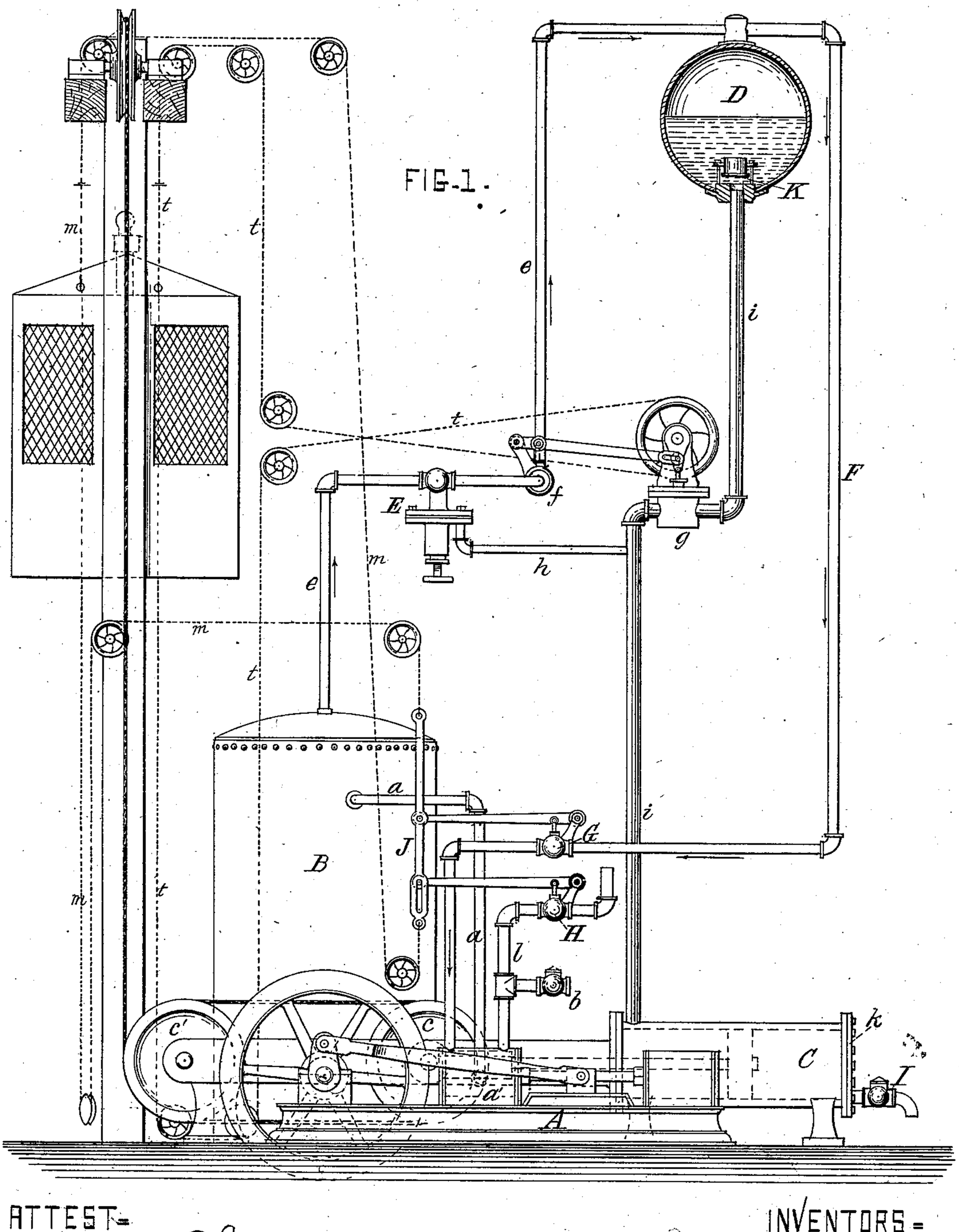
2 Sheets—Sheet 1.

G. JOHNSON & W. M. BAILEY.

HYDRAULIC AND PNEUMATIC ELEVATOR.

No. 256,702. Patented Apr. 18, 1882.

FIG-1.



