Aug. 8, 1944. L. F. JASEPH 2,355,164

ELEVATOR CONTROL

Filed Feb. 8, 1941 2 Sheets-Sheet 1

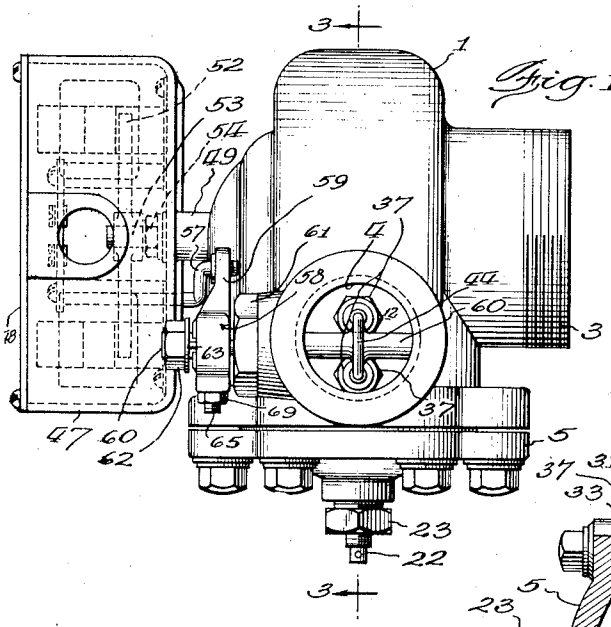


Fig. 1.

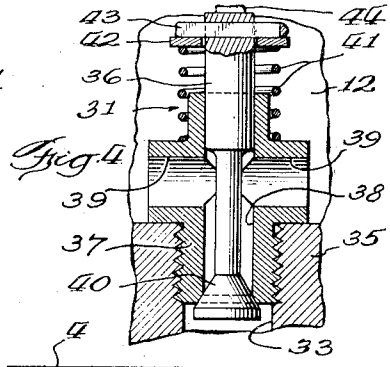


Fig. 4.

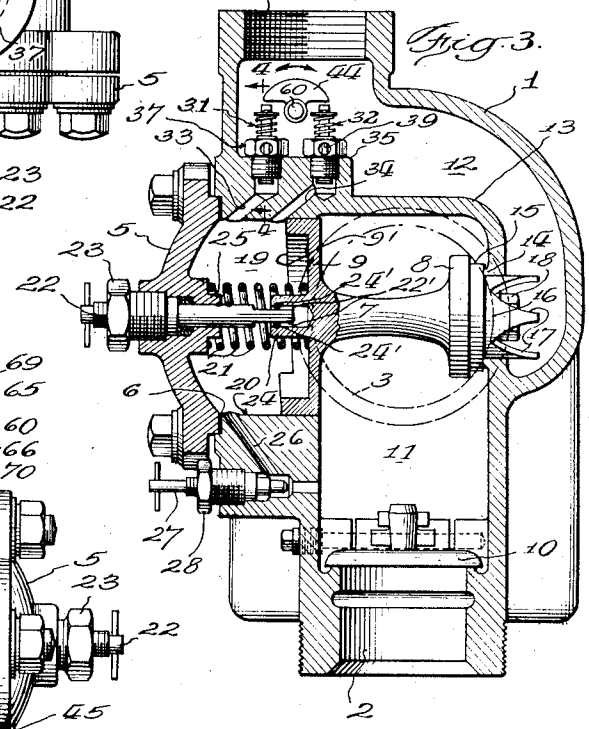


Fig. 3.

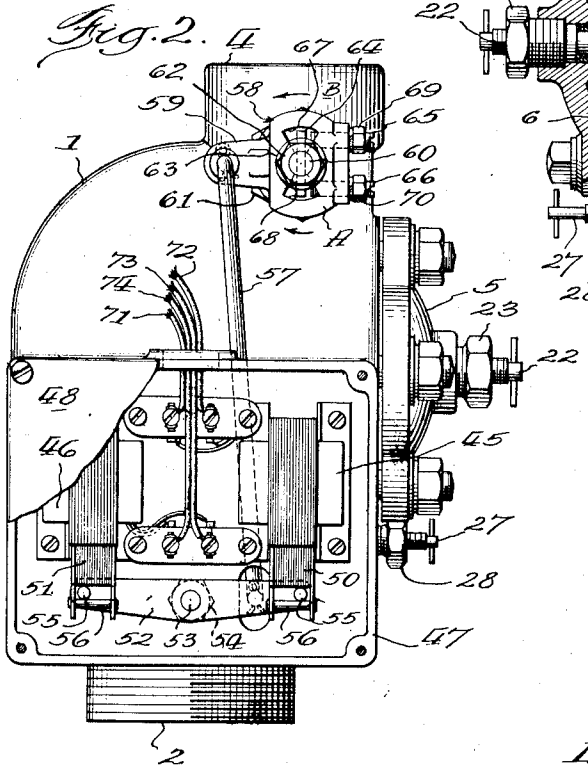


Fig. 2.

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Fig. 5.

