March 11, 1952 H. A. HALGREN ET AL 2,588,520

HYDRAULICALLY OPERATED CHECK VALVE MECHANISM

Filed Oct. 12, 1946 3 Sheets-Sheet 1

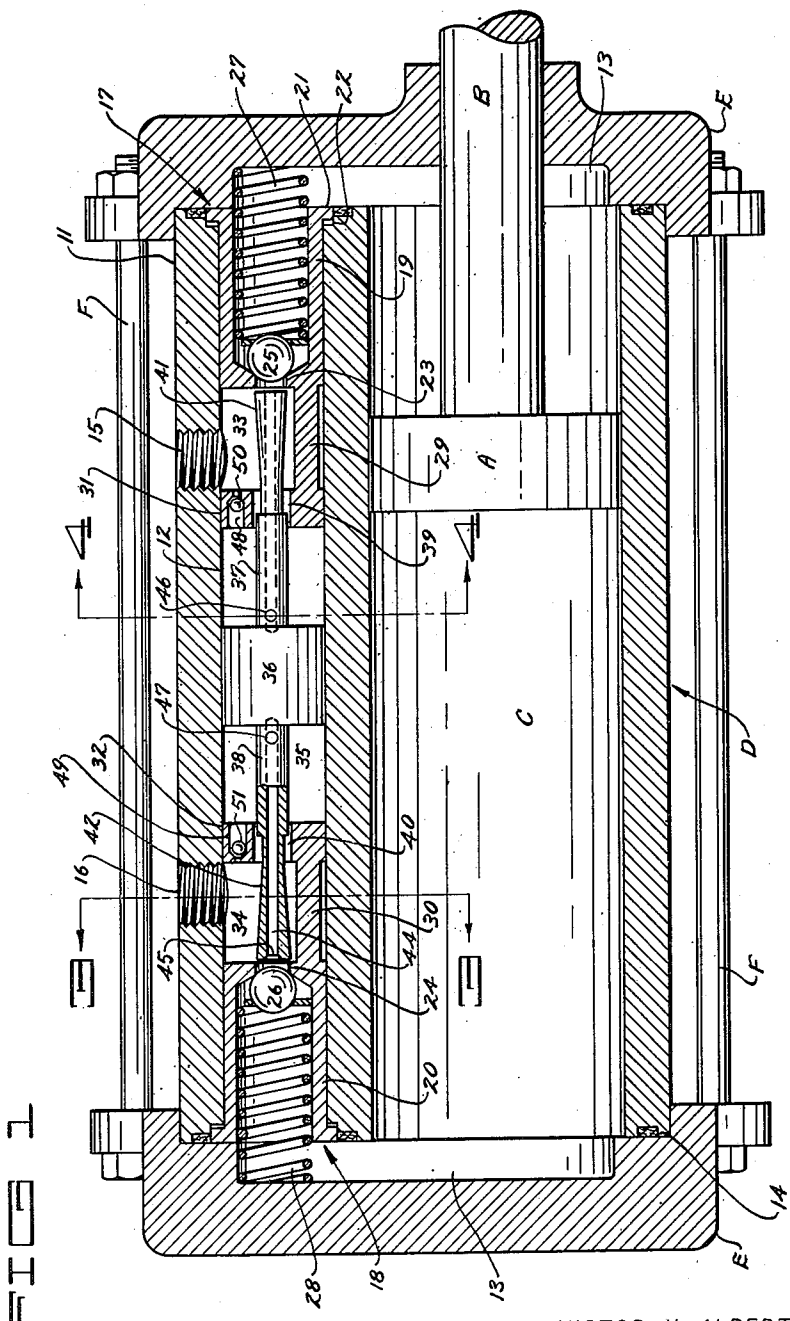


FIG. 1

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Filed Oct. 12, 1946 3 Sheets-Sheet 2

