No. 793,907. PATENTED JULY 4, 1905.

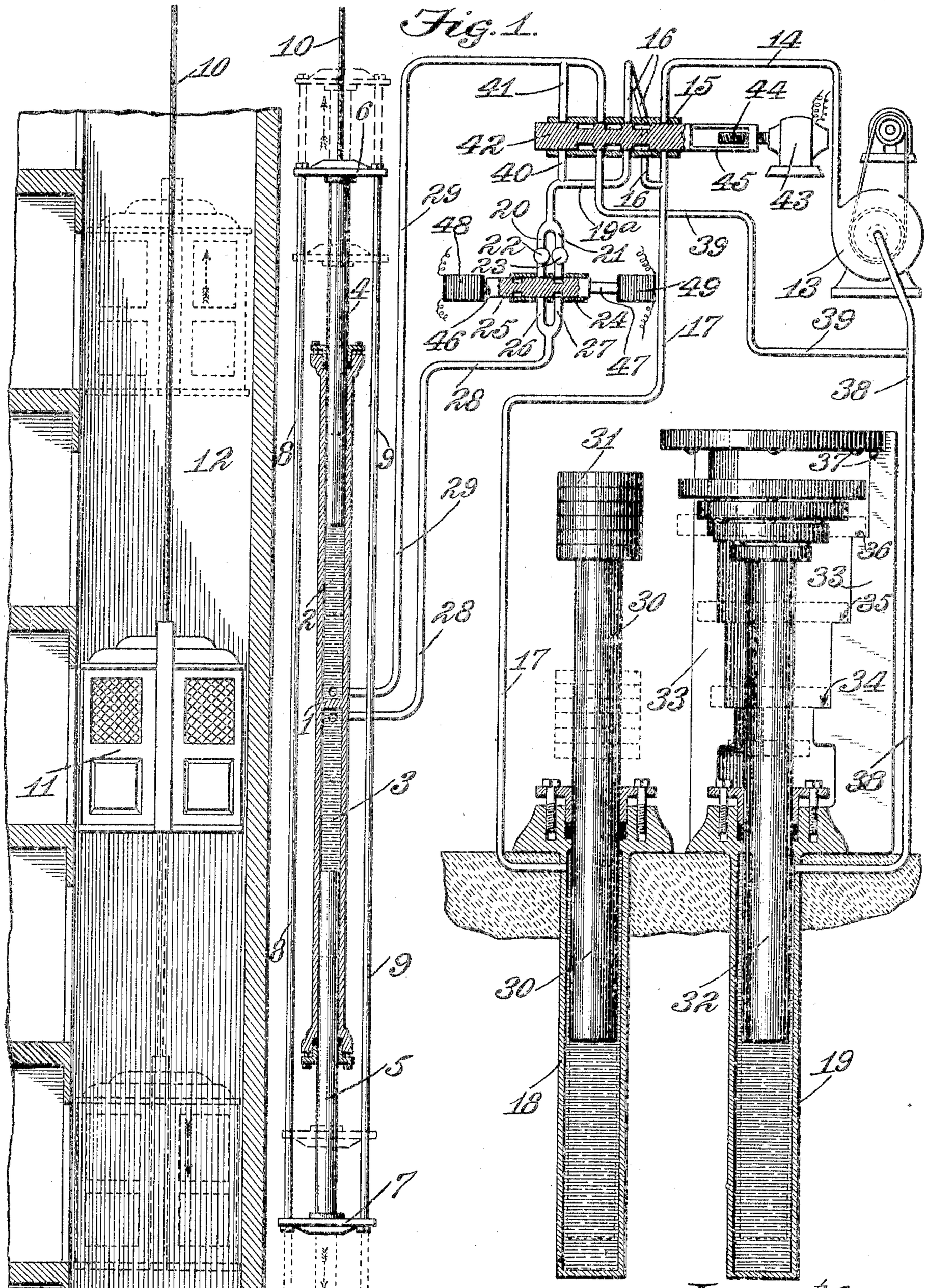
W. H. REEVES.

HYDRAULIC ELEVATOR.

APPLICATION FILED APR. 9, 1904.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

