E. M. FRASER.

ELECTROHYDRAULIC ELEVATOR SYSTEM.

APPLICATION FILED DEC. 19, 1908.

955,508.

Patented Apr. 19, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

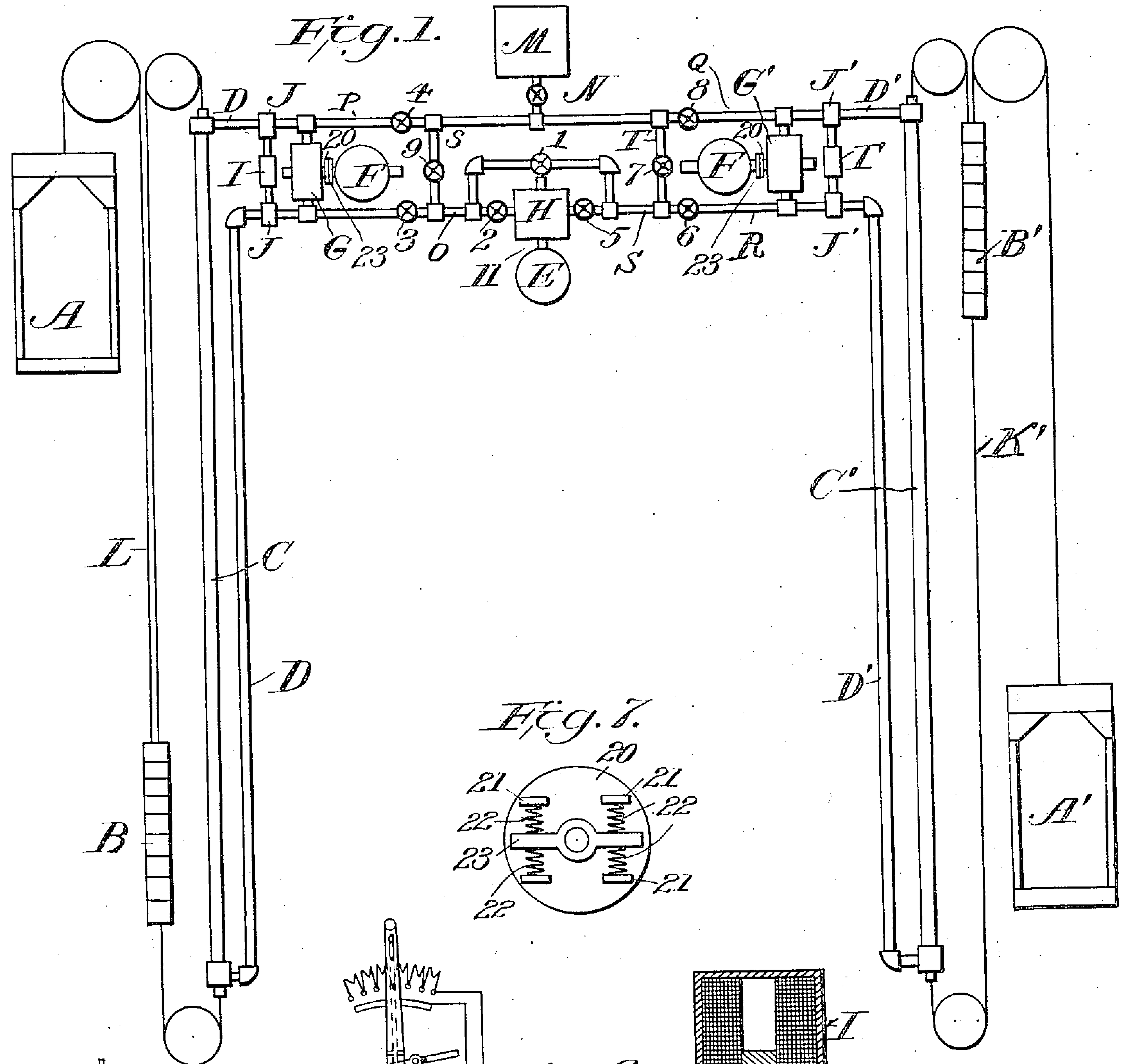

Fig. 7.

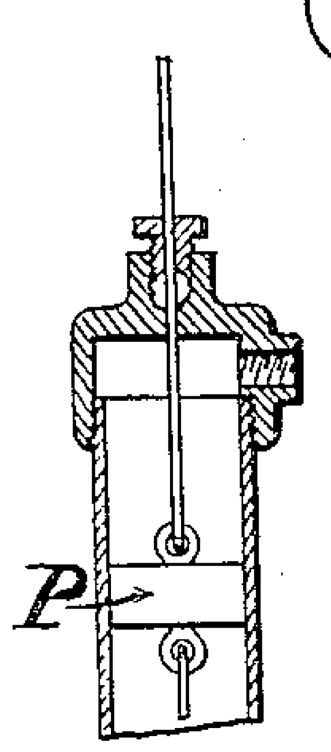

Fig. 4.

