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54 **INTEGRAL HYDRAULIC BLOCKING AND RELIEF VALVE.**

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73 Proprietor: **THE BOEING COMPANY**
P.O. Box 3707 Mail Stop 7E-25
Seattle, WA 98124 (US)

72 Inventor: **TURNER; Bernus Gene**
13818 - 162nd Northeast
Woodinville, WA 98072 (US)

74 Representative: **Hooijtink, Reinoud et al**
OCTROOIBUREAU ARNOLD & SIEDSMA 1,
Sweelinckplein
NL-2517 GK Den Haag (NL)

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Description

The present invention relates to an integral blocking and relief valve for blocking the flow of a hydraulic fluid unless the pressure of said fluid exceeds a predetermined value, as described in the preamble of claim 1.

Such a blocking and relief valve is known from US—A—3.943.968. In this known valve the second piston portion is part of the first piston, which has the effect that this piston must be biased with a heavy spring to urge it in a direction away from the second piston. Therefore, this known valve has a relatively great number of parts but provides successfully a constant relief setting regardless of system pressure.

It is an object of the invention to improve the valve of the kind as mentioned above by reducing the number of parts and therefore enhance the reliability in operation.

According to the invention this is achieved by the measures described in the characterizing part of claim 1. The number of necessary parts is reduced, because the first piston does not have to be biased by a spring. The first piston is simply guided in its bore. The reliability of the valve according to the invention is improved, as elimination of a spring means elimination of a potential source of failure.

The invention will be further illustrated in the following description of a preferred embodiment.

Fig. 1 is a cross-sectional view of the preferred embodiment of the integral blocking and relief valve in an aircraft spoiler actuator application;

Fig. 2 illustrates operation of the system shown in Fig. 1 in the spoiler extend mode; and

Fig. 3 illustrates the system of Fig. 1 in the spoiler retract mode and also shows the blocking and relief characteristics of the valve.

Fig. 1 is a cross-sectional view of an aircraft spoiler actuator system incorporating a preferred embodiment of the instant integral blocking and relief valve. The basic system components include a control valve 10, the integral blocking and relief valve 12 and the actuator 14.

The control valve 10 is of conventional design being comprised of a spool 20 having a series of three land portions 22—24 provided thereon. The spool 20 and lands 22—24 are slidably guided within a cylinder 26. A series of cavities 32—34 are associated with each land 22—24. In the present system, a source of high pressure hydraulic fluid is coupled to the cavity 33 whereas the return, or reservoir system pressure is coupled to cavity 32. Associated with each cavity is an exit port 36—38 with additional exit ports 40—42 being provided from the cavity 26. Thus, the control valve 10 responds to the position of the spool 20 within the cylinder 26 to meter hydraulic fluid into, and out of various of its ports.

As with the control valve 10, the actuator 14 is of conventional design. Thus, a piston 50 is slidably guided within a cylinder 52. Packing material 54, such as an "O" ring, seals the piston 50 against the cylinder walls thereby forming an

extend chamber 56 and a retract chamber 58. A rod 60 extending from the piston 50 connects through suitable linkage to an aircraft spoiler (not shown).

As shown, hydraulic fluid is coupled to the actuator extend chamber 56 directly from the output port 42 of the control valve 10 whereas fluid from the retract chamber 58 passes through the integral blocking and relief valve 12 before reaching the control valve. Thus, the blocking and relief provided by valve 12 operates on fluid in the actuator retract chamber 58.

The preferred construction of the integral blocking and relief valve 12 includes an input port 70 which couples fluid to a first chamber 72. A first piston P_A is slidably guided in the first chamber 72. At its first end 74 the piston P_A has an area A_A exposed to hydraulic fluid coupled through the input port 70. Suitable packing 76 seals the piston P_A in its chamber 74.

A second piston P_B has a first portion 80 which is slidably guided in a pressure relief chamber 83. Suitable packing 84 seals the first portion 80 within the chamber 83.

Integral with the first portion 80 of the second piston P_B is a second portion 82. Second portion 82 is slidably guided in, and exposes a total area A_{SB} to a relief bias chamber 86. Suitable packing 88 seals the second portion 82 within the chamber 86.

A plunger 90 extends from the second end of the first portion 80. A second input port 92 connects to the pressure relief chamber 82 and, as shown, is coupled to output port 40 of control valve 10.

