March 25, 1947. C. H. REEDY 2,417,947

HYDRAULICALLY OPERATED ELEVATOR

Filed Dec. 6, 1943

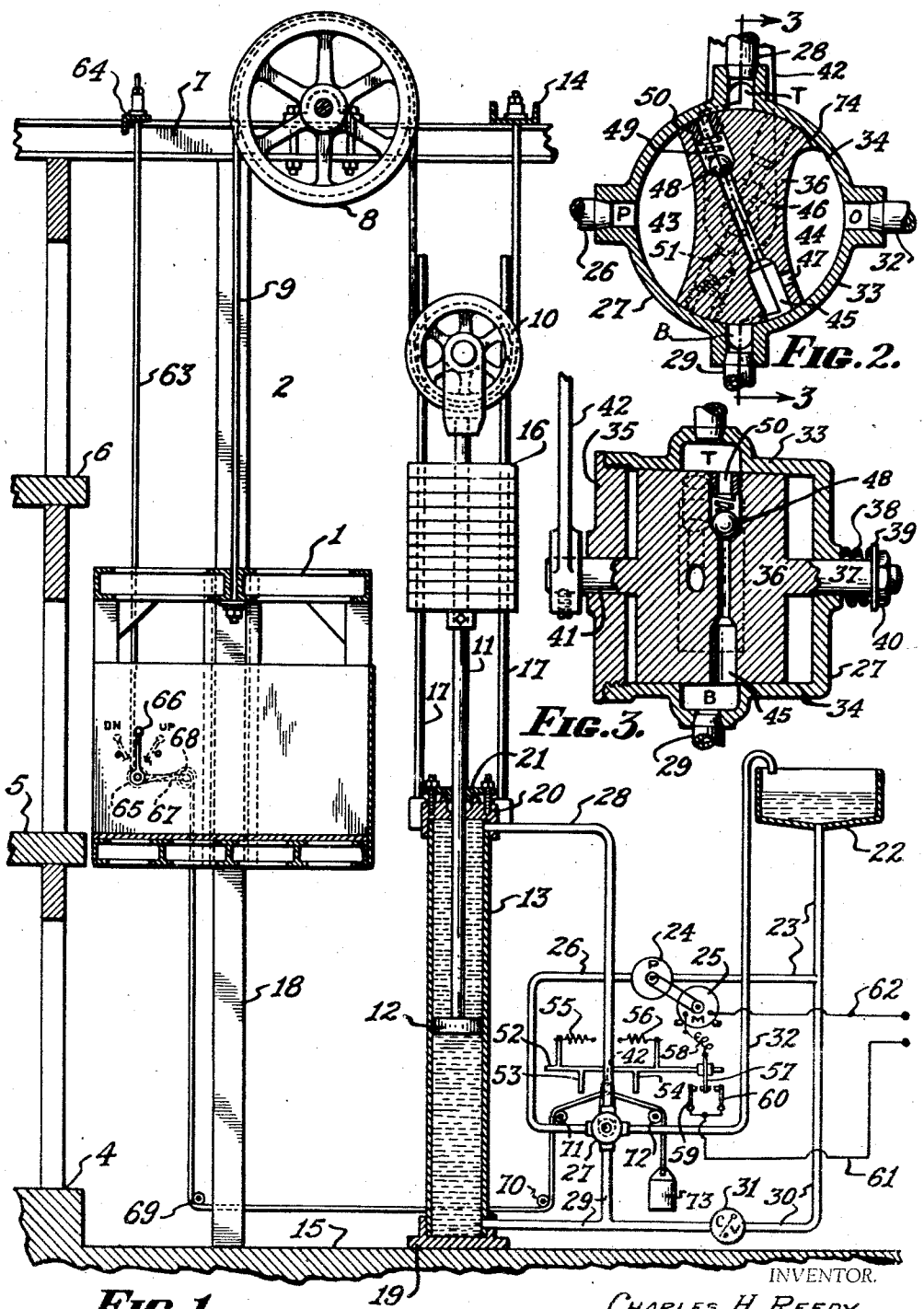

FIG. 1.

FIG. 2.

FIG. 3.

