(No Model.) 2 Sheets—Sheet 1.

E. HILL.

AIR COMPRESSOR.

No. 463,386. Patented Nov. 17, 1891.

Fig. 1

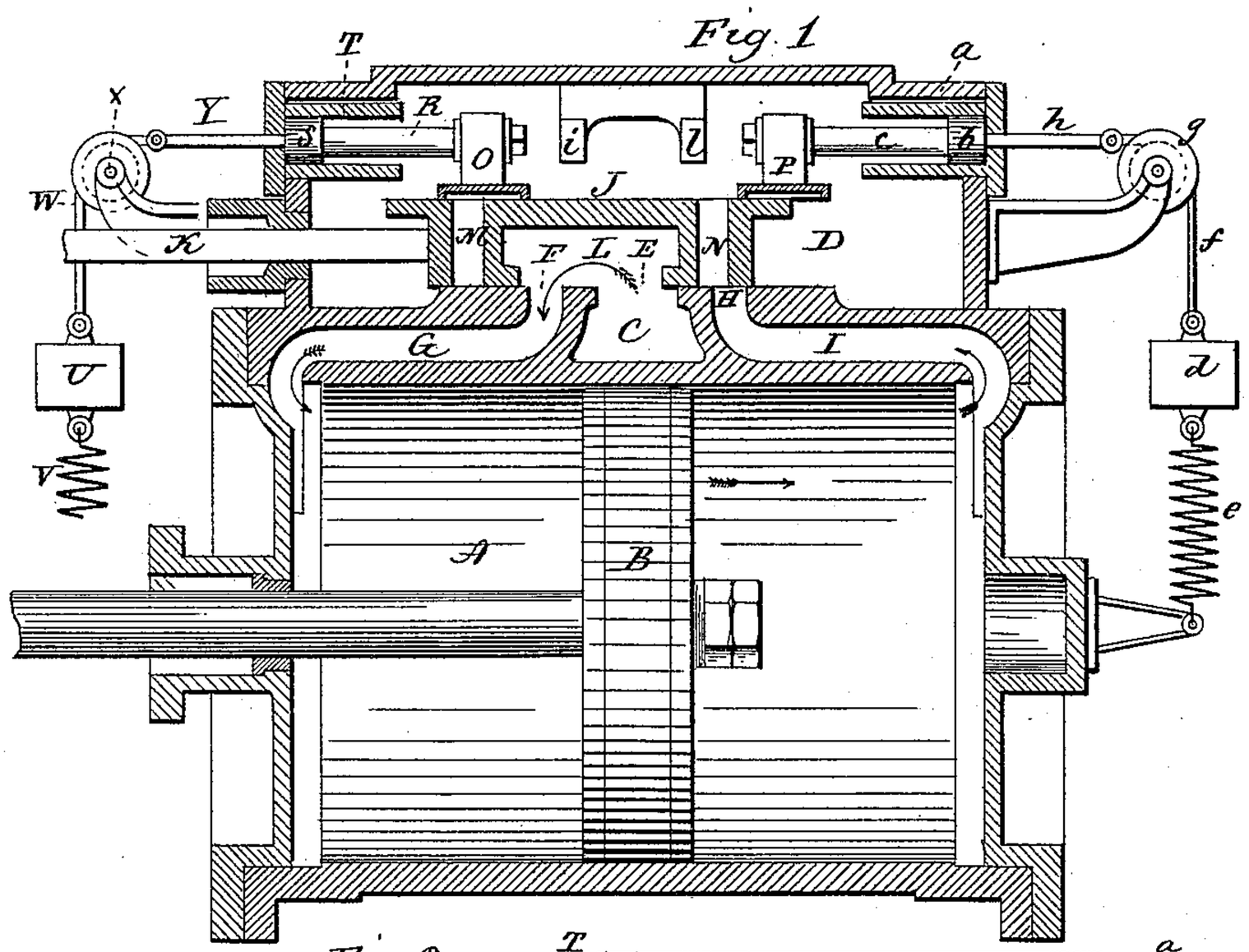

