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Remarks:

Amended claims in accordance with Rule 137(2) EPC.

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(54) **A FUEL PUMP UNIT FOR A FUEL DISPENSING UNIT, A FUEL DISPENSING UNIT FOR REFUELLING A VEHICLE, AND A METHOD FOR HANDLING A FUEL PUMP UNIT FOR A FUEL DISPENSING UNIT**

(57) The invention relates to a fuel pump unit (8) for a fuel dispensing unit (1). The fuel pump unit (8) comprises a pump (9) with a suction side (S) and a pressure side (P), and a first bypass channel (10) arranged between the pressure side (P) and the suction side (S), which first bypass channel (10) comprises a first control valve (12). The fuel pump unit (8) is characterized in that it further comprises a second bypass channel (11) extending between the pressure side (P) and the suction side (S), which second bypass channel (11) comprises a second control valve (13). The invention also relates to fuel dispensing unit (1) for refuelling a vehicle and a method for handling a fuel pump unit (8) for a fuel dispensing unit (1).

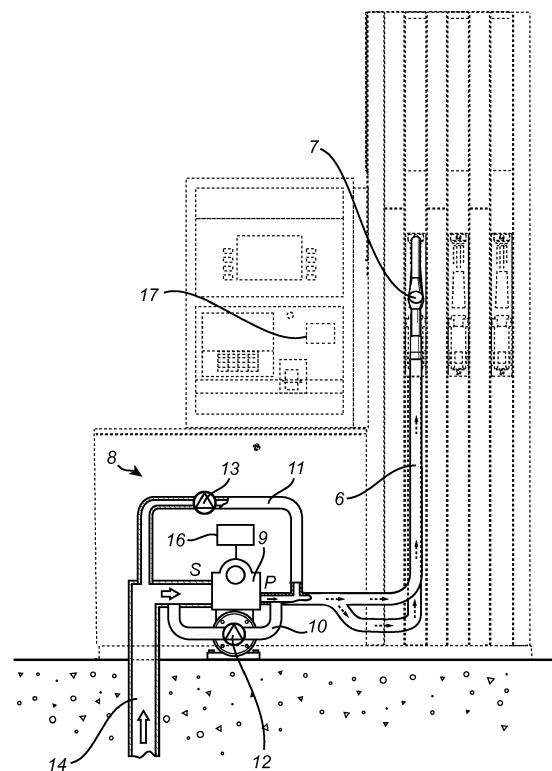


Fig. 3

Description

Technical field

[0001] The invention relates to a fuel pump unit for a fuel dispensing unit, a fuel dispensing unit for refuelling a vehicle and a method for handling a fuel pump unit for a fuel dispensing unit.

Background art

[0002] In retail service station environments, a submersible turbine pump associated with an underground storage tank is often used to pump fuel to one or more fuel dispensers. However, some fuel dispensers comprise a self-contained pumping unit, meaning fuel is drawn to the fuel dispenser by a motor-driven pump positioned within the fuel dispenser housing. Where multiple grades of fuel are dispensed, these fuel dispensers typically comprise a self-contained pump for each grade of fuel. Often, these pumps are sliding vane pumps or gear pumps and are driven by a motor which operates at a fixed speed.

[0003] A fuel dispenser having an integrated pump normally comprises a bypass spring valve arranged between the suction side and the pressure side of the pump. The pump is driven by a motor which operates at a fixed speed. In one mode of operation, the pump is used in a fuel dispenser to supply fuel to two or more nozzles for delivering the same grade of fuel. The pump is designed to produce a fuel stream having a sufficient pressure to allow simultaneous fuelling from the two or more nozzles at a desirable flow rate. During simultaneous fuelling, the bypass valve remains closed. However, when the fuel dispenser is used to deliver fuel from only one nozzle, a backpressure develops and causes the bypass valve to open. Thereby, a portion of the pumped fuel is recirculated to the inlet of the pump.

[0004] Since the motor pump operates at a fixed speed independent of one or several nozzles are in operation, this solution provides for an elevated temperature over the bypass valve when fuel is pumped from only one nozzle. In turn, this will lead to a high energy consumption of the fuel dispenser.

Summary of the invention

[0005] It is an objective of the present invention to provide an improvement of the above technique and prior art. More particularly, it is an objective of this invention to provide an improved fuel pump unit with a decreased energy consumption.