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Patented Mar. 25, 1947 2,417,947

UNITED STATES PATENT OFFICE

2,417,947

HYDRAULICALLY OPERATED ELEVATOR

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Application December 6, 1943, Serial No. 513,054

5 Claims. (Cl. 60—52)

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My invention relates to improvements in hydraulic elevators and has for its principal objects the provision of a new, improved and simplified mechanism whereby it becomes possible to overcounterbalance the car or cab of the elevator, propel it by power in either direction where power is required, and to coast in either direction where the actual load is such as to permit it. A fundamental object of my invention is the provision of a substantial saving of power in over-all operation. Another object of my invention is the provision of an apparatus which, while it enables me to gain the advantages which are set forth, is greatly simplified both in its construction and in its operation, is inexpensive to construct and install, and has the minimum number of working parts.

These and other objects of my invention which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish by that certain construction and arrangement of parts of which I shall now describe an exemplary embodiment. Reference is made to the drawings which in a diagrammatic way show the general features of the aforesaid exemplary embodiment of my invention, and in which:

Figure 1 is a diagrammatic vertical section of an elevator installation and the several connections appertaining thereto.

Figure 2 is a sectional view through a valve structure which I may employ.

Figure 3 is another sectional view taken along the line 3—3 of Figure 2.

In the practice of my invention, I provide an elevator structure comprising a cab or car, diagrammatically shown at 1, the construction of which is not a limitation upon my invention. This cab or car operates in an elevator shaft broadly indicated at 2, and which may be of any length desired. In the exemplary and diagrammatic showing of my drawing, I have indicated three floors, respectively 4, 5 and 6, in ascending order. At the top of the elevator shaft there is a fixed support 7, which may be a part of the building, or may be supported from the foundation by the guides 8, and which carries a rotatable sheave 8. The car is suspended by one or more cables 9 passing over the sheave 8 and downwardly alongside the elevator shaft so as to pass under a sheave 10 which is connected in some suitable fashion to the piston rod 11 of a piston 12 operating in an hydraulic cylinder 13. Thence, the cable 9 passes upwardly

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again to a suitable anchorage 14 at the level of the top of the elevator shaft.

I have thus shown an elevator with a ratio of 1:2, in which the car moves twice as far as the piston in the cylinder. But it will be clear that this forms no limitation upon my invention, and that the principles of it apply equally to ratios of 1:1 or 1:3 and so on, depending upon the cable arrangement chosen.

Also, it should be noted that a number of the principles of my invention may be applied to arrangements other than that shown.

The exemplary embodiment, having a cable-suspended car and an off-side power cylinder with the counterweights attached to its piston rod, and a 1:2 ratio of piston and car movements, serves merely to illustrate the application of the principles of my invention to a particular structure.

The hydraulic cylinder 13 may be suitably anchored to a floor or base 15; but its position may be varied. When located alongside the elevator shaft as shown, and coupled to the car in a 1:2 ratio, it will be of such length that the travel of the piston 12 within it is half the length of the elevator shaft portion through which the car 1 travels from its lowermost to its uppermost position. It will be noted that the sheave and cable arrangement is such that as the piston 12 descends, the car 1 is caused to ascend and vice versa, in this embodiment. Suitable counterweights 16 are shown fastened to the piston rod 11, and guided in suitable guides diagrammatically shown at 17. The car itself will, of course, be guided in the elevator shaft by suitable guides 18.

The bottom of the cylinder is closed by the anchoring means 19, and the top of it is closed by a cap 20 perforated for the passage of the piston rod 11 and provided with a packing gland 21 to maintain a fluid-tight connection with the piston rod. Conduits are so connected with the hydraulic cylinder 13, both above and below the piston 12, that by controlling the ingress and egress of the operating fluid, the piston may be driven in either direction under power, or permitted to move in either direction under gravitational forces in the system, as will hereinafter be explained.

In my invention, the effective value of the counterweight is greater than the weight of the car, though not greater than the weight of the car plus the weight of the maximum load. I preferably counterbalance the weight of the car plus approximately one-half of the weight of the

maximum expected load. It will be understood, of course, that the disposition of the cable 9 over and under the respective rotatable sheaves 8 and 10, and its anchorage as at 14, giving a 1:2 ratio, requires that the actual value of the weight at 16 (neglecting, of course, the weight of the piston, piston rod and sheave 10), must be twice that of the weight which it is to counterbalance. Where the ratio is changed, or where the car is separately counterbalanced, the ratio of effective weight to actual counterbalance weight will also vary, as will be clear. It will also be understood that in speaking of the counterbalancing of the car itself, I mean to include the use of a sufficient counterbalance to overcome frictional relationships, where that is desired and practiced.