Fig. 2

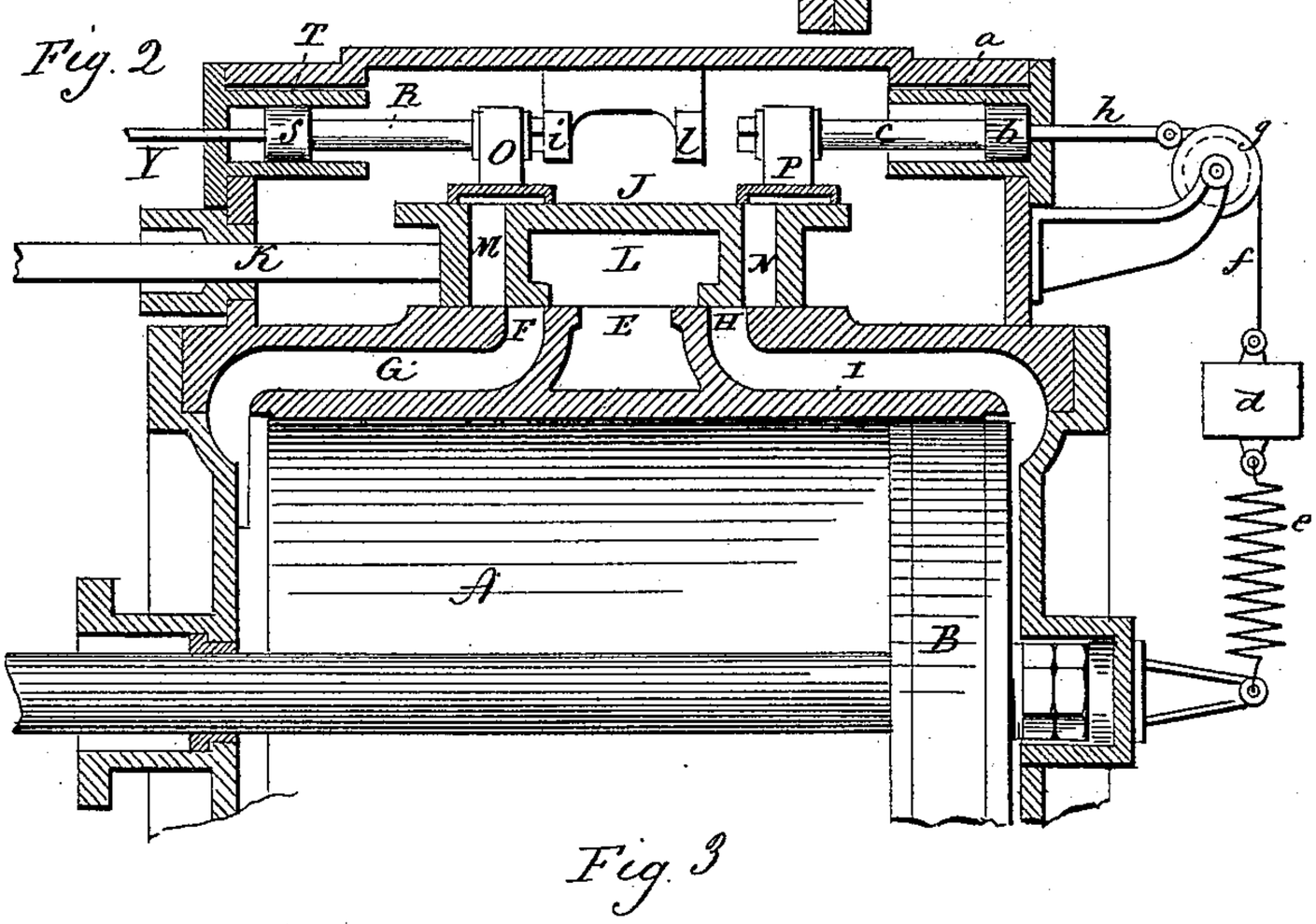

Fig. 3

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(No Model.) 2 Sheets—Sheet 2.

