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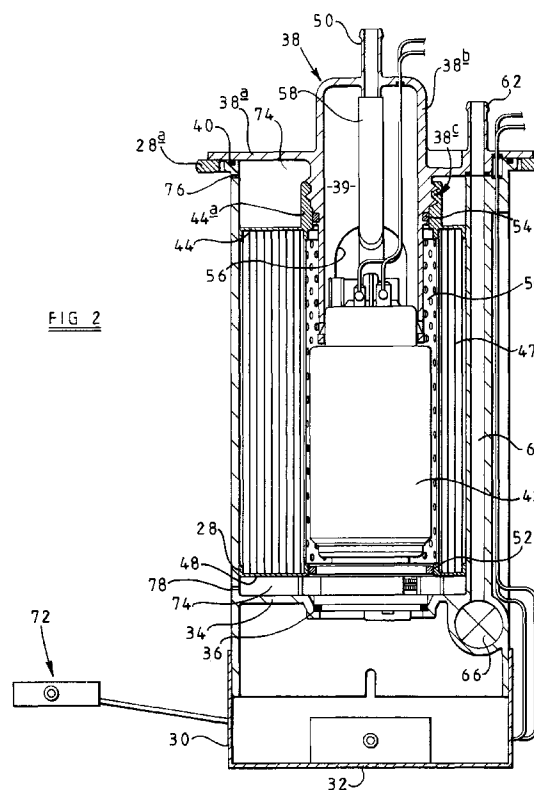
AL LT LV MK RO SI(30) Priority: **26.11.1996 FR 9614454**(71) Applicant: **LUCAS INDUSTRIES public limited company****Solihull, B90 4LA (GB)**

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(57) A fuel filter is disclosed which comprises a filter element 47 located within a housing 28. A fuel pump is arranged to draw fuel from a fuel tank 10 to the dirty side of the filter element 47, and to supply fuel from the clean side of the filter element 47 to a high pressure pump 14. The fuel filter incorporates a buffer volume 39 on the clean side of the filter element 47.

**FIG. 2****EP 0 844 382 A2**

Description

This invention relates to a filter for use in filtering fuel to be supplied to an internal combustion engine.

Fuel filters, and in particular filters for use in filtering Diesel fuel, suffer from the disadvantage that when the fuel is cold, waxing occurring in the fuel is sufficient to restrict the flow of fuel through the filter element of the filter. It is an object of the invention to provide a fuel filter in which this disadvantage is reduced.

According to the present invention there is provided a fuel filter comprising a filter element, and a fuel pump for supplying filtered fuel to a fuel system, wherein the fuel filter defines a buffer volume located on the clean side of the filter element.

Where the fuel filter is used in conjunction with a fuel system of the type including a high pressure fuel pump arranged to supply fuel to the cylinders of an associated engine, the fuel pump may be arranged to return fuel to the fuel filter. Similarly, the injectors to which the high pressure pump supplies fuel may be arranged to return fuel which is not injected to the fuel filter.

In use, when the engine is started from cold, the initial supply of fuel to the high pressure pump is drawn from the buffer volume, thus the initial low rate of filtering does not effect the initial rate of fuel supply to the high pressure pump. The fuel returned to the fuel filter is conveniently not returned to the fuel tank, but is instead returned immediately to the filter. As the fuel returned to the fuel filter has passed through the high pressure pump, the temperature of this fuel will be relatively high, thus it will be of relatively low viscosity compared to cold fuel, the level of waxing being reduced due to the increased temperature. The presence of the heated fuel permits the rate of fuel flow through the filter to be maintained at a relatively high rate.

After the engine has been running for a while, the temperature of the fuel within the fuel tank will increase, thus the fuel will become less viscous, and the rate of fuel filtering can be maintained without directing the returned fuel to the filter element.

The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a fuel system including a fuel filter in accordance with an embodiment of the invention;

Figure 2 is a cross-sectional view of the fuel filter shown in Figure 1; and

Figure 3 is a perspective view of part of the fuel filter of Figures 1 and 2.

