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(71) Applicant: **Delphi Technologies, Inc.**
Troy, Michigan 48007 (US)

(72) Inventors:
• **Marx, Patrice**
54650 Saulnes (FR)
• **Millard, Yannick**
6840 Hamipre (BE)
• **Sanchez, Michel**
54260 Allondrelle La Malmaison (FR)

(74) Representative: **Waller, Stephen**
Murgitroyd & Company
Scotland House
165-169 Scotland Street
Glasgow G5 8PL (GB)

(54) **Fuel delivery module**

(57) A fuel delivery module 1 comprising a fuel tight housing having a fuel inlet 14 for communication with a volume of fuel stored in a fuel tank, at least one fuel outlet 16 for communication with a fuel system of a vehicle and a vent/return outlet 18 for returning excess fuel and/or fuel vapour and air to the fuel tank, a fuel pump 30 being located within the housing, said fuel pump preferably comprising an electric motor and a regenerative turbine pump assembly comprising an impellor drivingly connected to the motor for pumping fuel from the fuel inlet to said fuel outlet, at least one vapour vent port being provided for removing fuel vapour and air from the region of the impellor, wherein the housing defines a low pressure inlet region on the inlet side of the pump and a high pressure outlet region on the outlet side of the pump, the fuel inlet communicating with the low pressure inlet region and the at least one fuel outlet communicating with the high pressure outlet region, a vent passage being provided between said at least one vapour vent port and the vent/return outlet, whereby said fluid, vapour and air can pass from said vapour vent port to the vent/return outlet.

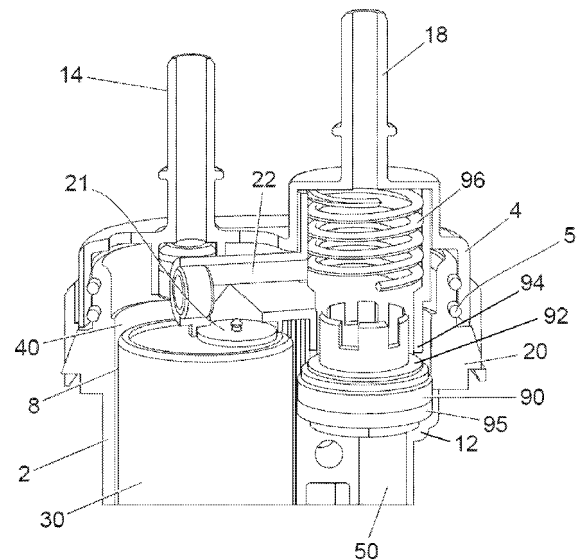


Fig. 2

Description

[0001] Typically fuel is delivered from a fuel tank of a vehicle to the fuel system of an engine by means of a fuel pump. The fuel delivery circuit also typically includes a fuel filter downstream of the fuel pump and a fuel pressure regulator to regulate the fuel pressure downstream of the pump. Smaller vehicles, such as motorcycles, scooters and snow mobiles, and small watercraft, such as jet skis, have often relied on more simple fuel delivery systems, typically using gravity to deliver fuel from a fuel tank to the fuel system, e.g. one or more carburettors, of the engine. Fuel injection systems are commonly replacing carburettors in such small vehicle applications, requiring higher fuel pressure than can be provided by a simple gravity feed. Furthermore, packaging constraints and alternative placements of the fuel tank may not provide sufficient gravity head between the fuel tank and the fuel system of the engine to permit the use of such gravity feed method of fuel delivery.

[0002] Generally in larger vehicles, such as cars or trucks, a fuel pump is provided within the fuel tank and the size, weight and packaging of the fuel delivery system is not particularly constrained due to the overall volume of the fuel tank and the size of the vehicle. Such fuel pumps generally comprise regenerative turbine type pumps which operate effectively when submerged in fuel. However, in smaller vehicle applications, the small volume of the fuel tank and difficulties in providing access to the interior of the tank can make the location of the fuel pump within the tank disadvantageous because it causes a significant reduction in the overall fuel capacity of the fuel tank and results in difficult assembly and maintenance procedures. Furthermore, strict packaging and weight constraints place limitations on the design, size and weight of inline fuel delivery components for use in such applications, rendering systems typically used for larger vehicles, such as cars, unsuitable. Also, due to the lower cost of such small vehicles, the cost of manufacturing and assembly of the fuel delivery system becomes more critical.

