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(54) **Vapour recovery pump and fuel dispenser**

(57) A vapour recovery pump for a fuel dispensing unit comprises a pump housing (2) with a first chamber (3) and a second chamber (4), each chamber (3, 4) having a vapour inlet valve (5, 7) and a vapour outlet valve (6, 8), respectively. The chambers (3, 4) are separated

by a movable piston (9) arranged to repeatedly decrease and increase the volumes of the chambers (3, 4). A controllable vapour flow passage (10) is connecting the first chamber (3) with the second chamber (4), for transportation of vapour from one of the chambers to the other.

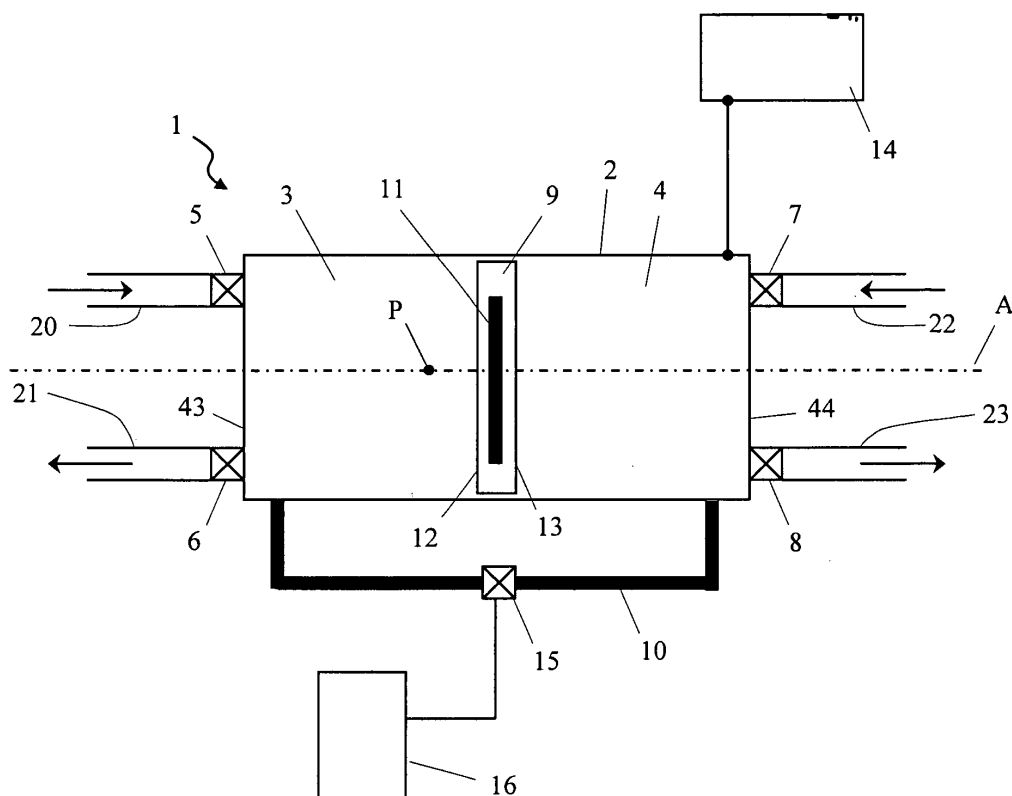


Fig. 1

Description

Technical Field

[0001] The present invention relates to a vapor recovery pump and fuel dispenser for efficiently recovering fuel vapour from a tank of a vehicle.

Background Art

[0002] When filling the fuel tank of a motor vehicle, it is a common measure to recover the vapour escaping the tank when filling it with liquid fuel. This measure is taken for both safety and environmental reasons, since the fuel vapours are flammable and constitute a health hazard. The vapour recovery is achieved, for instance, by arranging a vapour suction nozzle next to the fuel dispensing nozzle of a pistol grip that is used for filling the tank with fuel. Vapour is then removed from the tank during filling, at a certain rate, which is often controlled by the standard rate. Vapour recovery systems typically comprise a pump for removing fuel vapour, from the tank of the vehicle, by suction and feeding it back to the fuel container from which the fuel is fed to the vehicle. This mutual exchange of vapour/fuel is continuously performed when filling a vehicle with fuel.

[0003] US-3,826,291, for example, discloses a filling system for vehicle fuel, which system comprises means for recovering fuel vapour. The system has a fuel pump and a fuel meter with an output shaft which is connected to a fuel vapour pump which draws in vapour from the tank of the vehicle. The connection is by means of gear wheels in such manner that the volume of dispensed fuel corresponds to the volume of drawn-in vapour. Crank driven piston pumps are used, for example, and the motion of the piston is used on one side only, i.e. the piston is single-acting.

[0004] US-5,123,817 discloses another filling system where a double-acting piston pump is used as vapour pump. A common shaft is connected between the piston pump and a fuel pump, which permits a coordinated direct operation of the fuel pump and the vapour pump.

[0005] US-4,223,706 discloses a similar construction of a filling system where a flow of fuel through a hydraulic motor initiates the return flow of vapour through a vapour pump. In this construction, a direct operation, i.e. a common drive shaft, is available between the hydraulic motor and the vapour pump. An overflow valve is arranged between the inlet opening of the vapour pump and the fuel container of the filling system, to equalise pressure changes in the system.