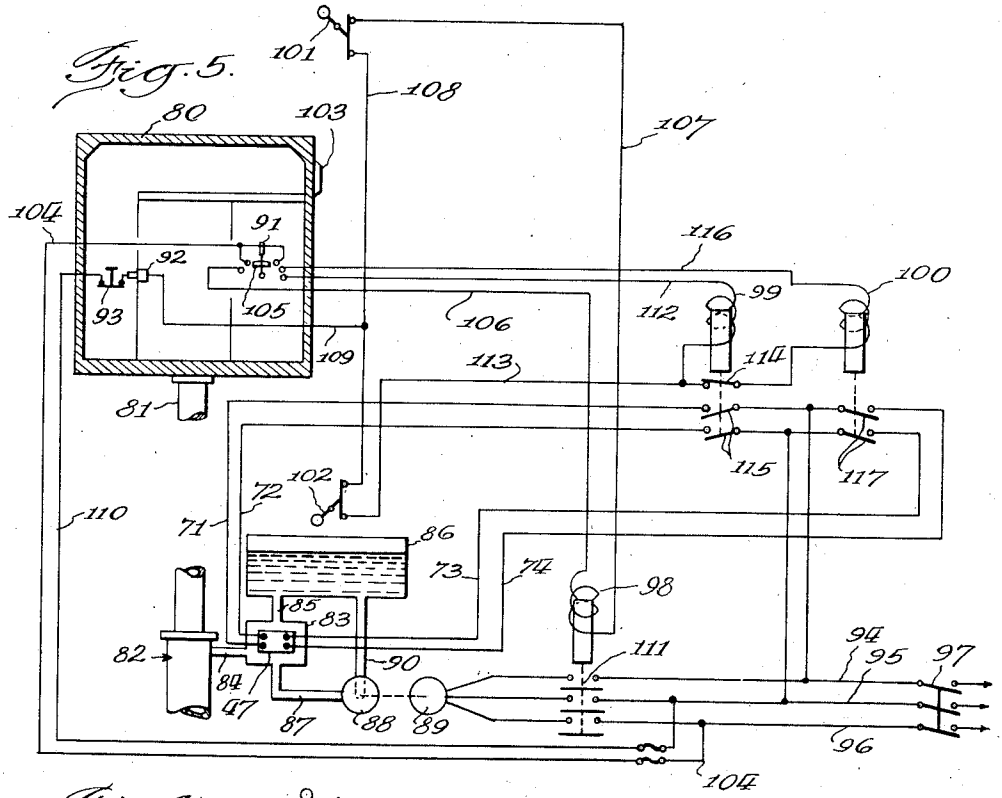
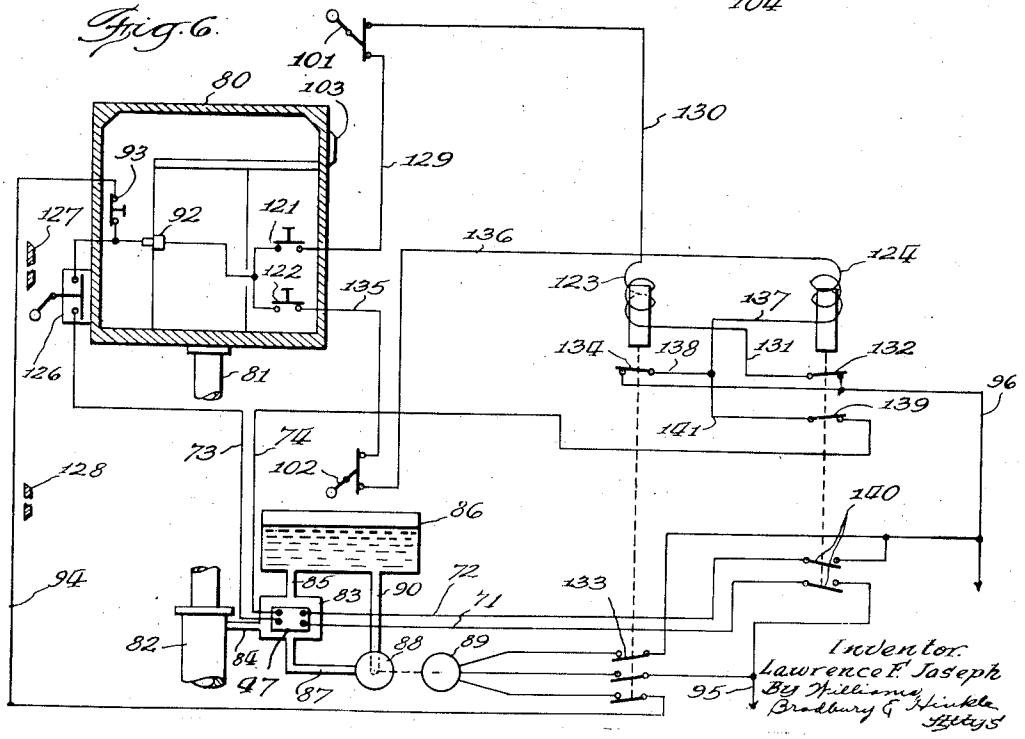


Fig. 6.



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2,355,164

ELEVATOR CONTROL

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20 Claims. (Cl. 187—29)

The present invention relates to improvements in elevator control and more particularly to improvements in lowering valves and in controls for such valves whereby they may be used to advantage in hydraulic elevator systems.

In hydraulic elevator systems, it is customary to control the descent of the elevator by lowering valves controlling the return of fluid from the elevator jack to a fluid reservoir. These lowering valves have been of many types, including both manually controlled and pilot operated valves. The latter have been found to be the more desirable as they are better adapted for remote control and require but a small amount of power for their operation.

The present invention relates primarily to pilot operated valves and has for one of its primary objects the provision of a new and improved valve whereby the rate of opening of the valve, the size of the opening, and the rate of closing of the valve may be readily adjusted. As a result, the acceleration, rate of travel, and the deceleration of the elevator may be readily adjusted.

A further object of the present invention is the provision of a new and improved valve capable of being operated to and maintained in a partially closed position, so that it is possible to lower the elevator at two speeds, one of which may be a high speed obtainable with the valve fully open, and the second a low speed obtainable with the valve partially closed.

Another object of the present invention is the provision of a new and improved valve capable of being operated to a partially closed position, which position may be readily adjusted so as to obtain a reduced lowering speed, making it easy to stop the elevator in desired position relative to an elevator landing.

A further object of the present invention is the provision of a new and improved valve of the type described, wherein the rate of closing of the valve from fully open to partially closed position and from the latter to fully closed position, and thereby the deceleration of the elevator from high to low speed and from the latter to a stop may be so adjusted as to insure the comfort of passengers riding in the elevator.

Another object of the present invention resides in the provision of new and improved controls for an elevator system including a lowering valve of the type referred to above.

