

[54] **FLOW CONTROL VALVE**  
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[58] Field of Search ..... **91/437, 443, 447, 91/468, 445 PR, 445, 446, 448; 137/504**

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[57] **ABSTRACT**

A fluid circuit includes a flow control valve comprising surge damping and counterbalance pressure control valves for controlling the actuation of a cylinder having the rod thereof operatively connected to an implement, such as a loader bucket lift arm. The counterbalance pressure control valve maintains a sufficiently high back pressure in the cylinder during the “hold” phase of loader operation to prevent the loader bucket from creeping downwardly. The surge damping valve co-operates with the latter valve to freely communicate pressurized fluid to the cylinder during the “raise” phase of loader operation and to automatically regulate return flow during the “lower” phase in direct proportion to the magnitude of load imposed on the cylinder rod by the loader bucket.

**7 Claims, 2 Drawing Figures**

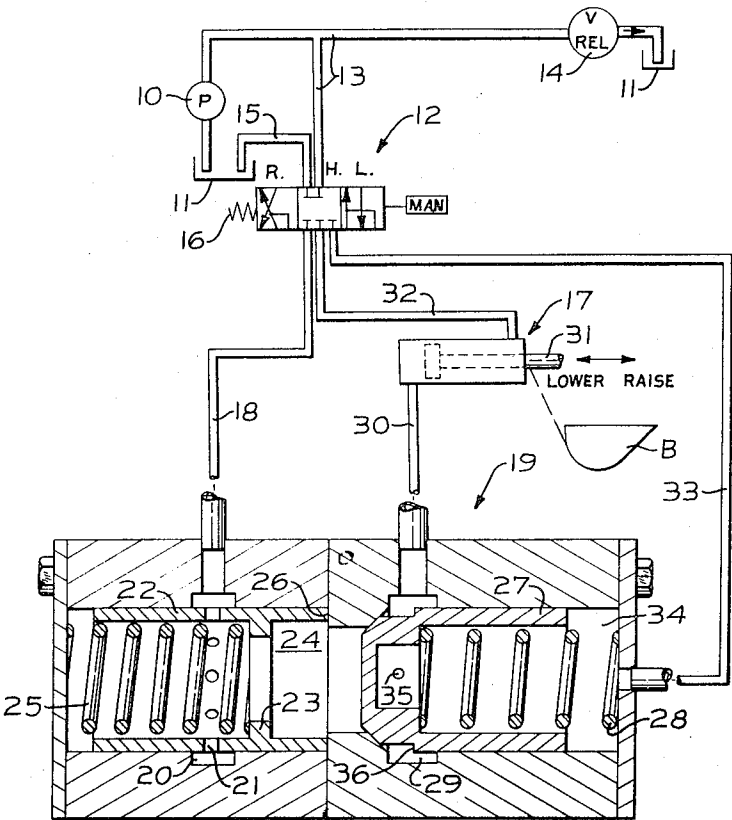
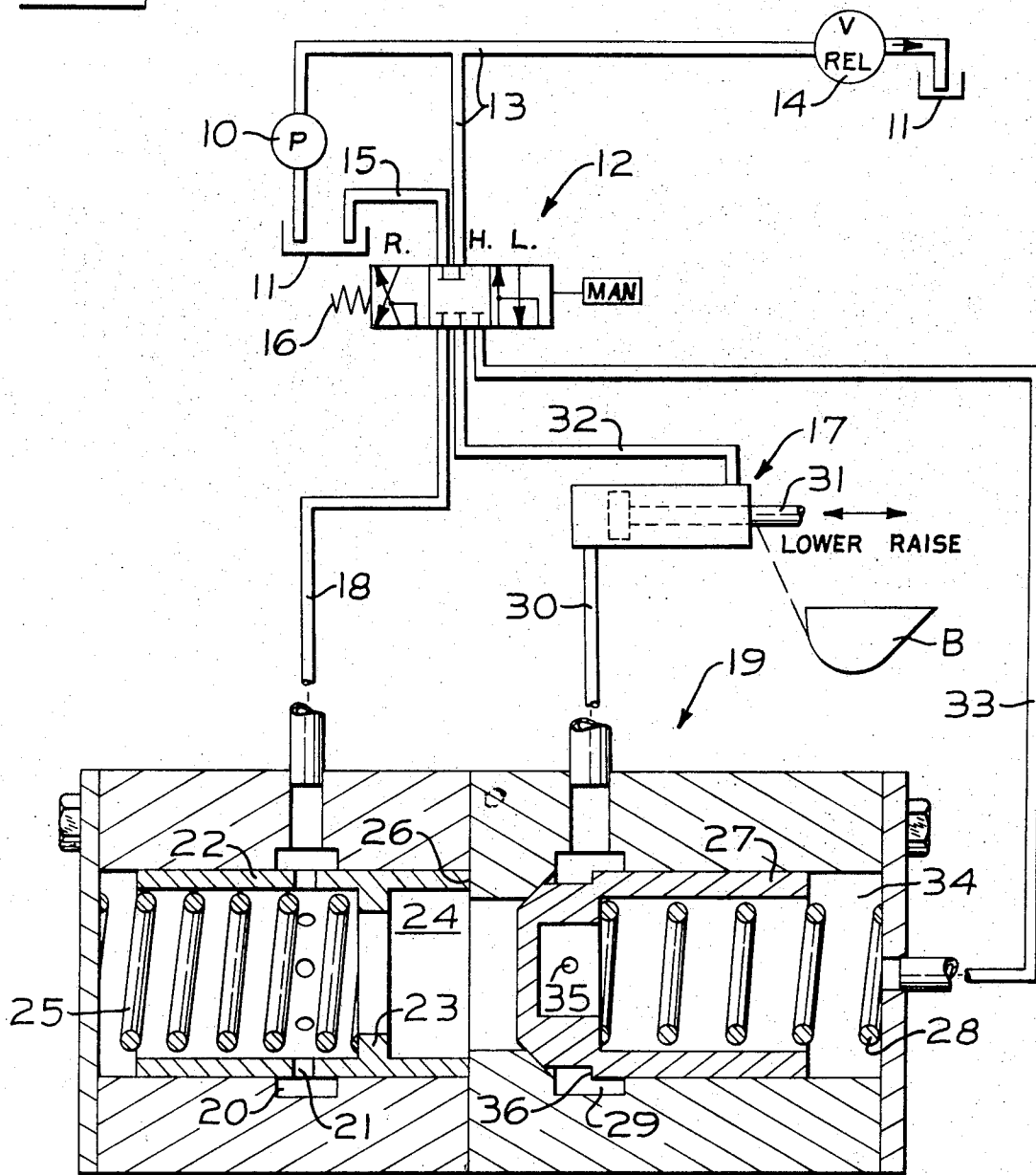


