

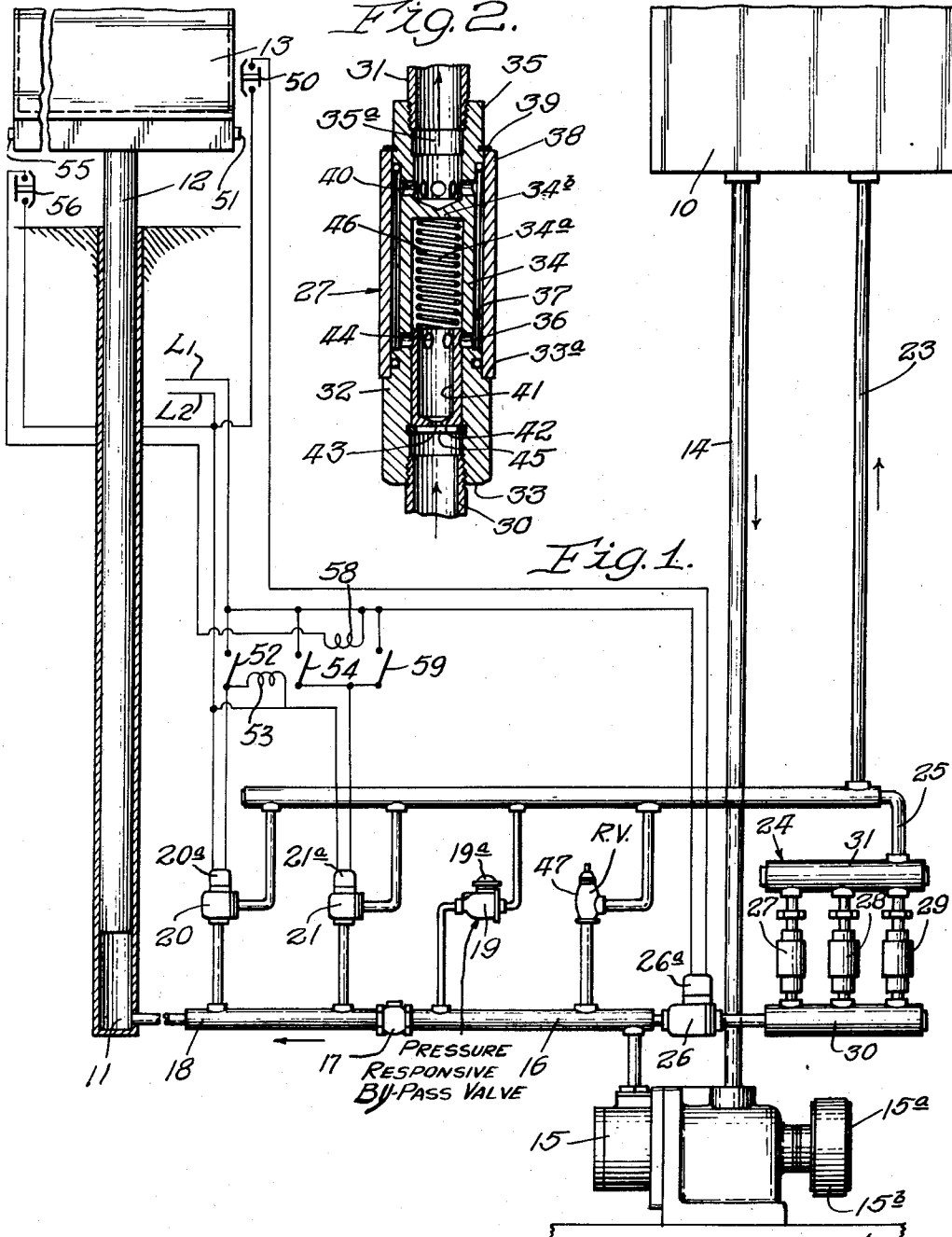
July 12, 1960

W. BECK

2,944,401

HYDRAULIC ELEVATOR LEVELING SYSTEM

Filed Oct. 29, 1956



Inventor:
Walter Beck,
By Schneider, Kufgren,
Brady, Wegner, Attys.

1

2,944,401

HYDRAULIC ELEVATOR LEVELING SYSTEM

Walter Beck, Moline, Ill., assignor, by mesne assignments, to Montgomery Elevator Company, a corporation of Delaware

Filed Oct. 29, 1956, Ser. No. 618,800

2 Claims. (Cl. 60—52)

This invention relates to a hydraulic elevator mechanism, and in particular it relates to such a mechanism which includes means for reducing variations in leveling speed of the elevator in the up direction due to differences in elevator loading.