ATTEST=

John E. Gavin

Chas. M. Higgins

INVENTORS=

George Johnson

Walter M. Bailey

by S. H. Wales Jr.

their Attys

2 Sheets—Sheet 2.

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FIG-2-

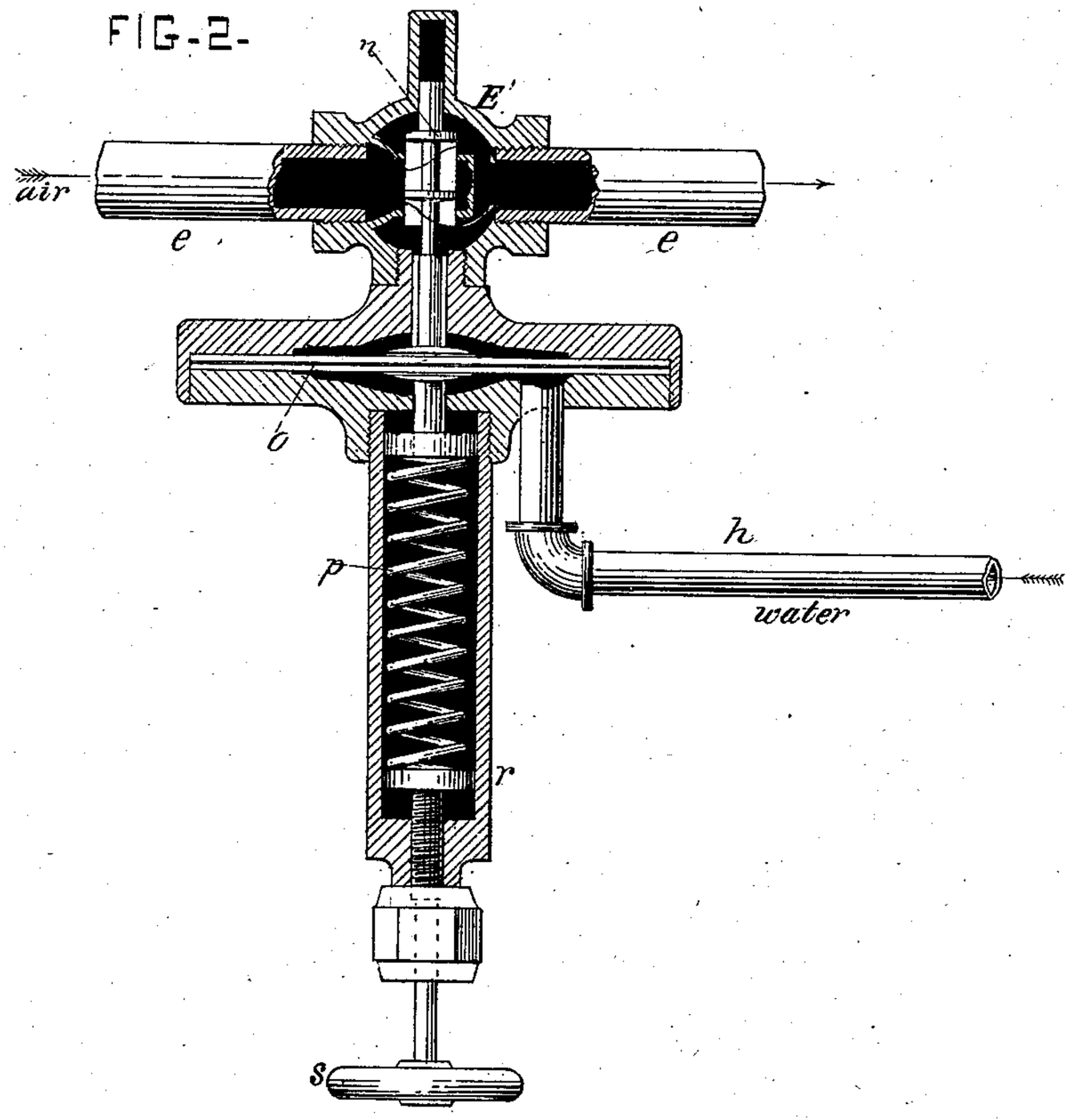
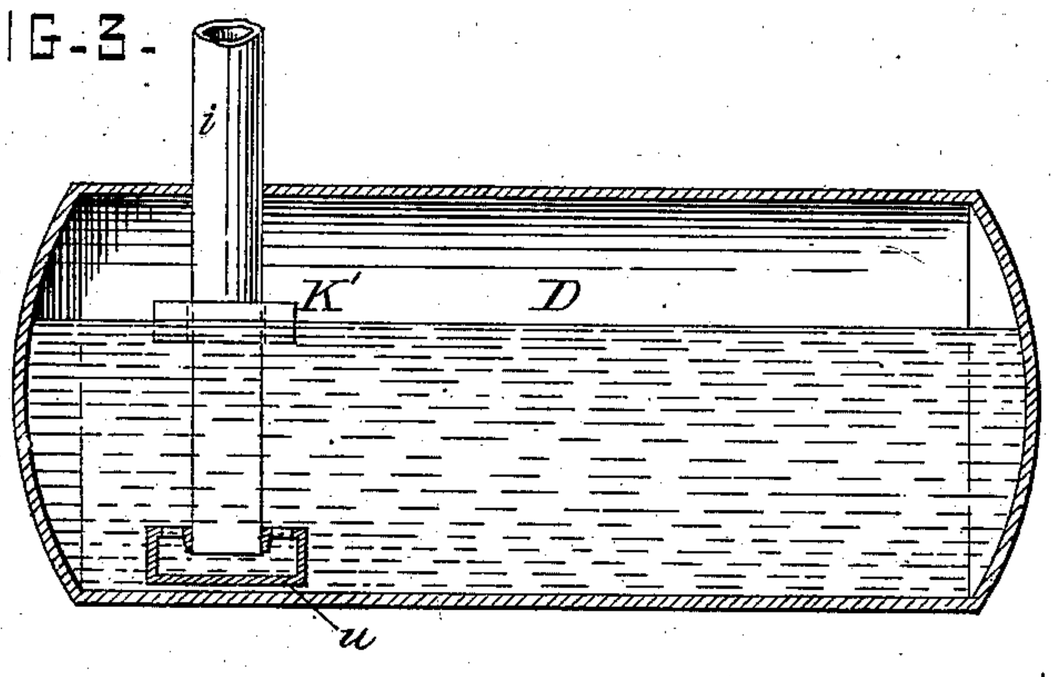