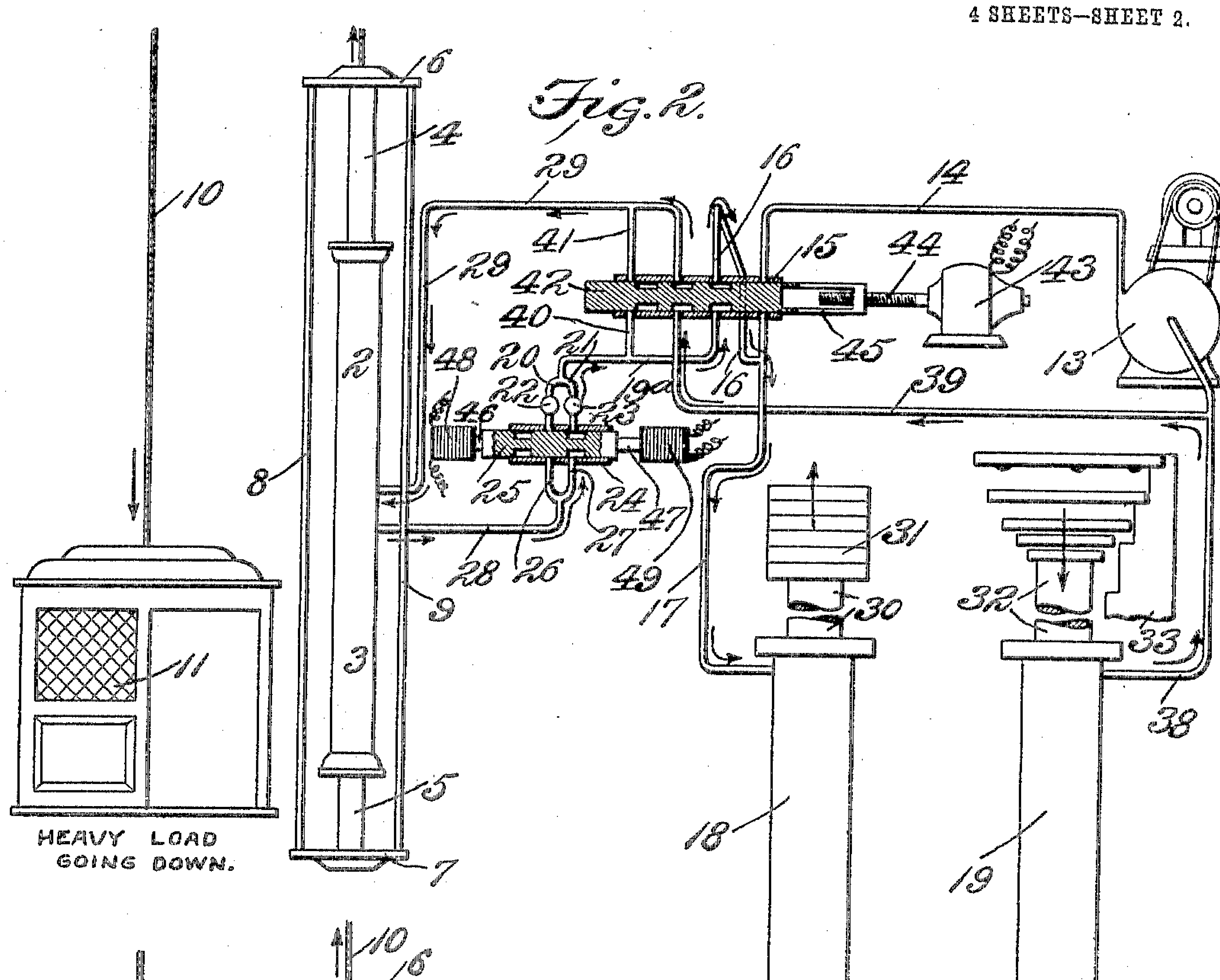
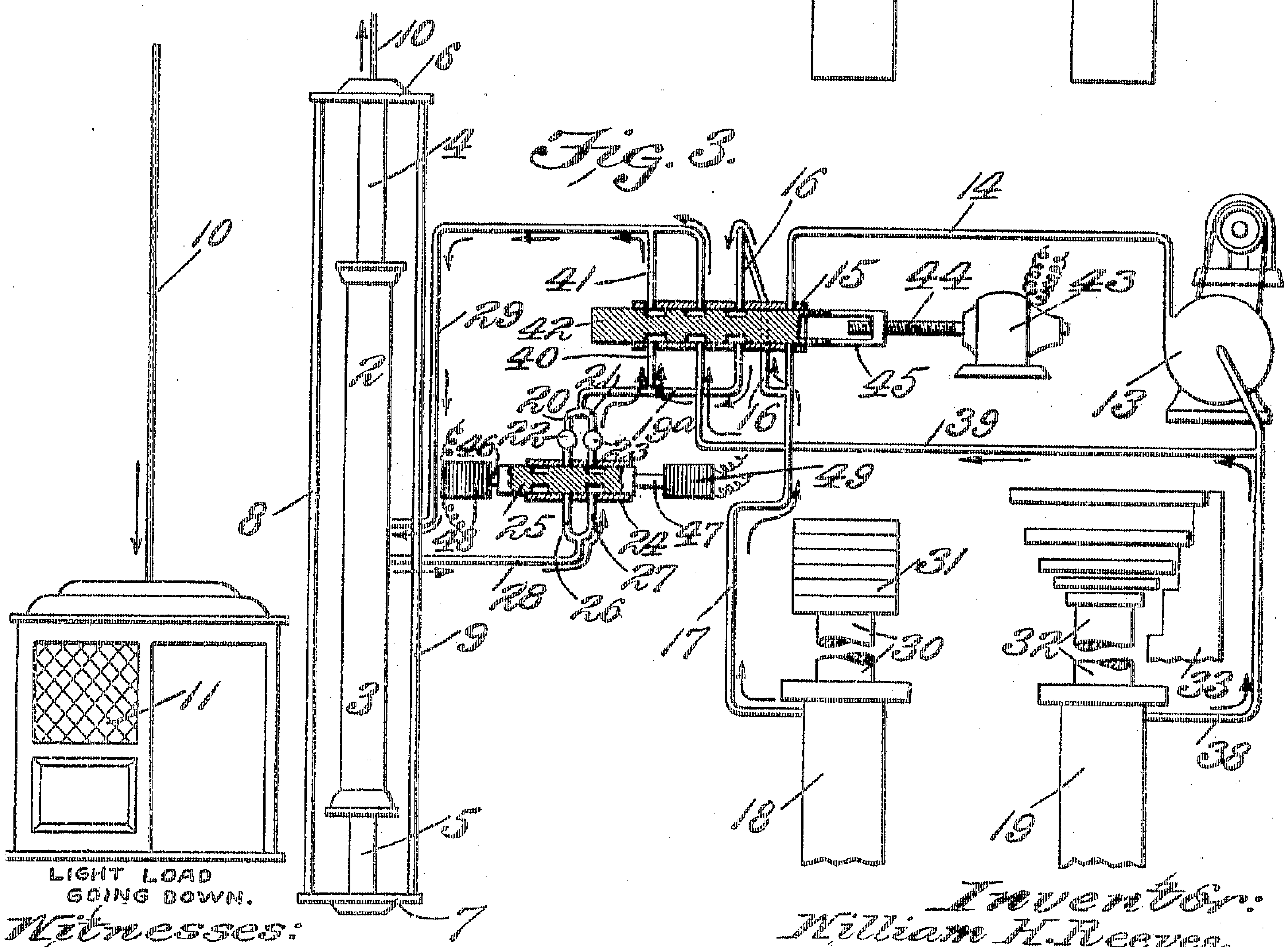


Fig. 3.



