(No Model.)

2 Sheets—Sheet 1.

G. MILES.

PNEUMATIC ELEVATOR.

No. 494,217. Patented Mar. 28, 1893.

Fig. 1

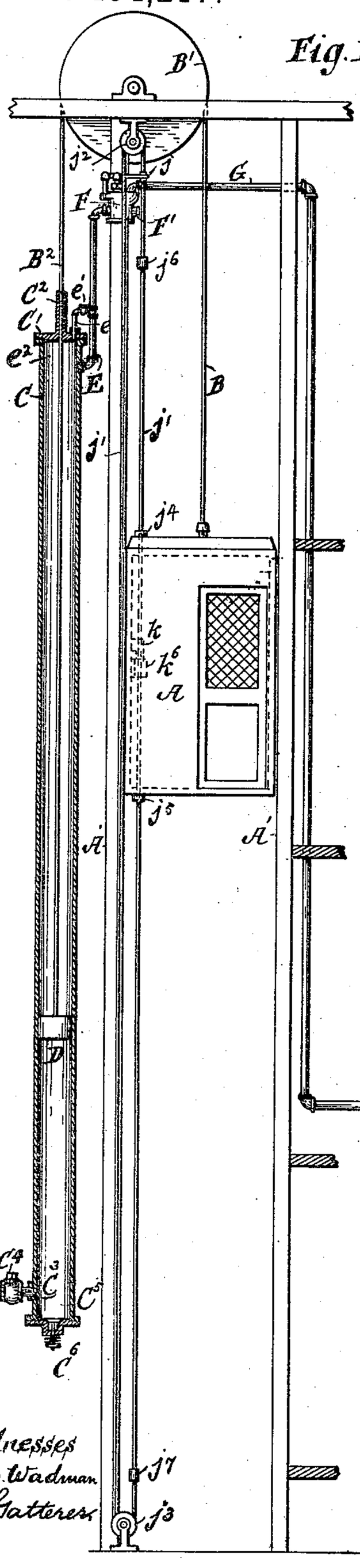

Fig. 6

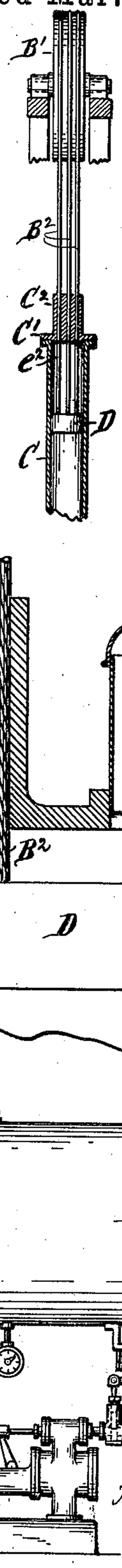

Fig. 7

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(No Model.) 2 Sheets—Sheet 2.

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PNEUMATIC ELEVATOR.