[0006] According to a first aspect, these and other objects, and/or advantages that will be apparent from the following description of embodiments, are achieved, in full or at least in part, by a fuel pump unit for a fuel dispensing unit, which fuel pump unit comprises a pump with a suction side and a pressure side, and a first bypass

channel arranged between the pressure side and the suction side, which first bypass channel comprises a first control valve. The fuel pump unit is characterized in that it further comprises a second bypass channel extending between the pressure side and the suction side, which second bypass channel comprises a second control valve.

[0007] In this way, when the fuel dispenser is used to deliver fuel from only one nozzle, the second valve is opened at a degree to allow fuel to pass through the second bypass channel at a predetermined rate. Preferably, the fuel flow in the second bypass channel is set at a rate to ensure that enough backpressure is developed to barely open the first control valve of the first bypass channel.

[0008] This is advantageous in that the loss of energy due to an elevated temperature over the bypass valve will be minimized and thus the overall energy consumption of the system will be decreased. The invention will also make it possible to drive the pump at a higher fixed speed to increase the fuel flow rate.

[0009] The capacity of the second bypass channel may be greater than the capacity of the first bypass channel. The capacity of the of first and second bypass channel is preferably measured based on fuel flow rate and/or pressure drop.

[0010] By having a second bypass channel with a large capacity, the strain acting on the first control valve in the first bypass channel is reduced. This will make it possible to minimize the size of the first bypass channel and to integrate it with the pump. Thus, the first bypass channel may connect the suction side with the pressure side inside the pump.

[0011] The fuel pump unit may further comprise a control unit which is adapted to control an opening degree of the second control valve based on an application level of the fuel dispensing unit.

[0012] In one embodiment, the pump may be equipped with at least one flow meter at the pressure side of the pump adapted to measure the fuel flow rate there through. Here, the control unit may be adapted to control the opening degree of the second control valve based on a fuel flow rate detected by the at least one flow meter.

[0013] The control unit may be further adapted to periodically start the pump to recirculate fuel through the first bypass channel and/or the second bypass channel.

[0014] The periodic recirculation of fuel, by starting the fuel pump, will reduce the tendency of the fuel congealing and make it harder for congealing components to adhere to any fuel filter present in the fuel pump unit.

[0015] Another advantage of periodic recirculation of the fuel is that the bacteria growth on such fuel filters, which may occur when using fuels made from biological raw materials like bio-diesel, will be reduced. The adherence of bacteria to surfaces is a process that is greatly enhanced in a stagnant environment, which is only present around the fuel filter when the fuel pump is stopped. The occasional starting of recirculation through

the fuel filter will reduce the possibilities of bacteria adhering to the fuel filter surfaces.

[0016] In one embodiment, the first control valve may be a spring valve, and in one embodiment the second control valve may be a proportional valve. The proportional valve may be controlled by electromagnetism.

[0017] According to a second aspect, these and other objects are achieved, in full or at least in part, by a fuel dispensing unit for refuelling a vehicle, which comprises a fuel pump unit according to the features described above.

[0018] According to a third aspect, these and other objects are achieved, in full or at least in part, by a method for handling a fuel pump unit for a fuel dispensing unit. The fuel pump unit comprises a pump with a suction side and a pressure side, a first bypass channel arranged between the pressure side and the suction side, the first bypass channel comprising a first control valve, and a second bypass channel extending between the pressure side and the suction side, the second bypass channel comprising a second control valve. The method is characterized by the step of controlling an opening degree of the second control valve based on an application level of the fuel dispensing unit.

[0019] The step of controlling the opening degree of the second control valve may comprise setting the fuel flow there through at a rate to ensure that enough back-pressure is developed to barely open the first control valve in the first bypass channel.

[0020] The method may further comprise the step of detecting a total fuel flow rate required at nozzles of the fuel dispensing unit at a present time point to control the opening degree of the second control valve accordingly.

[0021] Effects and features of the second and third aspect of the present invention are largely analogous to those described above in connection with the first aspect of the inventive concept. Embodiments mentioned in relation to the first aspect of the present invention are largely compatible with the further aspects of the invention.

[0022] Other objectives, features and advantages of the present invention will appear from the following detailed disclosure, from the attached claims, as well as from the drawings. It is noted that the invention relates to all possible combinations of features.

[0023] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the [element, device, component, means, step, etc.]" are to be interpreted openly as referring to at least one instance of said element, device, component, means, step, etc., unless explicitly stated otherwise.

[0024] As used herein, the term "comprising" and variations of that term are not intended to exclude other additives, components, integers or steps.

[0025] With the term "application level" it is meant to which extent the fuel dispensing unit is used. That is to say, the term is related to the overall flow rate of the fuel

that is to be delivered from the nozzles of the fuel dispensing unit during use.