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4 SHEETS—SHEET 3.

Fig. 4.

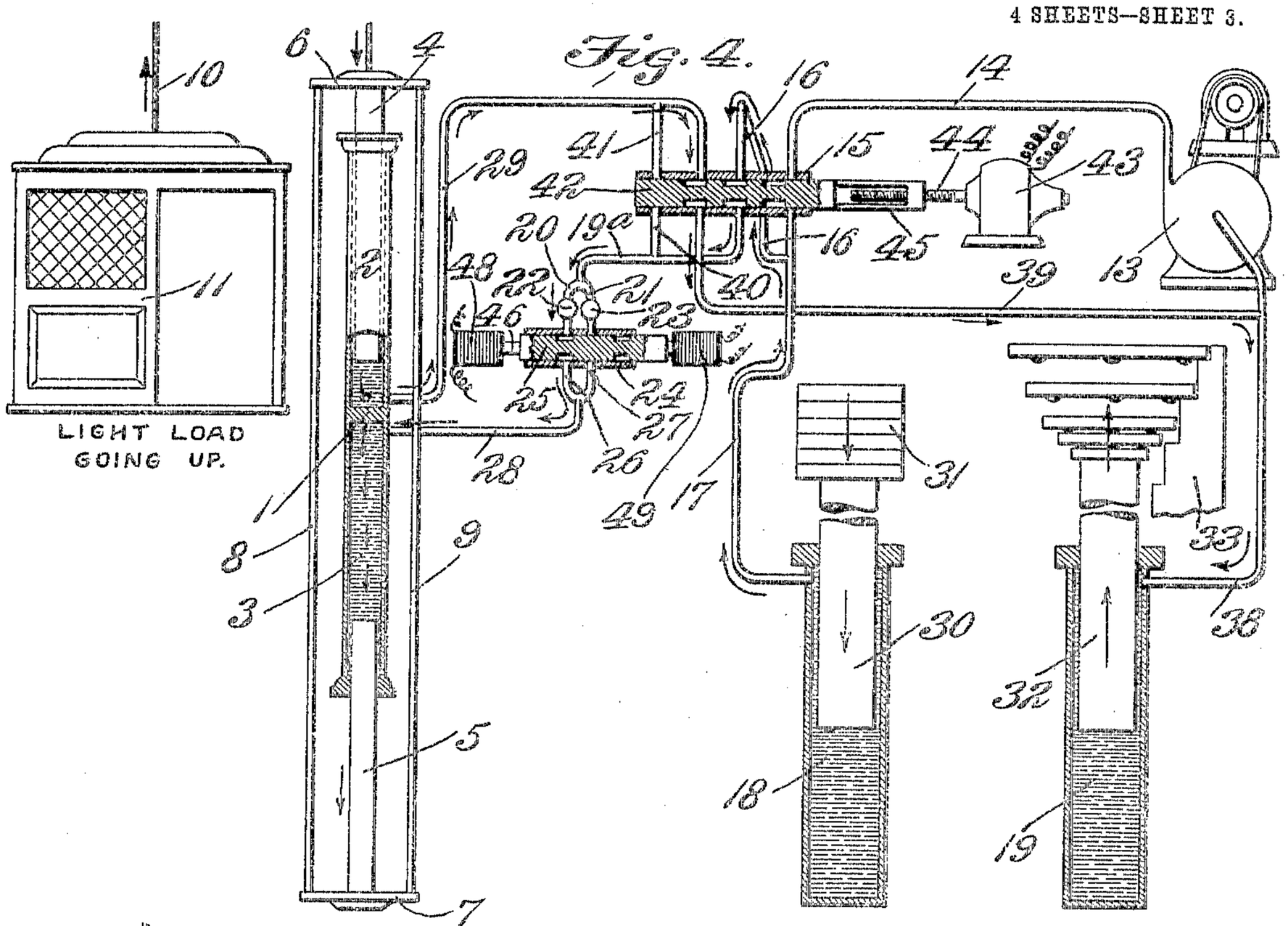
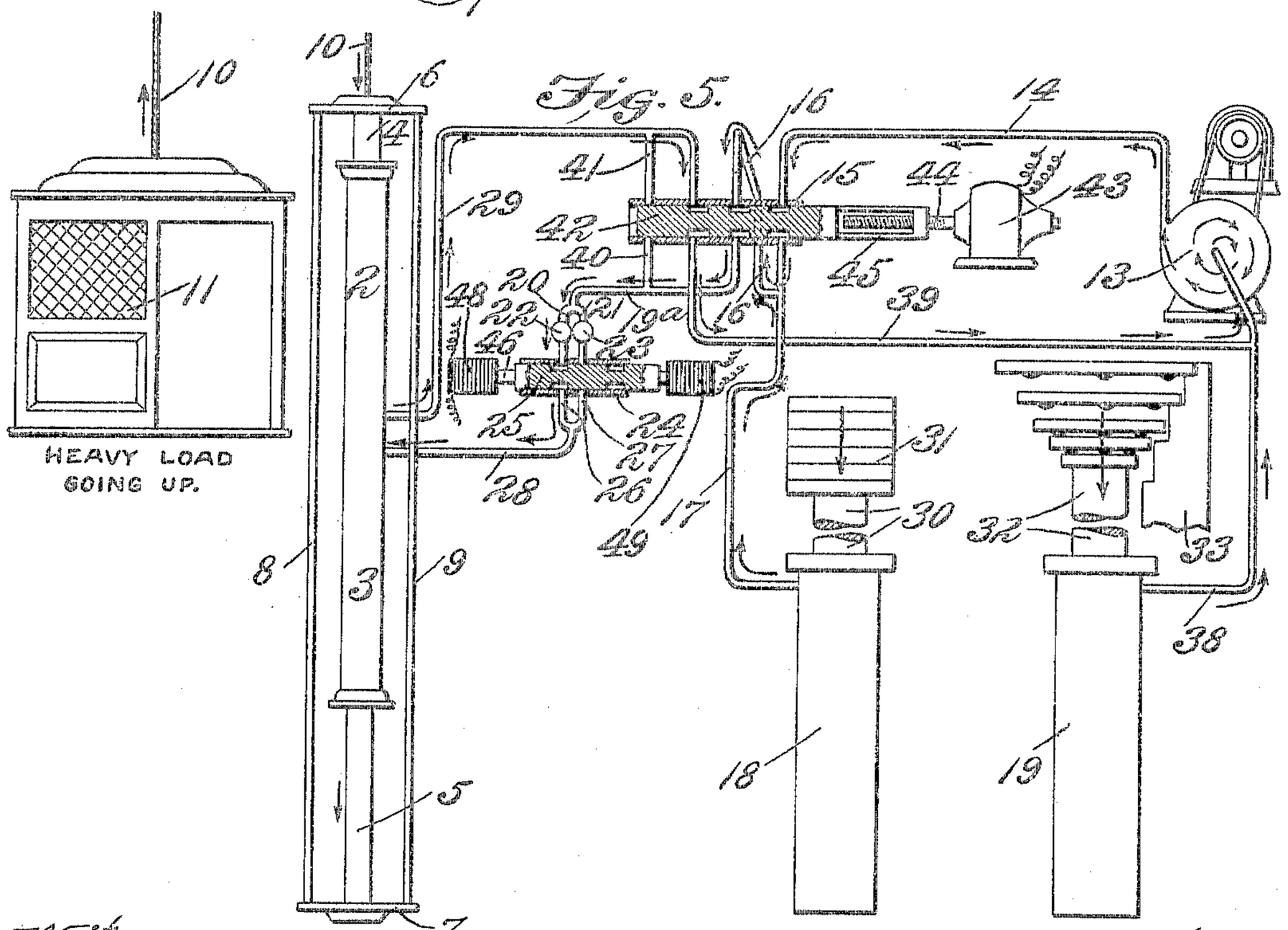


