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W. B. MANN.

ENGINE FOR AIR PUMPS.

(Application filed Jan. 11, 1899.)

(No Model.)

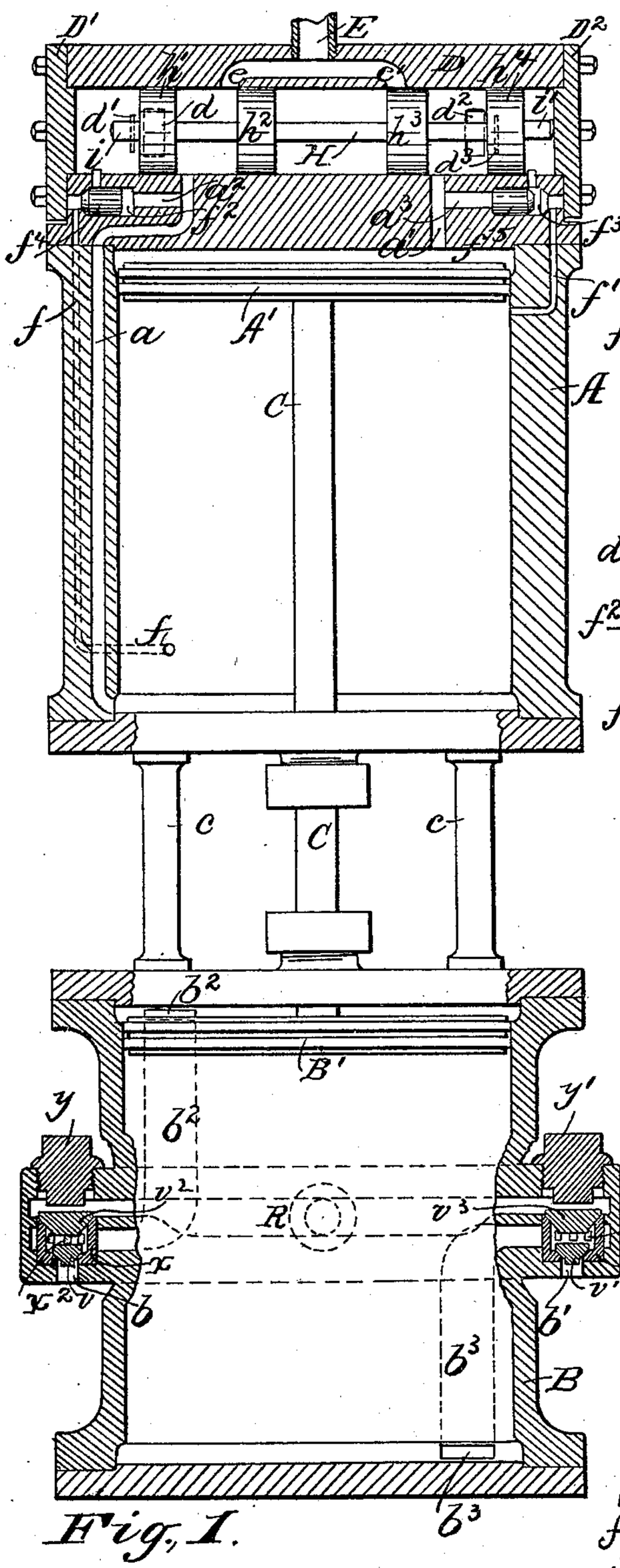

Fig. 1.