Fig. 1.



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## FLOW CONTROL VALVE

This application is a Continuation of application Ser. No. 768,733, filed Oct. 18, 1968, and now abandoned.

Double-acting hydraulic cylinders, such as those used for lowering and raising the lift arms of loader buckets, are subjected to heavy and varying loads during earth-moving operations. The increased size and capacity of present day loaders dictate the need for high capacity pumps for actuating the loader's lift and tilt circuits efficiently and expeditiously. For example, maximum system pressure limits for large loaders have been increased above presently used pressure levels. Such higher pressure levels render conventional circuits prone to leakage and related problems requiring design changes thereto, such as the closing of control valve tolerances.

An object of this invention is to provide a fluid circuit, particularly useful for high pressure applications, having a non-complex flow control means for efficiently controlling the operation of an actuating means, such as a The cylinder. The flow control means preferably comprises surge damping means for automatically restricting the rate of return fluid flow from the cylinder to a pressurized fluid source in direct proportion to the increase in the fluid pressure level prevalent in an expansible chamber of the cylinder resulting from an increased loading of a rod thereof.

The preferred flow control means embodiment functions to permit the rod to retract at a substantially constant linear velocity regardless of the magnitude of load imposed thereon. Another feature of this invention comprises counterbalance control means employed in the flow control means to aid in maintaining the desired back pressure in the cylinder during a hold or neutral condition of operation thereof.

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

FIG. 1 schematically illustrates a fluid circuit, employing the flow control means of this invention therein, in its neutral or hold condition of operation; and

FIG. 2 is a view identical to FIG. 1, except that the fluid circuit is shown in a lower or cylinder retraction condition of operation.

The fluid circuit illustrated in FIG. 1 comprises an engine-driven pump 10 co-operating with a fluid retaining reservoir 11 to provide a pressurized fluid source. The source preferably communicates pressurized oil or other suitable fluid to a selector control valve 12 via branch conduit 13. Conventional pressure relief valve 14 may be set to relieve system pressures exceeding 5,000 to 6,000 p.s.i., if necessary. It should be noted that such pressure level substantially exceeds maximum pressure levels normally prevalent in fluid circuits of the type herein described.