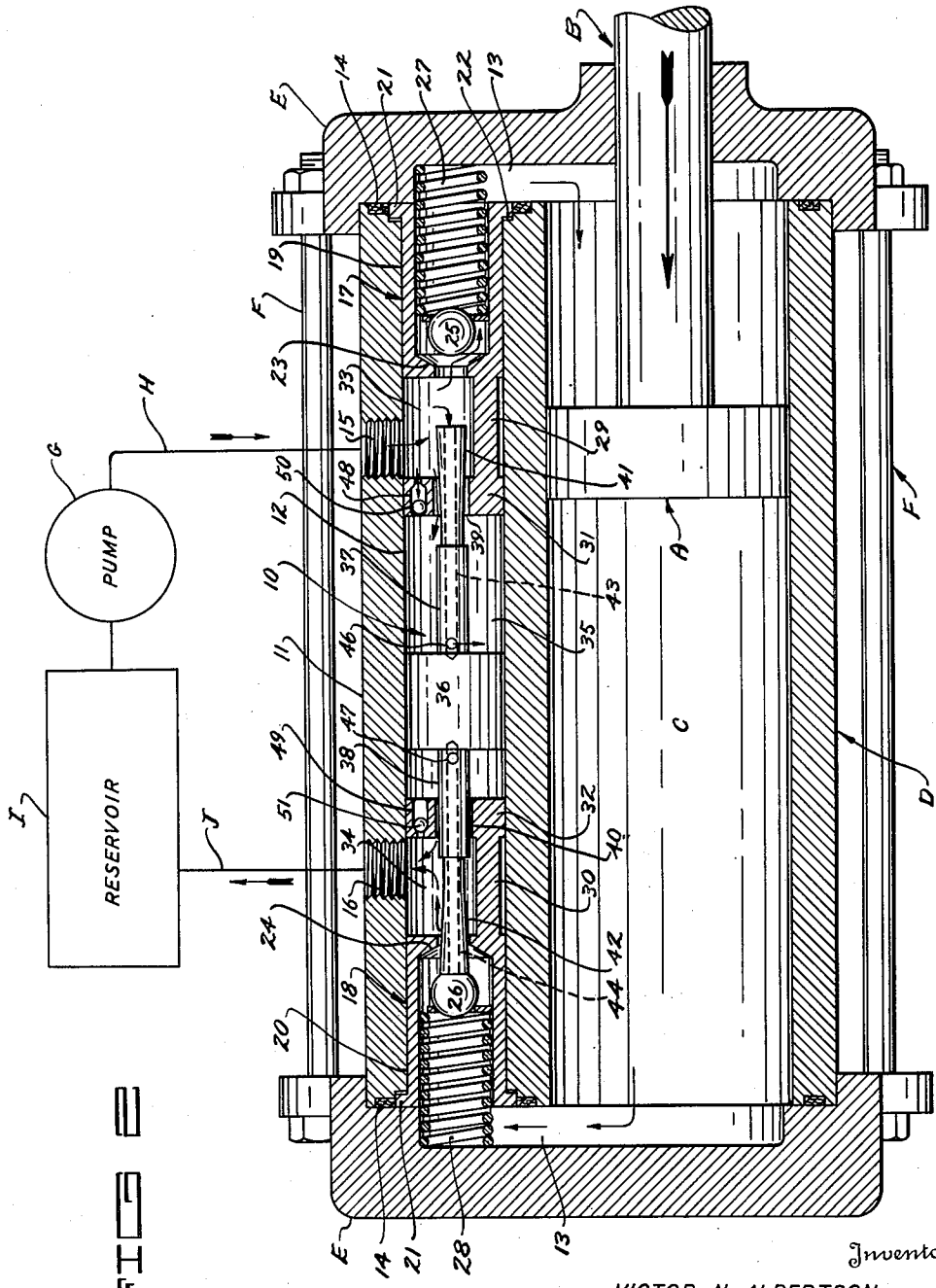


FIG 2

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March 11, 1952 H. A. HALGREN ET AL 2,588,520