The fuel system illustrated in Figure 1 comprises a fuel tank 10 within which a fuel filter 12 is located. The fuel filter 12 incorporates a low pressure pump arranged

to supply fuel from the tank 10 at relatively low pressure to the inlet of a high pressure fuel pump 14 through a supply line 16. The high pressure pump 14 is arranged to charge an accumulator or common rail 18 which communicates with and is arranged to supply fuel under pressure to a plurality of injectors 20. The injectors 20 are arranged to supply fuel at appropriate times to respective cylinders of a compression ignition internal combustion engine 22.

In use, not all of the fuel supplied to the high pressure pump 14 is required to charge the common rail 18, and the excess fuel is returned to the filter 12 through a return line 24. A return line 26 is arranged to return back-leak fuel from the injectors 20.

As shown in Figure 2, the fuel filter 12 comprises a generally cylindrical housing 28 of plastics material, the lower end of the housing 28 being closed by a bowl 30 having an opening in its lower surface, a pre-filter member 32 being located in the opening and arranged to remove large contaminant particles from the flow of fuel entering the bowl 30 through the opening.

Part way along the length of the housing 28 is located an inwardly extending flange 34 which carries, at its inner periphery, an O-ring 36.

The upper end of the housing 28 is closed by a removable cover member 38. The cover member 38 includes an annular part 38a which is arranged, in use, to abut an outwardly extending flange 28a provided at and integral with the upper end of the housing 28. An O-ring 40 is located between the annular part 38a and the flange 28a to seal the cover member 38 to the housing 28. The inner periphery of the annular part 38a is integral with a cylindrical wall 38b, the cylindrical wall 38b extending both above and below the annular part 38a. The upper end of the cylindrical wall 38b is closed. The lower end of the cylindrical wall 38b carries an electrically powered two-stage pump 42. The lower end of the pump 42 engages the O-ring 36 thus is sealed to the flange 34.

The outer surface of the cylindrical wall 38b is provided with a screw threaded region 38c which is in screw threaded engagement with a threaded part 44a of an upper support 44 of a filter cartridge 46. As shown in Figure 3, the filter cartridge 46 includes a pleated paper filter member 47 located between the upper support 44 and a lower, annular support 48. A perforated tubular member 50 further interconnects the upper and lower supports 44, 48, the tubular member 50 extending along the axis of the filter cartridge 46. As shown in Figure 2, part of the cylindrical wall 38b and the pump 42 are located within the tubular member 50, the pump 42 being sealed to the lower support 48 by an O-ring 52, whilst the cylindrical wall 38b is sealed to the upper support 44 by an O-ring 54. The cylindrical wall 38b is provided with an opening 56 whereby communication is permitted between the interior of the chamber or buffer volume 39 defined by the cylindrical wall 38b and the interior of the tubular member 50.

A flexible outlet pipe 58 is connected to the outlet

of the pump 42, and is arranged to supply fuel to a first connection nipple 60 which is integral with the cover member 38. The cover member 38 includes a second connection nipple 62 which is arranged to communicate with a return pipe 64, integral with the housing 28. The lower end of the return pipe 64 communicates with a temperature actuated valve 66 arranged such that when the temperature of fuel within the bowl 30 is below a predetermined temperature, fuel returned through the return pipe 64 is supplied to the interior of the bowl 30, the returned fuel being returned to the tank 10 when the fuel temperature within the bowl 30 exceeds the predetermined temperature. In the illustrated embodiment, the temperature actuated valve 66 is arranged to switch between supplying fuel to the interior of the bowl 30 and the tank 10 at a temperature of approximately 35°C.

In order to permit the pipe 64 to extend to the bowl 30 without increasing the dimensions of the filter, the upper and lower supports 44, 48 of the filter cartridge 46 include recesses 68 which are aligned with one another, and the filter element 47 is arranged so as not to extend between the recesses 68, thus defining a channel 70 within which the return pipe 64 extends, in use.

A fuel gauge 72 is associated with the filter whereby the quantity of fuel within the tank 10 can be monitored, and in response to the measured quantity of fuel, adjustments can be made to the operation of the engine, if required, to avoid damage to the fuel system or engine should the fuel level fall dangerously low.