[0003] Therefore it is desirable to provide a fuel pump that can be located outside of the fuel tank, in-line with a fuel pipe leading from the fuel tank to the fuel system of the engine. If regenerative turbine type pumps are used in an in-line arrangement rather than within the fuel tank, it is necessary to ensure that the inlet side of the pump can be readily primed with liquid fuel as turbine type pumps are very poor at self priming. This can be achieved where it can be ensured that the fuel pump inlet is always sufficiently below the lowest point of the fuel tank to ensure sufficient gravity feed of fuel to the inlet region of the fuel pump. However, packaging constraints may not always make this possible. Furthermore, when parked on a sloping surface or on a side stand, especially when the fuel level in the fuel tank is low, sufficient gravity head to prime the pump may not be available.

[0004] Attempts have been made to use gerotor type

positive displacement pumps which have the ability to self prime. However, such pumps generate excessive pressure pulsations at their outlet and thus have not proven successful.

[0005] According to the present invention there is provided a fuel delivery module comprising a fuel tight housing having a fuel inlet for communication with a volume of fuel stored in a fuel tank, at least one fuel outlet for communication with a fuel system of a vehicle and a vent/return outlet for returning excess fuel and/or fuel vapour and air to the fuel tank, a fuel pump being located within the housing, said fuel pump preferably comprising an electric motor and a regenerative turbine pump assembly comprising an impellor drivingly connected to the motor for pumping fuel from the fuel inlet to said fuel outlet, at least one vapour vent port being provided for removing fuel vapour and air from the region of the impellor, wherein the housing defines a low pressure inlet region on the inlet side of the pump and a high pressure outlet region on the outlet side of the pump, the fuel inlet communicating with the low pressure inlet region and the at least one fuel outlet communicating with the high pressure outlet region, a vent passage being provided between said at least one vapour vent port and the vent/return outlet, whereby said fluid, vapour and air can pass from said vapour vent port to the vent/return outlet.

[0006] To ensure rapid priming of the pump, a further flow passage is provided between the fuel inlet and the vent/return outlet, valve means being provided for selectively closing or restricting said further flow passage after priming of the pump.

[0007] In one embodiment the valve means comprises a piston slidably mounted within a valve chamber, said piston dividing said valve chamber into a low pressure side communicating with said vent/return outlet and a high pressure side communicating with said high pressure outlet region of the housing, the piston being moveable between a first position, wherein the piston engages a valve seat to close communication between the further flow passage and the valve chamber, and a second position, wherein the piston is spaced from a valve seat whereby said further flow passage communicates with said vent/return outlet, biasing means being provided for biasing the piston towards its second position, whereby, when the pump is operational, high pressure fuel on the high pressure side of the valve passage pushes the piston to its first position against the action of the biasing means to close the further flow passage.

[0008] In a preferred embodiment the valve means incorporates a fuel pressure regulator for enabling excess fuel pressure in the high pressure outlet region to be relieved via the vent/return outlet.

[0009] Preferably a check valve is provided in said fuel inlet to prevent fuel from draining out of the low pressure inlet region via said flow inlet.

[0010] An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a perspective view of a fuel delivery module according to one embodiment of the present invention;

Fig. 2 is a sectional view of the module of Fig. 1 along line A-A; and

Fig. 3 is a perspective part sectional view of the module of Fig. 1.

[0011] Figs 1 to 3 illustrate a fuel delivery module 1 for supplying fuel from a fuel tank of a small vehicle, such as a motorcycle, scooter, small watercraft or snow mobile, to an engine of the vehicle.

[0012] The fuel delivery module 1 comprises a housing comprising a hollow body 2 having first and second ends caps 4,6 releasably secured to respective ends of the body 2 to form a closed, fuel tight assembly. The housing defines a first chamber 8 adapted to receive a fuel pump 30, a second chamber 10 adapted to receive a fuel filter (not shown) and a third chamber 12 adapted to receive a fuel pressure regulator 90. The housing is preferably formed from a plastic material.

[0013] A fuel inlet 14 is provided on the first end cap 4 of the housing communicating with the first chamber for supplying low pressure fuel from a vehicle fuel tank to the fuel pump 30. A fuel outlet 16 is provided on the second end cap 6 communicating with the second chamber downstream of the fuel filter 60 for supplying high pressure fuel to the fuel system of a vehicle engine. A drain/vent outlet 18 is provided on the first end cap 4, spaced from the fuel inlet 14 and communicating with the third chamber 12 downstream of the fuel pressure regulator 90 for returning excess fuel to the fuel tank and for removing vapour/air the fuel delivery module 1 as will be described below.