HYDRAULICALLY OPERATED CHECK VALVE MECHANISM

Filed Oct. 12, 1946 3 Sheets-Sheet 3

FIG 3

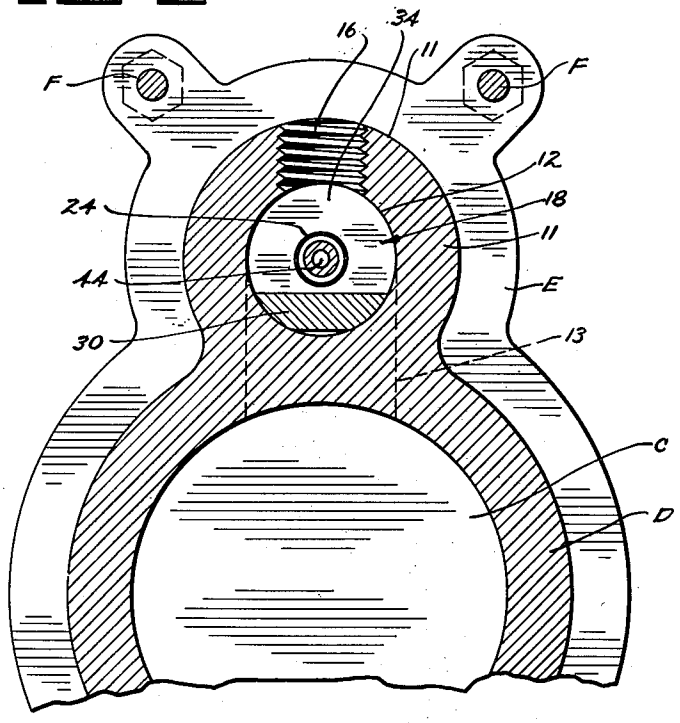
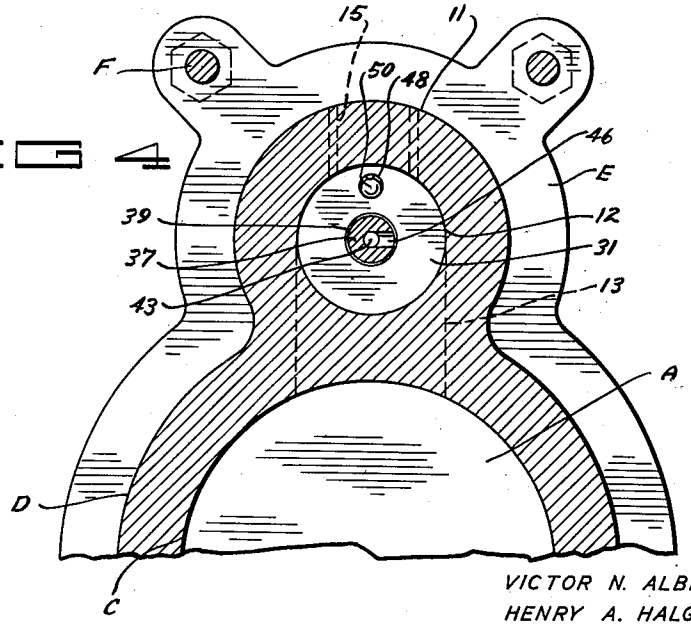


FIG 4



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HYDRAULICALLY OPERATED CHECK VALVE MECHANISM

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Application October 12, 1946, Serial No. 702,984

15 Claims. (Cl. 121—40)

1

This invention relates to improvements in valves for controlling hydraulic jacks such as used for example in tractor-implement combinations for raising and lowering implements supported from or operated by a tractor.

The usual hydraulic lift system for this and analogous purposes includes, in addition to the jack and source of fluid under pressure for operating the same, a manually controllable valve by which fluid may be admitted to and allowed to escape from the jack as required to operate it, and another valve assembly which is ordinarily automatically operative and has the purpose of normally preventing the escape of fluid from either end of the jack in order to maintain it in an adjusted position. Our present invention relates more particularly to improvements in the latter type of valve and which for convenience hereafter will be referred to as a "lock-out" valve since its purpose is to lock-out the jack from the fluid system except when the manual control valve is operated.

The ordinary lock-out valve includes two separate check valves which normally prevent return flow from either end of the jack cylinder to reservoir or the low pressure side of the system. When fluid is to be admitted to one end of the cylinder, however, it is obvious that the check valve connected to the other end must be unseated in order to allow displaced fluid to return to the reservoir. For this purpose there is conventionally provided an actuator in the form of a plunger against one end of which fluid pressure is admitted when the manual control valve is operated to admit fluid to the jack cylinder. When pressure is thus applied to the actuator plunger it is displaced endwise, and it is arranged to mechanically engage and unseat one of the said check valves to permit displaced fluid to pass through as fluid enters under pressure into the other end of the jack cylinder. In the operation of such lock-out valves as heretofore constructed it is found that there is a tendency for the actuator plunger to flutter or chatter causing very uneven operation of the jack, as well as damage to the valves such as to sometimes render it inoperative. This fluttering or chattering action results from a fluctuating differential in pressure on opposite sides of the actuator plunger causing it to vibrate back and forth as this pressure varies. For example, when the jack is to be lowered under load, fluid pressure must be admitted at one side of the jack piston while fluid is allowed to escape from the opposite side thereof. As this condition is brought about, by manipulation of the manually controlled valve, the lock-out valve actuator plunger is moved in one direction by the pressure of the fluid flowing to the jack cylinder so that it unseats the check valve connected to the opposite end of the cylinder enabling displaced fluid to escape therefrom. Immediately, however, as the jack starts to lower the load, the pressure falls on the side of the jack piston to which fluid is being admitted and as a result the fluid pressure at the other side of the jack piston has a tendency to return the lock-out valve toward its starting position. As this occurs the check valve previously opened by the actuator plunger starts to close which not only has a tendency to stop the lowering movement of the jack but results in a reversal of the pressure differential on the actuator plunger such as to tend to restore it to a position for again causing the jack to lower. This action repeated rapidly and continuously, will be seen to cause uneven operation of the jack and chattering of the valve and associated parts such as to materially interfere with its operation. In fact this chattering action is sometimes so severe as to cause fracture of parts such as hose lines and fittings connected to the jack, and aside from the loss of time and expense incurred in repairing the damage, such breakage is dangerous due to the fact that the implement or other load upon the jack may fall when such damage occurs.

