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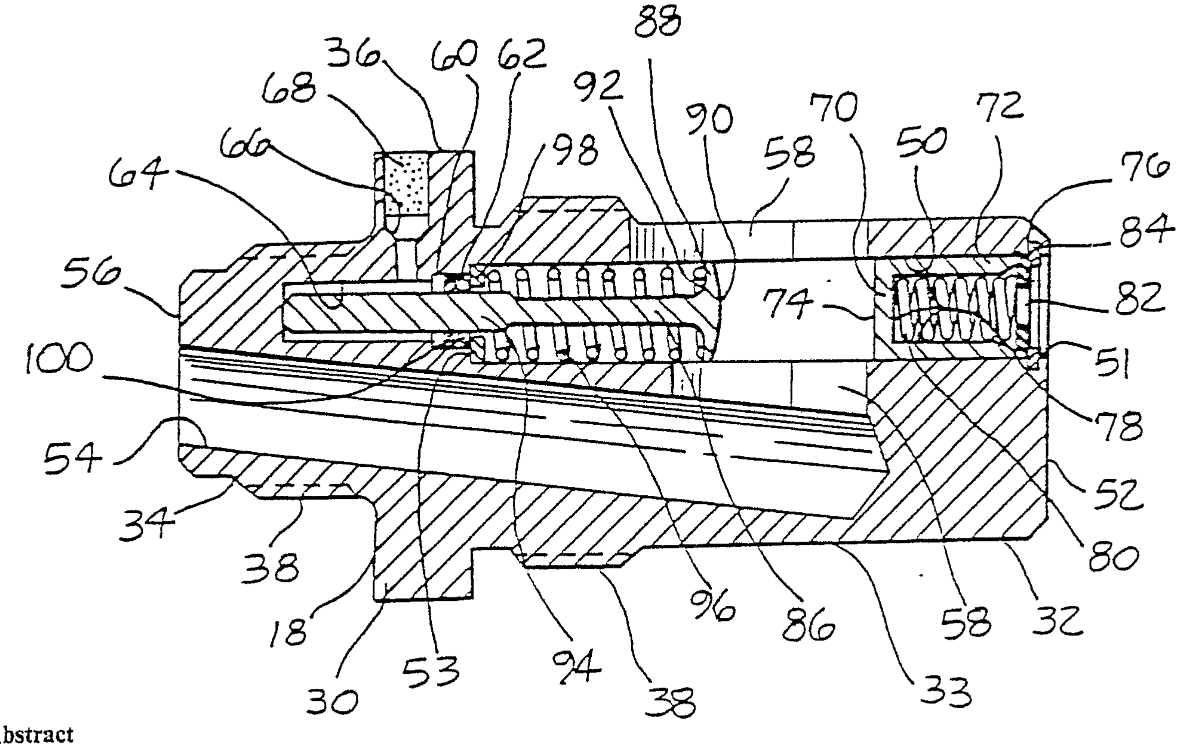
(54) Title: LOAD RESPONSIVE FLOW CONTROL VALVE



(57) Abstract

Flow control valve (18) for a fluid operated system (10) having a motor (16). The flow control valve (18) has a bore (50) and a passage (58) opening in the bore (50). A piston (70) and a plunger (86) are slidably disposed in the bore. The plunger (86) is actuatable in response to a load pressure in the motor (16) for establishing an axial position in the bore (50) at which the piston (70) modulates fluid flow with the passage, prior to the introduction of fluid flow through the valve from the motor (16). The flow control valve thus improves response, regulation and requires fewer and less complex parts. The flow control valve (18) is particularly useful in a hydraulic lift system such as used on a lift truck.

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Description

Load Responsive Flow Control Valve

Technical Field

This invention relates to a flow control valve for a fluid operated system and more particularly to a load responsive flow control valve for a fluid operated lift system which establishes a flow rate in response to a load being lifted prior to the initiation of fluid flow.

Background Art

Flow control valves are frequently used in fluid operated systems, such as a lift system. For example, when used with a lift mast on a lift truck such valves permit substantially unrestricted fluid flow to be delivered from a pump to a fluid operated motor, such as a hydraulic jack, and controllably regulate the rate of flow passing from the jack to a reservoir.

Typically such systems include a main control valve for controllably directing the fluid flow between the jack, pump and reservoir. Actuation of the main control valve and passing fluid flow to tank establishes a differential pressure condition upon which the flow control valve reacts for establishing a rate of flow proportional to said differential pressure. Such a fluid operated system is shown in U.S. Patents 4,180,098, issued December 25, 1979 to T. Budzich and U.S. Patent 4,204,459, issued May 27, 1980 to H.L. Johnson.

