2 Sheets—Sheet 1.

G. JOHNSON & W. M. BAILEY.

Hydro-Pneumatic Lifts.

No. 220,479. **Patented Oct. 14, 1879.**

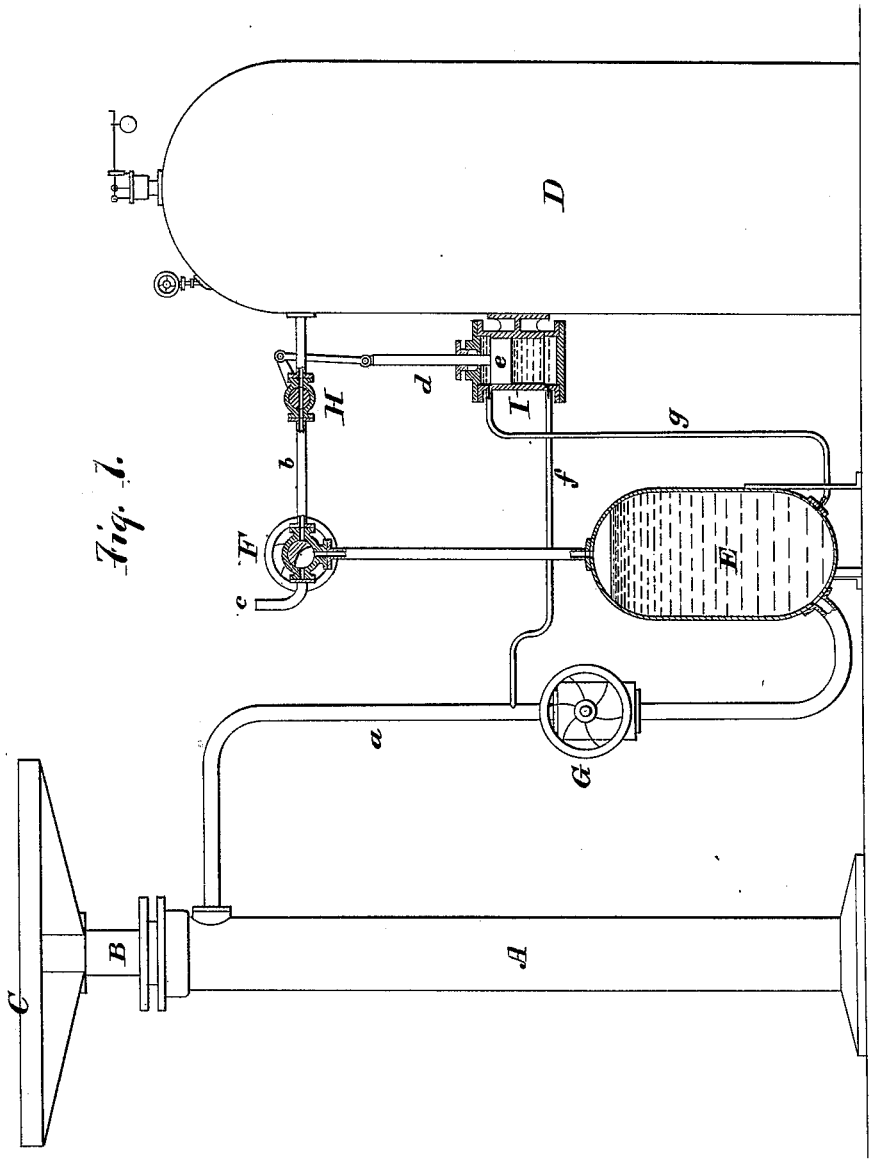

Fig. 1.

ATTEST:

Arthur C. Fraser.
Joseph Goodrich

INVENTORS:

George Johnson and
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2 Sheets—Sheet 2.