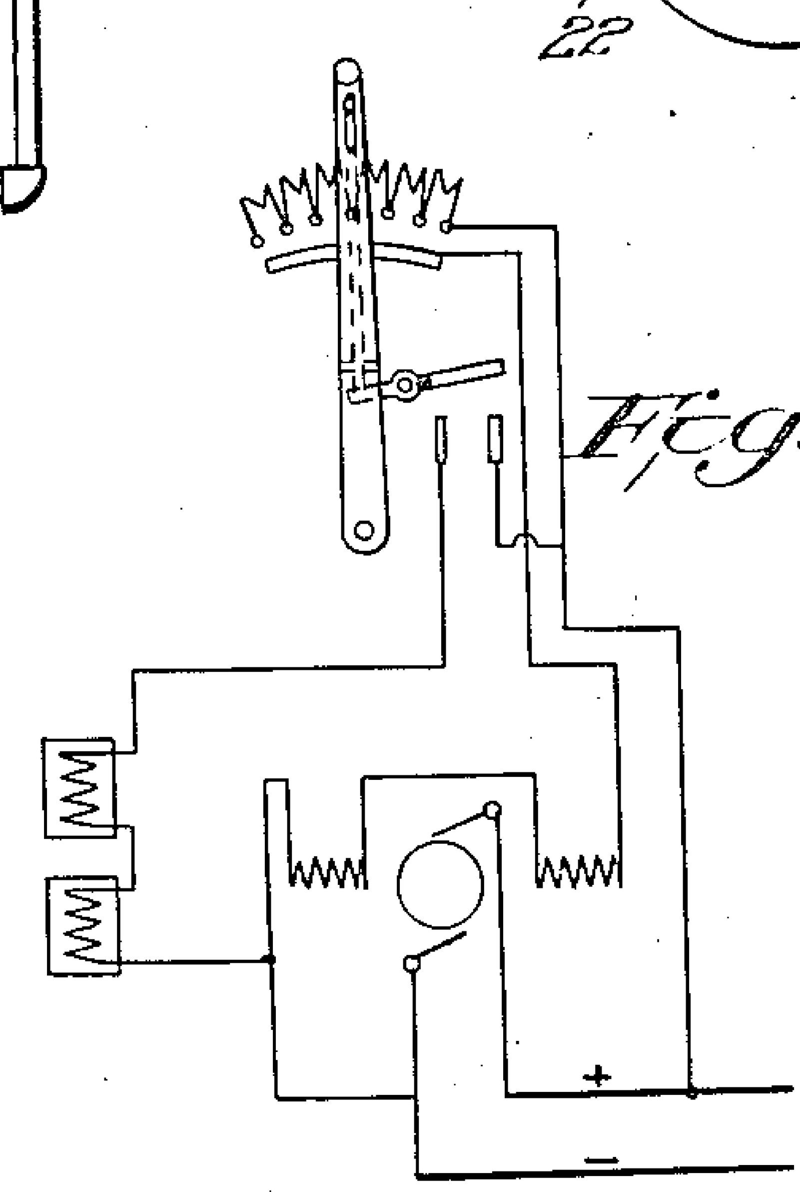

Fig. 6.