[0006] A problem associated with prior art is relatively high production costs due to complex arrangements. Maintenance is cumbersome and many of the techniques are sensitive to leakage of vapour past the piston. Another problem is that some of the arrangements are rather bulky and takes a lot of space when mounted inside a fuel dispensing unit.

Summary of the invention

[0007] It is an object of the present invention to provide an improvement of the above techniques and prior art, which is achieved by a vapour recovery pump that has a first chamber and a second chamber and a vapour flow passage connecting the first chamber with the second chamber.

[0008] A particular object is to provide a double-acting vapour recovery pump that incorporates means that facilitates efficient control of the double-acting effect.

[0009] Other objects and advantages that will be apparent from the following description of the present invention are achieved by a vapour recovery pump and a fuel dispensing unit according to the respective independent claims. Preferred embodiments are defined in the dependent claims.

[0010] Accordingly, a vapour recovery pump for a fuel dispensing unit is provided, comprising a pump housing with a first chamber and a second chamber, each chamber having a vapour inlet valve and a vapour outlet valve, respectively, the chambers being separated by a movable piston arranged to repeatedly decrease and increase the volumes of the chambers. A controllable vapour flow passage is connecting the first chamber with the second chamber, for transportation of vapour from one of the chambers to the other.

[0011] The inventive vapour recovery pump is advantageous in that both sides of the vapour recovery pump may be used for transporting vapour, which renders the pump more insensitive for vapour leakage past the piston. Another advantage is that the pump rate of the vapour recovery pump may be controlled by the control of the vapour flow passage. By a controllable vapour flow passage is meant that the passage is controllable in respect of how much vapour that may be transported from one of the chambers to the other, i.e. the size of an opening in the vapour flow passage may be varied. Further, the direction of the flow of vapour may be controlled.

[0012] The vapour flow passage may be arranged in the piston, and extend from one of the chambers, through the piston, to the other chamber. Alternatively, the vapour flow passage may be formed by tilting the piston, for allowing passage of vapour from one of the chambers, between the piston and the pump housing, to the other of the chambers. As another alternative, the vapour flow passage may be arranged external of the first chamber and the second chamber. These techniques are advantageous in that they each offer a simple way of providing an opening between the two chambers.

[0013] The piston may comprise a magnetic device, for facilitating convenient control of the piston. Preferably, the magnetic device is either an electromagnet, a permanent magnet or a combination thereof.

[0014] The movable piston may have a first side facing the first chamber and a second side facing the second chamber, and electromagnetic control means may be provided to move the piston by altering a magnetic field,

and the magnetic device may be arranged between the two sides of the piston, which provides a compact design of the vapour recovery pump.

[0015] The two sides of the piston may each pass a common point along the direction of movement of the piston, when the volumes of the chambers are repeatedly decreased and increased, which results in increased pumping efficiency in respect of the total effective chamber size.

[0016] The pump housing may comprise coils fed by a current for moving the piston, which also provides a compact design.

[0017] In one embodiment, the vapour flow passage may be configured to be substantially open when the piston decreases the volume of the first chamber, and be substantially closed when the piston increases the volume of the first chamber, the outlet valve of the second chamber and the inlet valve of the first chamber each being essentially open when the vapour flow passage is substantially closed. This is advantageous in that the pump may be used basically as a single sided pump, without causing excessive pressure build-up in any of the chambers.

[0018] The vapour flow passage may comprise a controllable valve and a control unit for controlling the flow of vapour through the vapour flow passage, and the direction of through-flow of vapour may be selectable for the controllable valve, which further increases the control options of the vapour recovery pump.

[0019] An overflow valve may be connected to both chambers. A third chamber defining a void may be connected, via a controllable valve, to any of the first chamber and the second chamber. Both features are advantageous in that excessive pressure build-up in the chambers is avoided.

[0020] The vapour recovery pump may further comprise a first vapour line connected to the inlet valve of the first chamber, a second vapour line connected to the outlet valve of the first chamber, a third vapour line connected to the inlet valve of the second chamber, a fourth vapour line connected to the outlet valve of the second chamber, and a vapour circulation line comprising a valve and connecting any of the first vapour line with the second vapour line and the third vapour line with the fourth vapour line. This further increases the control options of the pump, since vapour may be circulated within a chamber.

[0021] According to another aspect of the invention, a fuel dispensing unit for refuelling vehicles is provided, comprising a vapour recovery pump incorporating any of the features described above, wherein a vapour suction nozzle is connected to at least one of the two chambers via a vapour flow line, for transporting flammable fuel vapour. The inventive fuel dispensing unit is, inter alia, advantageous in that it has compact vapour recovery pump that offers a flexible regulation of the rate of vapour recovered via the vapour suction nozzle.

[0022] The vapour suction nozzle may be connected to the first chamber via a first vapour flow line, and a

second vapour suction nozzle may be connected to the second chamber via a second vapour flow line, which reduces the amount of components in the fuel dispensing unit.

