No. 667,418. Patented Feb. 5, 1901.

F. A. BATES.

HYDRAULIC ELEVATOR.

(Application filed Nov. 6, 1897.)

(No Model.)

FIG. 1.

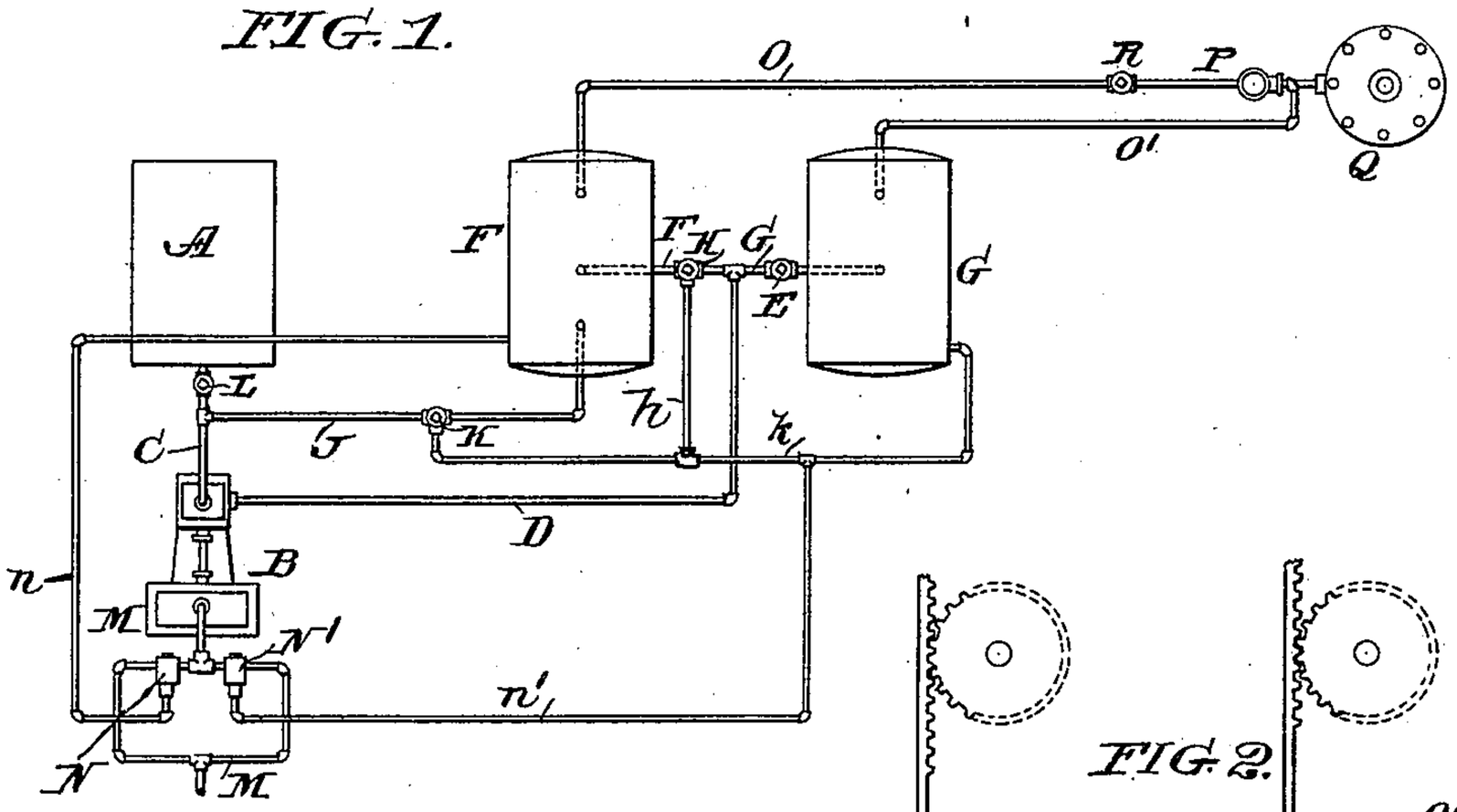


FIG. 2.