A pressure bias port 100, which connects to the metered system high pressure output port 37 of control valve 10, accesses a pressure bias chamber 102. The pressure bias chamber 102 joins the first chamber 72 with the relief bias chamber 86 such that the second end 75 of the first piston P_A can abut the free end of the second portion 82.

A relief port 120, which connects to system return pressure via port 36 of control valve 10, connects to the relief bias chamber 86.

A poppet valve 130 is slidably guided in a poppet chamber 132. The poppet chamber 132 joins with the pressure relief chamber 83 and the first input port 70 such that hydraulic fluid at the first input port 70 is controllably passed to the pressure relief chamber dependent upon the position of the poppet 130.

The poppet 130 has a face portion 134 which exposes an effective area A_P to the pressure relief chamber. Further, the poppet face portion 134 is engagable by the plunger portion 90 of the second piston P_B such that the poppet may be driven to a position allowing the flow from the input port 70 to the pressure relief chamber 83.

A passageway 136 provided in the poppet 132 allows equalization of hydraulic pressure throughout the poppet chamber 132.

A spring pair 140 biases the second piston P_B out of engagement with the poppet 130. A second

spring pair 142 biases the poppet 130 such that it tends to block fluid flow from the first input port 70 to the pressure relief chamber 83.

Identical reference numerals are used throughout Figs. 2 and 3 to correspond to identical parts shown in Fig. 1.

Fig. 2 illustrates operation of the system shown in Fig. 1 in the cylinder extend mode. Here, via a suitable control (not shown) from the flight deck, the control valve spool 20 slides to the right within cylinder 26. Thus, the system pressure P forces hydraulic fluid into the cavity 33, out output port 42 and into the extend chamber 56 of the actuator 14.

Thus, the piston 50 is driven to the right whereby rod 60 deflects the spoiler (not shown) to its extend position.

Fluid in the retract chamber 58 is routed to the first input port 70 where it is coupled both to the exposed area A_A of the first piston P_A and to the poppet chamber 132.

Also, system high pressure is routed through the pressure bias port 100 to the pressure bias chamber 102. In this mode, the net forces on the second piston P_B are sufficient to overcome the forces due to the spring pair 140 such that second piston P_B is deflected to the left. In so doing, the plunger 90 engages the poppet 130 such that it is driven to the left in opposition to its spring pair 142. Now, fluid from the retract chamber 58 is permitted to flow from the first input port 70 to the pressure relief chamber 83. The fluid then flows out port 92 and into port 40 of control valve 10 and, finally, out of cavity 32 to the system return reservoir.

Fig. 3 illustrates operation of the system in the cylinder retract mode. Here, a suitable signal from the flight deck moves the spool 20 to the left within cylinder 26 of control valve 10. This allows fluid in the extend chamber 56 to pass into control valve port 42, chamber 34 and through port 36 to chamber 32 and, thus, to system return pressure. The piston 50 moves to a "bottomed" position within its cylinder thereby activating the spoiler (not shown) to its retract position. Fluid pressure in the retract chamber 58 rises to system pressure.

Now, system pressure as metered through cavity 33, output port 40 and second input port 92, along with the force exerted by the spring pair 140 drives the second piston P_B to the right against system pressure in the pressure bias chamber 102. This results in the poppet 130 closing (shown in dashed lines) thereby acting as a blocking valve to prevent movement of the piston 50 (and, thus, the spoiler) due to loads on the spoiler.

By design, the exposed area A_A of the first piston P_A is greater than the exposed area A_P on the face 134 of the poppet 130. Thus, if pressure in the retract chamber 58 exceeds a predetermined level due to thermal effects or external loading, then this pressure acting on the differential area $A_A - A_P$ creates a force urging the first piston P_A to the left contacting piston P_B and driving the second piston P_B to the left opening the poppet

130 and thereby relieving the trapped pressure into chamber 83 and, via port 92 and control valve 10, to the hydraulic system.

A particular feature of the invention is that the stepped area A_{SB} of the second portion 82 of the second piston P_B referenced to return is related to the exposed area A_A of the first piston P_A and to the exposed area A_P of the poppet 130 by the relationship:

$$A_{SB} \cong A_A - A_P.$$

This relationship assures that pressure in the retract chamber 58 will be relieved independent of the value of system pressure.

