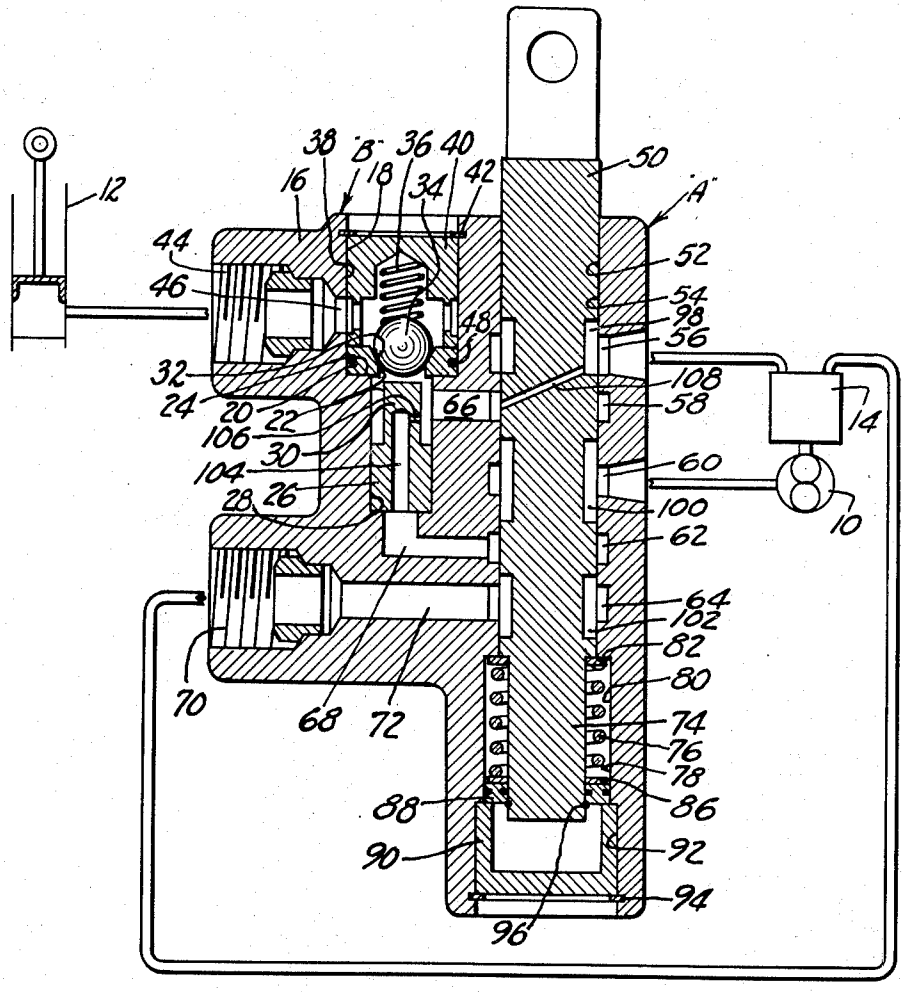
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SELECTOR VALVE WITH SNUBBING ACTION

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SELECTOR VALVE WITH SNUBBING ACTION

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The present invention relates to valves having so-called "lock out means" therein for preventing return flow through the valve; and more particularly to valves of the above type having means which will prevent the "lock out valve" from slamming shut against its seat during stoppage of the reverse flow through the valve.

When valves of the above described type are used for controlling flow to and from fluid pressure motors which actuate large masses in which considerable momentum can be developed, and more especially with lift cylinders used to raise heavy loads in farm machinery and the like, extremely high pressures can be developed should the control valve suddenly be slammed shut when the load is being lowered and return flow from the lift cylinder is being experienced through the valve. In most control valves of this type there is provided a so-called "lock out valve" usually of a poppet type construction which acts very much like a check valve to prevent leakage or return flow from the lift cylinder when the control valve is in its normal or non-actuating condition. The so-called "lock out valves" are usually necessary to hold the load in any given position, inasmuch as the control valve usually used in such systems cannot be made leakage tight. One of the difficulties with the prior art structures with which I am familiar, develops when the control valve begins to throttle off the return flow from the lift cylinder, at which time the so-called "lock out valve" slams shut to abruptly stop the return flow of fluid from the lift cylinder, thereby causing the load to be abruptly stopped and thereby subjecting portions of the system to extremely high pressures.