2

It is the primary object of our invention to provide a lock-out valve mechanism which completely cures this chattering action and in which the actuator plunger is so damped or controlled that it can not set up a fluttering action even under widely varying load conditions. Another object is to provide a lock-out valve mechanism which includes also means for metering the flow of fluid to and from the cylinder in such manner that the movement of the jack will start gradually as the manual control valve is manipulated and will gradually accelerate as the movement continues. Precise adjustments of the position of the implement or other load upon the jack are thus made very conveniently.

It will be evident that the lock-out valve acts as a safety valve for the jack in that so long as the check valves are closed fluid can not escape from the jack and cause it to move in any direction and particularly in such direction as to drop the implement or load. So far as we are aware, however, all previous valves for this purposee have been remotely located with respect to the jack cylinder and connected thereto by the usual hose lines and fittings. In such an arrangement leakage anywhere in the system, such as might be caused by a broken hose or imperfect fitting will allow fluid to escape and the jack to change its position so that the safety factor of the lock-out valve is largely counteracted. Further in accordance with our invention and as an important object thereof we so locate our lock-out valve that damage to the fluid lines and fittings will not render the safety feature of the valve useless. For this purpose and reason we mount the lock-out

valve directly on the jack cylinder and in direct, intimate communication with the interior thereof in such manner that the check valves have immediate and complete control over the escape of fluid from the cylinder.

These and other more detailed and specific objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which—

Fig. 1 is a longitudinal diametrical section through a jack cylinder and lock-out valve mechanism embodying our invention. The valve mechanism is here shown in its normal or inoperative position.

Fig. 2 is a similar view but showing the valve mechanism adjusted to permit fluid to flow to and from opposite ends of the jack cylinder and showing also diagrammatically the pump reservoir and connecting lines of the hydraulic system.

Figs. 3 and 4 are fragmentary cross sectional views along the lines 3—3 and 4—4 in Fig. 1.

Referring more particularly and by reference characters to the drawing we show therein a jack having the usual piston A and piston rod or plunger B adapted to be fluid actuated and connected to the load in any desired manner. For convenience herein it is assumed that the load is so applied to the piston and plunger that it tends to move these parts in the direction opposite to that of the arrow in Fig. 2. The piston A operates in a jack cylinder C which is formed in a housing D over which are placed the usual caps E, held in place by tie rods F. In the ordinary jack such as used in tractor-implement combinations and for power lifts of various other kinds, the cylinder housing D or the end caps E are merely provided with conventional fittings (not here shown) by which fluid may be admitted to force the piston A and attached plunger B toward the other end of the cylinder, and so that fluid in this other end of the cylinder may be allowed to escape as it is displaced by travel of the piston. As shown in Fig. 2 a pump G is indicated as having a supply line H for supplying fluid under pressure to the cylinder while a reservoir I is indicated as having a return line J through which displaced fluid may be returned to the reservoir. Ordinarily there is connected between the pump G and the reservoir I and the jack a manually adjustable valve, the purpose of which is to connect the lines of H and J selectively to opposite ends of the jack cylinder and reverse the direction of movement of the piston A and plunger B as may be required for positioning the load. This valve being entirely conventional is for convenience sake not shown herein.

In accordance with our invention, we provide a lockout valve mechanism designated generally at 10 and for its accommodation we form an enlargement 11 longitudinally along one side of the jack cylinder housing D and provide such enlargement with an elongated cylindrical bore 12, the opposite ends of which communicate with opposite ends of the jack cylinder C through recesses 13 formed inside the end caps E. These recesses 13 obviously directly and intimately connect the ends of the jack cylinder C and bore 12 and suitable gaskets or packing rings 14 are provided to prevent the escape of fluid at the ends of the cylinder. It will be evident therefore that by thus intimately associating the lock-out valve 10 with the interior of the jack cylinder that no intervening hose lines or fittings are required to connect the valve and jack and thus that damage to such fittings and lines can not in any way effect the adjustment of the jack and its supported load.