FIG-3-



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by S. N. Wales Hon

their attys.

UNITED STATES PATENT OFFICE.

GEORGE JOHNSON, OF CINCINNATI, OHIO, AND WALTER M. BAILEY, OF NEW YORK, N. Y.

HYDRAULIC AND PNEUMATIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 256,702, dated April 18, 1882.

Application filed October 6, 1879.

To all whom it may concern:

Be it known that we, GEORGE JOHNSON, of Cincinnati, Ohio, and WALTER M. BAILEY, of New York city, New York, have invented certain new and useful Improvements in Combined Hydraulic and Pneumatic Elevators, of which the following is a specification.

Our present invention embodies that form of elevating apparatus patented to us October 14, 1879, in which the work of lifting is performed by the pressure of compressed air acting on a controlled hydraulic column of water which supports and governs the movement of the car.

Our present improvements lie in effecting a vacuum in the rear or idle end of said cylinder; in an improved form of automatic regulating valve or governor so constructed as to secure great certainty and sensitiveness of action; in a connection between the intermediate air and water vessel and the air-compressors, whereby the exhaust-air from said vessel is utilized by the compressor; and in a submerged float-valve governing the water-exit from the said vessel to the hydraulic lifting-cylinder, whereby the inflow of air into the latter is prevented, as hereinafter fully set forth.

Figure 1 in the annexed drawings presents an elevation of our improved elevating apparatus. Fig. 2 is an enlarged vertical section of the automatic regulating-valve connecting with the air and water pipes, and Fig. 3 is a modification of a portion of the apparatus.

In Fig. 1, A indicates the air-compressing pump or engine of any approved form.

B is the compressed-air reservoir, into which the pump discharges the compressed air through the connecting-pipe *a*.

C is the cylinder of the hydraulic lifting-engine; *c*, the movable sheaves, mounted on the cross-head of its piston-rod, as usual; and *c'*, the fixed sheaves, mounted at the end of the guides, over which sheaves the cables pass and connect with the car, as indicated, in the ordinary manner.