The result of counterbalancing the car and half of the maximum expected load is that gravity will tend to move the car upwardly if unloaded or loaded with less than one-half the maximum load, whereas gravity will tend to move the car downwardly if loaded with more than one-half the maximum expected load, in the exemplary embodiment. Thus, coasting in either direction is possible depending upon the load conditions and, since my hydraulic cylinder 13 is equipped for power operation in either direction, the driving of the car 1 in either direction under power is possible. These facts enable me to effect a very substantial power saving over an elevator system in which the car is driven in one direction only by power and is returned solely by gravity in the other direction.

In the practice of my invention, I contemplate the provision of control means which act to permit coasting in the desired direction where coasting is possible, and further act to produce power operation in the desired direction where coasting is impossible. Further, my control means automatically effects the application of power where power is required and further acts, as will hereinafter be explained, to offset differences in fluid displacement above and below the piston 12.

Before these control means are explained, however, I will describe exemplary connections for fluid operations:

I may provide a holder or reservoir 22 for operating fluid. This is connected by a pipe 23 to a pump diagrammatically indicated at 24. This pump may be operated by an electric motor or other prime mover diagrammatically indicated at 25. The delivery part of the pump is connected by a pipe or conduit 26 to my control valve 27. A port in the upper end of my cylinder 13 is also connected to the valve by a conduit 28, and a port near the bottom of the cylinder is connected to it by a conduit 29. The last mentioned conduit (or another port near the bottom of the cylinder 13) is connected by a conduit 30 either back to the conduit 23 or directly to the reservoir 22. The conduit 29 contains a check valve 31 permitting movement of the fluid toward the lower end of the cylinder 13 but not in the opposite direction. The valve 27 is finally connected by a conduit 32 to a reservoir 22.

The precise construction of my valve mechanism may be widely varied. I have illustrated the mechanism in its simplest form in Figures 2 and 3. One essential function of the valve is to connect either the part of the cylinder above the piston 12 or the part below to the source of hydraulic fluid under power, selectively, while connecting the other end of the cylinder to an overflow, exhaust or return, and also to provide

an intermediate or neutral position in which the elevator car will be maintained stationary.

In operating from this neutral position to either of the power actuated positions, however, the valve functions first to effect a connection between the upper and lower parts of the cylinder for coasting. In the connection so effected, there will be a check valve to prevent coasting in the wrong direction if the conditions of load of the elevator car are such as to produce a tendency to coast in the wrong direction. To this end I provide two passages for hydraulic fluid for coasting, one becoming effective as the valve is actuated in either direction from the intermediate or neutral point to the point or position for power operation.

Yet again, my valve functions in part to compensate during coasting for the difference in fluid displacement in the upper and lower parts of the cylinder due to the presence of the piston rod at one side of the piston.

In its simplest form, my valve may comprise an outer body or housing 33 having a tapered interior bore 34. The outer housing has a port P for the entrance of fluid under pressure through a conduit 26. Opposite this port, there is a port O for the outlet of fluid through the conduit 32. Another port T is connected with the top of the cylinder 13 by the conduit 28 as hereinabove described, while another port B is connected by the conduit 29 with the bottom of the cylinder. The housing 33 may be closed by a removable cap 35 at its open end. Within the housing there is a valve plug 36 shaped to fit the tapered bore. This valve plug, in the form shown, has a shaft-like projection 37 at its smaller end which passes through a perforation in the closed end of the housing, where a compression spring 38, abutting against the housing and against a washer or the like 39 held by a nut 40 on the end of the projection, may act to keep the plug 36 drawn tightly into the taper. At the other end of the plug there is a projection 41 which passes through a perforation in the cap 35 and to which there is non-rotatably attached an operating lever 42 or its equivalent. Where the projections 37 and 41 pass through the housing or the cap, there may be packing glands, (not shown), as may be desired.