The outer wall of the cylinder housing enlargement 11 is provided at longitudinally spaced points with tapped openings 15 and 16 to which the aforesaid supply and return lines H and J may be conventionally connected so that fluid may flow into and out of the bore 12 under control of the aforesaid manually adjustable control valve. Positioned in opposite ends of the bore 12 are end plugs or housings, designated generally at 17 and 18, having substantially cylindrical cage portions 19 and 20 the outer ends of which are peripherally flanged as designated at 21 and adapted to seat in annular recesses 22 formed in the extremities of the bore 12 for their accommodation. It will be understood that when the end caps E are removed these end plugs or housings 17 and 18 may be inserted into opposite ends of the bore 12 and that when the end caps are replaced they will hold the flanges 21 in the annular grooves 22, thereafter preventing endwise displacement of the said housings. The cage portions 19 and 20 have inner ends which are closed except for conventionally formed check valve seats 23 and 24 with which cooperate check valve balls 25 and 26 normally urged into closing relation with the said seats by expansion coil springs 27 and 28 placed between the balls and the end caps E as clearly shown. The housings 17 and 18 further have extensions 29 and 30 which extend inwardly from adjacent the check valve seats 23 and 24 and support plugs 31 and 32 which arround their peripheries tightly fit the bore 12. It will be noted that the aforesaid construction is such that the check valve seats 23 and 24 are located outwardly with respect to the fluid openings 15 and 16 respectively, whereas the plugs 31 and 32 are located inwardly thereof. The arrangement is further such that the extensions 29 and 30 are spaced inwardly with respect to the openings 15 and 16 forming chambers 33 and 34 in the bore 12 which directly communicate with these openings. The check valves are, of course, thus located between the openings 15 and 16 and the opposite ends of the jack cylinder C and the direction of the opening of the check valves is such that they will be seated by pressure of fluid trying to escape from the jack cylinder and so will lock out the jack from other parts of the hydraulic system as previously described.

The length of the bore 12 in comparison with that of the plugs or housings 19 and 20 is such that a third chamber of substantial length is formed between the plugs 31 and 32 at the center of the bore and this chamber is hereinafter referred to and designated as the actuator piston chamber or cylinder 35. Movably positioned in the chamber 35 is an actuator plunger 36 which nicely, slidably fits the interior of the chamber and which is short enough, in comparison with the length of the chamber, to have a substantial range of endwise movement therein. Projecting endwise from the centers of the opposite ends of the plunger 36 are valve actuating stems 37 and 38 and the aforesaid plugs 31 and 32 have central openings 39 and 40 through which the stems 37 and 38 respectively may freely and quite loosely pass. The overall length of the aforesaid stems 37 and 38 is such that, in the normal position of the valve with the plunger 36 centrally located in the chamber 35 as seen in Fig. 1, these stems will project through the openings 39 and 40, will traverse the chambers 33 and 34, and terminate just inwardly of the check valve seats 23 and 24. It will be noted that substantially half

the length of the stems 37 and 38, at the outer ends thereof, are adapted to operate as metering pins in conjunction with the check valves and for this purpose these portions of the stems, designated at 41 and 42, are tapered from their extremities and in the direction of the chamber 35. The diameter of the larger, outer ends of the metering pins is such, however, that they may loosely pass through the check valve seats 23 and 24 as indicated in Fig. 2.

The valve stems 37 and 38 are provided with axially extending bores or passages 43 and 44 which extend from adjacent the ends of the plunger 36 through the outer ends of the stems and are provided at these outer ends with shallow countersinks, one of which is indicated at 45 in Fig. 1. At their inner ends the passages 43 and 44 communicate with radially extending ports 46 and 47 so that the passages communicate with the interior of the chamber 35 at the respective opposite ends of the plunger 36 and form a means of communication between the opposite ends of the chamber 35 and the chambers 33 and 34. Also communicating with these chambers are openings 48 and 49 formed through the end plugs 31 and 32, parallel with the valve stems, and in these openings 48 and 49 we position check valve balls 50 and 51, the purpose of which is to prevent escape of fluid from either end of the chamber 35, into the adjacent chambers 33 and 34 respectively, but to permit opposite flow of the fluid toward the chamber 35 as will be readily apparent.