D is the water-reservoir intermediate between the air-reservoir B and the hydraulic engine-cylinder C, and connected with each, as illustrated. The air-pipe *e* from the reservoir B opens into the top of the water-vessel D above the water therein, while the water-pipe *i*, which connects with the hydraulic engine-cylinder C, of course opens into the bottom of the vessel D, as illustrated. The water-passage *i* is controlled by a valve, *g*, and the air-passage *e* is controlled by a similar valve, *f*, which are constructed to work simultaneously, or nearly so, as illustrated, and are operated by a cord or chain from a pulley on the crank-shaft of the valve *g*, which extends to the car in the usual manner, as will be readily understood.

By this form of elevating apparatus it will be observed that while the work of elevating is performed by the compressed air an uninterrupted hydraulic column of water is interposed between the air and the lifting-piston, and as this column moves through a long and narrow passage between the intermediate vessel and the lifting-cylinder, and is controlled by a valve therein, the elevator is not supported or controlled by the elastic air alone, but by an inelastic water column, thus securing the stability and certainty of hydraulic action, together with the economy and quick action of air-pressure, as fully set forth in our former patent above referred to.

In our former apparatus we arranged the intermediate air and water vessel, D, on about the same level as the lifting-cylinder C, and proposed to counterweight the car in the usual manner. One feature of our present invention, however, consists in arranging the intermediate vessel, D, considerably above the lifting-cylinder, as illustrated, and at such a height that the hydraulic pressure of the column of water therefrom on the elevating-piston will serve to counterbalance the car, thus enabling a counterweight to be dispensed with. It will therefore be readily observed that in being thus enabled to balance the car without a counter-weight we present the important advantage of cheapness in dispensing with many parts, and for the same reason largely reduce friction, and also cause the hoisting-cables to remain constantly taut, whether ascending or descending. Furthermore, greater safety is secured, as there is no counter-weight to fall and do damage in case of breakage of ropes; and, moreover, the car may be fitted with a safety-catch spring much stronger than is usual, and

which will more nearly approach to the weight of the car, whereas in ordinary counterweighted cars the strength of the spring cannot be greater than the difference between the counter-weight and the car.

The height at which to arrange the intermediate vessel, D, above the hydraulic cylinder C, so as to counterbalance the car, will of course depend upon the weight of the car, and this weight being known, as also the diameter of the piston, the height of a column of water to balance, or nearly balance, the car can be readily found and the vessel D placed accordingly, so that in some cases the vessel will require to be elevated but one or two stories above the cylinder, while in others it may be placed in the top of the building. In buildings, however, where a heavy car is used, and where it will not be convenient to locate the intermediate vessel on the story of balancing height, it may be located in a lower story and the difference made up by effecting a vacuum back of the piston in the idle end of the cylinder C. Hence, according to this feature of our invention, the back or idle end of the cylinder, which is usually left open, we close by an air-tight head, *k*, and attach to the same a check-valve, I, opening outward. Hence, when the piston moves forward, it will force out through the check-valve any air or water that may have leaked into the space, so that when the piston returns as the car descends a vacuum will be effected in the idle end of the cylinder, which, with the water column from the reservoir D, will in most all cases serve to perfectly counterbalance the car.

According to our present invention, instead of discharging the exhaust-air from the intermediate vessel, D, into the atmosphere, we extend the exhaust-pipe F therefrom to the jacket *a'* of the air-compressing cylinder, so that as the suction-ports of the cylinder open into this jacket the cylinder thus receives its air in a cooled condition, and also under a slight pressure from the vessel D, which, as will be obvious, greatly conduces to the economical working of the compressor.

The exhaust-pipe F is fitted with a valve, G, the opening of which admits the exhaust from the vessel D into the jacket of the compressor, and a secondary exhaust-pipe, *l*, extends from the jacket, which is fitted with a valve, H, which, when opened, allows a free exhaust into the atmosphere from the vessel D through the jacket, when required, as will be readily understood. This pipe *l* is also fitted with a check-valve, *b*, opening inward to admit a free air-suction into the jacket when the supply of exhaust-air from the vessel D is not sufficient.