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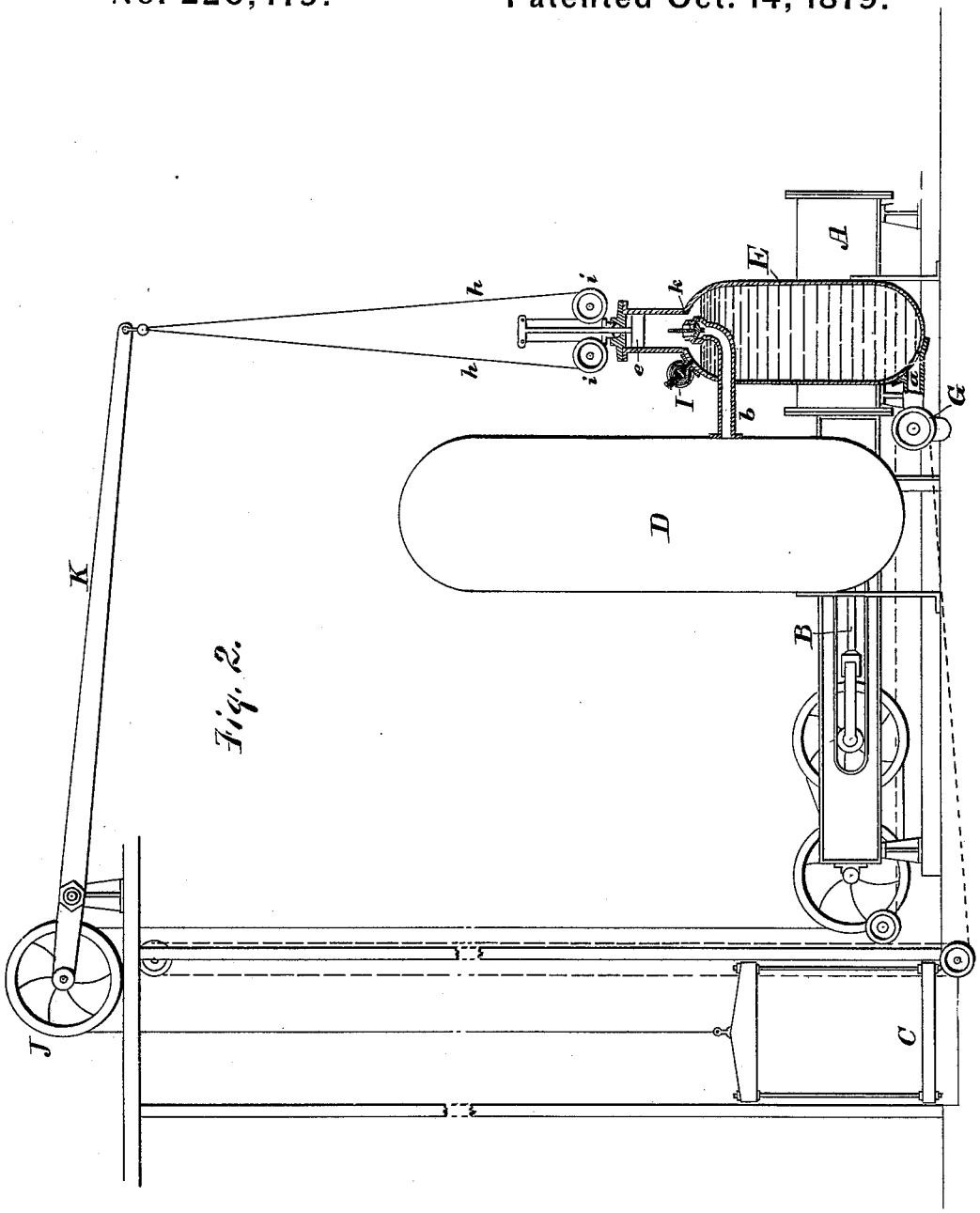

Fig. 2.

ATTEST:

Arthur C. Fraser.
Joseph Goodrich

INVENTORS:

George Johnson and
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By their Attorneys:
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UNITED STATES PATENT OFFICE.

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

IMPROVEMENT IN HYDRO-PNEUMATIC LIFTS.

Specification forming part of Letters Patent No. **220,479**, dated October 14, 1879; application filed September 10, 1878.

To all whom it may concern:

Be it known that we, GEORGE JOHNSON, of Cincinnati, Hamilton county, Ohio, and WALTER M. BAILEY, of the city, county, and State of New York, have jointly invented certain Improvements in Hydro-Pneumatic Lifts, of which the following is a specification.

This invention relates, in part, to a lift in which air is used under pressure to do the work of lifting, and water, or some non-compressible liquid, acting upon a piston moving in a cylinder, is employed to prevent vibration of the car or platform, which would be produced by the direct action of the compressible and elastic fluid upon the same; also, in part, to an automatic pressure-regulator, whereby the pressure on the piston of the lift-engine is adjusted to the weight to be lifted by the weight itself; also, in various combinations and arrangements of parts, all as will be hereinafter set forth.

It is found difficult, if not impossible, to operate a lift or hoist by the direct action of an elastic compressible fluid, as air, upon the piston, for the reason that the platform or car tends to vibrate or oscillate, and to rise suddenly, as if upon springs, when the load is removed.