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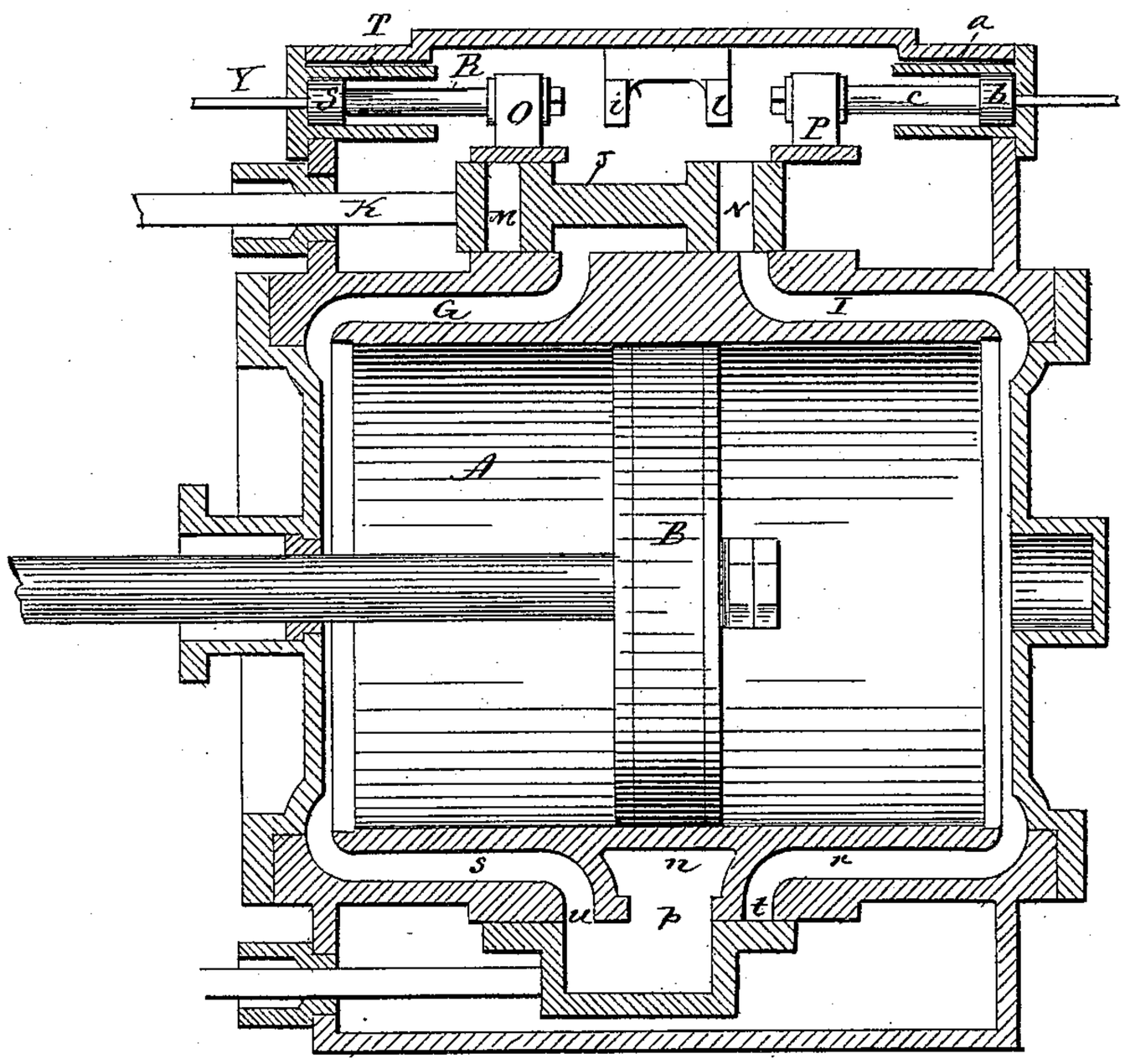
Fig. 4



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UNITED STATES PATENT OFFICE.

