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(54) **TORQUE AND HIGH PRESSURE LIMITING CONTROL FOR VARIABLE DISPLACEMENT PUMPS.**

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**US-A-3 999 892**
**US-A-4 034 564**

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**Description**

Technical Field

This invention relates generally to a torque and high pressure limiting control for variable displacement pumps and more particularly to modulating means for continuously modulating a fluid pressure signal originating in a fluid actuator to vary the displacement of a variable displacement pump to prevent the system from exceeding a desired horsepower range and pressure level.

Background Art

Hydraulic control circuits employed for controlling the actuation of variable displacement pumps of the type employed in construction vehicles, such as excavators, oftentimes include a so-called "load-plus" valve. The valve generally functions to maintain the discharge pressure of the pump above a minimum pressure level and also above a load pressure generated in a fluid actuator, such as a double-acting hydraulic cylinder. A valve of this type is fully disclosed in U.S. Patent No. 4,116,587, issued on September 26, 1978 to Kenneth P. Liesener and assigned to the assignee of this application.

The "load-plus" valve functions to sense a load pressure signal and to automatically actuate a swash plate of the pump in response to such signal to maintain a desired pump discharge pressure. Although this control system works quite well, it has been found lacking in the provision of means for limiting system pressures to acceptable levels and obtaining maximum performance efficiency from the prime mover for the pump. In accordance with the teachings of this invention, it has been found that the horsepower required of the prime mover can be limited and closely controlled in an infinite manner by modulating the load pressure signal directly to vary the load pressure signal communicated to the "load-plus" valve.

The present invention is directed to overcoming one or more of the problems as set forth above.

It should be noted that US—A—4 034 564 teaches a fluid circuit having a fluid actuator, a variable displacement pump including a control member movable between first and second displacement positions, first biasing means for urging said control member toward its first displacement position, and second biasing means for urging said control member towards its second displacement position in opposition to said first biasing means and in response to a load pressure signal communicated thereto from said fluid actuator, wherein modulating means for modulating said load pressure signal in said second biasing means to vary the displacement of said pump in response to the magnitude of said load pressure signal. Further, US—A—3 999 892 teaches modulating means which vary the displacement of a pump also in response to the position of a control member of said pump.

In accordance with the present invention a fluid circuit having the features set forth in the preamble of claim 1 is characterized by the features of the second part of claim 1. Preferred embodiments of the invention are disclosed in the subclaims.

The improved fluid circuit, incorporating the modulating means therein, will thus provide maximum performance efficiency from the prime mover, such as an internal combustion engine, utilized to drive the pump. The control circuit is torque limiting since the modulated load pressure signal is a function of both pump discharge pressure and pump displacement, i.e., the load pressure signal thus becomes a function of pump torque. This relationship is graphically illustrated in Figure 4 wherein curve A plots pump flow versus the load pressure signal and wherein curve B represents a horsepower curve for a particular engine.

Brief Description of the Drawings

Other objects and advantages of this invention will become apparent from the following description and accompanying drawings wherein:

Figure 1 schematically illustrates a fluid circuit employing a torque and high pressure limiting control for a variable displacement pump incorporating a first modulating valve embodiment of the present invention therein;

Figure 2 is a longitudinal sectional view through the pump and control therefor;

Figure 3 is an enlarged sectional view of the modulating valve of the control;

Figure 4 graphically illustrates a curve A plotting pump flow versus a load pressure signal and a horsepower curve B;

Figure 5 is a sectional view illustrating a second modulating valve embodiment;

Figure 6 is a sectional view illustrating a third modulating valve embodiment; and

Figure 7 is a sectional view illustrating a fourth modulating valve embodiment and an override means associated therewith.

Best Mode of Carrying Out the Invention

Figure 1 illustrates a fluid circuit 10 comprising a variable displacement pump 11 adapted to communicate pressurized fluid from a source 12 to a fluid actuator 13 under the control of a directional control valve 14. A prime mover 15, such as an internal combustion engine, is adapted to drive pump 11 which may take the form of a hydraulic pump of the type shown in Figure 2. In the illustrated fluid circuit, actuator 13 constitutes a double-acting hydraulic cylinder adapted for use in construction vehicles and the like in a conventional manner.

Upon selective actuation of directional control valve 14, head and rod ends of actuator 13 may be alternately pressurized and exhausted in a conventional manner via lines 16 and 17 and lines 18 and 19. Upon pressurization of one of the ends of actuator 13, a line 20 will communicate a load pressure signal $P_L$ through an orifice 21 and into a passage 20′ within a servo-system 22 for pump 11. As described more fully hereinafter, servo-system 22 includes a so-called "load-plus" valve 23 (Figure 2) for maintaining pump discharge pressure $P_D$ in line 18 at a specified level above load pressure signal $P_L$ in line 20 and a modulating means or horsepower limiting valve 24 for modulating load pressure signal $P_L$.

Referring to Figure 2, pump 11 comprises a barrel 25 adapted to be driven by an output shaft 26 of engine 15, a plurality of reciprocal pistons 27 connected to a control member or swash plate 28, and a housing 29 enclosing the pump assembly. The displacement of pump 11 is determined by the rotational orientation of swash plate 28 which has opposite sides thereof connected to first and second biasing means 30 and 31 by rods 32 and 33, respectively. In the position shown, swash plate 28 will effect maximum pump displacement, whereas horizontal orientation of the swash plate in Figure 2 will effect zero or minimum displacement of the pump.

Second biasing means 31 may be considered to include "load-plus" valve 23, which functions substantially identically to the corresponding valve disclosed in above-referenced U.S. Patent No. 4,116,587. In the illustrated position of a spool 34 of valve 23, pump discharge pressure $P_D$ in a main discharge passage 35 will communicate with branch passages 36 and 37, connected to first and second biasing means 30 and 31, respectively. Branch passage 36 communicates discharge pressure to an actuating chamber 38 of biasing means 30 via a port 39 formed in a tubular member 40 secured within housing 29. The force generated by fluid pressure in chamber 38 will tend to urge swash plate 28 counterclockwise in Figure 2, towards its maximum displacement position shown, by acting on a piston 41 and rod 32. Such force is additive to the force of a compression coil spring 42 which is mounted between member 40 and a retainer 43 mounted on a lower end of piston 41.

