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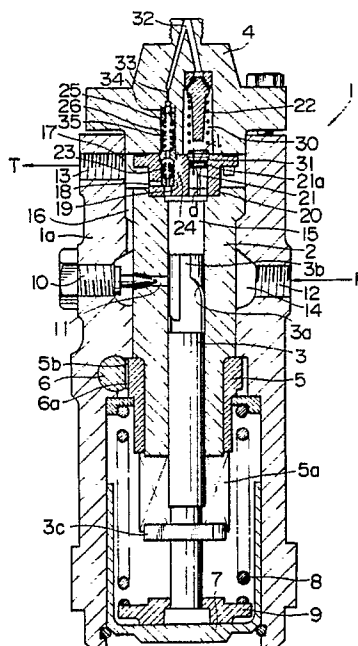
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Fuel injection system for diesel engines.

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The present invention relates to a fuel injection pump in an accumulator fuel injection system for diesel engines. In this fuel injection pump, a plunger (3) is biased by means of a spring (8) in an opposite direction against which the fuel is pressurized, and the plunger chamber (15) and the passage (32) of the discharge union (4) are connected each other via a delivery valve (21), whereas a suction chamber (17) and a plunger chamber (15) are connected each other via an inlet valve (23).

FIG. 1(b)



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Fuel Injection System for Diesel Engines

2. FIELD OF THE INVENTION AND RELATED ART STATEMENT

The present invention relates to an accumulator fuel injection system for diesel engines.

It is a requirement for a fuel injection system for diesel engines to be capable of injecting a suitable quantity of elevated pressure fuel into an engine in a suitably timed sequence.

What is particularly important in this case is to prevent the problem of secondary injection of fuel and a cavitation erosion.

3. OBJECT AND SUMMARY OF THE INVENTION

An object of the present invention is to provide a fuel injection system for diesel engines which is adapted to prevent the occurrence of the secondary injection of the fuel and the cavitation.

To achieve the above object, the present invention provides an arrangement wherein a plunger is biased by means of a spring in an opposite direction against which the fuel is pressurized, a suction chamber is connected with said plunger chamber on one hand via an inlet valve, there is also established a connection between said plunger chamber and the passage of the discharge union on other hand via a delivery valve, said passage is provided with a branch passage which is in turn connected at its opposite branch end with the plunger chamber via a retraction valve.

The spring which biases the plunger in a direction in which the plunger lowers acts to facilitate the fuel supply to the plunger chamber while at the same time reducing a power loss, whereas the delivery valve and the retraction valve serve to prevent the secondary injection of fuel and the cavitation from occurring, and thereby improving the fuel injection system in its durability as well as an engine performance.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Figs 1 - 3 are views of the present invention, wherein;

Fig. 1 (a) is a cross-sectional view of a servo-mechanism for a fuel injection pump;

Fig. 1(b) is a cross-sectional view of the fuel injection pump;

Fig. 1(c) is an enlarged cross-sectional view of a upper portion of the fuel injection pump;

Fig. 2 is a diagrammatic view illustrating a relation between control grooves and a discharge

opening ; and

Fig. 3 is an enlarged cross-sectional view of a upper portion of the fuel injection pump in an alternative embodiment of the present invention;

5. DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1 - 3, there is shown a plunger barrel 2 which is supported in place in a fuel injection pump 1 and a plunger 3 which is made movable upwardly and downwardly and freely pivotably supported in place in the plunger barrel 2, the plunger 3 having a plunger guide 7 at its lower end.