It has been found that flow control valves, operative in response to a differential pressure established subsequent to the initiation of fluid flow, have a tendency to either react too slowly or too quickly in achieving a flow regulating position. A slow reacting flow control valve will tend to reduce the responsiveness of the system and thus the controllability and efficiency will suffer. A fast reacting flow control valve will have a tendency to overshoot and hunt resulting in erratic or cyclical control of the flow and bouncing of the hydraulic jack.

There have been attempts to solve the above-noted problems of response and regulation by adding additional and/or modifying existing components. This, however, adds to the cost, bulk and complexity of the system and is often not a totally satisfactory solution. The present invention is directed to overcoming one or more of the problems as set forth above.

Disclosure of the Invention

In one aspect of an embodiment of the present invention, a flow control valve is provided for a fluid operated system having a motor. The flow control valve includes a housing having a bore and a passage in the housing opening in the bore and connected to the motor. A piston and a plunger are each slidably disposed in the bore and seperable to a nonmodulating position with respect to the passage permitting substantially unrestricted fluid flow to the motor and being movable together to a flow modulating position with respect to said passage in response to the fluid pressure in the motor. Simultaneously with the termination of fluid flow through the passage to the motor the flow control valve automatically establishes a maximum rate of fluid flow from the motor prior to the initiation of fluid flow from the motor through the passage.

Brief Description of the Drawings

Fig. 1 is a schematic diagram of the fluid operated system including the flow control valve of the present invention.

Fig. 2 is an enlarged diagrammatic sectional view of the flow control valve of Fig. 1 showing the plunger and piston in a nonmodulating position.

Fig. 3 is an enlarged diagrammatic sectional view of the flow control valve of Fig. 1 showing the plunger and piston together in abutment in a flow modulating position.

Fig. 4 is an enlarged diagrammatic view of the passage as seen in the direction of the arrows IV-IV of Fig. 3.

Best Mode for Carrying Out the Invention

Referring to the drawing of Fig. 1, a fluid operated system 10, such as a hydraulic lift system for use on a material handling vehicle (not shown) includes a source of pressurized fluid 12, such as a pump, a control valve 14, a fluid operated motor 16, such as a single acting hydraulic jack, a flow control valve 18 and a reservoir 20. The pump 12 is connected to the control valve 14 by a conduit 22 and to the reservoir 20 by a conduit 24. The control valve 14, a manually actuated three position open center type control valve, is connected to the reservoir 20 by a conduit 26 and to flow control valve 18 by a conduit 28. Flow control valve 18 is preferably connected to jack 16 directly so as to pass fluid flow betweeen the jack 16 and control valve 14. However, it is to be noted that the flow control valve 18 could be connected directly to the control valve 14 or anywhere between the control valve and jack 16 and to the conduit 28.

Referring to Figs. 1 and 2, the flow control valve 18 includes a housing 30 having a first cylindrical end portion 32 and a surface 33, a second cylindrical end portion 34 and a flange portion 36 extending radially from the first end portion 32 adjacent the second end portion 34 and dividing the first and second end portions. Each of the first and second end portions 32,34 have a threaded portion 38 extending radially therefrom and along a preselected axial distance.

The jack 16, as shown in Fig. 1, has a tubular cylinder 40 and a piston and rod assembly 42 slidably disposed in the cylinder and extendable and retractable relative thereto. Adjacent a head end of the cylinder is provided a threaded bore 44 opening into a cavity 46 therein. The cavity 46 is open to and in fluid communication with a head end 48 of the piston and rod assembly 42. The housing 30, and more specifically its first end portion 32, is disposed in the cavity 46 with the threaded portion 38 of the first end portion engaged in the threaded bore 44 of the cylinder 40.

A bore 50 as best seen in Figs. 2 and 3 having a first end 51 and a second end 53, is axially disposed in the first cylindrical end portion 32 of the housing 30 with said first end 51 opening at a first end 52 of the housing. A drilled passage 54 is disposed in the housing and is open at a second end 56 of the housing and extends toward the first end portion 52 of the housing 30 a preselected depth. A passage 58 is disposed in the housing's second end portion 32 at a preselected axial location along the second end portion of the housing, preferably between the threaded portion 38 and the first end 52. The passage 58 is preferably radially oriented relative to the bore 50 and the first cylindrical end portion 32 and passes through the housing to a depth so as to open in the bore 50 and the drilled passage 54. Thus, the drilled passage 54, the bore 50 and the passage 58 together pass fluid between conduit 28 and cavity 46 (see Fig. 1).