Brief description of the drawings

[0026] The above, as well as additional objects, features and advantages of the present invention, will be better understood through the following illustrative and non-limiting detailed description of embodiments of the present invention, with reference to the appended drawings, where the same reference numerals may be used for similar elements, and wherein:

Fig. 1 is a schematic view of an exemplary embodiment of a fuel dispensing unit according to a second aspect of the invention.

Fig. 2 is a cross sectional view of an exemplary embodiment of a fuel pump unit according to a first aspect of the invention for the fuel dispensing unit in Fig. 1.

Fig. 3 is a cross sectional view of another exemplary embodiment of the fuel pump unit according to the first aspect of the invention for the fuel dispensing unit in Fig. 1.

Detailed description of preferred embodiments of the invention

[0027] Fig. 1 illustrates an exemplary fuel dispensing unit 1, having hose storage spaces 2 on each opposing side of the fuel dispensing unit 1, an electrical cabinet 3 containing all the electronics for the fuel dispensing unit 1, a hydraulic cabinet 4 containing fuel dispensing means (not shown), e.g. fuel metering means, valves, vapour recovery system etc., and a column 5 extending vertically between and separating the electrical cabinet 3 and the hydraulic cabinet 4 from the hose storage spaces.

[0028] The fuel dispensing unit 1 is connected to an underground reservoir (not shown) containing fuel. When filling up the tank of a motor vehicle, the fuel is pumped from the underground reservoir by means of a pump (not shown) which is located in the hydraulic cabinet 4, and from there to the column 5 and out to a nozzle 7 via a hose 6.

[0029] The fuel dispensing unit 1 has a nozzle boot 15 for each nozzle 7, which nozzle boot 15 preferably comprises a sensor (not shown) for detecting if the nozzle 7 is present in the nozzle boot 15. Further, the nozzle 7 is equipped with a flow meter (not shown) for detecting the fuel flow rate from the nozzle 7 upon refuelling.

[0030] In Fig. 2, an exemplary embodiment of a fuel pump unit 8 for the fuel dispensing unit 1 is illustrated. The fuel pump unit 8 comprises a pump 9 with a suction side S and a pressure side P, a first bypass channel 10 arranged between the pressure side P and the suction side S of the pump 9, and a second bypass 11 channel extending between the pressure side P and the suction side S. The first bypass channel 10 comprises a first con-

trol valve 12 and the second bypass channel 11 comprises a second control valve 13.

[0031] In this exemplary embodiment, the first control valve 12 is constituted by a spring valve and the second control valve 13 is constituted by a proportional valve which is controlled by means of electromagnetism.

[0032] The capacity of the second bypass channel 11 is greater than the capacity of the first bypass channel 10. The capacity of the first and second bypass channel 10, 11 is preferably measured based on fuel flow rate or pressure drop.

[0033] A main fuel supply pipe 14 extends between the underground reservoir and the suction side S of the pump 9, while the hose 6 extends between the pressure side P of the pump 9 and a fuel nozzle 7. The suction side S provides an underpressure to the main fuel supply pipe 14 and the pressure side S provides an overpressure to the hose 6. The pump 9 is equipped with a flow meter 16 which is adapted to measure the fuel flow rate.

[0034] The fuel pump unit 8 further comprises a control unit 17 which is connected to the pump 9, the first and second control valve 12, 13 and to all flow meters 16 and sensors present in the fuel dispensing unit 1. The control unit 17 is adapted to control the opening degree of the second control valve 13 based on the application level of the fuel dispensing unit 1. In one embodiment, the control unit 17 is adapted to control the opening degree of the second control valve 13 based on a fuel flow rate detected by the flow meter 16 of the pump 9.

[0035] The first and second control valves 12, 13 can be used for constantly adjusting the flow through the first and second bypass channel 10, 11 or for shutting the bypass channels 10, 11 completely if required.

[0036] Fig. 3 illustrates a further exemplary embodiment of the fuel pump unit 8. In this embodiment, two hoses 6 are connected to the pressure side P of the pump 9. The remaining components of the fuel pump unit 8 are the same as disclosed above.

[0037] In the following paragraphs, one exemplary method of handling the later fuel pump unit 8 (illustrated in Fig. 3) for the fuel dispensing unit 1 upon refuelling will be discussed.

[0038] In this specific case, the fuel pump unit 8 is capable of handling refuelling of two different vehicles simultaneously, i.e. the pressure side P of the pump 9 is connected to two fuel hoses 6, one for each side of the fuel dispensing unit 1.

