(No Model.) 4 Sheets—Sheet 1.

J. PARKINSON.

COMBINED ELECTRIC HYDRAULIC ELEVATOR.

No. 569,934. Patented Oct. 20, 1896.

Fig. 1.

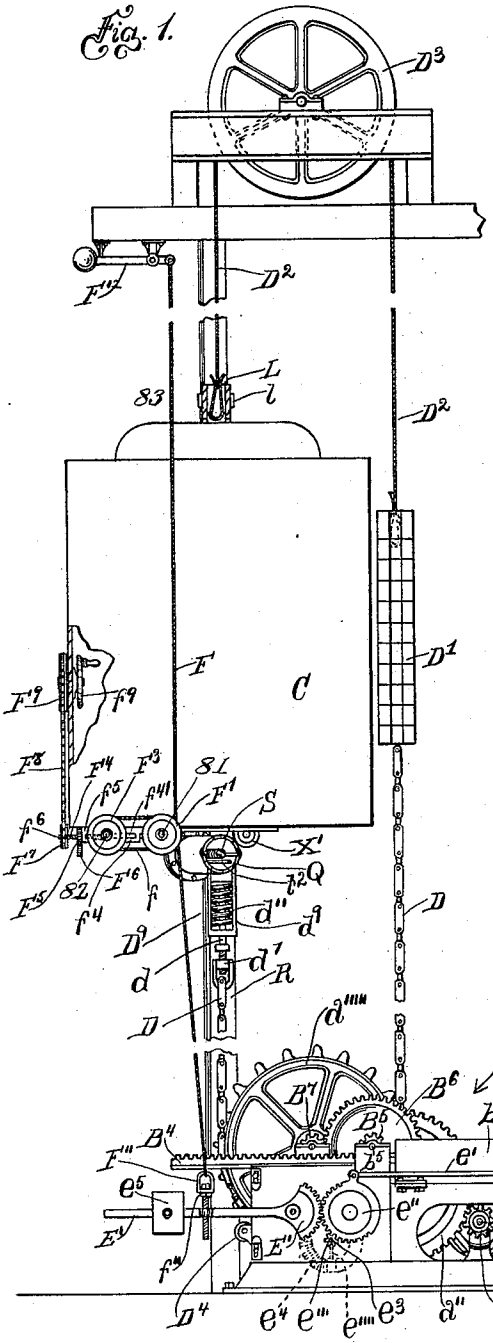
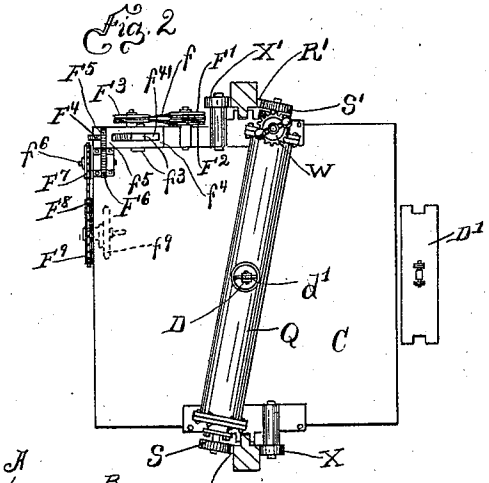


Fig. 2.



Witnesses.
P. W. Harbeson.
Alfred Townsend.

Inventor.
John Parkinson.
By
Hazard & Townsend.
His Attys.

(No Model.) 4 Sheets—Sheet 2.

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No. 569,934. Patented Oct. 20, 1896.

Fig. 3.

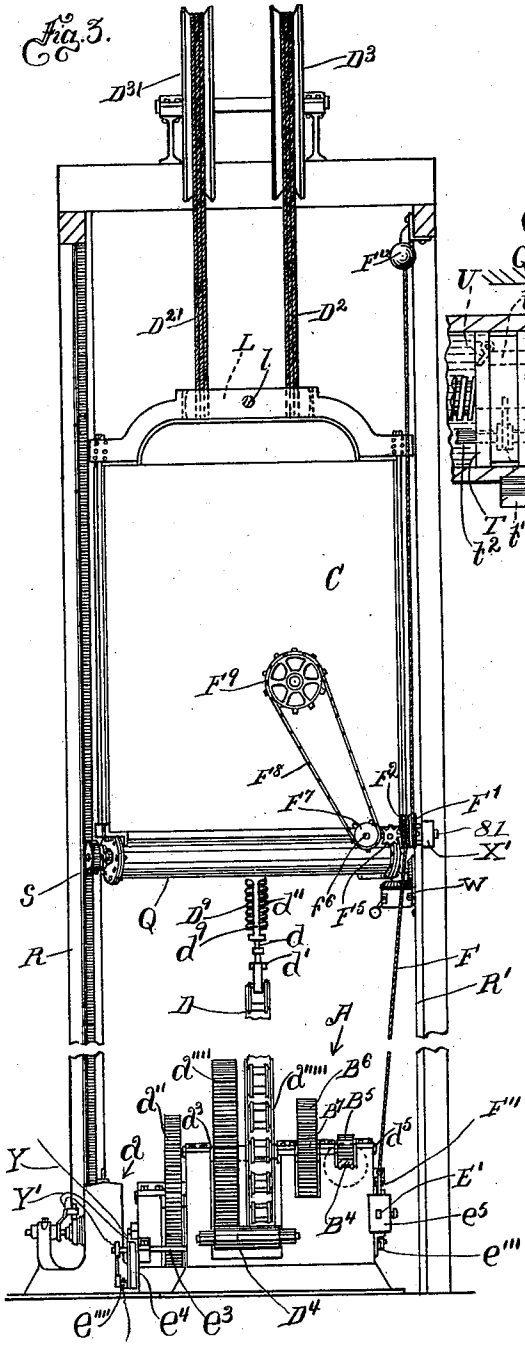


Fig. 4.

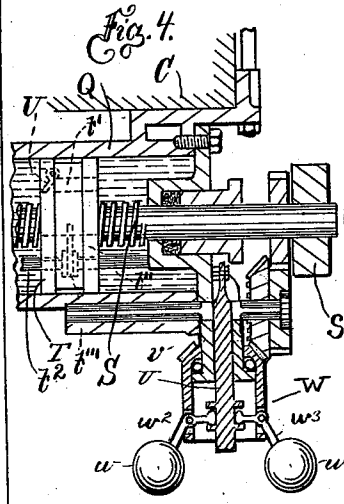


Fig. 5.

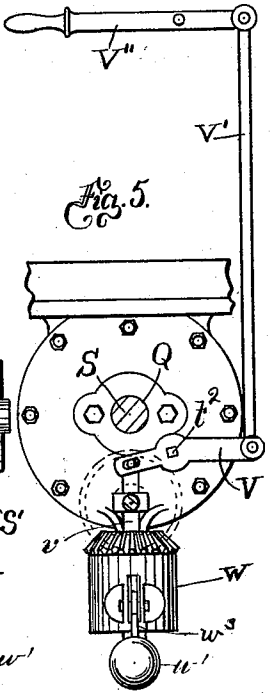


Fig. 6.

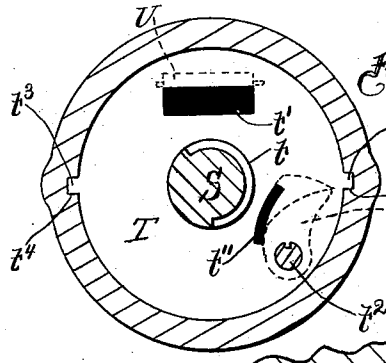
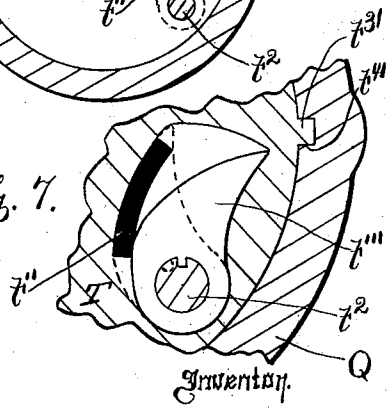


Fig. 7.