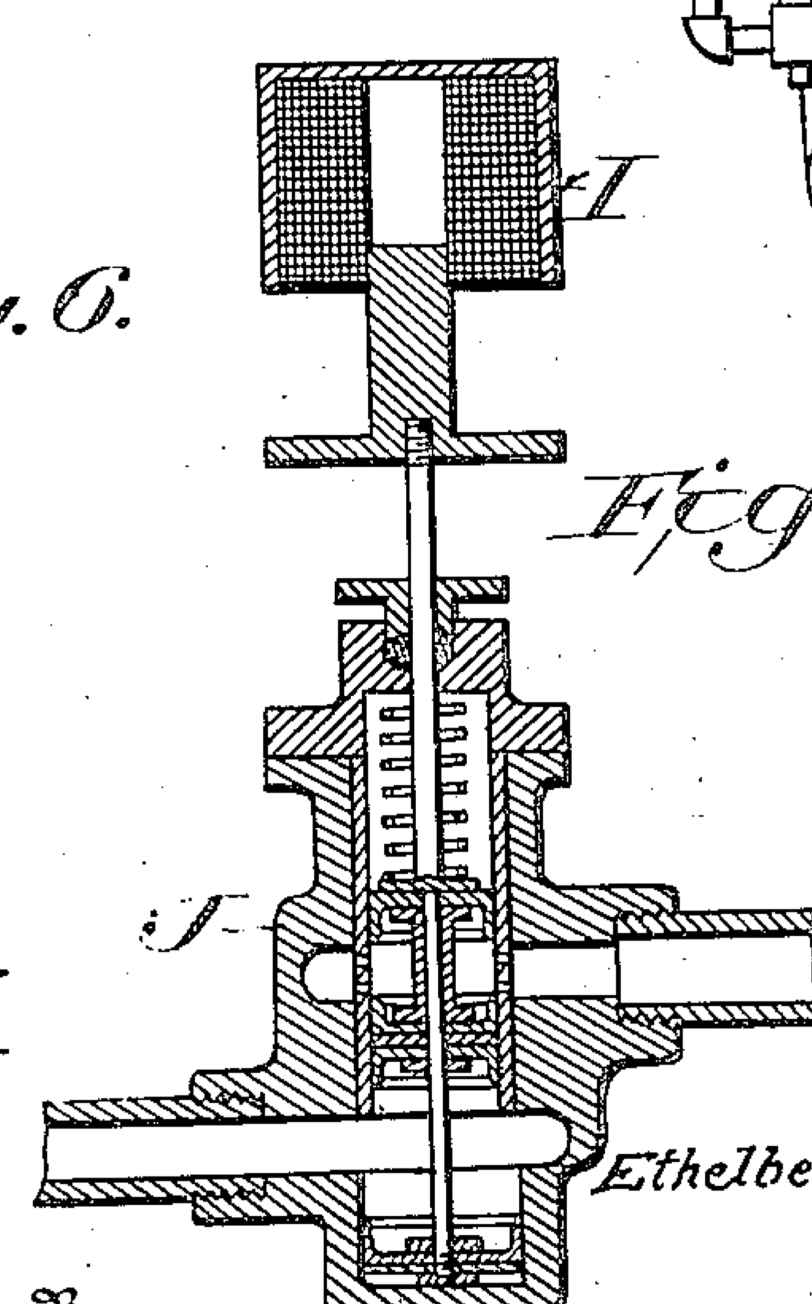

Fig. 5.

Witnesses

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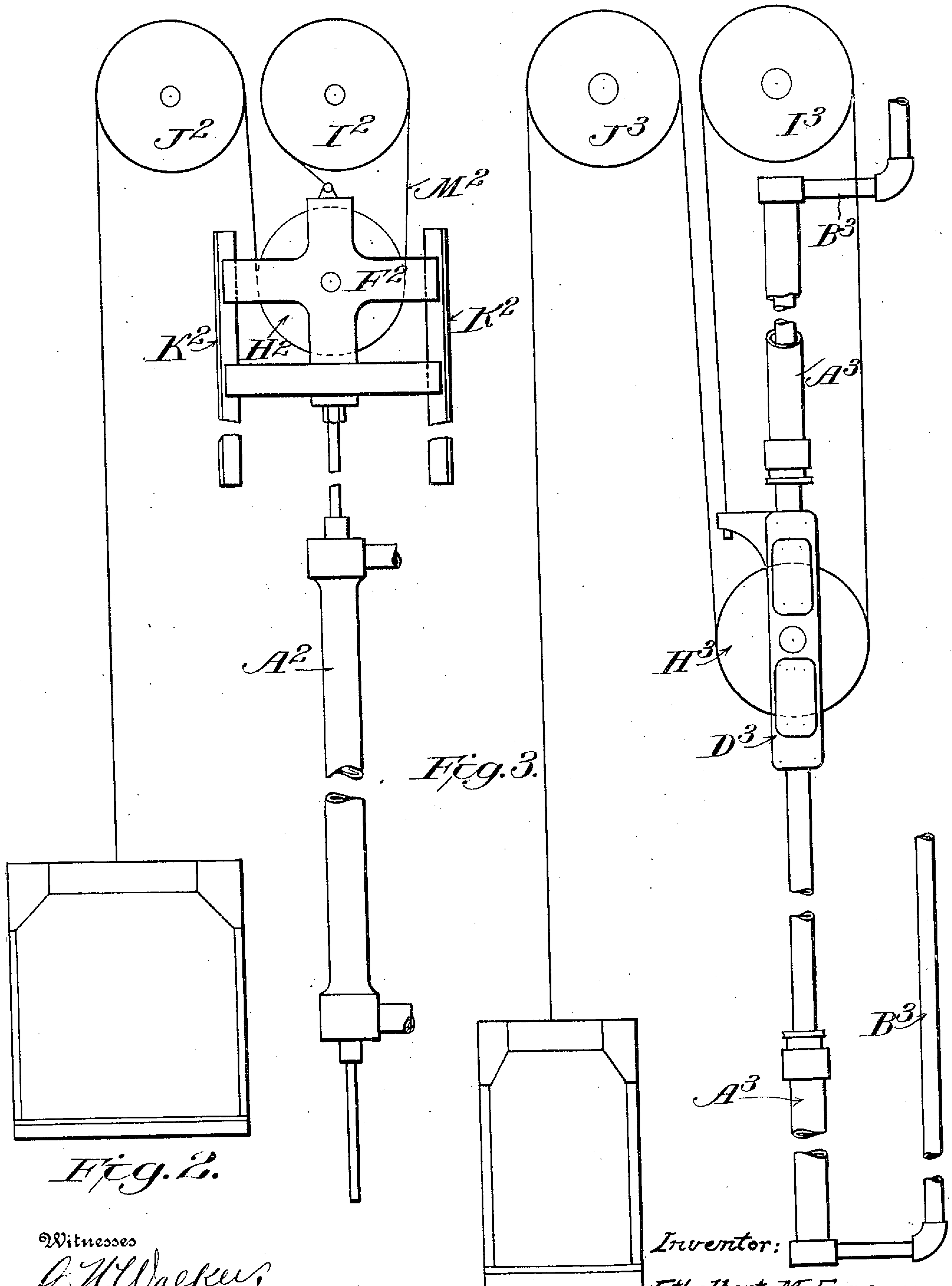
2 SHEETS—SHEET 2.