In operation, it will be assumed that it is desired to operate the jack to lower its load thus requiring movement of the jack piston A and plunger B in the direction of the arrow in Fig. 2. It will, first of all, be understood that the lock-out mechanism normally stands in the position of Fig. 1 and that the check valves 25 and 26 are closed. Now to lower the load the manual control valve is so positioned as to cause fluid under pressure to flow from the pump G into the opening 15 and into chamber 33 as indicated by the arrows in Fig. 2. The fluid pressure is thus exerted against the check valve ball 25 in such direction as to unseat the ball against the resistance of the spring 27 and allow the fluid to flow into the right hand end of the jack cylinder C and urge the piston A in the required direction. At the same time the fluid in the chamber 33 enters the adjacent end of the chamber 35 by unseating the check valve ball 50 and also flows through the passage 43 and out through the port 46. The fluid pressure is thus brought to bear against the actuator plunger 36 so that it is moved in the chamber 35 toward the left as viewed in Fig. 2 and as this occurs the valve stem 38 is projected endwise against the other check valve ball 26 to mechanically engage and unseat the same. The way is thus cleared for the escape of displaced fluid from the left hand end of the jack cylinder C into the chamber 34 and thence out through the opening 16 and to the reservoir I, as also indicated by the direction of arrows. Thus the necessary conditions are met in order to provide the desired direction of movement of the jack piston A and plunger B.

It will be understood, however, that the movement of the lock-out valve plunger 36 is damped or retarded by fluid pressure which operates to yieldably resist its said movement. At the outset, and starting from the position of Fig. 1 toward the position of Fig. 2, it will be understood that fluid pressure in the left hand end of the chamber 35 may escape freely through the port 47

and the passage 44 as well as around the stem 38 through the opening 40. Thus the initial movement of the valve actuator plunger 36 is rapid but when the end of the stem 38 strikes the check valve ball 26 the end of the passage 44 is plugged by the ball so that this way of escape for the fluid is stopped. Fluid may then escape from the left hand end of the chamber 35, as the plunger 36 continues to move, only through the relatively restricted opening formed around the stem 38 and inside the opening 40. There results then a fluid damping action, or dash pot action, to retard the rate of travel of the plunger 36, to prevent any chattering effect. In actual practice, it has been found that this retarding or damping of the escape of the fluid from the lock-out valve chamber is very effective for the purpose and that the valve operates without chattering and permits even, smooth movement of the jack itself, under all load conditions, and even when the jack is supporting an implement during transport.

As soon as the jack movement is stopped the decrease in pressure on the opposite side of the lock-out valve actuating plunger 36 allows the remaining pressure on the opposite side thereof to return the valve to its starting position of Fig. 1 and it will be evident that this pressure may quickly reassert itself on the plunger to return the same to center due to the fact that the fluid may unseat the check valve ball 51 to enter the chamber 35 rapidly and also may enter through the passage 44 as soon as the stem 38 clears the check valve ball 26. The valve is then ready for the next operation and it will, of course, be understood that when the fluid pressure flow is reversed from the directions just described that the plunger 36 will move in the opposite direction to unseat the check valve ball 25 while the operation will otherwise remain exactly the same.

Attention is called to the fact that as the valve stem 38 penetrates the valve seat 24 to unseat check valve ball 26 it restricts the return flow of fluid through this check valve but due to the tapering formation of the metering pin portion 42 of the stem the rate of flow is regulated in accordance with the position assumed by the lock-out valve plunger 36. In other words, the greater the travel of the plunger 36, the more rapid will be the return flow of the displaced fluid due to the fact that the tapering metering pin gradually increases the effective area of the opening through the check valve. It will thus be seen that the jack movement will at first be slow and will gradually accelerate as it proceeds due to this metering action and without any attention whatever on the part of the operator as he manipulates the manual control valve. This is a distinct advantage since the slow starting movement of the jack enables minor adjustments of the jack and its load to be made very precisely.

It is understood that suitable modifications may be made in the structure as disclosed, provided such modifications come within the spirit and scope of the appended claims. Having now therefore fully illustrated and described our invention, what we claim to be new and desire to protect by Letters Patent is:

1. In a device of the character described, a valve housing having spaced fluid chambers and a check valve communicating with each chamber controlling fluid flow thereinto, and said housing having also a third fluid chamber, means supplying fluid to the chambers, an actuator plunger in said third chamber having stems

adapted to selectively engage and unseat the check valves, and means separating the first mentioned chambers from opposite ends of the third chamber but having openings permitting restricted fluid flow therebetween, said stems having tapering portions operative as metering pins for metering fluid flow through the check valves.