The selector control valve is illustrated in its neutral or hold H position (FIG. 1) whereby conduit 13 communicates with a return conduit 15 to vent pressurized fluid back to the reservoir. Spring means 16 may be employed in a conventional manner to normally return the valve's spool to such neutral position upon release thereof by the operator. Subsequent movement of the valve to its raise R or lower L position will function to operate an actuating means, preferably a double-acting cylinder 17, mechanically connected to an implement means such as the illustrated loader bucket B.

Although the fluid circuit is hereinafter described as functioning to raise or lower the lift arms (not shown) of a loader, it should be understood that this invention contemplates a wide variety of other applications therefor. In addition, the actuating means could constitute other well-known fluid actuated devices. Also, the implement means could comprise conventional loader bucket tilt linkages, a bulldozer blade, a moveable element of a hydraulically actuated machine tool or other suitable devices.

When the selector control valve's spool is manually shifted to its raise R position, conduit 13 communicates with a conduit 18 to supply pressurized fluid to a flow control valve or means 19. The latter conduit communicates with an inlet passage means comprising an annular chamber 20 formed in the valve's housing. The chamber, in turn, normally communicates with variable port means, preferably in the form of radial ports 21, formed in a spool 22 reciprocally mounted in the housing. The spool further comprises a flange or baffle means 23 and chamber 24 formed internally thereof for purposes hereinafter described.

A coil spring 25 is disposed between an end plate of the housing and the spool to normally urge the spool in a rightward or first direction against a maximum stop means or shoulder 26 of the two-part housing. When fluid pressure in chamber 24 exceeds a predetermined level a cup-shaped piston 27 will move rightwardly from its normal blocking position against the opposing force of a coil spring 28. Substantially unrestricted fluid flow will then pass by the illustrated valve seat and into an outlet passage means comprising an annular chamber 29 and conduit 30 to pressurize an expansible chamber at the head end of cylinder 17. Such pressurization will function to move a rod 31 of the cylinder rightwardly to raise loader bucket B for earth-moving or unloading purposes.

During the raising phase of loader operation the rod end of the cylinder will be maintained in vented communication with the reservoir by means of conduit 32. In addition, a conduit 33 communicates with a chamber 34 formed in part by piston 27 to exhaust fluid pressure in such chamber. Thus, the force of the pressurized fluid in chamber 24 need only overcome the counteracting force of spring 28 to supply such fluid to the cylinder. It should be further noted that the piston has at least one orifice 35 formed therein to normally communicate chambers 29 and 34 for the purposes hereinafter described.

When bucket B has been raised to its desired, elevated position, the operator will release the selector control valve's spool to automatically place the circuit in its normal FIG. 1 hold H condition. The loader bucket is prevented from "creeping" downwardly primarily due to counterbalancing pressure control means comprising piston 27. In particular, a leftwardly directed force imposed on rod 31 will proportionately increase the fluid pressure level in the expansible chamber at the head end of the cylinder and in conduit 30. Such increase will be communicated to chamber 29, through orifice 35 and into chamber 34. Since venting via conduits 18 and 33 is now blocked by the selector control valve, the force of spring 28 and the increased fluid pressure in chamber 34 will hold piston 27 against its seat to prevent fluid leakage thereby to chamber 24.

When the selector control valve is shifted to its lower L position (FIG. 2), pressurized fluid communicates through conduits 13 and 32 to the rod end of the cylinder. Fluid expelled from the head end thereof flows from conduit 30 and into annular chamber 29 to urge piston 27 rightwardly. Such rightward movement is caused by the fluid pressure acting on an annular surface area 36 formed externally on piston 27 which overcomes the counteracting biasing force of spring 28. Surface area 36 may be considered as a differential surface area means, relative to the reduced surface area at the left end of the piston, continuously exposed to fluid pressure in conduit 30. It should be noted that during lowering phase of loader operation that conduit 33 functions to exhaust chamber 34.

Another feature of this invention is the provision of surge damping means for automatically decreasing the return fluid flow rate from the expansible chamber of the cylinder in direct proportion to an increase in the fluid pressure level prevalent therein. Such increased pressure level will, of course, be directly proportional to the magnitude of load imposed on rod 31 to move it leftwardly. Such means comprises baffle means 23, formed internally of spool 22, arranged to have the returning fluid impinge thereon to urge the spool in a second, leftward direction. The flow rate of the returning fluid dictates the magnitude of force urging the spool leftwardly and is proportional to the abovementioned load imposed on rod 31.