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 6.

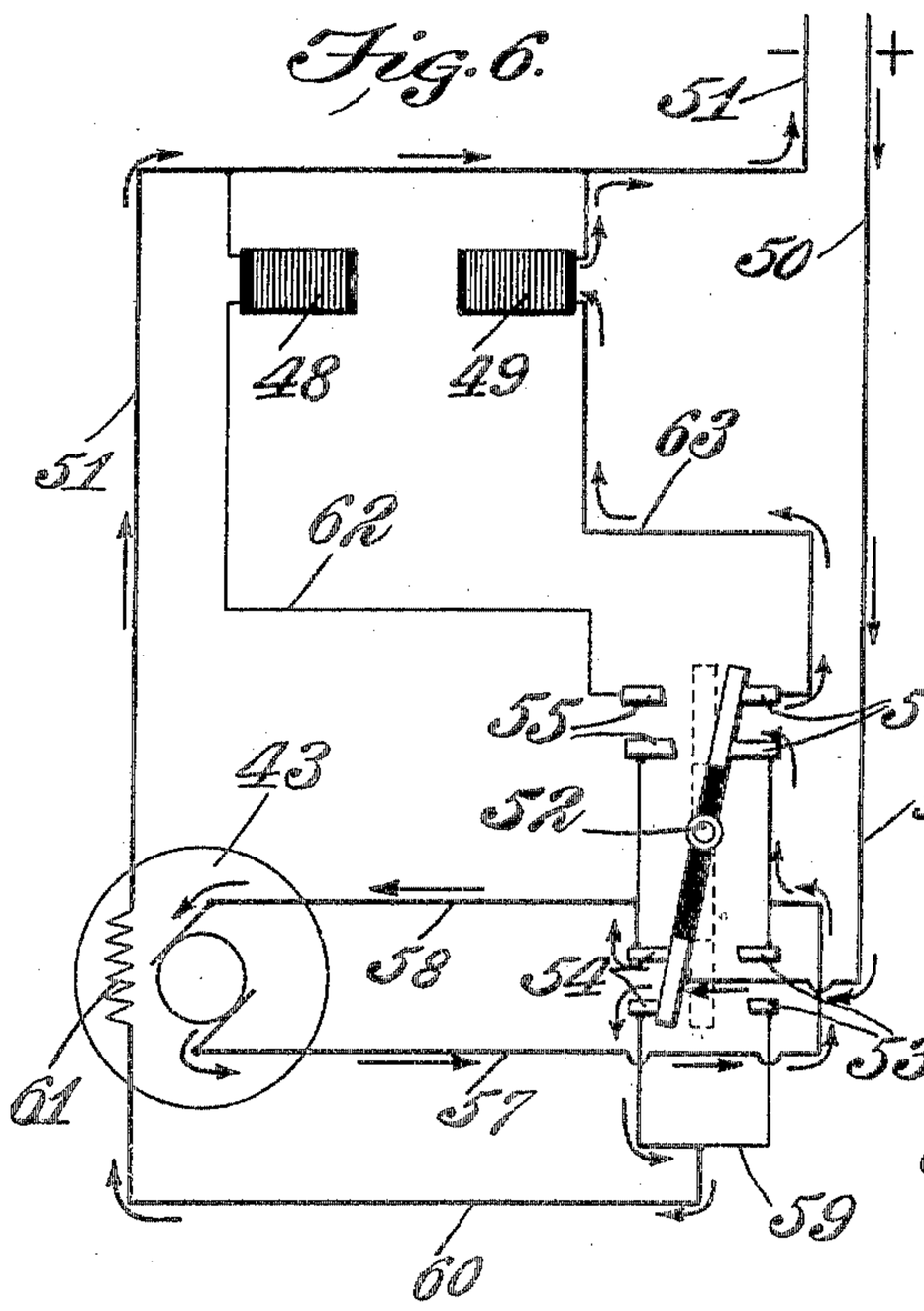
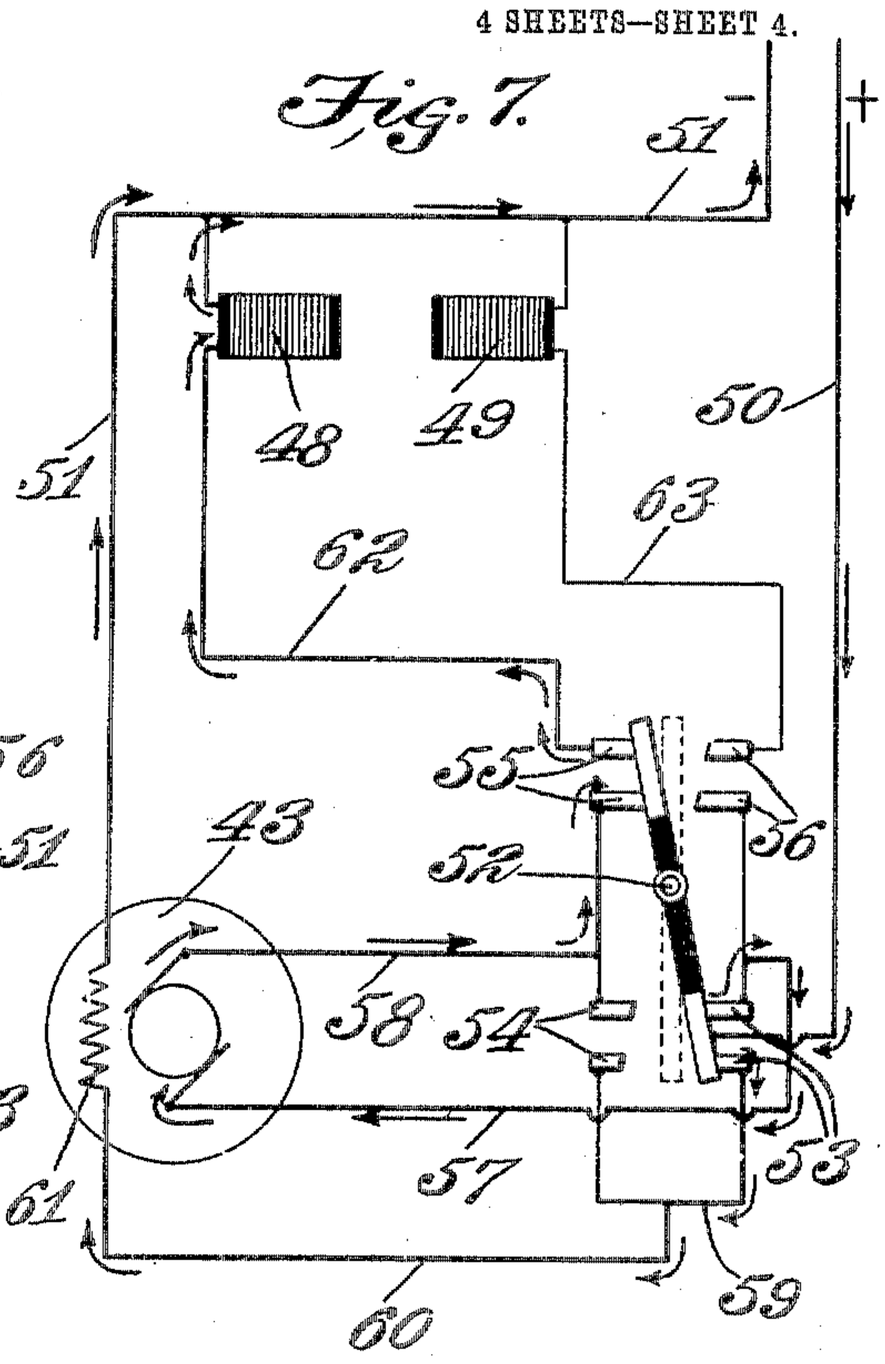


Fig. 7.



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No. 793,907. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

WILLIAM H. REEVES, OF ST. LOUIS, MISSOURI.

HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 793,907, dated July 4, 1905.

Application filed April 9, 1904. Serial No. 202,404.

To all whom it may concern:

Be it known that I, WILLIAM H. REEVES, a citizen of the United States, residing in the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Hydraulic Elevators, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a diagrammatical view of an elevator system constructed in accordance with this invention. Fig. 2 is a diagrammatical view of the system, showing the positions of the various parts when the car is descending with a heavy load. Fig. 3 is a similar view when the car is descending with a light load. Fig. 4 is a like view showing the positions of the parts when the car is ascending with a light load. Fig. 5 is a like view showing the positions of the parts when the car is ascending with a heavy load, and Figs. 6 and 7 are diagrammatical views of the valve-controlling circuits and motor.