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(No Model.) 4 Sheets—Sheet 3.

J. PARKINSON.

COMBINED ELECTRIC HYDRAULIC ELEVATOR.

No. 569,934. Patented Oct. 20, 1896.

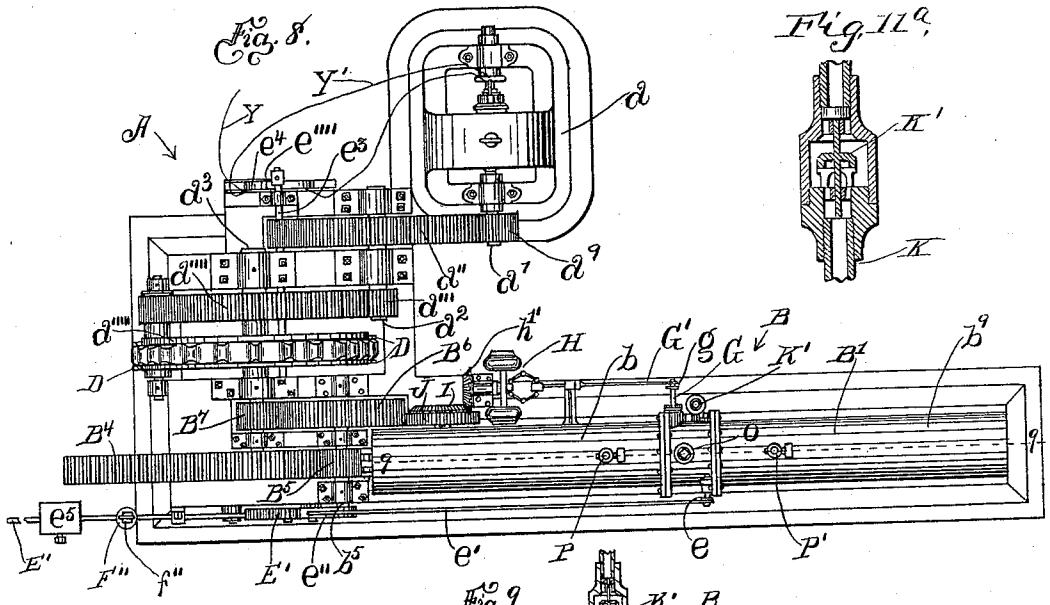

Fig. 8.

Fig. 11a.

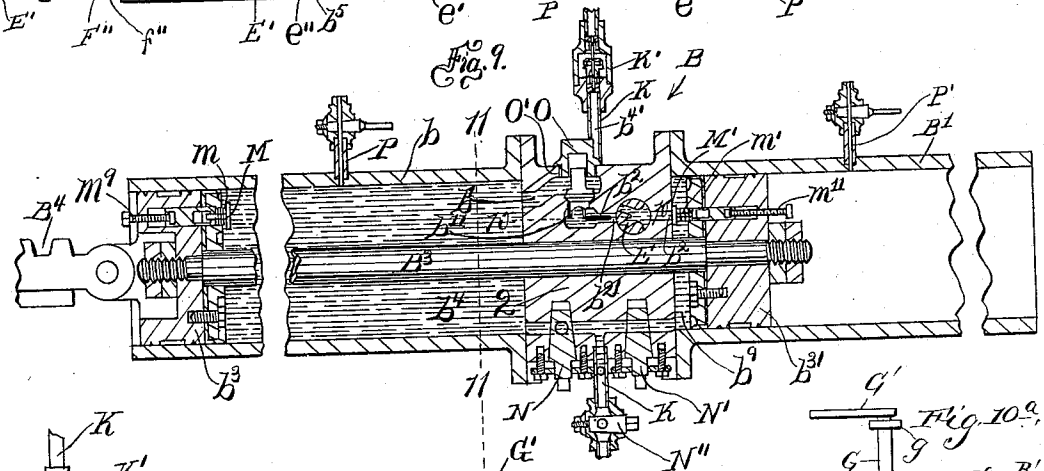

Fig. 9.

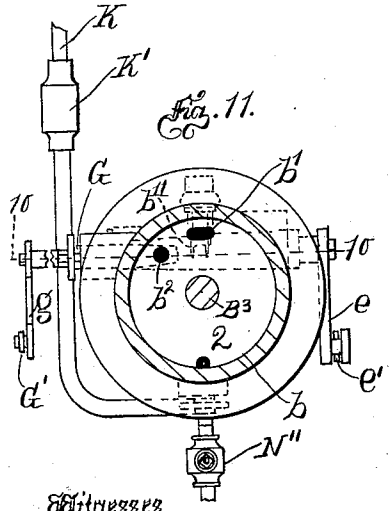

Fig. 11.

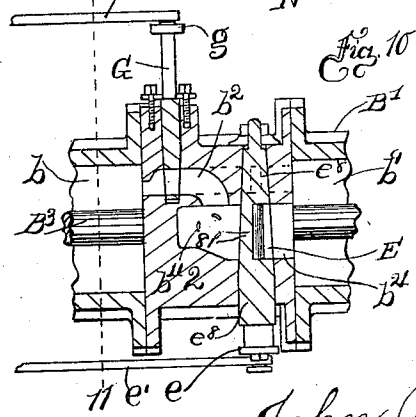

Fig. 10.

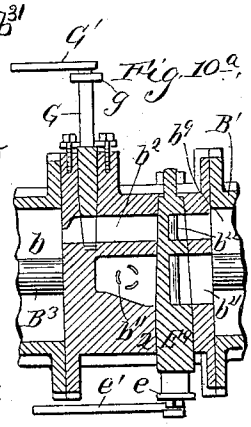

Fig. 10a.

Witnesses.
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COMBINED ELECTRIC HYDRAULIC ELEVATOR.

No. 569,934. Patented Oct. 20, 1896.

Fig. 12

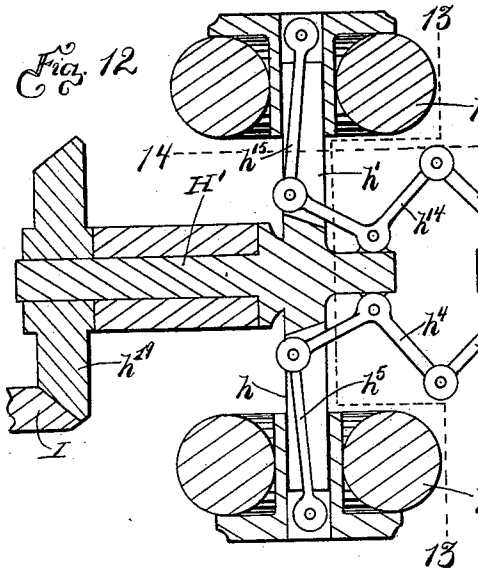


Fig. 13

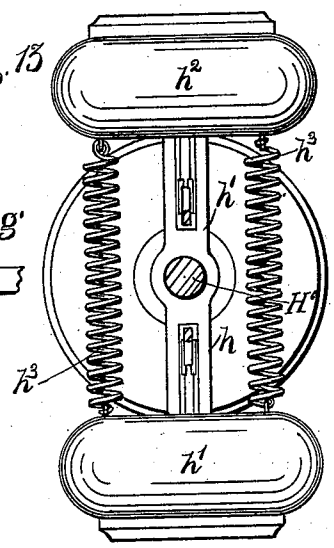


Fig. 14.

