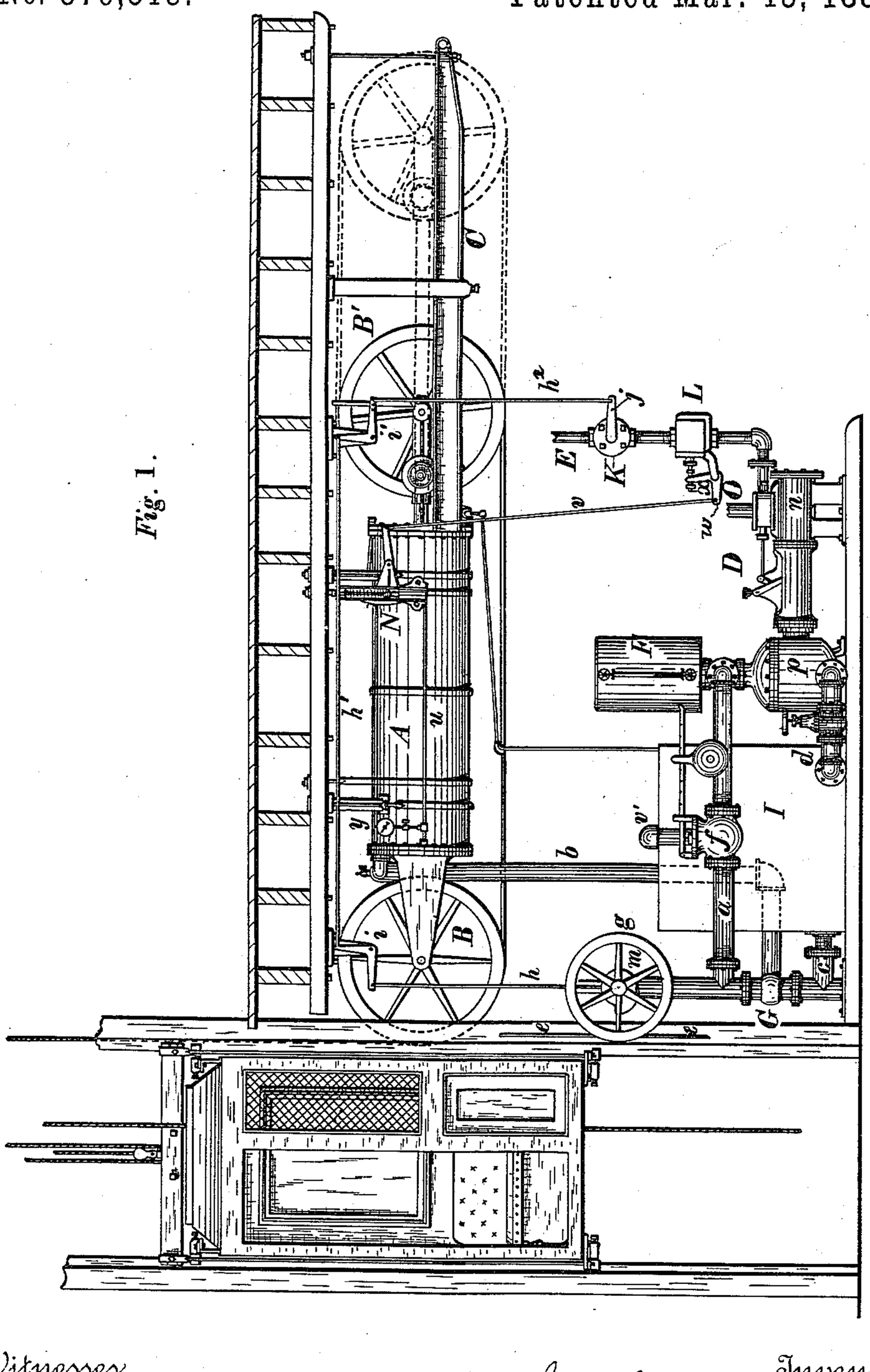
(No Model.) 2 Sheets—Sheet 1.

L. S. & F. B. GRAVES.

HYDRAULIC ELEVATOR.