This invention relates to hydraulic elevators; and the principal object thereof is to improve their efficiency by providing means whereby power can be stored from the descent of a loaded car for subsequent use in causing the ascension of the car and by providing means whereby the amount of power required to cause the car to ascend will be commensurate with the weight of the load carried by the car. In commonly-constructed hydraulic elevators the surplus power resulting from the descent of the car is wasted and also the amount of the power required to cause the car to ascend is uniform irrespective of the weight of the load carried by the car.

Other objects and advantages will be specifically described hereinafter, it being understood that minor changes in form, proportion, and details of construction may be resorted to without departing from the spirit of the invention or sacrificing any of the advantages thereof.

In the preferred embodiment of this invention a compartmental ram-cylinder is employed having an intermediate diaphragm 1, forming the chambers 2 and 3, respectively, in which the pistons 4 and 5 are mounted. On the free ends of the pistons 4 and 5 are cross-heads 6 and 7, which cross-heads are connected by rods 8 and 9. Connected to one of the heads and passing over a sheave (not shown) is a cable 10, which is suitably connected to the elevator-car 11, vertically movable in the shaft 12.

The accumulator 18 is provided with a piston 30 and a weight 31 and is employed to create and maintain a uniform pressure in chamber 3 of the ram-cylinder.

The accumulator 19 is provided with a piston 32 and a variable sectional weight, and in order that the weight carried by piston 32 may be varied, thereby giving variation to the pressure of the liquid within the accumulator-cylinder, a suitable weight-support 33, having varying-sized seats 34, 35, 36, and 37, is employed, so that as the piston 32 descends the weights will be released or permitted to rest upon their respective seats, thereby gradually lessening the pressure of the liquid, and as the piston 32 ascends the weights will be successively picked up and carried by the piston, thereby gradually increasing the pressure of the liquid. It is obvious that the pressure will vary according to the amount of liquid contained in the accumulator-cylinder. This accumulator 19 is employed to provide a variable pressure in chamber 2 of the ram-cylinder.

By the term "accumulator" as employed in the claims is meant the device of that name and commonly employed in connection with hydraulic apparatus for receiving and storing power, said power being given out automatically and without the application of power thereto by means of valves, an example being found at 18 in the drawings, and by the term "variable accumulator" is meant one in which the resistance to the reception of power is variable. Said term "variable accumulator" does not include a power-transmitting device in which the power is intro-

duced at one end and transmitted through the piston or ram to and given out by a body of liquid at the other end of the piston or ram.

Preferably the accumulators 18 and 19 may be of the same capacity, and the maximum pressure exerted in the variable-pressure accumulator 19 may be the same as that exerted by the constant-pressure accumulator 18.

The movements of the pistons 4 and 5 and the car 11 are caused by the difference between the constant pressure in the ram-cylinder 3, created by the accumulator 18, and the variable pressure in the ram-cylinder 2, created by the accumulator 19. The effect of the interaction of the elements of the system is to store power in the accumulator 18 when a heavy load is going down or to store power in accumulator 19 from accumulator 18 when a light load is going up.

The pump 13, preferably of the centrifugal type, that it may be operated constantly at uniform speed and also consume power in approximate proportion to the volume of liquid handled and the difference between inlet and outlet pressures, is employed to transfer liquid from the cylinder of variable-pressure accumulator 19 to the cylinder of the constant-pressure accumulator 18, thereby lessening the pressure in the cylinder 19 of the variable-pressure accumulator and the chamber 2 of the ram-cylinder until the pressure exerted on the piston 4 is sufficiently less than the pressure exerted on the piston 5 to move the pistons and cause the car to ascend. Manifestly this necessary difference of pressure and the work of the pump will vary according to the weight of the load carried by the ascending car.

Assuming the car to be descending with a heavy load, the positions of the parts would be as shown in Fig. 2. The ram-cylinder 3 would be discharging the liquid displaced by the piston 5 into constant-accumulator cylinder 18 through the tubes 28 and 27, the ports of the valve-piston 25 and the valve-casing 24, the check-valve 23 and the tubes 21 and 19[a], the ports of the valve-piston 42 and the valve-casing 15 and tubes 16 and 17, and the chamber 2 of the ram-cylinder would be filling with liquid from the cylinder of the variable-pressure accumulator 19 through the tubes 38 and 39, the ports of the valve-piston 42, and the valve-casing 15 and the tube 29. It is obvious that by this operation the quantity of liquid stored in the cylinder of the constant-pressure accumulator 18 will be increased and the quantity of liquid stored in the cylinder of the variable-pressure accumulator 19 will be decreased, thereby storing up power for subsequent use in causing the car to ascend, consequently lessening the work of the pump for the succeeding trip.

Assuming the car to be descending with a light load of only sufficient weight to overcome friction, the positions of the parts would be as shown by Fig. 3. The liquid displaced from the chamber 3 of the ram-cylinder by the piston 5 would empty into the chamber 2 of the ram-cylinder through the tubes 28 and 27, the ports of the valve-piston 25 and the valve-casing 24, the check-valve 23, the tubes 21 and 40, the ports of the valve-piston 42 and the valve-casing 15, and the tubes 41 and 29. The tubes connecting the chamber 3 of the ram-cylinder with the cylinder of the constant-pressure accumulator 18 and the chamber 2 of the ram-cylinder with the cylinder of the variable-pressure accumulator 19 are open, thereby equalizing the pressure throughout the entire system.

Assuming that the car is ascending with a light load immediately succeeding a descent with a heavy load, the positions of the parts would be as shown in Fig. 4, the piston 30 of the constant-pressure accumulator 18 being up and the piston 32 of the variable-pressure accumulator 19 being down. Therefore the pressure exerted on the ram-piston 4 is less than that exerted on the piston 5, thereby causing the ram-pistons 4 and 5 to move, the ram-cylinder 3 being filled with liquid from the constant-pressure-accumulator cylinder 18 through the tubes 17 and 16, the ports of the valve-piston 42 and the valve-casing 15, the tubes 19[a] and 20, the check-valve 22, and the ports of the valve-piston 25 and the valve-casing 24 and the tubes 26 and 28, and the liquid displaced from the ram-chamber 2 by the piston 4 will be discharged to the cylinder 19 of the variable-pressure accumulator through the tubes 29, the ports of valve-piston 42 and the valve-casing 15, and the tubes 39 and 38. The car is thus caused to ascend without any work being performed by the pump.