Leveling of hydraulic elevators in the up direction has always presented a serious problem in the art. For many years the commonest arrangement was to use a single speed electric motor driving one liquid pump, and the controls were such that there was no slowdown or speed reduction as the elevator approached a floor at which it was to stop in the other direction. This necessitated that the stopping switches or floor selector contacts be so set that the elevator would carry full load up to the floor, go a short distance above the floor due to inertia of the motor, pump, etc., and then settle back to floor level. If the controls are set to carry a full load to floor level, an empty car may go 8 or 10 inches past floor level.

An improvement on this system consists in providing an up leveling bypass valve which opens when the elevator is a short distance below the floor level at which a stop is to be made, so that the over-travel of the elevator would be reduced.

This improvement, however, also has some disadvantages. When the bypass valve opens to initiate the up leveling operation, it immediately makes the system sensitive to differences in back pressure due to changes in the load on the elevator car, because it is obvious that the higher the back pressure the more rapid will be the outflow through the bypass. Typical pressure variations may range from 100 p.s.i. when the elevator car is empty, and 300 p.s.i. when the car is fully loaded. Test readings on a hydraulic elevator mechanism including an up leveling bypass valve showed that with full load on the car the speed during leveling was about 5 feet per minute, while with the car empty the speed was 30 feet per minute. Obviously, this is a very undesirable situation in providing accurate leveling of the car at a floor.

In accordance with the present invention the bypass line for up leveling is provided with a flow regulator valve of a type in which passages for passing liquid through the valve have their area changed by movement of a valve piston so that the liquid which may pass through the valve varies inversely with the back pressure in the system which is exerted on the valve piston. With such a flow regulator valve in the bypass line, increased load on the elevator car moves the piston in a direction to reduce the available liquid passage area so that the volume of liquid which may pass through the flow regulator valve is smaller when the pressure due to elevator car loading is greater. This tends to reduce the difference between maximum and minimum speed of the car during up leveling.

Proper design of the flow regulator valve to substantially eliminate variations in elevator leveling speed due to differences in elevator load requires that the flow regulator valve be designed to compensate for flow variations in the system which are due to factors other than

2

the weight in the elevator car and the internal peculiarities of the regulator valve itself. Using a commercially available flow regulator valve which was not specially designed to compensate for external variations in the system, the variation in up leveling speed was brought to a minimum of 12 feet per minute and a maximum of 18 feet per minute. When the flow regulator valve is specially fitted to the system in which it is used, this variation may be reduced substantially to zero.

The invention is illustrated in the preferred embodiment in the accompanying drawings in which:

Fig. 1 is a schematic piping, valve and control circuit layout for a hydraulic elevator system embodying the invention; and

Fig. 2 is a central longitudinal sectional view of a flow regulator valve which is suitable for inclusion in the system of Fig. 1.

Referring to the drawings in greater detail, the elevator system includes a liquid reservoir 10, a hydraulic cylinder 11, an elevator plunger 12 slidably mounted in the cylinder and surmounted by an elevator car 13, together with suitable piping, valves and pump mechanism for moving hydraulic fluid between the reservoir 10 and the cylinder 11.

A main oil supply line 14 connects the reservoir 10 with a positive displacement pump 15 which pumps hydraulic fluid into a manifold 16, through a shockless check valve 17, and through a second manifold 18 into the cylinder 11. The pump 15 is provided with a pulley 15a by means of which the pump may be driven by a belt 15b connected to a suitable electric motor (not shown). A typical small installation would have a pump 15 adapted to deliver 50 gallons per minute when operated off an 1800 r.p.m. motor at the correct operating speed.

Control of elevator movement is effected by a pressure controlled, normally open starting valve 19, a main down valve 20 and a down leveling valve 21, all of which are provided with suitable communications into a return manifold 22 from which a return line 23 carries hydraulic fluid back to the reservoir 10. Leveling of the elevator when moving in the up direction is effected by means of up leveling bypass means, indicated generally at 24, which includes a bypass line 25 which is controlled by a solenoid bypass valve 26 and, in the illustrated system, a battery of three flow regulator valves 27, 28 and 29 which are positioned between an inflow bypass manifold 30 and an outflow bypass manifold 31. The bypass valve means 24 permits hydraulic fluid to be selectively bypassed from the manifold 16 back to the liquid reservoir 10 through the bypass line 25, the manifold 22 and the return line 23. One or more flow regulator valves may be required, depending on the capacity of the hydraulic system and of the valves.