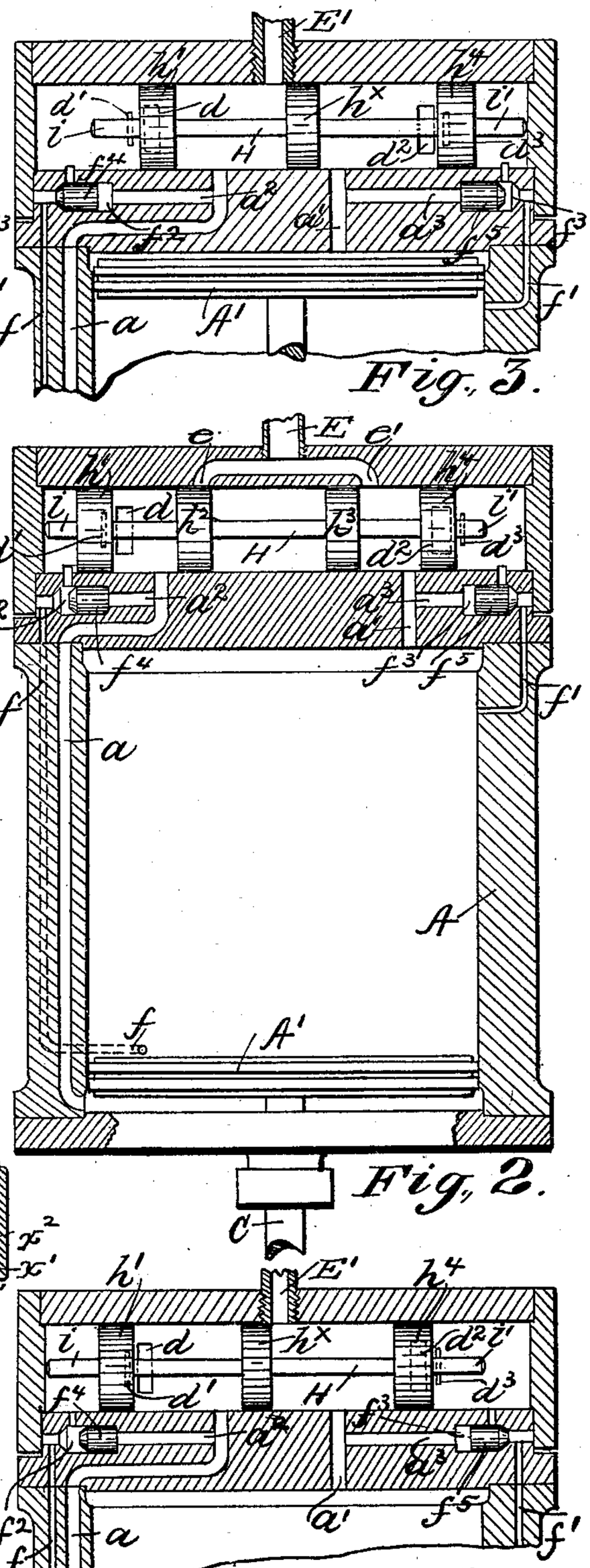

Fig. 3.

Fig. 2.

Fig. 4.

Witnesses.
W. R. Edelen.
S. T. Cameron

Inventor.
William B. Mann,
by Philip Mason,
his attorneys.

UNITED STATES PATENT OFFICE.

WILLIAM B. MANN, OF BALTIMORE, MARYLAND.

ENGINE FOR AIR-PUMPS.

SPECIFICATION forming part of Letters Patent No. 630,380, dated August 8, 1899.

Application filed January 11, 1899. Serial No. 701,855. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM B. MANN, a citizen of the United States, and a resident of the city of Baltimore, State of Maryland, have invented a new and useful Improvement in Engines for Air-Pumps, which invention is fully set forth in the following specification.

This invention relates to means for compressing air or other gases, and has particular relation to a compressor designed for use in connection with air-brake systems for railways and similar purposes, and has for its objects to simplify the construction of such compressors, to increase their efficiency and facilitate the repair of the same, and to provide a compressor which shall be inexpensive to manufacture.