Second branch passage 37 communicates pump discharge pressure to an annulus 44 to communicate such pressure to valve 23, via ports 45 and 46. Spool 34 of valve 23 has lands 47, 48, and 49 formed thereon to define annuluses 50 and 51 about the spool. Spool 34 is slidably mounted in a bore 52 defined in a tubular member 53 secured within housing 29 with the bore being blocked at the lower end of the spool by a plug 54.

An actuating chamber 55 is thus between reciprocal spool 34 and plug 54 and another actuating chamber 56 is defined between the plug and a piston 57 attached to rod 33. As discussed more fully hereinafter, pump discharge pressure communicated to branch passage 37 is communicated to actuating chamber 55 via port 46 and a longitudinal passage 58 formed in spool 34 to shift the spool upwardly in Figure 2 under certain operating conditions, against the opposed biasing force of a compression coil spring 59 and the fluid pressure prevalent in an actuating chamber 60. Chamber 60 is adapted to have load pressure signal $P_L$ communicated thereto via passage 20'.

Upward shifting of spool 34, responsive to pressurization of chamber 55, will uncover port 45 at land 48 to communicate the port with annulus 50 to, in turn, pressurize chamber 56 via annulus 50 and passage 61. Drain ports 62 are also formed in member 53 for exhausting chamber 56 upon downward movement of spool 34 from its Figure 2 position. Pressurization of chamber 56 will function to rotate swash plate 28 clockwise in Figure 2 against the opposing biasing forces of spring 42 and the fluid pressure prevalent in chamber 38 to destroke the pump by moving the swash plate towards its minimum displacement position of operation. The function of "load-plus" valve 23 is more fully described in above-referenced United States Patent No. 4,116,587.

As suggested above, this invention is directed to an improved fluid circuit 10, which further includes modulating means 24 for modulating load pressure signal $P_L$ in line 20' to continuously vary and automatically reset the displacement of pump 11. Referring to Figures 2 and 3, modulating means 24 includes a first spool 65 reciprocally mounted in a bore 66, defined in member 40, and a second spool 67 reciprocally mounted in a bore 68 defined in spool 65.

A stop, shown in the form of a cross pin 69, is secured within spool 65 to limit downward movement of spool 67, as shown in Figure 3. Spool 65 is urged downwardly in Figures 2 and 3 by a first compression coil spring 70 of a two-stage biasing means 71 which further includes a second compression coil spring 72. A lower end of spring 70 seats on a retainer 73 which receives an upper end of spool 67 therein.

Load pressure signal $P_L$ communicated to modulating means 24 by line 20 will enter an annulus 74 and communicate to an actuating chamber 75 via a port 76 defined in member 40, an annulus 77 defined on spool 65, and a port 78 formed in the spool. As described more fully hereinafter, pressurized fluid communicated to chamber 75 will act on the lower end of piston 67 to urge it upwardly against the opposed biasing force of spring 70 to initiate modulation of load pressure signal $P_L$, as depicted at point $A_1$ in Figure 4. In particular, upon sufficient upward movement of spool 67, load pressure signal $P_L$ will be modulated through metering slots 79 defined on spool 67, which are in communication on their upstream side with chamber 75 via a passage 80 and ports 81 and on their downstream side with a drain passage 82 upon opening thereof. This modulation of fluid will cause a fluid flow through orifice 21, creating a pressure drop thereacross to cause load pressure signal $P_L$ to become less in passage 20' than in line 20. If so desired, second spring 72 may be employed in cooperation with spring 70 to restage the modulation feature, as depicted at point $A_2$ in Figure 4.

As briefly described above, such modulation will vary load pressure signal $P_L$ in actuating chamber 60 of "load-plus" valve 23 to control the position of swash plate 28 and, thus, the displacement of pump 11. It should be noted that rod 32 and piston 41 comprise a follow-up linkage along with a rod 83 secured to the piston. Such follow-up linkage, upon clockwise pivoting of swash plate 28 in Figure 2, will function to move spool 65 upwardly and relative to spool 67 to modulate the opening and closing of slots 79 to drain passage 82, through a variable orifice 84 thus provided thereat.

It should be noted again in Figure 4, wherein pump flow or displacement is plotted against load pressure signal $P_L$ on a curve A, that at point $A_1$ and in response to increase in the load pressure signal that spool 67 will have moved upwardly against the opposed biasing force of spring 70 to modulate the load pressure signal through orifice 84. As a result, pump flow or displacement will drop towards point $A_2$ whereat spring retainer 73 will engage second spring 72 to provide a stiffer resistance to the opening of the orifice whereafter the curve will tend to flatten out. Figure 4 also illustrates a horsepower curve B which reflects the ability of the system to operate as close thereto as possible to thus conserve energy and operate the system efficiently. It is well known in the art that this typical horsepower curve is a direct function of pump displacement and load pressure.

It should be noted in Figure 3 that when the pump strokes sufficiently to obtain a predetermined maximum system pressure (MAX. at point $A_3$ in Figure 4) that the upper end of spool 65 will mechanically engage a stationary shoulder 65' so that no more spring force is applied to the spool by springs 70 and 72. Thus, load pressure signal $P_L$ is prevented from raising the spring load any higher and the maximum discharge pressure of the pump is limited.

Figure 5 illustrates a second horsepower limiting or modulating means embodiment 24a which functions similar to modulating means 24, described above. Identical numerals depict corresponding constructions and arrangements of the respective modulating means, with numerals depicting modified constructions in Figure 5 being accompanied by an "a".

As shown in Figure 5, load pressure signal $P_L$ communicated to modulating means 24a by line 20, will pass through fixed orifice 21 and communicate to passage 20'. Load pressure signal $P_L'$ will also communicate with an actuating chamber 75a, via annulus 74, port 76, an annulus 77a formed on a sleeve-like spool 65a, and ports 78a formed in the spool proper and a plug 65a' thereof. Spool 65a is reciprocally mounted in a tubular member 40a, having rod 83 of the follow-up linkage reciprocally mounted therein in a manner similar to that shown in Figure 2. A poppet 67a is biased downwardly against a seat formed on plug 65a' and defining a variable orifice 84a thereat by a compresssion coil spring 70a of a biasing means 71a.

Poppet 67a will thus control venting of load pressure signal $P_L$ from chamber 75a to drain passage 82 to thus control the operation of "load-plus" valve 23 (Figure 2) via passage 20'. Thus, the maximum desired pressure for a given displacement setting of pump 11, which is communicated to chamber 75a, will tend to open poppet valve 67a to vent the load pressure signal to reduce the displacement of the pump. A subsequent follow-up action will be effected by rod 83 moving upwardly to close poppet valve 67a at a position which has increased the force imposed on the poppet by spring 70a. In this manner, poppet 67a and its seat on plug 65a', defining variable orifice 84a, will function substantially in the manner described in respect to modulating means 24 whereby the feedback from the pivoting of swash plate 28 will vary the force of spring 70a to infinitely adjust the load pressure setting in proportion to the position of the swash plate, so that a pump displacement reduces, system pressure will become proportionately higher and still not overcome maximum available horsepower.