A discharge union 4 is secured to a pump housing 1a via a valve seat body 20 by means of bolts. A reference numeral 5 represents a control sleeve which is freely pivotably supported on the plunger 2. A notched groove 5a is formed in the lower portion of the sleeve 5, and the plunger 3 has its flange 3c inserted into the notched groove 5a. Accordingly, it is possible for the plunger 3 to rotate itself about its axis when the sleeve 5 is rotated. Also, a pinion 5b is defined around the upper outer circumference of the sleeve 5. A control rack 6 is provided so that its teeth 6a may engage the pinion 5b of the sleeve 5. The control rack 6 is freely slidably mounted upon the pump housing 1a and actuated by means of a governor (not shown). As the control rack 6 is actuated, the sleeve 5 is caused to pivot about its axis via teeth 6a and the pinion 5b to control the quantity of fuel to be delivered. There is also provided a spring 8 which biases the plunger 3 downwardly in the view via a spring receiver 9, a straightening rod 10 which is inserted into a discharge opening 11 defined in the plunger barrel 2, and a delivery valve 21 which has a piston 21b, the piston 21b having an annular sealing portion 21a engaged therewith. The delivery valve 21 is freely pivotably supported in place on the valve seat body 20 and is biased downwardly in the view by means of a spring 22. A reference numeral 23 represents an inlet valve which is freely slidably supported in place on the valve seat and biased downwardly in the view by means of a spring 24. A reference numeral 25 represents a retraction valve which is freely slidably supported in place on the discharge union 4 and biased upwardly by means of a spring 26.

There is further shown a fuel inlet port 12 defined in the pump housing 1a, a fuel outlet port 13 defined in the pump housing 1a, a fuel chamber 14, a plunger chamber 15 formed in the upper portion inside the plunger barrel 2, a plurality of oil

passages 16 notched in the plunger barrel 2 which connects between the fuel chamber 14 and a suction chamber 17, a suction opening 18 for opening and closing the seat 19 by the upward and downward movement of the inlet valve 23 so as to supply the fuel to the plunger chamber 15, a passage 30 for connecting a delivery passage 32 with the plunger chamber 15 by opening and closing the seat 31 to move the delivery valve 21 upwardly and downwardly, and an orifice 33 provided between the seat 34 and the passage 32, the seal 34 being opened and closed with the upward and downward movement of the retraction valve 25. When the retraction valve 25 is in an opened state, the passage 32 is in communication with the plunger chamber 15 via the orifice 33, through the passage 25a of the retraction valve 25, the passage 35, the bore 27a of the spring retainer 27 and through the bore 23a of the retraction valve 23. Moreover, the plunger 3 is provided at its upper portion with two control grooves 3a.

There is also a servo cylinder 51 provided in series at the lower end of the pump housing 1a, having a servo piston 52 freely slidably provided therein. The top end of the servo piston 52 is in abutment with the plunger guide 7 of said plunger 3. A reference numeral 53 represents a piston chamber which comprises a servo cylinder 51, a cover 54 arranged at the lower end of the servo cylinder 51, and a servo piston 52.

The piston chamber 53 of the fuel injection pump 1 thus arranged is connected either with the line which connects with the tank 61 through the pump 63 and the strainer 62, or with the line which connects directly with the tank 61, under the operation of the directional control valve. Furthermore, an accumulator 64 is provided at a pipe line connecting between the directional control valve 65 and the fuel pump 63.

Then, the operation of the present invention will be described hereinbelow.

In the fuel injection system as shown in Fig. 1a, the piston chamber 53 is connected directly with the tank 61. Accordingly, the servo piston 52 is at its lowermost position under the bias of the spring 8. The plunger 3 is also at its lowermost position as shown in Fig. 1b.

On the other hand, the oil is supplied to the accumulator 64 by means of the pump 63 even in this the accumulator 64. The state and then collected in suction chamber 17 is also supplied with the fuel from a pump P not shown via the fuel inlet 12, through the fuel chamber 14 and the discharge opening 16, and any overflow of the fuel is returned back to the tank T not shown.

In Fig. 1 (a) , when the directional control valve 65 is actuated, a fluid is pumped under an elevated pressure from the accumulator 64 into the piston