Other objects and advantages of the present invention will become apparent from the ensuing description, in the course of which reference is had to the accompanying drawings, in which:

Fig. 1 is a top plan view of the lowering valve of the present invention;

Fig. 2 is a side elevational view of the valve, partly broken away in order better to illustrate details of construction;

Fig. 3 is a vertical cross-sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is an enlarged vertical cross-sectional view of one of the two pilot valves incorporated in the valve shown in the preceding views. The view is taken along the line 4—4 of Fig. 3; and

Figs. 5 and 6 are schematic diagrams showing two types of controls for elevator systems including the valve shown in Figs. 1 to 4, inclusive.

As already indicated, the lowering valve of the present invention is adapted particularly for use with hydraulic elevators. As a consequence, the valve illustrated in detail in Figs. 1 to 4 comprises certain structural details adapting it for such use, which details, however, are not necessary in valves coming within the scope of this invention.

The valve comprises a body 1, provided with three openings 2, 3 and 4, an aperture closing cap 5 seating in an annular recess upon a gasket 6, and a movable member 7 comprising a main valve 8 and a piston 9. The three openings 2, 3 and 4 are connected, as will be explained in greater detail later, to a pump or other source of hydraulic pressure, an elevator jack, and a fluid reservoir, respectively. When the elevator is to be raised, fluid under pressure is supplied to the elevator jack, the fluid flowing past a swing type check valve 10 into a chamber 11 and thence through the opening 3 and a suitable conduit to the jack. At this time the valve 8 is kept closed by the pressure existing in chamber 11, which pressure is applied to the rear of piston 9. When the elevator is to be stopped during its ascent, the pressure is removed, and as a result the check valve 10 closes and valve 8 remains closed because of the back pressure exerted by the elevator. When the elevator is to be lowered, valve 8 is opened either fully or partially by selective operation of pilot valves operable to relieve the pressure at the rear of piston 9, as described hereinafter, and fluid flows from the elevator jack to the reservoir through opening 3, chamber 11, past valve 8, a second chamber 12, opening 4, and a suitable conduit to the reservoir. The elevator may be stopped in its descent by closure of the pilot valves, thereby to increase the pressure back of piston 9 to effect closure of valve 8.

Chambers 11 and 12 are separated by a partition 13 formed with an annular valve seat 14. A valve disc 15 carried by main valve 8 seats against the valve seat when the valve is closed.

The construction of the main valve 8 is such as to provide a uniform rate of fluid flow reduction, and thereby uniform deceleration of the elevator, as the valve is closed. This uniformity is obtained by utilization of a cup-like throttling disc 16 having a number of spaced-apart slots 17 tapering to points adjacent the disc 15. Throttling disc 16 acts also as a guide for the movable member 17. It is closely fitted into the valve seat 14 and is of a length such that it cannot be completely withdrawn from the seat even when the valve is fully open. The disc 15 and throttling disc 16 are secured to valve 8 by a screw 18 threaded into the valve.

The previously referred to chamber at the rear of piston 9, indicated by reference character 19, is defined by the piston, the closure cap 5, and a cylindrical opening 20 formed in body 1 and in which piston 9 is movable. The piston fits closely in the opening and it should have at least twice the cross-sectional area of the main valve seat 14, and in order to secure best results it should preferably have about five times the area of the valve seat. The piston and valve are biased to valve closing position by a relatively light spring 21. The movement of the valve in opening direction is limited by a stop screw 22 adjustably mounted in a packing nut 23 and having an end portion comprising opposed flattened sides 22' extending into a bore in a boss 24 formed at the rear side of the piston 9. The valve is stopped in its adjusted fully open position when the end of the stop screw strikes the bottom of the bore. The spring 21 is guided and held in place by the boss 24 and a boss 25 formed on the inside of cap 5 opposite boss 24.

The stop screw 22 is utilized not only to adjust the open position of the valve, but also to adjust its partially open position, as will be made more apparent hereinafter. To effect this adjustment, the rearwardly extending skirt portion of the piston 9 is formed with a helical edge 9' and the boss 24 formed at the rear of the piston is provided with a pair of pins 24' cooperating with the flattened sides 22' of the stop screw to permit free longitudinal movement of the stop screw and piston relative to each other but to constrain them for rotation with each other.

The opening and closing movements of the valve are effected, as already indicated, by controlling the pressure in chamber 19 by means of pilot valves. The pressure existing in chamber 11 is utilized to build up pressure in chamber 19, the two chambers being interconnected by a passage 26 of relatively small diameter, the effective size of which is adjustable by a needle valve 27 rotatably mounted in a packing nut 28.

The opening and closing of the valve 8 is controlled by a pair of pilot valves, indicated generally by reference characters 31 and 32, selectively operable to relieve the pressure in chamber 19. The pilot valves are biased to their closed positions and when opened permit fluid to flow from chamber 19 into chamber 12 through passages 33 and 34 drilled into a boss 35 formed on the side of partition 13 adjacent chamber 12. The passages 33 and 34, as well as the hereinafter described passages through the valves 31 and 32, are of a size such that liquid in chamber 19 flows therethrough at a greater rate than that at which the fluid enters the chamber through passage 26.

Valves 31 and 32 are identical in construction and the former has been illustrated in greater detail in Fig. 4, to which reference is now had. The valves comprise a valve stem 36 having an intermediate portion of reduced diameter and mounted for vertical movement in a valve body 37 threaded into boss 35. The valve body has a vertical passage 38 communicating with passage 33 and a pair of aligned horizontal passages 39 providing communication between the former and chamber 12. Passage 38 is normally closed by a valve 40 formed integrally with the valve stem immediately below the reduced diameter portion and cooperating with a suitable seat at the lower end of passage 38. The valve is biased to closed position by spring 41, one end of which abuts against valve body 37 and the other end of which abuts against a washer 42 prevented from moving upwardly by a pin 43 inserted through the upper end of valve stem 36.

Pilot valves 31 and 32 are selectively opened to obtain either full or partial opening of the valve. When both the pilot valves are closed and pressure exists in chamber 11, pressure is built up in chamber 19 and main valve 8 is closed. When pilot valve 31 is opened, the pressure existing in chamber 19 is reduced, allowing the main valve 8 to open fully, whereas, when valve 32 is opened, the main valve is maintained in a partially open position, all as will be described in greater detail hereinafter in the description of the operation of the valve.

