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(54) **Injection engine fuel supply system**

(57) There is described a fuel supply system (1) for an engine (2), having a fuel tank (3); a fuel injector (4); an injection pump (5) having an inlet (5a) connected to the fuel tank (3) by an intake line (6), and an outlet (5b) connected to the fuel injector (4) by a delivery line (7); and an engine cut-off device (12) for cutting off the engine (2) when the lubricating oil in the oil sump (17) of the engine (2) is below a desired minimum level. More

specifically, the engine cut-off device (12) is defined by a pulse-operated pump (12) having an inlet (14a) communicating with an air-containing environment (3); an excitation port (13a) communicating with the oil sump (17) of the engine (2) along an excitation conduit (18) having an outlet section (18a) located substantially at the minimum lubricating oil level; and an outlet (14b) communicating with the intake line (6).

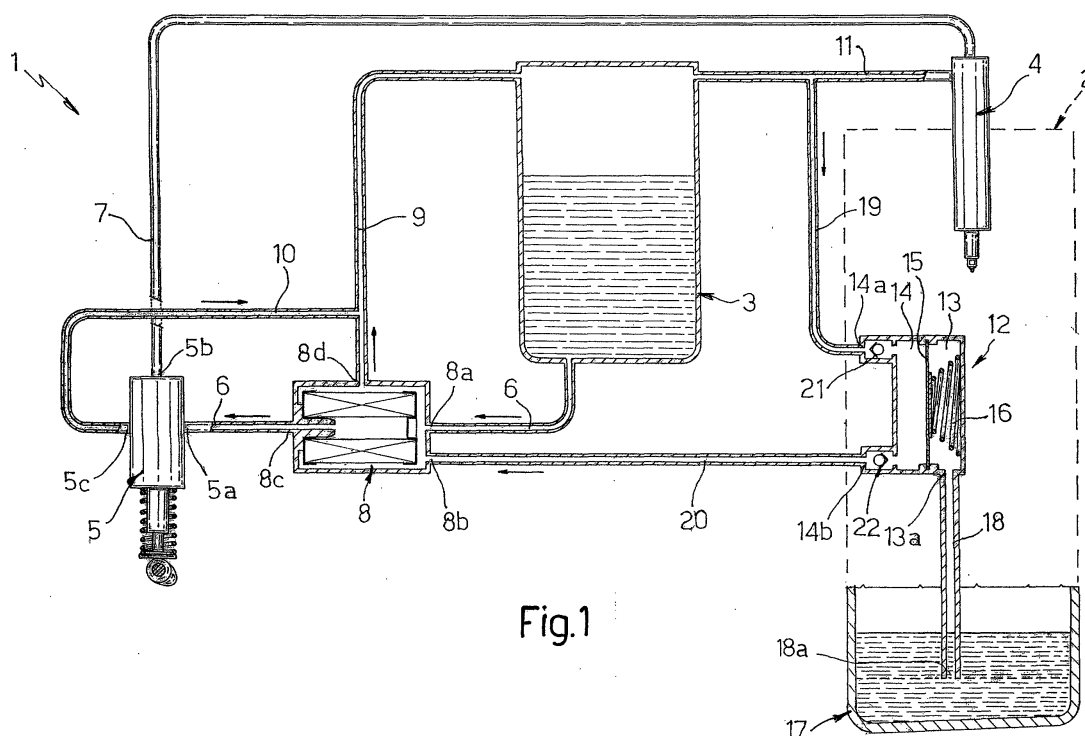


Fig.1

Description

[0001] The present invention relates to an injection engine fuel supply system.

[0002] In particular, the present invention may be used to advantage, though not exclusively, in hand-start injection engines with no electric system, such as the type used in agricultural or industrial machines in general, to which the following description refers purely by way of example.

[0003] As is known, in agricultural or industrial machines featuring a hand-start injection engine with no electric system, failure to regularly and systematically check the lubricating oil level in the oil sump is undoubtedly one of the main causes of poor lubrication, and therefore damage, of injection engines of this type.