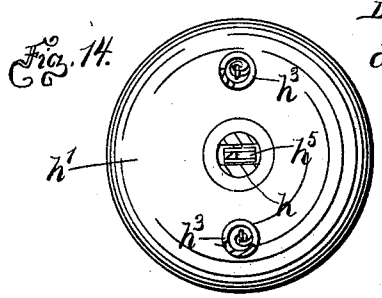


Fig. 15

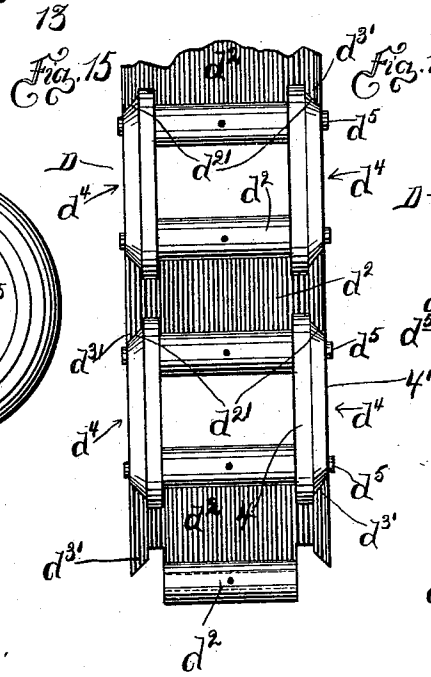
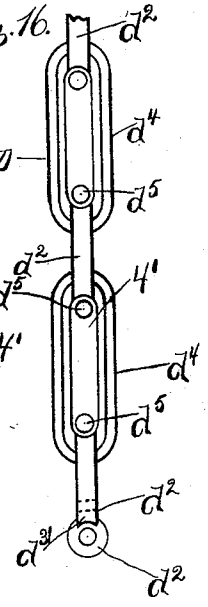


Fig. 16.



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His Att'ys.

UNITED STATES PATENT OFFICE.

JOHN PARKINSON, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE PARKINSON ELEVATOR COMPANY, OF SAME PLACE AND PHŒNIX, ARIZONA.

COMBINED ELECTRIC HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 569,934, dated October 20, 1896.

Application filed January 25, 1895. Renewed February 25, 1896. Serial No. 580,752. (No model.)

To all whom it may concern:

Be it known that I, JOHN PARKINSON, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Combined Electric Hydraulic Elevator, of which the following is a specification.

One object of my invention is to provide an improved and unobjectionable elevator driven directly by electric power; also to provide an electrically-driven elevator in which the car is supported at all times during its downward motion by a body of liquid.

Another object of my invention is to secure safety in an electric elevator without the use of a worm, and thus avoid the vibration of the car which is attendant upon the operation of all elevators in which the car is driven by electric power applied through a worm.

Another object of my invention is economy of power, power being applied only to raise the car and load, the descent being wholly by gravity of the load and regulated by the escape of liquid from one compartment to another in a cylinder in which the liquid remains and when the car rises returns automatically to the first compartment without waste of power or liquid, so that the loss of liquid and power attendant upon the operation of hydraulic elevators is done away with. By dispensing with the worm great economy of power is gained by the reduction of friction.

Another object is simplicity of construction, the counterweight and car being hung on one rope and the driving chain or rope being attached to the bottom of the car and to the bottom of the counterweight.

Another object is to accurately gage the speed of descent by means of a governor controlling the flow of the liquid from one compartment to the other in the cylinder.

Another object is to provide a safety-support carried by the car, and which will allow the car to move freely up and down and yet will prevent too rapid descent, the same being operated by a governor and also adapted to be operated from the car.

Another object is to provide improved mechanism for controlling the elevator from within the car, the same being so arranged that the rheostat is operated directly by a simple mechanical device and yet the power can only be applied slowly, thus dispensing with expensive electric regulators, and yet avoid all jerking and danger of injuring the motor by turning on the current too suddenly.

Another object is to equalize the strain on the supporting-ropes.

Another object is to provide an improved governor for operating the mechanism which controls the speed of descent.

One object of the improvement in the governor device is to gain, by a limited movement of the governor-weights, an extensive movement of the sliding rod which operates the speed-controlling valve; also to dispense with a part of the length of car-supporting ropes; also to provide improved adjustable automatic stops for limiting the upward and downward movements of the car; also to provide an improved device for controlling the passage of liquid from one compartment to the other of the cylinder, allowing it to flow freely in one direction as the car ascends and to restrict the flow in the other direction as the car descends; also to provide improved means for stopping the car by a safety device carried by the car; also to provide an automatic device for keeping the cylinder full of liquid.

My invention is broadly different from other elevators with which I am acquainted in that my elevator comprises an electric lifting apparatus and a hydraulic supporting and lowering apparatus, so arranged in combination that the strain is taken off of the electric motor at all times except when the motor is in operation to raise a load. This enables me to dispense with the worm connection which, as a safety precaution, has heretofore been employed for transmitting the power from the armature-shaft to the operating-gear.

By my invention I am enabled to gear with a cog on the armature-shaft with perfect safety, thereby saving an immense amount of friction over the worm-gearing ordinarily employed.

In the accompanying drawings the construction and arrangement of cylinder and piston shown are such as to allow the piston to force the liquid from one compartment of the cylinder to the other, and I regard my inven-

tion as including the arrangement of valves by which I control the flow of liquid between the compartments whether the liquid is forced through the passage by a piston having two heads or by some other suitable means. The principle upon which the flow is controlled will be the same in either case.

This invention employs a principle of hydraulic control which is set forth in my applications for Letters Patent of the United States, Serial No. 545,175, filed April 10, 1895, Serial No. 553,959, filed June 25, 1895, Serial No. 568,898, filed November 14, 1895, and Serial No. 570,875, filed December 3, 1895, and which consists, essentially, of controlling the downward movement of the elevator-car by a body of liquid arranged to flow from one liquid-containing compartment to another through passages provided with valves which regulate the obstruction which the liquid may present to the operation of the piston. Said applications illustrate a new type of elevator having means for applying power directly from electric motors, and my present invention also applies power directly from an electric motor to raise the car and employs the weight of the car to cause its descent, so that, as in the other said inventions, the power of the motor is used only to lift the car, thus giving great economy of electricity. With my new type of elevators shown in these several applications the expenditure of power is exactly proportionate to the work done.

In my application for Letters Patent of the United States, Serial No. 568,898, filed November 14, 1895, I have broadly and generically claimed the invention underlying this appliance, and which invention consists, essentially, of controlling the downward movement of the elevator-car by a body of liquid arranged to flow from one liquid-containing compartment to another through passages provided with valves which regulate the obstruction which the liquid may present to the operation of the piston.

The new type of elevator which I have invented and which is claimed in said application includes, broadly, the combination, with an electric motor, of a piston operated thereby and operatively connected with the car to drive the same, and suitable means or appliances arranged to allow the free movement of the piston when the car ascends and to afford perfect control of the movement of the piston at the descent of the car.

The said invention comprises an electric lifting apparatus and a hydraulic supporting and lowering apparatus so arranged in combination that the strain is taken off of the electric motor at all times except when the motor is in operation to raise a load. It comprises a cylinder, a piston arranged in such cylinder, means connected with the piston to move it in one direction, a receptacle or reservoir, a body of liquid in the cylinder and receptacle, a passage being provided between the receptacle and cylinder, a valve arranged to allow the liquid to flow freely through such passage from the receptacle into the cylinder and prevent its return, a passage being provided to allow liquid to flow from the cylinder into the receptacle, a valve arranged to control and to prevent the flow of liquid through such passage, and means for operating such valve.