Furthermore, in hydraulic hoists or lifts it has been customary, in most cases, to have a tank at the top of the building for the purposes of a head, and a steam-pump to keep it supplied with water, the water from the hydraulic cylinder wasting into a well, from which the pump transfers it to the tank. In such a case it is obvious that the absorption of power is the same whether the load lifted be heavy or light.

To obviate these defects is the object of our present invention, which we will now describe.

In the drawings, Figure 1 is a side elevation, with parts in section, showing a lift provided with our improvements. Fig. 2 is a modification of the same.

A represents the hydraulic cylinder of a lift or hoist; B, the piston; and C the platform to sustain the load.

Any other arrangement of the cylinder and piston wherein a non-compressible liquid, as water, is interposed between the weight to be lifted and the air used for power may be used. A somewhat different arrangement is shown in Fig. 2.

D is a compressed-air reservoir, in which air may be forced by an engine and air-pump in the usual way. This reservoir should be strong enough to sustain a pressure greatly in excess of that required for the heaviest lift.

E is an intermediate vessel or retiring-fountain, connected by a pipe, *a*, with the hydraulic cylinder, and by a pipe, *b*, with the reservoir D.

There may be more than one vessel, E, if the exigencies of the cases require it; but where only one is used it should have sufficient capacity to hold all of the water ejected from the hydraulic cylinder by the descent of the load.

F is the air-cock, and G is the water-cock or valve, both of which are arranged to be operated from the platform or car, or from the floors in the building, by means of ropes and sheaves in the usual way. The former is a three-way cock, arranged to permit the passage of air from the vessel D to E, or from E to the open air through an exhaust-pipe, *c*.

So far as described, the operation is as follows: The platform or the car being down, the operator opens the valves F and G by means of the cords or ropes for the purpose. The compressed air from D enters the vessel E through the pipe *b*, forcing the water contained therein into the cylinder A, thus lifting the platform or car C. The non-elastic fluid thus prevents the elastic vibration of the platform which would take place were the compressed air to act direct. It is obvious that in such a case as that just described the full pressure in the reservoir D would be exerted upon the liquid in E whether the load on the platform were light or heavy.

One important feature of our invention consists in providing a means for automatically regulating the pressure to suit the load lifted through the medium of the load itself, the pressure in the reservoir being in excess. One method of accomplishing this, which we adopt by preference, is as follows: H is a valve or cock in the pipe *b*, so arranged as to govern or control the passage of compressed air from the reservoir D to the vessel E. A lever to

operate this valve connects, through a rod, *d*, with a piston, *e*, in a small cylinder, I. When the piston is up the valve H is open; when it is down the valve is closed. A pipe, *f*, from the cylinder A, or from the pipe *a*, between the cylinder and the cock G, leads to the cylinder I below the piston, and a pipe, *g*, from the lower part of the vessel E leads to the cylinder I above the piston.

When the platform or car is down the valve or cock F is turned so as to cut off communication between the vessels D and E, but leaves the vessel E open to the air through the exhaust *c*. The back-pressure on the piston *e* through the pipes *a* and *f* keeps it up and the valve H open. The load being placed upon the platform and the valve F thrown open, the pressure rises in the vessel E until it is sufficient to lift the load. This it does, in the present arrangement, by expelling the water from E through the pipe *a* into the cylinder A; but before it can lift the load there must be a percentage of pressure in E in excess of the pressure in A, and this excess, when the proper accumulation for the lift is reached, drives the piston *e* down and closes, or nearly closes, the valve H. This valve will not, however, entirely close, because any decrease of pressure in the vessel E will throw it open again. In practice, it will admit air from the reservoir in quantity sufficient to keep up the requisite pressure in the vessel E to raise the load at the proper rate of speed and no faster.

To stop the car, it is only necessary to shut the valve G, in which case the excess of pressure in the vessel E will force down the piston *e* and close the valve H.

The pressure in E will always exceed by a few pounds the pressure in the cylinder A, and to preserve this difference when the valve G is closed the piston rod *d* is made of the proper diameter to lessen the area of the upper side of the piston *e* to the extent required. This construction necessitates a certain excess of pressure in E before the valve H will close.