No. 379,513. Patented Mar. 13, 1888.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

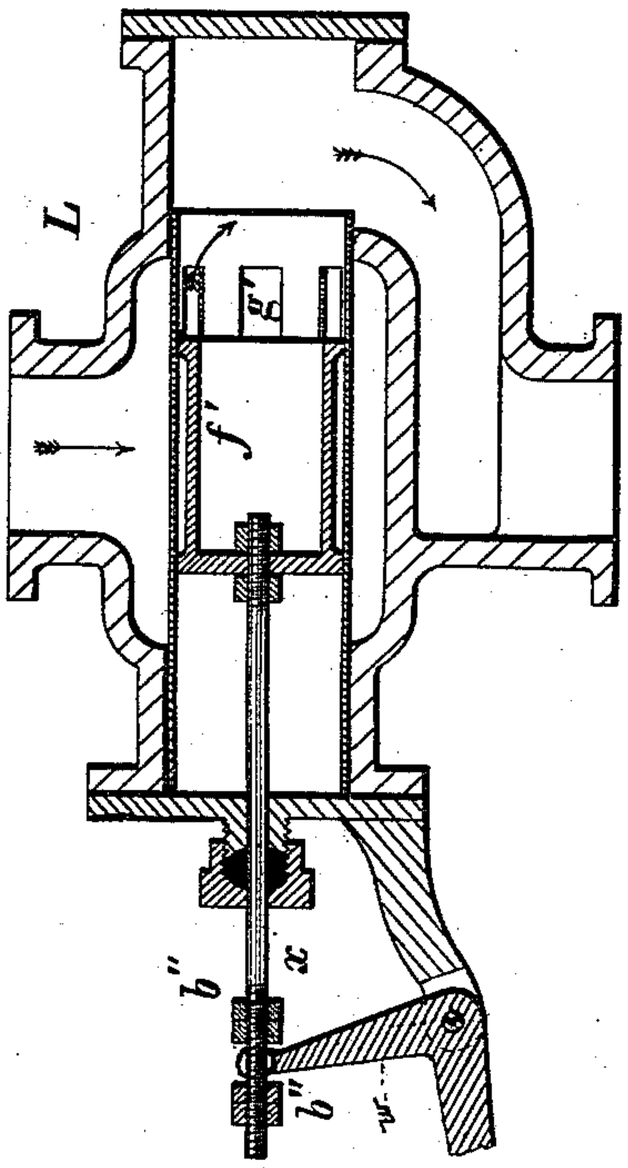


Fig. 4.