Recesses 43 and 44 are formed in the sides of the valve plug 36. As the valve plug is turned by means of the lever 42, the recess 44 can act either to connect the outlet port O with the port T or the port B, while the recess 43 acts to connect the port P with the port B or with the port T.

In Figure 2 the valve plug is shown in the intermediate position in which none of the ports are interconnected.

Through the valve plug I provide a pair of perforations 45 and 46. These perforations or passageways are angularly related to each other. If the valve plug 36 be turned in a clockwise direction in Figure 2, the passageway 45 will first come into position to connect the port T with the port B, before the ports P and O become connected to any other port. Such a position will effect a connection between the upper part of the cylinder 13 and the lower part thereof. This is a connection for coasting. The turning of the valve plug 36 in the clockwise direction in Figure 2 is a movement produced when it is desired that the elevator car ascend. If the car is loaded in such a way that ascent is possible by gravity, when the lower portion of the cylinder

is connected to the upper portion, the piston 12 will descend because the counterweight 16 will cause the piston 12 to displace fluid from the lower part of the cylinder through conduit 29, which fluid will enter the upper part of the cylinder through conduit 28.

It will be seen that the displacement of fluid from the lower part of the cylinder 13 below the piston 12 will be greater than the reception of fluid by the upper part of the cylinder during the descent of the piston. This is because of the presence of the piston rod 11 in the upper part of the cylinder. Some of the hydraulic fluid displaced from the lower part of the cylinder must, therefore, be got rid of, and to accomplish this, I provide a small passageway 47, (Figure 2), between the passageway 45 and the recess 44. Excess fluid from the lower part of the cylinder 13, entering the valve mechanism through the conduit 29, can thus escape into the outlet port O. The passageway 45 is proportioned as to size to control the ascent of the elevator car by permitting transfer of fluid from the lower part of the cylinder to the upper part thereof at a rate proportionate to a desired speed of ascent; and the passageway 47 is, of course, very small and is proportioned in diameter to the difference in displacement in the upper and lower parts of the cylinder at the speed of transfer of fluid through the passageway 45.

At the particular time when the valve in Figure 2 is operated in the clockwise direction to the extent hereinabove described, the conditions of loading of the elevator car may be such, however, as to preclude a coasting ascent, but tend to produce a coasting descent. To prevent coasting in the wrong direction, I include in the passageway 45 a check valve mechanism, which, in the form illustrated, includes a ball 48 seating against a suitably shaped portion of the passageway 45, a compression spring 49, and a perforated plug 50 against which the spring abuts. As a consequence, if the operator of the car, desiring to ascend, moves the valve plug 36 in the clockwise direction until the passageway 45 connects ports B and T, and if at that time the loading of the car is such as to tend to produce a gravity descent, the check valve will prevent the transfer of fluid from the upper part of the cylinder to the lower part of the cylinder, and the car will remain stationary. Thereupon, the operator moves the valve plug 36 still further in the clockwise direction. When so moved, the passageway 45 will no longer connect ports B and T, but will have moved to a position in which the passageway is closed. However, the recess 44 will now connect ports B and O, thus effecting an outlet passageway for fluid from the lower part of the cylinder 13 to the overflow or reservoir. At the same time the recess 43 will have been positioned to connect ports P and T so that the upper part of the cylinder is connected to the pump. Assuming the pump to be started into operation at this point, fluid will be fed under power to the cylinder 13 above the piston 12. The piston will descend and the fluid displaced from the lower portion of the cylinder will find its way through conduit 29, the valve, and conduit 32 to the overflow or reservoir. The car will thus be caused to ascend under power. When the desired ascent has been accomplished, the operator will return the valve to the neutral position shown in Figure 2.

Similarly, when descent is desired, the operator will rotate the valve plug 36 in the counterclockwise direction. As an incident to such rotation, the passageway 46 will first be brought into position to connect ports B and T. If the load conditions are such that descent by gravity is possible, fluid will flow from the upper part of the cylinder to the lower part of the cylinder through the passageway 46 of the valve, which is again so proportioned in size as to control the rate of descent. In order to prevent a coasting ascent when a coasting descent is desired, a check valve 51 is placed in the passageway 46. It is oppositely directed to the check valve hereinabove described, but may be of the same construction.