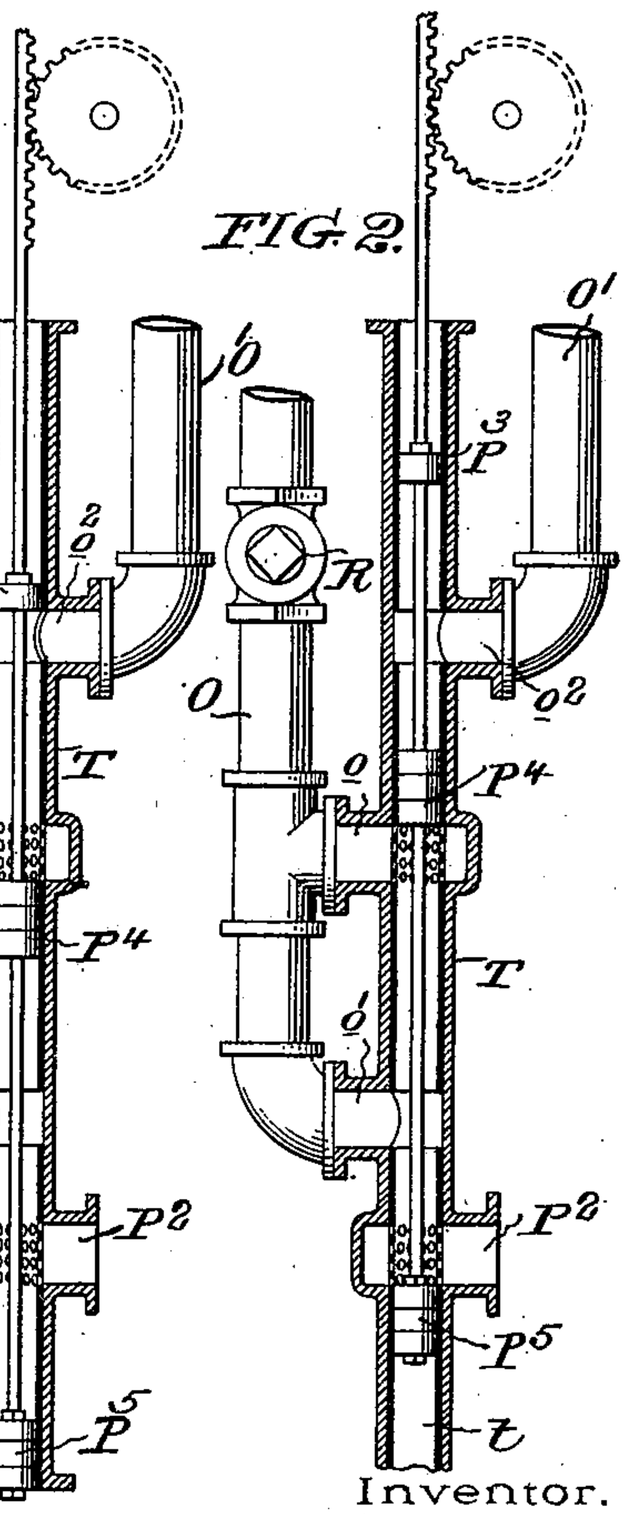


FIG. 3.