With these objects in view the invention consists of the usual air and steam cylinders, with their pistons connected by a suitable piston-rod, and a steam-chest on the steam-cylinder having therein a compound valve mechanism controlling the alternate admission of steam to and the exhaust thereof from the two ends of the steam-cylinder, which valve mechanism is actuated by steam taken from the steam-cylinder into the steam-chest near the completion of each stroke of the piston, and means without the steam-chest and wholly independent of said valve mechanism for controlling the admission of steam from the steam-cylinder to the steam-chest. By thus providing valve-controlling means wholly without the steam-chest and disconnected from the valve mechanism of the chest I insure the working of the latter with a minimum amount of friction, which contributes to the greater accuracy of the device as a whole.

While various means may be employed to effect the control of the steam passing from the steam-cylinder to the steam-chest to operate the valve mechanism of the latter, I prefer to employ piston-valves subjected to differential pressures, whereby they are operated at the proper moment to open or close by-passages from the steam-cylinder to the steam-chest, so as to effect the shifting of the valve mechanism of the latter to permit the entrance of live steam into the steam-cylinder alternately on opposite sides of its piston to effect the reciprocation thereof. The cylinders of said piston-valves are open at one end to said by-passages and at the opposite end are opened to the working passages which conduct the live steam to the steam-cylinder, and as said by-passages and working passages are alternately open to steam-pressure and to exhaust the differential pressures for operating the piston-valves are thereby secured. In order to facilitate inspection and repairs, the steam-chest and piston-valves controlling the by-passages may be and preferably are all located within the head of the steam-cylinder, so that by removing the latter and substituting an interchangeable head a locomotive may be retained in active use while the removed cylinder-head, with its steam-chest and connected parts, is in the shop for repairs; but the invention is not limited to such location of the steam-chest, as it may be placed in any position on the cylinder which may be desired and still be within the scope of my invention.

In the drawings forming a part of this specification I have illustrated my invention, said drawings being designed, however, merely to facilitate the proper understanding of the invention and not as defining the limits thereof.

In said drawings, Figure 1 is a vertical longitudinal section of the steam and air cylinders and steam-chest, parts being shown in elevation and with the several valves in the positions they occupy at the instant the piston of the steam-cylinder has completed its upstroke. Fig. 2 is a like view of the steam-cylinder with the valves in the positions they occupy at the instant the piston of the steam-cylinder has completed its downstroke. Fig. 3 is a similar view of a modification, the positions of the parts corresponding to Fig. 1; and Fig. 4 is a view of such modification with the parts in positions corresponding to Fig. 2.

Referring to Figs. 1 and 2, A indicates a steam-cylinder; B, a compressor-cylinder; A′, a piston in cylinder A; B′, a piston in cylinder B, and C a rod connecting the two pistons, while *c c* indicate suitable rods or pillars holding the cylinders A and B in fixed relation to each other.

D is a steam-chest, preferably arranged on the head of the cylinder A, as shown, and may, if desired, be made integral therewith. I prefer to form this chest D in the shape of

a uniform cylinder, closed at each end by suitable heads D' D², which may be bolted or otherwise securely attached to the chest D. The chest has communication with a source of live steam through a pipe E, which in the construction shown in Figs. 1 and 2 enters the cylinder through the branch passages *e e'*, which enter the cylinder in proximity to but in opposite sides of its longitudinal center. Working passages *a a'* connect the steam-chest D to the cylinder A, one, as *a*, extending to one end of the cylinder A and the other, *a'*, to the opposite end thereof. It will be noted that passages *a a'* connect with the steam-chest D on opposite sides of the longitudinal center of said chest and in different transverse planes from the passages *e e'*. Two by-passages *f f'* connect the ends of the steam-chest with the cylinder A, one of them, as *f*, entering said cylinder at a point where the piston A' just passes it upon the completion of its stroke in one direction and the other, *f'*, entering at a point where the piston just passes it upon the completion of its stroke in the opposite direction. Each of said by-passages *f f'* traverses cylinders f^2 f^3, within which are located piston-valves, as f^4 f^5, the by-passages entering said cylinders at one end, where a valve-seat is formed, and leaving the cylinders at a point on the side thereof removed from said end, so that when the piston-valves f^4 f^5 are seated the by-passages are closed and steam communication from the cylinder to the chest along the by-passages is cut off. Cylinder f^2 is connected to working passage *a* by a branch passage a^2, which enters cylinder f^2 at the end thereof opposite the valve-seat, and passage *a'* is connected to cylinder f^3 by a like passage, which enters the cylinder at the end thereof opposite the valve-seat formed therein.