chamber 53. This high pressure fluid serves to move the servo piston 52 upwardly and downwardly. The servo piston 52 causes the plunger 3 to move upwardly and downwardly via the plunger guide 7 shown in Fig. 1b. As the plunger 3 moves upwardly and downwardly, then the fuel oil of the plunger chamber 15 is pressurized and such elevated pressure fuel is effective to move the retraction valve 21 upwardly in opposition against the bias of the spring 22, and thus the sealing portion 21a shifts upwardly from the seat 31 to open the valve. Thus, the fuel is injected into the cylinder from the injection nozzle through an injection pipe not shown. At this instant, the retraction valve 25 and the inlet valve 23 close the seats 19 and 34 under an internal pressure as shown in Fig. 1(c). As the fuel is injected in a desired quantity, the plunger 3 stops its upward and downward movement, and correspondingly a pressure inside the plunger chamber drops abruptly and thereby causing the spring 22 to bias the delivery valve 21 to displace it downwardly for opening the valve 21. At this instance, since the fuel inside the pipe is withdrawn by the quantity of $\Delta Q = \pi/4 d^2 l$, and consequently the pressure present inside the injection pipe is reduced abruptly to a level close to a pressure at which the injection nozzle valve is closed. As the wave of the in-line pressure having an amplitude greater than that required to open the valve returns back to the passage 32, the wave force is transmitted to the retraction valve 25 passing through the orifice 33 to lower the retraction valve 25 and open the seat 34, whereby withdrawing the fuel in the injection pipe via the oil passage 35. Then, the pressure present inside the injection pipe may gradually drops below a level at which the injection nozzle is opened, and subsequently the retraction valve 25 is closed. Thus, the injection nozzle may not be reopened, i.e., it is possible to prevent the occurrence of secondary injection of the fuel so that the injection cycle may be completed. The bore of the orifice 33 is sized to be optimum so that no negative pressure is generated inside the injection pipe and the problem of cavitation may be prevented. After the injection cycle is complete, the plunger 3 is controlled to be movable downwardly. As the pressure prevailing inside the plunger chamber 15 may be reduced below a level present in the suction chamber, and thus the inlet valve 23 is caused to be movable upwardly in opposition against the bias of the spring 24 to open the seat 19 and thereby allowing the supply of the fuel in the suction chamber to the plunger chamber 15 flowing through the seat 19. The supply of the fuel is completed when the plunger 3 stops its lowering movement. At this instance, the spring 8 acts to move the plunger 3 downwardly to facilitate the supply of fuel.

During the above cycle of operation, the communication between the plunger chamber 15 and the discharge opening 11 is interrupted by means of control grooves 3a, and the discharge and supply of the fuel oil for the plunger chamber 15 do not take place through the discharge opening 11. Fig. 2 shows a relationship between the control grooves 3a and the discharge opening, and the operation of these control grooves 3a in association with the discharge opening 11 will be described hereinbelow with reference to Fig. 2. To vary the effective area of control grooves, the rack positions of the control rack 6 are varied and the plunger 3 is caused to pivot. The stroke of the plunger on its upward and downward movements is represented by the distance S_1 . If the stroke of the plunger is excessive to go beyond the distance S_1 to reach an additional stroke ΔS_1 , the plunger chamber 15 starts establishing a communication with the discharge opening 11 via the suction opening 3b. As the plunger 3 moves on a upward stroke, the fuel oil under pressure in the plunger chamber 15 is discharged into the fuel chamber 8 via the discharge opening 11. As a result, the pressure of the fuel oil is reduced, and thus the injection of the fuel into the engine cylinder may not take place. That is, a maximum stroke at the rack position R_{c1} is $(S_1 + \Delta S_1)$ and this ΔS_1 represents a limit stroke at which the engine may be protected from the imposition of overloads. Similarly, symbols S_2 and ΔS_2 represent a normal stroke and a limit stroke at the rack position R_{c2} respectively.

Fig. 3 is an assembly view showing the upper portion structure in a second embodiment of the present invention. In a system where an injection pressure is relative low, there is a less tendency that the secondary injection of the fuel and the phenomenon of cavitation take place, and so the provision of the orifice 33 and the retraction valve which is needed in the first embodiment to effectuate a secondary withdrawal can be dispensed, i. e., the system only needs the provision of the delivery valve and the inlet valve.

In the first embodiment, it is not needed to arrange the retraction valve 25 and the inlet valve in series provided that a sufficient space is available on the valve seat body 20 for arranging a suction opening of dimensions greater than the orifice 33 in parallel with the inlet valve.