The pilot valves are selectively opened by a cam 44 operable in opposite directions by selectively energizable solenoids 45 and 46. When solenoid 45 is energized, cam 44 is rotated in a counter-clockwise direction, as viewed in Fig. 3, to open pilot valve 31, and when solenoid 46 is energized, the cam is rotated in the opposite direction to open pilot valve 32.

The two solenoids are mounted upon suitable brackets inside a casing 47 having a removable cover 48 and secured to the side of the valve body 1 as by a boss 49 (see Fig. 1). Solenoids 45 and 46 are provided with laminated armatures 50 and 51 respectively, having sliding connections with a rocker arm 52 mounted for pivotal movement about a stud 53 secured to the boss 49 by means of a nut 54 that also secures case 47 to the boss. The sliding connections of the armatures to the rocker arm are constituted by pins 55 secured to the ends of the arm and by pins 56 mounted in the outermost laminations of each armature and spaced from the ends of the armature a sufficient distance slidably to receive pins 55, as best illustrated in Fig. 2. The rocker arm is connected to cam 44 by means of a connecting rod 57 and pilot valve movement adjusting means indicated generally by reference character 58. The lower end of connecting rod 57 is connected to the connecting rod adjacent armature 50. The upper end of the rod is connected to a lever 59 forming part of the pilot valve movement adjusting means. The latter, as will appear shortly, is so constructed that the extent of opening of the pilot valves may be adjusted exteriorly of the valve assembly, thereby permitting ready adjustment of the operation of the main valve.

Cam 44 is preferably formed integrally with a rocker shaft 60 journaled for rotation in valve body 1. One end of the rocker shaft 60 extends outside the valve body rotatably to receive the lever 59. The lever is located between a fluid seal-

ing plug 61 and a nut 62 threaded on the outermost end of shaft 60. A washer 63 is located between the nut and the lever 59. A short key 64 (see Fig. 2) extends through rocker shaft 60.

Movement of lever 59 is imparted to shaft 60 by means of the key 64 and a pair of adjustable screws 65 and 66 providing a certain amount of lost motion between the lever and key. The innermost ends of the screws, as well as the key 64, are located in spaced-apart recesses 67 and 68 formed in lever 59. The screws are held in adjusted position by means of lock nuts 69 and 70.

Before proceeding with the description of the operation of the valve, it should be noted that solenoid 45 is adapted to be energized through conductors 71 and 72 and that solenoid 46 is similarly adapted to be energized through conductors 73 and 74.

In the description of the operation of the valve, it is assumed that the elevator has reached the upermost limit of its travel and is stopped there. At this time maximum back pressure exists in chamber 11 which, it may be remembered, is connected to the elevator jack. This pressure depends upon the weight of the elevator, its load, the nature of the liquid, and the height of the liquid above the valve. The pilot valve controlled passages 33 and 34 are both closed at this time and as a result a pressure is built up in chamber 19 substantially equal to that in chamber 11 by reason of the connection of these two chambers by passage 26. The main valve 8 is, therefore, urged against its seat by a force equal to the unit pressure existing in chamber 11 multiplied by the area of the opening of seat 14, plus that of the spring 21.

When it is desired to lower the elevator at a rapid rate, solenoid 45 is energized to open pilot valve 31. Since fluid escapes from chamber 19 to chamber 12 at a greater rate than fluid enters chamber 19 from chamber 11 through passage 26, the pressure in chamber 19 is reduced a considerable extent. As a result, the pressure in chamber 11 acting to the left on the right side of piston 9, as viewed in Fig. 3, is greater than the sum of the pressures acting to the right on the opposite side of the piston, which pressures result from the fluid pressure in chamber 19 and the pressure exerted by spring 21. The piston 9 consequently moves to the left, moving valve disc 15 away from valve seat 14 and permitting fluid to flow from chamber 3 and from the elevator jack to the fluid reservoir through chamber 12.

The rate of movement of the piston in valve opening direction is determined by the rate at which the fluid in chamber 19 escapes to chamber 12 through passage 33 past pilot valve 31. The valve continues to open until it encounters adjustable stop 22.

When solenoid 45 is deenergized, pilot valve 31 is closed by its biasing spring 41 to cut off the flow of fluid from chamber 19. The pressure in chamber 19 then tends to rise to equality with that existing in chamber 11 and this pressure, together with that exerted by spring 21, effects movement of piston 9 to the right to close valve 8 at a rate determined by the effective size of passage 26 as adjusted by needle valve 27. This closing movement continues until the disc 15 is firmly seated and flow through the main valve entirely stopped.

As has been previously indicated, it has been found desirable to reduce the lowering speed of the hydraulic elevator to a low value just before reaching a landing, in order to improve the accuracy with which a stop may be made. In accordance with the present invention, this lowering at reduced speed is effected by opening second pilot valve 32.

Returning now to the conditions existing when the valve is fully opened and the elevator is being lowered at high speed, then in order to effect lowering of the elevator at reduced speed, solenoid 45 is deenergized and solenoid 46 energized. As a result, pilot valve 31 is closed and pilot valve 32 opened. The opening of pilot valve 32 has no immediate effect upon the valve by reason of the fact that passage 34 is closed by piston 9. However, after the piston has moved to the right, as described above, passage 34 is opened, and movement of piston 9 to the right is terminated because the pressure in chamber 19 is prevented from building up above a certain value by the escape of fluid through passage 34. By suitably locating passage 34, the lowering speed resulting from the partial opening of the valve may be made small enough that the distance traveled by the elevator during the time that the valve completes its closing after the deenergizing of solenoid 46 and closure of pilot valve 32 is short, and the variation in level due to varying loads, etc., made negligible.