The cylindrical steam-chest D has exhaust-ports *d d'* leading from one end portion thereof to the atmosphere and similar exhaust-ports d^2 d^3 leading from the other end portion to the atmosphere, the exhaust-ports *d d'* being situated in transverse planes between the points where the passages *a* and *f* enter the cylinder and the ports d^2 d^3 being situated in similar planes between the entrance-points of the passages *a'* and *f'*. The ports *d* d^2 are the main exhaust-ports, through which the steam-cylinder is exhausted, and the ports *d'* d^3 are the auxiliary exhaust-ports, through which the ends of the steam-chest are exhausted. It will be readily understood that the partitions between the ports *d d'* or between d^2 d^3 might be removed, thus forming at each end of the steam-chest a combined main and auxiliary exhaust-port, without in any way departing from the invention, as the pistons *h' h⁴* would still open and close the exhaust to the steam-cylinder and the steam-chest precisely as is done with the main and auxiliary ports formed separately side by side.

Within the cylindrical steam-chest D in the form shown in Figs. 1 and 2 are four piston-valves *h'*, h^2, h^3, and h^4, rigidly connected together by a rod H. The piston *h'* has a lug or projection *i* extending from its outer face toward the end D' of the steam-chest, and the piston h^4 has a like lug *i'* extending toward the end D² of the chest. These lugs *i i'* may be and preferably are mere extensions of the rod H and are of such length as to impinge on the heads D' D² to determine the throw of the rod H and the valves carried thereby. The relative spacing of the pistons *h'*, h^2, h^3, and h^4 on the rod H and of the several ports and passages leading into and out of the steam-chest is such that in the shifting of the rod and pistons, as will be hereinafter described, the passages *a a' f f'* are always open or unobstructed thereby, while the passages *e e'* and exhaust-ports *d d'* d^2 d^3 are alternately opened and closed.

The operation of the device as thus far described is as follows: Assuming the parts to be in the position shown in Fig. 1, live steam is entering the cylinder A by way of passages E *e*, steam-chest D, (between piston-valves *h' h²*,) and passage *a* and has driven the piston A' past the inlet to the passage *f'*, as shown. The cylinder A on the upper side of the piston A' and the passage a^3 are exhausted through passage *a'* and exhaust-port d^2, while that portion of the steam-chest lying between the piston *h'* and the head D' is open to exhaust through port *d'*. The cylinders f^2 f^3 have a contracted opening on the side adjacent the passages *f f'*, so that when the piston-valves f^4 f^5 are seated—as, for example, f^4 of Fig. 1—there is a less surface exposed to pressure by way of by-passage *f* than is exposed to pressure by way of branch passage a^2, the valve in this position forming, in effect, a differential piston, and therefore the live steam entering the cylinder f^2, Fig. 1, through passage a^2 firmly holds the valve f^4 to its seat even after live steam has entered passage *f*. In f^3, Fig. 1, however, the pressure to the rear of piston-valve f^5 is about that of the atmosphere, and hence when piston A' in assuming the position of Fig. 1 passes the mouth or port of passage *f'* live steam from cylinder A enters passage *f'*, throws piston-valve f^5 to position shown in Fig. 1, and enters steam-chest D between piston h^4 and head D². This will cause the rod H and four piston-valves *h' h² h³ h⁴* to shift from position shown in Fig. 1 to that shown in Fig. 2, thereby shutting off the flow of live steam to cylinder A through passages *e* and *a* and opening said cylinder to exhaust through passage *a* and port *d*. (See Fig. 2.) At the same time exhaust-ports *d'* and d^2 are closed by piston-valves *h' h⁴*, respectively, and exhaust-port d^3 is opened, while live steam enters cylinder A through passages *e'* and *a'* and acts on piston-valve f^5 by way of passage a^3, whereby the valve is closed and the piston A' starts on its reverse stroke—that is, from the position shown in Fig. 1 to that shown in Fig. 2. During the time consumed by piston A' in making its stroke piston-