[0039] Independently of the refuelling situation of the fuel dispensing unit 1, the motor (not shown) driving the pump 9 is operated at a fixed speed during use of the fuel dispensing unit 1. Thus, the motor operates at the same speed when one of the nozzles 7 are used for refuelling as when both of the nozzles 7 are in operation simultaneously. With conventional fuel pumps, this provides for a big strain on the one and only bypass channel extending between the pressure side and the suction side of the pump, as well as on the control valve normally present therein.

[0040] With the present invention, when one nozzle 7 is lifted from a nozzle boot 15, the sensor in the nozzle boot 15 will detect that the nozzle 7 has left the same and start the pump motor. At this stage, the desirable fuel flow rate out from the nozzle 7 in operation may be about 30 litres/minute. With a pump capacity of 100 litres/minute, the second control valve 13 of the second bypass channel 11 is simply opened to a degree where 70 litres/minute is circulated through the second bypass channel 11 with the result of a fuel flow rate of 30 litres/minute out from the nozzle 7. Normally, the second control valve 13 of the second bypass channel 11 is adjusted to ensure that enough backpressure is developed to barely open the first control valve 12 of the first bypass channel 10. During the remaining part of the refuelling of the vehicle it will be possible to adjust the fuel flow rate out from the nozzle 7 in use based on information of the flow meter at the nozzle 7.

[0041] When both of the nozzles 7 are in operation simultaneously, the desirable fuel flow rate out from each nozzle 7 in operation might be about 30 litres/minute, i.e. 60 litres/minute in total. With a pump capacity of 100 litres/minute, the second control valve 13 of the second bypass channel 11 is simply adjusted to a degree where 40 litres/minute is circulated through the second bypass channel 11 with the result of a fuel flow rate of 30 litres/minute out from each nozzle 7. Naturally, the fuel flow rate out from the nozzles 7 in use can then be adjusted based on information of the flow meters of the same.

[0042] The second bypass channel 11 could also be used for reducing clogging of fuel filters (not shown) present in the fuel pump unit 8.

[0043] Here, the pump 9 creates an underpressure at the suction side S of the pump 9 that will suck fuel from the underground reservoir (not shown). The fuel filter will prevent particles contained in the fuel from entering the pump and the rest of the fuel dispensing system. Particles in the fuel will adhere to the filter surface. The amount of trapped particles will build up until the filter will have to be cleaned by maintenance of the fuel dispensing unit 1. This process is worsened due to congealing fuel components forming wax on the filter, especially in cold weather, and, in the case of bio fuels, due to bacterial growth on the filter and particles. As presented by this invention, these processes are reduced by introducing a periodical recirculation of fuel from the pressure side S of the pump 9 via the second bypass channel 11 to a point upstream of the fuel filter in the flow direction when the fuel dispensing unit 1 is not in use.

[0044] To this end the fuel pump 9 is periodically started when the fuel dispensing unit 1 is not in use. Since the nozzle 7 is closed in that situation all fuel pumped by the pump 9, will be forced to recirculate at least through the second bypass channel 11. Additional fuel from the underground storage tank will not be added since the volume in the system is kept constant while the nozzle 7 is closed. The fuel in the recirculation process will thus

be pumped in a loop from the outlet of the second bypass channel 11 in the main fuel supply pipe 14, through the fuel filter, through the pump 9 and through the second bypass channel 11. The movement of fuel through the fuel filter will reduce the adherence of congealing fuel components on the filter. The recirculation will also generate heat from friction between the recirculated fuel and the walls in the piping and pump 9.

[0045] The recirculation will also reduce bacterial growth when dispensing bio fuel with the fuel dispensing unit. The growth of bacteria is reduced by the movement of the fuel. The bacterial adherence to the fuel filter will also be reduced by the movement of the recirculated fuel.

[0046] The skilled person realizes that a number of modifications of the embodiments described herein are possible without departing from the scope of the invention, which is defined in the appended claims.

[0047] For instance, the capacity of the first bypass channel 10 and the second bypass channel 11 may also be established by means of their size, for example by means of the lengths and/or the cross-sections of the same.