Ideally, ignoring friction, this may be understood as follows. For the condition of zero system pressure, the system will provide relief (i.e. poppet 130 will begin to open) in accordance with the following relationship:

$$P_R = F_s / (A_A - A_P)$$

where

P_R = relief pressure and
 F_s = spring force.

For the condition of an existing system pressure P_s , and ignoring the force resulting from the stepped area A_{SB} of the second piston P_B , pressure relief would be provided in accordance with the following relationship;

$$P_R = [F_s / (A_A - A_P)] + P_s.$$

Comparing the above relationships, it is apparent that relief pressure is directly related to system pressure.

Assuming a given system pressure P_s and assuming that return pressure is equal to zero, the following relationship, taking into account the contribution from the stepped area A_{SB} may be shown:

$$(P_R - P_s) (A_A - A_P) + P_s A_{SB} = F_s.$$

Assuming

$$A_{SB} \cong A_A - A_P,$$

the expression for the relief pressure reduces to:

$$P_R = F_s / (A_A - A_P).$$

Comparing this last equation with the above equation for the condition wherein system pressure is zero, it can be seen that due to the contribution of the stepped area A_{SB} the present unique valve design relieves system pressure at the same, predetermined level, independent of any influence due to system pressure.

In summary, an improved integral blocking and relief valve has been shown which provides pressure relief at a value independent of system pressure levels. In addition, the valve utilizes relatively few parts and, as such, is simple to construct and relatively reliable in use.

While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which are within the true spirit and scope of the invention.

For example, while fluid blocking in the retract position of the spoiler has been described, it is apparent that such blocking could be provided in the extend position.

Claims

1. An integral blocking and relief valve (12) for blocking the flow of a hydraulic fluid unless the pressure of said fluid exceeds a predetermined value, comprising:

a first input port (70) adapted to be connected to the hydraulic fluid source (58) to be blocked and relieved;

a second input port (92) adapted to be connected to a system controlled hydraulic flow line (40);

a pressure bias port (100) adapted to be connected to a source (37) of system hydraulic pressure (P);

a relief port (120) adapted to be connected to the system return pressure (R);

a first chamber (72) connected to the first input port (70) and slidably guiding a first piston (P_A) having at a first end (74) an area (A_A) exposed in the first chamber (72);

a pressure bias chamber (102) connected to the pressure bias port (100), in which a second end (75) of the first piston (P_A) is exposed;

a pressure relief chamber (83) connected to the second input port (92) and slidably guiding a second piston (P_B), comprising a plunger portion (90) extending therefrom and at the opposite side being exposed in the pressure bias chamber (102) capable of engagement with the second end (75) of the first piston (P_A);

a poppet chamber (132) joining the pressure relief chamber (83) and being connected to the first input port (70) and housing a poppet valve (130) exposing an area (A_P) to the pressure relief chamber (83) and being engageable by the plunger portion (90) of the second piston (P_B) to drive the poppet (130) to a position to allow flow from the poppet chamber (132) to the pressure relief chamber (83); and

a relief bias chamber (86) connected to the relief port (120) and slidably guiding a second piston portion (82) integral with a first piston portion (80) of smaller diameter of one (P_B) of said pistons and exposing an annular area (A_{SB}) to the relief bias chamber (86), characterized in that the relief bias chamber (86) is arranged between the pressure relief chamber (83) and the pressure bias chamber (102), and that the second piston portion (82) exposed therein is part of the second piston (P_B).

2. Valve according to claim 1, characterized in that the area (A_{SB}) of the second piston (P_B) exposed in the relief bias chamber (86) is substantially equal to the difference between the area (A_A)

of the first piston (P_A) exposed in the first chamber (72) and the area (A_P) of the poppet valve (130) exposed to the pressure relief chamber (83) ($A_{SB} \cong A_A - A_P$).