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Fig. 2

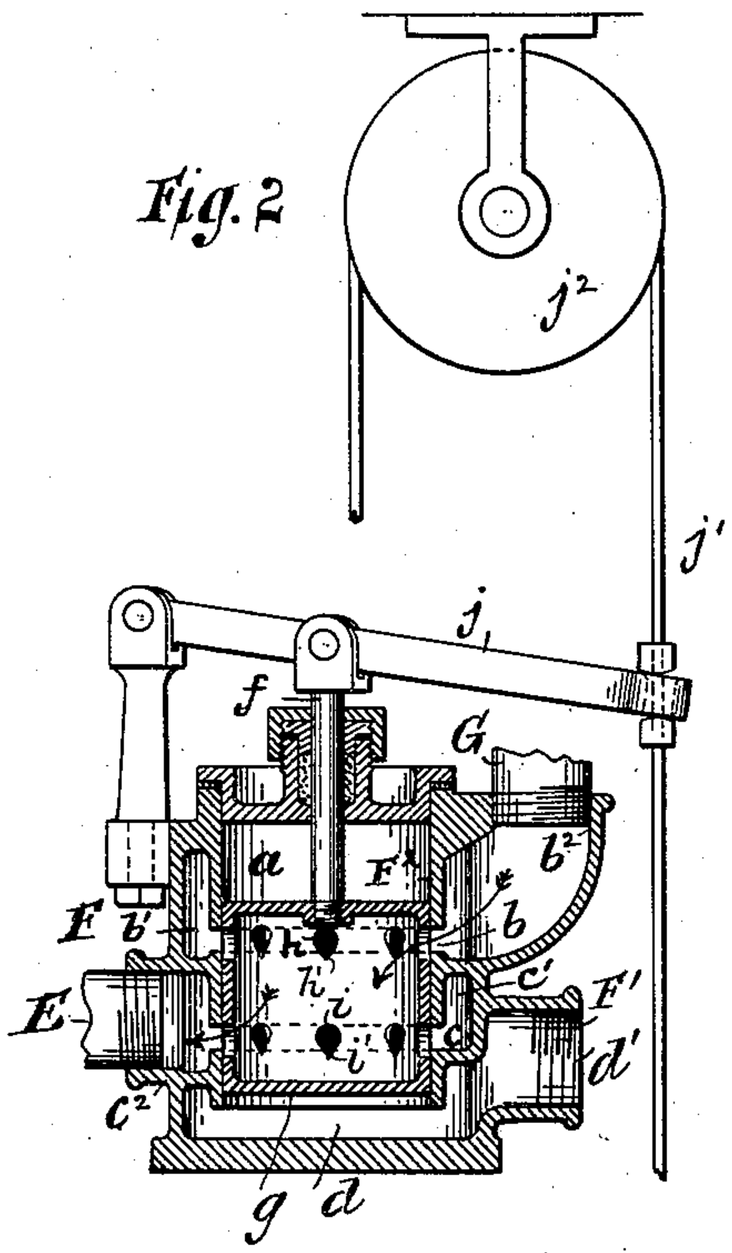


Fig. 3

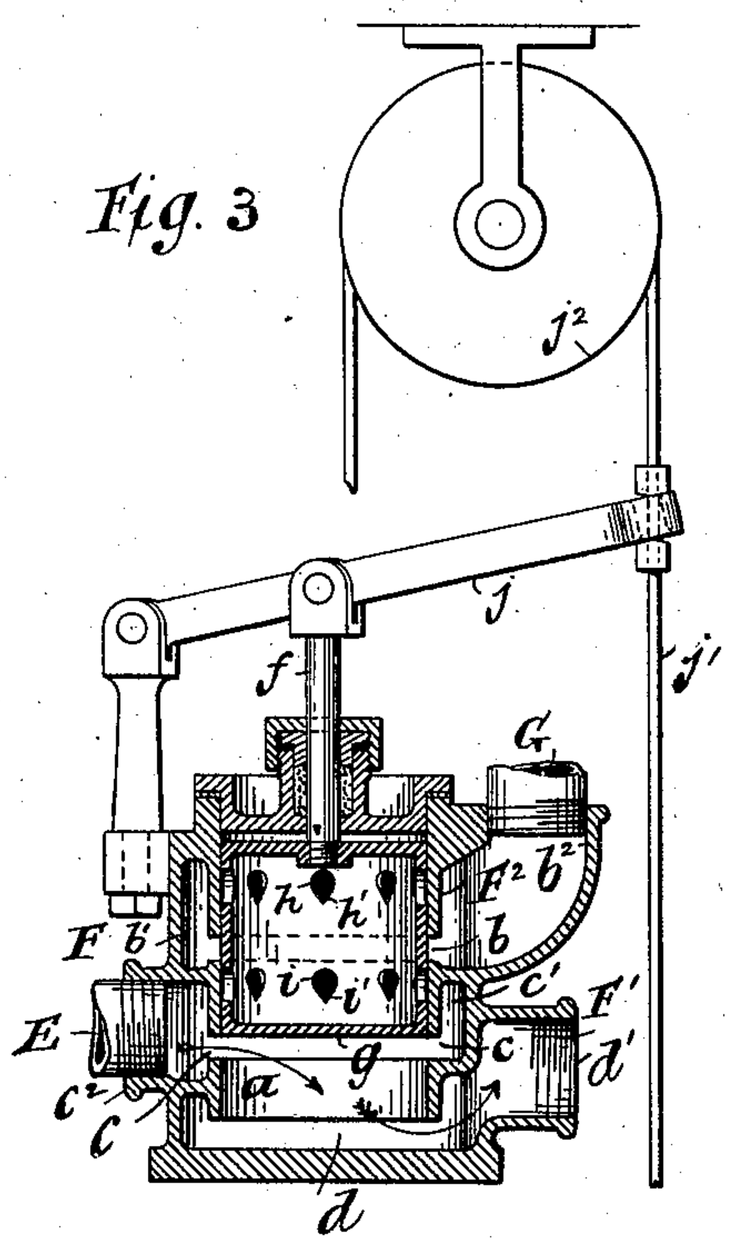


Fig. 4