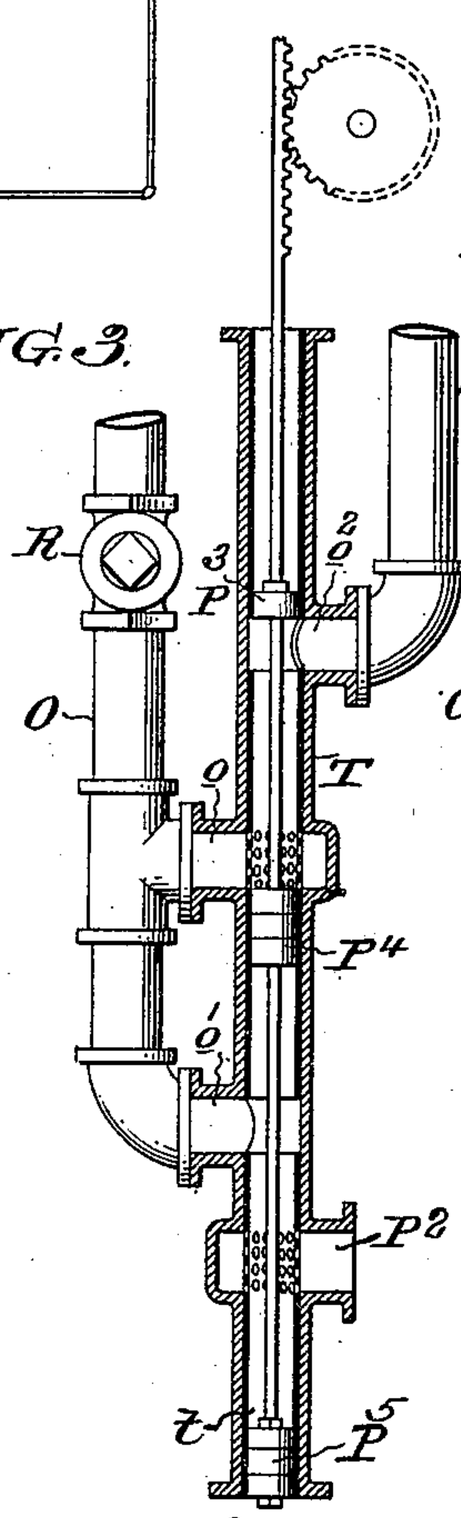


FIG. 4.

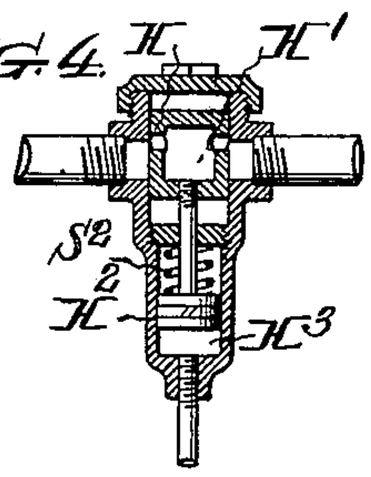
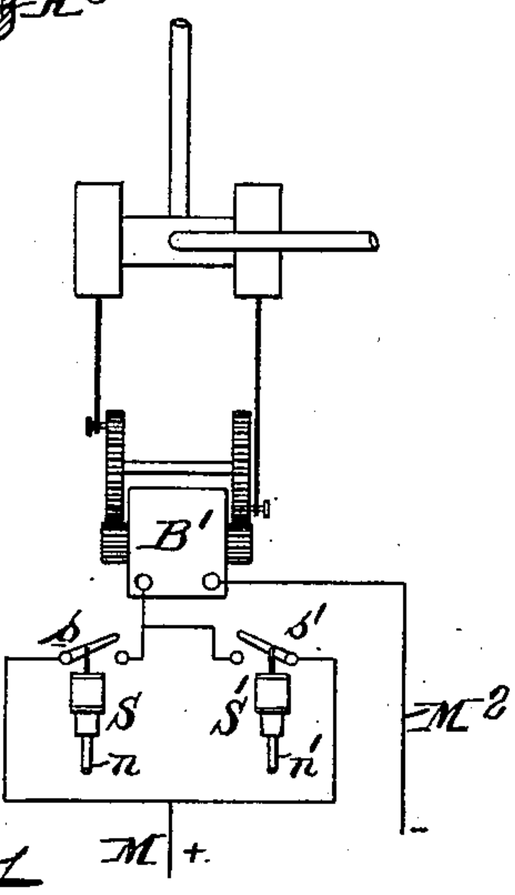


FIG. 5.



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HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 667,418, dated February 5, 1901.

Application filed November 6, 1897. Serial No. 657,598. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS A. BATES, of the city and county of Philadelphia, in the State of Pennsylvania, have invented an Improvement in Hydraulic Elevators, of which the following is a specification.

My invention has reference to hydraulic elevators; and it consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

The object of my invention is to provide a suitable construction of apparatus and method of operating the same for lifting heavy and light loads under proportional powers, whereby economy in cost of apparatus and small size thereof may be secured.

More specifically explained, my invention comprehends the employment of a hydraulic cylinder adapted to work under a pressure of, say, one hundred and ten pounds to perform the normal and usual work and when an excessive load is required to be elevated increasing the power automatically while employing the same pump, so that this large load may be raised with equal facility. This enables the use of a small pump and gives greater capacity to the ordinary construction of hydraulic elevators.