A principal object of the present invention is the provision of a new and improved control valve having "lock out means" which will not slam shut when the control valve is moved to its neutral or non-actuating condition of the control fluid pressure motor.

Another object of the present invention is the provision of a new and improved control valve of the above described type having a movable wall or piston in a flow chamber which will be biased up against and hold the lock out valve off its seat when the control valve is in a position adapted to permit lowering of the load; and which control valve when moved into its normal or non-actuating position establishes a restricted flow path for the return fluid, while at the same time trapping fluid on the opposite side of said movable wall from said lock out valve in a manner causing the trapped fluid to flow through a restriction to thereby prevent the lock out valve from slamming shut—the movable wall preferably having a projection which may be moved through a valve port to lift the lock out valve from its seat and which movable member forms a flow restriction with respect to the valve port when the movable wall begins to withdraw from the port to restrict return flow when the lock out valve approaches its valve seat.

Another object of the present invention is the provision of a new and improved valve of the above described

type in which the movable wall projects through a valve port to lift the lock out valve from its valve seat, and in which the control valve does not completely shut off the return flow of fluid through the lock out valve when moved to its neutral or non-actuating position; the improved valve further causing fluid to be trapped behind the opposite side of the movable wall when the control valve is moved to its neutral position and to force the trapped fluid through a flow restriction in a manner producing a force tending to oppose the closing of the lock out valve and thereby slowly permit the lock out valve to abut its valve seat.

The invention resides in certain constructions and combinations and arrangements of parts, and further objects and advantages of the present invention will become apparent to those skilled in the art to which the invention relates from the following description of the preferred embodiment described with reference to the accompanying drawing forming a part of this specification.

The improved valve structure shown in the drawing generally comprises a control valve A which in one position will conduct flow from a pump 10 to a single acting lift cylinder 12 such as is used for the raising and supporting of loaders on farm tractors, and the like. The control valve A has a second position for permitting the lowering of the load, in which position return flow from the lift cylinder 12 is conducted through the control valve A to the reservoir 14 which supplies hydraulic fluid for the pump 10. Operatively positioned between the control valve A and the lift cylinder 12 is a "lock out valve" B which, when in its closed position, prevents leakage of return fluid from the lift cylinder 12 to the control valve A such that its load can be held in any position. When the control valve A is moved into a third position, flow to the lift cylinder is prevented, and the lock out valve is permitted to close, thereby preventing return flow from the lift cylinder 12.

While the control valve A and the lock out valve B may be made as separate units connected by suitable conduit means, the preferred embodiment shown in the drawing combines the two within a single body member 16. The portion of the body member 16 forming the lock out valve B is formed by a longitudinal stepped bore or flow chamber 18, and an annular member 20 having a centrally located valve port 22 therein is positioned against the shoulder 24 provided by the stepped portion of the bore 18. A movable wall or piston 26 is positioned in the bottom or small diameter section 28 of the stepped bore 18, and is provided with a centrally located boss or projection 30 which is capable of being moved through the valve port 22. The side of the annular member 20 which is opposite the piston 26 is bevelled at approximately a 45° angle in the region surrounding the valve port 22 to provide a valve seat 32 against which a ball valve 34 is biased by coil spring 36. The outer end of the enlarged diameter section 38 of the stepped bore 18 is closed off by means of a cup shaped closure member 40 which is held in place by a snap ring 42, and which supports the coil spring 36 for abutment with the ball valve 34. Unrestricted flow communication is provided between the portion of the flow chamber provided by its large diameter section 38 (the portion above the ball valve 34 as seen in the drawing) and the lift cylinder 12 by means of a connection 44 in the body member 16, and suitable porting 46 in the side walls of the cup shaped closure member 40. An O-ring seal 48 is provided the annular member 20, to prevent leakage around the side edges of the member 20 in which the valve seat 22 is formed.

The control valve A shown in the drawing is a slide valve formed by means of a cylindrically shaped slide

50 positioned in a longitudinal bore 52 extending generally parallel with respect to the stepped bore 18. The side walls 54 of the longitudinal bore 52 are provided with a plurality of annular recesses forming a return port 56, a first motor port 58, a pressure port 60, a port 62 for the piston 26, and a return port 64 arranged in that order proceeding in the axial direction of the stepped bore 18. The return port 56 is of course adapted to return fluid to the reservoir 14; the first motor port 58 is connected with the small diameter section 28 of the flow chamber 18 immediately beneath the valve port 22; the pressure port 60 is adapted to be connected with the pump 10; the port 62 is connected with the bottom end of the stepped bore 18 by means of a suitable passageway 68; and the return port 64 is communicated with a return connection 70 by a passageway 72.