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Patentansprüche

1. Integrales Blockierungs- und Entspannungsventil (12) zum Blockieren der Strömung eines hydraulischen Strömungsmittels, sofern nicht der Druck dieses Strömungsmittels einen vorbestimmten Wert übersteigt, umfassend:

einen ersten Eingangskanal (70), der dazu geeignet ist, mit der hydraulischen Strömungsmittelquelle (58), die blockiert und entlastet werden soll, verbunden zu werden;

einen zweiten Eingangskanal (92), der dazu geeignet ist, mit einer systemgesteuerten Hydraulikströmungsleitung (40) verbunden zu werden;

einen Druckvorspannungskanal (100), der dazu geeignet ist, mit einer Quelle (37) von Systemhydraulikdruck (P) verbunden zu werden;

einen Entspannungskanal (120), der dazu geeignet ist, mit dem Systemrückdruck (R) verbunden zu werden;

eine erste Kammer (72), die mit dem ersten Eingangskanal (70) verbunden ist und einen ersten Kolben (P_A) verschiebbar führt, der an einem ersten Ende (74) eine Fläche (A_A) hat, die in der ersten Kammer (72) freiliegt;

eine Druckvorspannungskammer (102), die mit dem Druckvorspannungskanal (100) verbunden ist, in welcher ein zweites Ende (75) des ersten Kolbens (P_A) freiliegt;

eine Druckentspannungskammer (83), die mit dem zweiten Eingangskanal (92) verbunden ist und einen zweiten Kolben (P_B) verschiebbar führt, der einen Plungerteil (90) umfaßt, welcher sich von diesem aus erstreckt und an der entgegengesetzten Seite in der Druckvorspannungskammer (102) freiliegt sowie in der Lage ist, mit dem zweiten Ende (75) des ersten Kolbens (P_A) in Eingriff zu treten;

eine Ventilkegelkammer (132), die sich an die Druckentspannungskammer (83) anschließt und mit dem ersten Eingangskanal (70) verbunden ist sowie ein Tellerventil (130) beherbergt, von dem eine Fläche (A_P) zu der Druckentspannungskammer (83) freiliegt und das mit dem Plungerteil (90) des zweiten Kolbens (P_B) in Eingriff treten kann, so daß der Ventilkegel (130) in eine Position getrieben wird, in der eine Strömung von der Ventilkegelkammer (132) zu der Druckentspannungskammer (83) ermöglicht wird; und

eine Entspannungsvorspannungskammer (86), die mit dem Entspannungskanal (120) verbunden ist und einen zweiten Kolbenteil (82) verschiebbar führt, der integral mit einem ersten Kolbenteil (80) von kleinerem Durchmesser von einem (P_B) der Kolben ist und von dem eine ringförmige Fläche (A_{SB}) zu der Entspannungsvorspannungskammer (86) freiliegt,

dadurch gekennzeichnet, daß die Ent-

spannungsvorspannungskammer (86) zwischen der Druckentspannungskammer (83) und der Druckvorspannungskammer (102) angeordnet ist und daß der zweite Kolbenteil (82), der darin freiliegt, ein Teil des zweiten Kolbens (P_B) ist.

2. Ventil nach Anspruch 1, dadurch gekennzeichnet, daß die Fläche (A_{SB}) des zweiten Kolbens (P_B), die in der Entspannungsvorspannungskammer (86) freiliegt, im wesentlichen gleich der Differenz zwischen der Fläche (A_A) des ersten Kolbens (P_A), die in der ersten Kammer (72) freiliegt, und der Fläche (A_P) der Tellerventils (130), die zu der Druckentspannungskammer (83) freiliegt, ist ($A_{SB} \equiv A_A - A_P$).

Revendications

1. Distributeur monobloc d'arrêt et de décharge (12) destiné à interrompre la circulation d'un fluide hydraulique à moins que la pression du fluide dépasse une valeur prédéterminée, comprenant:

un premier canal d'entrée (70) destiné à être connecté à la source de fluide hydraulique (58) afin que le fluide soit arrêté et que sa pression soit déchargée,

un second canal d'entrée (92) destiné à être relié à une canalisation hydraulique (40) commandée par le circuit,

un canal de rappel par pression (100) destiné à être connecté à une source (37) de pression hydraulique du circuit (P),

un canal de décharge (120) destiné à être connecté à la pression de retour du circuit (R),

une première chambre (72) reliée au premier canal d'entrée (70) et guidant le coulissement d'un premier piston (P_A) ayant, à une première extrémité (74) une section (A_A) exposée dans la première chambre (72),

une chambre de rappel par pression (102) reliée au canal de rappel par pression (100), dans