[0014] Cooperating releasable fastening means 20 are provided on the end caps 4,6 and the housing body 2 to releasably secure the end caps 4,6 to the body 2 of the housing. As can be seen from Fig. 2, O-ring seals 5 are provided between the housing body 2 and the end caps 4,6 to prevent fuel leakage.

[0015] The first chamber 8 of the housing is adapted to receive the fuel pump 30. The fuel pump 30 comprises a regenerative turbine pump assembly having first and second pump casing halves defining a pumping chamber therebetween, the pumping chamber containing an impeller rotatably mounted therein. The impeller is mounted on an output shaft of the rotor of an electric motor assembly to be rotatably driven thereby to pump fuel from a low pressure inlet region 40 of the first chamber 8 adjacent the fuel inlet 14 to a high pressure outlet region 50 downstream of the pump assembly. At least one vapour vent port is provided in the pumping chamber radially inwardly of pump inlet and outlet ports for removing any fuel vapour or air from the pumping chamber. Such vapour vent port communicates with a vent outlet 21 leading to a vent passage 22 communicating with the drain/

vent outlet 18.

[0016] A major drawback of known regenerative turbine fuel pumps is a poor ability to generate a vacuum at the pump inlet when the pump inlet is not filled with liquid.

[0017] If the low pressure inlet region 40 of the housing is allowed to drain (for example if the vehicle runs out of fuel), the air captured therein has to be evacuated before the pump can operate correctly. In known pumps this can only be achieved through the small diameter vapour vent port (typically 0.5mm to 0.8mm diameter). A liquid seal can be created in such port, requiring a high liquid head (typically 10 to 15cm) to displace the liquid seal and allow venting of the low pressure region 40.

[0018] To mitigate this problem, a direct flow communication is provided between fuel inlet 14 and the drain/vent outlet 18 to enable rapid evacuation of air and fuel vapour from the low pressure inlet region 40 during priming of the pump.

[0019] In order to close such direct communication between the fuel inlet 14 and the drain/vent outlet during normal operation of the pump, the fuel pressure regulator is formed within a piston 90 slidably mounted within said third chamber 12, said piston dividing said third chamber into a low pressure side communicating with said vent/return outlet 18 and a high pressure side communicating with said high pressure outlet region 50 of the housing 2, the piston being moveable between a first position (as shown in the drawings), wherein an O-ring seal 92 provided on the piston engages an annular valve seat 94 to close communication between the fuel inlet 14 and the vent/return outlet 18, and a second position wherein the piston O-ring seal 92 is spaced from the valve seat 94 to allow direct communication between the fuel inlet 14 and the drain/vent outlet 18. A seal 95, such as a lip seal, x-seal or low friction O-ring, is provided around the circumference of the piston 90 for sealing against the inner walls of the third chamber 12

[0020] A compression spring 96 is located above the piston 90 to urge the piston away from the valve seat 94 towards its first position.

[0021] When the pump is operational, high pressure fuel (typically 250-350 kPa) on the high pressure side 50 of the valve passage moves the piston 90 into engagement with the valve seat 94 to close communication between the fuel inlet 14 and the vent/return outlet 18.

[0022] When the pump is switched off, the spring 96 pushes the piston 90 away from the valve seat 94 so that any air and fuel vapour within the low pressure inlet region 40 can pass straight to the vent/return outlet 18. Thus the low pressure region 40 can be purged even where the fuel tank level is low or the fuel tank is barely above the fuel pump. With the fuel delivery module of the present invention, the pump can be successfully primed with a liquid head as little as 20 mm.

[0023] While the fuel pressure regulator can usefully be integrated with the piston 90 to reduce packaging requirements and reduce the total number of components,

it is envisaged that the piston 90 may not contain the fuel pressure regulator, which may be a separate component or may be omitted from the fuel delivery module all together.

[0024] As illustrated in Fig. 3, in order to retain a volume of fuel in the low pressure inlet region 40, even if the vehicle is parked on a hill or tips over, a check valve 100, such as an umbrella valve, is located between the fuel inlet 14 and the low pressure inlet region 40 to prevent fuel from draining out of the low pressure region 40 via the fuel inlet.