The lower end of the slide 50 is provided with a reduced diameter section 74 for the accommodation of a centering spring 76 adapted to hold the slide 50 in its previously referred to neutral or non-actuating condition. The lower end of the longitudinal bore 52 is provided with a double stepped counterbore, the smaller diameter section 80 of which is made coextensive with the reduecd diameter section 74 of the slide 50. An annular washer 82 is positioned in the annular space provided by the reduced diameter section 74 and the smaller diameter section 80 of the double stepped counterbore, and is biased into engagement with the shoulders so provided in the slide and body member by the coil spring 76. The lower end of the coil spring 76 is abutted by a similar annular washer 86 which in turn is supported by an annular sealing member 88 adjacent the lower end of the smaller diameter section 80 of the double stepped bore 78. The annular sealing member 88 is in turn held in place by a cup-shaped closure member 90 positioned in the lower or larger diameter section 92 of the double stepped bore 78. The cup-shaped closure member 90 is held in place by a snap ring 94, and the upper end of the closure member 90 abuts both the shoulder as provided by the double stepped bore and the annular sealing member 88 to retain the sealing member 88 in position and limit its movement in a downward direction. The lower end of the slide 50 is in turn provided with a snap ring 96 which may abut the radially inner edges of the sealing member 88 to oppose upward movement of the slide 50. Movement of the slide 50 in an upward direction causes the sealing member 88 to compress the coil spring 76, inasmuch as the upper end of the coil spring 76 will be confined by the upper shoulder of the double stepped bore 78. Downward movement of the slide 50 causes the shoulder on the slide to move the upper end of the spring 76 downwardly, while the annular sealing member 88 is held stationary by the cup-shaped closure member 90. It will therefore be seen that the spring 76 will move the slide 50 into its neutral or non-actuating condition when no external actuating forces are applied to the slide.

The slide valve structure is completed by a plurality of cooperating recesses in the slide 50 comprising a return groove 98, a pressure groove 100, and a return groove 102 positioned in the same order as indicated for the recesses in the side walls of the valve bore. In the neutral position of the slide 50, the upper return groove and recesses 98 and 56 of the slide and bore, respectively, will be generally opposite each other; the pressure groove 100 and recess 60 will be opposite each other; the lower return groove 102 and recess 64 will be opposite each other; and the first motor port 58 and piston port 62 will be valved off by means of suitable land portions on the slide 50.

When the slide 50 is moved into its upper position: the return groove 102 will communicate the return port 64 with the piston ports 62; the pressure groove 100 will communicate the pressure port 60 with the first motor port 58; and the motor port 58 will be isolated from the return port 56 by suitable land portions on the slide 50. With the slide 50 in this position, full pump pressure will be delivered to the upper portion of the piston 26 while the lower portion of the piston will be communicated with the system reservoir 14. The piston 26 will therefore be held into its lower position; and the pump pressure in the upper end of the small diameter section 28 of the flow chamber will force the ball valve 34 off its seat 32 to permit full flow of pump pressure to the single acting lift cylinder 12.

When the slide 50 is moved into its downward position: the return groove 98 will communicate the first motor port 58 with the return port 56; the pressure groove 100 will communicate the piston port 62 with the pressure port 60; and the return groove 102 communicates only with the return port 64. In the downward position, therefore, the slide 50 causes pressure to be delivered to the lower end of the piston 26 forcing it upwardly to unseat the ball valve 34 from its valve seat 32. Return flow from the lift cylinder 12 may therefore be established through the valve port 22 past the projection 30 of the piston 26, through the passageway 66 and groove 98, to the return port 56 leading to the reservoir 14. The load upon the power lift cylinder will cause flow through this path to proceed fairly rapidly whereby considerable downward momentum will be developed in the load supported by the power lift cylinder.

When downward actuating force on the slide 50 is released, the slide 50 will be immediately shifted by the coil spring 76 to its neutral on non-actuating condition previously referred to. In this condition, the piston port 62 is closed off with the piston 26 in its extended position biasing the ball valve 34 out of engagement with the seat 20. The fluid beneath the piston 26 will therefore be trapped in place were it not for the provision of a flow restricting passageway 104 communicating the lower end of the piston 26 with the pasageway 66. The flow restricting passageway 104 is formed by a longitudinal drilling in the lower end of the piston 26, and a small diameter transverse drilling 106 which will restrict flow from the bottom end of the piston 26 into the passageway 66 sufficiently to develop enough pressure differential across the piston 26 to oppose and slow down movement of the ball 34 towards its seat 32. To further facilitate the slowing down of the piston and the power lift cylinder 12, an additional flow restricting passageway 108 is positioned in the slide 50—which passageway communicates its land portion which closes off the first motor port 58 in its neutral position with the slide return groove 98.