A blind stepped bore 60 having a seal support bore portion 62 and a guide bore portion 64 is disposed in the housing 30 in axial alignment with the bore 50. The seal support portion 62 is smaller in diameter than the bore 50 and the guide bore portion 64 is smaller in diameter than the seal support bore portion 62. The seal support portion is connected to the second end of the bore 50 and opens in the bore 50. A vent passage 66 is radially disposed in the flange 36 to connect the guide bore portion 64 to the atmosphere so as to prevent fluid pressure buildup therein. A filter 68 of any suitable type well known in the art is positioned in the vent passage to prevent dirt from entering the guide bore portion.

A flow control piston 70 is slidably disposed in said bore 50 adjacent the first end 51 of the bore. The piston 70 has a cylindrical body 72, a head surface 74, a base end 76 and a cylindrical recess 78 disposed in said base end and into said body 72. A first spring 80 is disposed in the recess 78 and bears against a flange 82 retained in said bore 50 in any suitable manner, such as by a snap ring 84, to bias the piston 70 toward the second end 53 of the bore.

A stop or plunger 86 is slidably disposed in the bore 50 adjacent the second end 53 thereof. The plunger 86 includes a cylindrical head portion 88 which has a stop surface 90 and a connecting surface 92, and a cylindrical shank portion 94 which is rigidly centrally affixed to extend axially from the connecting surface 92. A second spring 96 is centrally disposed about shank 86 and between the connecting surface 92 and the second end 53 of the bore 50. The second spring 96 biases the plunger toward the first end 51 of the bore by applying force to the connecting surface 92 and a flange 98 retained at the second end 53 of the bore 50. A seal 100 is disposed in seal support bore 62 and in sealing engagement with the support bore 62 and the shank portion 94 of the plunger 86. The seal 100 prevents pressurized fluid from entering the guide bore 64 and acting against a crossectional area of the shank 86.

The piston 70 and plunger 86, flow control members, are axially movable in the bore in response to fluid pressure applied thereto or in the absence of pressure to a spring biased axial position in the bore 50. In both situations the position of the plunger 70 and the piston are significant. The piston 70 cooperates with the passage 58 to regulate the flow of fluid therethrough and the plunger establishes a position in the bore at which to stop the piston from further movement in the direction toward the piston thereby establishing a maximum flow rate for a given pressure. It is to be noted that the head portion 88 of the plunger 86 was designed with a very thin crossectional area between the stop surface 90 and the connecting surface 92 to eliminate or reduce the possibility of the plunger 86 affecting flow of fluid through the passage 58. Thus, only the piston functions as a flow modulating member within the passage 58.

It has been found that the shape of and the size of the passage 58 is important in providing a flow control valve with good modulating characteristics on one hand and unrestricted free flow on the other. The preferred passage 58 configuration, as best seen in Fig. 4, has a basic keyhole shape oriented axially along the first cylindrical end portion 32 of surface 33. The passage is disposed radially in the housing 30, relative to the bore 50, and opens on surface 33, and in bore 50 and drilled passage 54, as previously discussed. The keyhole shaped passage 58 has a circular end portion 102 and a rectangular end portion 104 extending from said circular end portion. The circular end portion 102 is postioned closer to the first end portion 52 of the housing 30 than the rectangular end portion 104. The rectangular end portion 104 preferably terminates with an arcuate end portion 106. It is to be noted that the rectangular portion 104 between the bore 50 and the drilled passage 54 is preferably shorter axial length than the rectangular portion 104 between the bore 50 and the surface 33 of the first cylindrical end portion 32. This establishes a slight pressure drop with fluid flowing across the passage portion between the bore 50 and drilled passage 54 and not with the passage portion between the outer surface 33 and the bore 50, thereby improving the flow modulating characteristics.

The piston 70 is axially movable in the bore 50 between a nonmodulating postion, as shown in Fig. 1 at which time it is in abutment with the flange 82 at the first end 51 of the bore 50 and spaced away from an overlying postion with the passage 58 to a flow modulating position wherein the piston moves toward the second end 53 to lie within the passage 58. One of such positions is shown in Fig. 3. As the piston 70 moves from the nonmodulating position toward the second end 53 it first closes off the large flow of fluid through the circular portion 102 which greatly reduces the flow being passed. Subsequent movement toward the second end 53 provides smaller increments in flow reduction for a given piston travel thereby offering good modulating characteristics. Therefore the large circular passage portion 102 is provided primarily to permit free unrestricted flow when the piston 70 is in the nonmodulating position and is sized according to the flow capacity of the system 10.

