No. 646,776.

Patented Apr. 3, 1900.

H. J. WILLARD.

HYDRAULIC ELEVATOR.

(Application filed June 23, 1899.)

(No Model.)

2 Sheets—Sheet 1.

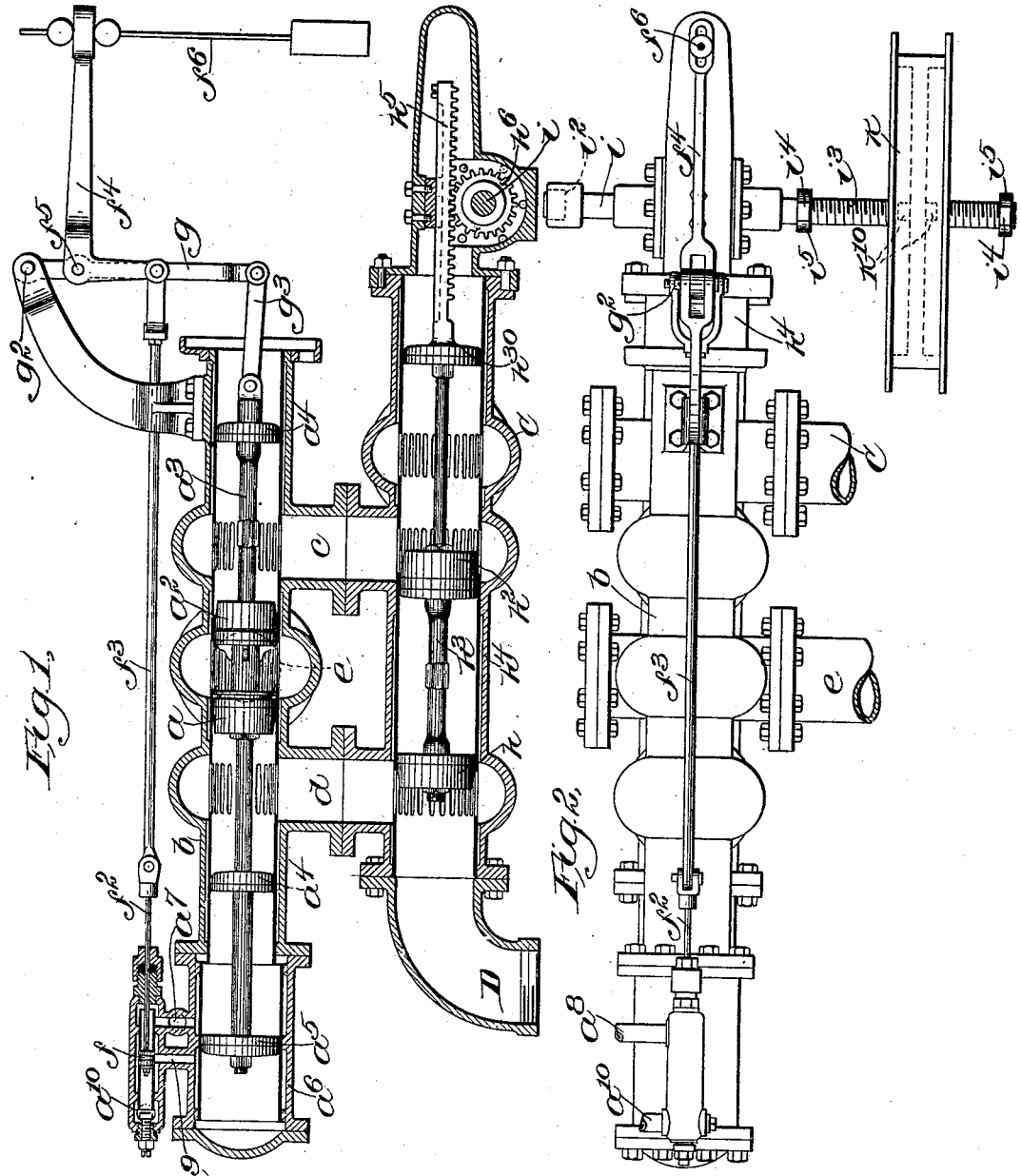

Fig. 1.