Figure 6 illustrates a third horsepower limiting or modulating means embodiment 24b which functions similar to modulating means 24 and 24a with one of the differences being that modulation of load pressure signal $P_L$ is accomplished by a pair of variable orifices 21b and 84b in series rather than by a series of one fixed orifice 21 and a variable orifice 84 or 84a. Identical numerals appearing in Figure 6 also depict corresponding constructions with numerals depicting modified constructions being accompanied by a "b" in Figure 6.

Load pressure signal $P_L$ communicated to modulating means 24b via line 20, is adapted to communicate with passage 20' leading to "load-plus" valve 23 (Figure 2) after undergoing a pressure drop across variable orifice 21b. The size of orifice 21b will vary depending on the reciprocal position of a spool 65b. When spool 65b moves upwardly from its position shown in Figure 6 to open orifice 21b, load pressure signal $P_L$ is communicated to passage 20' via passages 85 defined by a plurality of flat surfaces formed on the periphery of spool 65b, an annulus 66b, ports 76, and annulus 74. Simultaneously therewith, reduced load pressure signal $P_L$ will communicate from annulus 66b to an actuating chamber 75b, defined in spool 65b, via one or more ports 78b formed in spool 65b.

A slug 67b has its upper end disposed in engagement with housing 29 and has its lower end seated on the exit end of chamber 75b to define a second variable orifice 84b thereat. A compression coil spring 70b of a biasing means 71b has its lower end engaged on a retainer 87 which engages a rod 83b of a follow-up linkage. The follow-up linkage further includes a compression coil spring 42b disposed between a retainer 88 secured to a lower end of rod 83b and a piston 41b, engaged with rod 32. It should be noted in Figure 6 that branch passage 36, communicating with the pump discharge, further communicates with an actuating chamber 38b within the follow-up linkage via passages 39b.

In operation, spool 65b is normally urged upwardly in Figure 6 by spring 70b to provide substantial open communication from line 20 to line

20'. Load pressure signal $P_L$ prevalent in actuating chamber 75b acts against the lower end of slug 67b to exert a downward force on spool 65b in opposition to spring 70b. As the load pressure reaches the desired maximum for a given displacement of pump 11, equalling the available horsepower generated by the engine, spool 65b will move downwardly to create a variable orifice at 84b to vent load pressure signal $P_L$ to drain via drain passages 82b' and 82b, the periphery of retainer 73b being slotted for this purpose. The resultant reduction in load pressure signal $P_L$ in passage 20' will be reflected in actuating chamber 60 of "load-plus" valve 23 (Figure 2) to reduce the displacement of pump 11 in the manner described above. Clockwise pivoting of swash plate 28 in Figure 2, towards its minimum displacement position, will raise rod 32 of the follow-up or feedback linkage in Figure 6 to increase the force of spring 70b to thus increase the maximum pressure setting at this lower displacement setting for the pump.

Figure 7 illustrates a fourth horsepower limiting or modulating means embodiment 24c wherein identical numerals depict corresponding constructions, but wherein numerals depicting modified constructions are accompanied by a "c". Modulating means 24c functions similar to above-described modulating means 24, 24a, and 24b and is further associated with a hereinafter described override means 89 for selectively overriding the automatic function of modulating means 24c. It should become obvious to those skilled in the arts relating hereto that override means 89 could be also associated with modulating means 24, 24a, and 24b with minor modification to these systems.

Load pressure signal $P_L$ communicates to modulating means 24c through line 20 and fixed orifice 21 in passage 20', connected to chamber 60 of "load-plus" valve 23 (Figure 2). Load pressure signal $P_L$ communicates to an actuating chamber 75c, via annulus 74, port 76, an annulus 77c, and radial ports 78c formed in a rod 83c which is attached to a piston (not shown), similar to piston 41 in Figure 2. A piston or spool 67c is reciprocally mounted in rod 83c to selectively communicate chamber 74c with a drain passage 82c, through variable orifices 84c formed in the rod. Piston 67c is biased downwardly to cover orifices 84c by a compression coil spring 70c, having its lower end seated on a cup-shaped retainer 73c. It should be further noted that an upper end of piston 67c engages retainer 73c to act against spring 70c to provide the type of follow-up and resetting function described above.

Override means 89 includes a piston 90 adapted to apply a counteracting and overriding force to rod 83c, additive to the force of spring 70c, upon the selective pressurization of an actuating chamber 91. Chamber 91 is connected to a control 92, such as the steering valve of a construction vehicle, whereby orifices 84c, when opened by upward movement of piston 67c, can be closed upon pressurization of the chamber which forces piston 90 downwardly.

Industrial Applicability

Fluid circuit 10 and the modulating means 24, 24a, 24b, and 24c, employed in servo-system 22 thereof, find particular application to hydraulic circuits for construction vehicles and the like wherein close and efficient control of fluid actuator or cylinder 13 is required.

Referring to Figures 1—4, "load-plus" valve 23 will function as a conventional pressure compensated flow control valve operating in a normal manner throughout the working range of pump 11 to provide a load-sensitive control of pump discharge pressure $P_D$ in line 18, relative to load pressure signal $P_L$ by continuously providing a margin between these pressures, as described in above-referenced U.S. Patent No. 4,116,587. As load pressure signal $P_L$ reaches the desired maximum for a given displacement setting of pump 11, representative of the usable horsepower available from the engine, the load pressure signal $P_L$ in actuating chamber 75 (Figure 3) will initiate upward movement of spool 67 against the opposed biasing force of spring 70 until metering slots 79 open to form a variable orifice at 84. At this point, the load pressure signal in chamber 75 will be modulated to decrease the fluid pressure in chamber 60 (Figure 2) in a closely controlled manner thus causing an increase in fluid pressure in chamber 56 to rotate swash plate 28 clockwise, thus reducing the displacement of pump 11. Such rotation of swash plate 28 will move rod 32 of the follow-up linkage upwardly to close off metering slots 79 and variable orifice 84. The resultant upward movement of spool 65 will increase the force on spring 70 to that required for the particular displacement setting of the pump. This transition is depicted at point $A_1$ of curve A in Figure 4.