Both the piston 70 and the plunger 86 are continuously automatically responsive to the fluid pressure in the cavity 46 of jack 16. This pressure generates a force proportional to the weight of a load being supported by the piston and rod assembly 42 and is commonly termed load pressure. The presence of load pressure in the cavity 46 will cause the plunger 86 to seek a pressure force balanced position in the bore 50 since the passage 58 and the entire bore 50 are in continuous open communication with the fluid in the cavity 46. The load pressure acts against the stop surface 90 and the connecting surface 92 of the head portion 82 of the plunger 86 to cause the plunger to move to a pressure force balanced axial postion in the bore 50. The axial force balanced position is determined by the differential area established on the stop surface 90 and the opposing force of second spring 96. The differential area is the surface area of the stop surface 90 minus the surface area of the connecting surface 92 less the crossectional area of the shank portion 94. It thus can be seen that the plunger 86 is continuously monitoring the pressure irrespective of flow and seeking an automatic pressure-force balanced position so as to establish a position at which the flow control piston 70 is stopped and a maximum flow rate for the given pressure is maintained (see Fig. 3).

The flow control piston 70 like the plunger 86 is responsive to load pressure. The load pressure acts against the head surface 74 and the base end 76 including the cavity 78. Since the effective area of the head surface 74 and the base end 76 plus the cavity 78 are equal, the first spring 80 will force the piston 70 to move into abutment with the stop surface 90 of plunger 86. This is true in all conditions except one such as shown in Fig. 2. When fluid is being passed to the jack the pressurized fluid flow from bore 50 across passage 58 encounters a slight pressure drop across the passage. Since the pressure in the bore 50, acting on the head surface side is greater than the pressure in the bore 50 on the base end side 76, the piston 70 will move against the light force of first spring 80 toward a nonmodulating position at the first end 51 of the bore 50 for delivering free flow to the jack 14.

Industrial Applicability

In operation and with reference to Fig. 1, shifting of the control valve 14 to the left to a jack extending position will cause a pressurized flow of fluid to be delivered by the pump 12, from the reservoir 20 through conduit 22 across the control valve 14 and downstream thereof through conduit 28 to the flow control valve 18. With reference to Fig. 2, the flow will pass through drilled passage 54, passage

58, bore 50, passage 54 and into cavity 46 of jack 16. Since the pressure in the bore 50 acting against the head surface 74 of piston 70 is greater than the pressure in either the cavity 46 or the base end 76 side of the bore 50 due to the pressure drop across the passage 54, the piston 70 will be instantaneously forced by the pump generated fluid pressure to the nonmodulating position adjacent the first end 51 of bore 50 and away from the passage 58. The plunger 86 will, at the same time, automatically seek the forced balanced position in the bore 50 in response to the fluid pressure. However, due to its construction it will have substantially no effect on the flow being delivered to cavity 46. The force of the fluid pressure acting against the head end 48 of the piston and rod assembly 42 will cause extension thereof and the lifting of a load (not shown).

Upon shifting of the control valve 14 to the neutral or centered position, the flow of fluid from the pump 12 will be directed to the reservoir 20 via conduit 26 and the fluid downstream of the control valve 14 will be blocked at the control valve. Simultaneously therewith load pressure in the cavity of the cylinder will act against the differential area of the plunger 86 so as to automatically establish a force balanced position in the bore 50 in response thereto. It is to be noted that the pressure in the bore 50 during the raising of the load will normally be only slightly higher than the load pressure in the bore in a no flow condition, therefore only a slight amount of movement of the plunger 86 may be observed. Since flow to the cylinder has ceased so also has the differential pressure acting on the piston 70. Therefore, the load pressure acting against the head surface 74 and the base end 74 of the piston 70 are equal. Since no differential area is present the piston 70 will automatically move into abutment with the plunger 86 as shown in Fig. 3 under the influence of first spring 80 and establish a flow rate with the passage 58 as determined by the position of plunger 86.

Thus, it can be seen, that the position of the plunger 86 in the bore 50 is directly proportional to the weight of the load being lifted. For heavy loads, the plunger will be at a position closer to the second end 53 of the bore than for light loads or no load.

Upon shifting of the control valve 14 rightwardly to a jack retracting position the fluid in the jack 16 will be open to the reservoir 20 via conduit 28, control valve 14 and conduit 26. Since the piston 70 and plunger 86 have already automatically been prepositioned to a load responsive flow modulating position with the passage 58, the flow will pass across the unblocked or open portion of the passage and through the flow path in the housing 30 in reverse of that previously described. Again, as in the raising mode, there will be a pressure drop across the passage 58 as determined by the position of the spool. However, in the lowering mode the pressure in chamber 46 will be the highest in the system. Therefore the force against the base end 76 of the piston 70 will insure that the head surface 74 of the piston remains in contact with the stop surface 90 of the plunger.

In view of the foregoing, there is provided a flow control valve for a fluid operated system which is continuously responsive to fluid pressure in the motor to establish a flow rate in response to this pressure prior to the initiation of flow of any fluid from the motor and affording substantially unrestricted fluid flow in the opposite direction to the motor.