In use, the filter shown in Figure 2 is located within the fuel tank 10 with the supply line 16 connected to the first nipple 60 and the return lines 24, 26 connected to the second nipple 62. The fuel pump 42 is operated so that a first stage of the pump 42 draws fuel from the bowl 30, supplying the fuel to a chamber 74 defined between the housing 28 above the flange 34 and the outer periphery of the filter cartridge 46 at a pressure of, for example, 0.5 bar relative to the pressure within the tank 10. Separation of water and air from the Diesel within the chamber 74 due to their different relative densities results in air collecting in the top of the chamber 74 and water collecting in the bottom part of the chamber 74. A small opening 76 is provided adjacent the top of the chamber 74 whereby air which collects in the chamber 74 can escape to the tank 10, and a small opening 78 adjacent the bottom of the chamber 74 permits water to escape to the tank 10.

Fuel from the chamber 74 passes through the filter element 47 which separates contaminants from the flow of fuel, and enters the interior of the tubular member 50 through the perforations thereof. The fuel is then able to enter the buffer volume 39 through the opening 56. Fuel from the buffer volume 39 is drawn into the second stage of the pump 42 and is supplied, under pressure, through the outlet pipe 58 to the first nipple 60.

As described hereinbefore, the fuel from the filter 12 is supplied to the inlet of a high pressure pump 14 from where some of the fuel returns to the tank through

the return line 24, other fuel being returned through the return line 26 from the injectors 20. The returned fuel is at a relatively high temperature as a result of having passed through the high pressure pump 14.

The returned fuel is supplied through the nipple 62 and return pipe 64 to the valve 66. When the engine is started from cold, the temperature of the fuel within the tank 10 and bowl 30 is relatively cold, thus the valve 66 supplies the returned fuel to the interior of the bowl 30 from where the fuel is once more drawn by the first stage of the pump 42 to the chamber 74. By returning warm fuel to the interior of the bowl 30, the temperature the fuel supplied to the chamber 74 and hence to the filter element 48 is increased, thus the disadvantages associated with attempting to filter cold, relatively viscous, waxy fuel are reduced. Although warm fuel is returned to the interior of the bowl 30, some fuel will be drawn into the bowl 30 from the tank 10 through the pre-filter member 32 in order to replace fuel which is supplied to the engine.

After the engine has been running for a while, the temperature of fuel within the tank 10, and hence within the bowl 30, will rise to a sufficient extent that the viscosity of the fuel to be filtered is reduced, and the valve 66 then returns fuel to the tank 10 rather than to the interior of the bowl 30. As the returned fuel is not supplied directly to the interior of the bowl 30, all of the fuel drawn from the bowl 30 is replaced with fuel drawn through the pre-filter member 32 from the tank 10.

As the filter includes a relatively large buffer volume, for example approximately 2 litres, on the clean side of the filter element, the initial flow of fuel to the high pressure pump does not need to be passed through the filter element 47 whilst cold, thus the disadvantages of being unable to filter fuel at a sufficient rate to meet the initial demand for fuel, for example at a rate of 200 litres per hour, are reduced. Further, as the quantity of cold fuel applied to the filter is relatively low, the disadvantages of having to filter cold fuel are overcome relatively quickly.

In order to change the filter cartridge 46, for example when the filter element 47 becomes clogged, the cover member 38 is removed from the housing 28, removal of the cover member 38 also resulting in removal of the filter cartridge 46 and pump 42 from the housing 28. The filter cartridge 46 is separated from the cover member 38 by rotating the filter cartridge 46 with respect to the cover member 38 to disengage the threaded coupling therebetween, and the filter cartridge is replaced by a new cartridge. The cover member 38 together with the pump 42 and new cartridge 46 is then replaced on the housing 28. It will be appreciated that such a technique is relatively simple and can be carried quickly and efficiently without the risk of parts of the filter being mislaid or lost.