This interaction within modulating means 24 will permit pump 11 to continue to operate at such a higher pressure setting without exceeding the horsepower limitations of the engine. Should the load carried by cylinder 13 demand an even greater pressure, the cycle will be repeated. It should be noted in Figure 4 that engagement of spring retainer 73 with second spring 72 of biasing means 71 will permit a restaging of the load pressure and pump displacement, as reflected at point $A_2$ on curve A. This cyclic action of modulating means 24 and interassociated biasing means 30 and 31 will continue throughout the working pressure range of pump 11 until spool 65 contacts shoulder 65' (Figure 3), as reflected at point $A_3$ on curve A in Figure 4. This establishes the maximum pressure obtained and further decreasing pump displacement will not increase maximum pressure obtained.

The above-described control system thus provides an infinitely variable horsepower limiting mechanism which will closely follow horsepower curve B of the engine to provide maximum work efficiency with minimum energy consumption or specified hydraulic circuit condition of operation. Fixed orifice 21 will ensure that actuating chamber 60 of "load-plus" valve 23 can be bled-off at a sufficiently high rate to provide quick response of "load-plus" valve 23.

As described above, modified modulating means 24a, 24b, and 24c will function similar to modulating means 24. As further described above, override means 89 (Figure 7) can be readily adapted for use with any one of the modulating means to selectively override the automatic functions thereof.

Other aspects, objects, and advantages of this invention can be obtained from a study of the drawings, the disclosure, and the appended claims.

**Claims**

1. A fluid circuit (10) having a fluid actuator (13), a variable displacement pump (11) including a control member (28) movable between first and second displacement positions, first biasing means (30) for urging said control member (28) towards its first displacement position, and second biasing means (31) for urging said control member (28) towards its second displacement position in opposition to said first biasing means (30), said second biasing means (31) includes a flow pressure compensated valve (23) responsive at one end to a pump discharge pressure signal ($P_D$) and at the other end to a load pressure signal ($P_L$) received from the fluid actuator (13) and being adapted to generate a control signal for moving the control chamber (28) in response to a varying load signal from the actuator (13), characterized by;

modulating means (24) for modulating said load pressure signal to said other end of the flow pressure compensated valve (23) to vary the displacement of said pump (11) in response to both the magnitude of said load pressure signal and the position of said control member (28), said modulating means (24) includes a reciprocal first valve member (65), a second valve member (67) reciprocally positioned with respect to the first valve member (65), biasing means (71) for biasing the second valve member (67) with respect to the first valve member in opposition to said load pressure signal, and variable orifice means (84a, b, c) for venting the load pressure signal in response to relative movement between the first and second valve members (65, 67);

means (83) for changing the setting of said modulating means (24) in response to actuation of said first biasing means (30) by said second biasing means (31) and said control member (28), said means (83) for changing the setting of said modulating means (24) includes a rod (83) interconnected between said first biasing means (30) and the first valve member of said modulating means (24); and

a fixed orifice (21) connected in series between said fluid actuator (13) and said variable orifice means (84).

2. The fluid circuit (10) of claim 1 wherein said modulating means (24a) includes a reciprocal spool (65a), poppet valve means (67a) for opening in response to an increase in said load pressure signal, and biasing means (71a) for urging said poppet valve means (67a) to a closed position on a seat defined on said spool (65a).

3. The fluid circuit (10) of claim 1 wherein said modulating means (24b) includes a spool (65b) defining an actuating chamber (75b) therein, slug means (67b) for normally closing said chamber (75b) and for defining said variable orifice means (84b) upon opening of said chamber (75b) in response to relative movement of said spool (65b), and said biasing means (71b) being adapted for biasing said spool (65b) into engagement with said slug means (67b).

4. The fluid circuit (10) of claim 3 wherein said variable orifice (21b) is interconnected between said fluid actuator (13) and the variable orifice means (84b) defined between said slug means (67b) and said spool (65b), said variable orifice (21b) being defined in part by said spool (65b).

5. The fluid circuit (10) of any one of claims 1 to 4 further including override means (89) for selectively overriding said modulating means (24).

**Patentansprüche**

1. Eine Strömungsmittelschaltung (10) mit einem Strömungsmittelbetätiger (13) einer eine veränderbare Verdrängung aufweisende Pumpe (11) einschließlich eines Steuerglieds (28) bewegbar zwischen ersten und zweiten Verdrängungspositionen, ersten Verdrängungspositionen, ersten Vorspannmitteln (30), um das Steuerglied (28) in seine erste Verdrängungsposition zu drükken, und zweite Vorspannmittel (31), um das Steuerglied (28) in seine zweite Verdrängungsposition entgegengesetzt zu den ersten Vorspannmitteln (30) zu drücken, wobei die zweiten Vorspannmittel (31) ein strömungsdruckkompensiertes Ventil (23) aufweisen, welches an einem Ende auf ein Pumpenabgabedrucksignal ($P_D$) anspricht und am anderen Ende auf ein Lastdrucksignal ($P_L$) empfangen von dem Strömungsmittelbetätiger (13) anspricht und geeignet ist, um ein Steuersignal zu erzeugen zur Bewegung des Steuerglieds (28) infolge eines sich ändernden Lastsignals vom Betätiger (13), gekennzeichnet durch:

Modulationsmittel (24) zum Modellieren des Lastdrucksignals zu dem erwähnten anderen Ende des strömungsdruckkompensierten Ventils (23) zur Veränderung der Verdrängung der Pumpe (11) infolge von sowohl der Größe des Lastdrucksignals wie auch der Position des Steuerglieds (28), wobei die Modulationsmittel (24) folgendes aufweisen: ein hin- und herbewegliches erstes Ventilglied (65), ein zweites Ventilglied (67), welches hin- und herbewegbar bezüglich des ersten Ventilglieds (65) angeordnet ist, Vorspannmittel (71) zum Vorspannen des zweiten Ventilglieds (67) bezüglich des ersten Ventilglieds entgegengesetzt zu dem Lastdrucksignal, und veränderbare Zumeßöffnungsmittel (84) zum Ablassen des Lastdrucksignals infolge der Relativbewegung zwischen den ersten und zweiten Ventilgliedern (65, 67);

Mittel (83) zur Änderung der Einstellung der Modulationsmittel (24) infolge der Betätigung der ersten Vorspannmittel (30) durch die zweiten Vorspannmittel (31) und das Steuerglied (28), wobei die Mittel (83) zur Änderung der Einstellung der Modulationsmittel (24) eine Stange (83) aufweisen, und zwar verbunden zwischen den ersten Vorspannmitteln (30) und dem ersten Ventilglied der Modulationsmittel (24); und

eine feste Zumeßöffnung (21) verbunden in Serie zwischen dem Strömungsmittelbetätiger (13) und den veränderbaren Zumeßöffnungsmitteln (84).