[0004] This applies even more so in the case of agricultural or industrial machines for hire, in which case, the lubricating oil level tends to be neglected by the user.

[0005] One solution to the problem adopted in other types of injection engines, e.g. automotive engines, is to indicate - typically by means of an indicator light - when the oil level falls below a minimum value, on the basis of an electric signal supplied by an oil level or oil pressure sensor in the oil sump.

[0006] Applying this solution to hand-start injection engines with no electric system would therefore call for providing an electric system enabling use of an oil level or oil pressure sensor, a processing circuit for processing the signal from the sensor, and an indicator light, thus increasing the production cost of the engine.

[0007] It is an object of the present invention to provide an injection engine supply system designed to act effectively on the engine in the event of poor lubrication, but without requiring an electric system or oil level or pressure sensors.

[0008] According to the present invention, there is provided an injection engine supply system as defined in Claim 1.

[0009] Two preferred, non-limiting embodiments of the present invention will be described purely by way of example with reference to the accompanying drawings, in which:

Figure 1 shows an injection engine fuel supply system in accordance with a first embodiment of the present invention; and

Figure 2 shows an injection engine fuel supply system in accordance with a second embodiment of the present invention.

[0010] Numeral 1 in Figure 1 indicates as a whole a fuel supply system for an injection engine 2, in particular a one-cylinder diesel engine (shown schematically).

[0011] Fuel supply system 1 substantially comprises a fuel tank 3; a fuel injector 4; a one-way-flow injection pump 5 connected to fuel tank 3 by an intake line 6, and to fuel injector 4 by a delivery line 7; and a fuel filter 8

along intake line 6.

[0012] More specifically, fuel filter 8 is a cartridge type, and comprises a fuel inlet 8a connected to the bottom of fuel tank 3; an air inlet 8b; an outlet 8c connected to the inlet 5a of injection pump 5; and a vent outlet 8d connected to the top of fuel tank 3 by a vent conduit 9 to feed any air in fuel filter 8 back into the tank.

[0013] Injection pump 5 also comprises an outlet 5b connected to fuel injector 4 by delivery line 7; and a recirculating outlet 5c connected to fuel tank 3 by a recirculating conduit 10 connected to vent conduit 9.

[0014] For reasons explained later on, injection pump 5 conveniently has a high intake flow, much higher than - preferably three times - the injection flow of fuel injector 4, and the surplus fuel drawn from fuel tank 3 is fed back into fuel tank 3 along recirculating conduit 10 and vent conduit 9.

[0015] Fuel injector 4 is connected to fuel tank 3 by a recirculating conduit 11, which feeds back into fuel tank 3 part of the fuel used in known manner by and for operation of fuel injector 4.

[0016] Fuel supply system 1 also comprises an engine cut-off device for turning off engine 2 when the lubricating oil level in the oil sump 17 falls below a desired minimum.

[0017] More specifically, the engine cut-off device substantially comprises a pulse-operated pump 12 having an excitation chamber 13 and a pumping chamber 14 separated by a diaphragm 15 on which acts a contrast spring 16 housed in excitation chamber 13.

[0018] More specifically, excitation chamber 13 has an excitation port 13a communicating with oil sump 17 of engine 2 along an excitation conduit 18, the outlet section 18a of which is located substantially at the minimum lubricating oil level (shown by the dash line); and excitation conduit 18 is so positioned that the incoming lubricating oil can flow back into oil sump 17.

[0019] Pumping chamber 14, on the other hand, has an inlet 14a communicating with the top of fuel tank 3 along an intake conduit 19 to draw in air from the tank; and an outlet 14b communicating with the air inlet 8b of fuel filter 8 along a delivery conduit 20.

[0020] Inlet 14a and outlet 14b of pulse-operated pump 12 have respective non-return valves 21 and 22 permitting one-way airflow from the top of fuel tank 3 to pumping chamber 14, and from pumping chamber 14 to fuel filter 8 respectively.