[0023] The fuel dispensing unit may further comprise a fuel dispensing nozzle arranged at the vapour suction nozzle, a fuel meter configured to measure an amount of fuel dispensed from the fuel dispensing nozzle, and a control device configured to regulate the vapour recovery pump such that the amount of recovered vapour substantially corresponds to the amount of dispensed fuel. Accordingly, this results in quite efficient control of the vapour recovery pump.

[0024] The fuel dispensing unit may further comprise a detector configured to send a signal representative of the hydrocarbon content of the fuel vapour, the control device being configured to receive the signal and to prevent the recovering of vapour, if the hydrocarbon content of the fuel vapour is below a specific level. This is advantageous in that the vapour recovery pump is not operated when a user refuels a vehicle fitted with a system for on-board refuelling vapour recovery.

Brief Description of the Drawings

[0025] Embodiments of the present invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 is a schematic view of a vapour recovery pump according to a first embodiment of the invention, Fig. 2 is a schematic view of the inventive vapour recovery pump comprising magnetic control means, Fig. 3 is a schematic view of a vapour recovery pump according to a second embodiment of the invention, Fig. 4 is a schematic view of a vapour recovery pump according to a third embodiment of the invention, Fig. 5 is a schematic view of the inventive vapour recovery pump comprising various means for reducing pressure in a chamber of the vapour recovery pump, and Fig. 6 is a fuel dispensing unit according the invention.

Detailed Description of Preferred Embodiments of the Invention

[0026] Fig. 1 illustrates a vapour recovery pump 1 that has a pump housing 2 with first chamber 3 that is separated from a second chamber 4 by a piston 9 that is movable along a main axis A of the pump 1. The volume of each chamber 3, 4 depends on the location of the piston 1, but the total volume of the chambers 3, 4 is constant. The first chamber 3 has an inlet valve 5 and an outlet valve 6, and the second chamber 4 has corresponding inlet valve 7 and a corresponding outlet valve 8.

[0027] A first vapour inlet line 20 is connected to the inlet valve 5 of the first chamber 3 and a first vapour outlet

line 21 is connected to the outlet valve 6 of the first chamber 3, while a second vapour inlet line 22 is connected to the inlet valve 7 of the second chamber 4 and a second vapour outlet line 23 is connected to the outlet valve 8 of the second chamber 4.

[0028] The piston 9 has a magnetic device 11 arranged between a first side 12 and a second side 13 of the piston 9. Preferably the magnetic device 11 is a permanent magnet or an electromagnet.

[0029] Electromagnetic control means 14, which will be further described below, during operation of the pump 1 induces an electromagnetic field that repeatedly and alternately attracts the magnetic device 11 towards a first side 43 of the pump 1 and towards a second side 44 of the pump 1, which causes an alternating increase and decrease of the volume of the chambers 3, 4. The piston 9 moves back and forth along the axis A, which means that each side 12, 13 of the piston passes a common point P on the axis.

[0030] A vapour flow passage 10 is connected to the first chamber 3 near the first side 43 and to the second chamber 4 near the second side 44. The vapour flow passage has a valve 15 that is controlled by a control unit 16 in respect of how much vapour that may pass the vapour flow passage 10, and in which direction.

[0031] The control unit 16 may set the valve 15 to be fully open, completely closed, or to an opening degree ranging from fully open to completely closed. The control unit 16 may also set the through flow direction of the valve 15. To achieve this the valve 15 preferably comprises a first non return valve (not shown) that allows passage of vapour only from the first chamber 3 to the second chamber 4, and a second non return valve (not shown) that allows passage of vapour only from the second chamber 4 to the first chamber 3. Each non-return valve may be selectively opened or closed by the control unit 16.

[0032] When the valve 15 is fully closed the pump 1 acts as a conventional double sided pump. However, when the valve 15 permits a flow of vapour from the first chamber 3 to the second chamber 4 via the vapour flow passage 10, and when the piston 9 moves towards the first side 43, then the outlet valve 6 of the first chamber 3 and the inlet valve 7 of the second chamber 4 remain closed during operation (since pressure levels necessary to open these valves 6, 7 are not reached). When the piston thereafter moves 9 to the second side 44, the inlet valve 5 of the first chamber 3 is opened for letting in vapour into the first chamber 3, while the outlet valve 8 of the second chamber 4 is opened for letting out vapour from the second chamber 4.

[0033] When the valve 15 permits a flow of vapour from the second chamber 4 to the first chamber 3 via the vapour flow passage 10, and when the piston 9 moves towards the second side 44, then the outlet valve 8 of the second chamber 4 and the inlet valve 5 of the first chamber 3 remains closed during operation (since pressure levels necessary to open these valves 5, 8 are not reached). When the piston 9 thereafter moves to the first

side 43, then the inlet valve 7 of the second chamber 4 is opened for letting in vapour into the second chamber 4, while the outlet valve 6 of the first chamber 3 is opened for letting out vapour from the first chamber 3.

[0034] Hence it is possible to select which side of the pump that shall draw vapour from a vapour source.

[0035] The pump 1 may also be used while keeping the vapour flow passage 10 closed. In this case the mode of operation is as follows.