2. Strömungsmittelschaltung (10) nach Anspruch 1, wobei die Modulationsmittel (24a) einen hin- und herbewegbaren Kolben (65a) aufweisen, Kopfventilmittel (67a) zur Öffnung infolge eines Anstiegs des Lastdrucksignals und Vorspannmittel (71a), um die Kopfventilmittel (67a) in eine Schließposition an einem durch den Kolben (65a) definierten Sitz zu drücken.

3. Strömungsmittelschaltung (10) nach Anspruch 1, wobei die Modulationsmittel (24b) einen Kolben (65b) aufweisen, der eine Betätigungskammer (75b) darinnen definiert, Stiftmittel (67b) zum normalerweisen Schließen der Kammer (75b) und zur Definition der variablen Zumeßöffnungsmittel (84b) beim Öffnen der Kammer (75b) infolge der relativen Bewegung des Kolbens (65b) und Vorspannmittel (71b) geeignet zum Vorspannen des Kolbens (65b) in Eingriff mit den Stiftmitteln (67b).

4. Strömungsmittelschaltung (10) nach Anspruch 3, wobei die variable Zumeßöffnung (21b) zwischen dem Strömungsmittelbetätiger (13) und den veränderbaren Zumeßöffnungsmitteln (84b) liegt, und zwar definiert zwischen den Stiftmitteln (67b) und dem Kolben (65b), wobei ferner die variable Zumeßöffnung (21b) teilweise durch den Kolben (65b) definiert ist.

5. Strömungsmittelschaltung (10) nach einem der Ansprüche 1 bis 4, wobei ferner Übersteuermittel (89) vorgesehen sind, um selektiv die Modulationsmittel (24) zu übersteuern.

**Revendications**

1. Circuit de fluide (10) comportant un actionneur à fluide (13), une pompe à cylindrée variable (11) comprenant un organe de commande (28) déplaçable entre des première et seconde positions de déplacement, des premiers moyens de sollicitation (30) pour solliciter ledit organe de commande (28) vers sa première position de déplacement, et des seconds moyens de sollicitation (31) pour solliciter ledit organe de commande (28) vers sa seconde position de déplacement, dans le sens opposé à l'action desdits premiers moyens de sollicitation (30), lesdits seconds moyens de sollicitation (30) comprenant une soupape (23) à compensation de la pression d'écoulement, qui est sensible, à une première extrémité à un signal ($P_D$) de pression de refoulement de la pompe et, à la seconde extrémité, à un signal de pression de charge ($P_L$) envoyé par l'actionneur à fluide (13), et étant adaptée pour produire un signal de commande pour déplacer l'organe de commande (28) en réponse à un signal de charge variable délivré par l'actionneur (13), caractérisé par:

— des moyens de modulation (24) pour moduler ledit signal de pression de charge appliqué à ladite seconde extrémité de la soupape (23) à compensation de la pression d'écoulement, de manière à modifier la cylindrée de ladite pompe (11) en réponse à la fois à la valeur dudit signal de pression de charge et à la position dudit organe de commande (28), lesdits moyens de modulation (24) comprenant un premier élément de soupape à déplacement alternatif (65), un second élément de soupape (67) disposé dans une position inverse par rapport au premier élément de soupape (65), des moyens de sollicitation (71) pour solliciter le second élément de soupape (67) par rapport au premier élément de soupape, en sens opposé dudit signal de pression de charge, et des moyens en forme d'orifices à ouverture variable (84a, b, c) pour mettre à l'évent le signal de pression de charge en réponse à un déplacement relatif entre les premier et second éléments de soupape (65, 67);

— des moyens (83) pour modifier le réglage desdits moyens de modulation (24) en réponse à l'actionnement desdits premiers moyens de sollicitation (30) par lesdits seconds moyens de sollicitation (31) et ledit organe de commande (28), lesdits moyens (83) pour modifier le réglage desdits moyens de modulation (24) comprenant une tige (83) montée entre lesdits premiers moyens de sollicitation (30) et le premier élément de soupape desdits moyens de modulation (24); et

— un orifice fixe (21) disposé en série entre ledit actionneur à fluide (13) et lesdits moyens formant orifices à ouverture variable (84).

2. Circuit de fluide (10) selon la revendication 1, dans lequel lesdits moyens de modulation (24a) comprennent un tiroir déplaçable en va-et-vient (65a), des moyens formant soupape à clapet (67a) destinés à s'ouvrir en réponse à un accroissement dudit signal de pression de charge, et des moyens de sollicitation (71a) pour solliciter lesdits moyens formant soupape à clapet (67a) dans une position fermée contre un siège défini sur ledit tiroir (65a).

3. Circuit de fluide (10) selon la revendication 1, dans lequel lesdits moyens de modulation (24b) comprennent un tiroir (65b) définissant en lui une chambre d'actionnement (75b), des moyens formant bouchon (67b) pour fermer normalement ladite chambre (75b) et pour définir lesdits moyens formant orifice à ouverture variable (84b) lors de l'ouverture de ladite chambre (75b) en réponse au déplacement relatif dudit tiroir (65b), et lesdits moyens de sollicitation (71b) étant adaptés pour solliciter ledit tiroir (65b) en contact avec lesdits moyens formant bouchon (67b).

4. Circuit de fluide (10) selon la revendication 3, dans lequel ledit orifice à ouverture variable (21b) est disposé entre ledit actionneur à fluide (13) et lesdits moyens formant orifice à ouverture varia-

ble (84b) et définis entre lesdits moyens formant bouchon (67b) et ledit tiroir (65b), ledit orifice variable (21b) étant défini en partie par ledit tiroir (65b).

5. Circuit de fluide (10) selon l'une quelconque des revendications 1 à 4, comprenant en outre des moyens de surpassement (89) pour surpasser sélectivement lesdits moyens de modulation (24)

FIG.1.