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

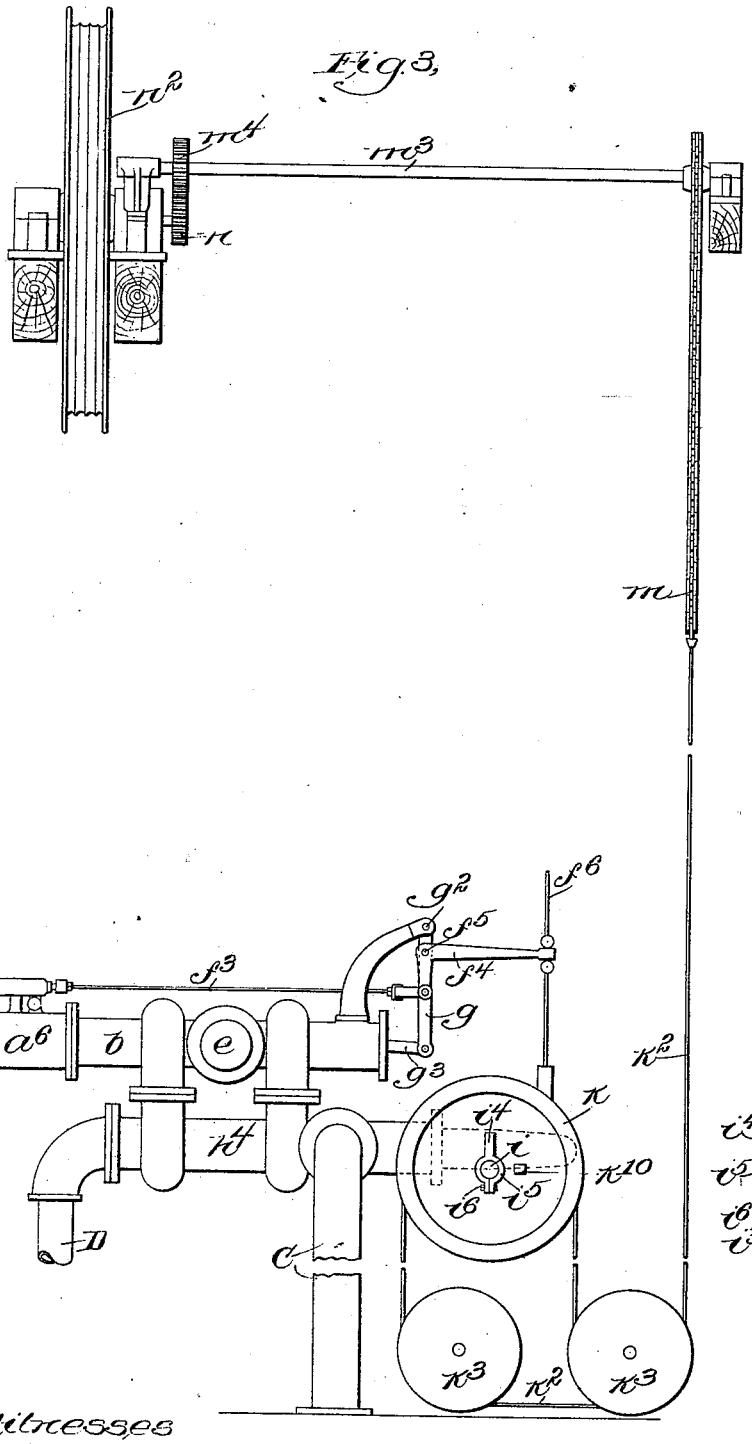
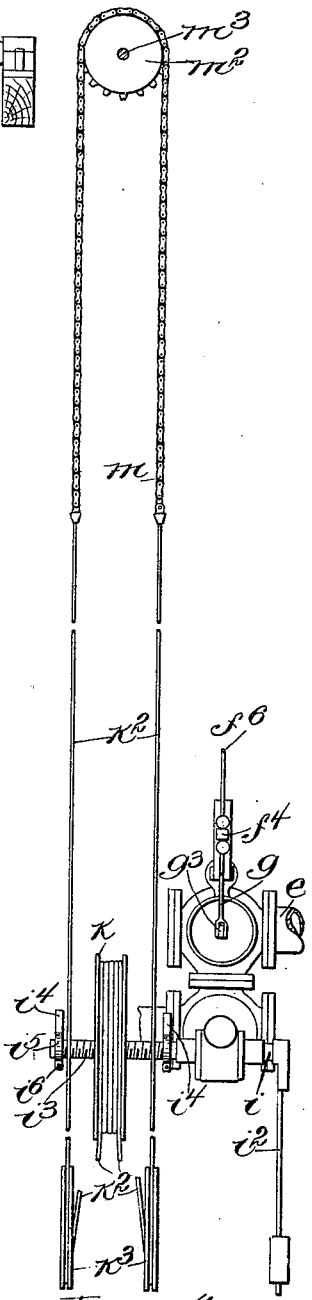