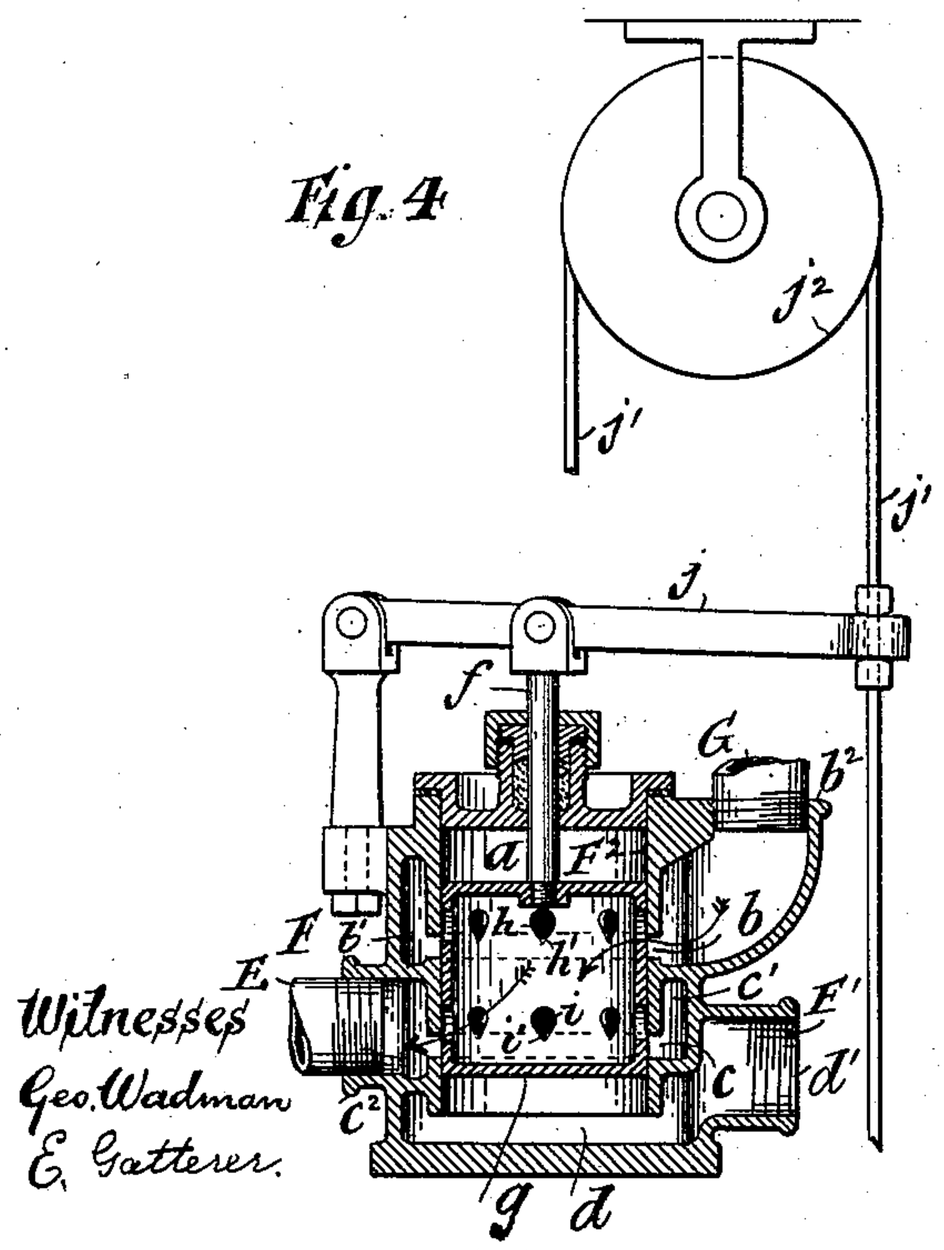
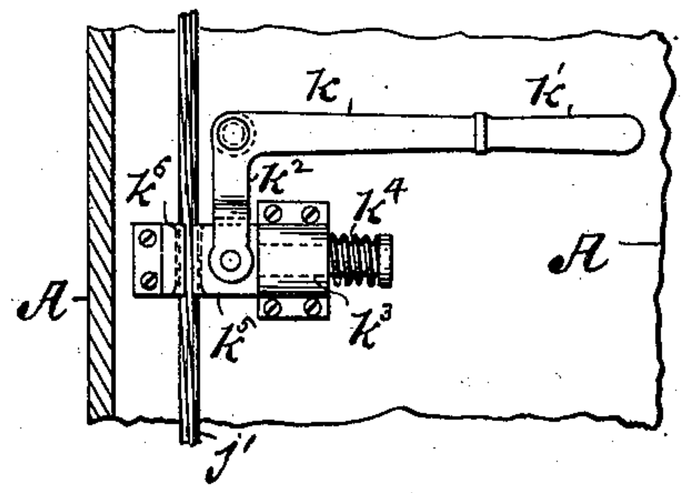


Fig. 5



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UNITED STATES PATENT OFFICE.