Witnesses
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ELECTROHYDRAULIC ELEVATOR SYSTEM.

955,508. Specification of Letters Patent. Patented Apr. 19, 1910.

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To all whom it may concern:

Be it known that I, Ethelbert M. Fraser, a citizen of the Dominion of Canada, residing at Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Electrohydraulic Elevator Systems, of which the following is a specification.

My invention relates to a new and useful electro-hydraulic elevator system embodying the perfect control of what is known as the differential system with the safety of the hydraulic system and the flexibility and economy of operation of the elevators of what is known as the direct electric type.

It is well known to those familiar with the art as it relates to hoisting machines and particularly elevators designed for passenger service, that a first-class passenger elevator in order to give the best service and most general satisfaction, must be constructed for meeting and overcoming many exacting conditions, among the most prominent of which might be included the following:—(1) absolute safety: (2) dependability, or the ability to keep running without the liability of breaking down: (3) ease of control whereby the operator is enabled to make accurate, quick and safe stops while the elevator is running at high speed: (4) the attainment of high speed combined with safety to the elevator and its occupants: (5) the reducing to a minimum of the costs of repairs: and (6) increased economy of operation.

It can be safely said that electric elevators as heretofore generally constructed do not satisfactorily fulfil the foregoing requirements because:—They are not absolutely safe as the stop must necessarily be made by some form of brake; usually a friction brake is used and this is very liable to derangement while the varying loads to which the elevator is subjected in daily use often cause the brake to slip. Electric elevators are, also, very liable to get out of order thereby necessitating a shutting down of the plant and the annoying interference with the service. This objection is commonly the result of the complicated switching apparatus necessary to control the elevator and the severe work the switch is called upon to do in breaking heavy current many thousand times each day. It is also well known that the electric elevator is difficult to control and cannot make true and quick stops at high speed; that the repairs to the complicated controller are expensive, and that while economy of operation is reasonably low at slow speed the running expenses are excessive at high speed owing almost entirely to the heavy starting current necessary to make frequent starts. To avoid disturbances in the lighting system, the start of the elevator must be comparatively slow.

Because of the foregoing and other objections not necessary to state, the hydraulic elevator has practically held the field where high duty and the most effective service are required.

In a prior patent granted to me September 6, 1898, No. 610,481 I have fully disclosed a very desirable type of high-speed electric elevator and one wherein it is recognized that the control is as near perfect as can reasonably be attained in any type of elevator. A drawback of this elevator, however is the cost of the two large slow-speed motors, and under certain conditions the wear on the transmission ropes is excessive. The present electro-hydraulic elevator combines the perfect control of the electric elevator of my aforesaid prior patent with the safety of the elevators of the hydraulic type, and the flexibility and economy of operation of the direct electric character; the cost of installing the present invention is between that of the hydraulic and that of the direct-electric types.

My present invention can be applied to existing types of hydraulic elevators where it is desirable to use electricity for the motive power, which is more economical than installing the regular electric pump. The saving effected will then be fully fifty (50) per cent. in the operating cost.

In order that the present invention may be fully understood, I will now refer to the accompanying drawing wherein similar characters indicate like parts in the several views.

Figure 1 is a diagrammatic view of an electro-hydraulic elevator system embodying my invention, Figs. 2 and 3 represent somewhat modified embodiments of my invention. Figs. 4, 5, 6 and 7 details which I will hereinafter refer to.

In the aforesaid drawings A represents any well known and desired form of elevator cage adapted to run in or on suitable guides in a well, shaft or other inclosing structure, said cage being connected with a cable, L, passing over a guide or direction pulley and sustaining the usual counterbalance or weights, B.