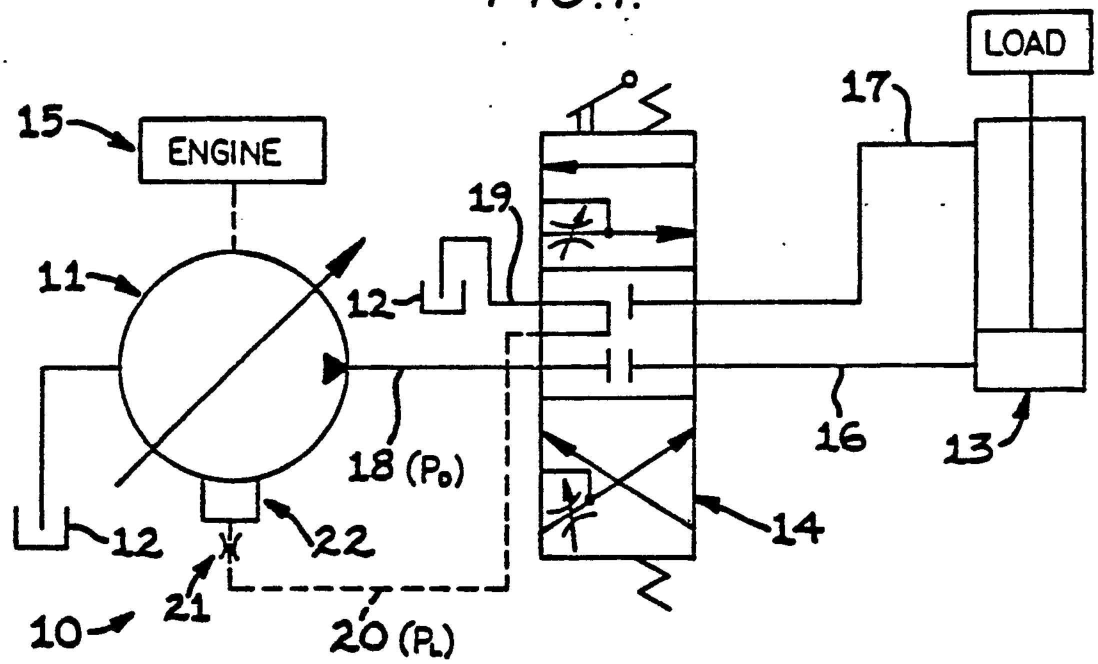



FIG.4.

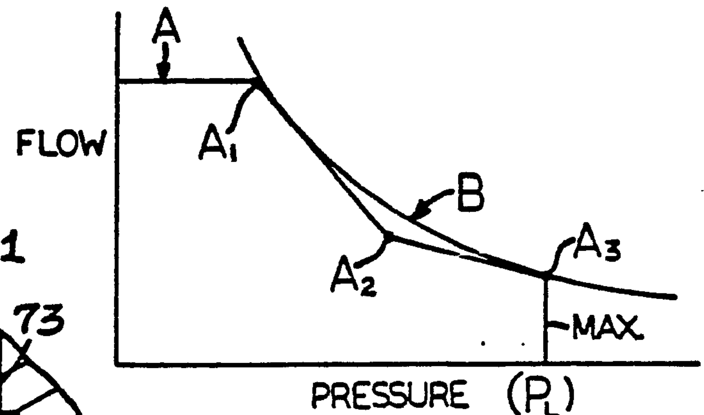



FIG.3.

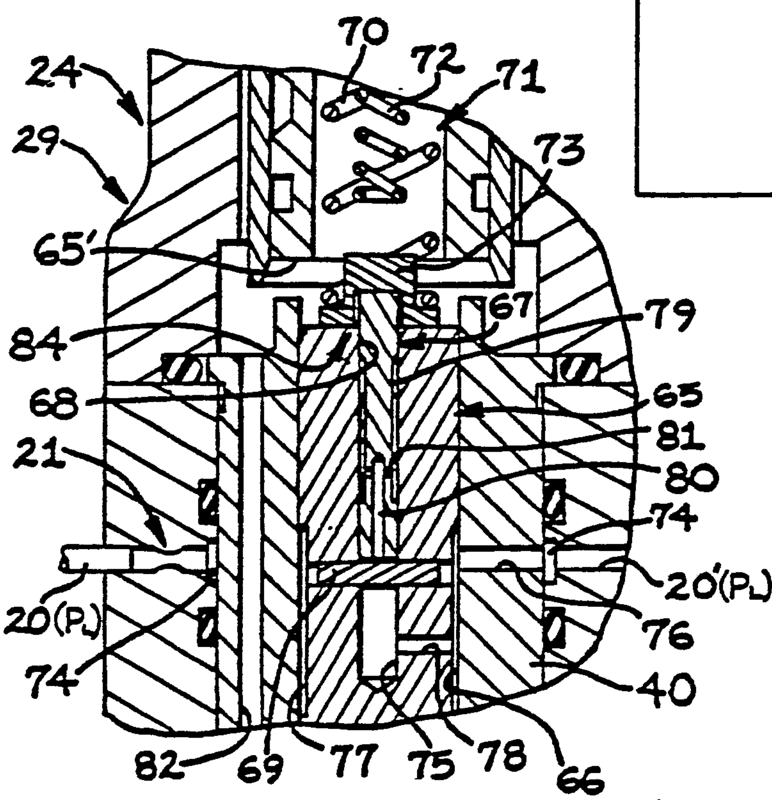
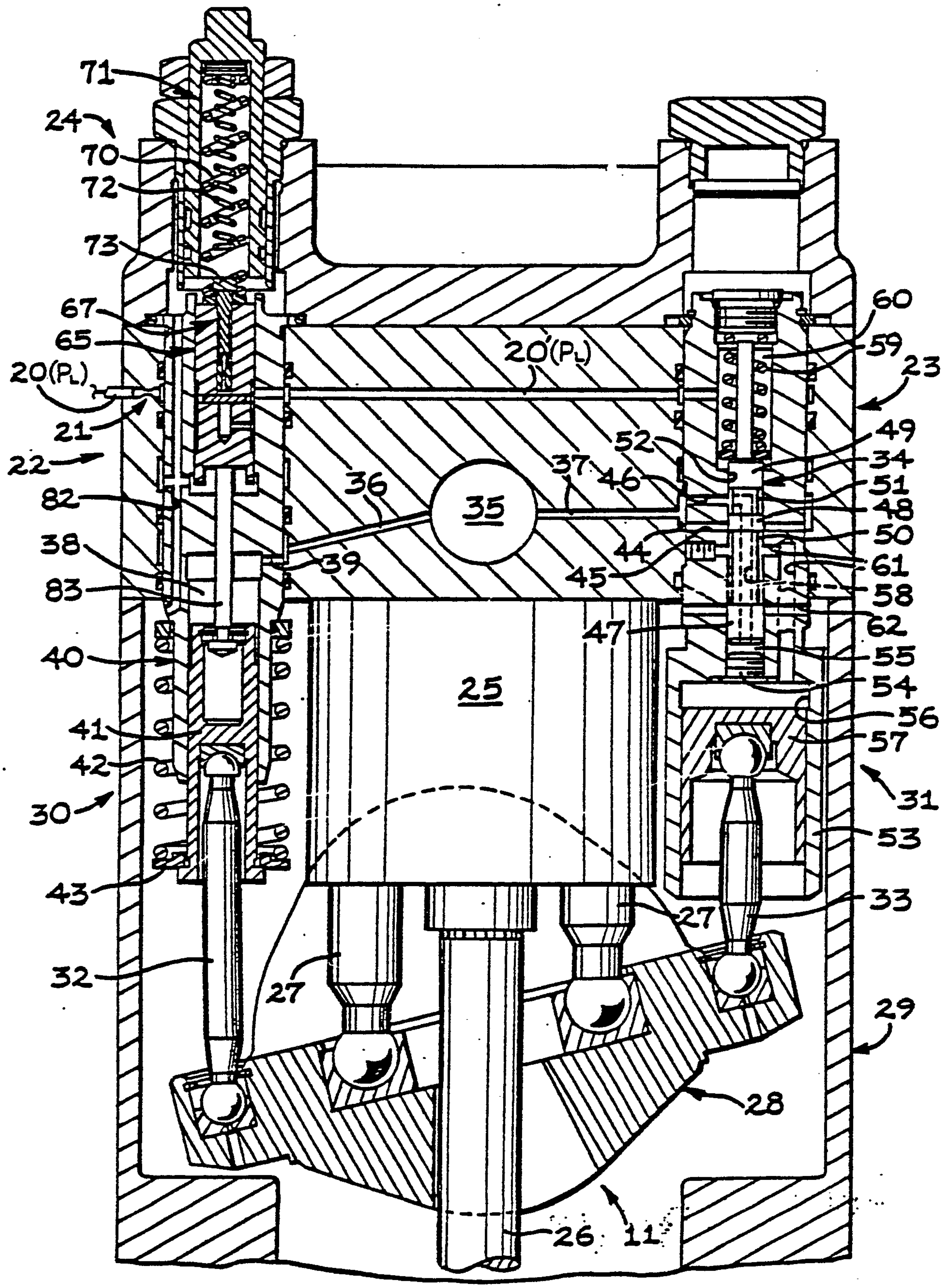