One of the advantages of the valve described above is that it may be adjusted both readily and simply from its exterior. After installation, the valve may be adjusted to open by first applying pressure to chamber 11 and energizing solenoid 45, and then if valve 8 does not open, moving screw 66 inwardly until opening occurs. Inward movement of screw 66 reduces the amount of lost motion between lever 59 and cam rocker shaft 60, and when the screw is moved in sufficiently, opening of pilot valve 31 upon energization of solenoid 45 is insured.

The extent of opening of valve 8, and of the high lowering speed of the elevator, is then adjusted by adjustment of stop screw 22 a number of full turns. This adjustment is made during lowering of the elevator. The reason why the stop screw should be rotated a number of full turns is that the stop screw is rotated fractional parts of a turn to obtain the desired reduced lowering speed, as will be explained shortly.

The rate of closing of valve 8, and of the deceleration of the elevator while descending, is next set by adjustment of needle valve 27 either to decrease or increase the effective size of passage 26 while repeatedly opening and closing pilot valve 31 by solenoid 45.

The rate of opening of the main valve, and of the acceleration of the elevator in descending, is finally secured by adjusting screw 66 outwardly to decrease the rate or inwardly to increase it as the valve is repeatedly opened and closed. Moving screw 66 outwardly increases the lost motion between lever 59 and cam rocker shaft 60, and decreases the extent of opening of pilot valve 31 and the rate at which fluid escapes from chamber 19, while inward movement of the screw increases the extent of opening of the pilot valve and the rate at which fluid escapes from chamber 19.

The adjustment of the second pilot valve 32 is effected in substantially the same manner as that of the first. If the valve fails to remain in partially open position upon energization of solenoid 46, the screw 65 is moved inwardly so that pilot valve 32 is opened.

The partially open position of the valve, and the reduced lowering speed of the elevator, may

be adjusted by rotating the valve and piston 9 about its axis so as to vary the position of the valve relative to the passage 34. When the shortest portion of the piston skirt is adjacent the passage 34, the reduced lowering speed will be highest and when the longest portion is adjacent the passage, the reduced lowering speed will be lowest. Adjustment of the lowering speed is effected, as already indicated, by rotating the piston and valve through fractional turns, and this is accomplished by rotating the stop screw 22 the desired extent, it being remembered that this screw and the piston are constrained to rotate together. The partially open position of the valve may also be adjusted to a limited extent by moving the adjusting screw 65 either inwardly or outwardly to determine the rate at which fluid escapes through pilot valve 32.

An application of this valve together with a form of control therefor is illustrated in Fig. 5. In this figure the elevator car is illustrated by reference character 80. It may be secured to a piston 81 actuable by fluid pressure existing in a jack 82. The valve of Figs. 1 to 4 is shown diagrammatically and is indicated by reference character 83. It is connected by conduit 84 to the elevator jack, by conduit 85 to a fluid reservoir 86, and by conduit 87 to the high pressure side of a pump 88 driven by a suitable motor 89 illustrated as being of the three-phase alternating current type. The low pressure side of the pump is connected to the fluid reservoir by conduit 90. The solenoid casing is indicated by reference character 47. Conductors 71 and 72 lead to solenoid 45 and conductors 73 and 74 lead to solenoid 46.

The lowering valve described above is susceptible of different types of control. In Fig. 5 the control is under the manual control of an operator in the car 80, which is provided with a movable controller 91 movable in a counter-clockwise direction to effect upward movement of the elevator and in a clockwise direction to effect downward movement of the elevator either at a fast or slow speed. The car is also provided with door contacts 92 which must be closed before the elevator can be operated and with a normally closed emergency switch 93 which may be opened to stop the elevator. Power is supplied to the pump motor and control through conductors 94, 95 and 96 adapted to be connected to a suitable source of power by a manually operable switch 97. The control comprises, in the main, a solenoid 98 energizable to effect upward movement of the elevator, a solenoid 99 energizable to effect lowering of the elevator at high speed, a solenoid 100 energizable to effect lowering of the elevator at slow speed, and top and bottom limit switches 101 and 102, respectively, operable by a cam 103 which may be affixed to the side of the elevator.

When it is desired to effect upward movement of the elevator, controller 91 is moved counter-clockwise to energize solenoid 98 and thereby initiate operation of the pump. The solenoid is energized through a circuit including supply conductor 96, conductor 104, movable contact 105 of controller 91, conductor 106 leading to solenoid 98, conductor 107 leading from the solenoid to the top limit switch 101, conductors 108 and 109, door contacts 92, emergency switch 93, and conductor 110 leading to supply conductor 95. Energization of solenoid 98 results in closure of pump motor switch 111 and operation of pump 88. Fluid under pressure is supplied to the elevator jack through the valve 83 and the elevator is raised. The elevator continues to rise either until the controller 91 is moved to its neutral position or solenoid 98 is deenergized by opening of the top limit switch 101 by cam 103. In either event the solenoid 98 is deenergized to deenergize the pump motor and the elevator is stopped and maintained in a predetermined position by reason of the fact that the check valve 10 and main valve 8 of the valve 83 are closed.

When it is desired to lower the elevator at high speed, controller 91 is moved clockwise to connect conductor 104 to solenoid 99, which is thereupon energized through a circuit leading from the controller through conductor 112 to the solenoid, from the solenoid to bottom limit switch 102 through conductor 113, and thence to supply line 95 through a circuit including the previously mentioned conductors 108, 109 and 110. Energization of solenoid 99 results in the deenergization of solenoid 100 which is connected by controller 91 to conductor 104 just prior to connection of solenoid 99 thereto. Solenoid 100 is deenergized by the opening of normally closed switch 114 by solenoid 99. Energization of solenoid 99 results also in the energization of pilot valve operating solenoid 45 by reason of the connection of conductors 71 and 72 to supply lines 94 and 95 by switches 115 which are closed by solenoid 99. The energization of solenoid 45 results in the opening of pilot valve 31 with the result that valve 8 is operated to its fully open position.

