No. 670,000. Patented Mar. 19, 1901.

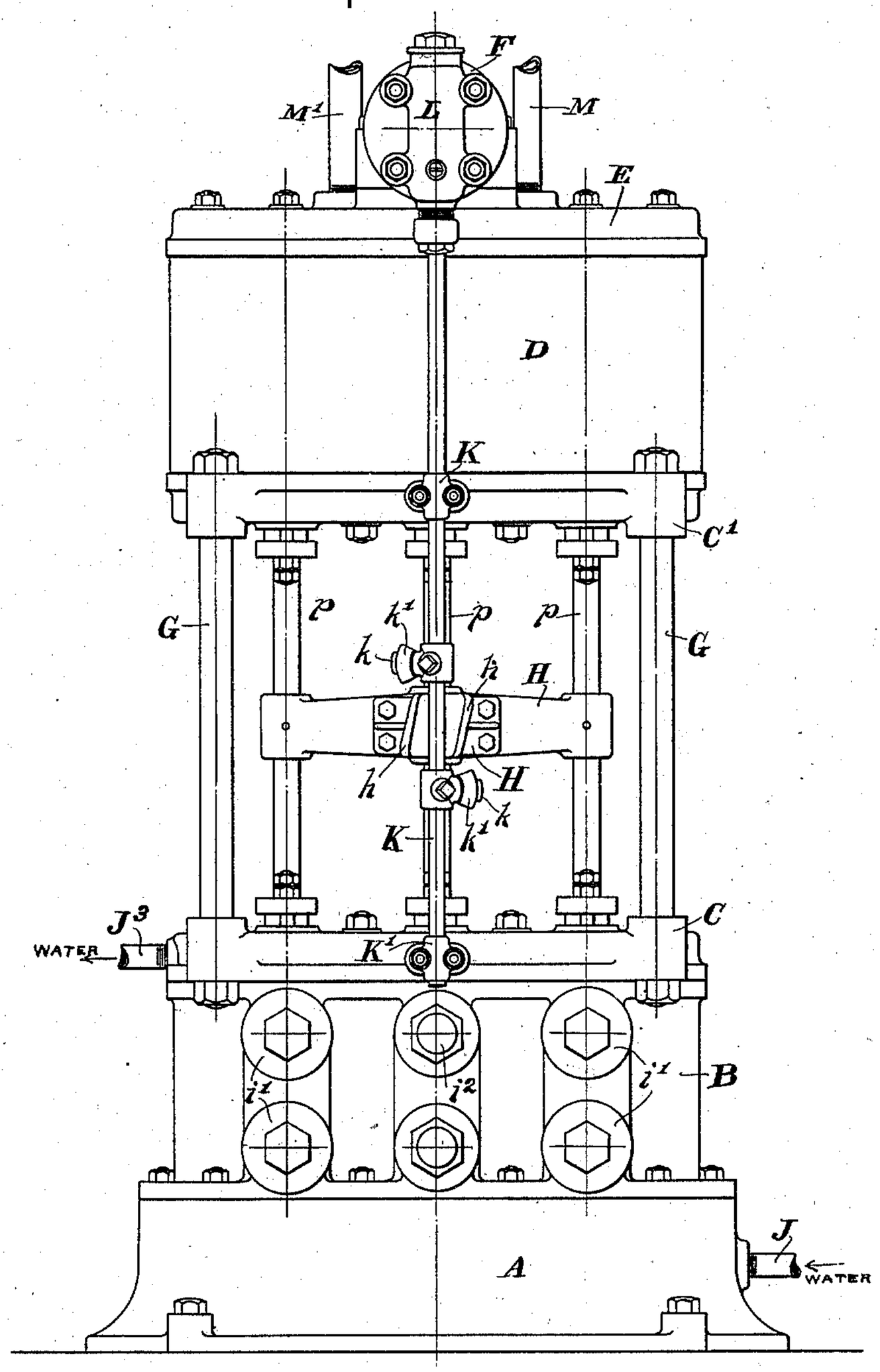
F. H. MERRILL.