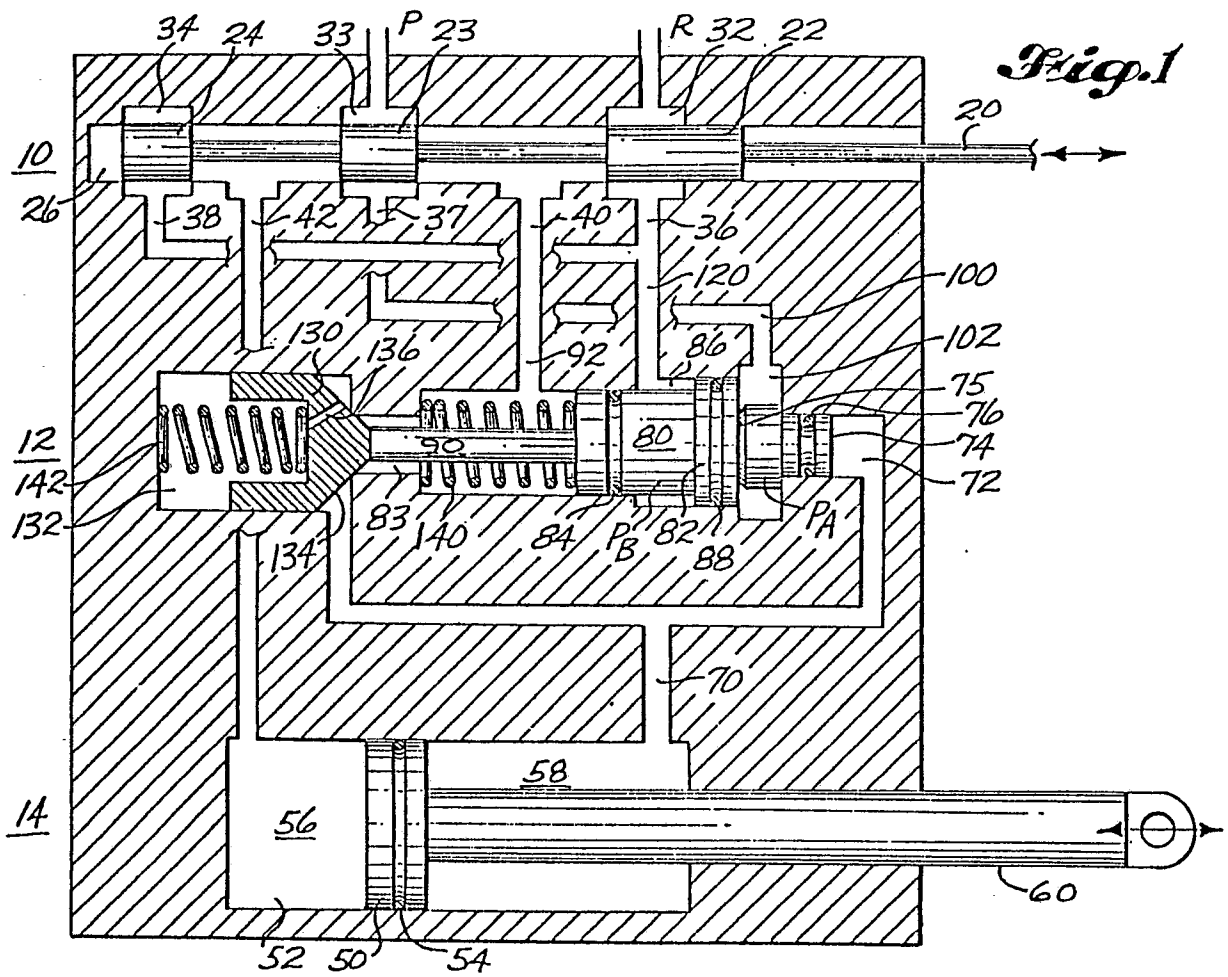
laquelle une seconde extrémité (75) du premier piston (P_A) est exposée,