FIG.2.


71
24
70
72
73
67
65
20(PL)
21
22
82
38
83
40
41
42
30
43
32
27
20(PL)
36
35
37
46
39
45
44
47
25
27
26
11
28
60
59
23
52
49
34
51
48
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61
58
62
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53
33
29

FIG.5.

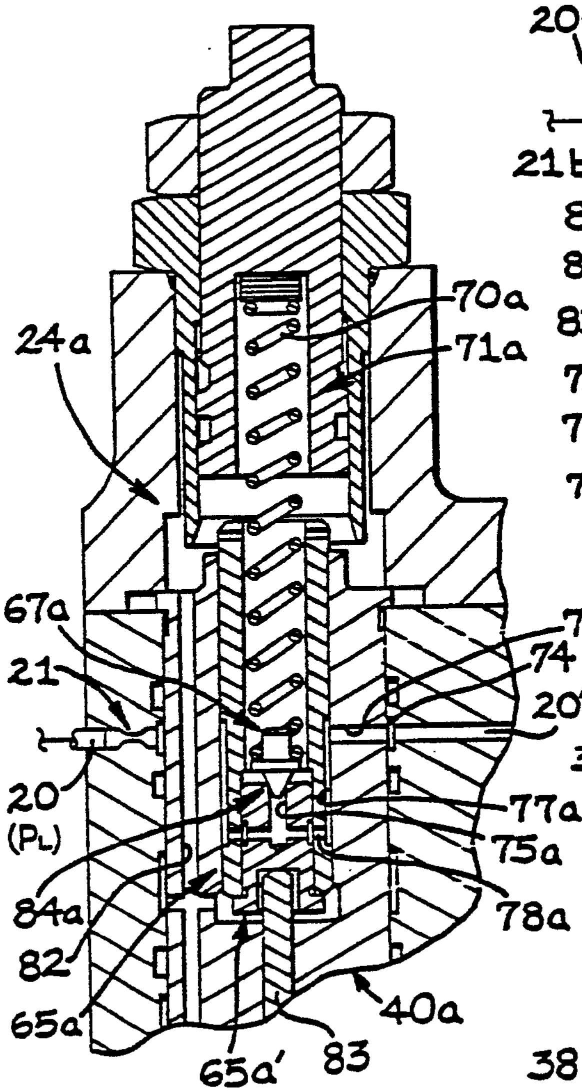

24a
70a
71a
67a
76
74
21
20'(PL)
20
(PL)
77a
75a
84a
78a
82
65a
40a
65a'
83

FIG.6.