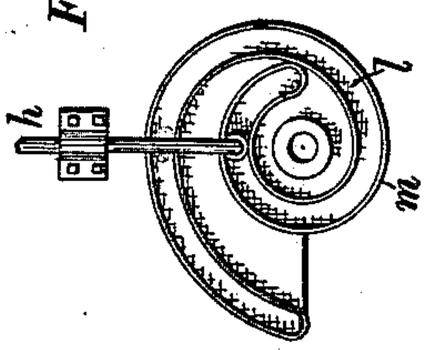
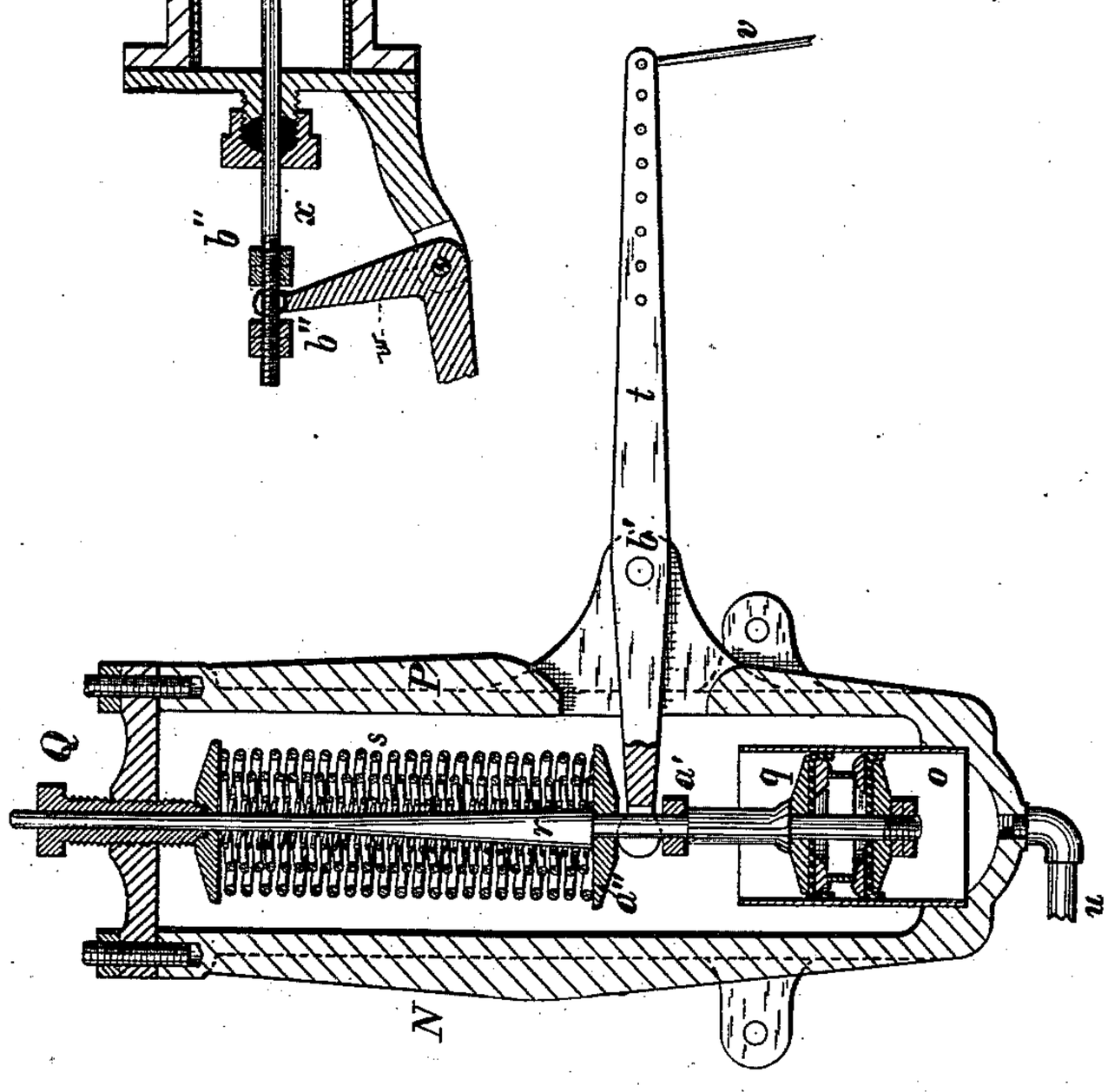


Fig. 2.



Witnesses.
H. G. Phillips.
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F. B. Graves,
By their Attorney
Geo. B. Selden

UNITED STATES PATENT OFFICE.

LORENZO S. GRAVES AND FRED. B. GRAVES, OF ROCHESTER, NEW YORK.

HYDRAULIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 379,513, dated March 13, 1888.

Application filed April 19, 1886. Serial No. 199,398. (No model.)

To all whom it may concern:

Be it known that we, LORENZO S. GRAVES and FRED. B. GRAVES, citizens of the United States, residing at Rochester, in the State of New York, have jointly invented an Improved Direct-Pumping Hydraulic Elevator, of which the following is a specification, reference being had to the accompanying drawings.

Our invention relates to an improved system of constructing direct-pumping hydraulic elevators, whereby we effect an economy of steam and avoid the vibratory or pulsating motion of the elevator-platform, which has been heretofore a serious objection to the use of elevators of this class.

Our invention is fully described and illustrated in the following specification and accompanying drawings, and the novel features thereof specified in the claims annexed to the said specification.

In the accompanying drawings, representing our improved direct-pumping elevator system, Figure 1 is a side elevation showing the pump, tank, air-chamber, hydraulic cylinder and attachments, and the regulator with its connecting mechanism. Fig. 2 is a central vertical section through the regulator. Fig. 3 is a vertical section through the steam-valve. Fig. 4 represents the scroll or cam for operating the steam-inlet valve.

A is a hydraulic cylinder, which may be located in any preferred relation to the steam-pump and elevator-well, as convenience in any particular case may require. The hydraulic cylinder A is provided, as usual, with a piston and the stationary and movable sheaves B B′, around which the lifting-cable, which is connected with the elevator car or platform, is led. The movable sheaves B′ are connected with the piston by suitable piston-rods and arranged to travel on suitable ways, C, as in elevators of ordinary construction.