In carrying out my invention I employ two accumulator-tanks in which water is forced under pressure against a volume of inclosed air and in which one tank has approximately twice the pressure in normal operation of that contained in the other. These tanks are connected by suitable pipes with a valve of novel construction arranged adjacent to the hydraulic or lifting cylinder for the elevator, so that either one may be brought into communication with the hydraulic cylinder. Furthermore, I employ a source of water-supply, such as a large tank which receives the return water from the hydraulic cylinder in the usual manner, and this I connect by a suction-pipe with an ordinary steam-pump, preferably a duplex pump. The discharge from this pump I connect with both accumulator-tanks, the connection with the high-pressure tank being through a check-valve and the connection with the low-pressure tank being through an automatic valve which closes the communication when the maximum pressure of the tank is secured. Furthermore, I provide a pipe connection between the low-pressure tank and the suction side of the pump and insert therein a similar automatic valve connecting with the high-pressure tank in such a manner that communication by said pipe is cut off whenever the high-pressure tank contains a maximum pressure. I further provide the steam-pump with automatic control-valves for stopping and starting it or changing its speed, which are operated by pressure in pipes in communication, respectively, with the high and low pressure tanks. In addition to these features of construction I arrange a check-valve in the discharge between the low-pressure tank and the valve of the hydraulic cylinder and a similar check-valve in the immediate discharge from the reservoir or source of supply of the water. The method of operation of this apparatus after being brought to an operative condition is as follows: If a light load is to be lifted, the movement of the valve of the hydraulic cylinder will permit the water under the pressure contained in the low-pressure tank to actuate the piston of the hydraulic cylinder. As the pressure in the tank decreases the automatic valve in the supply-pipe thereto will open and water under the pressure of the pump will find its way into the said low-pressure tank to restore its pressure, and upon reaching its maximum pressure the automatic valve will close and the pump stop. In this manner the supply of water is made commensurate with that used in the hydraulic cylinder.

If a heavy load were being raised by the elevator, the operation of the control-valve would throw the high-pressure tank into communication with the hydraulic cylinder and reduce its pressure. The reduction of this pressure in the high-pressure tank not only starts the pump, but automatically operates the valve between the low-pressure tank and the suction side of the pump, so as to supply the pump with water under pressure from the low-pressure tank. In this manner the pump may use small steam-cylinders and yet have capacity on account of the pressure of the suction side to discharge the water against the

maximum pressure of the high-pressure tank. In this manner the transfer of the water from the low-pressure tank to the high-pressure tank to restore the pressure in the latter is automatically made.

By my improved construction a plant having the usual maximum lifting capacity may have that capacity doubled with the same apparatus by simply adding the second or high-pressure tank with the necessary additional pipes and valves at an additional cost, which is very small as compared with that which would be necessary with a larger apparatus acting directly for heavy loads. Furthermore, it is far more economical, since for eight-tenths of the time only light loads would have to be lifted. With my improved apparatus no more water is circulated than is absolutely essential for the duty.

My invention will be better understood by reference to the accompanying drawings, in which—

Figure 1 is a plan view showing my improved apparatus. Figs. 2 and 3 are sectional elevations of the control-valve for the hydraulic cylinder. Fig. 4 is a sectional elevation of one of the automatic valves, and Fig. 5 is a plan view showing my improvements adapted to electric motors for operating the pump instead of steam-power.

A is the usual reservoir or tank into which the water exhausting from the hydraulic cylinder returns and from which the water is drawn to supply the constant demand of the hydraulic or lifting cylinder.

B is the pump, which is usually of the duplex pattern and connects by suction-pipe C with the tank A, the said suction-pipe being provided with a check-valve L.

F is a low-pressure tank or accumulator, and G is a high-pressure tank or accumulator. Ordinarily the tank F will contain the water pumped in against the air-pressure with a maximum pressure of about one hundred and ten pounds per square inch, while the pressure in the tank G may rise to two hundred pounds. The discharge-pipe D from the pump connects by a branch with both the tanks F and G, the connection with tank G being through a check-valve E, permitting entrance of water into the tank G, but not from it. The connection of the pipe D with the tank F is through an automatic valve H, to be hereinafter described. The suction-pipe C, intermediate of the check-valve L and pump, is connected by a pipe J with the tank F, and this pipe contains an automatic valve K, similar in construction to the valve H.

Q is the hydraulic lifting-cylinder, of the well-known construction, which by means of suitable cables operated by its piston raises or lowers the cage or platform. (Not shown.) P is the control-valve thereof, adapted to supply water under the pressure of the tank F or tank G to the cylinder Q. The valve P connects with the tank F by means of a pipe O, containing a check-valve R to permit the water to flow to the valve, but not backward, and by a second pipe O′ with the tank G.