The down valves 20 and 21 and the bypass valve 26 are all provided with operating solenoids, numbered respectively 20a, 21a and 26a, and the solenoids are all controlled by conventional electric control components.

Briefly, the electrical control components may include, as diagrammatically illustrated in Fig. 1 of the drawing, a normally open switch 50 which is closed by a suitable magnetic device 51 (see Beck Patent 2,843,697) when elevator car 13 ascends to a predetermined position. The closing of switch 50 connects solenoid 26a of the bypass valve 26 across power supply leads L1 and L2, and, thus, opens valve 26 to permit fluid to flow through bypass manifold 30, the flow regulator valves, and return line 23.

The operation of valve solenoids 20a and 21a to open valves 20 and 21 and effect a descent of elevator car 13 is controlled by a normally open switch 52. Switch 52 comprises herein the normally open contacts of a con-

stant pressure push button unit which contacts close when the push button is depressed for down service and open when the push button is released. Conventionally, such a push button unit is maintained in the depressed position by the operator until the elevator reaches a point slightly above the preselected floor level at which it is intended the elevator be stopped. The closing of switch 52 connects solenoid 20a across power supply leads L1 and L2 and concurrently energizes a relay coil 53 to close normally open contacts 54 associated therewith and thereby connect solenoid 21 also across power supply leads L1 and L2. Thus, the main descent operation of the elevator car is effected by concurrent opening of valves 20 and 21.

When the elevator car reaches a point slightly above the selected floor level and the operator releases the push button to open switch 52, valve solenoid 20a is de-energized. While coil 53 is simultaneously de-energized to open contacts 54, an alternative circuit to maintain valve solenoid 21a energized is established to maintain valve 21 open and thereby lower the car slowly to the preselected floor level. This alternative circuit is established through a normally open switch 56 closed by a magnetic device 55 on the elevator car (similar to magnetic device 51) and connected in series with a relay coil 58 controlling normally open relay contacts 59, which relay contacts, when closed by the energization of coil 58, bypass contacts 54 to energize solenoid 21a. When the elevator car reaches the selected floor level, magnetic device 55 allows switch 56 to open and thereby de-energize coil 58, whereupon contacts 59 open and solenoid 21a opens to close valve 21.

Similarly, operation of the motor to drive the pump 15 is effected through conventional elevator control components.

In operation, assuming the plunger 12 to be at the bottom of its travel and the elevator car 13 to be positioned at the lowest floor level which it serves, operation of the elevator car starting control starts up the motor to operate the pump 15 which pumps liquid from the reservoir 10 into the manifold 16, and against the check valve 17. The starting valve 19 is normally open, while the down valves 20 and 21 and the bypass valve 26 are normally closed; so that at the start of operation liquid from the pump goes through the starting valve 19 into the return manifold 22. With development of pressure in the system, the starting valve gradually closes through the operation of pressure valve control head 19a so that liquid passes through the check valve 17 and into the cylinder 11 to start raising the elevator plunger 12. When pressure in the system drops due to cutting off the pump motor, the check valve 17 closes to maintain the plunger in the position which it has reached during pump operation.

When it is desired to move the elevator down, the electric elevator controls open both the down valves 20 and 21 so as to permit rapid flow of liquid from the cylinder 11 into the manifold 22, and back to the reservoir 10 through the return line 23. When the elevator car gets within a short distance of a floor at which it is to stop in the down direction, the elevator controls close the main down valve 20, but leave the down leveling valve 21 open. The main down valve closes gradually, and when the elevator reaches floor level the down leveling valve also becomes fully closed so that the elevator may stop at floor level. The leveling problem heretofore noted in up operation does not occur when the elevator is moving down, because control of elevator travel through the two down travel valves 20 and 21 permits accurate leveling of the elevator car at any floor regardless of the load on the car.

The present invention is directed particularly to the up leveling bypass means 24, which provides a relatively uniform up travel leveling speed regardless of variations in elevator loading.

When the elevator car approaches a floor at which it

is to stop, the control circuit operates as previously described to open the normally closed solenoid bypass valve 26, so the liquid may pass through the manifold 30, the flow regulator valves 27, 28 and 29, the manifold 31 and the bypass line 25. It is obvious that the rate of flow of liquid through the bypass means 24 will vary with the load in the elevator car 13, which will necessarily produce a variation in back pressure in the system. Thus, with a heavy load on the car, the leveling speed of the elevator will be very low, due to the rapid flow of liquid through the bypass means, while if the elevator is empty, or very lightly loaded, the small back pressure will produce a relatively slow flow through the bypass means 24 and a correspondingly rapid travel of the elevator in the leveling zone. This speed variation is eliminated by the flow regulator valves 27, 28 and 29, all of which are structurally alike, so that only the valve 27 will be described in detail with reference to Figure 2.