D is a duplex steam-pump, of ordinary construction, arranged to receive steam from a suitable steam-boiler through the supply-pipe E. The water-cylinders *p* of the duplex pump are provided with the ordinary air-chamber, F. From the water-cylinders the water is forced by the pump through the pipe *a*, the valve G, and the pipe *b* into the hydraulic cylinder A, the discharge from the hydraulic cylinder taking place through the pipe *c* into the water-tank I.

d is the inlet or suction pipe connecting the water-tank with the water-cylinders. The pipe *a* is provided with the weighted safety or overflow valve *f*, the surplus water discharged by the valve being delivered into the tank I through a suitable pipe, *v′*.

e is the shifting-cable, which is attached to the wheel *g*, the shaft of which is provided with a pinion meshing with a rack connected with the valve in the valve-casing G, by the movement of which valve the supply of water to or the discharge of water from the hydraulic cylinder is effected.

The valve and valve-casing may be of any ordinary or preferred construction.

Upon the shaft of the wheel *g* is placed a scroll or cam, *m*, (represented on an enlarged scale in Fig. 4,) which, by means of the rods *h* *h′* *h²* and bell-crank levers *i* *i″*, if required, transmits motion to the lever *j*, which opens or closes the valve K in the steam-supply pipe E. The lower end of the rod *h* is provided with a roller fitted to the groove *l* in the scroll *m*, the lower end of the rod being arranged to slide in a suitable guide. As will be observed from an inspection of Fig. 4, the groove *l* of the scroll or cam *m* is made on a true circle for about half its length and extended outwardly for the other half, the object of such construction being to open the throttle-valve K when the hydraulic valve in the casing G is shifted to the position it is required to occupy in order to admit water from the pump to the hydraulic cylinder, while permitting the valve G to be moved in the opposite direction for the purpose of discharging the water from the cylinder without affecting the position of the throttle-valve K. The valve K is opened and closed by the outer or curved portion of the cam-groove, but remains closed while the roller on the end of rod *h* is engaged with the circular or concentric portion of it. The bell-cranks *i* *i′* are pivoted to suitable brackets attached to the ceiling or any other convenient portion of the building, the particular arrangement shown in the drawings being illustrative merely of the manner of operating the valve K from the scroll or cam *m*. Any other suitable means of effecting this action may be

adopted as the location or relative arrangement of the steam-pump, the hydraulic cylinder, and the valve-casing G may require in any particular case.

In order to regulate or proportion the supply of steam to the steam-cylinders *n* of the duplex pump D, we insert in the steam-supply pipe E the steam-valve L, arranged to be operated by the regulator N, the construction of which is shown on an enlarged scale in the sectional view, Fig. 2. This valve is placed in the pipe between the throttle-valve and the cylinders. The regulator N consists, essentially, of a suitable cylinder, *o*, provided with one or more water-tight pistons, *q*, attached to the rod *r*, and one or more spiral-springs, *s*.

The cylinder *o* is connected by means of the pipe *u* with the interior of the hydraulic cylinder at the end next the inlet-pipe, or to the inlet-pipe itself, and the rod *r* is connected by means of the lever *t*, rod *v*, and bell-crank lever *w*, if required, with the stem *x* of the steam-valve L. The construction is such that the amount of steam admitted through the valve L to the steam-cylinders *n* of the pump D will vary with the pressure of the water in the hydraulic cylinder A, according to the load on the platform of the elevator. If there be a light load on the platform, the pressure in the cylinder *o* will only raise the rod *r*, compressing the spring *s* a short distance, and thereby, through the levers *t w* and rod *v*, opening the steam-valve L but slightly and permitting the entrance of a limited quantity of steam to the cylinders *n*, while if there be a heavy load on the platform the pressure in the cylinder *o* will be greater than in the previous case, the rod *r* will be moved a greater distance, and the valve L will be opened wider, thus proportioning or graduating the quantity of steam used to the amount of work to be done in elevating the load. Thus if a water-pressure of twenty pounds be required in the hydraulic cylinder A in order to raise a given load, the pressure of steam in the cylinders *n* will be regulated by the steam-valve L, so as to produce a water-pressure in the cylinders *p* of the pump sufficient to perform the work at the desired speed. This pressure is slightly above that required in the hydraulic cylinder, sufficient to overcome the friction in the valve and pipes, thereby effecting a large degree of economy in the use of steam and destroying the vibrations of the elevator-platform caused by the motion of the pump if a full head of steam were used. The power is applied in a graduated manner exactly as required, thereby avoiding shocks or pulsations. A pressure-gage, *y*, may be employed to indicate the amount of water-pressure in the hydraulic cylinder. The pistons *q* in the cylinder *o*, which are preferably made double in order to prevent leakage, are provided with the ordinary cup-leather packing. The rod *r* is provided with the collars a' a^2, between which the inner end of the lever *t* is fitted. Provision is made for adjusting the tension of the spring or springs *s* by means of a screw or threaded rod, Q, at the upper end of the frame-work P of the regulator. The lever *t* is pivoted at b' to a projecting lug on the frame-work of the regulator.