It will be seen that there are in effect two flow restrictions to the return flow from the single lift cylinder 12 when the ball valve 34 is biased off of its seat by means of the piston 26, and the slide 50 is first moved to its neutral or non-actuating position. The first of these restrictions is provided by means of an annular space between the projection 30 of the piston 26, and the side walls of the valve port 22; and the second of which is provided by the flow restricting passageway 108 in the slide valve 50. The combined resistance of these two flow restrictions will be designed to provide a terminal downward velocity of the lift cylinder 12 which will be acceptable in the particular system in which the valve is to be installed. In the embodiment shown in the drawing, the major amount of restriction to the return flow from the power lift cylinder 12 is provided by means of the passageway 108 and only a minor amount of the flow restriction is provided by means of the clearance between the port 22 and projection 30 of the piston 26. This was done because of the stack-up of tolerances which may be experienced in the manufacturing process of the valve. It has been established that the quantity of fluid passing through the valve port 22, when the projection 30 is positioned to one side of the opening, may be approximately 2.5 times that experienced when the

projection 30 is centrally located with respect to the valve port 22. Inasmuch as the location of the projection 30 with respect to the valve port 22 is determined by a stack-up of manufacturing tolerances, the flow restriction so provided by the projection 30 and valve port 22 will not preferably be relied upon to produce a major portion of the total resistance to return flow from the power lift cylinder 12.

By way of further refinement, the upper end of the projection 30 may be slightly enlarged with respect to the remainder of the projection 30 such that its throttling action will be confined to the position of the piston 26 wherein the ball piston 34 approaches its seat 32. When the ball piston approaches its seat, a throttling of the reverse flow occurs between the ball and its seat which tends to slam the ball 34 into engagement with its seat. Because these forces across the ball 34 increase rapidly as the ball approaches its seat, only the tip portion of the projection 30 need be enlarged to provide the above referred to restriction; and of course when full flow is desired through the lock out valve B, the piston 26 will be forced upwardly sufficiently to move the ball and tip portion of the projection 30 clear of the valve seat 32. In this upper position, the reduced diameter center section of the projection 30 will extend through the valve port 22 such that substantially no flow restriction is experienced when the ball is held in its upper fully released position.

It will be apparent that the flow restriction as provided by the passageway 108 need not necessarily be confined to the slide portion 50 of the valve structure, but may be positioned anywhere in a second flow path which is communicated with the passageway 66 when the valve is in its neutral position. This restriction could occur anywhere in this second flow path which of course would include positions outside of the body member 16.

While the invention has been described in considerable detail, I do not wish to be limited to the particular constructions shown and described, and it is my intention to cover hereby all novel adaptations, modifications and arrangements thereof which come within the practice of those skilled in the art to which the invention relates.

I claim:

1. In a fluid pressure control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position or the equivalent for providing reverse flow; a source of fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a valve closure member on the other side of said valve seat from said second movable wall, said valve closure member being biased against said valve seat, said second movable wall being constructed and arranged to abut said valve closure member and force it from its seat, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, valve means constructed and arranged to conduct pressure from said pressure source to said second port while permitting return flow out of said first port when said valve means is in one position, and closing off said second port while permitting flow out of said first port when in a second position, means providing a restriction to flow out of said second opposing chamber with said valve means in its second position, and means forming a restriction to return flow from said lift cylinder during the time in which said second movable wall moves in a direction permitting said valve closure member to approach its valve seat, whereby a cushioning effect is provided for said lift cylinder before return flow is stopped by said valve closure member.

2. In a hydraulic control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position, or the equivalent for providing reverse flow: a source of hydraulic fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a valve closure member on the other side of said valve seat from said second movable wall, said valve closure member being biased against said valve seat, said second movable wall being constructed and arranged to abut said valve closure member and force it from its seat, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, valve means constructed and arranged to conduct pressure from said pressure source to said second port while permitting return flow out of said first port through a first flow path when said valve means is in one position, and closing off said second port while establishing flow out of said first port through a second flow path when in a second position, means providing a restriction to flow out of said second opposing chamber with said valve means in its second position, and means providing a flow restriction in said second flow path causing the rate of flow out of said first port when said valve is in its second position to be less than when in its first position, and whereby said valve closure member is made to slowly approach its valve seat when said valve means is moved into its second position.