Fig. 4.



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UNITED STATES PATENT OFFICE.

HERBERT J. WILLARD, OF PORTLAND, MAINE, ASSIGNOR TO THE PORTLAND COMPANY, OF MAINE.

HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 646,776, dated April 3, 1900.

Application filed June 23, 1899. Serial No. 721,638. (No model.)

To all whom it may concern:

Be it known that I, HERBERT J. WILLARD, of Portland, county of Cumberland, and State of Maine, have invented an Improvement in Hydraulic Elevators, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present invention relates to a valve apparatus for hydraulic elevators, and is mainly embodied in a novel construction and arrangement of the "pilot-valve," as it is called, the said pilot-valve consisting of a main valve dependent upon the action of the water or other motive fluid upon differential pistons in what is known as the "motor-cylinder," and a secondary valve controlling the main valve and itself being controlled both by the shipper-rope or equivalent manual actuator and by the movement of the main valve itself, the two means of control being independent of each other.

The invention further relates to an automatic cut-off valve independent of the pilot-valve and arranged to be operated in response to the movement of the elevator itself when the said elevator approaches the end of its run in either direction. As herein shown, the motor-cylinder, which controls the main valve, is provided with a differential piston having a larger pressure area on one side than on the other, the side having the smaller area being constantly exposed to the fluid at normal pressure, while the cylinder at the opposite side of the piston is provided with an inlet and exhaust, the inlet communicating with the fluid at normal pressure and the exhaust when open permitting the fluid to escape. When, therefore, the inlet is open and the exhaust closed, the piston will travel toward the opposite end of the cylinder, owing to the difference in area at the two sides of said piston, while if the exhaust is opened and the inlet closed the piston will obviously travel in the opposite direction, and if both ports are closed the piston will remain stationary, being held by the fluid confined in the cylinder. A single duct leading from the said cylinder may constitute both the inlet and exhaust port, the said duct being controlled by a valve adapted to close the said duct, connect it with the exhaust-outlet, or connect it with the fluid-inlet. The said valve is arranged to be initially controlled from the elevator-car and secondarily controlled by the movement of the main valve, so that after the said motor-valve has been moved in one direction or the other to start the main valve it will be carried by said main valve back to its neutral position, closing both the inlet and exhaust, so that the said main valve will remain stationary during the travel of the elevator. In order to insure a prompt and accurate movement of said motor-valve, it is arranged, in accordance with the present invention, to have an unbalanced pressure constantly exerted upon it in a direction away from its actuating device or devices, so that such lost motion as there may be in the various mechanical connections will be taken up by the said unbalanced pressure, as will be hereinafter described.

In order that the pilot-valve may travel a predetermined distance and then stop, the secondary or motor-cylinder valve is arranged to be restored to its normal position by the movement of the pilot-valve itself independently of the movement of the shipper-rope, and is shown as connected directly with a lever, also connected with the shipper-rope, the said lever in turn being pivotally supported upon an independent lever connected with the stem of the main valve.