Claims

1. A fuel pump unit (8) for a fuel dispensing unit (1), comprising
a pump (9) with a suction side (S) and a pressure side (P), and
a first bypass channel (10) arranged between the pressure side (P) and the suction side (S), the first bypass channel (10) comprising a first control valve (12),
characterized in that the fuel pump unit (8) further comprises a second bypass channel (11) extending between the pressure side (P) and the suction side (S), the second bypass channel (11) comprising a second control valve (13).
2. The fuel pump unit (8) according to claim 1, wherein the capacity of the second bypass channel (11) is greater than the capacity of the first bypass channel (10).
3. The fuel pump unit (8) according to claim 2, wherein the capacity of the first and second bypass channel (10, 11) is measured based on fuel flow rate and/or pressure drop.
4. The fuel pump unit (8) according to any one of the preceding claims, wherein the first bypass channel (10) connects the suction side (S) with the pressure side (P) in the pump (9).
5. The fuel pump unit (8) according to any one of the preceding claims, further comprising a control unit (17) adapted to control an opening degree of the

second control valve (13) based on an application level of the fuel dispensing unit (1).

6. The fuel pump unit (8) according to claim 5, wherein the pump (9) is equipped with at least one flow meter (16) at the pressure side (P) of the pump (9) adapted to measure the fuel flow rate there through.
7. The fuel pump unit (8) according to claim 6, wherein the control unit (17) is adapted to control the opening degree of the second control valve (13) based on a fuel flow rate detected by the at least one flow meter (16).
8. The fuel pump unit (8) according to claim 5, wherein the control unit (17) is further adapted to periodically start the pump (9) to recirculate fuel through the first bypass channel (10) and/or the second bypass channel (11).
9. The fuel pump unit (8) according to any one of the preceding claims, wherein the first control valve (12) is a spring valve.
10. The fuel pump unit (8) according to any one of the preceding claims, wherein the second control (13) valve is a proportional valve.
11. The fuel pump unit (8) according to claim 10, wherein the proportional valve is controlled by electromagnetism.
12. A fuel dispensing unit (1) for refuelling a vehicle, comprising a fuel pump unit (8) according to any one of the claims 1-11.
13. A method for handling a fuel pump unit (8) for a fuel dispensing unit (1), the fuel pump unit (8) comprising a pump (9) with a suction side (S) and a pressure side (P),
a first bypass channel (10) arranged between the pressure side (P) and the suction side (S), the first bypass channel (10) comprising a first control valve (12), and
a second bypass channel (11) extending between the pressure side (P) and the suction side (S), the second bypass channel (11) comprising a second control valve (13), and
characterized by the step of controlling an opening degree of the second control valve (13) based on an application level of the fuel dispensing unit (1).
14. The method according to claim 13, wherein the step of controlling the opening degree of the second control valve (13) comprises setting the fuel flow there through at a rate to ensure that enough backpressure is developed to barely open the first control valve (12) in the first bypass channel (10).

15. The method according to claim 14 or 15, further comprising the step of detecting a total fuel flow rate required at nozzles (7) of the fuel dispensing unit (1) at the present time point to control the opening degree of the second control valve (13) accordingly.

Amended claims in accordance with Rule 137(2) EPC.

1. A fuel pump unit (8) for a fuel dispensing unit (1), comprising
a pump (9) with a suction side (S) and a pressure side (P), and
a first bypass channel (10) arranged between the pressure side (P) and the suction side (S), the first bypass channel (10) comprising a first control valve (12),
characterized in that the fuel pump unit (8) further comprises a second bypass channel (11) extending between the pressure side (P) and the suction side (S), the second bypass channel (11) comprising a second control valve (13).
2. The fuel pump unit (8) according to claim 1, wherein the capacity of the second bypass channel (11) is greater than the capacity of the first bypass channel (10).
3. The fuel pump unit (8) according to claim 2, wherein the capacity of the first and second bypass channel (10, 11) is measured based on fuel flow rate and/or pressure drop.
4. The fuel pump unit (8) according to any one of the preceding claims, wherein the first bypass channel (10) connects the suction side (S) with the pressure side (P) in the pump (9).
5. The fuel pump unit (8) according to any one of the preceding claims, further comprising a control unit (17) adapted to control an opening degree of the second control valve (13) based on an application level of the fuel dispensing unit (1).
6. The fuel pump unit (8) according to claim 5, wherein the pump (9) is equipped with at least one flow meter (16) at the pressure side (P) of the pump (9) adapted to measure the fuel flow rate there through.
7. The fuel pump unit (8) according to claim 6, wherein the control unit (17) is adapted to control the opening degree of the second control valve (13) based on a fuel flow rate detected by the at least one flow meter (16).
8. The fuel pump unit (8) according to claim 5, wherein the control unit (17) is further adapted to periodically

start the pump (9) to recirculate fuel through the first bypass channel (10) and/or the second bypass channel (11).