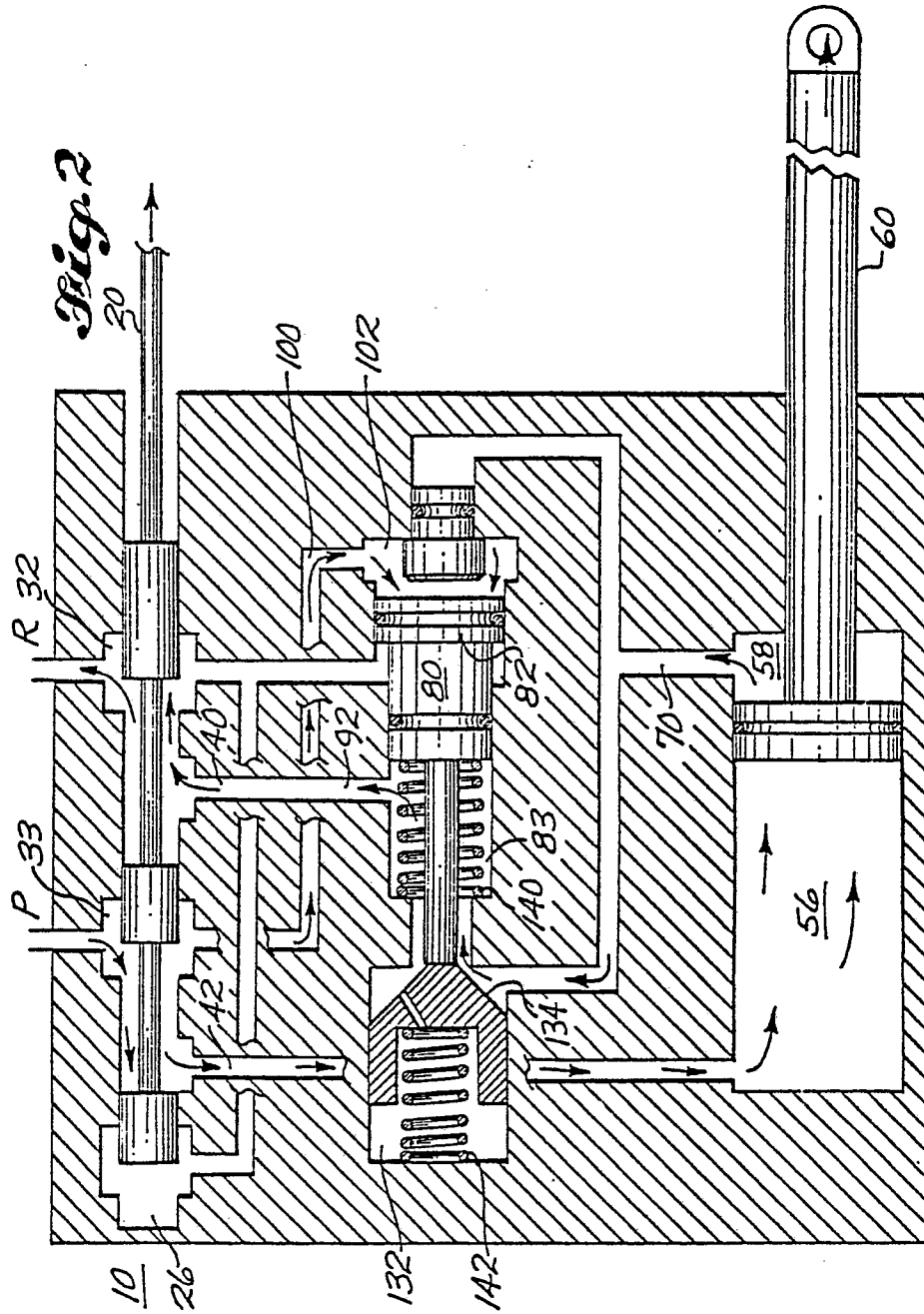
une chambre de décharge de pression (83) reliée au second canal d'entrée (92) et guidant le coulissement d'un second piston (P_B) comprenant une partie formant plongeur (90) qui en dépasse d'un côté et, de l'autre, qui est exposé dans la chambre de rappel par pression (102), tout en pouvant coopérer avec la seconde extrémité (75) du premier piston (P_A),

une chambre de soupape (132) rejoignant la chambre de décharge de pression (83) et reliée au premier canal d'entrée (70) et logeant une soupape (130) qui expose une section (A_P) à la chambre de décharge de pression (83), et qui est destinée à coopérer avec la partie de plongeur (90) du second piston (P_B) afin que la soupape (130) soit déplacée vers une position permettant la circulation de la chambre de soupape (132) à la chambre de décharge de pression (83), et

une chambre de rappel et de décharge (86) reliée au canal de décharge (120) et logeant une seconde partie de piston (82) qui peut y coulisser et qui est solidaire d'une première partie de piston (80) de plus petit diamètre de l'un (P_B) des pistons et exposant une surface annulaire (A_{SB}) du côté de la chambre de rappel et de décharge (86), caractérisé en ce que la chambre de rappel et de décharge (86) est placée entre la chambre de décharge de pression (83) et la chambre de rappel par pression (102), et en ce que la seconde partie de piston (82) exposée dans la chambre fait partie du second piston (P_B).