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

Claims

1. A flow control valve (18) for a fluid operated system (10) having a fluid operated motor (16) and a control valve (14), comprising:

a housing (30) having a bore (50) and a passage (58) opening in said bore (50), said passage (58) being connected to said motor (16) and said control valve (14) for passing pressurized fluid between said motor (16) and said control valve (14) through said bore (50);

a flow control piston (70) slidably disposed in said bore (50) and operatively associated with said passage (58) to pass unrestricted fluid flow to said motor and controllably regulate the flow of fluid passing through said bore (50) from said motor (16) in response to the fluid pressure in said motor (16), and;

stop means (86) slidably disposed and axially movable to a pressure force balanced location in said bore (50) in response to the fluid pressure in said motor (16) for limiting axial movement of said flow control piston (70) in a direction toward said stop means (86) and establishing a maximum rate of flow to be delivered from said motor (16) to said control valve (14) prior to actuation of the control valve (14), said stop means (86) being in continuous communication with said pressurized fluid in said motor (16).

2. The flow control valve (18) as set forth in claim 1 wherein said passage (58) extends through said housing (30) and radially opens into said bore (50).

3. The flow control valve (18) as set forth in claim 2 wherein said passage (50) has substantially a keyhole configuration extending in an axial direction along the bore (50) and in said housing (30).

4. The flow control valve (18) as set forth in claim 3 wherein said keyhole shaped passage has a circular end portion (102) and a substantially elongated rectangular end portion (104).

5. The flow control valve (18) as set forth in claim 1 wherein said bore (50) has a first end (51) opening from said housing (30) and in fluid communication with said motor (16) and a second end (53).

6. The flow control valve (18) as set forth in claim 5 wherein said piston (70) is disposed in said bore (50) adjacent said first end (51) and said stop means (86) is disposed in said bore adjacent said second end (53), said piston (70) being urged toward said second end (53) by a first spring (80) and said stop means (86) being urged toward said first end (51) by a second spring (96).

7. The flow control valve as set forth in claim 6 wherein said first spring (80) is of a substantially lesser force rate than said second spring (96).

8. The flow control valve (18) as set forth in claim 7 wherein said passage has a keyhole configuration having a circular end portion (102) and a rectangular end portion extending axially along said bore (104), passing through said housing (30) and opening radially in said bore (50), said circular end portion (102) being disposed in said housing (30) adjacent the first end (51) of said bore (50).

9. The flow control valve (18) as set forth in claim 8 wherein movement of said piston (70) toward the second end (53) of said bore (50) progressively closes the circular portion (102) of said passage (58) prior to any closing of the reectangular portion (104).

10. The flow control valve (18) as set forth in claim 5 wherein said stop means includes a plunger (86) having cylindrical head portion (88), a stop surface (90) and a reduced diameter cylindrical shank portion (94), said head portion (88) being slidably supported in said bore (50).

11. The flow control valve (18) as set forth in claim 10 wherein said second end (53) of said bore is connected to and opens in a stepped bore (60) having a seal (100) disposed therein in sealing engagement with said stepped bore (60) and said shank (94).

12. The flow control valve (18) as set forth in claim 5 wherein said housing (30) is screw threadably secured in a threaded bore (44) in said motor (16) and said first end (51) of said bore (50) and said passage (58) are disposed in said motor (16) and in direct open fluid communication therewith.

13. A fluid operated sytem (10) having a single acting hydraulic jack (16), a pump (12), a reservoir (20) and a control valve (14) operatively connected to said jack (16), pump (12) and reservoir (20), said control valve (14) being selectively actuatable for controllably directing pressurized fluid from the pump (12) to the jack (16) and from the jack (16) to the reservoir (20), comprising:

a flow control valve (18) operatively connected between said control valve (14) and said jack (16) for passing fluid flow directed by said control valve (14);

a piston (70) operatively disposed in said flow control valve (18) and movable therein for controllably regulating the flow of fluid being directed by said control valve (14) from the jack (16) to the reservoir (70);

stop means (86) operatively associated with said piston (70) and movable in response to fluid pressure in said jack (16) for establishing a pressure-force balanced location at which the piston (70) is restrained from movement past said stop means in a direction toward said stop means (86) and a maximum rate of flow, from said jack (16), prior to actuation of said control valve (18) and the passing of fluid flow is established.

14. The fluid operated system as set forth in claim 13 wherein said flow control valve (18) includes,

a housing (30) having a bore opening from said housing (50) at a first end (51) and a passage (58) passing through said housing (30) and opening radially in said bore (50);

said piston (70) being slidably disposed in said bore (50) and axially positionable relative to said passage (58) between a passage open and a passage restricting position in response to the fluid pressure in said jack (16); and

said stop means includes a plunger (86) having a head (88) and a shank (94) and being slidably disposed in said bore (50) and axially positionable relative to said passage (58) in response to the fluid pressure in said jack (16).