Claims

(1). A fuel injection system, wherein a plunger (3) is caused to slide under the action of elevated pressure oil from an external fuel chamber so that a fuel to be pressurized inside the plunger chamber (15) may be supplied to a fuel injection nozzle

via the passage (32) of the discharge union (4), said fuel injection system being characterized in that said plunger (3) is biased by a spring (8) in an opposite direction against which the fuel is pressurized, a suction chamber (17) and said plunger chamber (17) are connected each other via an inlet valve (23) and said plunger chamber (15) and said passage (32) are also connected each other via a delivery valve (21).

(2). The fuel injection system in accordance with Claim (1), wherein there is further provided a passage which is branched off from said delivery passage (32), and an opposite branch end of said branch passage is connected with said plunger chamber (15) via a retraction valve (25).

(3). The fuel injection system in accordance with Claims (1) - (2), wherein a plunger barrel (2) is provided with a discharge opening (11) which communicates with a suction chamber (17) and said plunger (3) is provided with a control groove (3a) for controlling the piston stroke.

(4). The fuel injection system in accordance with Claim (3), wherein said plunger barrel (2) is provided with a control sleeve (5) which is freely pivotably supported thereon and can cause said plunger (3) to rotate, and a pump housing (1a) is provided with a control rack (6) for pivoting said sleeve (5).

FIG. 1(a)