Since the motor-valve is normally held stationary by the action of the fluid in the motor-cylinder until such action is changed by the movement of the secondary valve, it is obvious that the lever connected with the main valve will be stationary, so that the movement of the shipper-rope causes the secondary-valve lever to rock on its fulcrum and to move the said secondary valve. The shipper-rope remaining in abnormal position, it is obvious that when the main-valve lever begins to move in response to the movement of the main valve it will bodily carry the secondary-valve lever with it, thus restoring the said secondary valve to its normal position. This controls the exhaust-port in the motor-cylinder, so that the main valve will be at

once arrested in its new position and will remain in such position until again affected by another operation of the secondary valve.

The automatic controlling-valve, the operating mechanism for which forms part of the invention, is independent of the pilot-valve and normally stands in a neutral position with the main inlet and exhaust ports open, so that the elevator can travel in either direction under the control of the pilot-valve. The said automatic valve, however, is connected with a traveling member under the control of the elevator-car, but adapted to be actually connected therewith only when the said car has nearly reached the end of its travel in either direction. As the car approaches the end of its upward movement, for example, it becomes connected with the automatic valve-controlling device, which is then moved to carry the said automatic valve to a position to cut off the supply of fluid, thus immediately stopping the elevator. This, however, does not affect the control of the elevator by the pilot-valve to cause the same to travel in the opposite direction or downward, since the main exhaust-port is still open. In order to restore the automatic valve to its neutral position, said valve is arranged to become disconnected from the car as soon as the said car has traveled downward to the point where it originally became engaged with the actuating device, and for this purpose the valve-actuating member is provided with an automatic restoring device, such as a weight or spring, adapted to restore it to its neutral position as soon as it becomes disconnected from the car. As herein shown, the said valve is geared to a shaft so as to be moved in one direction or the other by the rotation of said shaft, and the said shaft is provided with a screw-thread upon which is supported a sheave which is adapted to be rotated in response to the travel of the elevator first in one direction and then in the other. As the said sheave rotates it will turn upon the threaded shaft and travel from one end to the other of the thread, the shaft being provided with adjustable stops at the ends of the thread, it being obvious that as soon as the sheave comes in contact with one of the said stops its further independent rotation will be prevented and during any further rotation the shaft will rotate with it. A slight rotation or oscillation of the shaft, however, operates the said automatic valve, at once stopping the elevator, so that the sheave rotates no farther. Upon starting the elevator in the opposite direction the shaft is restored to its normal position, where it is held during the travel of the sheave by a suitable centering device, preferably a weight hung vertically from the said shaft, so as to restore it to the normal position after it has been moved in either direction.

Figure 1 is a general sectional view of the controlling-valves, including the pilot-valve, the secondary valve, the shipper connection, and the automatic cut-off valve, all of the said valves being shown in a neutral position. Fig. 2 is a top plan view of the same. Figs. 3 and 4 are details showing in end and side elevation, respectively, enough of the mechanism to illustrate the operation of the controlling devices for the automatic cut-off valve.

The main valve is shown as of the usual construction, and consists of two pistons $a\,a^2$, adapted to travel in the main-valve cylinder b, which is provided with the inlet-port c and exhaust-port d and also the pipe or duct e, which leads to the main hydraulic cylinders which operate the elevator. A longitudinal movement of the valve-stem or piston-rod a^3 in either direction from the position shown will obviously open communication between the pipe e and the inlet c or exhaust d, as the case may be.