3. In a hydraulic control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position, or the equivalent for providing reverse flow: a source of hydraulic fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a valve closure member on the other side of said valve seat from said second movable wall, said valve closure member being biased against said valve seat, said second movable wall being constructed and arranged to abut said valve closure member and force it from its seat, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, slide valve means constructed and arranged to conduct pressure from said pressure source to said second port while permitting return flow out of said first port through a first flow path when said valve means is in one position, and closing off said second port while establishing flow out of said first port through a second flow path located in said slide when said slide is in a second position, said second flow path causing the rate of flow out of said port when said valve is in its second position to be less than when in its first position, and means providing a restriction to flow out of said second opposing chamber with said slide valve means

in its second position, whereby said valve closure member is made to slowly approach its valve seat when said valve means is moved into its second position.

4. In a hydraulic control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position, or the equivalent for providing reverse flow: a source of hydraulic fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a valve closure member on the other side of said valve seat from said second movable wall, said valve closure member being biased against said valve seat, said second movable wall being constructed and arranged to be moved into said valve seat for abutment with said valve closure member to force it from its seat, said second movable wall forming a flow restriction between itself and said seat when said closure member is held adjacent its seat by said second movable wall, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, valve means constructed and arranged when in one position to conduct pressure from said pressure source to said second port to cause said second movable wall to move said valve closure member from its seat while permitting return flow out of said first port through a first flow path, and when in a second position to close off said second port while also establishing flow out of said first port, and means providing a restriction to flow out of said second opposing chamber with said valve means in its second position, whereby said valve closure member is made to slowly approach its valve seat when said valve means is moved into its second position.

5. In a hydraulic control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position, or the equivalent for providing reverse flow: a source of hydraulic fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a valve closure member on the other side of said valve seat from said second movable wall, said valve closure member being biased against said valve seat, said second movable wall being constructed and arranged to be moved into said valve seat for abutment with said valve closure member to force it from its seat, said second movable wall forming a flow restriction between itself and said seat when said closure member is held adjacent said seat by said second movable wall, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, valve means constructed and arranged when in one position to conduct pressure from said pressure source to said second port to cause said second movable wall to move said valve closure member from its seat while permitting return flow out of said first port through a first flow path, and when in a second position to close off said second port while also establishing flow out of said first port through a restricted flow path, and means providing a supplemental flow restriction in said restricted flow path in addition to that between said second movable wall and said valve seat causing the rate of flow out of said first port when said valve is in its second position to be less than when in its first position, and means providing a restriction to flow out of said second opposing chamber with said valve means in its second position, whereby said valve closure member is made to slowly approach its valve seat when said valve means is moved into its second position.

6. In a hydraulic control system having a lift cylinder with a movable wall therein to form an expansible chamber in which the movable wall is biased into a retracted position, or the equivalent for providing reverse flow: a source of hydraulic fluid pressure, a valve body member having a flow chamber therein, a second movable wall in said flow chamber dividing said flow chamber into first and second opposing chambers and being adapted for longitudinal movement in said flow chamber, a valve seat in said first opposing chamber facing away from said second movable wall, a ball valve on the other side of said valve seat from said second movable wall, said ball valve being biased against said valve seat, said second movable wall being constructed and arranged to be moved into said valve seat for abutment with said ball valve to force it from its seat, flow conducting means communicating the opposite side of said valve seat from said second movable wall to said expansible chamber of said lift cylinder, a first port in said first opposing chamber positioned in such manner as to communicate with said valve seat during the time said closure member is biased off of its valve seat by said second movable wall, a second port in said second opposing chamber, valve means constructed and arranged to conduct pressure from said pressure source to said second port to cause said second movable wall to move said ball valve from its seat while permitting return flow out of said first port through a first flow path, and when in a second position to close off said second port while establishing flow out of said first port through a second flow path in said valve means when said valve means is in a second position, said second flow path causing the rate of flow out of said first port when said valve is in its second position to be less than when in its first position, and means providing a restriction to flow out of said second opposing chamber with said valve in its second position, whereby said ball valve is made to slowly approach its valve seat when said valve means is moved into its second position.

No references cited.