I will now refer to the control-valve construction, although the same is not specifically claimed in this application, since it forms the subject-matter of my Patent No. 599,466, dated February 22, 1898. The valve consists of a cylinder T, having a port P^2 leading to the cylinder Q, a discharge-port t at the bottom, two supply-ports $o\ o'$, connecting with the supply-pipe O, and a further port o^2, connecting with the supply-pipe O′. The valve-rod is provided with three pistons P^3 P^4 P^5. These pistons are so spaced that when the valve-rod is moved so that they occupy the position shown in Fig. 2 the pressure from the pipe O′ is counterbalanced between the pistons P^3 and P^4, while the water from the pipe O passes through the check-valve R and by port o' into the cylinder T, and thence out by the port P^2 to the hydraulic cylinder Q. If the valve-rod be moved downward to the position shown in Fig. 3, we will then have the ports o, o', o^2, and P^2 in direct communication with the pipe O′. The water under high pressure then passes by pipe O′ through these several ports and the connecting portion of the pipe O through the port P^2 into the cylinder Q. This enables the same-sized piston therein to perform almost double the work on account of the excess of the pressure applied thereto. The check-valve R prevents the pressure from the pipe O′ exerting its influence back into the tank F. By moving the valve-rod sufficiently high, so that the piston P^5 is moved above the port P^2, the contents of the cylinder Q is discharged backward through the port P^2 and out of the bottom t of the valve-cylinder T and may be returned to the tank A by a suitable pipe in the usual manner. It will thus be seen that if the pistons of the control-valve are only moved to permit water to enter from the pipe O into the cylinder Q and then discharge the elevator will be operated under low pressure as often as required. If, however, a very heavy load is upon the cage, which might occur half a dozen times or more a day, then the pistons are moved downward, so as to put the pipe O′ into communication with the port P^2, and thus double the power of the elevator.

M is the steam-pipe, communicating with the steam-cylinder of the pump through two branches, in which are placed, respectively, valves N N′, of suitable automatic construction—for example, similar in general construction and operation to the valve H. These automatic valves are all controlled by the pressures in the tanks F and G, as follows: The valve K is governed by the pressure from the tank G through a small pipe k, and likewise the valve N′ is controlled by the same pressure through a pipe n'. The valve N is controlled by the pressure from the tank F, exerted through a small pipe n. The

valve H is controlled by the pressure existing in the tank G by connecting with the pipe *k*, leading therefrom, by means of a pipe *h*. The construction of these automatic valves is shown in Fig. 4. They consist of a cylinder H, into which the two main pipes open. A piston-valve H′ is movable in the cylinder, so as to open or close the orifices to the pipes leading thereto, and hence said piston operates as a balanced valve. A second cylinder H^3 is arranged below the cylinder H and contains a piston H^2, directly connected with the piston-valve H′. A spring S^2 tends to move the valve under a predetermined pressure and is counteracted in its effect to a greater or less extent by the pressure of the water in the cylinder H^3, exerted through the pipe *h*. It is self-evident that these automatic valves may be operated by the pressure of the water or by the pressure of the air in the tanks F G above the water, as the operation and results would be the same. Any suitable construction of automatic valve may be employed in lieu of that shown.

In describing the valve H, I have in effect described all of the valves K, N, and N′, as they all operate on the same principle.

The passage through the valve H registers with the pipes controlled by it at the highest point of its movement, whereas the piston through each of the other regulating-valves will so register at the lowest point of the movement; otherwise the general construction of the valves may be the same in practice.