No claim is herein made broadly and generically to said invention, because the same is broadly claimed in said application, Serial No. 568,898.

The accompanying drawings illustrate my invention.

Figure 1 is a fragmental side elevation, partially in section, showing my improved elevator in position for operation. In this view the safety-cylinder Q and the supporting-lever and cross-head are sectioned. Fig. 2 is a view looking up at the bottom of the car. Fig. 3 is an end elevation looking toward the right in Fig. 1. Fig. 4 is a fragmental sectional detail of one end of the safety appliance which is secured to the under side of the car. Fig. 5 is an end view of the same, showing the operating device or lever which extends into the car for operating the safety appliance. Fig. 6 is a cross-section of the safety-cylinder carried by the car, showing the traveling piston-head therein with the restricted passage open. Fig. 7 is a cross-sectional detail of the restricted-passage valve t''' and its valve-operating rod. Fig. 8 is a plan of the machinery beneath the car. Fig. 9 is a fragmental longitudinal mid-section on line 9 9, Fig. 8. In this view the automatic supply-valve is also shown in longitudinal mid-section. Fig. 10 is a plan section on line indicated by 10 10, Figs. 9 and 11. Fig. 10^a is a like section showing a modification. Fig. 11 is a section looking to the right on line 11 11, Figs. 9 and 10. Fig. 11 is an enlarged detail of the check-valve of the automatic device for keeping the cylinder full of water. Fig. 12 is a sectional detail of the governor. Fig. 13 is a sectional view of the governor on line indicated by 13 13, Fig. 12. Fig. 14 is a view on line indicated by 14 14 in Fig. 12. Figs. 15 and 16 are details of the driving-chain.

My machine embraces a safety appliance for elevators, which, in general terms, consists in the combination of a hydraulic cylinder; a movable head within the cylinder; means for moving such head back and forth along within the cylinder; a body of liquid in the cylinder arranged to receive the thrust of the head when it moves in one direction; means for allowing a restricted relief of such liquid when it receives such thrust, and means for freely returning the liquid to supply the vacuum when the head moves in the other direction.

In this relation my invention pertains to the arrangement of conduits, valves, and mechanism whereby the flow of liquid be-

tween the compartments of the cylinder is controlled, the same being so arranged that when the car is ascending the liquid passes from one cylinder into the other without using any of the power required to raise the machine, and when the car is descending the liquid is constantly under control to regulate the speed of descent and to stop and support the car.

It also embraces other features, elements, combinations, and parts.

My invention broadly includes an elevator having its driving mechanism operatively connected with and controlled by an independent hydraulic speed-regulator, in which a piston working in a hydraulic cylinder is provided with a rack which is carried by the piston and meshes with a pinion which is connected with and operated by the driving mechanism, as by this means I am enabled to support the car by a body of liquid at all times during the downward movement of the car and avoid the necessity of the worm which has heretofore been used in electrically-driven elevators as a safety precaution in gearing with the motor. This allows the current to be entirely cut off from the motor during the entire descent of the car, thus saving a per cent. of the power heretofore necessary in the operation of electric elevators.

In my invention the hydraulic speed-regulator is designed simply to regulate the speed of descent and to support the car at all times except when being raised, the liquid of the regulator being allowed to return freely when the car is being raised, and my invention in this relation comprises the combination, in an elevator having driving mechanism and an independent hydraulic speed-regulator, of a piston working in a hydraulic cylinder, a rack carried by the piston, and a pinion meshing with the rack and connected with the driving mechanism.

It also embraces the combination of the hydraulic cylinder comprising two compartments with a partition between the compartments, a piston provided with two heads one in each of the compartments of the cylinder and arranged with its rod passing through the partition, two conduits or passage-ways connecting the two compartments between the piston-heads, valves to control the flow of the liquid through the conduits, and a body of liquid in the cylinder and conduits between the piston-heads.

More specifically it comprises the combination of the car, a cylinder having two compartments communicating with each other through two conduits or passage-ways, a body of liquid in the two compartments and conduits, a piston operatively connected with the car of the elevator through intermediate mechanism and arranged in the cylinder to force the liquid from one compartment to the other through the conduits as the car rises and descends, such intermediate mechanism, a main valve controlling the flow through both of the conduits to prevent and to allow the flow of liquid in either direction, valve-operating means operatively connecting the valve and the car for operating the main valve, a check-valve arranged in one of the conduits to automatically allow a free flow in one direction through such conduit and to entirely prevent any flow in the other direction, a valve arranged in the other conduit to control the quantity of liquid which is allowed to pass therethrough, governor mechanism connected with the quantity-controlling valve to operate the same, and operative mechanism connecting the governor with the car.

In the drawings, A indicates in a general manner the entire driving mechanism, and B in a like manner the entire hydraulic speed-regulator, and C indicates the car. The driving mechanism comprises a motor a and power-transmitting mechanism for transmitting power from the motor to raise the car. Such power-transmitting mechanism, as shown in the drawings, comprises the pinion a^9, mounted on the armature-shaft a' and meshing with the cog-wheel a'', which is connected with the pinion a''' by means of a shaft a^2, and which pinion a''' meshes with a cog-wheel a'''', which is mounted on the shaft a^3, which carries the driving-wheel a''''', which is fixed upon such shaft a^3; a flexible connection D, which in the form shown in the drawings in this instance consists of a driving-chain, hereinafter more particularly described, and which is connected with the bottom of the car C and with the bottom of the counterweight D'; such counterweight, a supporting-rope D^2, and supporting-sheave D^3, which supporting-rope is fastened to the counterweight and to the top of the car and passes over the sheave. By this arrangement of mechanism the power is applied through the motor a from a suitable electric generator (not shown) and operates the car.

As shown in the drawings, (see Figs. 1, 8, 9, 10, and 11,) the hydraulic speed-regulator is composed of a hydraulic cylinder, (indicated generally in the drawings by B',) comprising two compartments b and b^9, communicating with each other through suitable passage-ways b' and b^2, the latter of which is smaller than the other to restrict (that is, to control the quantity of) the flow of liquid therethrough; a check-valve b^{11}, arranged to control the flow of liquid through the passage b' to prevent the liquid from flowing through such passage from the compartment b into the compartment b^9 when the liquid receives the thrust of the piston-head b^3 when it moves to the right and to allow the liquid to return freely from the compartment b^9 into the compartment b to supply the vacuum when the piston-head moves to the left; a piston B^3, (the piston-rod of which passes through the partition 2 in the cylinder,) provided with two heads b^3 and b^{31}, one arranged in each com-

partment; a body of liquid b^4 in the cylinder between the piston-heads; a rack B^4, connected with the piston to reciprocate the same, and suitable means connecting the rack with the driving-wheel, so that the rotation of the driving-wheel will operate said rack.

In the drawings the means for connecting the rack with the driving-wheel consist of the pinion B^5, fixed upon the shaft b^5, and thereby connected with the cog-wheel B^6, the pinion B^7, fixed upon the driving-shaft a^3 and thereby connected with the driving-wheel a''''. By this arrangement the several parts are so connected that when the car is lifted the liquid is freely returned through the partition from the compartment b^9 into compartment b, being caused to do this by the operation of the piston which is driven by the rack and intermediate gearing. Upon the descent of the car the rack is forced in the other direction and the liquid receives the thrust of the piston-head b^3, and this closes the check-valve b^{11} and compels the liquid to pass through the restricted passage b^2, which allows a restricted relief of the liquid, and by this means the car is cushioned on the liquid and is supported at all times during its downward movement by the body of liquid, and the descent is safely made without the application of power through the motor, so that when the car descends the motor is not operated to drive the car or to hold the car.