GEORGE MILES, OF WELLESLEY, MASSACHUSETTS.

PNEUMATIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 494,217, dated March 28, 1893.

Application filed December 4, 1891. Serial No. 413,972. (No model.)

To all whom it may concern:

Be it known that I, GEORGE MILES, of Wellesley, Massachusetts, have invented a certain Improvement in Pneumatic Elevators, of which the following is a specification.

It is the object of these improvements to facilitate the use of compressed air for operating freight and passenger elevators in buildings. To this end there is employed,—First, a single acting piston reciprocating in a cylinder long enough to afford room for cushioning the piston at both ends and to afford a length of stroke equal to the required length of travel of the elevator. Secondly, a flexible piston connector which is loosely run through an elongated leader in the cylinder head, and connected to the piston and which is connected to or forms a prolongation of the elevator suspender rope. Thirdly, a compressed air reservoir in which a substantially uniform pressure is maintained and a service pipe for supplying compressed air therefrom. Fourthly, a conducting pipe for conducting compressed air into one end of the cylinder to effect the direct stroke of the piston and for conducting off the exhaust during the return stroke of the piston. Fifthly, a three way valve for shutting off the service pipe and establishing a connection between said conducting pipe and an exhaust outlet to permit the return stroke of the piston and for disestablishing the connection between said conducting pipe and exhaust outlet and opening a connection between said conducting pipe and service pipe to supply compressed air for effecting the direct stroke of the piston. Sixthly, a bleed valve for admitting into the cylinder a supply of compressed air sufficient to compensate for the leakage therefrom and maintain upon the piston just enough pressure to counterbalance the weight of the elevator and thereby permit the elevator to be held stationary at any desired stage of its upward or downward excursion. The said bleed valve may be an independent valve with independent operating devices, or the said three-way valve may be provided with an especial system of relatively small passages and be thus adapted to itself act as a bleed valve when made to occupy a prescribed position different from either of the positions which it occupies when performing, as hereinbefore stated, its principal functions. Seventhly, an adjustable valve for regulating the cross area of a passage, which affords during the direct stroke an air outlet from, and during the return stroke an air inlet into, the interior of the cylinder at a point just above that portion of the extreme lower end of the cylinder which serves as a dash pot for containing the air which cushions the piston at the end of its direct stroke. Eighthly, a check valve opening inwardly into the lower end of the cylinder to admit air therein, if required, when the piston starts upon its return stroke.

While all of the enumerated devices may be usefully assembled and employed in the same elevator apparatus, it is also the fact that many of them possess independently valuable features adapting less than the whole number of them to enter into various combinations productive of novel and advantageous results. Thus they permit the use for operating the elevator, of a fluid under pressure, to wit, compressed air, the leakage, or discharge of which from the cylinder into the elevator well is unattended with any disagreeable effects such as would necessarily attend the similar leakage or discharge of steam or water from the cylinder.

It results from the elasticity of the compressed air that the elevator is started or brought to rest without the shock which usually attends the stopping or starting of a water driven elevator. This does away with the discomfort which such shocks inflict upon the elevator passengers and with the wear and tear upon the apparatus incident to such shocks.

As the leakage of compressed air produces no unpleasant effects it is not necessary to employ a stuffing box for tightly packing the piston connector in the cylinder head. By merely elongating the tubular part of the cylinder head through which the piston connector is led, the leakage is reduced to a negligible quantity without subjecting the piston connector to the friction which the ordinary stuffing box would exert upon it.

It has heretofore been proposed to employ in the organization of steam or water driven elevators, a flexible piston connector, and to make such flexible piston connector a prolongation of the elevator suspender rope,

and to make the stroke of the piston equal to the range of motion of the elevator. It will therefore be understood that the present invention embraces improvements adapting such an organization for operation by compressed air and secures the advantages resulting therefrom.

While it is preferred to use a single acting piston having a stroke equal to the range of movement of a vertically moving elevator in order to thereby lessen the degree of pressure required to effect the direct stroke of the piston, and to utilize the force of gravity acting upon the elevator to effect the return stroke of the piston, it is to be observed that the common multiplying gear may be used in the ordinary manner to transmit power to or from the elevator from or to a piston having a shorter stroke but operated by compressed air of higher pressure, without departing from the present invention.