The operation of the apparatus will now be clearly understood. Assume first that the pressure in the tank F has been raised to one hundred and ten pounds per square inch and in the tank G to two hundred pounds per square inch as a preliminary matter. If now the valve P is moved, so as to draw water from the tank F, it may be operated several times before the pressure in that tank is materially reduced. When the pressure in the tank F falls to any appreciable extent, the pressure in the valve N is reduced and automatically permits this valve to open and put the pump B into operation. Water is then pumped from the tank A through the pipe D and thence through valve H into the tank F to supply that which is being drawn off. When the pressure in the tank F again reaches one hundred and ten pounds, the valve N closes the steam-supply and the pump B stops. The operation of the pump is therefore automatic. Now assuming that a heavy load is to be lifted the valve P is operated to permit water to flow from the tank G. The effect of this is to lower the pressure in the tank G. Several operations of the cylinder Q might lower the pressure to, say, one hundred and eighty pounds; but when lowered to any material extent below two hundred pounds it is desirable to have the pressure increased again as soon as possible. When the pressure falls below, say, one hundred and ninety-seven pounds, the valve K automatically opens. When this is done, the pressure in the suction-pipe C and in the pipe J increases to one hundred and ten or that of the tank F. The valve H remains closed whenever the pressure in the tank G falls below two hundred pounds or the pressure predetermined for said tank, but is automatically opened when this pressure is reached, so that the tank F may receive further supply of water if its pressure of one hundred and ten pounds has been lowered at a time when the pressure of the tank G is a maximum. The falling of the pressure in the tank G reduces the pressure in the pipe *n*′ and this permits the valve N′ to open and supply steam to the pump B. Once more the pump is put into operation, only that now the pressure of the suction-supply of the pump is one hundred and ten pounds, and hence the pump has a capacity, with its assisted suction, to force the water through the pipe D and check-valve E into the tank G to bring the pressure back to two hundred pounds. The proportions of the tanks F and G should in practice be preferably such that whenever water is taken from the tank F and transferred to the tank G to increase its pressure again to two hundred pounds this is done without decreasing the pressure of the tank F to below, say, eighty pounds. As soon as the pressure is increased in the tank G the valves K and N′ automatically close and valve H opens. However, the valve N has been opened, because the pressure in the tank G was below one hundred and ten pounds. The water is then drawn from the tank A and delivered through the pipe D and valve H into the tank F, so as to return its pressure to one hundred and ten pounds. In this manner the working pressures of the two tanks F and G may be maintained continuously within practical limits. The adjustment of the valves H K N N′ may be such that they are caused to operate under smaller differences or variation of pressure in the tanks F and G, so that the differences in the pressure of these respective tanks may be so proportioned as never to vary by more than ten pounds—that is to say, the pressure in the tank F might never fall below one hundred pounds and that in the tank G below one hundred and ninety pounds.

The proper proportioning of the tanks to the hydraulic cylinder of the elevator for a given number of possible operations under normal conditions would limit the possibility of lowering the pressure in the tanks below the figures above given or those determined in designing the apparatus. The adjustment of the spring S^2 of the automatic valves will determine the maximum pressures which the tanks F and G would be made to sustain, as these springs govern the operation of the valves to insure the pumps acting the moment the predetermined pressures of the tanks are reduced.

In place of operating the pump B by steam it may in some cases be operated by electric

power, as shown in Fig. 5. In this case B′ is an electric motor which operates the pump proper. M′ is a supply electric circuit containing two branches, each of which is provided with circuit-closing switches, *s* representing a switch in one branch and *s′* a switch in the other branch. M^2 is the return-circuit from the motor. S is an automatic switch-operating device corresponding to the valve N of Fig. 1 and operates the switch *s*. This device is operated by the pressure in the tank F through the pipe *n*. S′ is the operating device for moving the switch *s′* and is operated by the pressure in the tank G through the pipe *n′*. The cylinder H^3, piston H^2, and spring S^2 would be the same in the devices S S′ as in the valves H K N N′; but the piston H′ would be substituted by the connection with the switches *s s′* to complete the electric circuit in lieu of supplying the steam. The principle of operation, however, is identical.

In originally filling the tanks with water this may be done by controlling the automatic valve H by hand; but before that, when there is no pressure, the pump may be made to operate to fill the tank G up to at least one hundred and ten pounds. The automatic valve H would then be temporarily adjusted by hand, so as to enable the pressure in tank F to be raised to one hundred and ten pounds or more. After this the apparatus would work automatically, provided the supply of the tank F is sufficiently great to maintain its pressure while raising the pressure in the tank G to its maximum. If not, then the pressure in the tank G should be raised as far as the pump will perform the duty and the valve H then once more controlled by hand to again raise the pressure in the tank F, so that the operation of the apparatus may again be proceeded with, each time using the pressure of the tank F to increase the pressure in the tank G under the action of the pump. After the apparatus has been once brought to an operative condition it will thereafter take care of itself and continue to operate in the manner above described.

While I prefer the construction shown, I do not limit myself to the details thereof or to the particular arrangement of the parts, as these may be more or less modified or varied to suit the wishes of the designer.