E is the main valve arranged to control both of the conduits or passages b' and b^2 and to cut off communication between the two cylinders. In Fig. 10^a this valve (marked E^9) is shown with two openings, one for each conduit or passage, but in Fig. 10 only one opening is required, since both conduits unite before entering the compartment b^9. The main control-valve E is composed of journals e^8, journaled in the valve-seat on the opposite sides of the passage b^{21}, a valve-web 81, having an arc face for the valve-seat and slightly wider than the passage b^{21} and arranged to fit the valve-seat and close such passage and to open the passage when the valve is slightly rotated in either direction. This construction provides a valve having a very slight extent of motion to open both ways and which will open in either direction with a very slight turn of the valve. e is a crank for operating such valve, and e' is the valve-operating rod pivoted at one end to such crank and at the other end to a valve and rheostat operating toothed wheel e'', which meshes with the rheostat-pinion e''', which is mounted on the rheostat-shaft e^3 on which the rheostat-arm e'''' is fixed so as to swing into connection and out of connection with the rheostat e^4. Suitable means for rotating the toothed wheel e'' are provided and, as shown in the drawings, consist of the power connecting and disconnecting arc lever E', provided with cogs which mesh with the teeth of such toothed wheel.

e^5 is a weight for depressing the end of the lever, thus to hold taut the operating-rope, which is attached thereto.

F is the operating-rope, fixed to a tension device F^{12} at its upper end, and connected at the other end through adjustable means, such as the swivel-screw F'', with the power connecting and disconnecting arc lever E' and arranged with one member around one of the rope-receiving pulleys F' and the other member around the other rope-receiving pulley F^2, and with a loop f, between the two rope-receiving pulleys, arranged around the adjustable pulley F^3, which is connected with suitable means for moving such pulley toward and from the rope-receiving pulleys.

The rope-receiving pulleys F' F^2 are mounted on a single stationary axle or shaft 81, fixed to and carried by the car, and the movable pulley F^3 has its axle or shaft 82 in the same horizontal plane with the stationary axle or shaft of the rope-receiving pulleys and moves in such plane toward and from such pulleys. My improved controlling device in this respect is different from others, principally in that only one single line of rope having one end fixed at the top of the well 83 and its other end fastened to the power connecting and disconnecting lever E is used, and the mechanism is very compact and adapted to be placed in the most desirable position—viz., at the bottom of the car.

The means for moving the adjustable pulley F^3 toward and from the rope-receiving pulleys F' and F^2 consist of a screw F^4, arranged to operate such adjustable pulley, and means for operating such pulley-operating screw. The means for operating the pulley-operating screw F^4 consist of a toothed nut F^5, screwed upon the screw F^4 and resting against a bearing f^5, arranged between the toothed nut and the adjustable pulley, and a cog-wheel F^6, geared with the toothed nut to operate the same and fixed upon a shaft f^6, upon which is a sprocket-wheel F^7, connected by a sprocket-chain F^8 with a driving sprocket-wheel F^9, which is operated by a crank f^9 in the car. f^3 is a sliding cross-head attached to the screw and arranged to slide in suitable ways or slide-frame f^4, fixed to the car. The adjustable pulley F^3 is journaled upon and carried by this cross-head f^3. The slide-frame f^4 is provided with suitable slots f^{41}, in which the arms of the cross-head are fitted. This slotted slide-frame and the cross-head therein holds the adjustable pulley from canting. The weights F^{12} and e^5 hold the rope F taut, and this draws the movable pulley F^3 and the screw F^4 toward the rope-receiving pulleys and thus holds the toothed nut F^5 constantly against the bearing f^5.

To operate the operating-rope, the crank f^9 is turned, and this drives the sprocket-wheels, chain, and cog-wheel to rotate the toothed nut, and this causes the screw F^4 to move endwise. When turned in one direction, the screw is operated to draw the adjustable pulley away from the rope-receiving pulleys, and

this operates the rope F to pull the free end of the power connecting and disconnecting lever upward, thus operating the toothed wheel e'' and causing the same to operate the rheostat-arm to throw it into connection with the rheostat, thus turning on the current to operate the motor to elevate the car. At the same movement the toothed wheel e'' operates the valve-rod e' to open the valve E, and thus allow the liquid to flow freely from the compartment b^9 into compartment b.

A reverse movement of the crank f^9 in the car throws the adjustable pulley F^3 toward the rope-receiving pulleys F′ and F^2, thus allowing the weight e^5 to operate the power connecting and disconnecting lever E′ in the opposite direction, thus turning the toothed wheel e'' to throw the rheostat-arm e'''' out of engagement with its rheostat to turn off its current of electricity from the motor, and at the same movement the valve E is first turned to cut off the flow of liquid through the passage b^{21} b', thus leaving the valve in the position shown in Fig. 9, but upon a further movement of the crank f^9 in the same direction to further lower the free end of lever E′ the valve is further operated, so as to again open the passage, the rheostat-arm continuing to move out of engagement with the rheostat, so that communication between the compartments through the passage b^{21} b' is left free, and the electric current remains unapplied to the motor. The weight of the car then operates, through the flexible connection D, the driving-wheel a'''', the intermediate connection, and the rack B^4 to force the piston so as to drive the liquid through the passage b' b^2 b^{21} from the compartment b into the compartment b^9. The check-valve b^{11} prevents the liquid from passing through the passage b', and the liquid therefore flows slowly through the restricted passage b^2, thus allowing the car to descend at the predetermined rate of speed, such rate being regulated by the speed with which the liquid can pass through the restricted passage b^2.

In order to prevent too rapid descent, I provide means for further restricting the passage b^2 when the speed of descent is increased. G is a valve for restricting and cutting off the flow of liquid through the passage b^2. G′ is a reciprocating rod attached to such valve by a crank g and arranged to be reciprocated by a suitable governor H.

I have shown a suitable governor in Figs. 8, 12, 13, and 14 of the drawings, and the same consists in the combination of a rotating shaft H′, provided with radial arms h h', a sliding weight h^9, mounted on one arm and arranged to slide therealong; a sliding weight h^2, mounted on the other arm and arranged to slide therealong; spring connections h^3, arranged to draw the weights toward each other; a rocking lever h^4, pivoted to one side of the rotating shaft; a connecting-rod h^5, connecting one arm of such rocking lever with one of the sliding weights; another rocking lever, h^{14}, pivoted to the other side of the shaft; a connecting-rod h^{15}, connecting one arm of the rocking-lever h^{14} with the other sliding weight; stops g' g'' g''' to limit the movement of the reciprocating rod G′; a rotating sleeve h'', journaled on such rod and arranged to revolve and not to slide thereon, and two connecting-rods h^6 and h^{16}, pivoted to the sleeve and respectively pivoted to the rocking levers. The rotating shaft H′ is connected by gearing h^{19}, I, and J with a cog-wheel B^6, which is connected with the rack B^4 through the pinion B^5 and with the driving-wheel a''''' by the pinion B^7 and shaft a^8.