In Fig. 1 the several valves and pipes are shown somewhat disproportional and disarranged for convenience of illustration. In practice the air-valve *f*, water-valve *g*, and exhaust-valves G H will all be arranged upon the water-vessel D, or as close as possible to the connection of the several pipes therewith, so as to avoid all idle air-spaces in said connections which would cause a waste of compressed air. For the same reason the capacity of the intermediate vessel, D, will be so proportioned to the lifting-cylinder C, and so charged with water, as to become entirely filled when the water returns into the same from the cylinder C, when the piston reaches the end of its stroke on the full descent of the car, so as to leave no idle air-space in the vessel.

The levers of the exhaust-valves G H are connected, as illustrated, to an operating-bar, J, which is so slotted at its connection with the valve H that when the bar is raised partly it opens the valve G, but allows the free exhaust-valve H to remain closed, while when the bar is fully raised the valve H is also opened, thus allowing a free exhaust through the jacket into the air. When the car reaches the top of its ascent, where a stop is usually made till a call-signal is received from below, the terminal movement of the car is arranged to automatically operate the cord *m* and open the exhaust-valve G, allowing the exhaust-air from the vessel D to be discharged into the jacket of the compressor, where it is utilized by the compressor under whatever pressure it may possess, and also in a cooled condition from its previous expansion, thereby causing a great economy in the working of the compressor, as before described. The stoppage of the car at the top is usually sufficiently long to allow all of this air to be thus drawn in by the compressor, thus removing all back-pressure from the vessel D before it is necessary to descend. In case, however, a descent is required before this takes place, and the descent of the car is found to be too much retarded by the combined exhaust, this back-pressure may be entirely removed by giving the cord *m* an additional movement, and thus opening the free exhaust H, thus allowing the car to descend freely.

The air-valve *f* and water-valve *g* are also so connected that the movement of the crank-shaft in one direction opens the water-valve *g* and air-valve *f* simultaneously, allowing the air-pressure to bear upon the water in the vessel D, which, forcing the same into the cylinder C, moves the elevating-piston and raises the car. A partial reverse movement, however, closes the water-valve and also the air-valve and stops the car at the desired height. A full reverse movement, however, again opens the water-valve, but not the air-valve, thus allowing the car to descend, the exhaust-valves being already open, as before described.

Another feature of our invention aims to prevent any air being drawn into the cylinder C with the water from the vessel D, should the water-level happen to fall close to the mouth of the pipe *i*, and as this air would form an elastic cushion in the lifting-cylinder, thus causing an unsteady motion of the car, it is hence quite important to avoid it. This we effect by arranging a submerged float-valve, K, within the vessel D, over the opening of the

pipe *i*, which valve is guided and limited in its movement by headed rods or other means, as illustrated. It will now be readily seen that while there is sufficient water in the vessel D the buoyancy of the valve will keep the passage *i* open; but should the water fall to a dangerous level, the valve, becoming unsupported, will descend and close the passage, thus preventing any inflow of air. This feature is of course applicable to the common hydraulic elevator acting by the pressure of a head as well as to those acting by compressed air or other elastic fluid.

In cases where it is found convenient to have the water-pipe rise out of the top of the water vessel in the form of a siphon, as in Fig. 3, the mouth of the pipe may be fitted with a box or chamber, *u*, having an annular row of perforations on its top side, which may be guarded by an annular float-valve encircling and guided by the pipe, as illustrated.

The remaining feature of our invention lies in an improved form of automatic governing-valve to regulate the supply of air to the intermediate vessel, D, according to the requirements of the load to be lifted, on the same principle as that shown in our previous patent. In our former device, however, we employed a cylinder and piston as the means of moving the air throttling or governing valve, the air-pressure being admitted to one side of the piston and the water-pressure to the other, the piston being moved and the valve opened or closed, according to the difference between the two pressures. In our present invention we employ a diaphragm to move the valve, and so connect the same with the air-pipe that we obviate the packing of the valve-stem, and thus avoid friction in the working of the valve, rendering the same quite sensitive and certain in its action.

In Fig. 1, E represents our improved governing-valve attached to the air and water pipes, and Fig. 2 presents an enlarged sectional view of the valve removed.