9. The fuel pump unit (8) according to any one of the preceding claims, wherein the first control valve (12) is a spring valve.
10. The fuel pump unit (8) according to any one of the preceding claims, wherein the second control (13) valve is a proportional valve.
11. The fuel pump unit (8) according to claim 10, wherein the proportional valve is controlled by electromagnetism.
12. A fuel dispensing unit (1) for refuelling a vehicle, comprising a fuel pump unit (8) according to any one of the claims 1-11.
13. A method for handling a fuel pump unit (8) for a fuel dispensing unit (1), the fuel pump unit (8) comprising a pump (9) with a suction side (S) and a pressure side (P), and
a first bypass channel (10) arranged between the pressure side (P) and the suction side (S), the first bypass channel (10) comprising a first control valve (12),
characterized by
the step of providing a second bypass channel (11) extending between the pressure side (P) and the suction side (S), the second bypass channel (11) comprising a second control valve (13), and
the step of controlling an opening degree of the second control valve (13) based on an application level of the fuel dispensing unit (1).
14. The method according to claim 13, wherein the step of controlling the opening degree of the second control valve (13) comprises setting the fuel flow there through at a rate to ensure that enough backpressure is developed to barely open the first control valve (12) in the first bypass channel (10).
15. The method according to claim 14 or 15, further comprising the step of detecting a total fuel flow rate required at nozzles (7) of the fuel dispensing unit (1) at the present time point to control the opening degree of the second control valve (13) accordingly.