Claims

1. A fuel filter comprising a filter element (47) and a fuel pump (42) for supplying filtered fuel to a fuel system, wherein the fuel filter defines a buffer volume (39) located on the clean side of the filter element (47). 5
2. A fuel filter as claimed in Claim 1, wherein the fuel pump includes a first stage for supplying fuel from a fuel tank (10) to the dirty side of the filter element (47), and a second stage for supplying fuel from the clean side of the filter element (47) to a high pressure fuel pump (18) of the fuel system. 10
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3. A fuel filter as claimed in Claim 1 or Claim 2, further comprising a return pipe (64) whereby fuel is returned to the fuel filter from the fuel system, and a temperature actuatable valve (66) arranged to direct returned fuel to the filter element (47) when the temperature of the fuel within the fuel tank is below a predetermined level, the valve (66) directing returned fuel to the fuel tank when the fuel is at higher temperatures. 20
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4. A fuel filter as claimed in Claim 3, wherein the filter element (47) comprises a pleated filter element, and the return pipe (64) extends through the filter element (47) between adjacent pleats thereof. 30
5. A fuel filter as claimed in any one of the preceding claims, wherein the buffer volume is defined, in part, by a chamber defined by a cylindrical wall (38b) forming part of a lid (38) of a filter housing. 35
6. A fuel filter as claimed in Claim 5, wherein the chamber extends both above and below the plane of the remainder of the lid (38). 40
7. A fuel filter as claimed in any one of the preceding claims, wherein the capacity of the buffer volume (39) is approximately 2 litres. 45
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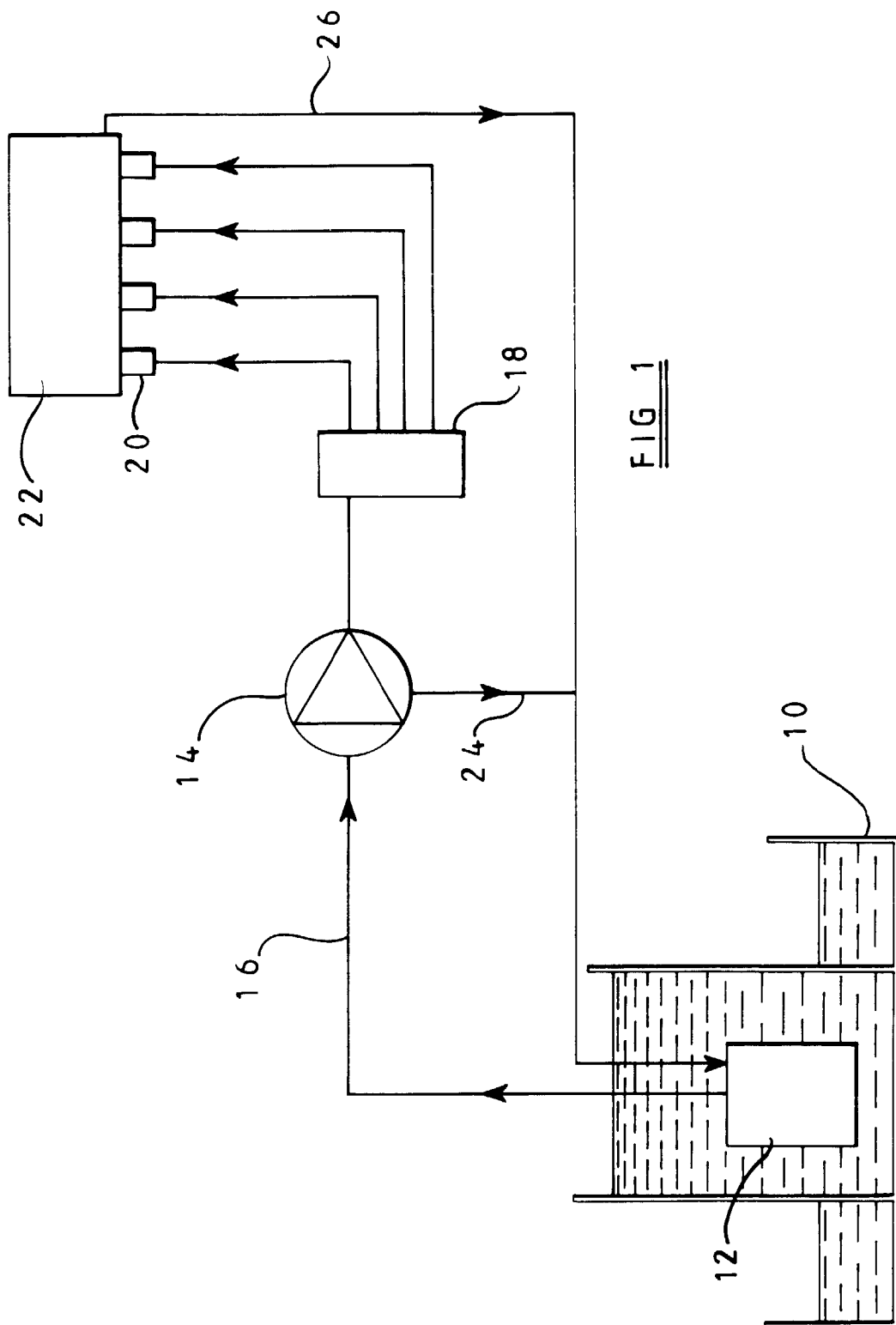
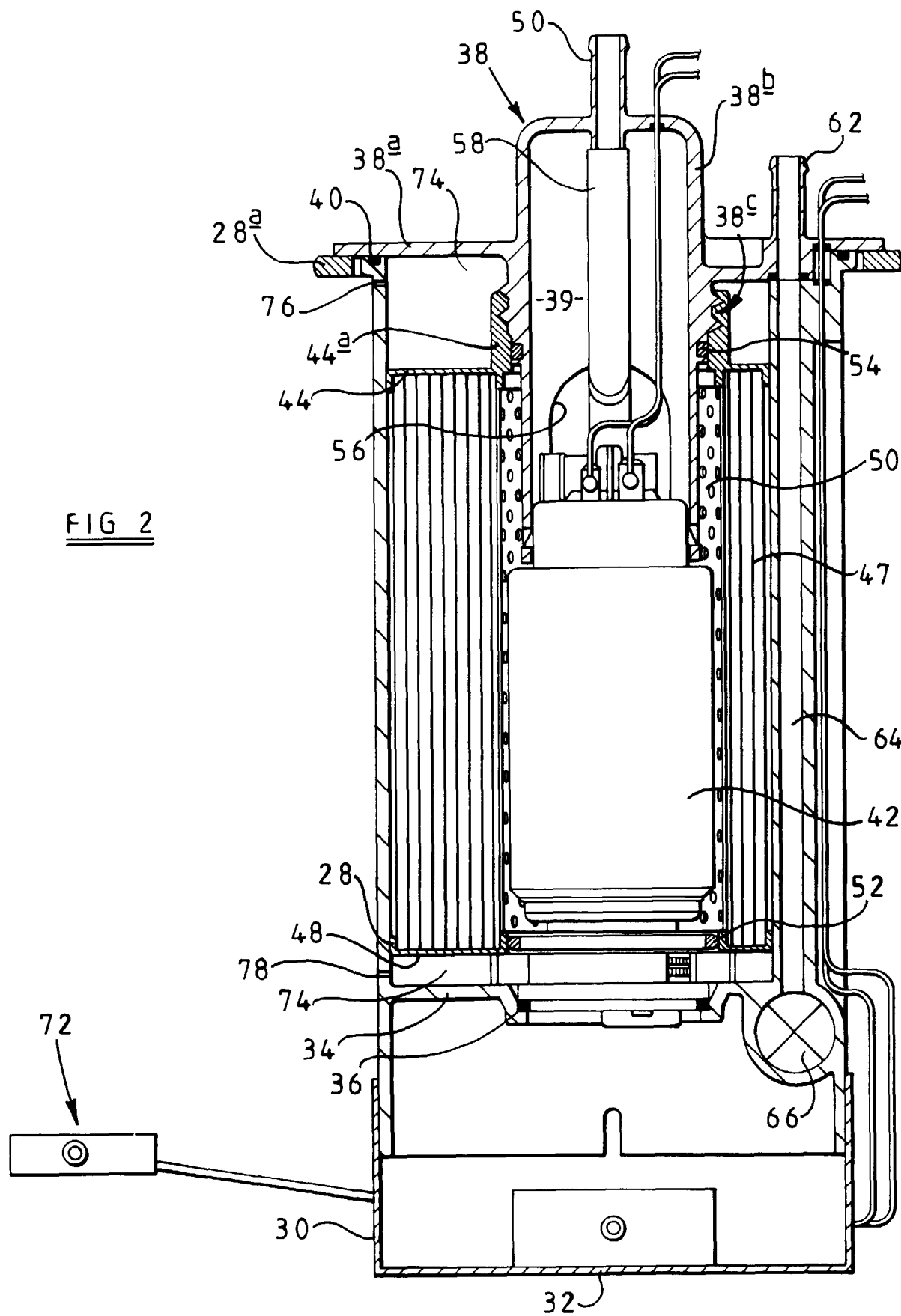