These improvements, so far as regards the organization of the pneumatic hoisting apparatus, are applicable not only to passenger elevators, but to freight elevators or hoists of any kind; therefore the term "elevator car" herein used is to be taken as comprehending a freight platform or any other device combined with the suspender rope for facilitating the suspension thereon of any heavy object which it is desired to elevate. It is also to be understood that the term "compressed air service pipe" herein employed is to be taken as comprehending any form of conduit, passage, or chamber which is in immediate connection with the valve for controlling the operation of the elevator, and similarly, that the expression "conducting pipe" is to be taken as comprehending any form of conduit, passage, or chamber connecting the cylinder with the said valve, and finally that the cylinder need not necessarily be upright.

The accompanying drawings, illustrating the application of the improvements to a passenger elevator operated by compressed air, are as follows:

Figure 1 is a view, partly in section, of an elevator well, a passenger car, a cylinder and piston, a flexible piston connector led over a guide pulley, and formed integrally with the elevator suspender rope, together with a symbolic representation of a compressed air reservoir, a steam driven air pump, a governor for automatically increasing the speed of the air-pump when the pressure in the reservoir falls, suitable pipe connections for supplying compressed air to the cylinder, a three way valve for controlling such supply and also controlling the outlet for the exhaust from the upper end of said cylinder, and an actuating valve rope extending through said passenger car. Fig. 2 is a view, partly in section, of the three way valve, its connections, and operating mechanism showing the three way valve in its lowest position which it occupies when affording a full supply of compressed air for effecting the downward stroke of the piston, and the consequent upward excursion of the elevator car. Fig. 3 is a section similar to Fig. 2, except that it shows the three way valve in its highest position which it occupies when completely shutting off the compressed air and opening the outlet for the escape of air from the upper end of the cylinder during the downward excursion of the car. Fig. 4 is a similar section of the three way valve showing it in its middle position which it occupies when closing the exhanst outlet and admitting into the upper end of the cylinder a quantity of compressed air just sufficient to counterbalance the elevator car. Fig. 5 is a vertical section of a portion of the passenger car showing in elevation a clamping device for clamping the valve actuating rope to bring the car to rest. Fig. 6 is a central vertical section of a portion of the cylinder and of the upper cylinder head, illustrating the provision of a multiplicity of elongated leaders for admitting a multiplicity of elevator suspender ropes into the interior of the cylinder for connection with the piston. Fig. 7 is a vertical section of the upper end of the cylinder, and of the pipes connected therewith, showing the piston at the end of its upward stroke, and showing the check valve for admitting compressed air into the upper end of the cylinder to initiate the downward stroke of the piston.

In the drawings a passenger car, A, is represented as adapted to be reciprocated between the vertical guides, A′ A′, established within an elevator well. The passenger car is hung upon the suspender rope, B, which is led over a guide pulley, B′, and into the upper end of the vertical cylinder, C, and fastened to the piston, D; the suspender rope thus serves as a flexible piston connector. The upper end of the cylinder is closed by a head, C′, provided with a tubular extension, C^2, which serves as an elongated leader for the end portion of the suspender rope B which constitutes the flexible piston connector, B^2. The flexible piston connector loosely fits the elongated leader; but in consequence of the elongation of the leader, the leakage through it is so small as to be negligible.

When ropes, either wire ropes or ropes made of vegetable fiber, are employed as piston connectors it is preferred to cover with grease those portions of the ropes which in operation are drawn through the elongated leaders. When this is done, even if air of high pressure is employed, leakage from the cylinder through the elongated leader will not be observable.

If, owing to the weight of the elevator car, it is found desirable to employ a multiplicity of suspender ropes, the upper cylinder head will be provided with a number of elongated leaders, equal to the number of suspender ropes employed, and the number of guide pulleys, or the number of grooves in a single guide pulley will be correspondingly increased. Fig. 6, for example, illustrates the

use of the three elongated leaders, permitting three flexible piston connectors or extensions of the suspender ropes to be led into the interior of the cylinder for connection with the piston. For the purposes of the present case, therefore, it will be understood that the terms "suspender rope" and "flexible piston connector" are to be taken as comprehending either a single suspender rope, or a single flexible piston connector, or a multiplicity of the same, as the case may be.

At a prescribed short distance above its closed lower end the cylinder is provided with a passage, C^3, equipped with a valve, C^4, for effecting a connection between the lower portion of the cylinder and the external atmosphere. Just before the conclusion of its downward stroke the piston passes across and closes the inner end of the passage C^3. The space within the cylinder below the level of the passsge, C^3, constitutes an air cushion chamber, C^5, and the cylinder is so proportioned in length with relation to the range of movement of the elevator car that the air in the extreme lower end of the cylinder will serve to cushion the piston at the completion of its downward or direct stroke when the elevator car has been carried up to its highest position. The direct stroke of the piston is effected by the introduction of compressed air into the upper end of the cylinder. Its return stroke is caused by the gravity of the car when an outlet is established for the escape of the air from the upper end of the cylinder.