Assuming the car to be ascending with a heavy load, the position of the parts will be as shown in Fig. 5. The pump 13 will transfer enough liquid from the cylinder 19 of the variable-pressure accumulator to the cylinder 18 of the constant-pressure accumulator through the tubes 38 and 14 and the ports of the valve-piston 42 and the valve-casing 15, and the tube 17 to lessen the pressure sufficiently in the cylinder 19 of the variable-pressure accumulator and the chamber 2 of the ram-cylinder to cause the pistons 4 and 5 to move, the ram-cylinder 3 being supplied with liquid from the tube 17 through the tube 16, the ports of the valve-piston 42 and the valve-casing 15, the tubes 19[a] and 20, the check-valve 22, the ports of the valve-piston 25 and the valve-casing 24 and the tube 28, and the liquid displaced from the ram-cylinder 2 by the piston 4 being discharged into the tube 38 through the tube 29, the ports of the valve-piston 42 and the valve-casing 15 and the tube 39.

An electromechanical means is shown for controlling the pump and the accumulators, which electromechanical means may comprise a valve 42, operated by an electric motor 43. Wherever the term "electromechanical valve" is used hereinafter, it is to be understood that said term includes a valve with an electrical motor for actuating the same. The valve 42 is reciprocated in the valve-casing 15 by a reversible electric motor 43, having a rotatable threaded stem 44 engaging a threaded opening in the yoke 45, fixed to the valve 42, so that the rotation of the motor and the stem will cause the valve to move in either direction to open or close the particular ports in the valve-casing required to govern the action of the car.

When the car is descending, the position of the valve-piston 25 in the valve-casing 24 will be as shown in Figs. 2 and 3, and the check-valve 23 will permit the flow of the liquid only in the direction indicated, thereby permitting the pistons 4 and 5 and the car to move only in the one direction, thus avoiding any chance of the car ascending should the load on the car be materially diminished at an intermediate stop. When the car is ascending, the position of the valve-piston 25 in the valve-casing 24 will be as shown in Figs. 4 and 5, and the check-valve 22 will permit the flow of the liquid only in the direction indicated, thereby permitting the pistons 4 and 5 and the car to move only in the one direction, thus avoiding any chance of the car descending should the load be materially increased at an intermediate stop.

In Fig. 6 the controlling-lever is indicated as being in association with the contacts of the circuits to cause the valves 25 and 42 to move in one direction, while in Fig. 7 the controller is indicated as being in a position to cause an opposite polarity of motor, solenoids, and circuits, causing said valves to move in the opposite direction. When it is desired to cause the valves to remain stationary in any desired position, the lever 52 is placed or moved to a neutral point between the pairs of contacts 53 and 54 and 55 and 56.

By reference to Figs. 6 and 7 it will be noticed that suitable conductors 50 and 51 lead from and to a suitable source of electrical generation, (not shown,) the conductor 50 being connected to a manually-operable pivoted controller 52, located in the car and which is intermediately insulated, so that one terminal will be capable of being contacted with either of the pairs of oppositely-arranged contacts 53 or 54 and the other end of said lever being capable of contacting with either of the pairs of contacts 55 or 56. The lead-in wires 57 and 58 for the motor become alternately the positive and negative wires, according to the position of the controlling-lever 52. It will be observed that the wire 57 is common to one of the contacts 53 and one of the contacts 56, while the wire 58 is common to one of each pair of contacts 54 or 55. Each of the wires 57 and 58 is connected to one of the brushes of the motor 43. One of the respective pairs of contacts 53 and 54 is connected to the other by means of a conductor 59, so that both contacts are connected to a conductor 60, passing through the field 61 of the motor 43, said conductor 60 forming a part of the return-conductor 51 and shunted into the solenoids 48 and 49, respectively, the contacts 55 and 56 being connected to the respective solenoids by the conductors 62 and 63. When the controller is in the position indicated in Fig. 6, the current will pass from the generator through the in-lead wire 50, through the lever, from one of the contacts 54, as indicated by the arrows, through the wire 58, thence through the motor, through the wire 57, through the contacts 56, through the wire 63 to the solenoid 49, and then through the return-conductor 51. At the same time the current will be supplied from the generator to pass through the by-pass 60 and through the field of the motor to the return-conductor 51. This will cause the motor to rotate in the direction indicated by the arrows, so that the valve 42 will be reciprocated a sufficient distance to open the necessary ports in the valve-casing, which will be governed by the load carried by the car. Simultaneously with the actuation of this valve the solenoid 49 will move the valve 25 into the positions indicated in Figs. 4 and 5 to permit the introduction of the necessary quantity of fluid in the chamber 3. From the foregoing description it will be readily apparent that the reversal of the lever, as indicated in Fig. 7, will reverse the valves 25 and 42.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. A fluid-actuated, valve-controlled elevator system including a pump and accumulators coöperating with the pump, one of which provides an approximately constant pressure and the other a variable pressure, said pump having its suction connected to one accumulator and its delivery to the other; substantially as described.

2. A fluid-actuated, valve-controlled elevator having a system provided with a storage-accumulator, a reciprocating piston in said accumulator for expelling the fluid therefrom, and supported, varying-weighted arresting elements above the piston and adapted to be unseated thereby; substantially as described.