[0025] Various modifications and variations to the described embodiment of the invention will be apparent to those skilled in the art without departing from the scope of the invention as defined in the appended claims. Although the invention has been described in connection with a specific preferred embodiment, it should be understood that the invention as claimed should not be unduly limited to such specific embodiment.

Claims

1. A fuel delivery module comprising a fuel tight housing having a fuel inlet for communication with a volume of fuel stored in a fuel tank, at least one fuel outlet for communication with a fuel system of a vehicle and a vent/return outlet for returning excess fuel and/or fuel vapour and air to the fuel tank, a fuel pump being located within the housing, at least one vapour vent port being provided for removing fuel vapour and air from the region of an impellor of the fuel pump, wherein the housing defines a low pressure inlet region on the inlet side of the pump and a high pressure outlet region on the outlet side of the pump, the fuel inlet communicating with the low pressure inlet region and the at least one fuel outlet communicating with the high pressure outlet region, a vent passage being provided between said at least one vapour vent port and the vent/return outlet, whereby said fluid, vapour and air can pass from said vapour vent port to the vent/return outlet.
2. A fuel delivery module as claimed In claim 1, further comprising a further flow passage between the fuel inlet and the vent/return outlet, valve means being provided for selectively closing or restricting said further flow passage after priming of the pump.
3. A fuel delivery module as claimed in claim 2, wherein the valve means comprises a piston slidably mounted within a valve chamber, said piston dividing said valve chamber into a low pressure side communicating with said vent/return outlet and a high pressure side communicating with said high pressure outlet region of the housing, the piston being moveable between a first position, wherein the piston engages a valve seat to close communication between the further flow passage and the valve chamber, and a second position, wherein the piston is spaced from a valve seat whereby said further flow passage communicates with said vent/return outlet, biasing means being provided for biasing the piston towards its second position, whereby, when the pump is operational, high pressure fuel on the high pressure side of the valve passage pushes the piston to its first position against the action of the biasing means to close the further flow passage.
4. A fuel delivery module as claimed in claim 3, wherein the valve means incorporates a fuel pressure regulator for enabling excess fuel pressure in the high pressure outlet region to be relieved via the vent/return outlet.
5. A fuel delivery module as claimed in any preceding claim, wherein a check valve is provided in said fuel inlet to prevent fuel from draining out of the low pressure inlet region via said flow inlet.
6. A fuel delivery module as claimed in any preceding claim, wherein said fuel pump comprises an electric motor and a regenerative turbine pump assembly comprising an impellor drivingly connected to the motor for pumping fuel from the fuel inlet to said fuel outlet.