15. The fluid operated system as set forth in claim 14 wherein the fluid pressure in said jack (16) is communicated to said plunger (86) through said passage (58) and into said bore (50).

16. The fluid operated system as set forth in claim 15 wherein said plunger (86) is biased toward said piston (70) by a second spring (96) and said piston (70) is biased toward said plunger (86) by a first spring (80); said first spring (80) having a substantially lesser force rate than said second spring (96).

17. A flow control valve (18), for a fluid operated system (10) having a motor (16), comprising;

a housing (30) having a bore (50) and a passage (58) opening in said bore (50), said passage (58) being connected to said motor (16) to pass pressurized fluid flow to and from said motor, and

a pair of flow control members (70,86) slidably disposed in said bore (50) and separably movable to a nonmodulating position with respect to said passage (58), in response to a drop in pressure of fluid flowing through said bore (50) across said passage (58), thereby permitting substantially unrestricted fluid flow through said valve (18) to said motor 16, and said control members (70,86) being movable together to a flow modulating position with respect to said passage (58), in response to fluid pressure in said motor (16), so that prior to the initiation of an opposite modulated return flow of fluid from said motor (16) back through said valve (18), said flow control members (70,86) are automatically prepositioned to subsequently establish a maximum rate of such return flow simultaneously with the termination of said fluid flow from said valve (18) to said motor (16).

18. The flow control valve (18) as set forth in claim 17 wherein said pair of flow control members (70,86) includes a piston (70) and a plunger (86).

19. The flow control valve (18) as set forth in claim 18 wherein said plunger (86) includes a cylindrical head portion (88) having a stop surface (90) and a connecting surface (92) and a cylindrical shank portion (94) connected to said connecting surface (92) and extending axially therefrom, said shank portion (94) and said connecting surface (92) defines a differential area with said stop surface (90).

20. The flow control valve (18) as set forth in claim 19 wherein said piston (70) includes a cylindrical body (72) having a head surface (74), a base end (76) and a cylindrical recess (78) disposed in said base end (76).

21. The flow control valve (18) as set forth in claim 20 wherein said differential area of said plunger (86) and the head surface (74) and base end (76) of said piston (70) are in continuous communication with the fluid in said motor (16).

22. The flow control valve (18) as set forth in claim 21 wherein said piston (70) is biased toward said plunger (86) by a first spring (80) and said plunger (86) is biased toward said piston (70) by a second spring (96), said first spring (80) being of a lighter spring rate than said second spring (96).

23. The flow control valve (18) as set forth in claim 17 wherein said passage (58) has substantially a keyhole configuration having a circular end portion (102) and a substantially elongated rectangular end portion (104), said rectangular and circular end portions extend axially along said bore (58) and open radially through said housing (30) into said bore (50).

24. The flow control valve (18) as set forth in claim 17 wherein said motor is a single acting hydraulic jack (16).

25. The flow control valve (18) as set forth in claim 17 wherein said piston (70) is axially positioned in said bore (50) and spaced from covering said passage (58) in said nonmodulating position and positioned to overlie at least a portion of said passage (58) in the flow modulating position.

26. The flow control valve (18) as set forth in claim 21 wherein said plunger (86) moves to an axial position in said bore (50) in response to the fluid pressure in said motor (16) acting on the differential area of said plunger (86) for establishing said flow modulating position at which said piston (70) abuts said plunger (86) and is restrained from further movement toward said plunger (86).

Fig. 1

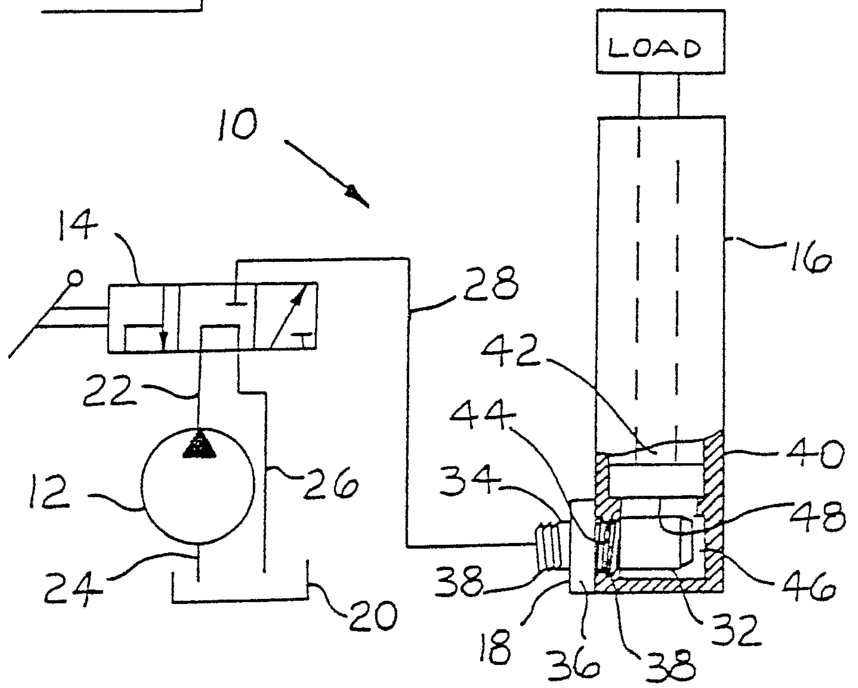
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Fig. 2