[0021] Fuel supply system 1 cuts off engine 2 by supplying air into fuel filter 8, which therefore supplies no fuel to injection pump 5 or, consequently, to fuel injector 4.

[0022] This is made possible by pulse-operated pump 12, operation of which is governed by the pressure pulses generated inside the block of engine 2 by movement of the piston.

[0023] More specifically, as long as the lubricating oil level in oil sump 17 is above the minimum level at which the outlet section 18a of excitation conduit 18 of pulse-

operated pump 12 is located, outlet section 18a remains immersed in the lubricating oil, and the pressure pulses generated by movement of the piston are effectively damped by the lubricating oil in oil sump 17, so that no pressure pulses reach excitation chamber 13 of pulse-operated pump 12, which therefore remains idle.

[0024] Conversely, when the lubricating oil falls below the minimum level at which outlet section 18a of excitation conduit 18 is located, outlet section 18a is no longer immersed in the lubricating oil, so that the pressure pulses generated by movement of the piston reach excitation chamber 13 of pulse-operated pump 12, which thus comes into operation to supply air from fuel tank 3 into fuel filter 8, which is consequently emptied of fuel.

[0025] The air in fuel filter 8 is fed by injection pump 5 to fuel injector 4 which, no longer supplying fuel to engine 2, rapidly cuts off the engine.

[0026] More specifically, fuel filter 8 is emptied, and therefore engine 2 cut off, extremely quickly, by injection pump 5 drawing much more fuel than required by fuel injector 4, so that air is fed rapidly from fuel filter 8 to injection pump 5.

[0027] When the engine is off, the air in fuel filter 8 is exhausted automatically through vent outlet 8d to enable fast start-up of engine 2.

[0028] During normal operation of engine 2, with the lubricating oil level above minimum, inevitable shaking of engine 2 may cause a small amount of air to be fed into fuel filter 8, but which is immediately expelled through vent outlet 8d.

[0029] Moreover, by virtue of pulse-operated air pump 12 drawing air from fuel tank 3 as opposed to the outside, operation of the pump is unaffected by the difference in pressure between the inside of fuel tank 3 and the outside atmosphere, and any fuel leakage from pulse-operated air pump 12 does not leak to the outside.

[0030] Numeral 25 in Figure 2 indicates as a whole a fuel supply system according to a second embodiment of the present invention. Like numerals indicate corresponding parts already described with reference to Figure 1.

[0031] Fuel supply system 25 differs from fuel supply system 1 in that intake conduit 19, which supplies air to port 14a, is connected to an air suction duct 26 of engine 2, downstream from an air filter 27, rather than to fuel tank 3.

[0032] The advantages of the fuel supply system according to the present invention will be clear from the foregoing description.

[0033] In particular, the present invention provides for acting on the engine in the event of poor lubrication without requiring an electric system or oil level or pressure sensors, and by simply adding a straightforward, low-cost, pulse-operated air pump.

[0034] The present invention also provides for fast cut-off and start-up of the engine, by the injection pump drawing large amounts of air and fuel from the fuel tank, so that air is fed and exhausted rapidly to and from the

fuel filter. This is particularly important in the case of injection engines with no electric system, which, being hand-started, must permit fairly fast start-up.

[0035] Clearly, changes may be made to the fuel supply system as described and illustrated herein without, however, departing from the scope of the present invention as defined in the accompanying Claims.

[0036] For example, the pulse-operated pump inlet may communicate directly with the outside as opposed to the top of the fuel tank or air suction duct; and the fuel filter may be other than as described.