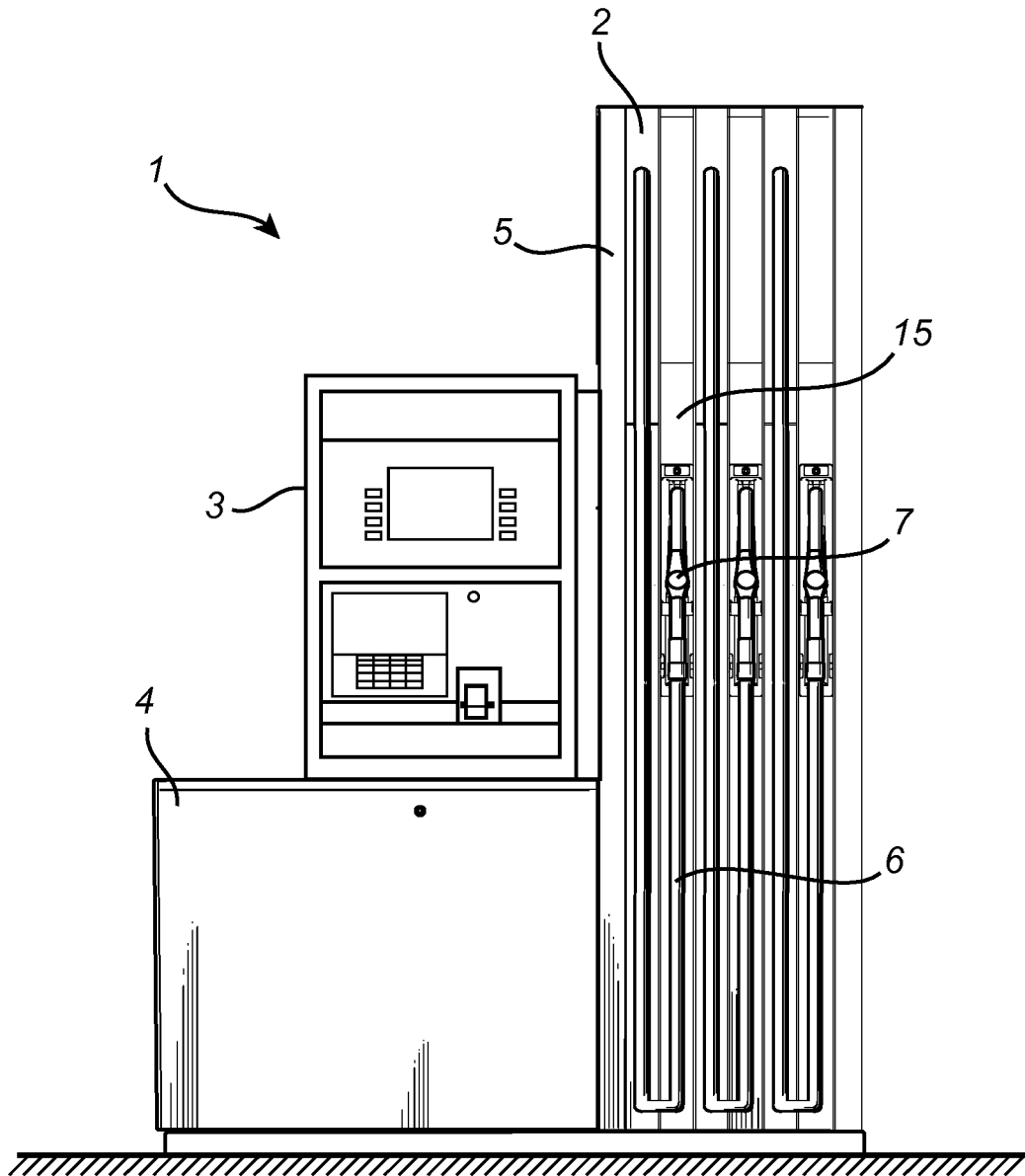


Fig. 1

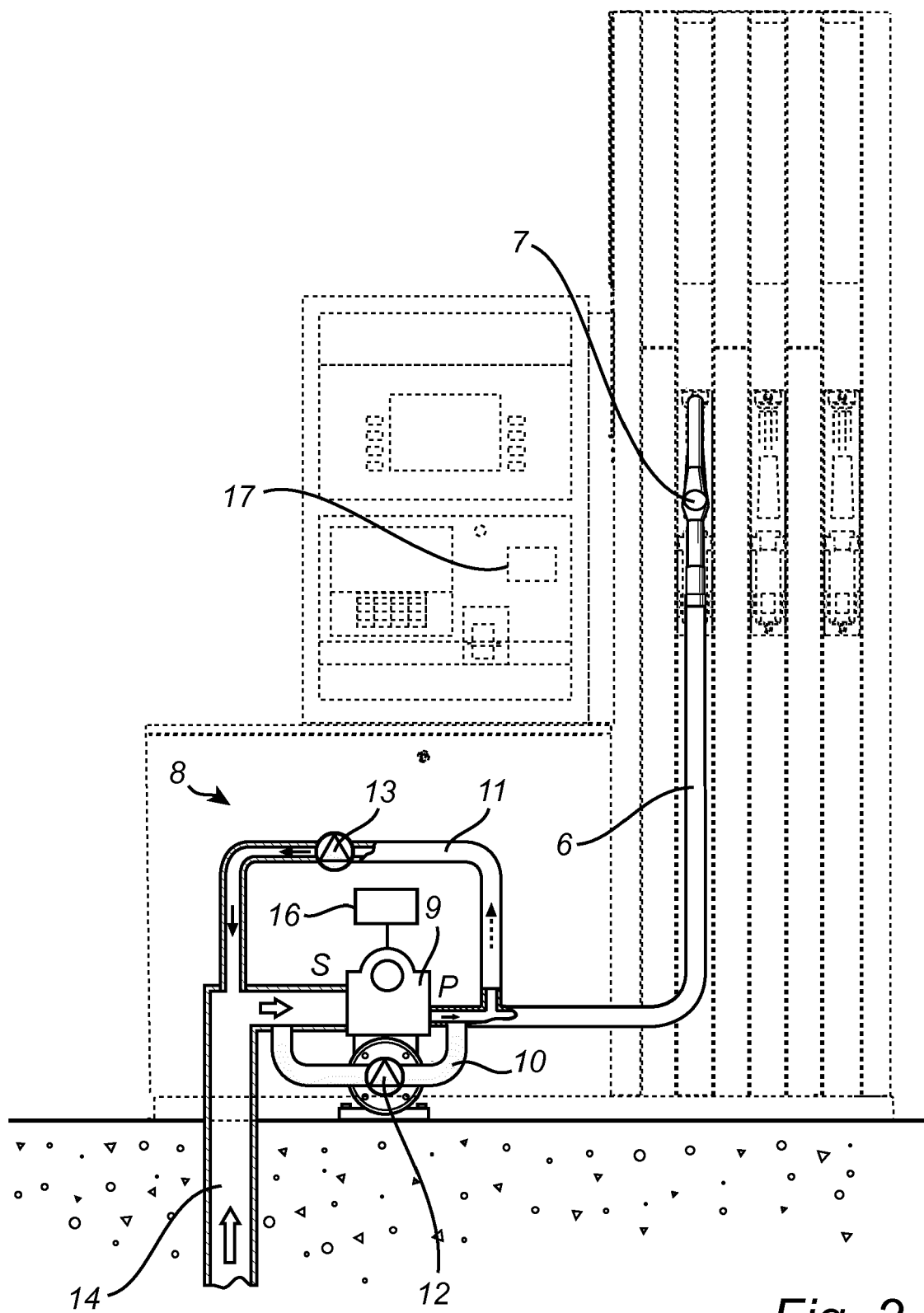


Fig. 2

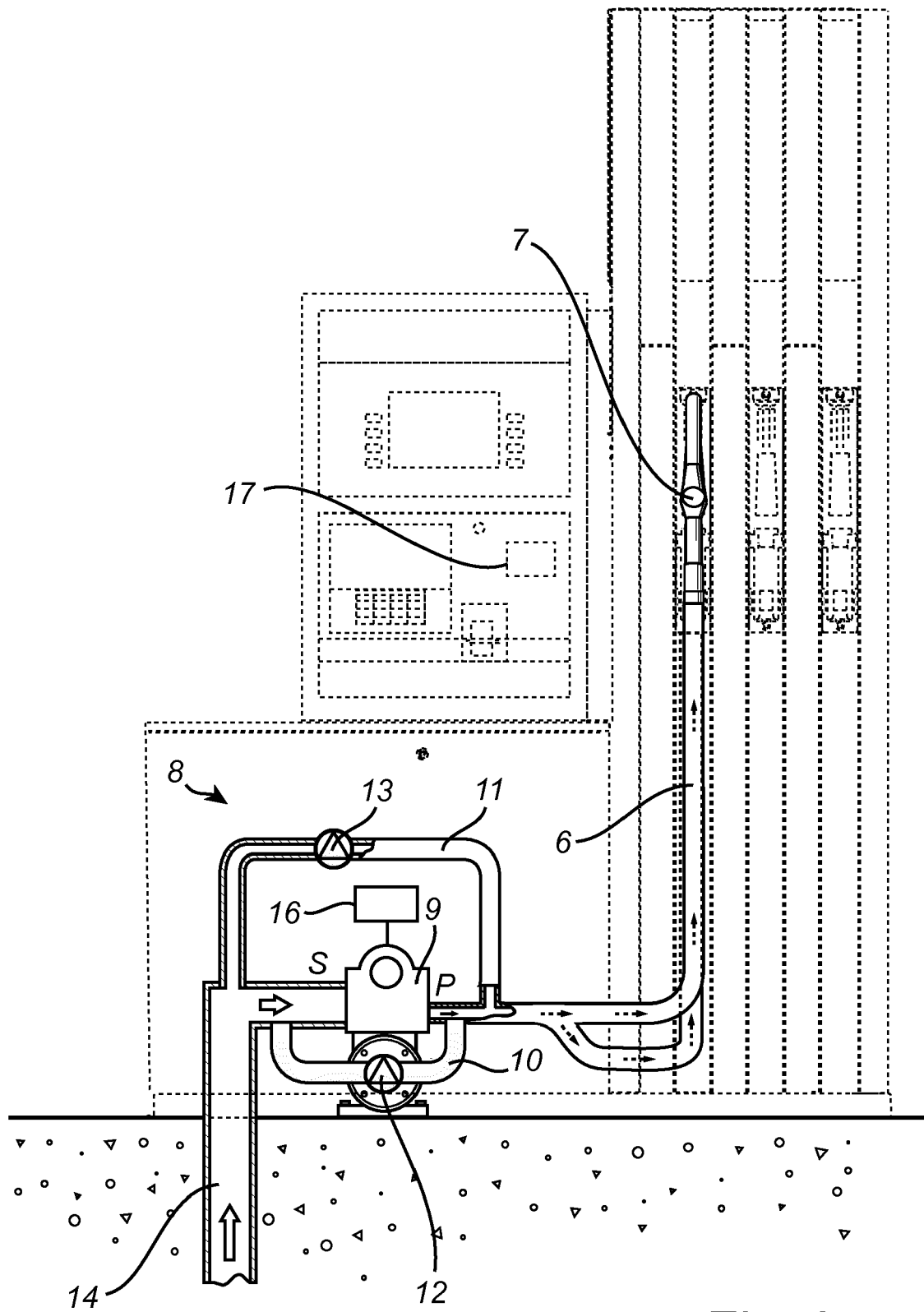


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 8777

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2015/187976 A2 (GILBARCO INC [US]) 10 December 2015 (2015-12-10) * page 27, line 17 - line 21 * * page 26, line 22 - page 27, line 3; figure 24 * -----	1-15	INV. B67D7/04 B67D7/08 B67D7/36
			TECHNICAL FIELDS SEARCHED (IPC)
			B67D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 October 2017	Examiner Schultz, Tom
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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EPO FORM 1503 03/82 (P04C01)

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

EP 17 16 8777

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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17-10-2017

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
	WO 2015187976 A2	10-12-2015	NONE	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82