The casing or cylinder b is closed at its ends by means of pistons a^4, which are also mounted upon the stem or piston-rod a^3, and the areas of all of said pistons are equal, so that the pressure of the water will be equalized throughout and will have no effect upon the movement of the valve itself. To control the movement of the valve, therefore, the rod a^3 is further provided with a piston a^5, somewhat larger in diameter (usually having twice the area) and inclosed in the motor-cylinder a^6, which communicates with the cylinder b. The motor-cylinder a^6 is provided with an inlet a^7, supplied by a pipe a^8, Fig. 2, which is in communication with the main supply, the said inlet being continually open, so that the space between the piston a^5 and the piston a^4 is continually full of water at normal pressure. It is obvious, therefore, that the constant tendency of said pressure, owing to the larger area of the piston a^5, is to move the stem a^3 toward the left. The space beyond the piston a^5, however, is provided with an inlet and an outlet duct a^9, controlled by the secondary valve f, which is so arranged as to connect the said duct with either the inlet or exhaust, as desired, the normal position of said secondary valve, however, being such as to completely close the said duct. While the said duct is closed and the space between the piston a^5 and the end of the motor-cylinder a^6 is full of water it is obvious that the rod a^3 cannot move to the left, although it has a constant tendency to do so, owing to the pressure on the right-hand side of the piston a^5. With the secondary valve in normal position, therefore, the main valve $a\,a^2$ will be retained stationary. Assuming such to be the conditions and it is desired to start the elevator upward, the secondary valve f will be moved to the right, thus uncovering the port a^9 and placing the outer end of the cylinder a^6 in communication with the exhaust-pipe a^{10}, thereby permitting the water to flow out of the cylinder a^6, so that the piston a^5 will be pushed toward the left. It is essential, however, that the main valve should be arrested in its abnormal position

as soon as the elevator is started and that said valve should not move until it is desired to stop the elevator or start it in the opposite direction. For this purpose the control of the secondary valve is arranged to be shifted from the shipper-rope which produces the initial movement thereof to the main valve itself, so that the latter by its movement will restore the secondary valve to normal position. In accordance with this invention the stem f^2 of the secondary valve is connected by a link f^3 with an actuating-lever f^4, shown as an elbow-lever pivoted at f^5 upon a secondary actuating-lever g. One arm of the lever f^4 is connected with the shipper-rope f^6 or equivalent actuator and the other with the link f^3, so that the movement of the shipper-rope in either direction from its normal position shown will move the secondary valve in one direction or the other, as the case may be. The lever g is pivoted at g^2 to some fixed portion of the frame, herein shown as a bracket mounted on the cylinder b, and is connected by a link g^3 with the end of the rod a^3, it being obvious, therefore, that as the said rod moves in either direction it will correspondingly move the lever g.

As has already been stated, the rod a^3 under normal conditions is held stationary, so that when the lever f^4 is moved by the shipper-rope it will be rocked upon a stationary fulcrum to produce the movement of the valve f. The movement of said valve, however, in either direction produces the movement of the main valve $a\ a^2$ in the opposite direction, which movement is transmitted to the lever g, it being obvious, therefore, that the lever f^4 is bodily moved with the lever g, carrying with it the stem f^2 and moving the valve f back to normal position. Assuming, for example, that the outer end of the lever f^4 has been lifted, moving the valve f to the right to open the exhaust a^{10} and cause a movement of the main valve to the left, starting the elevator upward, the said lever being held in that position during the upward travel of the elevator, it is obvious that the movement of the lever g in response to the movement of the valve $a\ a^2$ will carry the fulcrum of the lever f^4 to the left and with it the valve f, thus again closing the exhaust. The valve $a\ a^2$ will then be brought to rest and held stationary by the fluid inclosed in the end of the cylinder a^6. To stop the elevator, the lever f^4 will be restored to its normal position, in this case carrying the valve f to the left and opening communication between the duct a^9 and the inlet a^7, thus admitting water to the outer end of the cylinder a^6 at normal pressure. The pressure is then normal at both sides of the piston a^5; but the area of the said piston at the left-hand side is greater than that at the right-hand side, so that the said piston is caused to move to the right, carrying with it the main valve until the same is restored to its normal position. As herein shown, the difference in area at the two sides of the piston is equal to the sectional area of the piston-rod, this being sufficient to produce the necessary lack of balance. The movement of the stem a^3, produced as above described, is transmitted, as before, to the valve f, the parts being so timed that the said valve f will be closed when the valve $a\ a^2$ has reached its normal position, thus stopping the elevator. To start the elevator in the opposite direction, the operation is the same as has just been described, except, of course, that the valve $a\ a^2$ instead of starting to the left from its normal position starts to the right from its normal position, thus opening the main exhaust-port, the said valve being arrested, as before, when said main exhaust-port has been opened.