When the elevator reaches the leveling zone and it is desired to reduce the speed of the elevator, controller 91 is moved counter-clockwise a slight distance, thereby to deenergize solenoid 99 and energize solenoid 100. The deenergization of solenoid 99 results in deenergization of solenoid 45 and closure of pilot valve 31, and the energization of solenoid 100 results in the energization of solenoid 46 and opening of pilot valve 32. Solenoid 100 is energized through a circuit substantially the same as that through which solenoid 99 is energized, except that the controller is connected to the solenoid by conductor 116 and the circuit is through normally closed switch 114. Solenoid 100 closes switches 117 to connect conductors 73 and 74 to power supply lines 94 and 95, thereby to energize solenoid 46. When the elevator has reached its lower limit, the bottom limit switch 102 is opened by cam 103 with the result that solenoid 100 is deenergized and the elevator comes to an accurate stop at the landing.

The lowering valve is also adapted for an automatic control wherein the elevator is brought to a stop and leveled automatically in leveling zones. Referring now to Fig. 6, wherein such a control is illustrated, it may be seen that the hydraulic circuit corresponds to that of Fig. 5. The controls include the door contacts 92 and the emergency switch 93, and power is supplied to the pump motor and the controls through the power lines 94, 95 and 96. The controls include the top and bottom limit switches 101 and 102, normally open push button switches 121 and 122, operable to their closed positions to effect movement of the car upwardly and downwardly at a rapid rate, solenoids 123 and 124 energizable by closure of switches 121 and 122, respectively, and a leveling switch 126 adapted to be closed by cams 127 and 128 located in the leveling zones and when closed to energize solenoid 46.

The operation of the control of Fig. 6 may best be understood by considering the various phases of operation of the elevator. When it is desired

to raise the elevator, push button switch 121 is closed to initiate operation of pump 88. Closure of switch 121 effects energization of solenoid 123 through a circuit extending from line 94 to line 96 through stop switch 93, door contacts 92, push button switch 121, conductor 129, top limit switch 101, conductor 130, the solenoid 123, conductor 131, and normally closed switch 132 operable by solenoid 124. Energization of solenoid 123 results in the closure of motor switch 133 and in the opening of normally closed switch 134. Opening of the latter renders ineffective the leveling switch 126 and likewise prevents energization of solenoid 124 by closure of switch 122. The operation of pump motor 89 results in the operation of pump 88 and consequent raising of the elevator. The elevator continues to rise until push button switch 121 is opened or the elevator reaches the upper limit of its travel, at which time cam 103 opens the top limit switch 101. In both events solenoid 123 is deenergized.

To lower the elevator at high speed, switch 122 is closed to effect energization of solenoid 124. The solenoid is thereby connected across lines 94 and 96 through a circuit including emergency switch 93, door contacts 92, switch 122, conductor 135, bottom limit switch 102, conductor 136, the solenoid 124, conductors 137 and 138, and the normally closed switch 134 operated by solenoid 123. Energization of solenoid 124 results in the opening of switch 132 to prevent energization of solenoid 123, in the opening of switch 139 to render ineffective the leveling switch 126, and in the closure of switch 140. Closure of switch 140 connects solenoid 45 across conductors 95 and 96, and the latter opens pilot valve 31 with the result that main valve 8 is fully opened. The elevator travels downwardly at high speed until switch 122 is opened or the elevator reaches its lower limit of travel, at which time the bottom limit switch 102 is opened to effect deenergization of solenoid 124.

The control is so arranged that when the elevator is in the leveling zone, the speed may be automatically reduced and the elevator automatically brought to a stop. This automatic reduction of speed and stopping is accomplished by opening switch 122 to deenergize solenoid 124 and render leveling switch 126 automatically operative to reduce the speed and then to stop the elevator. When the switch 122 is opened in the leveling zone, solenoid 124 is deenergized to close switches 132 and 139 and open switch 140. Closure of switch 139 in the leveling zone results in the energization of solenoid 46 by connection thereof across conductors 94 and 96 through a circuit including stop switch 93, switch 126 closed by either cams 127 or 128 in the leveling zones, conductor 73, the solenoid 46, conductor 74, switch 139, conductors 141 and 138, and switch 134. Energization of solenoid 46 results in the opening of pilot valve 32, operation of main valve 8 to its partially open position, and reduction in speed of the elevator. When the elevator reaches the lower end of either cam 127 or 128, switch 126 is opened to effect deenergization of solenoid 46, and this, in turn, effects closure of pilot valve 32 and main valve 8, and the elevator is brought to a stop automatically at the desired landing level.

The controls illustrated and described above are susceptible of modification to meet the demands of various applications. For instance, the lowermost cam 128 associated with the leveling switch may be so located with respect to bottom limit switch 102 that the leveling switch is closed when the solenoid 124 is opened by the bottom limit switch 102. If this is done, the elevator will be stopped at the desired landing level even though push button switch 122 is closed. More elaborate control arrangements may also be used. For instance, the controls may be so arranged that momentary pressure of selected buttons is sufficient to call or send the elevator to a selected landing and that the elevator will be automatically stopped at the selected landings.

What I claim as new and desire to secure by United States Letters Patent is:

1. In a valve of the type comprising a casing provided with a fluid inlet passage adapted to be connected to a source of fluid under pressure, a combined fluid outlet and return passage communicating with said inlet passage, and a fluid outlet passage, the combination including, a valve controlling communication between said outlet passage and the other passages, a piston connected to said valve, said casing being provided with a piston chamber in which said piston is movable, a pressure chamber defined by said piston chamber and the side of the piston opposite the valve, a small passage connecting said pressure chamber to said inlet and said combined fluid outlet and return passages, a pair of small passages connecting said pressure chamber to said outlet passage, said pair of passages being spaced apart in the direction of movement of said piston, and means associated with said pair of passages for selectively opening and closing them to control the position of said valve.