Claims

1. A fuel supply system (1) for an injection engine (2) comprising an oil sump (17), the system comprising a fuel tank (3), a fuel injector (4), and an injection pump (5) having an inlet (5a) connected to the fuel tank (3) by an intake line (6), and an outlet (5b) connected to the fuel injector (4) by a delivery line (7); **characterized by** comprising an engine cut-off device (12) for cutting off said engine (2) when the lubricating oil in said oil sump (17) is below a minimum level; said engine cut-off device comprising a pulse-operated pump (12) having an inlet (14a) communicating with an air-containing environment (3, 26), an excitation port (13a) communicating with said oil sump (17) along an excitation conduit (18) having an outlet section (18a) located substantially at said minimum level of the lubricating oil, and an outlet (14b) communicating with said intake line (6).
2. A fuel supply system (1) as claimed in Claim 1, **characterized in that** said air-containing environment is said fuel tank (3).
3. A fuel supply system (1) as claimed in Claim 1, **characterized in that** said air-containing environment is an air suction duct of said engine (2).
4. A fuel supply system (1) as claimed in any of the foregoing Claims, **characterized by** also comprising a fuel filter (8) located along said intake line (6) and having a fuel inlet (8a) connected to said fuel tank (3), an air inlet (8b) connected to said outlet (14b) of said pulse-operated pump (12), and an outlet (8c) connected to said inlet (5a) of said injection pump (5).
5. A fuel supply system (1) as claimed in Claim 4, **characterized in that** said fuel filter (8) also has a vent outlet (8d) connected to said fuel tank (3) by a vent conduit (9) to exhaust the air in the fuel filter (8) into the fuel tank (3).
6. A fuel supply system (1) as claimed in any one of the foregoing Claims, **characterized in that** said in-

jection pump (5) has an intake flow greater than the injection flow of said fuel injector (4).

7. A fuel supply system (1) as claimed in Claim 6, **characterized in that** said injection pump (5) also has a recirculating outlet (5c) connected to said fuel tank (3) by a recirculating conduit (10) to feed surplus fuel intake back into the fuel tank (3). 5
8. A fuel supply system (1) as claimed in any one of the foregoing Claims, **characterized in that** said inlet (14a) and said outlet (14b) of said pulse-operated pump (12) have respective non-return valves (21, 22). 10
9. A fuel supply system (1) as claimed in any one of the foregoing Claims, **characterized in that** said pulse-operated pump (12) has an excitation chamber (13) and a pumping chamber (14) separated by a diaphragm (15). 15