The secondary valve f is so arranged in accordance with this invention as to have a constantly-unbalanced pressure tending to move it toward the left, it being obvious that the chamber is always in communication with the inlet a^7, while the chamber at the opposite side of the valve is in communication with the exhaust. This is an important feature of the invention, for the reason that the secondary valve must be connected with its actuating devices by parts having joints which are apt to work loose, so that in the valves as heretofore constructed there has been considerable inaccuracy owing to lost motion. With this construction, however, the lost motion is all taken up by the pressure upon the valve, so that the action is prompt and positive.

The automatic controlling-valve, the construction and arrangement of which forms a part of the present invention, is entirely independent of the pilot-valve and its actuating mechanism. As herein shown, the said automatic controlling-valve comprises a double piston-valve having the pistons h and h^2, mounted on a stem or a rod h^3, and adapted to travel longitudinally along a cylinder h^4, having the main inlet C and the main exhaust D. The pistons $h\ h^2$ normally stand, as shown, between the inlet c and exhaust d, it being obvious, therefore, that the said inlet and exhaust, respectively, are normally in communication with the main inlet C and main exhaust D. If, however, the rod h^3 is moved to the right, it will obviously cut off the inlet c from the main inlet C without, however, affecting the main exhaust-pipe. The movement in the opposite direction, on the contrary, will control the exhaust without affecting the inlet. To operate the said automatic controlling-valve, said valve is arranged to be connected with the elevator-car at a predetermined point in the travel thereof, either up or down, so that the further travel of the car will produce a corresponding movement of the valve to cut off either the inlet or the exhaust, and thereby stop the elevator from going farther up or farther down, as the case may be.

As herein shown, the stem h^3 is connected

by a rack h^5 with a pinion h^6, which is fast on a shaft i, capable of revolution in either direction, but normally yieldingly held in a neutral position, as by a weighted arm i^2, which hangs vertically downward. The said rack is shown as projecting beyond a piston h^{30}, which merely serves to complete the cylinder in which the valve h h^2 travels, it being obvious that any other form of connection might be used and that the stem h^3, for example, might be extended through a suitable stuffing-box and connected in any suitable way with the shaft i or equivalent actuating device.

In order that the shaft i may remain stationary and not affect the valve h h^2 during the main portion of the travel of the elevator-car, said shaft is adapted to be connected operatively with said car only at certain predetermined periods in the travel thereof. While this may be accomplished in various ways, the said shaft is herein shown as provided with a screw-thread i^3 and a sheave k, having a corresponding internal screw-thread, so that if the said sheave k is rotated independently of the shaft i it will travel along the same in one direction or the other, according to its direction of rotation. The shaft i is further provided with adjustable stops i^4 to limit the movement of the sheave as it travels along the screw-thread. It is obvious, therefore, that if the sheave is so connected with the elevator-car as to rotate in response to the travel thereof it will at some period in the travel of the said car come in contact with one or the other of said stops, according to the direction of travel, and will then produce a rotation or oscillation of the shaft itself. The said stops are shown as arms or projections having split sockets i^5, clamped to the shaft by means of bolts i^6, so that they can be adjusted in position as desired, and said stops coöperate with projections k^{10}, Fig. 3, from the sheave k. A slight oscillating movement of the said shaft will obviously move the valve h h^2 in one direction or the other, thus immediately stopping the car. If the car is going upward, the valve will be moved to a position to cut off the inlet, there being, however, nothing to prevent the control of the exhaust by the pilot-valve, so that the car is under control of the operator so far as the downward movement is concerned, but beyond his control so far as the upward movement is concerned. As soon as the car begins to move down, however, the shaft i is turned to its normal position, but prevented from moving beyond the same by the action of the weighted arm, the weight of which is sufficient to overcome the friction of the screw-threads, and the car is again under full control of the operator until it reaches its extreme downward position, when the shaft i is again rocked, but in the opposite direction.