Leftward movement of the spool will function to at least partially close variable port means 21, as illustrated in FIG. 2, to reduce the flow rate of returned fluid to exhaust conduits 18 and 15. Thus, it can be seen that such surge damping means will function in the preferred embodiment to maintain a substantially constant retraction or linear speed of rod 31 regardless of the magnitude of the load imposed thereon by the bucket. For example, when bucket B is empty to thus impose a minimal force on the rod the velocity of fluid flow in chamber 24 is sufficiently and proportionately low to not move spool 22 leftwardly. Thus, the fluid will freely flow through fully exposed ports 23 to lower the bucket at the predetermined, constant rate.

However, when a loaded bucket is lowered, for example, a considerably greater force is imposed on rod 31 to accelerate fluid flow in chamber 22 to a substantially higher velocity. Such increased fluid flow will impinge against baffle means 23 to move spool 22 leftwardly in direct proportion to the load imposed on rod 31 and the increased pressure level prevalent in the expansible chamber at the head end of the cylinder. Thus, ports 21, which are suitably calibrated, function to at least partially close and restrict return fluid flow into conduit 18. A desired and constant back pressure is thus automatically created at the head end of the cylinder to maintain the retraction speed of the cylinder rod substantially constant.

Likewise, when sudden pressure surges are created in the system by "catching" a descending and loaded bucket, for example, such surges will not become excessive since spool 24 will move leftwardly in a like manner to automatically regulate fluid outflow to conduit 18. When return flow is terminated by shifting selector control valve 12 to its FIG. 1 hold H position, spool 27 will seat immediately under the influence of

spring 28 to prevent undue pressurization in conduit 18 and valve 12.

I claim:

1. In a fluid circuit comprising:

- a. a pressurized fluid source,
- b. actuating means including a fluid pressure load responsive expansible chamber,
- c. selector control valve means operatively connectable to said source, and
- d. expansible chamber flow control means operatively connected to said valve means and said chamber including:

1. surge damping means including a housing containing a first annular chamber, a spool positioned in said housing, a single set of radial ports in said spool communicating fluid between said valve means, said first annular chamber, and a first interior chamber of said spool, spring means positioning said spool in said housing in normally open communication through said ports, axial port means in said spool communicating normally unrestricted fluid flow between said first spool interior chamber and a second spool interior chamber, and surge damping flow restricting baffle means formed on said spool and defining said axial port and between said first and second spool chambers, said surge damping means automatically decreasing the flow rate of fluid returned from said actuating means to said pressurized fluid source through said valve means in direct proportion to an increase in the magnitude of loads imposed on said actuating means and a resulting increase in the fluid pressure level present in the expansible chamber thereof, and provides substantially constant speed of the motion of said actuating means, and

2. counterbalance pressure control means between said second spool chamber and said actuating means including a piston positioned in a chamber formed by a counterbalance housing, a second annular chamber formed by said piston and said counterbalance housing, and fluid back pressure maintaining spring means between said piston and said counterbalance housing, said counterbalance means maintaining said fluid back pressure in the chamber of said actuating means when fluid flow from said pressurized fluid source to said actuating means is prevented.

2. The invention of claim 1 wherein said actuating means comprises a double-acting cylinder having a rod reciprocally mounted therein.

3. The invention of claim 2 further comprising implement means operatively connected to the rod of said cylinder for varying the fluid pressure level in said expansible chamber in direct proportion to the load imposed on said rod by said implement means.

4. The invention of claim 3 wherein said implement means comprises a loader bucket adapted to be raised and lowered by said cylinder.

5. The invention of claim 1 wherein said flow control means further comprises stop means for setting maximum movement of said spool in the direction urged by said spool spring means.

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6. The invention of claim 1 wherein said piston further includes a radial surface positioned in said second annular chamber formed externally thereon and continuously exposed to fluid pressure in the expandible chamber of said actuating means for urging said piston to an open position against the biasing force of said fluid back pressure maintaining spring means.

7. The invention of claim 6 wherein said piston forms a chamber in said counterbalance pressure control

means and has port means formed therethrough to communicate fluid between the chamber of said actuating means and the chamber of said piston and means including said selector control valve means for selectively communicating fluid from said counterbalance pressure control piston chamber to said pressurized fluid source.

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