valves f^4 and f^5 both remain seated; but when the piston A′ reaches the position shown in Fig. 2 live steam enters passage f, shifts the piston-valve f^4 from the position shown in Fig. 1 to that shown in Fig. 2, and entering the steam-chest between piston h' and head D′ shifts rod H and its four pistons from the position shown in Fig. 2 to that shown in Fig. 1. It will thus be seen that upon each stroke of the piston A′ the piston-valves in the steam-chest automatically shift so as to open the necessary steam and exhaust ports to cause the reverse movement of the piston A′.

Referring now to the compressing-cylinder B, b b' are ports communicating with the atmosphere and with passages b^2 b^3 within the walls of the cylinder B. These passages b^2 b^3 communicate with the interior of the cylinder at the respective ends thereof. The ports b b' are controlled by valves v v', opening inwardly, and immediately above said valves are other valves v^2 v^3, controlling communication between the passages b^2 b^3 and a third passage R, extending circumferentially around the cylinder B and preferably formed in the thickened walls thereof. The seats for the valves v v' v^2 v^3 are preferably formed in bushings x x', inserted in position through openings y y, closed by plugs y' y', the relative positions of the plugs and valves being such that valves v v' may be lifted from their seats by the incoming air, but cannot be displaced so as to fail to be properly reseated, because the valves v^2 v^3 prevent them from rising too far. Likewise the plugs y' y' act as stops for valves v^2 v^3. The bushings x x' have ports or openings x^2 therethrough, and it is by way of these openings that communication is had between the ports b b' and the passages b^2 b^3. The circumferential passage R is connected to a suitable reservoir by a pipe R′. (Shown in dotted lines in Fig. 1.)

The operation of the compressor is as follows: As the piston B′ makes its stroke from the position shown in Fig. 1 to the opposite end of the cylinder the air is forced through the passage b^3, raises the valve v^3, and enters the passage R, whence it is conveyed by pipe R′ to the reservoir. During the stroke of piston B′ there is a tendency to create a vacuum in the cylinder B above the piston, thereby permitting the atmospheric pressure on valve v through port b to lift said valve, whereupon air enters the cylinder B above piston B′ by way of port b and passage b^2. The valve v^2 remains seated during this operation, because the pressure above the valve—that is, the pressure in passage R—exceeds atmospheric pressure, which tends to raise it. At the end of the stroke valves v v^3 are returned to their seats by gravity, and upon the reverse stroke of piston B′ the compressed air in passages R and b^2 firmly holds them seated, while valve v^2 is lifted to permit the compressed air to flow from passage b^3 to R, and valve v' is opened by atmospheric pressure to permit fresh air to enter the cylinder B through the port b' and passage b^3.