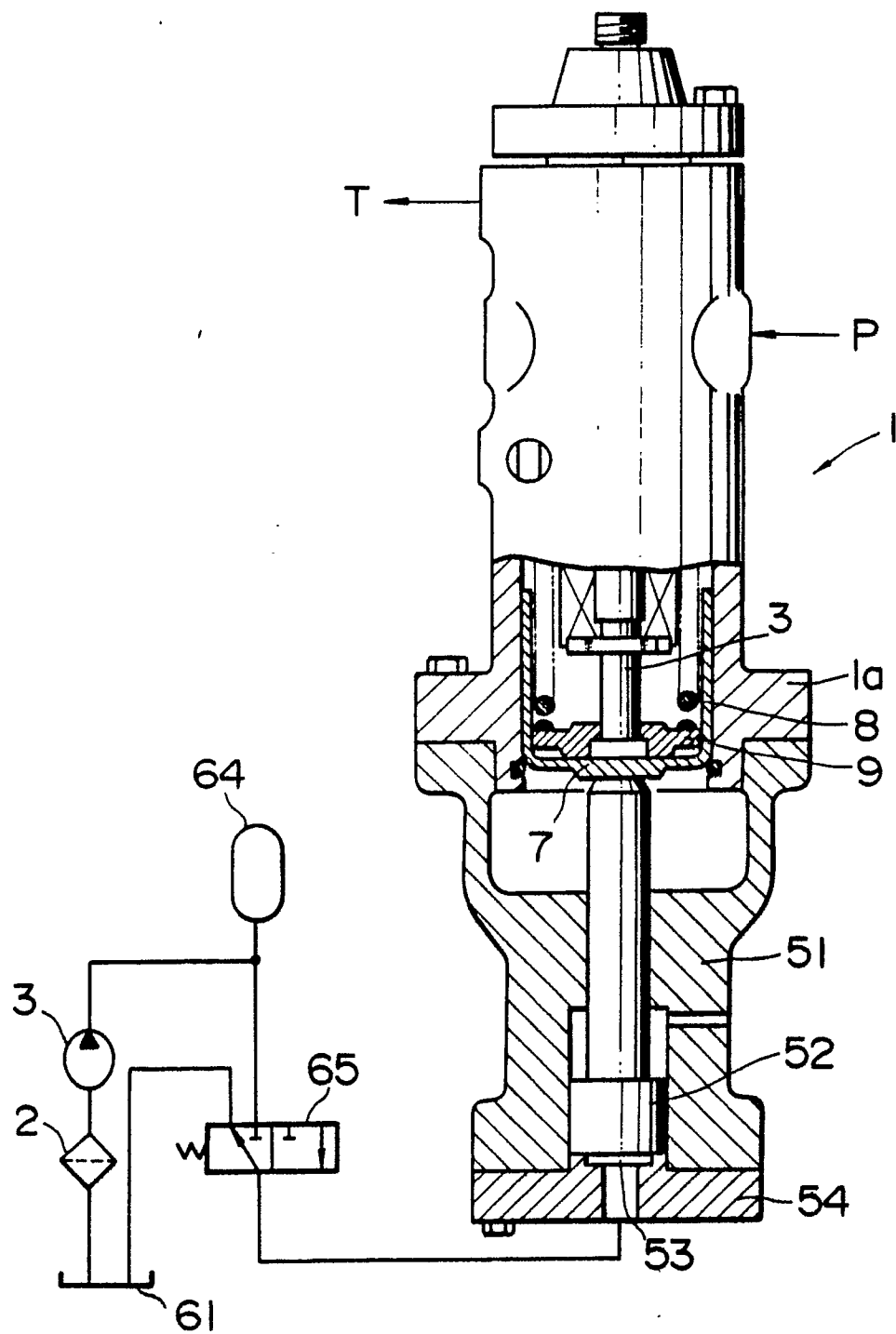


FIG. 1(b)