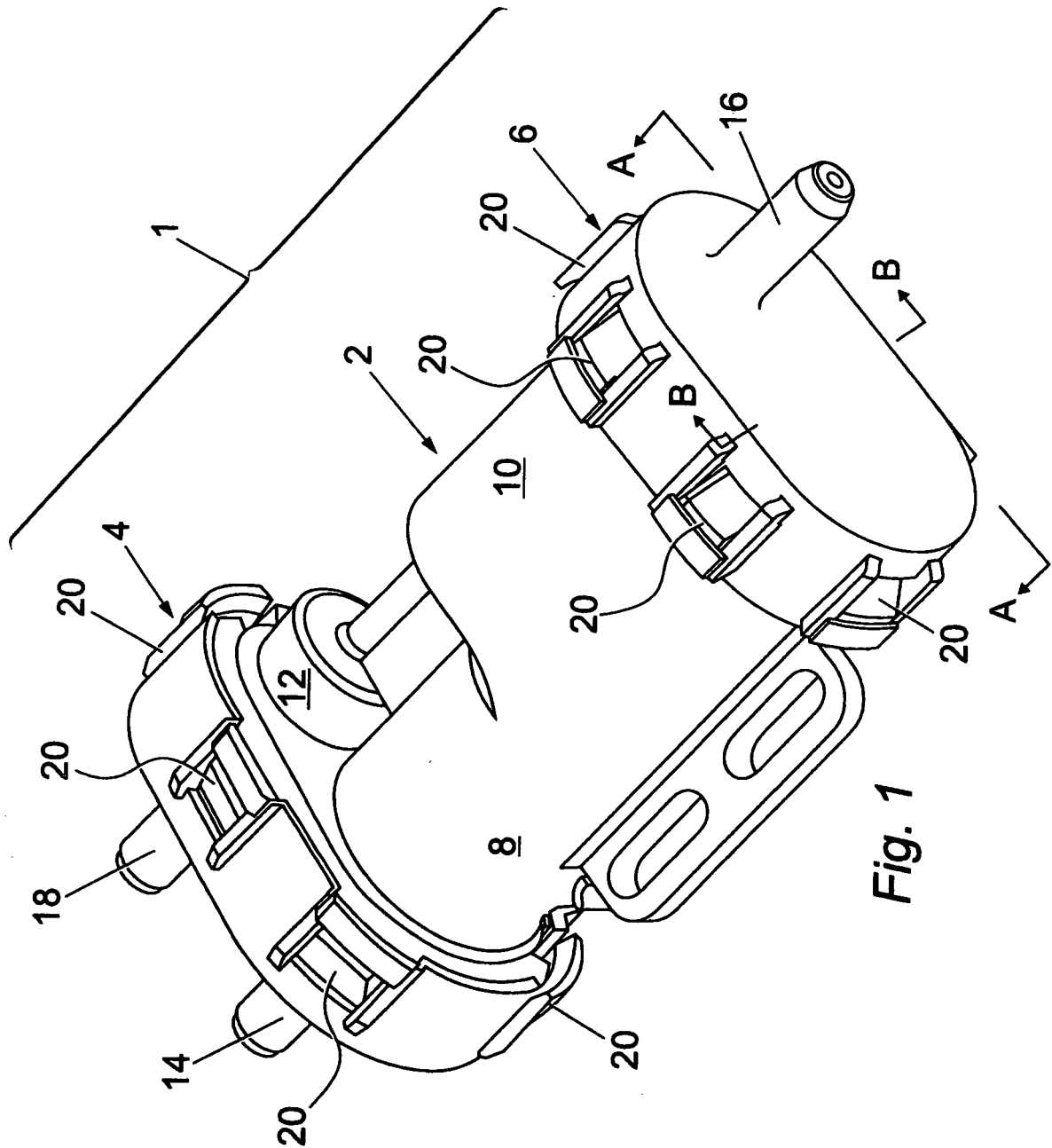


Fig. 1

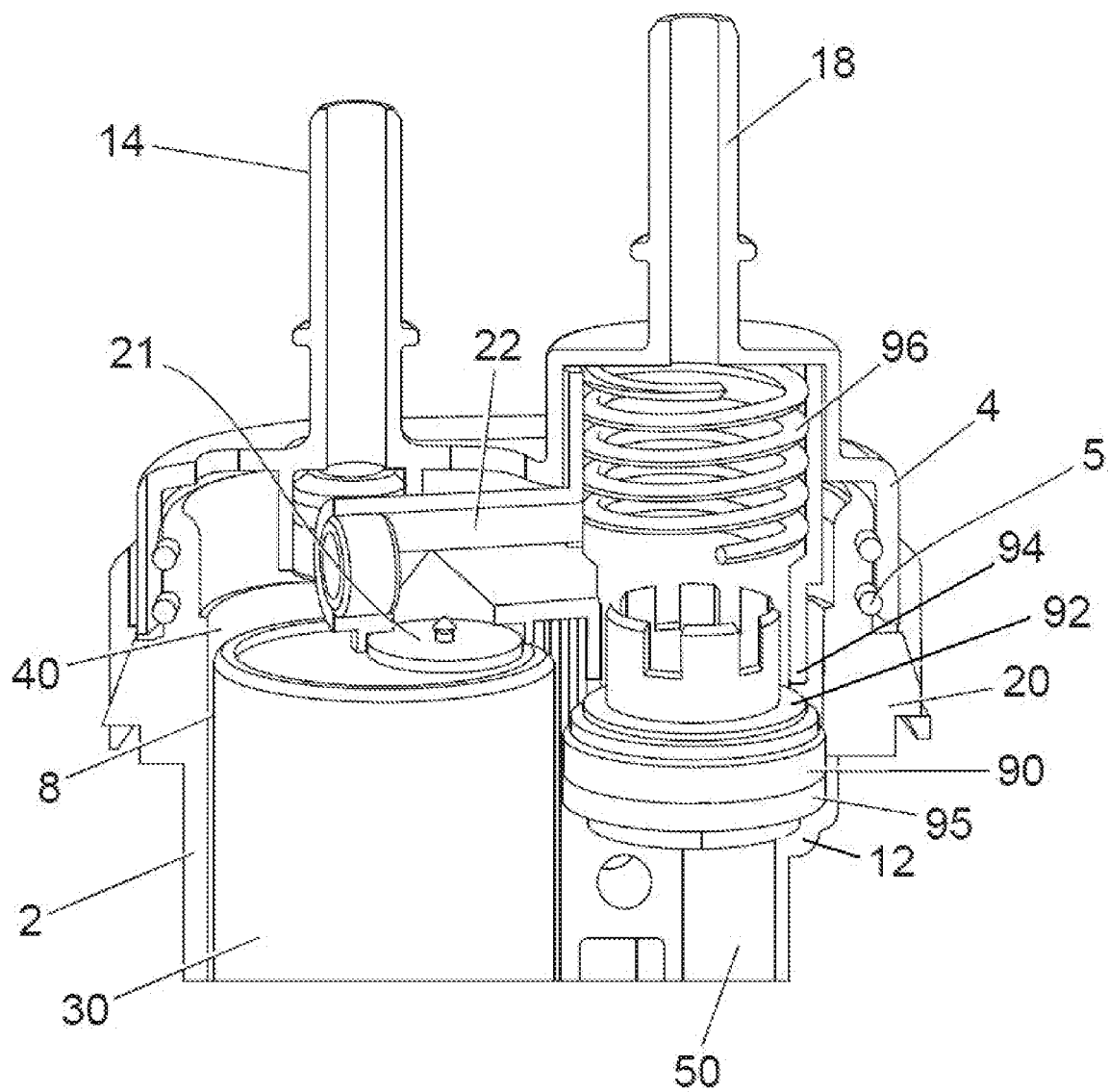