In place of the transmission rope or cable of my former patent, I now employ a double-acting hydraulic cylinder, C, of very small bore and suitable pipes for the transmission of a circulating fluid, as water, certain of the pipes D, connecting with the opposite ends of the cylinder and said cylinder having the usual plunger or piston, P; one of the aforesaid pipes, D, connects with the cylinder at one side of this piston and the other pipe, D, connects with said cylinder at the other side of the piston.

Connecting with one of the pipes, D, say the one leading from the lower end of the cylinder, is a pump H, which may be of any appropriate character; I prefer however, to use a rotary pump having a pair of coacting impellers 10, of cycloidal form as I have found that a pump of this type possesses the greatest efficiency and gives the best practical results. This pump has the shaft 11, of one of its impellers connected with an electric-motor, E, which I will hereinafter term the constant-speed motor since it is designed to run continuously and at a constant speed without regard to the changing condition of the loads to which the elevator is subjected, and which motor is designed to drive another or pumping-motor or a series of such motors according as there is one or a series of elevators in the particular plant.

At one side, the pump casing or cylinder of the constant-speed motor has an inlet through which the water or fluid to be circulated is first admitted. My system is self contained and consequently needs no external fluid supply once the pumps, pipes, etc., are filled with fluid. The discharge or exhaust side of the constant speed pump casing or cylinder connects with the pipe D which leads into the lower end of the small bore double-acting cylinder, A below the piston thereof, and which pipe, D, is provided with suitable valves 2 and 3 by which the flow of circulating fluid may be controlled at will and to meet existing conditions.

Between the constant-speed motor, E, and the double-acting cylinder, A, and having its intake and outlet suitably connected with the pipes, D, of the circulating system before mentioned, is a pumping-motor, G, of some well known form and preferably of the type described for the like motor H, to which motor G, a variable-speed electric motor F, is operatively connected, to cause the pump to withdraw water from one end of the cylinder, A and coördinately force water into the other end of said cylinder, as I will hereinafter fully describe. Each of the circulating pipes, D, is also shown as having a normally-closed spring-pressed valve, J, and the stems of these valves are connected with an electro-magnet in such manner that when the magnet is energized, the stems of the valves are moved against the pressure of the closing springs, to open the valves to permit the free circulation of the water; when the magnet is deënergized, the springs act to close the valves and obstruct the circulation of the water and thereby cut out the particular elevator with which the valves are associated.

Between the constant-speed motor and the variable-speed motors before described, I introduce a by-pass pipe S, which connects with the circulating pipes, D, and has a suitable controlling valve, 9. Provision is also made to compensate for irregular movements in the action of the pumping impellers whereby the rotation of the electric motor and the flow of water from the pump may be kept uniform and the car or cage be devoid of vibration. To this end, I secure to the shaft of one of the pump-motor impellers, a disk 20, having pairs of spaced lugs, 21, or like abutments or seats for suitable springs or cushions, 22; on the adjacent end of the motor shaft I also secure a spider or bar, 23, the opposite ends of which are contained between the inner ends of a pair of said springs, as shown in Fig. 7. In the event of irregular action of the pump impellers during the pumping operation, there will occur a relative axial movement between the disk 20, and the spider, 23, and the arms of the latter will operate to compress diagonally opposite springs. The springs will thereby store energy which is later imparted to the impellers at a different part of the revolution to give uniformity or regularity to the rotation.

In the drawings I show a system having two elevators associated with a single constant-speed motor, and it will be understood that the foregoing detailed description of one elevator and complementary parts is applicable to a second, third or any number of elevators with which a particular plant may be supplied. As herein shown, the second elevator A′ has its cable connected to the counterweight B′, from which lead the opposite portions of the cable K′.

The circulating pipes, D′, have the controlling valves 5, 6 and 8, the by-pass pipe, T, has a valve 7, and the valves J′, electro-magnet I′, variable speed motor F′ and pump or motor G′, are of the construction and are designed to operate like the corresponding parts of the elevator A system before described. When using two or more elevators in association I also provided a by-pass pipe with a controlling valve by which the circulating water may be diverted around the constant-speed motor when necessary.

M represents an elevated water tank and N is a valve controlling the outlet therefrom. No electrical connections are shown in Fig. 1 since these are all conventional and are not necessary for a complete understanding of my invention by those skilled in this art.

Instead of the long double-acting cylinder of Fig. 1 I may use a shorter cylinder, A^2, as shown in Fig. 2 which cylinder has a piston whose oppositely extending rods connect with a sliding cross head or frame F^2, movable in guides K^2, and carrying a sheave H^2 under which the cable M^2 passes, said cable passing over the sheaves I^2 and J^2 and having one of its ends connected to the cage or car and the other end attached to the top of the slidable cross head or frame.

A further modification is shown in Fig. 3 wherein short oppositely placed cylinders A^3 are associated with an intermediate reciprocating ram, D^3 which ram carries between its ends a sheave, H^3 for the cable, said cable having one end connected to a projecting portion of the ram and thence passing over a sheave I^3 and under the sheave H^3 and thence over a sheave J^3 and has its opposite end connected to the cage or car. From the outer ends of the two oppositely placed cylinders, the circulating pipes B^3, lead, substantially as in Fig. 1.