EBENEZER HILL, OF SOUTH NORWALK, CONNECTICUT.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 463,386, dated November 17, 1891.

Application filed July 10, 1889. Serial No. 317,038. (No model.)

To all whom it may concern:

Be it known that I, EBENEZER HILL, of South Norwalk, in the county of Fairfield and State of Connecticut, have invented a new Improvement in Air-Compressors; and I do hereby declare the following, when taken in connection with accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a longitudinal section of a cylinder and valves of an air-compressor embodying the invention, representing the position of the valves on the midway movement of the piston in one direction; Fig. 2, the same parts in the position of the piston at one extreme; Fig. 3, the same parts representing the piston midway of the return stroke; Fig. 4, a modification.

This invention relates to an improvement in that class of air-compressors in which the valves are mechanically operated for the escape of the compressed air from the cylinder. Under the more general construction of this class of air-compressors the outlet-valves are set so as to open at a predetermined point in the movement of the piston, and this point is intended to be when the pressure in the cylinder shall have reached the pressure in the receiver. For illustration, suppose the pressure outside the valve in the receiver or whatever it may be into which the air is to be forced is fifteen pounds. That pressure under ordinary circumstances will be attained in the cylinder when the piston has reached its half stroke in the cylinder. Now if under this positive arrangement of the valve with relation to the piston it be desired to reduce the pressure in the receiver or outside the valve say to ten pounds, the continued action of the machine will still compress the air to the same extent in the cylinder and discharge it under a pressure of fifteen pounds—that is, five pounds greater than the pressure in the receiver—and this because the valve would not ordinarily open until the time when that pressure of fifteen pounds in the cylinder had been attained. On the contrary, if it be desired to increase the pressure in the receiver, the valve will open before the receiver-pressure has been reached in the cylinder. In the first case the valve is opened too late and in the latter case opened too early. The results of thus opening the valve are too well known to require particular description. Hence when such change in pressure is desired a corresponding resetting of the valve is necessary to a perfect working of the machine.

In an application heretofore filed, Serial No. 304,622, I have described a valve mechanism in which the outlet-valves are arranged upon fixed seats with an auxiliary force, as a spring or weight, applied to the valve, which auxiliary force serves to open the valve when the pressure upon the cylinder side of the valve has been brought to substantially equal the pressure upon the back of the valve. In that case the valve is held in check by a movable dash-pot.

The object of my present invention is the construction of a valve arrangement in which the valve-seat for the outlet-valve is movable and the dash-pot stationary, and whereby when a substantial equilibrium is produced upon the two sides of the outlet-valves they will automatically open by means of a power independent of that power which operates the valve-seat; and the invention consists in the construction as hereinafter described, and more particularly recited in the claim.

A represents the air-compressing cylinder; B, the piston arranged therein; C, the passage through which air is admitted, this passage opening into the valve-chamber D through a port E.

F represents a port opening from the valve-chamber through a passage G to the left-hand end of the cylinder, and H represents a like port opening through a passage I to the other end of the cylinder, these passages, ports, cylinder, and piston being substantially the same as employed in the common slide-valve compressor or steam-engine.

J represents a common slide-valve, from which a rod K extends to the eccentric by which the valve is operated in substantially the usual manner, the valve J being recessed upon its under side, as at L, so as to work over the several ports to open from the inlet to either end of the cylinder, as the case may be, substantially as in the usual arrangement of slide-valves. Vertically through the valve at the left-hand end is a direct opening M,

and at the other end of the valve is a like direct opening N, these openings being outside the inlet-recess L of the valve. As the valve stands in Fig. 1, it is represented as at the extreme left-hand throw and with the passage open for the admission of air to the left-hand end of the cylinder. In Fig. 3 the valve is represented as at the opposite extreme and so as to admit air to the right-hand end of the cylinder. The openings M and N through the valve are adapted to register, respectively, with the ports F H, and so that communication may be opened from the cylinder through the respective ports F or H into the valve-chamber for the escape of air from the cylinder into the valve-chamber, from whence it is led to the receiver or wherever it may be required.