2. In a valve of the type comprising a casing provided with a fluid inlet passage adapted to be connected to a source of fluid under pressure through means preventing return of fluid to said source, a combined fluid outlet and return passage communicating with said inlet passage, and a fluid outlet passage, the combination including, a valve controlling communication between said outlet passage and the other passages, said valve having a closed position and being movable in opening direction to other positions to vary the flow of fluid to said outlet passage, a piston having an effective area greater than that of the seat of said valve and connected to said valve, means biasing said valve toward its closed position, means limiting movement of said valve in opening direction to fix the maximum rate of flow of fluid into said outlet passage, said valve casing being provided with a piston chamber in which said piston is movable, a pressure chamber defined by said piston chamber and the side of the piston opposite the valve, a small passage connecting said pressure chamber to said inlet passage and said combined fluid outlet and return passage, a pair of passages connecting said pressure chamber to said outlet passage, said pair of passages being spaced apart in the direction of movement of said piston and each having an effective area greater than that of said small passage, one of said passages opening into said pressure chamber at a point beyond the limit of opening movement of said piston and the other therebetween and the limit of closing movement of said piston, and means associated with said pair of passages for selectively opening and closing them to control the position of said valve, whereby, when said pair of passages are closed and pressure exists in the intercommunicating inlet and combined outlet and return passages, said valve is closed by said biasing means and pressure built up in said pressure chamber by reason of its connection to said intercommuni-

cating passages through said small passage, and when said one of said pair of passages is opened, said valve is opened to an extent determined by said movement limiting means, and when the other is opened, said valve is opened to an extent determined by the location of the opening of said other passage into said pressure chamber.

3. In a valve as claimed in claim 2, wherein the effective size of said small passage and of said pair of passages and the extent of movement of the valve in opening direction are adjustable.

4. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, and a pressure chamber defined by said casing and piston, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, a plurality of passages each having an effective area greater than that of said small passage providing communication between said pressure chamber and a low pressure region, said last mentioned passages opening into said chamber at points displaced along the line of movement of said piston, and means for selectively opening and closing said passages to control the position of said valve.

5. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, and a pressure chamber defined by said casing and piston, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, a plurality of passages each having an effective area greater than that of said small passage providing communication between said pressure chamber and a low pressure region, said last mentioned passages opening into said chamber at points displaced along the line of movement of said piston, normally closed pilot valves associated with each of said plurality of passages, and means adjustable to vary the extent of opening of said pilot valves for selectively opening said passages to control the position and speed of operation of said valve.

6. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, and a pressure chamber defined by said casing and piston, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, a pair of passages each having an effective area greater than that of said small passage providing communication between said pressure chamber and a low pressure region, said last mentioned passages opening into said chamber at points displaced along the line of movement of said piston, normally closed pilot valves associated with each of said plurality of passages, and means for selectively opening said pilot valves to control the position of said valve, said pilot valves being located within said valve casing, and said last mentioned means comprising valve operating means extending to the exterior of said casing, power operated means for actuating said valve operating means, and an adjustable lost motion connection located outside said casing and between said valve operating and power operated means for adjusting the rate of opening movement of the valve.

7. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, a pressure chamber defined by said casing and piston, a passage adapted to be connected to a source of fluid under pressure, and a passage defining a low pressure region, wherein said valve is located between said passages, the combination including, a small passage providing communication from said first passage to said pressure chamber, a second passage having an effective area greater than that of said small passage connecting said low pressure region and said pressure chamber, a pilot valve located in said low pressure region biased to close said second passage, a rotatable cam located in said region for opening said pilot valve to an extent determined by the angular movement imparted thereto, and means for rotating said cam, said means including a rocker shaft supporting said cam and extending outside the casing, a power actuated element movable through a predetermined distance, and an adjustable lost motion connection between said shaft and said power actuated element.

8. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, a pressure chamber defined by said casing and piston, a passage adapted to be connected to a source of fluid under pressure, and a passage defining a low pressure region, wherein said valve is located between said passages, the combination including, a small passage providing communication from said first passage to said pressure chamber, second and third passages each having an effective area greater than that of said small passage connecting said low pressure region and said pressure chamber, pilot valves associated with said second and third passages, said pilot valves being located in said low pressure region and being biased into passage closing positions, and means for opening said pilot valves, said last mentioned means including a cam located in said low pressure region and rotatable in opposite directions from a neutral position selectively to open said pilot valves, a rocker shaft supporting said cam and extending outside said casing, a power actuated element movable predetermined distances in opposite directions from a normal position, and a pair of adjustable lost motion connections interconnecting said element and rocker shaft.

9. In a hydraulic elevator control system, the combination including, a pilot operated valve structure including a variable position valve for controlling the rate of descent of the elevator, a pair of normally closed pilot valves adapted selectively to be opened for controlling the position of said variable position valve to effect descent of the elevator at high and low rates of speed, and control means for selectively opening said pilot valves.

10. In a hydraulic elevator control system, the combination including, a pilot operated valve structure including a variable position valve for controlling the rate of descent of the elevator, a pair of normally closed pilot valves adapted selectively to be opened for controlling the position of said variable position valve to effect descent of the elevator at high and low rates of speed, and control means automatically operable in a leveling zone first to open the low speed pilot valve and then to close it, whereby the elevator is caused to descend at low speed in the leveling zone and then stopped.

11. In a control system for a hydraulic elevator of the type comprising a jack, the combination including, a fluid reservoir, a pilot operated valve structure including a valve that is effective when closed to connect the jack to said source of fluid pressure to raise the elevator and effective when open to connect the jack to said reservoir to lower the elevator, said valve struc-

ture including a pressure chamber, a pair of normally closed passages, a pair of pilot valves for opening said passages to relieve the pressure in said chamber and a third passage for building pressure in said chamber when the pilot valves are closed, one of said pilot valves being operable to effect full opening of the valve and the other to effect partial opening of the valve, whereby said elevator may be caused to descend at either a high or low rate of speed, and remote control means including selectively energizable solenoids for opening of said pilot valves.

12. In a control system as set forth in claim 11, wherein adjustable means accessible from the exterior of the valve are provided (1) for determining the fully open position of the valve and thereby of the rate of descent of the elevator; (2) for determining the effective size of said third passage and thereby the rate of closure of said valve and deceleration while decending; and (3) for determining the effective sizes of said pair of passages and thereby the rate of acceleration in descending and the low speed, respectively.