In the above-described governor device the radial arms h h^9, along which the governor-weights are arranged to slide, are slotted and the connecting-rods h^5 and h^{15} are arranged within the arms h h^9, respectively, and extend therethrough beyond the ends thereof and are pivoted to the governor-weights outside of and beyond the ends of the arms, respectively, and the other ends of such rods are pivoted within the arms, respectively, to the ends of the rocking levers, respectively, which are pivoted to the shaft and are connected with the sleeve h'' in toggle fashion, so that a limited movement of the governor-weights produces an extensive movement of the sleeve. By this arrangement whenever the car descends too rapidly the governor-weights h' h^2 are thrown outward, thus operating the reciprocating valve-rod G′ to close the valve G, thus partially or wholly cutting off the flow of liquid through the port b^2.

The passages b^2 and b' are both controlled by the valve E, so that when the valve E is closed the communication between the two compartments is entirely cut off. They may both enter compartment b through one port b^{21}, as shown. It would be an equivalent construction if they entered separately, as indicated in Fig. 10^a, a passage b^{22} through the valve E being in that case provided for that purpose. When valve E is closed, it prevents any creeping of the car when the car has been stopped at any floor or elsewhere.

The means for keeping the compartments constantly full of liquid consists in the combination, with the cylinder having two compartments communicating with each other, the piston having two heads, one in each compartment, and the body of liquid within the cylinder between the two piston-heads, of a liquid-supply pipe K, communicating with one of the two compartments and extending upward therefrom to a source of supply, (not shown,) a supply of liquid b^4 in such pipe, and a check-valve K′, arranged to prevent the upward flow of liquid through such pipe and allow its downward flow therethrough. The check-valve is of ordinary construction well known in mechanics. When the piston moves during the descent of the car, the movement of piston-head b^{31} tends to form a vacuum in compartment b^9, and if both compartments are not full between the heads liquid will

pass downward through the supply-pipe into the compartment b^9, and upon the return movement of the piston the supply check-valve K′ will operate to retain the liquid which has thus entered the compartment, and by this means liquid is always supplied to prevent any vacuum.

The operating-rope F is connected with the lever E′ by an adjustable connection F″, in order that the rope may be adjusted so that when the pulley F^3 is in a central position, allowing movement of the operating-rope in either direction, the power connecting and disconnecting lever E′ will be held in its horizontal position, in which position the valve E is closed and the rheostat is cut off. This adjustable connection comprises a swivel-screw bolt, which screws through the lever E′, and if at any time the rope should stretch the slack can be taken up by turning the bolt.

f'' indicates an angular portion or head on the bolt of the swivel to receive a wrench by which it may be turned.

By thus providing the operating-rope with an adjustable take-up in addition to its operating mechanism the adjustment for operation is made easy.

The car C, the flexible connection D, the counterweight D′, and supporting-rope D^2 constitute practically an endless chain, the under loop of which passes beneath the driving-wheel a''''.

To prevent any slack of the chain D between the car and the driving-wheel, I provide a tension connection or spring-pressed adjustable take-up D^9 between the flexible connection or chain D and the car. This tension connection consists of a reciprocating spring-sustaining rod d, which is mounted in guides d^9, which are secured to the car.

d'' indicates the spring which sustains the rod d. The reciprocating rod d is screw-threaded at its lower end and is provided with a swivel-coupling d', to which the chain or flexible connection D is fastened. By turning the screw-rod d the tension upon the chain can be increased or diminished to the required degree. This tension connection also tends to prevent any danger of jerking in starting the car, for the reason that the chain is always held in perfect connection with the driving-wheel.

D^4 is a roller arranged close to the periphery of the teeth of the toothed driving-wheel a'''' to prevent the chain from dropping down from such teeth.

L is the car-supporting lever, pivoted to the car by the pivot l, and D^3 D^{31} indicate two supporting-sheaves, one above each end of such supporting-lever. The supporting-ropes are arranged in two sets of ropes D^2 and D^{21}. The rope D^2 is attached to one end of the lever L and passes over one sheave, D^3, and thence downward, and connects with one end of the counterweight D′, and the other rope, D^{21}, is fastened to the other end of the lever L and passes over the other sheave, D^{31}, and is then fastened to the other end of the counterweight. The driving flexible connection D is fastened to the counterweight midway between such ropes. By these means compensation is provided for any unequal tension of the supporting-ropes which otherwise might occur, and the tension on the supporting-ropes will remain equal.

Each of the piston-heads b^3 and b^{31} is provided with a valve arranged to be operated by the movement of such head. One of these valves, M, is arranged to close the passage b' at one limit of the piston's movement, and the other valve, M′, is arranged to close such passage at the other limit of the piston's movement. The valve M on the piston-head b^3 is arranged to close the port b^2 when the piston reaches its limit, with the car at the bottom of the shaft, so that the valve M will prevent any further flow of liquid from the compartment b after the car has reached the bottom. The valve M′ is arranged in like manner, in connection with the piston-head b^{31}, to close the port b^{21} when the car has reached the top of the shaft. These valves are held in the normal position, respectively, by springs m and m^9. These spring-pressed valves are adjustably arranged with relation to their piston-heads. m' and m^{11} indicate the means for adjustment of valves M and M′, and respectively consist of a screw which operates its valve-stem with relation to the piston-head.

N N′ N″ indicate blow-off valves. Normally the valves N and N″ are closed, N′ being left open to allow communication between the supply-pipe K and the compartment b^9.

O indicates a plug to give access to the check-valve b^{11}. When it is desired to remove this plug, the valves N and N′ should both be closed and the car should be at the bottom of the shaft, thus to prevent the liquid from being forced out through the opening O′, which the plug closes.

P P′ are air-cocks to allow the escape of air when the cylinder is being charged with liquid.

The flexible connection which connects the bottom of the car with the bottom of the counterweight may be of any desired form, either a wire rope or a chain, and the driving-wheel may either be a drum or a toothed wheel, depending upon the means of connection. In the drawings I have shown a toothed wheel and the chain, for the reason that the chain in this connection embodies a portion of my invention. The said chain is composed of bearing-links d^2, respectively provided at their ends with recesses d^{21} for the connecting-links and with link-retaining shoulders d^{31}, which form, respectively, the outer walls of the recesses to retain the ends of the connecting-links d^4 within such recesses. Pivots d^5 pass through the connecting-links and the bearing-links to pivot the connecting-links to the bearing-links, and in practice these pivots are riveted at the ends to

hold them in place. Preferably each of the connecting-links d^4 is formed of the two pieces which are marked in the drawings 4 and 4'. These pieces at their ends project to different distances from the pivots d^5 and the shoulders d^{31} are conformed to such ends, so that both of the pieces 4 and 4' are held in place by such shoulders independent of the rivet-heads. The purpose of thus separately constructing the connecting-links is to allow of their readily being stamped from comparatively thin sheet metal, each of the pieces 4 4' being sufficiently thin to be stamped and punched. This form of chain avoids all liability of spreading of the links and adds a valuable feature of safety to machines of this character.

Q is a hydraulic cylinder closed at the ends and fixed to and carried by the car.

R R' are racks arranged alongside the path of the car.

S is a screw-shaft arranged to revolve in the cylinder and provided at its ends, respectively, with a pinion s, (s',) each of which meshes with one of the racks.

T is a movable head fitted to slide and not revolve within the cylinder, and provided with a screw-threaded hole t, in which the screw-shaft S fits, and with a passage t' for liquid through the head.

U is a valve for hindering the flow of liquid in one direction through the head through such passage t' and allowing it to pass freely in the other direction through such passage.

t'' indicates a passage to allow the restricted flow of liquid through the cylinder, and t''' indicates a valve for closing such restricted passage.

t^2 is a rod for operating the valve for closing the restricted passage. This rod extends along within the cylinder parallel with the screw-shaft, and the valve t''' is arranged to slide and not rotate thereupon. This rod passes through one end of the cylinder, and a governor W is operatively connected with such valve-rod to rotate the same to open and close the valve, the governor being adjusted to normally hold the valve open and to close the valve when the predetermined speed of the car has been exceeded. Means for operating such valve-rod to open and close the valve within the car is also provided. These means are illustrated in Fig. 5, and consist of a lever V, mounted on such valve-rod t^2, the connecting-rod V', and the hand-lever V'', arranged in the car to be operated for opening and closing the valve.