2. In combination with a hydraulic jack cylinder having fluid inlet and outlet means for selectively supplying fluid to either end of the cylinder while permitting escape of displaced fluid from the other end, a valve mechanism of the character described having separate chambers connecting the opposite ends of the jack cylinder to said inlet and outlet means, check valves normally isolating the chambers from the jack cylinder, means forming a third chamber isolated from the other chambers but having openings permitting fluid flow from the third chamber at restricted rate, and a plunger operative by fluid pressure in the third chamber and having means for mechanically engaging and selectively unseating the check valves, said means isolating the third chamber from the other chambers also having openings normally closed by check valves but permitting rapid flow of fluid into the third chamber.

3. The combination with a hydraulic jack cylinder, of a valve including a housing having a bore communicating at opposite ends with the ends of the cylinder and having also fluid openings leading into the bore at spaced points, housing members in the ends of the bore, said members having check valves normally isolating the ends of the jack cylinder from the fluid openings, said housing members having end plugs forming an intervening chamber in the bore, a plunger movably mounted in the chamber and having stems extending from its opposite ends, the said end plugs having openings to loosely pass the stems and permit fluid to flow around the stems in the chamber, the said stems being adapted to selectively engage and open the check valves responsive to endwise movement of the plunger by pressure of fluid entering the chamber, and the said stems having passageways for connecting the chamber to the said fluid openings and said passageways being adapted to be closed as either stem contacts and opens its associated check valve.

4. The combination with a hydraulic jack cylinder, of a valve mechanism of the character described, comprising a housing assembly having a bore communicating at its ends with opposite ends of the cylinder and having two spaced fluid openings, check valves normally preventing fluid flow from the jack cylinder to said openings, spaced members in the bore forming a chamber between the fluid openings and said members having openings, a plunger movably mounted in the chamber and having stems extending loosely out through said openings in the said spaced members into proximity to the check valves and operative to selectively engage and open either check valve upon endwise movements of the plunger, said spaced members also having openings and check valves therein operative to admit fluid rapidly into the chamber at one end of the plunger and to prevent fluid escape from the other end of the chamber except about the valve stem whereby to damp the movement of the plunger.

5. The combination with a hydraulic jack cylinder, of a valve mechanism of the character described, comprising a housing assembly having a bore communicating at its ends with opposite ends of the cylinder and having two spaced fluid openings, check valves normally preventing the fluid flow from the jack cylinder to said openings, spaced members in the bore forming a chamber between the fluid openings and said members having openings, a plunger movably mounted in the chamber and having stems projecting loosely out through said openings in the said spaced members into proximity to the check valves and operative to selectively engage and open either check valve upon endwise movements of the plunger, said spaced members also having openings and valve means therein operative to admit fluid rapidly into the chamber at one end of the plunger and to prevent fluid escape from the other end of the chamber except about the valve stem whereby to damp the movement of the plunger, said valve stems having axially extending passages communicating at opposite ends with the associated ends of the chamber and adjacent fluid openings but adapted to be closed as either stem engages its check valve whereby the plunger is permitted to move rapidly in either direction until one of the check valves is opened and the movement is then retarded by the restricted escape of the fluid around the valve stem.

6. In a valve assembly of the character described for controlling fluid return from opposite ends of a jack cylinder, a housing having a bore communicating with opposite ends of the cylinder, check valves normally preventing fluid flow from the cylinder into said bore, said housing also having openings out through which fluid may pass under control of said check valves, means in the bore forming a chamber into which fluid may enter at opposite ends, a plunger in said chamber operative by fluid pressure entering either end of the chamber to move toward the other end and having stems adapted to selectively engage and open said check valves upon such endwise movement, and said stems having tapering portions operative to meter the flow of fluid through the opened check valve.

7. In a valve assembly of the character described for controlling fluid return from opposite ends of a jack cylinder, a housing having a bore communicating with opposite ends of the cylinder, check valves normally preventing fluid flow from the cylinder into said bore, said housing also having openings cut through which fluid may pass under control of said check valves, means in the bore forming a chamber into opposite ends of which fluid may enter from the openings, a plunger in said chamber operative by fluid pressure entering either end of the chamber to move toward the other end and having stems adapted to selectively engage and open said check valves upon such endwise movement, and said stems having tapered portions adapted to meter the flow of fluid through either check valve and to increase the rate of flow through the valve in proportion to the movement of the plunger.

8. The combination with a hydraulic jack cylinder and plunger, of a valve mechanism including check valves for controlling the escape of displaced fluid from the ends of the cylinder and thereby controlling the travel of the plunger, a fluid pressure responsive device operative by admission to fluid to either end of the cylinder to open the check valve to the other end and allow displaced fluid to escape, and said device including metering elements operative to meter the rate

of fluid escape from the cylinder and thereby regulate the rate of travel of the jack plunger.