The operation of my hereinbefore described system may be generally stated as follows: Before starting, the different valves are closed and opened as desired; for example the valves 2, 3, 4, 5, 6 and 8 are opened full, and the valves, 1, 9 and 7 are closed.

When the operator centers his lever and drops his latch the construction and operation of both of which are well known, the valves J J′ J J′ which are operated by the electro magnets, I, are closed thereby cutting off the circulation of water to and from the cylinder and forming a positive stop and securely holding the car. It will be remembered that the said valves are opened by the energizing of the magnets and are closed by springs; they would be normally closed before starting up.

The constant-speed motor E, is started by a hand rheostat or other suitable and well known starting device, not shown, and this motor being positively connected to the rotary pump and the pump being connected with a water supply, water is circulated through the pipe O to the pump or motor G, which is thereby started coincidently with the motor F. From the pump or motor, G, the water is forced through the pipes, P, and Q, thence through the pump or motor, G′, (which is thus started simultaneously with the pumps or motors E and G) and finally through the pipes, R and S, back to the pump or motor E completing the circuit.

For the sake of illustration I will suppose there is a constant flow of water in the system of one-hundred (100) cubic feet per minute and that the pump or motor E is accordingly running continuously and at a constant speed. If the operator wishes to start and run the elevator A to come down, he first lifts his latch when the electromagnet I is energized the valves J J′ opened and the variable-speed motor F, is cut in on the line. If the operator moves his lever in the down direction, the field of the electric motor F will be weakened and the armature of the motor will be speeded up. Suppose now that the pump or motor, G, is passing one hundred and fifty (150) cubic feet of water per minute at the maximum speed, while the constant-speed motor is only pumping one hundred (100) cubic feet, therefore the additional fifty (50) cubic feet of water must come from some source to supply the pump G. As the opposite ends of the double-acting cylinder A, is connected through the pipes D, with the intake and discharge of the casing of the pump or motor, G, it is apparent that the cylinder A will supply this pump or motor with the required fifty (50) cubic feet of water in excess of what is furnished by the constant-speed pump or motor, E, the water being taken out of one end of the cylinder and being delivered into the opposite end thereof in response to the movements of the cylinder piston. As the pump or motor G is now pumping one hundred and fifty (150) cubic feet of water through the pipes P, Q and R, S, back to the constant-speed pump H, and as this latter pump can only dispose of one hundred (100) cubic feet, and as the surplus fifty (50) cubic feet of water must be disposed of, therefore in my system it flows into the cylinder, C, above the piston thereby forcing the latter down, raising the counterweight and lowering the car. It will be understood, of course, that when the motor, F, is speeded up, as described, water is taken from the lower side of the piston in the cylinder C and forced into this cylinder on top of the piston. The amount of water taken is varied directly as the difference in speed between the motors E and F. In the case of the elevator A′, which is supposed to be at the bottom, if it is desired to ascend the operator lifts his latch and the same action takes place as before.

Upon moving the lever in the down position, the motor F′, is speeded up (Fig. 1 is drawn right and left so that when the motor is speeded up the car A descends but when the motor F′, is speeded up the car A′ descends; it is possible to make both motors raise or lower the car when speeded up, by crossing the piping leading to either the pump or motor G or G′. For the sake of clearness, the pipes art not shown crossed) and one hundred and fifty (150) cubic feet of water is pumped into the pipe, R, and only one hundred (100) is drawn away by the constant-speed pump consequently the additional fifty (50) cubic feet must flow into the cylinder C′, thereby raising the piston and causing the car to ascend. To cause the same car to ascend, the motor F′ is slowed down until say at the slowest speed only fifty (50) cubic feet of water is drawn from the pipe Q; as there is one hundred (100) feet flowing the surplus must pass into the cylinder C′, and as the pump G′ is only passing fifty (50) cubic feet and the pump H is using one hundred (100) cubic feet, the cylinder C′ must supply the difference. It will be observed that in this case I practically take fifty (50) cubic feet of water per minute from the top of the cylinder and deliver it into the bottom of said cylinder.

The speed of the elevator can be varied from nothing to the maximum by simply varying the speed of the variable-speed motor, and the reversal is accomplished by making the speed either greater or less than the speed of the constant-speed motor E. The stop is always brought about by bringing the variable speed motors to the normal speed. If the operator finds the elevator does not respond to the lever for any reason, all he has to do is to center his lever and drop the latch, when the valves J, J′, J, J′ close and the elevator is brought positively to a state of rest. If the elevator mechanism in connection with the elevator A should become deranged, all that is necessary to do to operate the elevator A′ is to close the valves, 3 and 4, and open valve 9. When this is done, the entire mechanism of elevator, A, is cut-off and the water flows in the by-pass S and elevator A′ can be operated as usual.

