). In addition, in Step S43, when maintenance data are inputted by a worker of the gas filling system 1 (Step S43; Yes), these data are stored (in Step S44) and the motion of the remote monitoring server 5 is finished.

[0051] Next, detail motion in Step S18 of the filling control device 30 and recovery motion of the filling unit 10a and so on to the motion in the step S18 will be explained with reference to Fig. 4 mainly and together with Figs. 1 to 3.

[0052] In step S51 (corresponding to the step S18), internal pressure of the display unit 10b is monitored by the pressure control device 24, at the same time (Step S51; No), in Step S52, whether or not the printer cover closing SW 23 and the display panel closing SW 25 are OFF is monitored.

[0053] When the pressure control device 24 detects change in internal pressure of the display unit 10b (Step S51; Yes), or that either one of the printer cover closing SW 23 or the display panel closing SW 25 is OFF, that

is, that either one of the printer cover or the display panel is opened is detected (Step S52; Yes), power sources of the filling unit 10a and the POS 4 are turn OFF (in Step S53). In this connection, it is possible to mount a relief valve in advance to manage when internal pressure of the display unit 10b increases.

[0054] After the power sources of the filling unit 10a and the POS 4 are turn OFF in Step S53, in Step S54, it monitors until both of the printer cover closing SW 23 and the display panel closing SW 25 turn ON. When the turn ON of both of the printer cover closing SW 23 and the display panel closing SW 25, that is, that both of the printer cover and the display panel are closed is detected (Step S54; Yes), in Step S55, by the pressure control device 24 is compared internal pressure and setting pressure of the display unit 10b.

[0055] In Step S55, when it is detected that inside of the display unit 10b becomes the setting pressure by the pressure control device 24 (Step S55; Yes), gas in the display unit 10b is removed (in Step S56).

[0056] In step S57, gas removal in the step S56 continues until the gas removal time T reaches a predetermined time t1. When the gas removal time T reaches the predetermined time t1 (Step S57; Yes), it is judged that combustible gas does not exist in the display unit 10b, and the power sources of the filling unit 10a and the POS 4 are turn ON (in Step S58) to restore the filling unit 10a and the POS 4.

[0057] As described above, in this embodiment, the display unit 10b adopts an internal pressure explosion-proof structure as an explosion-proof structure, so that the unit 10b can be downsized in comparison to flame-proof structure, and degree of freedom in design of the display unit can be increased. In addition, when the internal pressure of the display unit 10b changes, the power source of the filling unit 10a is shut-off, which allows inflow of combustible gas into the display unit 10b to rapidly be detected to prevent explosion.

[0058] In the above embodiment, hydrogen gas is filled in a vehicle as an example, the gas filling device 2 can be used to fill other kinds of gases.

[0059] And, although the antenna 16 for telephone network functioning as a part of the relay unit 3 is mounted to the display unit 10b in the embodiment, it is possible to communicate the gas filling device 2 and the remote monitoring server 5 with each other through a cable LAN mounted in the gas filling system 1 in advance and radio communication without utilizing telephone line.

[0060] Further, the gas transportation pipe 43 is branched to the gas transporting pipes 44, 45 through the three-way valve 46 in the embodiment, it is possible to separately connect the compressor and the display unit 10b, and the master valve 12 and the flow control valve 13 with two gas transporting pipes without the three-way valve 46 to securely supply gas in the display unit 10b regardless of driving of the valves 12, 13.