[0036] When the volume of the first chamber 3 is increased the volume of the second chamber 4 is decreased. This causes a relatively lower pressure level in the first chamber 3, which causes its inlet valve 5 to open for letting in vapour, while a relatively higher pressure level is caused in the second chamber 4, which causes its outlet valve 8 to open for letting out vapour. Correspondingly, when the volume of the first chamber 3 is decreased, the volume of the second chamber 4 is increased, a relatively lower pressure level is caused in the second chamber 4, which causes its inlet valve 7 to open for letting in vapour, and a relatively higher pressure level is caused in the first chamber 3, which causes its outlet valve 6 to open for letting out vapour.

[0037] The described operation mode may e.g. be used when two fuel dispensing pistols with vapour recovery nozzles are operated at the same time as is described in connection with Fig. 6 below.

[0038] With reference to Fig. 2, the electromagnetic control means 14 has a plurality of coils 37 arranged around the pump housing 2. Preferably the coils 37 are integrated in the pump housing 2. During operation of the pump 1, electrical currents are fed through the coils 37 which generate a magnetic field that attracts the piston 9, or more specifically, attracts the magnetic device 11 in the piston 9. By feeding electrical currents through coils near the first side 43 of the pump 1, the piston 9 is moved towards the first side 43. When the piston 9 is near the first side 43, electrical currents are fed through coils near the second side 44 of the pump 1, which causes the piston to move towards the second side 44. By repeatedly and rapidly altering current levels in the coils 37, the piston is moved back and forth.

[0039] With further reference to Fig. 3, in a second embodiment of the pump 1, the flow passage and the valve 15 is incorporated in the piston 9. The control options (open, closed, direction of through flow) of the valves in this embodiment are identical to the valves of the previous embodiment. However, the valve 15 preferably comprises opening and closing members, which define the control options which in turn are susceptible to a magnetic attraction force. The control of the opening and closing members is performed by a magnetic field generated in a suitable manner by the electromagnetic control means 14.

[0040] With further reference to Fig. 4, in a third embodiment of the pump 1, the piston 9 is tiltable such that a flow passage, or gap, is formed between the housing 2 and the piston 9, which allows vapour to pass directly

from one chamber to the other. The functional effect of the tilting corresponds to the functional effect of the previously discussed valve 15. When the piston is to permit passage of vapour from one chamber to the other, it is tilted, otherwise it is not. This means that the piston 9 is tilted when it is moved in one direction, and untilted when it is moved in the other direction. The tilting is preferably achieved by arranging two magnetic devices 11a and 11b at opposite sides of the piston, and by applying, by the electromagnetic control means 14, suitable asymmetrical magnetic attraction forces to these magnetic devices 11a, 11b.

[0041] With further reference to Fig. 5, an overflow valve 17 is connected, via a vapour flow line, to both the first chamber 3 and the second chamber 4. If the pressure in one of the chambers 3, 4 for some reason exceeds an undesirable level, the overflow valve 17 opens for preventing the pump 1 from being damaged by excessive pressure levels.

[0042] In one embodiment, the first chamber 3 is connected to a third chamber 18 via a controllable valve 19a, and the second chamber 4 is connected to the third chamber 18 via another controllable valve 19b. To reduce the relative level of pressure in any of the first 3 or second 4 chambers, corresponding valves 19a 19b are opened.

[0043] To allow regulation of vapour in the first chamber 3, a first vapour recirculation line 24 comprising a controllable valve 30a is connected to the first vapour inlet line 20 and to the first vapour outlet line 21. In a corresponding manner a second vapour recirculation line 25 comprising a controllable valve 30a is connecting the second vapour inlet line 22 with the second vapour outlet line 23.

[0044] The valves 19a, 19b, 30a and 30b are, for example, connected to and controlled by the control unit 16.

[0045] With reference to Fig. 6, a fuel dispensing unit 36 incorporates a vapour recovery pump 1 according to the description above. The fuel dispensing unit 36 has a conventional first fuel dispensing pistol 40 with a fuel dispensing nozzle 27 and a vapour recovery nozzle 26. The fuel dispensing nozzle 27 is, via a first fuel line 31 that has a fuel meter 32, in fluid communication with an underground fuel storage tank 42.

[0046] The fuel dispensing unit 36 has also a second fuel dispensing pistol 41 with a fuel dispensing nozzle (not shown) and a vapour recovery nozzle 28. The fuel dispensing nozzle is, via a second fuel line (not shown) that has a fuel meter (not shown), in fluid communication with an underground fuel storage tank 42.

[0047] The vapour recovery nozzle 26 of the first pistol 40 is, via a first vapour recovery line 33, connected to the inlet valve of the first chamber of the pump 1. The vapour recovery line 33 has detector 39a that detects the level of hydrocarbon in the first recovery vapour line 33. The vapour recovery nozzle 28 of the second pistol 41 is, via a second vapour recovery line 34, connected to the inlet valve of the second chamber of the pump 1. The vapour recovery line 33 has also a hydrocarbon-detector

39b for detecting the level of hydrocarbon in the second recovery vapour line 34.

[0048] The outlet valves of both chambers of the vapour recovery pump are connected to the fuel storage tank 42 via suitable vapour flow lines.

[0049] A control device 38 is connected to the fuel meters, to the hydrocarbon-detectors and to the vapour recovery pump control unit 16. Optionally, the vapour recovery pump control unit 16 is integrated in the control device 38.