In case the constant speed motor or pump H, should become deranged and I wish to operate the elevator A, the valves, 2 and 8 are closed and the valve, 1, is opened, and the electro-magnet valves J′ and J′ are also closed and the variable field circuit of the motor F′, is opened so that this motor will run at a constant speed. The motor F′, and pump G′, then take the place of the constant-speed motor E and pump H, and perform all the functions as usual, and elevator A, can be operated in the regular way. The elevator A′ can be run under the same conditions by closing the valves J, J, and treating the electrical connections of the motor F, in the same manner as the motor F′.

It is preferable to place all the motors, pumps and mechanisms at the top of the building as the apparatus will then not be subjected to the static head of the water in the cylinder, although the operation would be the same if these pumps and mechanisms are placed in the basement.

The storage tank, M, is connected with the system, through a check valve, N, and is for the purpose of supplying any leakage and always keeping the system full of water.

The cylinders instead of having the regular piston rods, may have a number of steel wires fastened to both sides of the pistons and to the top and bottom of the counterweights. These wires are preferably made of nickel steel which does not rust in water, and their elastic limit is so high the constant bending does not crystallize and break them.

My system can be adapted as readily to the present single acting hydraulic elevator thus saving the cost of installing the hatchway apparatus in old hydraulic installations. Any hydraulic elevator can then be converted into a direct electric with all the attendant advantages and practically none of the drawbacks.

From the foregoing it will appear that in place of the grooved pulleys of my aforesaid former patent, I now have a very simple and valveless rotary pump; in place of the two slow-speed motors for each elevator, I now have two high-speed small motors for one elevator, three similar motors for a two-elevator plant; four of such motors for a three-elevator plant, in fact there is only one additional motor required than would be otherwise necessary. This extra motor will be somewhat larger for a number of elevators but will not increase in direct proportion, as the different motors balance each other and the extra motor only acts as an equalizer.

The car can be overcounterweighted the same as the direct-electric. The motors run continuously thus doing away with the complicated controlling mechanism with all of the attendant evils. The control in the present case is exactly similar to the rope differential, *i. e.*, by varying the field strength and changing the speed of the armature, with the difference that only one motor is varied in my present system whereas both motors were varied in the former system. In place of the overhead clutch, used on the former patented system to hold the car when the motors are stopped and also when the motors are beyond control I now use a stop valve to prevent the water flowing out or in either end of the cylinder thus making a positive and absolutely safe stop under all conditions.

The piping can be so arranged that if one motor breaks down, the plant will not be completely disabled; if the constant-speed motor is put out of commission only one elevator is disabled; if either the variable-speed motor is disabled, only that particular elevator is affected. In the rope differential system, an automatic starting mechanism is necessary for every individual elevator; with this present system only an automatic or preferably a simple hand-starting rheostat for the constant-speed motor is required. This last-named motor starts all the other connected motors through the medium of the water circulation to the hydraulic motors. When the operator wishes to run any particular elevator, all that is necessary is to cut in automatically a switch connecting that particular motor armature with the line. The armature is already running up to speed so no resistance is necessary. In opening the switch there is no arcing of any consequence, as the armature is under no load and is running at normal speed.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. In an electro-hydraulic differential elevator system comprising a hydraulic motor and two pumps embraced in a fluid circulating system, and means whereby the hydraulic motor is operated by the differential discharge of the pumps.

2. An electro-hydraulic differential elevator system comprising a hydraulic motor and two pumps so connected as to circulate a fluid, and means whereby said motor is operated by the differential discharge of the pumps.

3. In an elevator system of the character described, a hydraulic motor and a plurality of pumps said motor and motor driven pumps forming parts of a fluid circulating system, and means whereby said motor is operated by a differential discharge of said pumps.

4. An electro-hydraulic differential elevator system, comprising a cage or car, a hydraulic motor and two associated pumps arranged for combined action and as parts of a fluid circulating system, means connecting said motor to the cage or car, said pumps adapted to operate at times as motors, and means whereby the cage-operating motor is operated by the differential of the fluid discharge of said pumps.

5. An electro-hydraulic elevator system comprising a cage or car; a hydraulic motor connected thereto; a primary pump; and a secondary pump, said pumps and motor forming parts of a fluid-circulating system, and means whereby said motor is actuated by a differential discharge of the pumps.

6. An elevator system comprising a cage or car; a hydraulic motor operated thereby; a primary constant-speed pump; a secondary variable-speed pump, said pumps and motor forming parts of a fluid circulating system, and means whereby said motor is actuated by the differential discharge of said pumps.