3. In a fluid-actuated, valve-controlled elevator, the combination with a system for raising and lowering the elevator-cage including a pump and an accumulator, of an electromechanical valve for shutting off the

pump and for releasing the fluid in the accumulator, an energized electric circuit having spaced contacts, and a controller for connecting the contacts to actuate the valve; substantially as described.

4. A fluid-actuated, valve-controlled elevator system having constant and variable pressure accumulators in the system, and means in virtue of which power due to a heavy load coming down may be stored for subsequent use in one of said accumulators; substantially as described.

5. A fluid-actuated, valve-controlled elevator having variable and constant pressure accumulators with means for varying the power consumption in approximate proportion to the weight carried by the elevator-car; substantially as described.

6. A fluid-actuated, valve-controlled elevator system having variable and constant pressure accumulators, a pump in the system and having communication with said accumulators, together with a valve, and connections whereby power due to a heavy load coming down may be saved in one of the accumulators for subsequent use; substantially as described.

7. A fluid-actuated, valve-controlled elevator system comprising the elevator-car, means for actuating the same comprising two pistons connected to the car, and means for applying a different pressure to each of the two pistons; substantially as described.

8. A fluid-actuated, valve-controlled elevator system having a pump and an accumulator, the motor for actuating the car and in communication with said pump and accumulator, said motor including two pistons, said accumulator and pump exerting a pressure on one of said pistons, means to exert a different pressure on the other of said pistons, and controlling devices; substantially as described.

9. A fluid-actuated, valve-controlled elevator system having therein a rotary pump, constant and variable pressure accumulators in the system, means for operating the car including two pistons, and means coöperating with the system for controlling the application of the pressures exerted by the two accumulators to the two piston-faces; substantially as described.

10. A fluid-actuated, valve-controlled elevator system having an elevator-car, two pistons for actuating the car and connected to the same, two fluid-reservoirs, one of said reservoirs having means for maintaining an approximately uniform pressure and the other a varying pressure on the piston-faces respectively, and means to control said pressures; substantially as described.

11. A fluid-actuated, valve-controlled elevator system, having a centrifugal pump, an accumulator, ported valves, and a motor for the car including two pistons, the pump, accumulator, ported valves, and elevator-operating means all communicating with each other, and a second source of pressure whereby the movement of the car may be caused by difference of pressure on the two piston-faces; substantially as described.

12. A fluid-actuated, valve-controlled elevator system having a motor-cylinder and constant and variable pressure accumulators, a pump having its suction in communication with one of the accumulators and its discharge in communication with the other, and a single motor-controlled valve mechanism for reversing and controlling the supply of fluid to and from the motor-cylinder and to and from the accumulators in communication with said motor-cylinder; substantially as described.

13. A fluid-actuated, valve-controlled elevator system including an elevator-car, means for operating the car and having two pistons, accumulators, and a valve in communication with the elevator-car-operating means, and an electrically-controlled valve having oppositely-opening check-valves coöperating therewith for preventing the car from changing its direction of travel due to change in weight of the load; substantially as described.

14. A fluid-actuated, valve-controlled elevator system including a car, and means for actuating said car comprising a compartmental cylinder, and two single-acting pistons in the respective compartments of the cylinder and connected together, said pistons being oppositely movable in the respective compartments; substantially as described.

15. A fluid-actuated, valve-controlled elevator system including a pump, variable and constant pressure accumulators in the system, means of communication between the pump and the accumulators, a car-actuating means including a compartmental cylinder in the system and having means for raising and lowering the car, and an electromechanical valve in the system for regulating the flow of fluid between the pump, actuating-cylinder, and accumulators; substantially as described.

16. A fluid-actuated, valve-controlled elevator system having a compartmental cylinder, two single-acting pistons for actuating the car, said pistons being oppositely movable in the compartments of the cylinder, an accumulator in communication with the cylinder for providing a constant pressure against one of the pistons and another accumulator for providing a variable pressure against the other piston, a pump for circulating the fluid, and a ported valve for controlling the flow of fluid from the pump to and from the actuating-pistons and accumulators; substantially as described.

17. A fluid-actuated, valve-controlled elevator system having a compartmental cylin-

der, a pump in valved communication with one compartment of the cylinder, two coöperating pistons in the compartmental cylinder and connected to each other, means for controlling the pistons and for causing each compartment to alternately become a receiving and discharging compartment, and means irrespective of the pump for varying the pressure in the respective compartments; substantially as described.

18. A fluid-actuated, valve-controlled elevator system including a pump for promoting the circulation of a suitable fluid, an electromechanical valve in the system for shutting off the pump and controlling the system, car-elevating means including a cylinder, a pipe in communication with the pump and cylinder, an electromechanical valve between the first-mentioned valve and the cylinder for preventing reversal of movement of the car, together with oppositely-opening check-valves between the two electromechanical valves, an elevator-controller, and an electric circuit connected to the valves and the controller for reversing both of the electromechanical valves; substantially as described.

19. A fluid-actuated, valve-controlled elevator system comprising controlling-valves in the system, solenoids for controlling one of the valves, an electric motor for controlling the other valve, an electric circuit, and means in the circuit for simultaneously actuating both valves; substantially as described.

20. A fluid-actuated, valve-controlled elevator system comprising controlling-valves in the system, solenoids for controlling one of the valves, an electric motor for controlling the other valve, an electric circuit, means in the circuit for actuating said valves; substantially as described.

21. A fluid-actuated, valve-controlled elevator system having constant and variable pressure accumulators in the system, means in virtue of which power due to a heavy load coming down may be stored in one of said accumulators for subsequent use, and means for varying the power consumption during ascent in approximate proportion to the load carried by the car; substantially as described.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 6th day of April, 1904.

WILLIAM H. REEVES.

Witnesses:

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George Bakewell.