AIR COMPRESSOR.

(Application filed Mar. 30, 1900.)

(No Model.) 4 Sheets—Sheet 1.

FIG. 1.



WITNESSES

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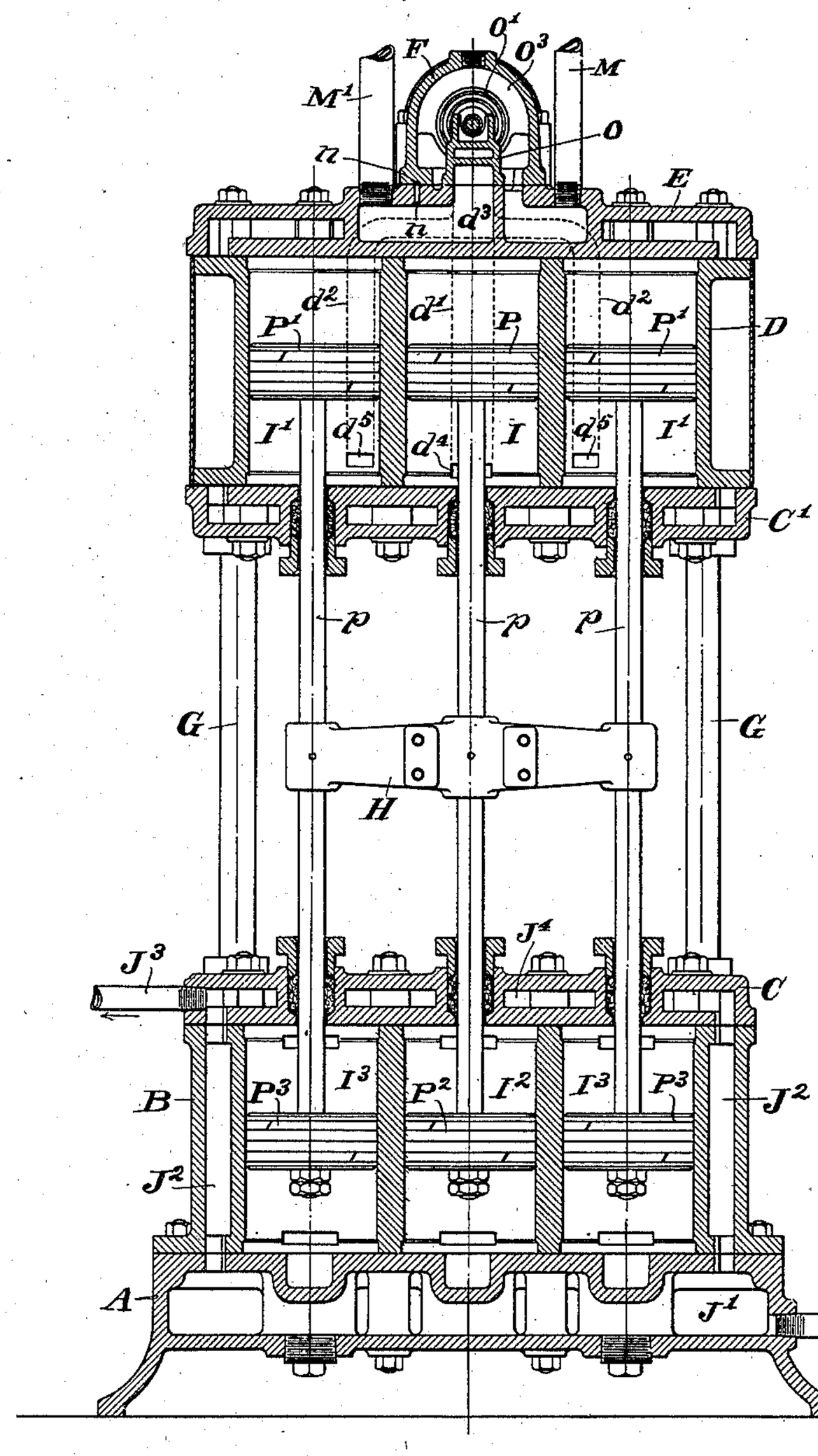
(No Model.) 4 Sheets—Sheet 2.