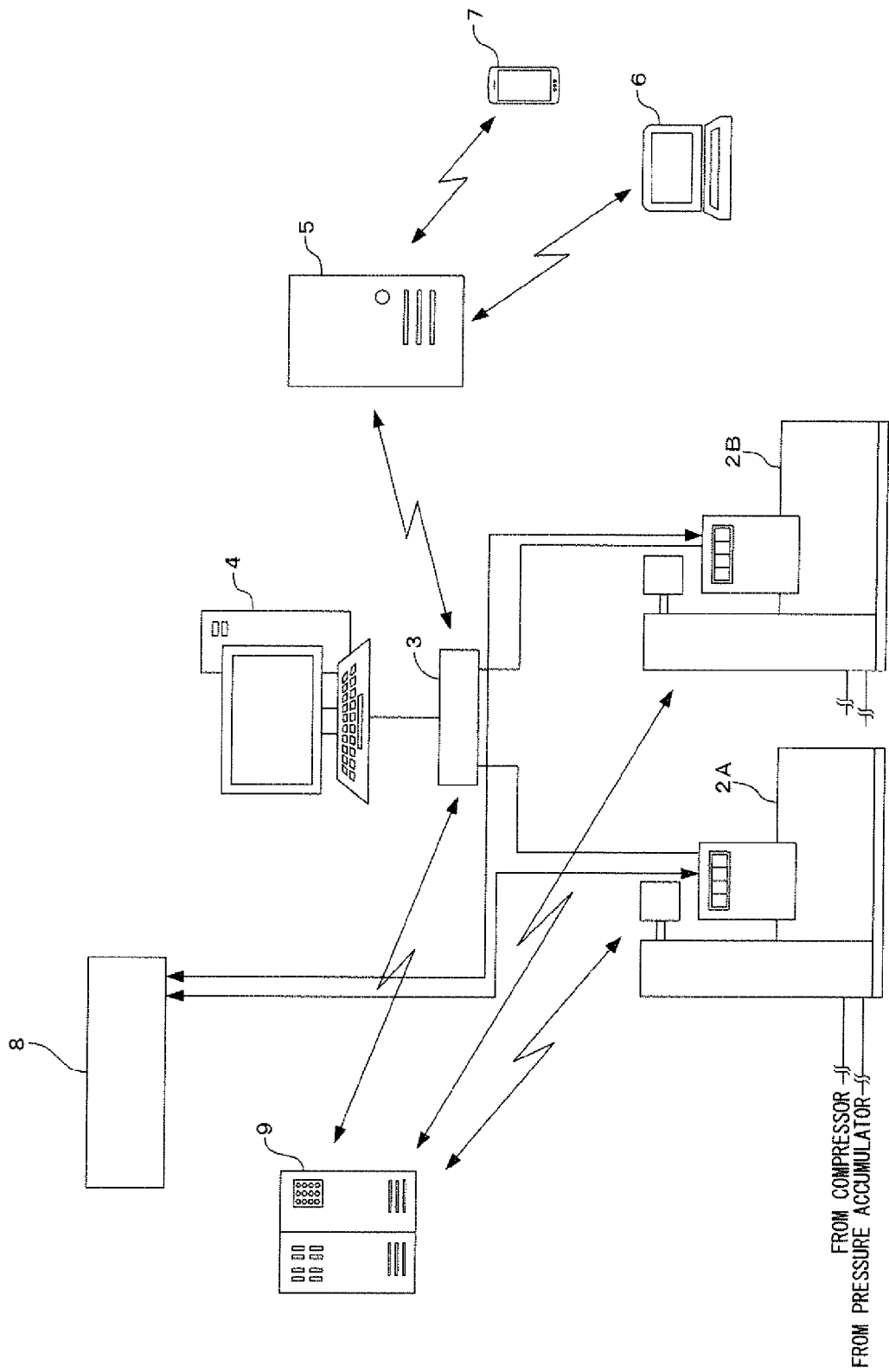
1 gas filling system

2	(2A, 2B) gas filling devices		comprising a monitoring device for monitoring an internal pressure of the display unit, and the monitoring device interrupts a power source of said gas filling device when the internal pressure of the display unit changes.
3	relay unit		
4	POS		
5	remote monitoring server		
6	supervisory PC	5	
7	portable terminal		
8	back facility		
9	settlement center		
10	main body unit		
10a	filling unit	10	
10b	display unit		
11	cooling device		
12	master valve		
13	flow control valve		
14	flow meter	15	
15	gas detector		
16	antenna for telephone network		
17	display		
18	touch display		
19	start SW	20	
20	finish SW		
21	vehicle detector		
22	printer		
23	printer cover closing SAW		
24	pressure control device	25	
25	display panel closing SW		
26	camera		
27	IC tag reader		
28	card reader		
29	keyboard	30	
30	filling control device		
31	setting control device		
32	hose unit		
33	vehicle tag reader		
34	filling hose	35	
35, 36	pressure gages		
37	gas detector		
41-45	gas transporting pipes		
46	three-way valve	40	