For abundant caution there is provided a check valve C^6, opening into the air cushion chamber C^5, to, if necessary, admit external air into the cushion chamber after the piston has commenced its upward or return stroke and until it has risen far enough to reopen the passage C^3.

The speed of movement of the piston during its direct stroke is to some extent influenced by the degree of freedom with which the air is permitted to be expelled through the passage, C^3, and the valve, C^4, and similarly, the speed of the return or upward stroke of the piston is to some extent influenced by the rapidity with which air is admitted into the lower part of the cylinder through the valve, C^4, the area of the check valve being purposely made small in order that the main supply of air into the lower part of the cylinder during the upward stroke of the piston shall be through the valve, C^4. It therefore follows that by varying the cross area of the passage, C^3, by means of the valve, C^4, the speed of movement of the piston, and consequently of the elevator may be to some extent regulated. A little below its upper end the cylinder is connected with a conducting pipe, E, which serves as the induction passage for admitting compressed air to effect the direct stroke of the piston, and also serves as the eduction passage through which air is expelled from the upper end of the cylinder during the upward stroke of the piston. A small tube, *e*, provided with a check valve, *e'*, inserted into the upper end of the cylinder, or into the upper cylinder head, as shown, and connected outside the cylinder with the conducting pipe, E, serves as the inlet into that portion of the upper end of the cylinder which is above its point of connection with the mouth of the conducting pipe, E, the said portion constituting the cushion chamber, e^2, for cushioning the piston at the end of its upward stroke after it has passed across and closed the mouth of the pipe, E. It will be seen that when it is desired to effect the downward stroke of the piston the tube, *e*, serves as the duct for admitting sufficient compressed air into the cushion chamber, e^2, at the upper end of the cylinder to initiate the downward stroke and drive the piston past the mouth of the pipe, E, through which the main supply of compressed air is furnished for the downward stroke. The check valve, *e'*, under the influence of its spring, closes when the supply of compressed air is cut off, and, as will be perceived on reference to Fig. 7, the check valve, *e'*, prevents the escape of air from the cushion chamber, e^2, during the upward movement of the piston. When the compressed air is let into the conducting pipe, E, to effect the downward stroke of the piston, the check valve yields and allows the compressed air to make its way through the pipe, *e*, into the cushion chamber, e^2.

To enable the conducting pipe, E, to thus serve alternately as the induction and as the eduction passage, it is alternately connected by means of the three way valve F, with the compressed air service pipe, G, and with the exhaust outlet, F'. The three way valve which it is preferred to employ is substantially like that shown and described in United States Letters Patent No. 461,981, granted to me, October 27, 1891. The said valve consists of a valve shell, F^2, containing the valve chamber, *a*, the wall of which is pierced with the two parallel ports, *b* and *c*. The port, *b*, opens into the jacket compartment, *b'*, extending around the upper portion of the valve chamber and communicating with a nozzle, b^2, which is tapped at its mouth for connection with the compressed air service pipe, G. The port, *c*, opens into the jacket compartment, *c'*, communicating with a nozzle, c^2, which is tapped at its mouth for connection with the conducting pipe, E. The lower open end of the valve chamber, *a*, opens into the compartment, *d*, communicating with the nozzle, *d'*, which itself may serve as the exhaust outlet, or may be tapped and connected with a pipe through which the exhaust from the upper end of the cylinder is discharged. At its upper end the valve chamber, *a*, is provided with the usual perforated cap through which the valve stem, *f*, extends. The valve stem, *f*, is affixed to, or formed integrally with, the hollow cylindrical valve, *g*, closed at its ends, and having its curved wall perforated by two

parallel rows of holes, *h* and *i*. The upper end of the valve stem, *f*, has the usual pivotal connection with the valve operating lever, *j*.

As will be seen on reference to Fig. 2, when the three way valve and its operating lever are in their lowest positions the ports, *b* and *c*, are open, and unconstricted communication is thus established for the supply of compressed air from the compressed air service pipe, G, to the conducting pipe, E.

On reference to Fig. 3 it will be seen that when the three way valve and its operating lever are in their highest positions, the port, *b*, is closed, thus completely shutting off communication with the compressed air service pipe, G, while the port, *c*, is open and in communication with the chamber, *d*, and exhaust outlet, *d'*.