[0050] When filling a vehicle by means of the first pistol 40, the rate of dispensed fuel is measured by the fuel meter 32. The control device monitors the rate of dispensed fuel and sends a signal to the vapour recovery pump 1 setting the vapour recovering rate, or pumping rate, to be equal to the fuel dispensing rate. If the detector 39a detects a predetermined, low level of hydrocarbon content, the vapour recovery pump is stopped. When filling a vehicle by means of the second pistol 41, a corresponding operation is performed.

[0051] When only one of the pistols 40, 41 is used for dispensing fuel, the described vapour flow passage between the two chambers of the vapour recovery pump 1 is open, such that vapour is drawn into the chamber that has its inlet valve connected to the vapour recovery line that belongs to the pistol that is used. When both pistols 40, 41 are used at the same time, the flow passage between the two chambers is closed.

Claims

1. A vapour recovery pump for a fuel dispensing unit, comprising a pump housing (2) with a first chamber (3) and a second chamber (4), each chamber (3, 4) having a vapour inlet valve (5, 7) and a vapour outlet valve (6, 8), respectively, the chambers (3, 4) being separated by a movable piston (9) arranged to repeatedly decrease and increase the volumes of the chambers (3, 4),
characterised by a controllable vapour flow passage (10) connecting the first chamber (3) with the second chamber (4), for transportation of vapour from one of the chambers to the other.
2. A vapour recovery pump according to claim 1, wherein the vapour flow passage (10) is arranged in the piston (9), and extends from one of the chambers, through the piston (9), to the other one of the chambers.
3. A vapour recovery pump according to claim 1, wherein the vapour flow passage (10) is formed by tilting the piston (9), for allowing passage of vapour from one of the chambers, between the piston (9) and the pump housing (2), to the other one of the chambers.

4. A vapour recovery pump according to claim 1, wherein the vapour flow passage (10) is arranged external of the first chamber (3) and the second chamber (4).
5. A vapour recovery pump according to any one of claims 1-4, wherein the piston (9) comprises a magnetic device (11).
6. A vapour recovery pump according to claim 5, wherein the movable piston (9) has a first side (12) facing the first chamber (3) and a second side (13) facing the second chamber (4), electromagnetic control means (14) being provided to move the piston (9) by altering a magnetic field.
7. A vapour recovery pump according to claim 6, wherein the magnetic device (11) is arranged between the two sides (12, 13) of the piston (9).
8. A vapour recovery pump according to claim 6 or 7, wherein the two sides (12, 13) of the piston (9) each passes a common point (P) along the direction of movement of the piston (9), when the volumes of the chambers (3, 4) are repeatedly decreased and increased.
9. A vapour recovery pump according to any one of claims 1-8, wherein the pump housing (2) comprises coils (37) fed by a current for moving the piston (9).
10. A vapour recovery pump according to any one of claims 1-9, wherein the vapour flow passage (10) is configured to
be substantially open when the piston (9) decreases the volume of the first chamber (3), and
be substantially closed when the piston (9) increases the volume of the first chamber (3),
the outlet valve (8) of the second chamber (4) and the inlet valve (5) of the first chamber (3) each being essentially open when the vapour flow passage (10) is substantially closed.
11. A vapour recovery pump according to any one of claims 1-10, wherein the vapour flow passage (10) comprises a controllable valve (15).
12. A vapour recovery pump according to claim 11, wherein the direction of through-flow of vapour is selectable for the controllable valve (15).
13. A vapour recovery pump according to any one of claims 1-12, further comprising a control unit (16) for controlling the flow of vapour through the vapour flow passage (10).
14. A vapour recovery pump according to any one of claims 1-13, wherein an overflow valve (17) is connected to both chambers (3, 4).
15. A vapour recovery pump according to any one of claims 1-14, wherein a third chamber (18) defining a void is connected, via a controllable valve (19a; 19b), to any of the first chamber (3) and the second chamber (4).
16. A vapour recovery pump according to any one of claims 1-15, further comprising
a first vapour line (20) connected to the inlet valve (5) of the first chamber (3),
a second vapour line (21) connected to the outlet valve (6) of the first chamber (3),
a third vapour line (22) connected to the inlet valve (7) of the second chamber (4),
a fourth vapour line (23) connected to the outlet valve (8) of the second chamber (4), and
a vapour circulation line (24, 25) comprising a valve (30a, 30b) and connecting any of the first vapour line (20) with the second vapour line (21) and the third vapour line (22) with the fourth vapour line (23).
17. A fuel dispensing unit for refuelling vehicles, comprising a vapour recovery pump (1) according to any one of claims 1-16, wherein a vapour suction nozzle (26) is connected to at least one of the two chambers (3; 4) via a vapour flow line (33), for transporting fuel vapour.
18. A fuel dispensing unit according to claim 17, wherein said vapour suction nozzle (26) is connected to the first chamber (3) via a first vapour flow line (33), and a second vapour suction nozzle (28) is connected to the second chamber (4) via a second vapour flow line (34).
19. A fuel dispensing unit according to claim 17 or 18, further comprising a fuel dispensing nozzle (27) arranged at the vapour suction nozzle (26), a fuel meter (32) configured to measure an amount of fuel dispensed from the fuel dispensing nozzle (27), and a control device (38) configured to regulate the vapour recovery pump (1) such that the amount of recovered vapour substantially corresponds to the amount of dispensed fuel.
20. A fuel dispensing unit according to claim 19, further comprising a detector (39a) configured to send a signal representative of the hydrocarbon content of the fuel vapour, the control device (38) being configured to receive the signal and to prevent the recovering of vapour, if the hydrocarbon content of the fuel vapour is below a specific level.