In Fig. 2 we have shown a modification of the arrangement just described. In this case the car C is suspended from a sheave, J, hung on bearings in the short end of a long lever, K. The sheave is allowed a very little vertical play, and the lever is arranged to slightly overbalance the weight of the empty car. When the load is put on the car the short end of the lever is drawn down to the stop and the long end correspondingly elevated. This movement acts through the cords *k* and sheave *i* to depress a piston, *e*, in a cylinder, I, opening into the vessel E. In the end of the pipe *b* from the air-reservoir is a valve, *k*, arranged to close automatically, and in its descent the piston strikes and opens this valve by depressing it. This admits compressed air from the reservoir to the vessel E, and when the pressure in E becomes sufficient to lift the load the piston *e* is forced up and the valve *k* closes. The arrangement of the lever is such that it will require a few pounds of pressure in E in excess of that actually needed to raise the load before the piston *e* will rise. Now, when the valve G is opened the load begins to rise; but when the pressure from expansion becomes insufficient to raise the load the piston *e* will descend and open the valve *k* again, thus preserving the pressure in E.

If all the parts are properly proportioned and arranged, however, the action of the piston *e* on the valve *k* will be such as to maintain a constant pressure in E corresponding with the weight of the load to be lifted.

An exhaust is provided to be operated from the car, as in the device shown in Fig. 1.

The air-valve F need only be operated at the turn of the car, being opened when the car starts up, and closed when it starts down.

As in our invention the pressure is obtained from compressed air, and the water serves, by its non-elasticity and momentum, only to prevent elastic vibration of the car, it will be obvious that various arrangements of the cylinders may be used.

It must be understood that we do not confine ourselves strictly to the particular mechanism herein shown, nor to the precise arrangement of the various parts as set forth, as they may be arranged in various ways without materially departing from our invention.

We are aware that elevating apparatus have been heretofore proposed in which the pressure of compressed air acting directly upon a body of water raises a piston within a cylinder and elevates the lifting-platform, as in the patent to Day of September 5, 1871, No. 118,696, and hence we disclaim the same; but in this instance the safety, certainty, and firmness of a hydraulic action upon the platform or car in ascending or descending is not secured, for as there is no controlling-valve between the air and water vessel and the lifting-cylinder, and, furthermore, as the connection between the two is actually of greater area than the lifting-piston itself, hence the action in ascending or descending is wholly pneumatic, and the weight of the car rests entirely upon an elastic column of air, and not upon an inelastic retarded column of water, and is hence subject to the dangerous vibrations and irregular motions which it is the very object of a hydraulic construction to obviate. In our apparatus, however, as the water-column between the lifting-piston and the air and water vessel is retarded and controlled by a long and narrow passage between them and a controlling-valve therein, the piston thus rests upon an inelastic retarded column of water, so that, while securing all the advantages of quickness of action, economy, &c., which accrue from the employment of compressed air, we also secure the advantage of a hydraulic action upon the platform in ascending and descending, thus securing the combined advantages of hydraulic and pneumatic action while avoiding the defects which apply to either system alone, and thus providing an improved form of elevating apparatus.

What we claim is—

1. A combined hydraulic and pneumatic elevating apparatus consisting of the following combination of coacting elements: a compressed-air reservoir, D, with pumping apparatus to charge the same, a water-reservoir, E, connected at its top by air-pipe *b* with said air-reservoir, a hydraulic lifting-cylinder and piston, A B, and platform or car C, a pipe or connection, *a*, between said cylinder and the bottom of said reservoir E of less area than the lifting-piston, a controlling-valve, G, in the said water-pipe *a*, and a similar controlling-valve, F, in said air-pipe *b*, the whole arranged and adapted to operate substantially as and for the purpose herein set forth.

2. The combination of a compressed-air reservoir, D, or its equivalent, one or more intermediate vessels or cylinders, E, a hydraulic engine-cylinder, A, with piston B, and a car or platform, C, the whole provided with suitable valves, and so arranged in connection with suitable mechanism that the weight on the platform will govern the admission of air or steam to the vessel or cylinder E, for the purposes set forth.

3. In a hydro-pneumatic hoist, the arrangement of parts, substantially as shown, whereby the weight of the load lifted acts through the engine-piston as a resistance to open a valve in the pipe for admitting air from the reservoir to the vessel E, or its equivalent, and the pressure from the air-reservoir acts or tends to close said valve, substantially as set forth, so as to form an automatic regulating device, for the purposes specified.

4. The combination, in a hoist or lift, of the air-reservoir D, intermediate vessel or vessels E, a hydraulic engine, the pipes *a b*, cylinder I, piston *e*, pipes *f g*, and valves H F G, or their substantial equivalents, all arranged as and for the purposes set forth.

In witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

GEORGE JOHNSON.
WALTER M. BAILEY.

Witnesses:
JAMES H. HUNTER,
HENRY CONNETT.