We do not confine ourselves in this application to any particular form of regulator; but one constructed in substantial accordance with the drawings annexed to this specification has been found in practice to operate satisfactorily. We prefer to use a number of coiled springs, *s*, of different diameters, placed one within the other; but a single coiled spring or any other preferred form of spring may be used. The outer end of the lever *t* is provided with a series of holes or other devices by which the point of connection between the lever and the rod *v* may be changed in order to alter the throw of the steam-valve L. The end of the bell-crank lever *w* is connected with the piston-rod *x* by the jam-nuts b^2 b^2, so that the position of the balanced piston-valve f' may be regulated with reference to the ports g'. The object of this adjustment is to admit of adjusting the valve f' so as to regulate the speed of the elevator. The valve f' is ordinarily set a trifle open, so that the pump will start with a light load on the platform or the weight of the platform itself. Any other suitable form of steam-regulating valve may, however, be employed instead of the one herein shown.

It will be evident on inspection that our improved construction of direct-pumping hydraulic elevators possesses many advantages over the usual tank system, in that it dispenses with the objectionable roof-tank and lengthy pipe-connections. Our construction also enables us to decrease the first cost; it occupies less room; there is less friction in the water-passages, and its lifting capacity can be increased beyond its ordinary limit, if required. We have demonstrated by practical trials on an extended scale that by our improved construction the pulsatory or vibrating motion of the elevator-platform is entirely obviated, which is due to the fact that the movement of the pump is regulated and controlled in direct proportion to the amount of work to be done.

We are aware of Patents Nos. 193,027, 220,479, and 248,562, and hereby disclaim the constructions shown in them, as our invention has for its leading idea the attachment of a spring piston-regulator to the hydraulic cylinder, so as to receive the pressure of the water therefrom, whereby the load is, as it were, weighed, and the amount of steam admitted to the steam-pump proportioned or graduated to the load. By our invention we can raise light or heavy loads at the same rate of speed, as with the heavy loads the amount of steam admitted to the steam-pump is increased in proportion, in consequence of the greater compression of the spring of the regulator by the higher pressure in the hydraulic cylinder,

whereby the inlet-valve L is opened, so as to permit the passage of a greater quantity of steam.

We are aware that it has been proposed to provide hydraulic elevators employing compressed air acting directly upon the water in the lifting-piston in the main cylinder with regulator-valves operated by the difference between the pressure in the main cylinder caused by the weight on the car and the pressure of air acting upon the water, and do not desire to be understood as claiming any such construction of devices, our construction being superior in many respects, among others in that we dispense with maintaining high pressures in reservoirs either of steam or air, but operate our direct-pumping apparatus by steam at a low pressure, if desired, the amount used being regulated automatically in proportion to the load to be raised.

We claim—

1. In a hydraulic elevator, a hydraulic cylinder, a piston operating therein, to which the weight to be moved is connected, a steam pumping apparatus for forcing water into the hydraulic cylinder, a valve controlled by the operator in the car for controlling the admission of steam to the pumping apparatus, a governing device—such as a piston operated upon by the pressure in the main cylinder—connected to a valve located in the main steam-supply, whereby the operator may, by a manipulation of the first-mentioned valve, admit steam to or cut it off from the pump, while the piston-regulator is so arranged as to admit a greater quantity of steam to the pump when the pressure in the cylinder increases, and vice versa, substantially as described.