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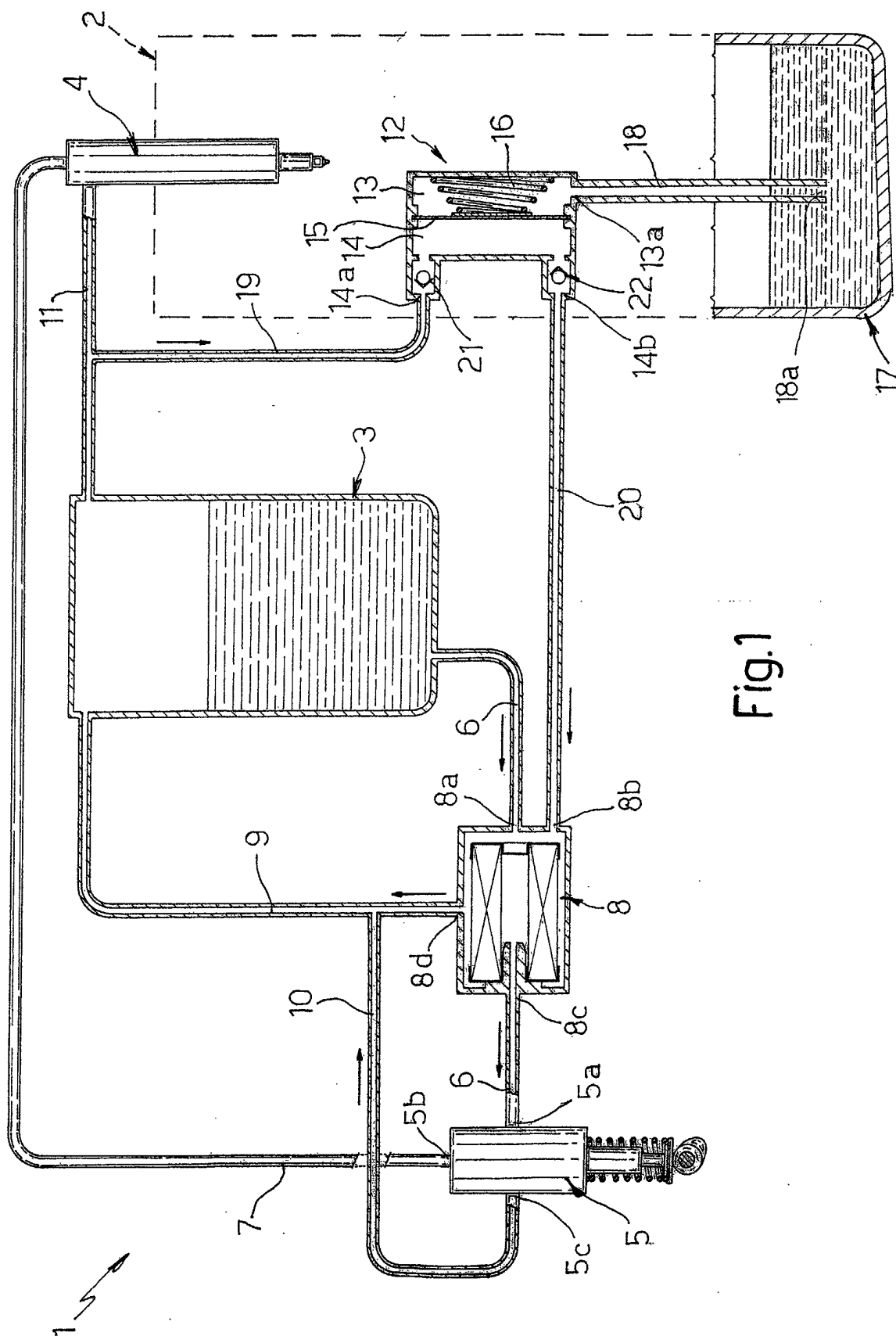