On reference to Fig. 4, it will be seen that the valve and its operating lever occupy a middle, or intermediate position in which the valve serves as a bleed valve, by virtue of the fact that the lower extremities of the ports, *h* and *i*, respectively, occupy positions slightly below the upper edges of the ports, *b* and *c*, thus partially opening communication from the compressed air service pipe, G, to the conducting pipe, E, and admitting into the conducting pipe, E, a comparatively small supply of compressed air, the object of which is to compensate for the leakage from the cylinder and to maintain upon the piston just enough pressure to counterbalance the weight of the elevator car. During the upward excursion of the elevator, the upper part of the cylinder is filled with compressed air, hence the elevator can be stopped and momentarily held stationary by raising the valve to an intermediate position, in which it completely closes the ports, *b* and *c*, and if it then be desired to hold the elevator stationary for any considerable period of time, a comparatively small opening of the valve passages will admit sufficient compressed air for that purpose. On the other hand, during the descent of the elevator, owing to the comparatively uncompressed condition of the air in the upper end of the cylinder, it will be necessary to open the valve ports wider and thus introduce a larger quantity of compressed air into the cylinder in order to establish sufficient pressure therein to counterbalance the weight of the elevator. It is also to be observed that differences of load upon the elevator car necessarily involve corresponding differences in the quantity of air required to be introduced into the upper end of the cylinder to counterbalance the weight of the car.

To adapt the three way valve for operation as a bleed valve, its apertures, *h* and *i*, instead of having a circular form, as they are represented in Letters Patent of the United States, No. 461,981, hereinbefore referred to, are provided upon their under sides with the notches or slots, *h'* and *i'*, in order that the rate of variations in the areas of the valve openings caused by the movements of the valve may be rendered more gradual than when the holes, *h* and *i*, are circular. This adapts the three way valve for use as an adjustable bleed valve, and enables the operator to easily vary the quantity of air introduced into the upper end of the cylinder to meet the various conditions which have been described.

To facilitate the manual control of the three way valve, the free end of the valve lever, *j*, is suitably connected with a rope, *j'*, which constitutes one side of an endless rope which is led over the stationary sheave, j^2, at the top of the elevator well and around the stationary sheave, j^3, at the bottom of the elevator well. The rope, *j'*, extends through leaders, j^4 and j^5, respectively, at the top and bottom of the car and through the interior of the car in convenient position to be grasped by the operator within the car. The part of the rope, *j'*, near its point of connection with the lever, *j*, is provided with a fixed collar, j^6. As the car nears the end of its upward excursion the collision of the leader j^4 with the collar, j^6, raises the valve, *g*, to an intermediate position in which it shuts off, or nearly shuts off, the communication between the compressed air service pipe, G, and the conducting pipe, E. Near the lower sheave the rope, *j'*, is provided with another fixed collar, j^7, so that by the collision therewith of the leader, j^5, near the end of the downward excursion of the elevator car the valve, *g*, will be lowered to an intermediate position, in which it disestablishes the communication theretofore existing between the conducting pipe, E, and the exhaust outlet, *d'*, leaving sufficient air in the upper end of the cylinder to cushion the piston at the end of its upward stroke.

It will be perceived that all that it is necessary to do to bring the elevator to rest at any stage during either its upward or its downward excursion, is to temporarily communicate the motion of the car to the valve rope, *j'*. This is conveniently effected by means of a manually operative yielding clamp, such, for example, as that illustrated in Fig. 5, which consists of the bell crank lever, *k*, the longer arm of which is provided with the handle, *k'*, and which is so pivoted to the wall of the elevator car that its shorter arm, k^2, engages a transverse pin in the clamping bolt, k^3. Downward pressure upon the handle, *k'*, imparts endwise motion to the bolt, k^3, compressing the spring, k^4, and driving the movable grooved jaw, k^5, against the rope, *j'*, whereby the rope, *j'*, is clamped against the stationary grooved jaw, k^6, affixed to the wall of the elevator. When the handle, *k'*, is released from downward pressure the spring, k^4, pushes back the clamping bolt and releases the rope, *j'*. By a little practice the operator will learn how to more or less quickly release the handle, *k'*, after having pressed it downward to clamp the rope and be thereby enabled to move the valve to

its desired intermediate position and bring the elevator car to rest at any stage of its movement in either direction.

To start the car upward after it has been brought to rest the operator will pull the rope, j', downward so as to lower the valve, g, to the position in which it fully opens communication between the compressed air service pipe, G, and the conducting pipe, E. To start the car downward, the operator will pull the rope, j', upward sufficiently to raise the valve, g, to the position in which it shuts off the compressed air and opens communication between the conducting pipe, E, and the exhaust outlet, d'.