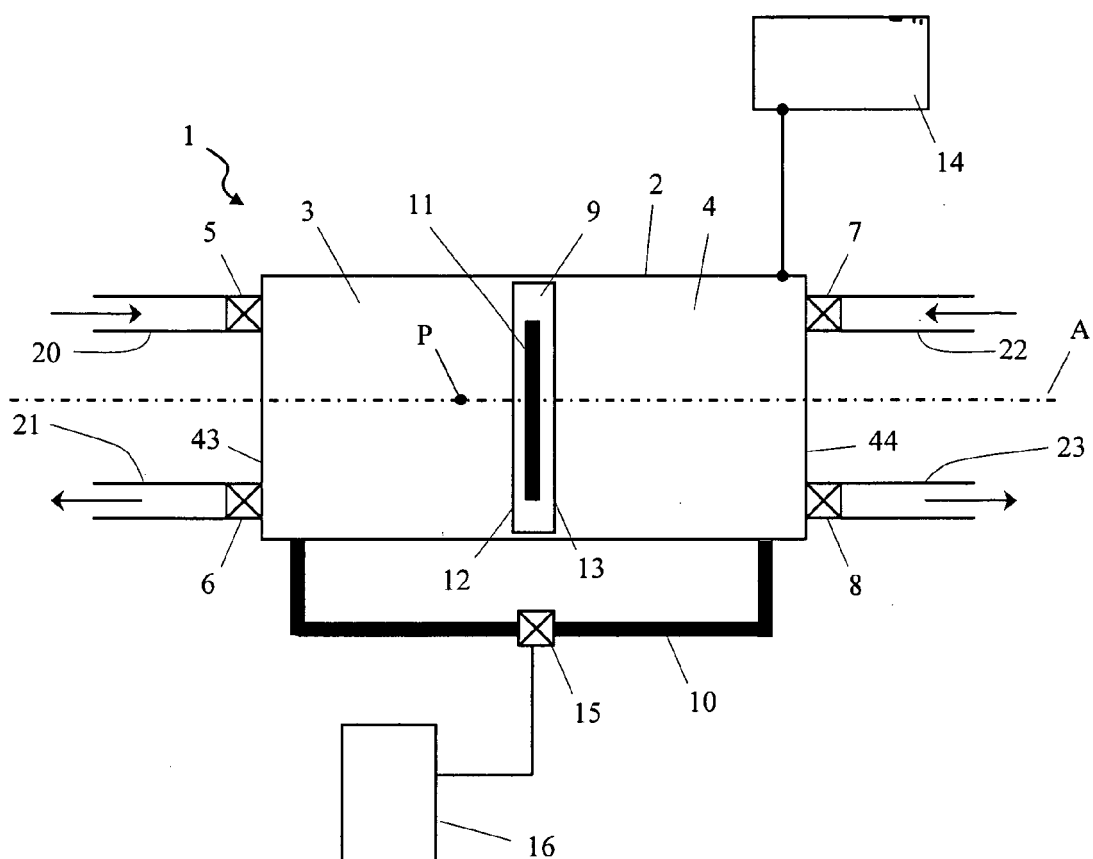


Fig. 1

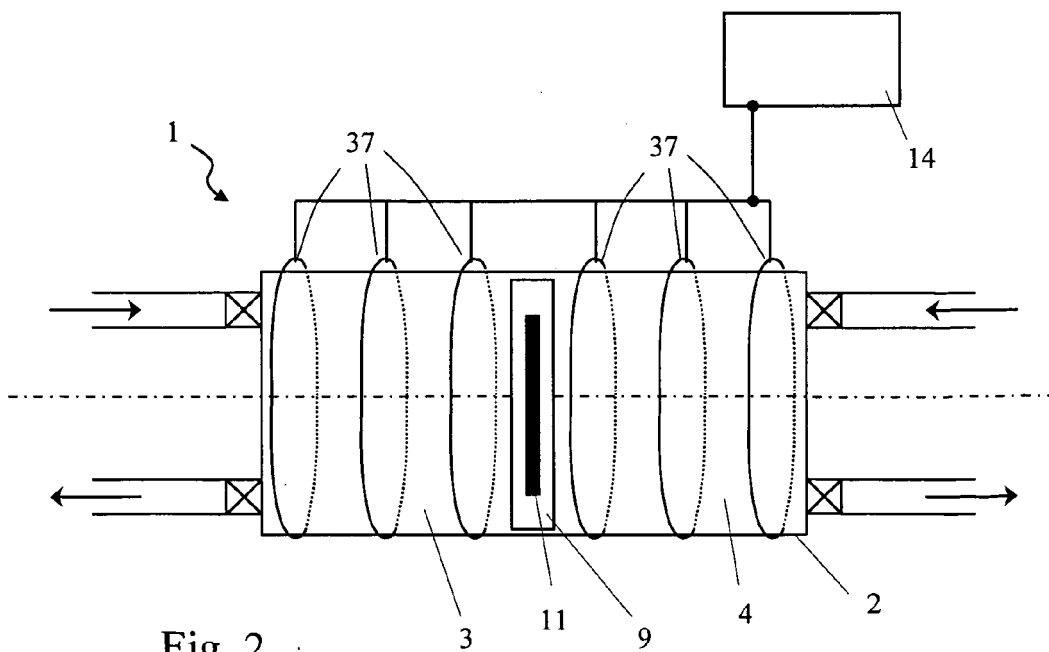


Fig. 2

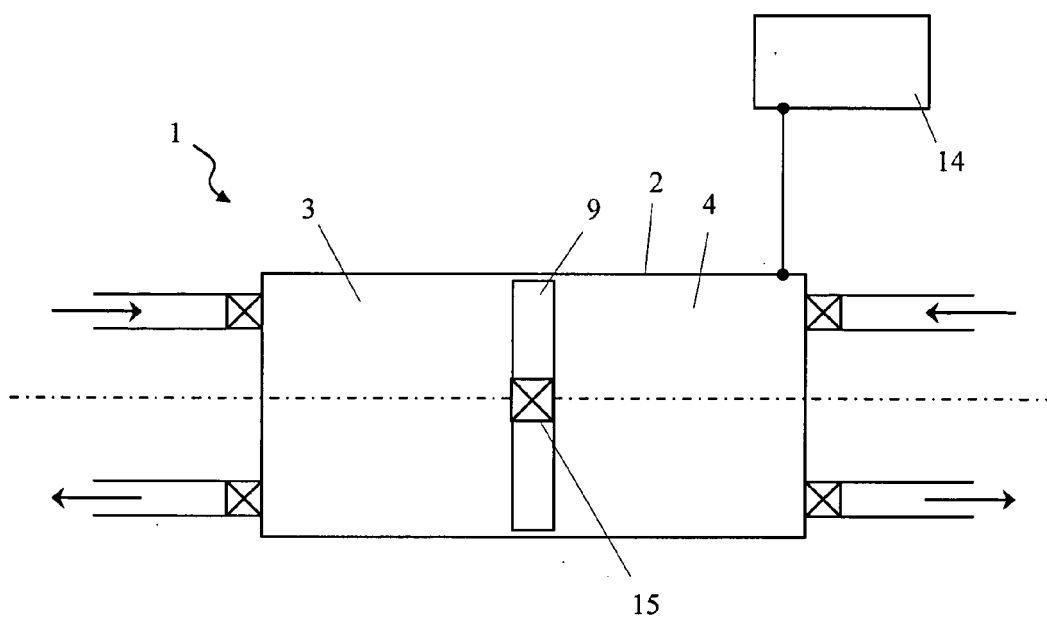


Fig. 3

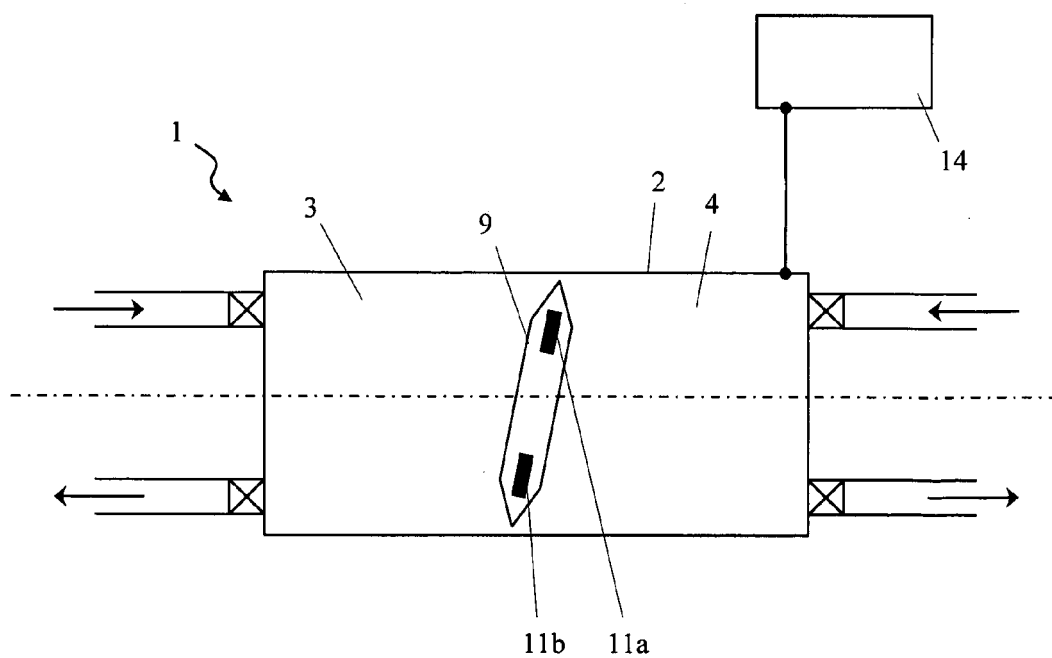


Fig. 4

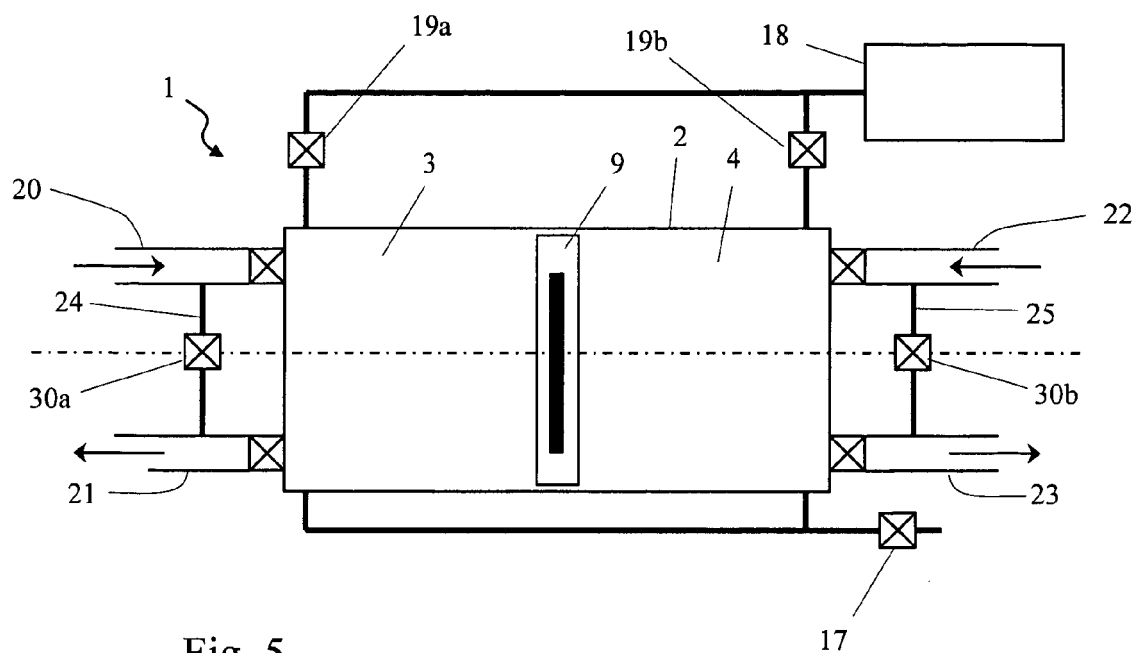


Fig. 5

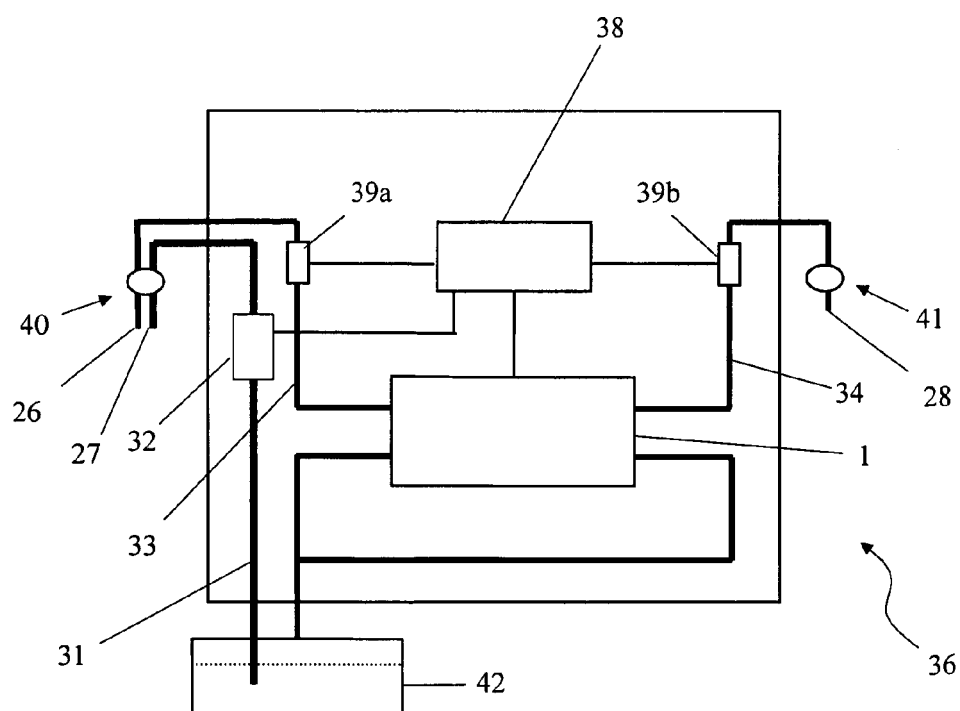


Fig. 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 02 6313

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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 15 June 2007	Examiner Richmond, Robin
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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Application Number
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Place of search Munich		Date of completion of the search 15 June 2007	Examiner Richmond, Robin
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