Having now described my invention, what I claim as new, and desire to obtain by Letters Patent, is—

1. In a hydraulic elevator, the combination of the hydraulic cylinder, a high-pressure tank, a low-pressure tank, pipes leading from the said tanks to the hydraulic cylinder, means to open communication between either of said tanks and the hydraulic cylinder, a pump, a discharge-pipe adapted to force water into each of the said tanks, a suction-pipe connecting the low-pressure tank with the suction side of the pump, a valve to control the admission of water from the pump into the low-pressure tank, an automatic valve to control the admission of water from the low-pressure tank into the suction-pipe of the pump, a power device to operate the pump, controlling means for regulating the operation of the power device, and automatic devices controlled by the pressures within the tanks for governing the operation of the means for controlling the power device and for automatically opening the valves in the supply-pipe and suction-pipe connecting with the low-pressure tank, permitting the passage of water when the pressures in the tanks fall below predetermined amounts.

2. In a hydraulic elevator, the combination of the hydraulic cylinder, a high-pressure tank, a low-pressure tank, pipes leading from the said tanks to the hydraulic cylinder, means to open communication between either of said tanks and the hydraulic cylinder, a pump, a discharge-pipe adapted to force water into each of the said tanks, a suction-pipe connecting the low-pressure tank with the suction side of the pump, a valve to control the admission of water from the pump into the low-pressure tank, an automatic valve to control the admission of water from the low-pressure tank into the suction-pipe of the pump, a power device to operate the pump, controlling means for regulating the operation of the power device, automatic devices controlled by the pressures within the tanks for governing the operation of the means for controlling the power device and for automatically opening the valves in the supply-pipe and suction-pipe connecting with the low-pressure tank when the pressures in the tanks fall below predetermined amounts, a water reservoir or tank open to the atmosphere connecting with the suction-pipe of the pump, and a check-valve interposed between the open tank or reservoir and the suction-pipe of the pump connecting with the low-pressure tank.

3. In a hydraulic elevator, the combination of the hydraulic cylinder, a high-pressure tank, a low-pressure tank, pipes leading from the said tanks to the hydraulic cylinder, means to open communication between either of said tanks and the hydraulic cylinder, a pump, a discharge-pipe adapted to force water into each of the said tanks, a suction-pipe connecting the low-pressure tank with the suction side of the pump, a valve to control the admission of water from the pump into the low-pressure tank, an automatic valve to control the admission of water from the low-pressure tank into the suction-pipe of the pump, a power device to operate the pump, controlling means for regulating the operation of the power device, automatic devices controlled by the pressures within the tanks for governing the operation of the means for controlling the power device and for automatically opening the valves in the supply-pipe and suction-pipe connecting with the low-pressure tank when the pressures in the

tanks fall below predetermined amounts, and a check-valve in the discharge-pipe from the pump for the high-pressure tank to prevent the escape of water once forced therein.

4. In a hoisting apparatus, the combination of a hydraulic cylinder, a low-pressure tank, a high-pressure tank, means for supplying water from either tank to the hydraulic cylinder, a pump for forcing water into the said tanks, a check-valve to prevent the flow of water from the high-pressure tank to the pump, an automatic valve to control the flow of water from the pump to the low-pressure tank, and means for supplying the pump with water under atmospheric and also at a higher pressure.

5. In a hoisting apparatus, the combination of a hydraulic cylinder, a low-pressure tank, a high-pressure tank, means for supplying water from either tank to the hydraulic cylinder, a pump for forcing water into the said tanks, a check-valve to prevent the flow of water from the high-pressure tank to the pump, an automatic valve to control the flow of water from the pump to the low-pressure tank, means for supplying the pump with water under atmospheric and also at a higher pressure, and means under the control of the pressure in the high-pressure tank for controlling said last-mentioned means whereby when the pressure in the high-pressure tank falls the pump is supplied with water at a pressure above that of the atmosphere.

6. In a hoisting apparatus, the combination of a hydraulic cylinder, a low-pressure tank, a high-pressure tank, means for supplying water from either tank to the hydraulic cylinder, a pump for forcing water into said tanks, a check-valve to prevent the flow of water from the high-pressure tank to the pump, an automatic valve to control the flow of water from the pump to the low-pressure tank, means for supplying the pump with water under atmospheric and also at a higher pressure, means under the control of the pressure in the high-pressure tank for controlling said last-mentioned means whereby when the pressure in the high-pressure tank falls the pump is supplied with water at a pressure above that of the atmosphere, and a valve to control the operation of the pump governed by the pressure in the high-pressure tank whereby the pump operates when the pressure falls.