The racks R R', in combination with the pinions s s', and, in fact, either one of such racks, in combination with the pinion which meshes with it, constitute means for rotating the screw-shaft, and in combination with the screw-shaft constitute means for sliding the movable head back and forth along the cylinder. When the head runs in one direction, the liquid q passes freely through the passage t', thus allowing the rod to move freely in that direction, and when the head moves in the other direction the valve U closes such passage, and then the only escape of liquid from one side of the head to the other is made through the restricted passage t'', so that the movement of the head along within the cylinder is restricted by the liquid which receives the thrust of the head and finds only a limited relief through the passage t'', and this operates to retard the movement of the means which operate the head. These means, being the screw-shaft and pinion in connection with the rack, when thus retarded in movement limit the movement of the car, thus to prevent too rapid descent. In case a load in excess of the weight the car will normally carry is placed within the car, the pressure upon the liquid is sufficient to force the liquid through the passage t'' with greater rapidity, and therefore the restricting-valve t''' is required, and in practice the governor W will operate to partially close such valve, thus to further restrict the liquid and allow the head to move with the predetermined speed. When the governor is rotated above the desired speed, the balls w w' fly outward and their levers w^2 w^3 operate the reciprocating valve-rod v to operate the valve. This particular style of governor is not claimed herein as new. Other style of governors may easily be applied for this purpose. This provision will cause the car to go down gradually even in case the supporting-rope is broken.

If the operator desires to absolutely stop the car, he may do so by means of the hand-lever V'', and he may also use such hand-lever to restrict the flow of liquid through the passage t'', so as to make the car descend with a slower motion than the governor is set for.

X X' are rollers fixed to the car and arranged to engage the untoothed or plain sides of the racks, thus to prevent the car from swinging to withdraw the pinions s s' from their engagement with the rack.

t^3 and t^{31} (see Fig. 6) indicate shoulders upon the movable head arranged to slide in grooves t^4 t^{41} in the safety-cylinder Q, thus to prevent the head from turning and yet allow it to move freely along the cylinder.

In operation, the electric wires Y Y' being properly connected to supply the electric current from generating means (not shown) and the cylinders being supplied with liquid and the whole being in operative form, as shown, the operator within the car will operate the crank f^9, thus to operate the operating-rope F and turn on the current of electricity to the motor and at the same time opening the valve E, as hereinbefore detailed. A further revolution of the crank being given the car will descend; and in case of too rapid descent both of the governors, the one attached to the car and the one connected with the hydraulic cylinder B, will be put into operation to prevent the too rapid descent. Further description of the operation is deemed unnecessary in view of the foregoing.

Now, having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an elevator having driving mechanism and an independent hydraulic speed-regulator, the combination set forth of the driving mechanism; the car-supporting piston working in a hydraulic cylinder, the rack carried by the piston, and the pinion meshing with the rack and connecting said rack with the driving mechanism to support the car.

2. In an elevator the combination set forth of a hydraulic cylinder comprising two compartments with a partition between the compartments; a piston provided with two heads, one in each compartment of the cylinder and arranged with its rod passing through the partition; two conduits connecting the two compartments between the piston-heads; valves to control the flow of the liquid through the conduits; and a body of liquid in the cylinder and conduits between the piston-heads.

3. In an elevator, the combination set forth of the car; a cylinder having two compartments communicating with each other through two conduits; a body of liquid in the compartments and conduits; a piston operatively connected with the car of the elevator through intermediate mechanism and arranged in the cylinder to force the liquid from one compartment to the other through the conduits as the car rises and descends; such intermediate mechanism; the main valve controlling both of the conduits to prevent and to allow the flow of liquid in either direction between the cylinders; valve-operating means operatively connected with the main valve and the car for operating the main valve; a check-valve arranged in one of the conduits to automatically allow a free flow in one direction through such conduit, and to entirely prevent any flow in the other direction therethrough; a valve arranged in the other conduit to control the quantity of liquid which is allowed to pass therethrough; governor mechanism connected with such valve to operate the same; and operative mechanism connecting the governor mechanism with the car.

4. In an elevator, the combination set forth of a car; a motor; power-transmitting mechanism for transmitting power from the motor to raise the car; a hydraulic cylinder comprising two compartments communicating with each other; a piston operatively connected with the power-transmitting mechanism and provided with two heads, one in each compartment of the cylinder; a body of liquid in the cylinder between the piston-heads; and a valve adapted and arranged to restrict the flow of liquid from one compartment to the other when the car descends and arranged to allow the liquid to return freely when the car rises.

5. In an elevator, the combination set forth of a car; a motor; power-transmitting mechanism for transmitting power from the motor to raise the car; a hydraulic cylinder comprising two compartments communicating with each other; a piston operatively connected with the power-transmitting mechanism and provided with two heads, one in each compartment of the cylinder; a body of liquid in the cylinder between the piston-heads; a valve adapted to control the flow of liquid between the compartments; valve-operating means for operating the same; means for applying power to and disconnecting power from the motor; and means connected with the car and arranged to operate the valve-operating means and the power connecting and disconnecting means.

6. In an elevator, the combination set forth of a car; an electric motor; a rheostat for controlling the supply of electricity to such motor; power-transmitting mechanism for transmitting power from the motor to raise the car; a hydraulic cylinder having two compartments communicating with each other; a piston operatively connected with the power-transmitting mechanism and having two heads, one in each compartment of the cylinder; a body of liquid in the cylinder between the piston-heads; a valve adapted to control the flow of liquid between the compartments; valve-operating means for operating the same, and operative mechanism connected with the rheostat and with the valve-operating means and arranged to operate the rheostat to cut off the electric current from the motor when the valve is closed.

7. In an elevator, the combination set forth of the car; an electric motor; power-transmitting mechanism for transmitting power from the motor to raise the car; a hydraulic cylinder having two compartments communicating with each other; a piston operatively connected with the power-transmitting mechanism and having two heads, one in each compartment of the cylinder; a body of liquid in the cylinder between the piston-heads; a valve for controlling the flow of liquid between the compartments; a valve-rod connected with such valve to open and close the same; a rheostat for turning the electric current onto and off from the motor; a valve-rod connected with the valve to open and close the same; a toothed wheel connected with such rod to operate the same to open and close the valve; means for partially rotating the toothed wheel and a rheostat-operating pinion connected with the rheostat and geared with the toothed wheel; the whole being so arranged as set forth that when the toothed wheel is thrown into position in one direction to close the valve, the rheostat is thrown into position to cut off the current from the motor.

8. In an elevator, the combination set forth of the well; the car; the power connecting and disconnecting lever at the bottom of the well; the two pulleys on one stationary axle; such axle carried by the car; a movable pulley carried by the car; a single line of rope having one end fixed at the top of the well, and its

other end fastened to the power connecting and disconnecting lever, and its body arranged around the pulleys; and means for operating the movable pulley.