E′ is the air-throttling valve, which is arranged in the air passage or pipe *e*, between the water-vessel D and the air-reservoir B. The valve-disk *n* of this valve is of double or balanced form, as illustrated, so as to open or close without resistance.

o is the operating-diaphragm, to which the stem of the throttling-valve connects, and this diaphragm we prefer to construct of a central layer of thin sheet-brass, with a thicker sheet of rubber upon each side thereof. The chamber below the diaphragm is connected by the water-pipe *h* with the hydraulic cylinder C, which, admitting the water from the cylinder or the pipe *i*, thus communicates the pressure on the lifting-piston, which of course corresponds to the weight on the car, to the under side of the diaphragm. Now, the chamber above the diaphragm opens into that branch of the pipe *e* which extends to the water-vessel D, so that the pressure of the air in said vessel is communicated to the upper side of the diaphragm through the neck of the casing in which the valve-stem moves, the stem being loose in said neck and flattened or grooved on its sides, so as to allow free communication between the said parts. It will now be evident that if the water-pressure on the under side of the diaphragm, which represents the weight of the car, is greater than the air-pressure on the top of the diaphragm from the vessel D, which represents the driving force, this driving force being therefore insufficient, the diaphragm will be raised by the preponderating water-pressure, causing the air-governing valve *n* to open and admit the full pressure of air from the reservoir B into the water-vessel D, thus supplying sufficient force to move the weighted car at proper speed. Should, however, the weight of the car be decreased by the discharge of one or more of the passengers, the air-pressure then becoming much greater than is necessary to lift the reduced load, preponderates over the water-pressure and depresses the diaphragm, thus shutting off any further supply of air from the reservoir, allowing the charge already in the vessel D to work expansively till it falls too low, when it will again receive a fresh charge or partial charge from the air-reservoir through the automatic action of the valve.

In order to render the action of the diaphragm in opening the air-valve more certain, a constant additional pressure is applied to the water or under side of the diaphragm by the spring *p*, inclosed in the tube *r*, and adjusted to the desired pressure by the hand-wheel *s*, by which means it will be observed that a slight but constant upward pressure is placed upon the diaphragm in addition to the water-pressure, so as to always give the water-pressure the advantage over the air-pressure, thus insuring the certain operation of the air-valve when the air-pressure falls, and also insuring that the supply of air to the vessel D shall always be ample for the work without being excessive. It will therefore be observed that by the described construction of our improved governing-valve we avoid all appreciable friction in its workings, thus rendering its action quite sensitive and certain, and regulating the supply of air precisely according to the requirements of the load to be lifted, thereby utilizing the full expansion and working-power of the air.

What we claim as our invention is—

1. A hydraulic elevating apparatus having its lifting-cylinder constructed with a closed or air-tight head on its idle end, provided with an outwardly-opening check-valve, whereby a vacuum is effected and maintained on the outer side of the piston during the descending movement, to serve to counterbalance, or partly counterbalance, the weight of the car.

2. A pneumatic or combined hydraulic and pneumatic elevating apparatus having the exhaust-air pipe connected with the jacket or

the suction-ports of the air-compressing pump, whereby the exhaust-air is utilized by the compressor or discharged through the jacket, serving to cool the air-cylinder and assist the working of the compressor, substantially as herein set forth.

3. A hydraulic elevating apparatus having a water-reservoir provided with a submerged float-valve guarding the water-exit therefrom to the lifting-cylinder, whereby said exit remains open during a sufficiency of water, but is closed by the descent of the float when the water falls below a normal level, thus preventing the inflow of air to the lifting-cylinder, substantially as shown and described.

4. The combination, in a hydraulic elevating apparatus operated by the pressure of air or other elastic fluid acting on a hydraulic column, of an automatic valve governing the supply of air-pressure on the hydraulic column, consisting of an air-throttling valve in the air-supply pipe connected with a movable partition or diaphragm, the chamber below which is connected with the water column, while the chamber above the partition or diaphragm is in direct and open connection with the air-pipe around the stem connecting the throttling-valve and diaphragm, whereby the valve-stem works without friction, thus rendering the action of the valve certain and sensitive.

5. The combination of the diaphragm *o* and air-throttling valve *n*, connected together, the water-pressure pipe *h*, communicating with one side of the diaphragm, the spring assisting said pressure, and the air-supply pipe *e*, communicating with the other side of the diaphragm, substantially as herein shown and described.

GEORGE JOHNSON.
WALTER M. BAILEY.

Witnesses:
EDWARD H. WALES,
CHAS. M. HIGGINS.