2. In a hydraulic elevator, the combination of the main cylinder, the piston operating therein connected to the weight to be moved, a steam pumping apparatus for forcing water into the cylinder, a tank with which the pump communicates and into which the main cylinder exhausts, a valve for controlling the passage between the main cylinder and the pumping apparatus, a valve for controlling the passage of steam to the pumping apparatus, and suitable connections between the said valves whereby they will be operated together, substantially as described.

3. In a hydraulic elevator, the combination of the main cylinder, a piston operating therein connected to the weight to be moved, a tank, a steam pumping apparatus for forcing water into the cylinder from the tank, a valve for controlling the passage between the pumping apparatus and the cylinder and between the cylinder and the tank, a valve for controlling the admission of steam to the pump, and connections between the two valves whereby they will be operated together, as set forth.

4. In a hydraulic elevator, the combination of the main cylinder, a piston operating therein connected to the weight to be moved, a tank, a steam pumping apparatus for forcing water into the cylinder from the tank, a valve controlling the passage between the pumping apparatus and the cylinder and between the cylinder and the tank, a valve located in the steam-supply to the pumping apparatus, and suitable connections between the two valves whereby the first-mentioned valve may be operated to regulate communication between the cylinder and tank, but when operated to open communication between the pumping apparatus and the cylinder the steam-valve will be opened, substantially as described.

5. In a hydraulic elevator, the combination of the main cylinder, the piston therein connected to the weight to be moved, a steam pumping apparatus for forcing water into said cylinder, a tank, a valve controlling the passage between the pumping apparatus and the cylinder and between the cylinder and tank, devices for operating said valve directly from the car, a valve controlling the admission of steam to the pumping apparatus, connections between the two valves, and a device—such as a cam—interposed in said connection, whereby the operator in the car may operate the water-valve to regulate the exhaust from the cylinder to the tank, but operating when communication is established between the pumping apparatus and the cylinder to open the steam-valve, substantially as described.

6. In a hydraulic elevator, the combination of the main cylinder, the piston therein connected to the weight to be moved, a steam pumping apparatus for forcing water into said cylinder, a valve for controlling the passage between said pumping apparatus and cylinder and also the exhaust from said cylinder, a valve for controlling the admission of steam to the pumping apparatus, a shaft by the rotation of which the water-valve is operated, a cam connected thereto, having a way therein partly concentric and partly eccentric, a projection operating in said way connected to the steam-valve, whereby when the water-valve is operated to control the exhaust the projection is in the concentric portion, but when the valve is operated to connect the pumping apparatus with the cylinder the projection engages the eccentric portion and the steam-valve is opened, substantially as described.

7. In a hydraulic elevator, the combination of the main cylinder, a piston connected to the weight to be moved operating therein, a steam pumping apparatus for forcing water into the cylinder, a tank with which said pump connects, a valve controlling communication between the pump and cylinder and also the exhaust from the latter into the tank, a valve for controlling the supply of steam to the pump, connection between the two valves for causing them to operate together, and an automatic pressure-regulator communicating with the main cylinder and with a governing-valve located in the main steam-supply operating to admit a quantity of steam to the pump pro-

portioned to the amount of pressure caused by the weight on the piston in the main cylinder, substantially as described.

8. In a hydraulic elevator, the combination of the main cylinder, the piston connected to the weight, the steam pumping apparatus for forcing water into the cylinder, a supplemental cylinder connected to the main cylinder, a piston therein, a spring operating on said piston against the movement caused by pressure in the main cylinder, means for adjusting the tension of the spring, a governor-valve in the main steam-supply to the pump, and a connection between said valves and the supplemental piston, whereby the amount of steam admitted to the pump is proportioned to the pressure in the main cylinder and this proportion can be regulated by adjusting the tension of the spring before mentioned, substantially as described.

9. The combination, with the cylinder A of a hydraulic elevator, of the steam-pump D, suitable water outlet and inlet passages, regulator N, connected to the hydraulic cylinder and arranged to operate the steam-valve L, the steam-inlet valve K, cam *m*, and suitable connecting mechanism, substantially as described.

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FRED. B. GRAVES.

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