13. In a control system for a hydraulic elevator of the type comprising a jack, a motor driven pump and a fluid reservoir, including in combination, a valve structure having an inlet passage connected to the pump discharge through a check valve preventing flow of fluid to the pump, a combined fluid outlet and return passage in communication with said inlet passage and elevator jack, an outlet passage leading to the reservoir, a valve between the outlet passage and other passages, a piston connected to the valve, a pressure chamber defined by said piston and the valve casing, a pair of passages connecting said chamber to the outlet passage and a third passage connecting said chamber to said other passages, said pair of passages being so located with respect to said piston that when a first is opened the valve is fully opened, when the second is opened the valve is partially opened, and when both are closed the valve is closed, a pair of pilot valves for opening said pair of passages, a pair of solenoids selectively energizable for selectively opening said pilot valves, a manually operable controller in said elevator, means including a relay energizable through said controller for energizing the pump motor to effect raising of the elevator, the valve being closed by reason of the pressure applied to said jack by the pump, which pressure is effective to build a pressure in said pressure chamber through said third passage, means including another relay energizable in another position of said controller for effecting energization of the solenoid controlling the pilot valve operable to effect full opening of the valve and descent of the elevator at high speed, means including a third relay energizable in a third position of said controller for effecting energization of the solenoid controlling the pilot valve operable to effect partial opening of the valve and descent of the elevator at low speed, a top limit switch for effecting deenergization of said first relay at a limit of upward movement of the elevator, a bottom limit switch for effecting deenergization of said second and third relays at a limit of downward movement of the elevator, and electrical interlock means associated with said second and third relays for preventing simultaneous energization thereof.

14. In a control system for a hydraulic elevator of the type comprising a jack, a motor driven pump and a fluid reservoir, including in combination, a valve structure having an inlet passage connected to the pump discharge through a check valve preventing flow of fluid to the pump, a combined fluid outlet and return passage in communication with said inlet passage and elevator jack, an outlet passage leading to the reservoir, a valve between the outlet passage and other passages, a piston connected to the valve, a pressure chamber defined by said piston and the valve casing, a pair of passages connecting said chamber to the outlet passage and a third passage connecting said chamber to said other passages, said pair of passages being so located with respect to said piston that when a first is opened the valve is fully opened, when the second is opened the valve is partially opened, and when both are closed the valve is closed, a pair of pilot valves for opening said pair of passages, a pair of solenoids selectively energizable for selectively opening said pilot valves, means including a manually operable control member and a first relay energizable thereby for energizing the pump motor to effect raising of the elevator, the valve being closed by reason of the pressure applied to said jack by the pump, which pressure is effective to build a pressure in said pressure chamber through said third passage, means including another manually operable control member and a second relay energizable thereby for effecting energization of the solenoid controlling the pilot valve operable to effect full opening of the valve and descent of the elevator at high speed, means including a switch automatically closed by the elevator in a leveling zone for energizing the solenoid controlling the pilot valve operable to effect partial opening of the valve and descent of the elevator at low speed, top and bottom limit switches for deenergizing said first and second relays at limits of movement in upward and downward directions, respectively, and electrical interlock means preventing simultaneous energization of said first and second relays and of said solenoids.

15. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, and a pressure chamber defined by said casing and piston, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, a second passage having an effective area greater than that of said small passage providing communication between said pressure chamber and a low pressure region, means for selectively opening and closing said second passage to control the position of said valve, and means including a helical surface on the pressure chamber side of the piston for adjusting the position taken by the valve when said second passage is opened.

16. In a pilot operated valve comprising a valve casing, an interconnected valve and piston, and a pressure chamber defined by said casing and piston, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, a second passage having an effective area greater than that of said small passage providing communication between said pressure chamber and a low pressure region, means for selectively opening and closing said second passage to control the position of said valve, and means including a helical surface on the pressure chamber side of the piston and a screw extending within said pressure chamber constructed and arranged to have longitudinal relative movement with respect to, and to effect rotation of, said piston for adjust-

ing the position taken by the valve when said second passage is opened.

17. In a valve of the type comprising a casing provided with a fluid inlet passage adapted to be connected to a source of fluid under pressure, a combined fluid outlet and return passage communicating with said inlet passage, and a fluid outlet passage, the combination including, a valve controlling communication between said outlet passage and the other passages, a piston connected to said valve, said casing being provided with a piston chamber in which said piston is movable, a pressure chamber defined by said piston chamber and the side of the piston opposite the valve, a small passage connecting said pressure chamber to said inlet and said combined fluid outlet and return passages, a pair of small passages connecting said pressure chamber to said outlet passage, said pair of passages being spaced apart in the direction of movement of said piston, and means including a helical surface on the chamber side of said piston and an adjusting means adapted to rotate said piston for adjusting the position taken by the valve in response to the opening of one of said passages.

18. In a pilot operated valve comprising a valve casing, an interconnected normally closed valve and an actuating piston therefor, the casing and piston defining a pressure chamber, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, and means including pilot valve means providing communication between said pressure chamber and a low pressure region for relieving the pressure in said chamber, and selectively operable means controlling said pilot valve means for positioning said normally closed valve at a plurality of open positions.

19. In a pilot operated valve comprising a valve casing, an interconnected normally closed valve and an actuating piston therefor, said casing and piston defining a pressure chamber, the combination including, a small passage providing communication from a region between the piston and valve to said pressure chamber, and means including pilot valve means providing communication between said pressure chamber and a low pressure region for relieving the pressure in said chamber, selectively operable means controlling said pilot valve means for positioning said normally closed valve at a plurality of open positions, and means associated with said pilot valve means controlling the rate at which pressure is relieved for determining the speed of operation of said normally closed valve.

20. In a hydraulic elevator control system, the combination including, a pilot operated valve structure having a variable position valve for controlling the rate of descent of the elevator, a piston connected to said valve, pilot valve means for controlling the position of said piston and thereby the position of said variable position valve, and selectively operable means controlling said pilot valve means for operating said piston and variable position valve to one position to effect descent of said elevator at one speed and to another position to effect descent of said elevator at another speed.

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