Fig.1

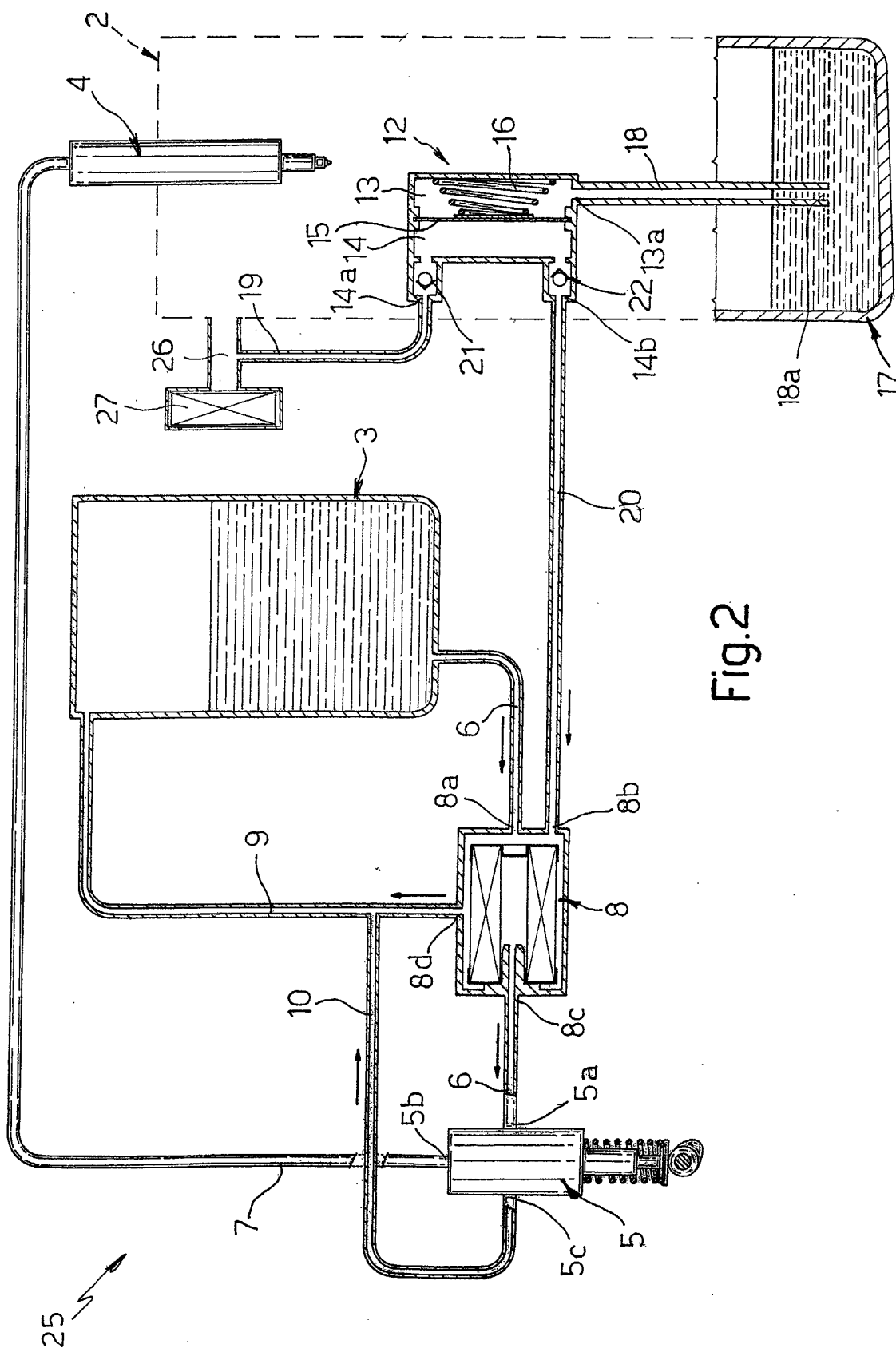


Fig.2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 02 2896

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 085 716 A (MADL ALBERT ET AL) 11 July 2000 (2000-07-11) * column 3, line 55 - column 6, line 36; figures *	1	F01M11/12 F01M1/24
A	US 4 203 408 A (TAKASU HITOYUKI ET AL) 20 May 1980 (1980-05-20) * column 3, line 5 - column 7, line 25; figures *	1	
A	US 5 878 710 A (RITTER ALBRECHT M ET AL) 9 March 1999 (1999-03-09) * column 1, line 66 - column 3, line 54; figures *	1	
A	DE 44 30 816 A (HONDA MOTOR CO LTD) 2 March 1995 (1995-03-02) * column 3, line 5 - column 6, line 24; figures *	1	
A	US 4 911 121 A (BARNES RICHARD W) 27 March 1990 (1990-03-27) * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	US 4 622 935 A (JANISCH DOUGLAS G) 18 November 1986 (1986-11-18) * abstract *	1	F01M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 January 2003	Examiner Mouton, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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

EP 02 02 2896

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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09-01-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6085716 A	11-07-2000	DE 19631652 A1	12-02-1998
		DE 29623234 U1	12-02-1998
		DE 59706781 D1	02-05-2002
		WO 9805852 A1	12-02-1998
		EP 0916017 A1	19-05-1999
		JP 2001508145 T	19-06-2001
US 4203408 A	20-05-1980	NONE	
US 5878710 A	09-03-1999	EP 0974751 A2	26-01-2000
DE 4430816 A	02-03-1995	JP 2785904 B2	13-08-1998
		JP 7071222 A	14-03-1995
		DE 4430816 A1	02-03-1995
		IT RM940557 A1	28-02-1995
US 4911121 A	27-03-1990	NONE	
US 4622935 A	18-11-1986	NONE	

EPC FORM P0459

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