The flow regulator valve 27 consists of a main valve body 32 which includes a hollow, internally threaded inlet portion 33, a hollow casing portion 34 of smaller external diameter than the inlet portion, and a hollow, internally threaded outlet portion 35 of intermediate outside diameter. The casing portion 34 has a cavity 34a which is in direct communication with the hollow inlet portion 33, but which is separated from direct communication with the hollow outlet portion 35 of the body by a transverse wall 34b. At one end of the casing portion 34 is a group of radially extending liquid outflow passages 36 which communicate with an annular manifold 37 the inner wall of which is defined by the casing 34 and the outer wall of which is defined by an outer sleeve 38 which seats on an external shoulder 33a of the inlet portion 33 of the valve body 32. A snap ring 39 engages the other end of the sleeve and is seated in a recess in the outlet end portion 35 of the valve body. From the annular manifold 37 liquid may pass through a second group of liquid passages 40 which opens directly into an outlet bore 35a of the outlet end portion 35 of the valve body 32. Thus, liquid may flow into the hollow inlet portion 33, through the liquid passages 36, the annular manifold 37, the liquid passages 40 and out through the outlet bore 35a.

Control of the flow of liquid through the flow regulator valve is effected by means of a cup-like valve piston 41 which has an end wall 42 provided with an axial opening 43 and a group of radially extending liquid ports 44. A snap ring 45 in the hollow inlet pipe portion 33 acts as a seat for the valve piston 41, against which the piston is resiliently urged by a valve spring 46 in the chamber 34a. When the valve piston 41 is seated on the flange 45 the liquid ports 44 are precisely aligned with the liquid outlet passages 36 in the casing 34, so that in this position of the valve piston a maximum flow of liquid through the flow regulator valve is permitted. The spring 46 is so calibrated as to retain the valve piston 41 on the ring 45 when there is a minimum load in the elevator car 13. Increase in the load on the elevator car 13 produces an increasing back pressure against the end wall 42 of the valve piston 41, and moves the valve piston in such a manner as to reduce the effective area of the liquid flow passages 36. Thus, the available outflow passage area varies inversely with respect to the back pressure on the piston end wall 42 caused by the load in the elevator car 13.

The system shown in the patent drawings uses three flow regulator valves so that each may be of relatively small capacity, and between them they are adequate to carry the total volume of liquid adapted to be bypassed through the solenoid bypass valve 26.

The system is also provided with an over pressure relief valve 47, in the conventional manner, which is set to open at a pressure about 10% above the normal operating pressure for the system, so that if there is any

5

failure of the normal operating valves the relief valve will prevent damage to the system.

The foregoing detailed description is given for clearness of understanding only and no unnecessary limitations are to be understood therefrom, as some modifications will be obvious to those skilled in the art.

I claim:

1. In an operating system for controlling the delivery of liquid to the cylinder and plunger of a hydraulic elevator to control its ascent from station to station and its leveling at a station in the course of such ascent: a constant delivery pump to deliver liquid under pressure; a bypass line; a normally closed bypass valve between said pump and said bypass line; means for opening said bypass valve to admit liquid to said bypass line when the rising plunger reaches a predetermined point at which a reduced rate of rise is desired; and a flow regulator valve in said line downstream from the bypass valve, said flow regulator valve having a liquid passage and means for modifying the available area of said passage

6

inversely with respect to back pressure at the pump outlet, whereby the rate at which liquid is bypassed remains substantially constant with variations in said back pressure.

2. The mechanism of claim 1 in which the flow regulator valve includes a longitudinally movable valve piston and spring means urging said piston to a position at which the liquid passage in the valve is fully open, said spring means being calibrated to permit movement of the piston to reduce the available area of the liquid passage when back pressure on the piston exceeds a predetermined minimum value.

References Cited in the file of this patent

UNITED STATES PATENTS

2,013,316	McLean	Sept. 3, 1935
2,280,291	Jaseph	Apr. 21, 1942
2,319,125	Grote	May 11, 1943
2,553,045	Jaseph	May 15, 1951
2,573,864	Moran	Nov. 6, 1951