Fig. 2

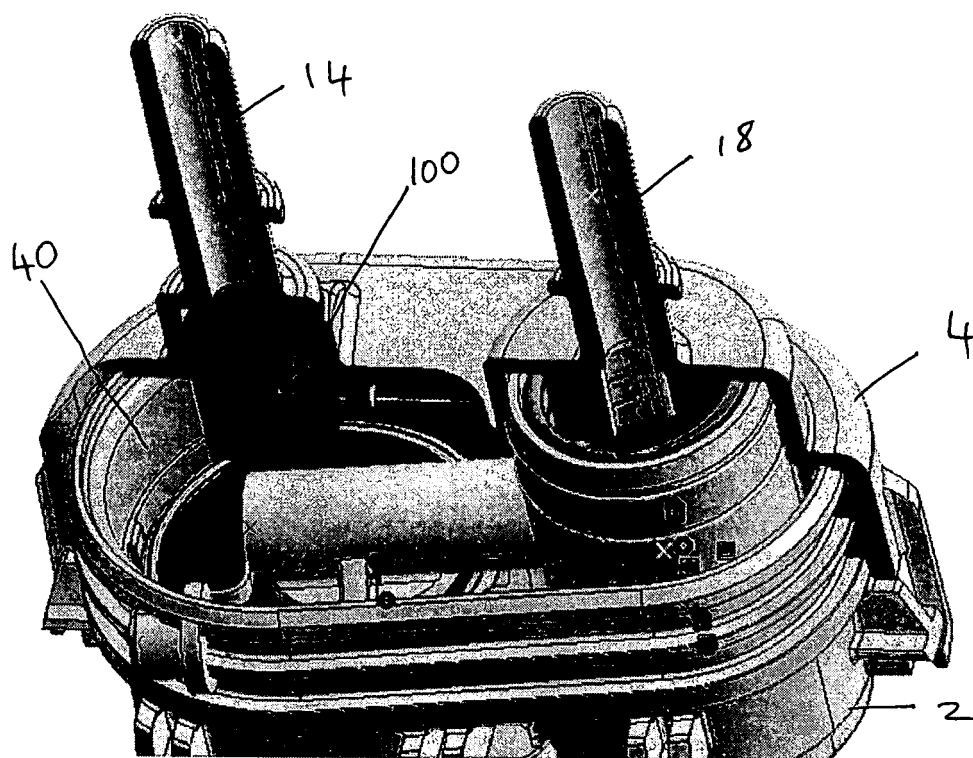


Fig. 3