7. In an elevator system, having a cage or car and a hydraulic cylinder provided with a piston with which the cage car is connected, a constant-speed pumping-motor, circulating-fluid connections between the cylinder and the said motor, a variable-speed motor and pump introduced into the circulation between the cylinder and the constant-speed motor, and adapted to be controlled from the cage or car, and normally-closed valves controlling the circulation of fluid to and from the cylinder and adapted to open coordinately with the starting of the cage or car and to close in unison with the stoppage of the car.

8. An electro-hydraulic differential elevator system having in combination a hydraulic cylinder and piston; a system of piping for the continuous circulation of water; primary and secondary pumping mechanisms connected with the circulating system, said primary mechanism including a constant-speed motor-driven pump for circulating a known volume of water, and said secondary pumping mechanism comprising a pump to which the water is delivered from the first-named pump, and an electric-motor designed to be run at variable-speed and to withdraw and supply water to opposite portions of the cylinder synchronously with the movement of the piston thereof; and normally-closed valves in the system of circulating pipes between the cylinder and the variable-speed pump, and adapted to interrupt and establish the circulation to and from the cylinder coördinately with the respective stopping and starting movements of the car.

9. An elevator system comprising a hydraulic cylinder; a piston operable therein; a constant-speed motor and connected pump; a variable-speed motor and pump connected thereto; fluid-circulating connections between the two pumps whereby a constant volume of fluid is normally delivered from one pump to the other; valve-controlled circulating pipes leading to and from the cylinder and connecting with the inlet and outlet of the variable-speed pump whereby when the speed of the latter pump exceeds that of the constant speed pump, a proportionate volume of fluid is withdrawn from one part of the cylinder and a corresponding proportionate volume of fluid is admitted to another portion of the cylinder; a cage or car; and connections therefrom to said piston.

10. In a system of the character described, the combination of a constant-speed motor-driven pump; a variable-speed motor and a pump coupled thereto; a cylinder and fluid circulating connections with which each of said pumps connect; said variable-speed pump adapted to receive a substantially constant volume of fluid delivered thereto from the first-named pump and when speeded up to coördinately withdraw fluid from one portion of the cylinder piston and deliver a corresponding amount of fluid into another

portion of said cylinder; a piston operable in the cylinder; and connections between the piston and the car or cage.

11. The combination of a hydraulic cylinder, a piston operable therein, two electric motors, two pumps connected with and operated by the motors, one of said motors being designed to operate at a constant speed and the other motor being designed for variable speed, pipes for circulating fluid from one pump to the other, other fluid-circulating pipes between the variable-speed pump and the cylinder, a cage and means connecting the same with the piston, and normally-closed valves controlling the pipes leading to and from the cylinder.

12. In an elevator system of the character described, the combination of a plurality of cages or cars; a corresponding plurality of cylinders, one associated with each car or cage; a single constant-speed motor and connected pump; a plurality of electric motors and associated pumps, one for each cage or car; a system of piping which provides for continuous circulation of fluid between the single constant-speed pump and the plurality of variable-speed pumps; other fluid circulating connections between each of said cylinders and the intake and outlet of an associated variable-speed pump; normally-closed valves in the last-named connections for interrupting the circulation of fluid therethrough when the cage or car is at rest; each of said variable-speed motors adapted to receive a constant and predetermined volume of fluid from the same constant-speed pump and when speeded up to coördinate with the opening of said valves to withdraw fluid from one portion of a cylinder and deliver a corresponding amount of fluid into another portion of the cylinder, the amount of fluid so withdrawn and delivered being varied directly as substantially the differences in speed between the constant-speed and variable-speed motors; pistons operable in the cylinders; and connections between the cages and cars and said pistons.

13. In an elevator system of the character described, the combination of a plurality of cages or cars; a corresponding plurality of cylinders, one associated with each car or cage; a single constant-speed motor and connected pump; a plurality of electric motors and associated pumps, one for each cage or car; a system of piping which provides for continuous circulation of fluid between the single constant-speed pump and the plurality of variable-speed pumps; other fluid circulating connections between each of said cylinders and the intake and outlet of an associated variable-speed pump; normally-closed valves in the last-named connections for interrupting the circulation of fluid therethrough when the cage or car is at rest; each of said variable-speed motors adapted to receive a constant and predetermined volume of fluid from the same constant-speed pump and when speeded up to coördinate with the opening of said valves to withdraw fluid from one portion of a cylinder and deliver a corresponding amount of fluid into another portion of the cylinder, the amount of fluid so withdrawn and delivered being varied directly as substantially the difference in speed between the constant-speed and variable-speed motors; pistons operable in the cylinders; and connections between the cages and cars and said pistons; and valve-controlled by-pass connections for cutting out of the fluid circulating system either of the cars or cages and its complementary mechanism.

In testimony whereof I affix my signature in presence of two witnesses.

ETHELBERT M. FRASER.

Witnesses:

WILLIAM H. BRODT,

CHARLES W. BOOTE.