During the descent of the car and the consequent ascent of the piston 12, the amount of fluid displaced from the portion of the cylinder above the piston will be less than the amount of fluid required for the lower part of the cylinder, and it will be necessary to admit a quantity of additional fluid to the lower part of the cylinder. This is accomplished through the conduit 30 hereinabove described and the check valve 31. The extra required fluid will be admitted through this check valve, but the fluid cannot pass in the opposite direction.

If the conditions of load are such that a gravity descent is impossible, the operator still further rotates the valve plug 36 in the counterclockwise direction to a point at which the recess 44 connects ports P and B. The valve is now in a position for a power actuated descent of the car, and assuming the pump 24 to be in operation, fluid under pressure will be fed into the lower part of the cylinder causing the piston 12 to rise, and fluid from the upper part of the cylinder will be exhausted to the reservoir.

While it is possible separately to start the pump motor, it is preferable to have this occur automatically as a consequence of the moving of the valve in either direction to a position for power operation. This may be done in a variety of ways. In the drawings I have diagrammatically illustrated a sliding rod 52 having arms 53 and 54 positioned to be actuated by the lever arm 42 when the switch is thrown in either direction to the power position. Springs 55 and 56 operate to keep the rod 52 in a neutral position when not actuated by the lever arm 42. The contact member 57 of a switch is fastened to or otherwise adapted to be moved by the rod 52. This contact member may be connected to one of the motor leads as at 58. A pair of cooperating contacts 59 and 60 are located, one on either side of the contact 57, so that actuation of the rod 52 will bring the contact 57 into engagement either with one or the other of the last mentioned contacts. These last mentioned contacts are electrically connected together and to one of the power leads 61. The other power lead 62 is connected to the motor 25. It will be understood that this showing is essentially diagrammatic, as is the means to operate the valve 27 from the car 1, next to be described.

A cable 63 is anchored as at 64 at the top of the shaft. This cable at the car runs over a sheave at 65, at which point is also pivoted a bell crank. One arm 66 of the bell crank is the operating lever for the elevator. The other arm 67, which is located at an angle to the first arm, bears a sheave 68 over which the cable 63 also passes. The cable, after descending to the bottom of the elevator shaft, passes beneath a sheave 69 and then horizontally, upwardly be-

neath a sheave 70, and over a sheave 71 to a point at which it is connected to the lever arm 42. A continuation of the cable passes over a sheave 72 and downwardly to a suspended weight 73 of sufficient mass to actuate the valve. It will be evident from this construction that the car 1 can move up and down the elevator shaft without varying the effective length of the cable 63. But if the operating lever 66 be moved in the clockwise direction, a lesser length of the cable will be taken up over the sheave 63, and the weight will move the lever arm 42 of the valve 27 in the clockwise direction. Similarly, if the operating lever 66 be moved counterclockwise, the cable 63 will be effectively shortened, and the lever arm 42 will be pulled in a counterclockwise direction.

It will be understood that this mechanism for operating the valve is exemplary only of a mechanism which may be used. There are many mechanical systems whereby the motion of a control element in the car can be transmitted to the valve in spite of the up and down travel of the car, and the particular mode of transmitting such movement is not a limitation on my invention.

I may make provision against the too rapid application of fluid to the cylinder 13, so as to avoid jerks and jolts. This can be accomplished by causing the valve to operate as a gradually acting valve, through expedients known to the art. For example, in the valve of Figure 2, tapering, groove-like configurations may be formed on the valve plug as at 74.

Modifications may be made in my invention without departing from the spirit of it. Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a mechanism of the character described an elongated cylinder, a piston therein, a piston rod passing through one end of said cylinder, fluid connections between each end of said cylinder and valve means, a fluid connection between a source of fluid under pressure and said valve means, and a connection between an overflow and said valve means, said valve means being operable in two directions with two operative positions in each direction at progressively greater distances from an intermediate neutral position, and said valve means having separate, check-valved passageways acting in the first of said operative positions in either direction to connect one end of the said cylinder with the other end thereof, and in the second of said operative positions to connect one end of said cylinder with said source of fluid under pressure and the other end of said cylinder with said overflow means, said source of fluid under pressure comprising a pump and a motor, and means actuable in connection with said valve means at the second of said positions in either direction to energize said motor, and means for compensating for differences in fluid displacement in said cylinder on either side of said piston when the ends of said cylinder are connected together.