Claims

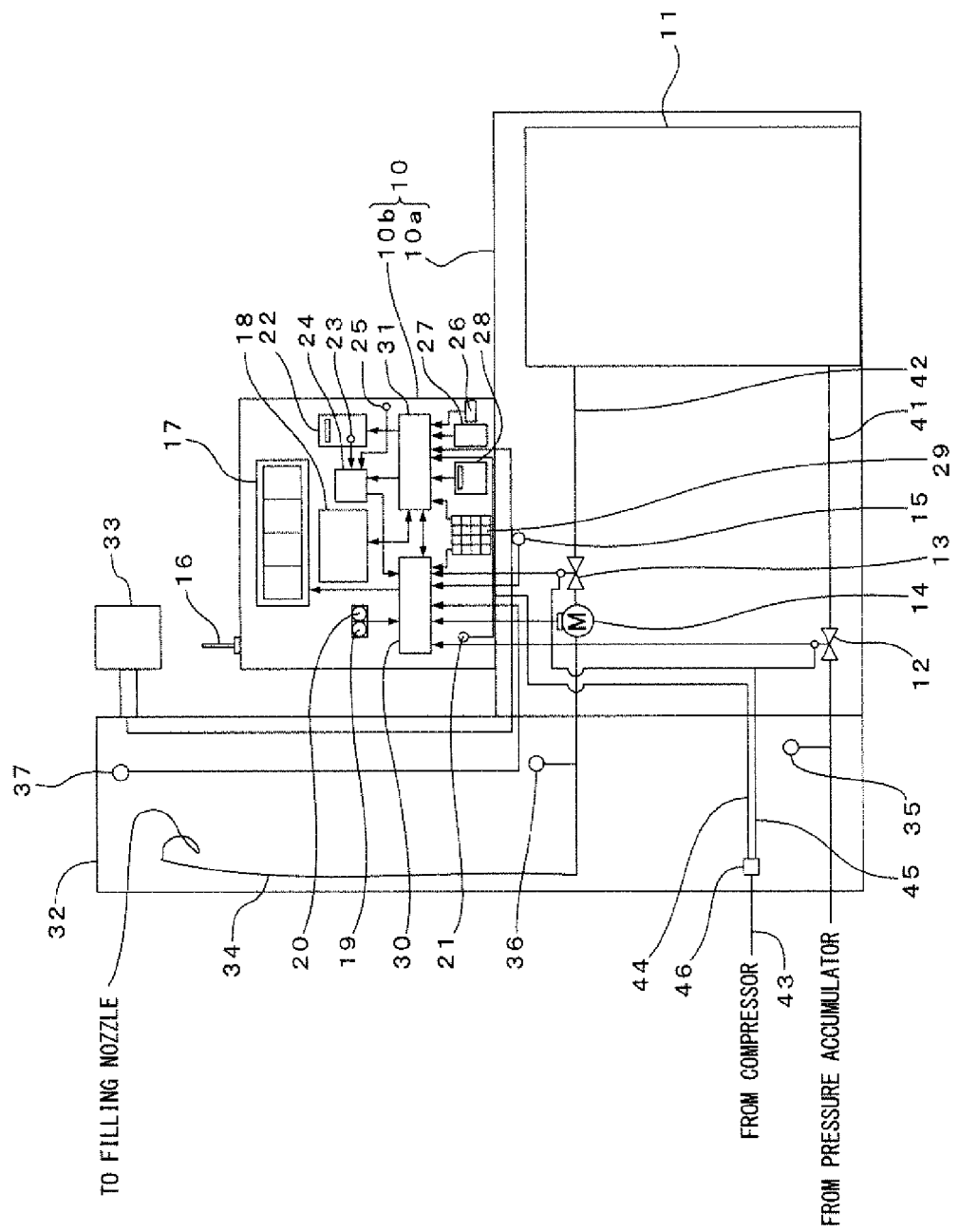
1. A gas filling device comprising:
 - a filling unit having a filling mechanism for transporting a gas from a gas supply source while measuring flow rate of the gas,
 - a hose unit having a filling hose connected to a gas outlet pipe of the gas filling mechanism and a filling nozzle attached to a tip of the filling hose; and
 - a display unit for displaying filling data measured by the filling mechanism,
 - wherein said display unit has an internal pressure explosion-proof structure.