7. In a hoisting apparatus, the combination of a hydraulic cylinder, a low-pressure tank, a high-pressure tank, means for supplying water from either tank to the hydraulic cylinder, a steam-pump for forcing water into the said tanks, a check-valve to prevent the flow of water from the high-pressure tank to the pump, an automatic valve to control the flow of water from the pump to the low-pressure tank, means for supplying the pump with water under atmospheric and also at a higher pressure, means under the control of the pressure in the high-pressure tank for controlling a pressure above that of the atmosphere, a valve to control the operation of the pump governed by the pressure in the high-pressure tank, and a second valve to control the steam to the pump governed by the pressure in the low-pressure tank whereby the pump operates when the pressure falls in either tank.

8. In hydraulic apparatus, the combination of a hydraulic power device for operating the elevator-cage, a primary tank open to the atmosphere and into which the water from the hydraulic power device discharges, a low-pressure tank, a high-pressure tank, means under the control of the operator on the elevator for supplying the hydraulic power device with water from either the low or high pressure tank at will, a pump for pumping water from the primary tank into the low-pressure tank, pipes connecting with the pump for withdrawing water from the low-pressure tank and delivering it into the high-pressure tank, and automatic means for closing the discharge from the pump to the low-pressure tank when pumping into the high-pressure tank.

9. In hydraulic apparatus, the combination of a hydraulic power device for operating the elevator-cage, a primary tank open to the atmosphere and into which the water from the hydraulic power device discharges, a low-pressure tank, a high-pressure tank, means under the control of the operator on the elevator for supplying the hydraulic power device with water from either the low or high pressure tank at will, a pump for pumping water from the primary tank into the low-pressure tank, pipes connecting with the pump for withdrawing water from the low-pressure tank and delivering it into the high-pressure tank, and automatic valve devices for closing the discharge from the pump to the low-pressure tank and opening the suction of the pump from the low-pressure tank when pumping into the high-pressure tank.

10. In hydraulic apparatus, the combination of a hydraulic power device for operating the elevator-cage, a primary tank open to the atmosphere and into which the water from the hydraulic power device discharges, a low-pressure tank, a high-pressure tank, means under the control of the operator on the elevator for supplying the hydraulic power device with water from either the low or high pressure tank at will, a pump for pumping water from the primary tank into the low-pressure tank, pipes connecting with the pump for withdrawing water from the low-pressure tank and delivering it into the high-pressure tank, automatic valve mechanism for closing the discharge from the pump to the low-pressure tank when pumping into the high-pressure tank, power device for operating the pump, and automatic controlling mechanism for regulating the operation of the power device operated by the pressure in both the low and high pressure tanks where-

by the pump is automatically put into operation when the pressure in either tank falls below a definite amount.

11. In hydraulic apparatus, the combination of a primary tank or reservoir containing water, a secondary or low-pressure tank, pipes connecting the low-pressure and primary tanks, pumping mechanism for circulating the water between the primary and low-pressure tanks and also between the low and high pressure tanks, automatic mechanism under the control of the pressure in the high-pressure tank for controlling the pump in pumping into the high-pressure tank, and automatic mechanism under the control of the pressure in the low-pressure tank for controlling the pump in pumping into the low-pressure tank.

12. In hydraulic apparatus, the combination of a primary tank or reservoir containing water, a secondary or low-pressure tank, pipes connecting the low-pressure and primary tanks, pumping mechanism for circulating the water between the primary and low-pressure tanks and also between the low and high pressure tanks, automatic mechanism under the control of the pressure in the high-pressure tank for controlling the pump in pumping into the high-pressure tank, automatic mechanism under the control of the pressure in the low-pressure tank for controlling the pump in pumping into the low-pressure tank, and power mechanism for operating the pump under the control of the pressures in both the high and low pressure tanks.

13. The combination with a hydraulic engine, of two supply-tanks containing motor fluid at different pressures, a valve device whereby either tank can be put into connection with said engine, a pump for pumping fluid into said tanks, a supply or suction pipe leading from the low-pressure tank to the pump, a valve to control the water flowing in said pipe, and automatic means for closing the valve in the supply-pipe when the pressure in the high-pressure tank is increased, substantially as set forth.

14. The combination with a hydraulic engine, of two supply-tanks containing motor fluid at different pressures, a valve device whereby either tank can be put into connection with said engine, a pump for pumping fluid into said tanks, and means for automatically putting the supply-pipe of the pump into communication with the low-pressure tank when the pressure on the high-pressure tank decreases, substantially as set forth.

In testimony of which invention I hereunto set my hand.

F. A. BATES.

Witnesses:
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D. C. GIBBONEY.