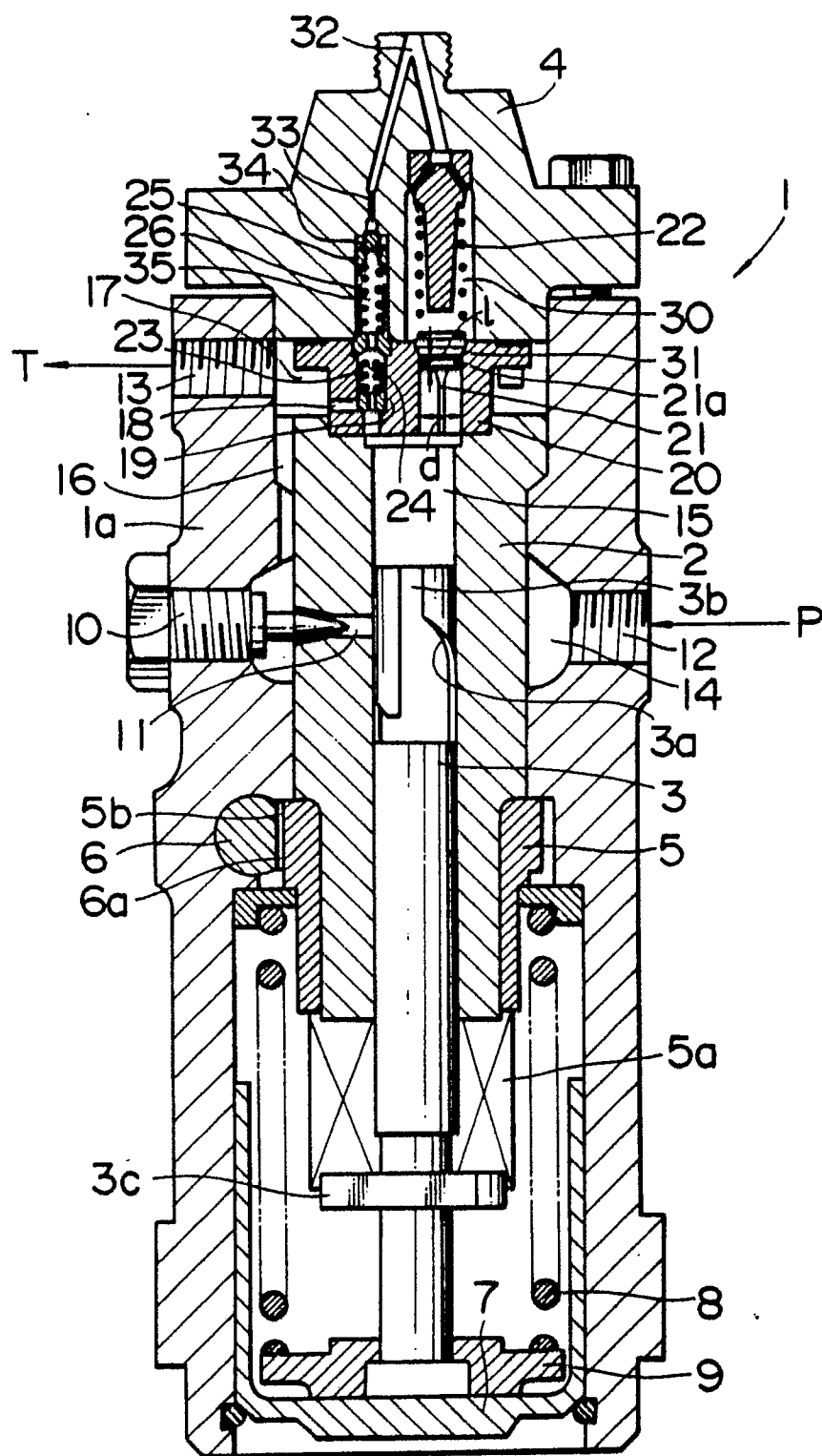


FIG. 1(c)