9. For use with a double action hydraulic jack having a cylinder and fluid inlets for opposite ends thereof, a valve mechanism for controlling the flow of displaced fluid from either inlet as fluid is admitted to the other, comprising a pair of check valves communicating with the inlets, means forming a chamber, a plunger movable endwise in the chamber and having parts operative to engage and unseat the check valves, and three separate means for admitting fluid to either end of the chamber for actuating the plunger, said means being so operative that first only two and then finally one will permit fluid to escape from the opposite end of the chamber to thereby damp the movement of the plunger therein.

10. For use with a double action hydraulic jack having a cylinder and fluid inlets for opposite ends thereof, a valve mechanism for controlling the flow of displaced fluid from either inlet as fluid is admitted to the other, comprising a pair of check valves communicating with the inlets, means forming a chamber, a plunger movable endwise in the chamber and having parts operative to engage and unseat the check valves, and a plurality of means for admitting fluid to either end of the chamber to move the plunger therein towards the other end, a part of said means operating only to pass fluid into the chamber whereby the escape of fluid from either end thereof will take place at a slower rate than it can enter the other end to thereby damp the plunger movement in the chamber.

11. For use with a double action hydraulic jack having a cylinder and fluid inlets for opposite ends thereof, a valve mechanism for controlling the flow of displaced fluid from either inlet as fluid is admitted to the other, comprising a pair of check valves communicating with the inlets, means forming a chamber, a plunger movable endwise in the chamber and having parts operative to engage and unseat the check valves, a plurality of separate means all operative to admit a part of the fluid flowing to either end of the jack cylinder into a corresponding end of the chamber to actuate the plunger, and check valves in a part of said means to prevent flow of fluid from the chamber.

12. For use with a hydraulic jack having a cylinder and fluid inlets at opposite ends thereof, a valve mechanism having a pair of check valves normally preventing the escape of displaced fluid from either end of the cylinder and means for unseating either check valve as fluid is admitted under pressure through the other valve to the cylinder, comprising a housing having a chamber and end closures therefor, said closures having openings to permit fluid flow into and out of the opposite ends of the chamber, a plunger slidable in the chamber and movable endwise by differences in fluid pressure in opposite ends of the chamber, means extending from opposite ends of the plunger for selectively engaging and unseating the check valves as the plunger moves in the chamber, and a check valve in one of the openings in each end closure of the chamber preventing fluid flow therethrough out of the chamber.

13. For use with a hydraulic jack having a cylinder and fluid inlets at opposite ends thereof, a valve mechanism having a pair of check valves normally preventing the escape of displaced fluid from either end of the cylinder and means for unseating either check valves as fluid is admitted under pressure through the other valve to the cylinder, comprising a housing having a chamber and end closures therefor, said closures having openings to permit fluid flow into and out of the opposite ends of the chamber, a plunger slidable in the chamber and movable endwise by differences in fluid pressure in opposite ends of the chamber, check valve engaging stems extending endwise from the plunger and operative to move toward and engage and unseat either check valve as the plunger moves in opposite directions in the chamber, and said stems having passages opening through their ends and permitting the escape of fluid from the corresponding ends of the chamber until the stems contact the check valves and the valves close off the ends of the said passages.

14. For use with a double action hydraulic jack having fluid inlet and outlet means at opposite ends of its cylinder and check valves controlling the fluid flow through said means and normally preventing the escape of displaced fluid from either end of the cylinder, a mechanism of the character described for opening either check valve to permit fluid to escape from either end of the cylinder as fluid is admitted to the opposite end thereof, the said mechanism including a reciprocatable plunger actuated endwise by the fluid entering one end of the cylinder to move towards the check valve controlling fluid escape from the opposite end, stems at the ends of the plunger for opening the check valves, and said stems being so shaped as to control and gradually increase the rate of displaced fluid flow in proportion to the distance through which the plunger moves.

15. For use with a double action hydraulic jack having fluid inlet and outlet means at opposite ends of its cylinder and check valves controlling the fluid flow through said means and normally preventing the escape of displaced fluid from either end of the cylinder, a mechanism of the character described for opening either check valve to permit fluid to escape from either end of the cylinder as fluid is admitted to the opposite end thereof, the said mechanism including a reciprocatable plunger actuated endwise by the fluid entering one end of the cylinder to move towards the check valve controlling fluid escape from the opposite end, stems on the ends of the plunger for engaging and opening the check valves, and the said stems being so shaped that as they open the check valves they will regulate the flow of fluid past and around the stems and the valves and gradually accelerate the rate of such flow.

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