On the back of the valve J an outlet-valve O is arranged to work over the passage M, and a like outlet-valve P is arranged to work over the passage M. The valve J therefore forms a movable seat for the outlet-valves O P. The valve O is attached to a rod R, which carries a piston S, working in a stationary cylinder T, this cylinder, as here represented, being an extension of the valve-chamber and opening into the chamber. This cylinder and piston form a dash-pot for the valve O. An auxiliary power is applied which will tend to move the valve O toward its end of the valve-chamber. As here represented, this auxiliary power is a combined weight U and spring V. A cord W, running over a pulley X, is connected to a rod Y, extending through the outer end of the cylinder in which the piston S works, and so that the tendency of the auxiliary power is to draw the piston into the cylinder and to bring the valve O to its extreme left-hand position. The cylinder and piston form a dash-pot as a check for the movement of the piston into the cylinder, so that if the valve O stand in the position as seen in Fig. 2, with the piston drawn from the outer or closed end of the cylinder, and in that position become free, the auxiliary power will operate upon the piston so as to throw it quickly toward the closed end of the cylinder and so as to move the valve O with the piston. The air which may then be in the cylinder T will serve as a cushion to check the movement of the valve, and the extent of this check will depend upon the rapidity with which the air may escape forward of the piston, and this may be varied in the usual manner of varying the escape of air from dash-pots, too well known to require illustration, the air being admitted to the cylinder T as the piston S is drawn therefrom, as from the position in Fig. 1 to that in Fig. 2. The valve P is combined with a like cushion or dash-pot cylinder *a*, piston *b* connected to the valve by a rod *c*, and is also provided with a similar auxiliary power, here represented as a weight *d* and spring *e*, connected by a cord *f* over a pulley *g* to a rod *h*, which extends from the piston *b* through the closed end of the cylinder *a*, all substantially the same as described with reference to the cushioning device and auxiliary power for the valve O. The valve-chamber is provided with suitable stops *i l* to arrest the inward movement, respectively, of the valves O P. This completes the construction.

The operation of the apparatus is as follows: Suppose the piston B to be moving to the right, as indicated by the arrow. It is now taking air at the left-hand end, the valve J being at its extreme left-hand position. At this time the valve P is in its place of rest and at its extreme outward position and so as to leave the passage N through the valve open for the escape of air from the advancing side of the piston into the valve-chamber, from whence it is conducted into the receiver or wherever it may be required. In this extreme left-hand position of the valve J the valve O is also at its extreme outward position or place of rest, held there by the auxiliary power the same as is the valve P, the valve O at this time standing over the passage M of the valve J and so as to close that passage. Consequently the pressure of the air in the valve-chamber bears upon the valve O, tending to hold it in frictional contact with the valve J to the extent of that pressure, for the reason that there is no opposing pressure upon the reverse side of the valve. The position of the piston, as represented in Fig. 1, is at the point midway of its stroke and just as the valve J is to commence its movement from the left-hand extreme to the right. The piston continues its movement to its right-hand extreme, as represented in Fig. 2. During this continued movement of the piston the valve J has been moved in the same direction as the piston and has brought the outlet-passage N through the valve beneath the then stationary valve P, as seen in Fig. 2. At the same time the valve O has moved with the valve J because of being frictionally held in contact therewith, as before described, that friction being greater than the auxiliary power which is applied to the valve, and this movement of the valve O has brought it against its stationary stop *i*, so that the valve O can advance no farther. In this position of the valve J the port F has been cut off from the inlet-port E and the valve J is about to open the other port H to the inlet-port E. As the piston commences its return, the valve J opens the port H to the inlet-port E, so as to permit air to enter on the retreating side of the piston, the valve O being stationary. While the valve J continues its movement the passage M of the valve J will pass onward over the port F, as seen in Fig. 3, permitting the air which is being compressed in advance of the piston to come upon the under or face side of the valve O, as seen in Fig. 3, this pressure increasing as the piston advances, until the pressure upon the under or face side of the valve O shall, with the auxiliary power applied to the valve O, counterbalance