It is important for the successful operation of the apparatus that a substantially constant pressure shall be maintained in the compressed air service pipe. This is most effectively accomplished by connecting the compressed air service pipe with a reservoir supplied with compressed air by an air pump, the speed of motion of which is varied by the action of a governor automatically controlled in its operation by the degree of pressure in the compressed air reservoir. An example of a form of apparatus which can be conveniently used for this purpose is shown and described in Letters Patent of the United States No. 294,899, granted to me, March 11, 1884. This apparatus is symbolically represented in Fig. 1, which shows the compressed air reservoir, I, a steam driven air pump, J, for forcing air into the compressed air reservoir, I.

To facilitate brevity in reference to the opposite ends of the cylinder and to the movements of the piston, it is herein assumed that the cylinder occupies a vertical position; but a cylinder occupying a horizontal or other position may be employed without departing from the invention. As a horizontal cylinder, provided with a flexible connector for connecting its piston with an elevator car, is well known in the art, no especial description of it is herein needed. It will therefore be understood that the expression "upright cylinder" is herein employed simply for convenience, and is not to be taken as imposing any limitation concerning the position of the cylinder.

What is claimed as the invention is—

1. In a pneumatic elevator apparatus an upright cylinder having its lower end closed but provided with an inwardly opening check valve, and having at a prescribed short distance above its lower end, a relief passage opening the adjacent part of its interior to the external atmosphere, in combination with a piston, an elevator car, connections for connecting said piston with said car, and means for effecting the reciprocation of said piston in said cylinder.

2. In a pneumatic elevator apparatus, an upright cylinder closed at its lower end and having at a prescribed short distance above its lower end a relief passage opening the adjacent part of its interior to the external atmosphere, a piston, an elevator car, connections for connecting said piston with said car and means for effecting the reciprocation of said piston in said cylinder, in combination with a valve for adjusting the cross area of said relief passage and thereby influencing the speed of movement of said piston.

3. In a pneumatic elevator apparatus, an upright cylinder having an opening through which its lower portion communicates with the external atmosphere, a piston, an elevator car, connections extending through the cylinder head at the upper end of said cylinder for connecting said piston with said car, a conducting pipe for conducting compressed air into the upper end of said cylinder to effect the direct stroke of said piston and for conducting off the exhaust during the return stroke of said piston, and a compressed air service pipe; in combination with valve mechanism for alternately connecting said conducting pipe with said service pipe to supply compressed air for effecting the direct stroke of said piston and for connecting said conducting pipe with an exhaust outlet to permit the escape of the air expelled from the upper end of said cylinder during the return stroke of said piston.

4. In a pneumatic elevator apparatus, the combination as herein set forth of an upright cylinder, a piston reciprocating therein, an elongated tubular head at the upper end of said cylinder, an elevator car, a suspender rope therefor, a flexible piston connector led loosely through said elongated tubular head and connected with said piston and connected with or forming a prolongation of said suspender rope and means for supplying compressed air to the upper end of said cylinder to effect the direct stroke of said piston and for shutting off the supply of compressed air and opening an outlet for the escape of the air from the upper end of said cylinder to permit the return stroke of said piston.

5. In a pneumatic elevator apparatus, the combination as herein set forth of a cylinder, a piston reciprocating therein, an elevator car, connections for connecting said piston with said elevator car, a compressed air service pipe, a conducting pipe for conducting compressed air to said cylinder to effect the direct stroke of said piston, a valve mechanism for opening or closing a connection between said service pipe and said conducting pipe, and means for maintaining the compressed air in said service pipe at a substantially constant degree of pressure.

6. In a pneumatic elevator apparatus, the combination as herein set forth of a cylinder, a piston reciprocating therein, an elevator car, connections for connecting said piston with said elevator car, a compressed air service pipe, a conducting pipe for conducting compressed air to said cylinder to effect the direct stroke of said piston, and a bleed valve for admitting from said compressed air service pipe into said conducting pipe and thence

into said cylinder, a supply of compressed air, enough to compensate for the leakage from said cylinder and to maintain upon said piston sufficient pressure to counterbalance the weight of said elevator car for the purpose of affording a convenient means for holding the elevator car stationary at any desired stage in its upward or downward excursion.

7. In a pneumatic elevator apparatus, a cylinder; a piston reciprocating therein; an elevator car; connections for connecting said piston with said elevator car; a conducting pipe connected with the side of said cylinder at a prescribed distance below its upper end; a tube inserted into the upper cylinder head, and connected outside the cylinder with the said conducting pipe and provided with a check valve, as shown, as and for the purposes set forth.

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