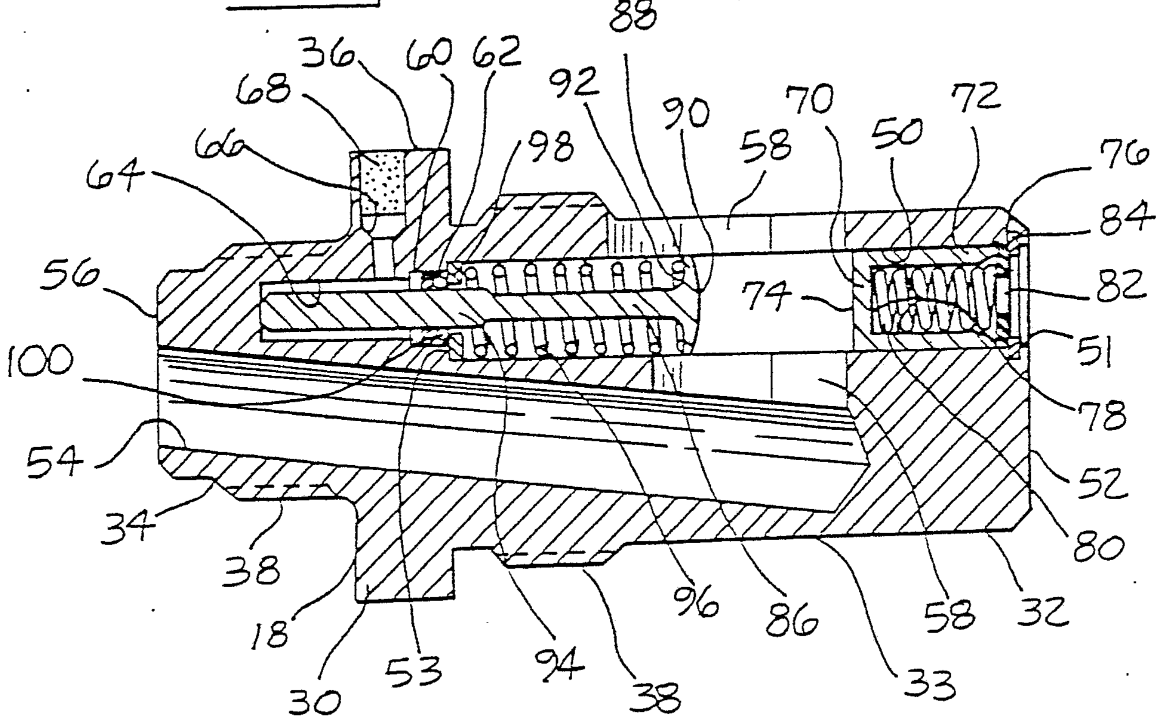
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Fig. 3.