2. Distributeur selon la revendication 1, caractérisé en ce que la section (A_{SB}) du second piston (P_B) exposée dans la chambre de rappel et de décharge (86) est sensiblement égale à la différence entre la section (A_A) du premier piston (P_A) exposée dans la première chambre (72) et la section (A_P) de la soupape (130) exposée à la chambre de décharge de pression (83) ($A_{SB} \approx A_A - A_P$).





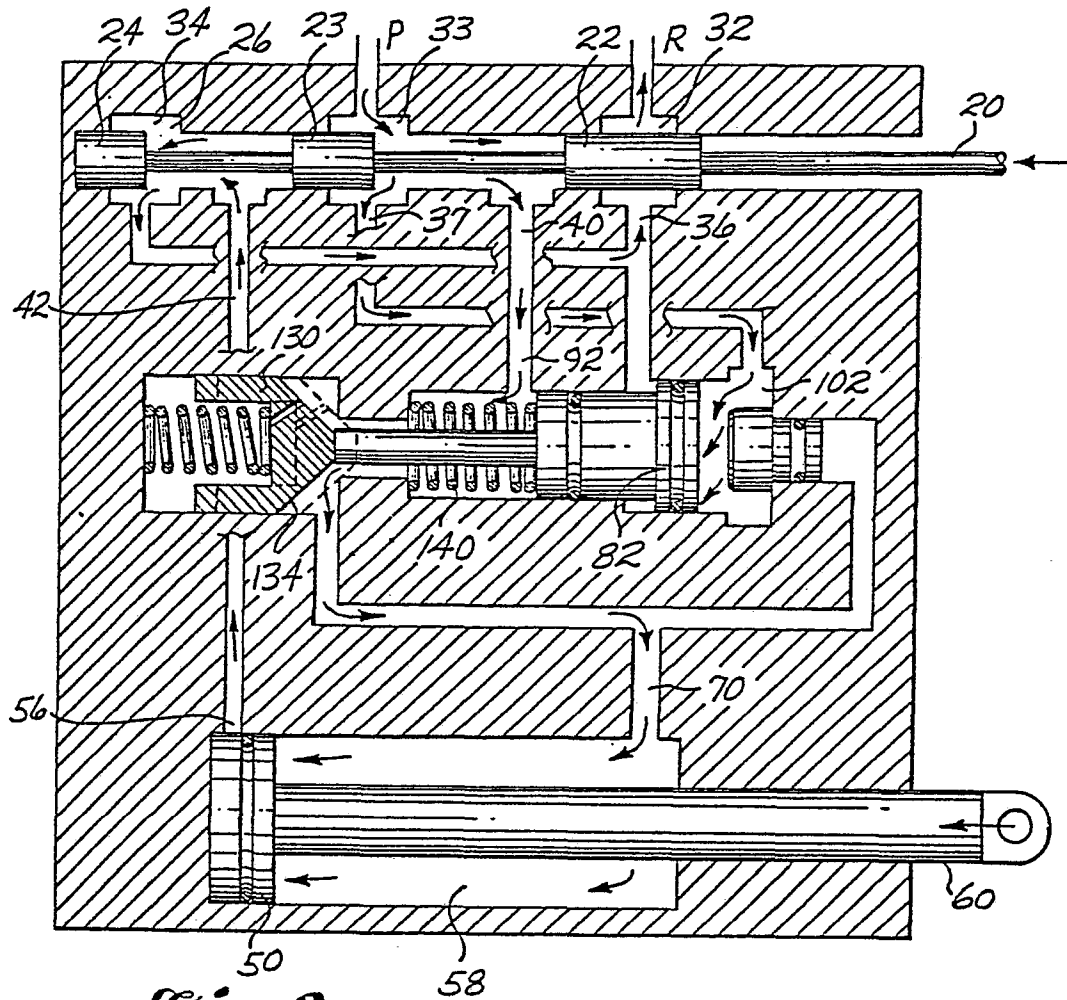


Fig.3