FIG. 1



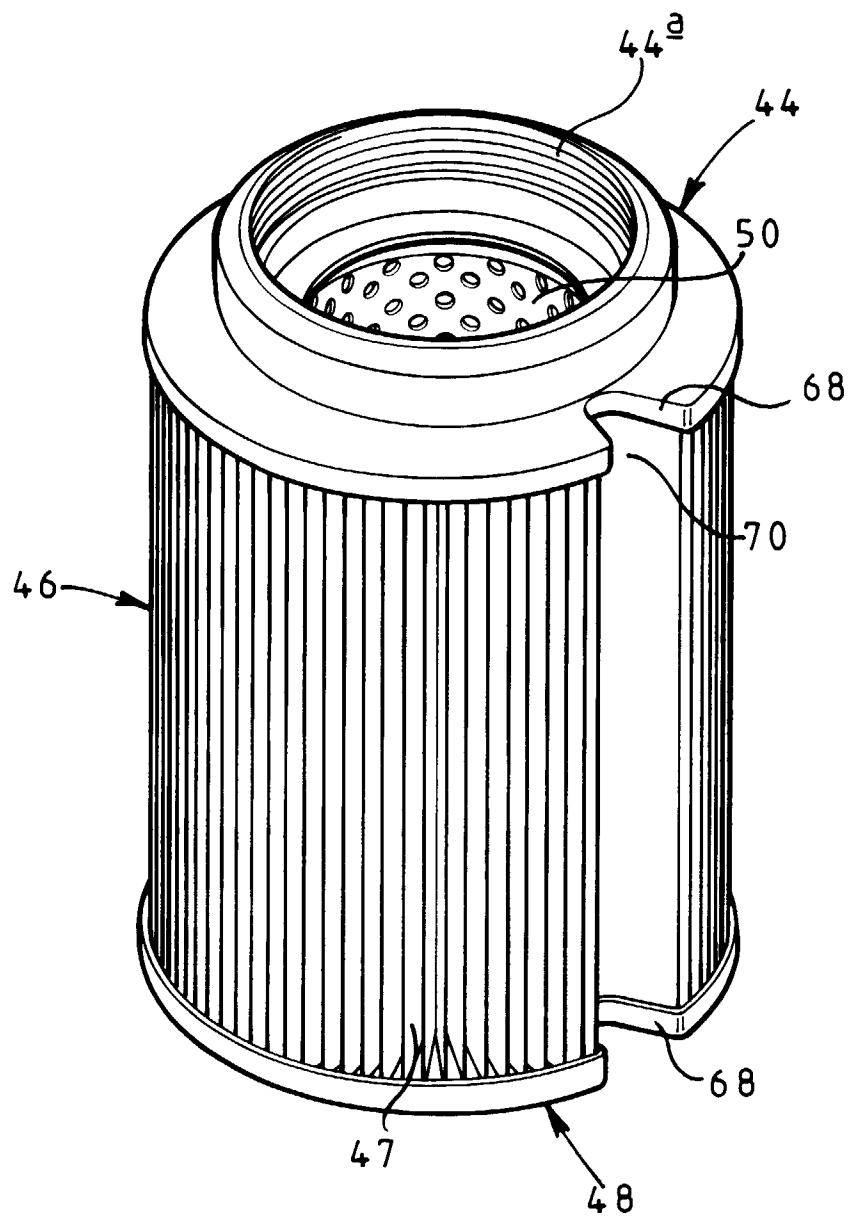


FIG 3