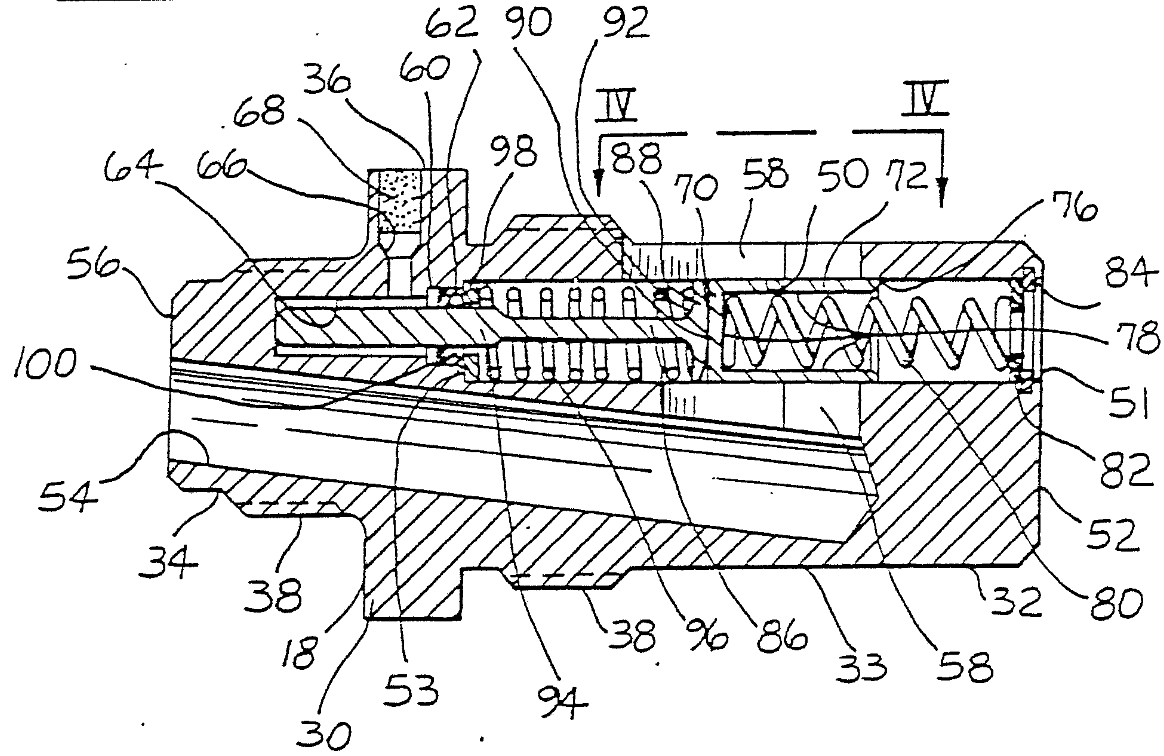
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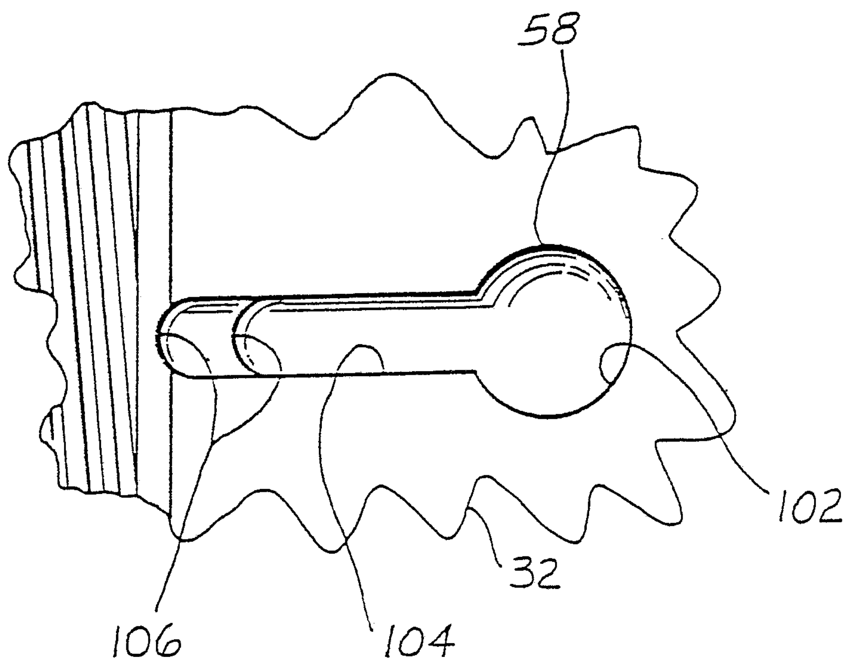
Fig. 4.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INTERNATIONAL SEARCH REPORT

International Application No PCT/US80/01510

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[3] F 15 B 11/04; F 15 B 13/042
U.S. CL. 91/447, 468; 138/46

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	91/447, 468; 137/512; 138/46

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
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A	US, A 2,603,235 Published 15 July 1952 Kirkham	
A	US, A 3,016,046 Published 9 Jan. 1962 Backofen	
A	US, A 3,072,107 Published 8 Jan. 1963 Cassell	
A	US, A 3,583,431 Published 8 June 1971 Diel	
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A	US, A 4,180,098 Published 25 Dec. 1979 Budzich	
A	US, A 4,204,459 Published 27 May 1980 Johnson	
A	DE, B 1,650,361 Published 21 Jan. 1971 McPherson	

* Special categories of cited documents: [15]

"A" document defining the general state of the art

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"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
9 JUNE 1981	19 JUN 1981
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	IRWIN CHARLES COHEN

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