2. In an apparatus of the character described an elongated cylinder, a piston in said cylinder, a piston rod passing through one end of the cylinder, a source of fluid under pressure, and overflow means and valve means, said valve means comprising a housing having radial ports therein, an opposite pair of said ports being connected respectively to the two ends of said cylinder, another opposite pair of ports being connected respectively to said source of fluid under pressure and said overflow means, and a valve core in said housing and capable of movement therein, and being so configured that upon movement in opposite directions, it will alternatively effect a connection between the last mentioned opposite ports and different ones of the first mentioned opposite ports, said valve core having a pair of separate passageways therethrough so disposed that upon movement of said core in either direction a connection will be effected between said first mentioned opposite ports prior to the effecting of the last mentioned connections, said passageways having check valves therein of opposite hand, and one of said passageways having a connecting passageway continuously in communication with said overflow port.

3. In an apparatus of the character described an elongated cylinder, a piston in said cylinder, a piston rod passing through one end of the cylinder, a source of fluid under pressure, and overflow means and valve means, said valve means comprising a housing having radial ports therein, an opposite pair of said ports being connected respectively to the two ends of said cylinder, another opposite pair of ports being connected respectively to said source of fluid under pressure and said overflow means, and a valve core in said housing and capable of movement therein, and being so configured that upon movement in opposite directions, it will alternatively effect a connection between the last mentioned opposite ports and different ones of the first mentioned opposite ports, said valve core having a pair of separate passageways therethrough so disposed that upon movement of said core in either direction a connection will be effected between said first mentioned opposite ports prior to the effecting of the last mentioned connections, said passageways having check valves therein of opposite hand, and one of said passageways having a connecting passageway continuously in communication with said overflow port, said passageways being of relatively small diameter whereby to control the rapidity of flow of fluid between one end of said cylinder and the other.

4. In an apparatus of the character described, an elongated cylinder, a piston in said cylinder, a piston rod passing through one end of the cylinder, a source of fluid under pressure, and overflow means and valve means, said valve means comprising a housing having radial ports therein, an opposite pair of said ports being connected respectively to the two ends of said cylinder, another opposite pair of ports being connected respectively to said source of fluid under pressure and said overflow means, and a valve core in said housing and capable of movement therein, and being so configured that upon movement in opposite directions, it will alternatively effect a connection between the last mentioned opposite ports and different ones of the first mentioned opposite ports, said valve core having a pair of separate passageways therethrough so disposed that upon movement of said core in either direction a connection will be effected between said first mentioned opposite ports prior to the effecting of the last mentioned connections, said passageways having check valves therein of opposite hand, and one of said passageways having a connecting passageway continuously in communication with said overflow port, said passageways being of relatively small diameter whereby to control the rapidity of flow of fluid between one end of said cylinder and the other, and a check valved connection between said overflow and the

end of said cylinder remote from said piston rod.

5. In an apparatus of the character described an elongated cylinder, a piston in said cylinder, a piston rod passing through one end of the cylinder, a source of fluid under pressure, and overflow means and valve means, said valve means comprising a housing having radial ports therein, an opposite pair of said ports being connected respectively to the two ends of said cylinder, another opposite pair of ports being connected respectively to said source of fluid under pressure and said overflow means, and a valve core in said housing and capable of movement therein, and being so configured that upon movement in opposite directions, it will alternatively effect a connection between the last mentioned opposite ports and different ones of the first mentioned opposite ports, said valve core having a pair of separate passageways therethrough so disposed that upon movement of said core in either direction a connection will be effected between said first mentioned opposite ports prior to the effecting of the last mentioned connections, said passageways having check valves therein of opposite hand, and one of said passageways having a connecting passageway continuously in communication with said overflow port, said passageways being of relatively small diameter whereby to control the rapidity of flow of fluid between one end of said cylinder and the other, and a check

valved connection between said overflow and the end of said cylinder remote from said piston rod, operating means for said valve core, said source of fluid under pressure comprising a pump and a motor, and switch means for energizing said motor, said switch means arranged to be actuated by said valve operating means upon movement to its final position in either direction.

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