9. The combination of the car; operative means for raising the car; means for connecting power with and disconnecting power from such operative means; rope-receiving pulleys attached to the car; an adjustable pulley carried by the car and arranged to move toward and from the rope-receiving pulleys; a rope fixed at one end and connected with and arranged to operate the means for connecting and disconnecting the power and arranged with one member around one of the rope-receiving pulleys, the other member around the other rope-receiving pulley, and with a loop in the rope between the two rope-receiving pulleys arranged around the adjustable pulley; means for holding such rope taut; a screw connected with the adjustable pulley to move the same toward and from the rope-receiving pulleys; a sprocket-wheel mounted on the car and provided with a crank for turning the same; a sprocket-wheel arranged to operate the screw; and a sprocket-chain connecting the two sprocket-wheels with each other.

10. In an elevator the combination set forth, of the two rope-receiving pulleys; the adjustable pulley arranged to move toward and from such rope-receiving pulleys; a screw arranged to operate the adjustable pulley toward and from the rope-receiving pulleys, means for operating such screw; and the operating-rope fixed at one end and having its other end operatively connected with the power connecting and disconnecting machinery and having one member wound around one of the rope-receiving pulleys and the other member wound around the other rope-receiving pulley and a loop between the rope-receiving pulleys passed around the adjustable pulley.

11. In an elevator the combination of the car; the supporting-sheave; the counterweight; the supporting-rope arranged over the sheave and fastened at one end to the car and at the other end to the counterweight; the driving-wheel; the flexible driving connection fastened to the counterweight and passed around the driving-wheel; and a spring-pressed adjustable take-up connecting the other end of the driving connection with the bottom of the car.

12. In an elevator a supporting-lever pivoted to the car; two supporting-sheaves arranged above the car; a counterweight; a supporting-rope passing over one of the sheaves and secured at one end to the counterweight and secured at the other end to one end of the supporting-lever; and another supporting-rope passing over the other sheave and fastened at one end to the counterweight and at the other end to the other end of the supporting-lever.

13. The combination of a hydraulic cylinder provided with a port; a piston arranged to work in such cylinder; a valve connected with the piston-head and arranged to close the port at one limit of the piston's movement; and adjustable means for adjusting the valve with relation to the piston-head.

14. The combination of a cylinder having two compartments communicating with each other through a suitable passage; a piston having two heads, one in each compartment; a body of liquid in the cylinder between the piston-heads; a check-valve arranged to hinder the flow of liquid in one direction through the passage and to allow the flow in the other direction; and another valve arranged to cut off communication between the compartments.

15. The combination of a cylinder having two compartments communicating with each other through a suitable passage; a piston having two heads, one in each compartment; a body of liquid in the cylinder between the piston-heads; a check-valve arranged to hinder the flow of liquid in one direction through the passage and to allow the flow in the other direction; a passage not controlled by the check-valve arranged to allow a restricted flow of liquid between the compartments when the check-valve is closed and when it is opened; a valve for closing such passage; a governor arranged to operate such valve to open and close the same; and operative mechanism connecting the piston with the governor to drive the same.

16. The combination of the cylinder having two compartments communicating with each other; a piston having two heads, one in each compartment; a body of liquid in the cylinder between the two piston-heads; a liquid-supply pipe communicating with one of the compartments and extending upward therefrom to a source of supply; a supply of liquid in such pipe; and a check-valve arranged to prevent liquid from passing upward through such pipe and allow it to pass downward therethrough.

17. The combination of the elevator-car; the driving-wheel; means connecting the driving-wheel with the car to operate the same; a pinion connected with the driving-wheel to be rotated thereby; a rack geared with such pinion and arranged to move freely in one direction, and means for retarding the motion of the rack in the other direction.

18. The combination of the elevator-car; the driving-wheel; means connecting the driving-wheel with the car to operate the same; a pinion connected with the driving-wheel to be rotated thereby; a rack geared with such pinion and arranged to move freely in one direction; a cylinder having two compartments communicating with each other through a suitable passage; a piston connecting with the rack and having two heads one in each compartment; a body of liquid in the cylinder between the piston-heads; and means ar-

ranged to hinder the flow of liquid in one direction through the passage and to allow the flow in the other direction.

19. In a hydraulic elevator, the combination of a cylinder having two compartments; a passage between the compartments; a body of liquid in the compartments and passage; a piston arranged to force the liquid through the passage in either direction; a check-valve arranged to hinder the flow of liquid in one direction through the passage and to allow the flow in the other direction; a passage not controlled by the check-valve arranged to allow the restricted flow of liquid between the compartments when the check-valve is closed and when it is open; and a valve for controlling such passage.

20. In a hydraulic elevator, the combination of a cylinder having two compartments; a passage between the compartments; a body of liquid in the compartments and passage; a piston arranged to force the liquid through the passage in either direction; a check-valve arranged to hinder the flow of liquid in one direction through the passage and to allow the flow in the other direction; the passage not controlled by the check-valve arranged to allow the restricted flow of liquid between the compartments when the check-valve is closed and when it is open; a valve for controlling such passage, and another valve arranged to cut off communication between the compartments.

21. In a governor, the combination of the rotating shaft having the slotted radial arms; the rocking levers pivoted to such shaft; the governor-weights arranged to slide along the radial arms respectively; the connecting-rods within such arms respectively, and extending beyond the ends thereof and there connected with the sliding weights, respectively; the sleeve, and its rod; and the connecting-rods connecting the rocking levers with the sleeve in toggle fashion substantially as set forth.

22. The combination of the elevator-car; means for operating the car; a cylinder closed at the ends and fixed to and carried by the car; a rack arranged along the path of the car; a screw-shaft arranged to revolve in the cylinder and provided with a pinion meshing with the rack; a body of liquid in the cylinder; a movable head fitted to slide and not revolve within the cylinder and provided with a screw-threaded hole in which the screw-shaft fits and with a passage for liquid through the head; and a valve for hindering the flow of liquid in one direction through the head and allowing it to pass freely in the other direction.

23. The combination of the elevator-car; means for operating the car; a cylinder fixed to and carried by the car; a rack arranged along the path of the car; a screw-shaft arranged to revolve in the cylinder and provided with a pinion meshing with the rack; a body of liquid in the cylinder; a movable head fitted to slide and not rotate within the cylinder and provided with a screw-threaded hole in which the shaft fits and with two passages for liquid through the head; a valve for one of such passages arranged to prevent the flow of liquid in one direction through the head and to allow it to pass freely in the other direction; a valve for the other passage; a governor; and operative means connecting the valve with the governor to cause the operation of the governor to close the valve.

24. The combination of the elevator-car; means for operating the car; a cylinder fixed to and carried by the car; a rack arranged alongside the path of the car; a screw-threaded shaft arranged to revolve in the cylinder and provided with a pinion meshing with the rack; a body of liquid in the cylinder; a movable head fitted to slide and not revolve within the cylinder and provided with a screw-threaded hole in which the shaft fits and with two passages for liquid through the head; a valve for preventing the flow of liquid in one direction through one of the passages in the head and allowing it to pass freely in the other direction; a rod extending along within the cylinder parallel with the screw-shaft; a valve for the other passage through the head arranged upon such rod to slide and not rotate thereupon; and a governor operatively connected with the valve-rod to rotate the same to open and close the valve.

25. The combination of a cylinder; a body of liquid therein; a movable head fitted to slide and not rotate within the cylinder and provided with a passage for the liquid therethrough, and with a screw-threaded hole; a screw-threaded shaft arranged in the cylinder and screwing through such hole and provided with a pinion; a valve arranged to hinder the flow of liquid in one direction through the head and allow it to flow freely in the other direction; and a rack meshing with the pinion for rotating the screw-shaft.

26. The combination of the cylinder; the body of liquid within the cylinder; the movable head arranged within the cylinder to slide therealong and provided with a passage for liquid therethrough; the valve arranged to close such passage; a valve-operating rod extending from such valve to the outside of the cylinder and means for operating such valve-rod to open and close the valve.

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