In Figs. 3 and 4 I have illustrated a preferred form of construction for the steam-chest and the valves moving therein. In this form the live steam enters the steam-chest directly from the pipe E′ instead of through the branch passages e e', as in Figs. 1 and 2, and the working passages a a' leave the chest at points on opposite sides of the point where steam-pipe E′ enters it—that is, in transverse planes lying on either side of said pipe. The piston-valves h' h^4 control exhaust-ports d d' d^2 d^3, as in the construction shown in Figs. 1 and 2; but valves h^2 h^3 are dispensed with, and instead a centrally-disposed valve $h^\times$, which during the reciprocations of the rod H plays back and forth across the mouth of pipe E′, alternately cutting off one of the working passages a a' from communication with steam-pipe E′ and opening communication to the other. Piston-valves h' h^4 control the exhaust-ports exactly as in Figs. 1 and 2, and the operation of valves f^4 f^5 is also the same. I would remark that exhaust-ports d d' may, if desired, be formed as a single port, the piston-valve h' playing across it, so as to expose a portion of the port first on one side and then on the other, just as ports d d' are exposed in the construction shown, and the same is true of exhaust-ports d^2 d^3 and piston-valve h^4, it only being essential that at each reciprocation of the exhaust piston-valve h' or h^4 it should close the chamber on one side of it to exhaust and open the other, and vice versa.

It will be noted that the parts of my invention are of exceedingly simple construction, entirely free from spring action of any kind, strong, and not liable to get out of order. It will also be noted that by reason of the fact that the steam-chest and by-passage valves are located on the cylinder-head they may be readily removed and taken to the shop for repairs, a second similar cylinder-head being substituted with very little difficulty or loss of time.

Having thus described my invention, what I claim is—

1. The combination of the steam-cylinder, and its piston with the steam-chest having communication with a source of live steam, working passages leading from the steam-chest to opposite ends of the cylinder, by-passages leading from the steam-cylinder to opposite ends of the steam-chest, fluid-actuated valves controlling said by-passages, auxiliary exhaust-ports near the opposite ends of the steam-chest, piston-valves controlling said auxiliary exhaust-ports, main exhaust-ports and a valve device attached to and actuated by said piston-valves and controlling the passage of live steam through the steam-chest to said working passages, substantially as described.

2. The combination of the steam-cylinder and its piston, with the steam-chest having communication with a source of live steam,

working passages leading from the steam-chest to opposite ends of the steam-cylinder, a valve in the steam-chest alternately admitting steam to one of said working passages and then to the other, main and auxiliary exhaust-ports near the opposite ends of the steam-chest piston-valves controlling said ports and means alternately admitting steam from the steam-cylinder to one of said piston-valves and then to the other; substantially as described.

3. The combination of the steam-cylinder, its piston, the steam-chest connected to a source of live steam, working passages leading therefrom to the opposite ends of the steam-cylinder, a steam-valve alternately connecting one of said working passages to the source of live steam and then cutting it off and connecting the other working passage thereto, means exhausting steam from opposite sides of said piston exhaust-ports in the steam-chest, piston-valves, playing across said exhaust-ports and connected to said steam-valve, by-passages connecting the opposite ends of the steam-chest with the steam-cylinder, and differential piston-valves controlling said by-passages substantially as described.

4. The combination of the steam-cylinder and its piston with a steam-chest, a steam-valve alternately admitting steam to opposite sides of said piston, main and auxiliary exhaust-ports in opposite ends of said steam-chest, piston-valves connected to said steam-valve and controlling said exhaust-ports and means alternately admitting steam to said piston-valves from opposite ends of the steam-cylinder.

5. The combination of the steam-cylinder, its piston, the steam-chest and steam-valve, with a pair of pistons operatively connected to said steam-valve, each piston controlling the exhaust of steam from one end of the steam-cylinder and from the space in the steam-chest behind itself, and means alternately admitting steam behind said pair of pistons.

6. The combination of a steam-cylinder, a cylindrical steam-chest having a port for the admission of live steam working ports leading to opposite ends of the steam-cylinder and main and auxiliary exhaust-ports, with a piston-valve device reciprocating in the cylindrical steam-chest and controlling the passage of steam through said working and exhaust ports, and valve-controlled passages leading from near the opposite ends of the steam-cylinder to opposite ends of the steam-chest.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WILLIAM B. MANN.

Witnesses:
JOSEPH T. GOTT,
JAMES M. FAIRBANK.