the pressure upon the back of the valve O and so as to leave that valve free. Then the auxiliary power will come into action and instantly draw that valve O from over the opening M of the valve J, as represented in broken lines, Fig. 3, and so as to open wide the escape-passage from that end of the cylinder into the valve-chamber. The valve J passes on to its wide-open position at the other extreme, as indicated in broken lines, Fig. 3. As the piston reaches the opposite extreme end of the cylinder, then on the next movement of the piston the valve J will operate with the valve P for the escape of air from the advancing side of the piston, the same as I have described for the operation of the valve O. The valve P comes against its stop *l* when it reaches its inner position the same as described for the valve O, and under the same conditions the auxiliary power operates to throw the valve P to its wide-open position, the valve-pistons cushioning in their respective cylinders as they are thus thrown to the wide-open position. By this arrangement of the outlet-valves O P they are held in their closed position until the pressure of the cylinder shall have reached substantially the pressure in the receiver, and this irrespective of the time when that pressure is reached in the cylinder. Consequently the difficulties arising from the use of the positively-operated outlet-valves is obviated.

I have represented the auxiliary power as a combined weight and spring; but it will be understood that either may be employed without the other, or any suitable equivalent may be substituted therefor, it only being essential to the invention that there shall be an auxiliary power applied to each valve independent of the power which operates the principal valve J.

I prefer to employ the stops *i l* to arrest the advancing movement of the respective outlet-valves O P; but these stops may be omitted and the outlet-valves continue their movement with the valve J until the equilibrium is produced to such an extent as to permit the auxiliary power to operate the valves.

I have described the invention as in a double-acting air-compressor, the outlet valve and its pistons at one end being a duplicate of the same parts at the opposite end. The invention, however, is equally applicable to a single-acting air-compressor. I do not, therefore, wish to be understood as limiting the invention to a double-acting air-compressor.

In the illustration of the invention I have represented the movable valve-seat for the outlet-valves as operating also as the inlet-valve; but the inlet-valve may be a valve independent of the movable outlet-valve seat, as represented in Fig. 4, in which *m* represents a slide-valve, and *n* the inlet-passage, having a port *p* opening to the inside of the valve, with the passages *r s* leading to the respective ends of the piston and opening through ports *t* and *u* to the inside of the valve *m* and so that the valve in reciprocating will alternately open communication between the inlet-port to the respective ends of the cylinder, the movable valve-seat J for the outlet-valves and the outlet-valves themselves being the same as in the first illustration. The valve-seat having the same positive movement imparted to it as in the first illustration, the invention is therefore not to be understood as limited to the movable valve-seat for the outlet valves performing any part in the admission of air to the cylinder.

I do not represent the mechanism for imparting the movement to the compressing-piston or for positively operating the valve or valve-seat J. These, being common and well-known devices, do not require illustration, it being understood that the valve-seat and the piston may be positively operated in substantially the usual manner of operating positively-moved valves and pistons.

I prefer to employ the cylinders and pistons for the respective auxiliary valves as a dash-pot to check their movement; but it will be seen that the dash-pots may be omitted or any suitable cushion substituted therefor.

I claim—

The combination, in an air-compressor, of a cylinder, piston, and valve-chamber, a passage opening from the cylinder in advance of the piston through a port into the said valve-chamber, a reciprocating valve arranged in said chamber, having an opening through it adapted under the movement of the said reciprocating valve to register with the said cylinder-port, the movement of said reciprocating valve being positive, an outlet-valve arranged upon said reciprocating valve-seat and adapted to work over said passage through the said reciprocating valve, an auxiliary power, substantially such as described, applied to said outlet-valve, the said auxiliary power being independent of the movement of the said reciprocating valve, a piston in connection with said outlet-valve and so as to move therewith, a stationary cylinder in which said piston is adapted to work, and a stop to arrest the advance of the said outlet-valve, substantially as and for the purpose described.

EBENEZER HILL.

Witnesses:
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JOHN A. SLATER.