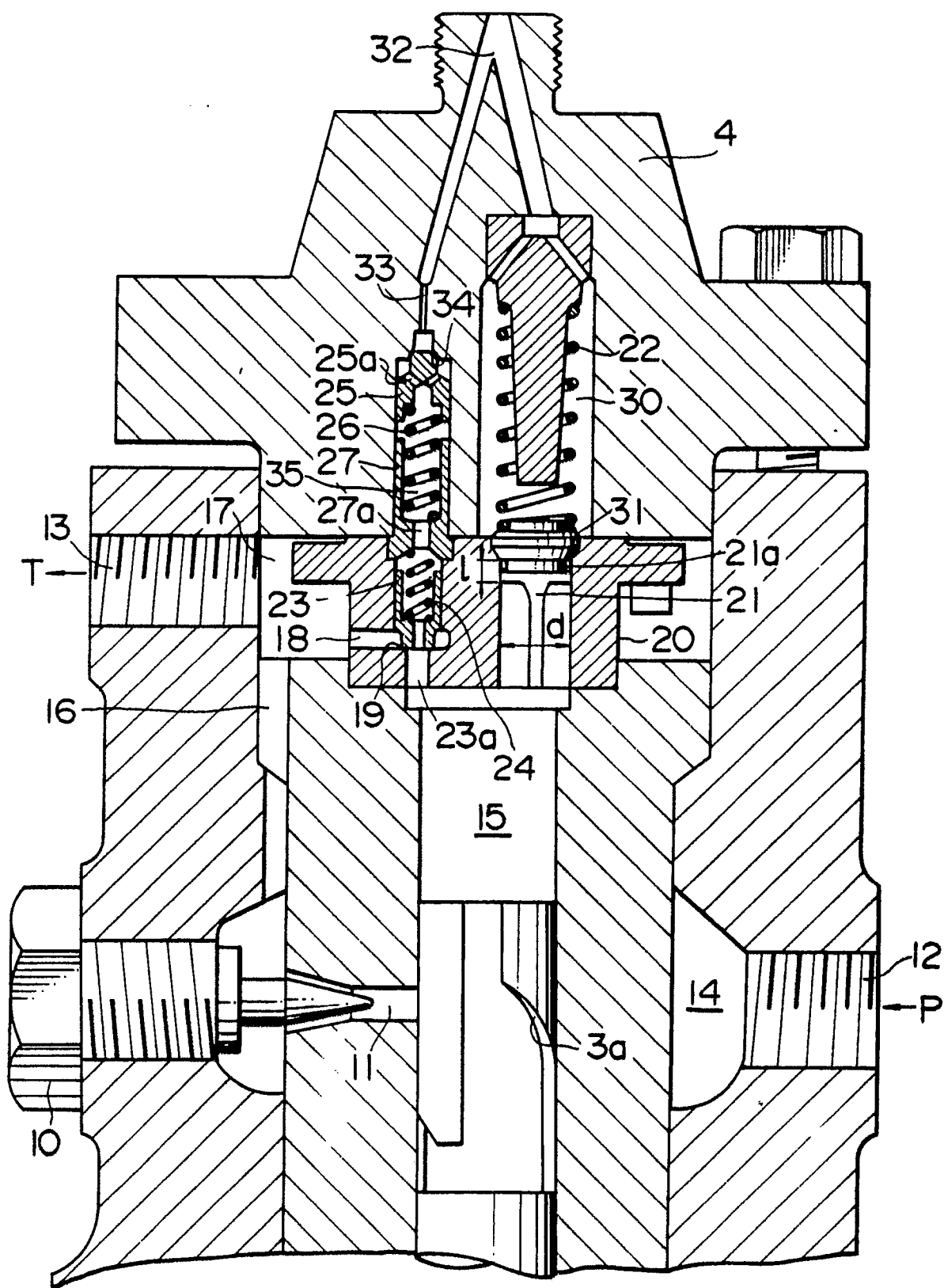


FIG. 2

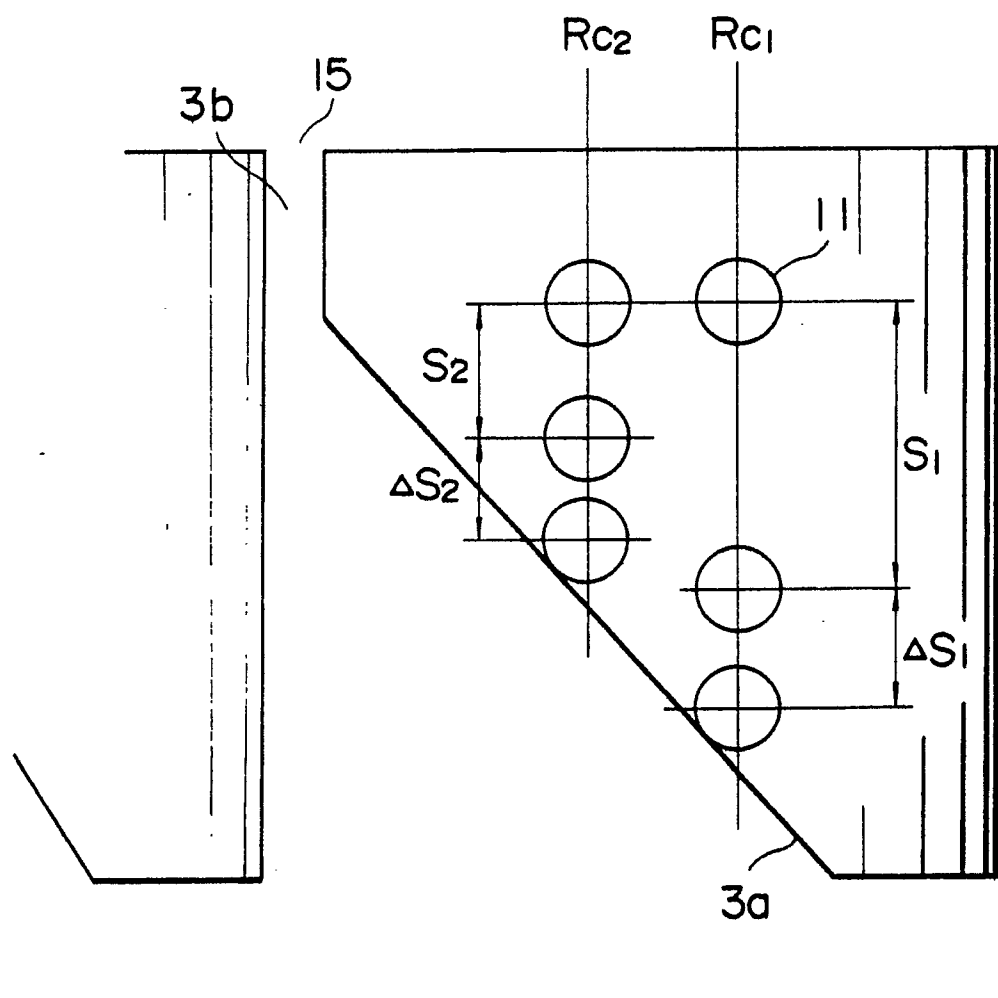
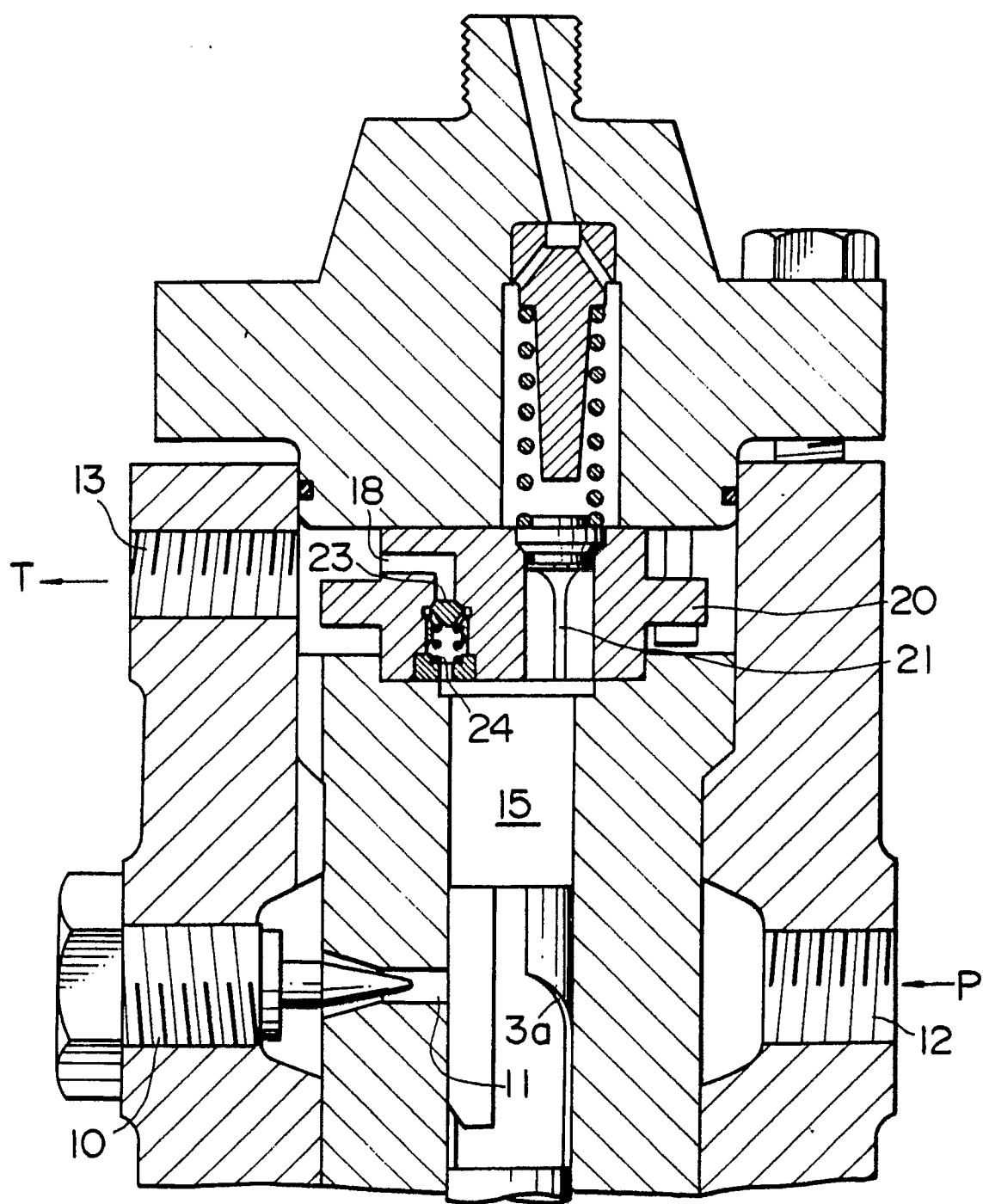


FIG. 3





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EUROPEAN SEARCH REPORT

Application Number

EP 90 25 0087

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.5)
X	FR-A-2456221 (BENAROYA) * page 4, line 18 - page 5, line 7; figure 1 * ---	1	F02M59/46
X	FR-A-803260 (ROGGERO) * the whole document * ---	1	
Y	FR-A-1377870 (SULZER FRERES SOCIETE ANONYME) * the whole document * ---	1-4	
Y	GB-A-2107801 (L'ORANGE GMBH) * the whole document * ---	1-4	
A	GB-A-690563 (C.A.V. LIMITED) * the whole document * ---	1, 3, 4	
A	FR-A-1550854 (BRYCE BERGER LIMITED) * the whole document * -----	1, 3, 4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02M
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 12 JULY 1990	Examiner HAKHVERDI M.
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