The sheave may be caused to rotate in response to the movement of the elevator in any suitable or usual way, but is herein shown as provided with a rope k^2, the ends of which pass, respectively, over idlers k^3 and are connected to the ends of a sprocket-chain m, which runs over a sprocket-wheel m^2, suitably geared to the hoisting-drum or some part of the elevator mechanism which rotates therewith. As indicated in Figs. 3 and 4, the sprocket-wheel m^2 may be mounted on a shaft m^3, provided with a gear m^4, meshing with a gear n, connected with one of the hoisting-sheaves n^2.

It is obvious that any suitable gear may be employed to cause the sheave k to travel the required distance during the complete upward or downward movement of the elevator between the limits desired, and that said limits may be independently adjusted, if necessary, by adjusting the position of the stops i^4 on the shaft i.

It is not intended to limit the invention to the specific construction herein shown and described, since modifications may obviously be made without departing from the invention.

I claim—

1. The combination with the motor-cylinder having a differential piston; of a valve-cylinder provided with a piston-valve; a common inlet to said valve-cylinder and said motor-cylinder at one side of said piston-valve; an actuating-rod connected with said piston-valve at the side thereof which is toward the said common inlet; a duct or passage connecting the opposite end of said motor-cylinder with said valve-cylinder; an exhaust-outlet from said valve-cylinder at the end opposite the common inlet; and means for moving the piston-valve actuator to cause said valve to travel across the said duct to close the same or connect it with the inlet to or the outlet from the valve-cylinder, as set forth.

2. The combination with the main valve having a valve-rod connected at one end with a lever and being provided at the other end with a differential piston; of a cylinder for said piston provided with a continually-open inlet admitting fluid to the smaller piston area; a secondary-valve cylinder, a piston-valve in said cylinder subjected to the pressure of fluid entering through said inlet; an actuator for said piston-valve connected with an operating-lever pivotally supported upon the lever to which the main-valve rod is connected, said actuator being connected with the side of the piston-valve which is toward the normally-open inlet; a duct leading from the cylinder for the main-valve piston to the cylinder for the secondary piston-valve, the said secondary piston-valve being movable across said duct; and an exhaust-outlet from said secondary piston-valve cylinder at the end opposite to the inlet thereto, as set forth.

3. The combination with an automatic controlling-valve for a hydraulic elevator; of an oscillating member suitably connected with said valve and adapted by its oscillation in

one direction or the other to produce a corresponding movement of said valve; means for yieldingly retaining said oscillating member in a neutral position corresponding to the neutral position of the valve, said oscillating member having a screw-thread and stops or engaging shoulders at the ends thereof; and a sheave or pulley having a screw-thread cooperating with the screw-thread on the said member and being connected with the elevator-car so as to rotate in one direction when the said car is traveling up, and in the other direction when the said car is traveling down, as set forth.

4. The combination with a piston-valve arranged by its movement in one direction to cut off the inlet, and by its movement in the other direction to cut off the exhaust of a hydraulic elevator, the said valve normally standing in a neutral position to leave said inlet and exhaust open; of a shaft geared to the said valve and arranged by its partial rotation to move the said valve in one direction or the other according to the direction of such rotation; a weighted arm depending radially from the said shaft to maintain the same normally in a neutral position; a sheave screw-threaded on the said shaft and connected with the elevator-car so as to be rotated in response to the travel thereof; and adjustable stops on the said shaft adapted to be engaged by said sheave after it has traveled a predetermined distance along the screw-thread in one direction or the other, as set forth.

5. The combination with the sheave k cooperating with the threaded shaft i; of the cable k^2 wound on the said sheave; the sprocket-chain m connecting the ends of said cable; the sprocket-wheel m^2 for said chain, said sprocket-wheel being geared to a member adapted to rotate in response to the travel of the elevator-car; the adjustable stops i^4 on the said shaft i; and the valve $h\,h^2$ controlled by the oscillation of said shaft, as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HERBERT J. WILLARD.

Witnesses:

HENRY J. LIVERMORE,

JAS. J. MALONEY.