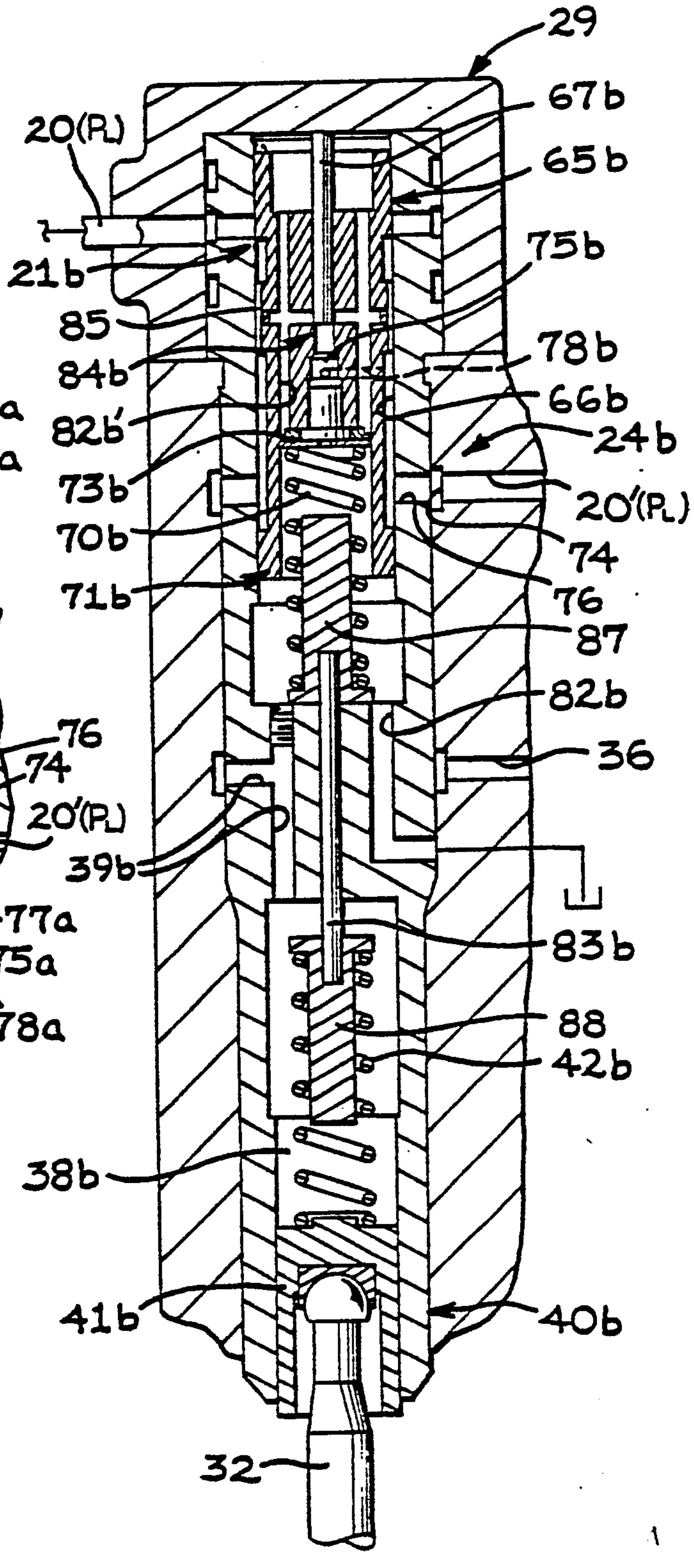
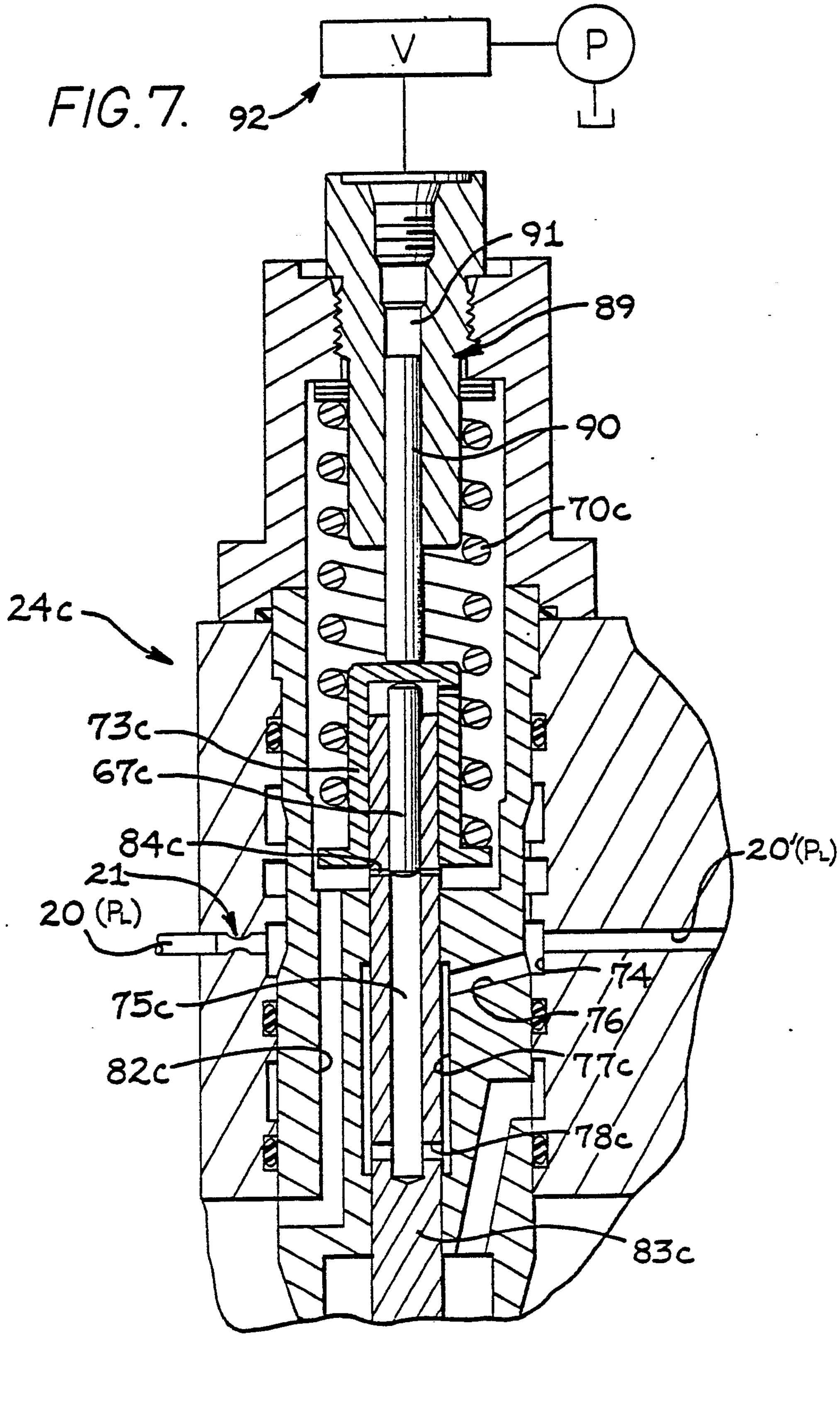

29
67b
20(PL)
65b
21b
75b
85
78b
84b
66b
82b'
24b
73b
20'(PL)
70b
74
71b
76
87
82b
36
39b
83b
88
42b
38b
41b
40b
32

FIG. 7.


V
P
92
91
89
90
70c
24c
73c
67c
84c
21
20 (PL)
20'(PL)
74
75c
76
82c
77c
78c
83c