2. The gas filling device as claimed in claim 1 further

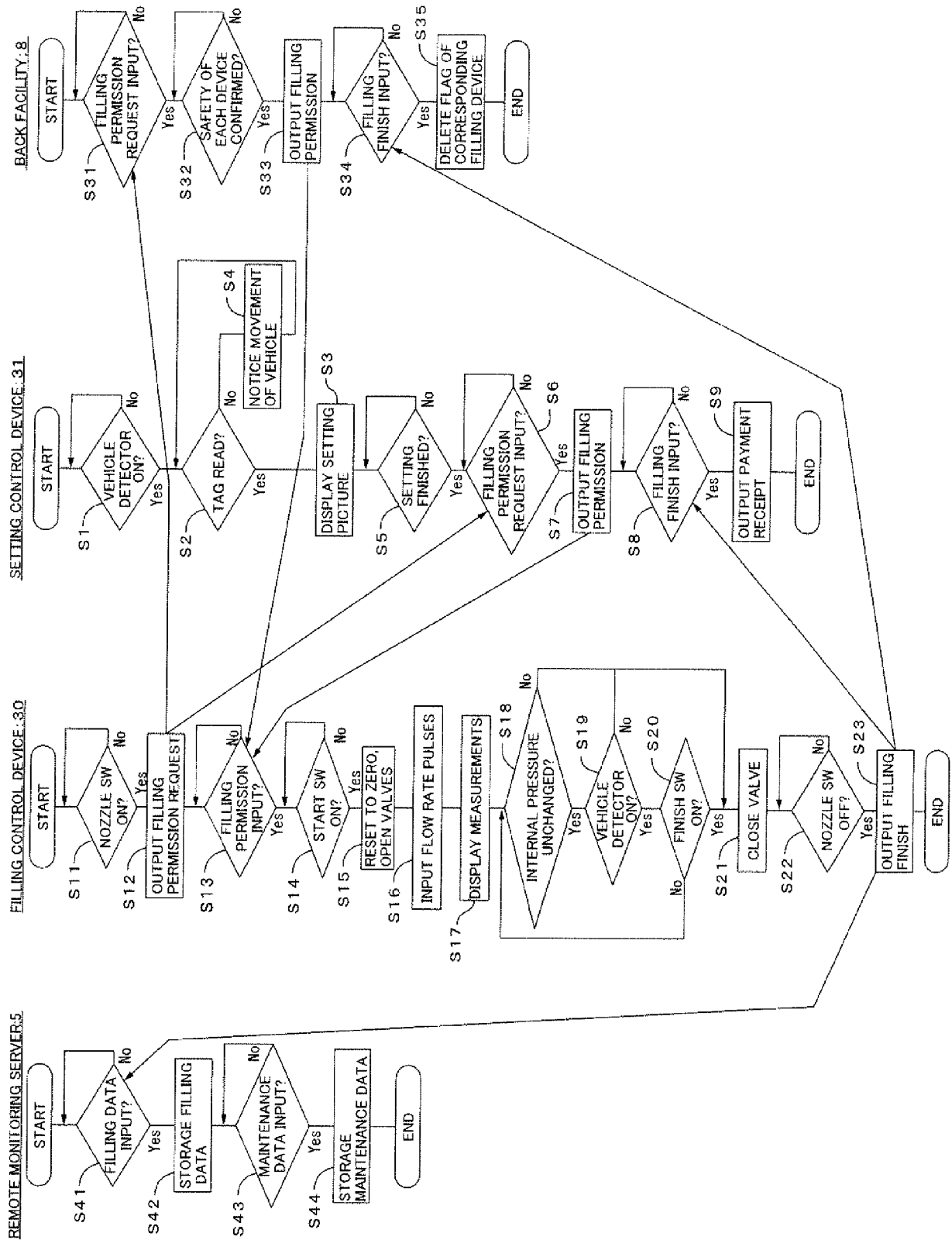


【Fig. 1】

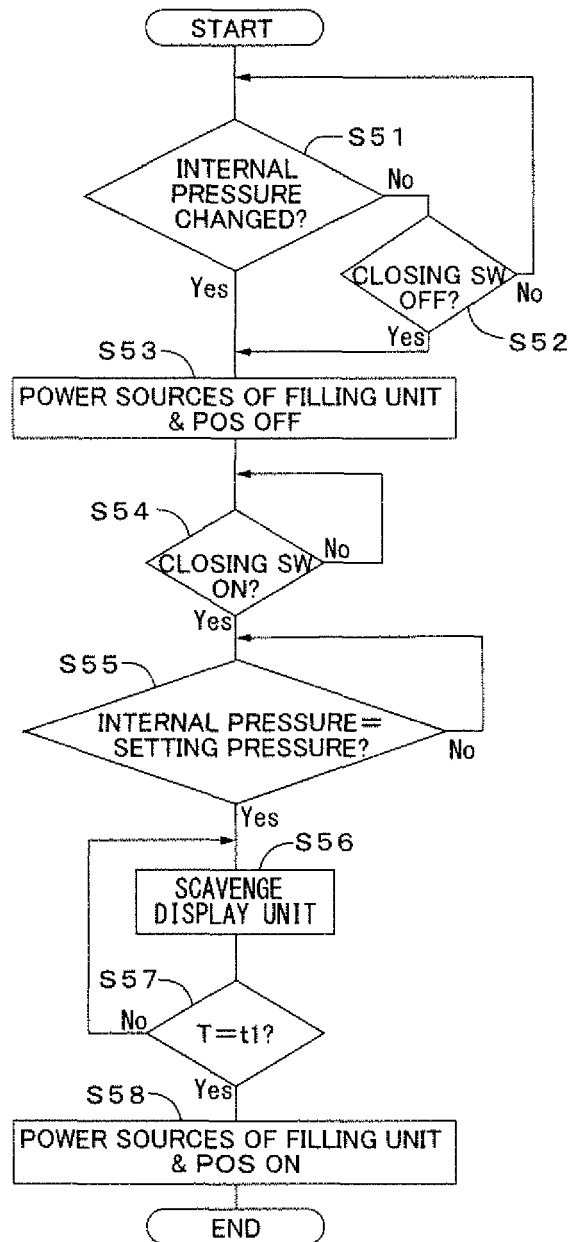
【Fig. 2】



【Fig. 3】



【Fig. 4】





EUROPEAN SEARCH REPORT

Application Number
EP 17 16 7186

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Y	* figures 1-3 * * paragraphs [0018], [0019], [0021] - [0024], [0038] - [0040] *	3,4,6	
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A	* figures 1a-b,2-6 * * paragraphs [0024], [0026], [0027], [0060], [0063], [0064], [0076], [0077], [0084], [0085] *	1,2,4-6	
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A	* paragraphs [0015] - [0018], [0030]; figures 1-3 *	1-3,5,6	
Y	US 2017/053252 A1 (VOTAW ELIZABETH [US] ET AL) 23 February 2017 (2017-02-23)	6	TECHNICAL FIELDS SEARCHED (IPC) F17C B67D G06Q G07F
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 September 2017	Examiner Sisinni, Giovanni
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 16 7186

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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