FIG. 2.



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(No Model.) 4 Sheets—Sheet 3.

FIG. 3.

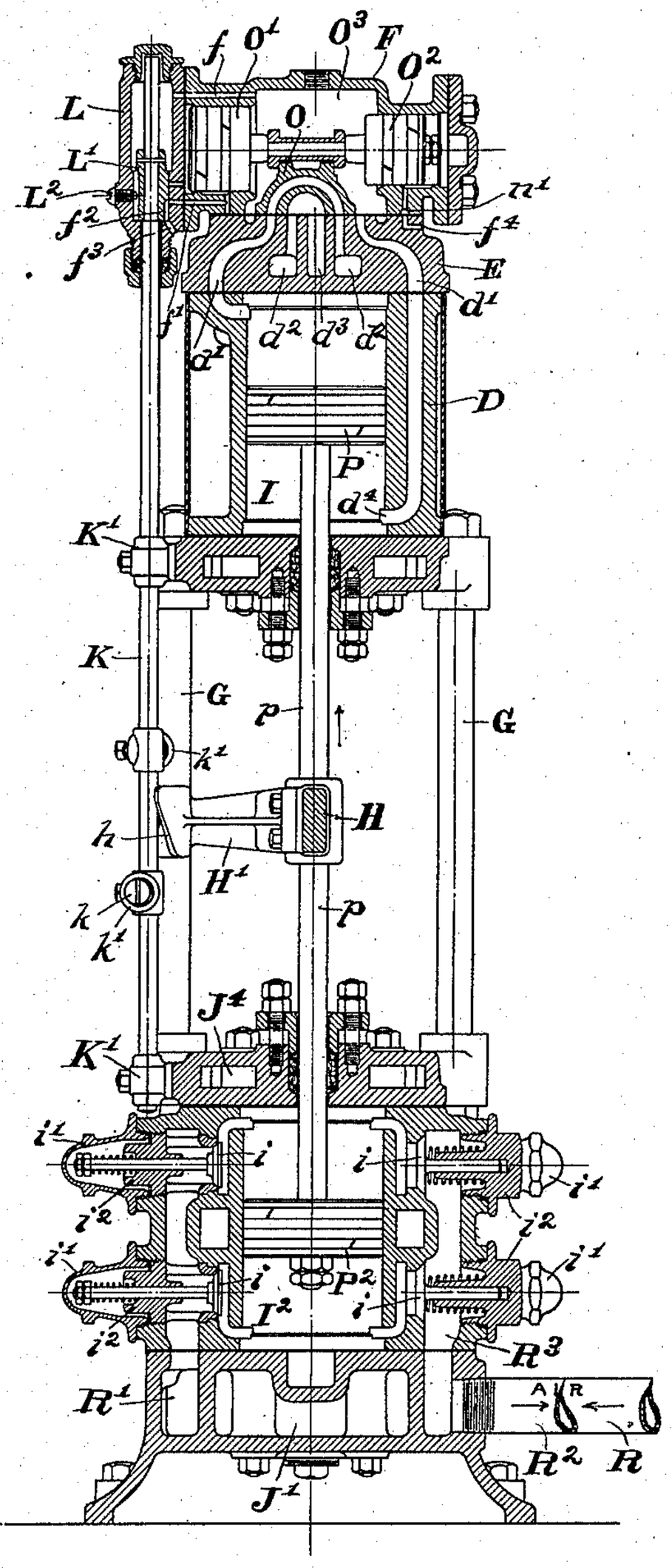

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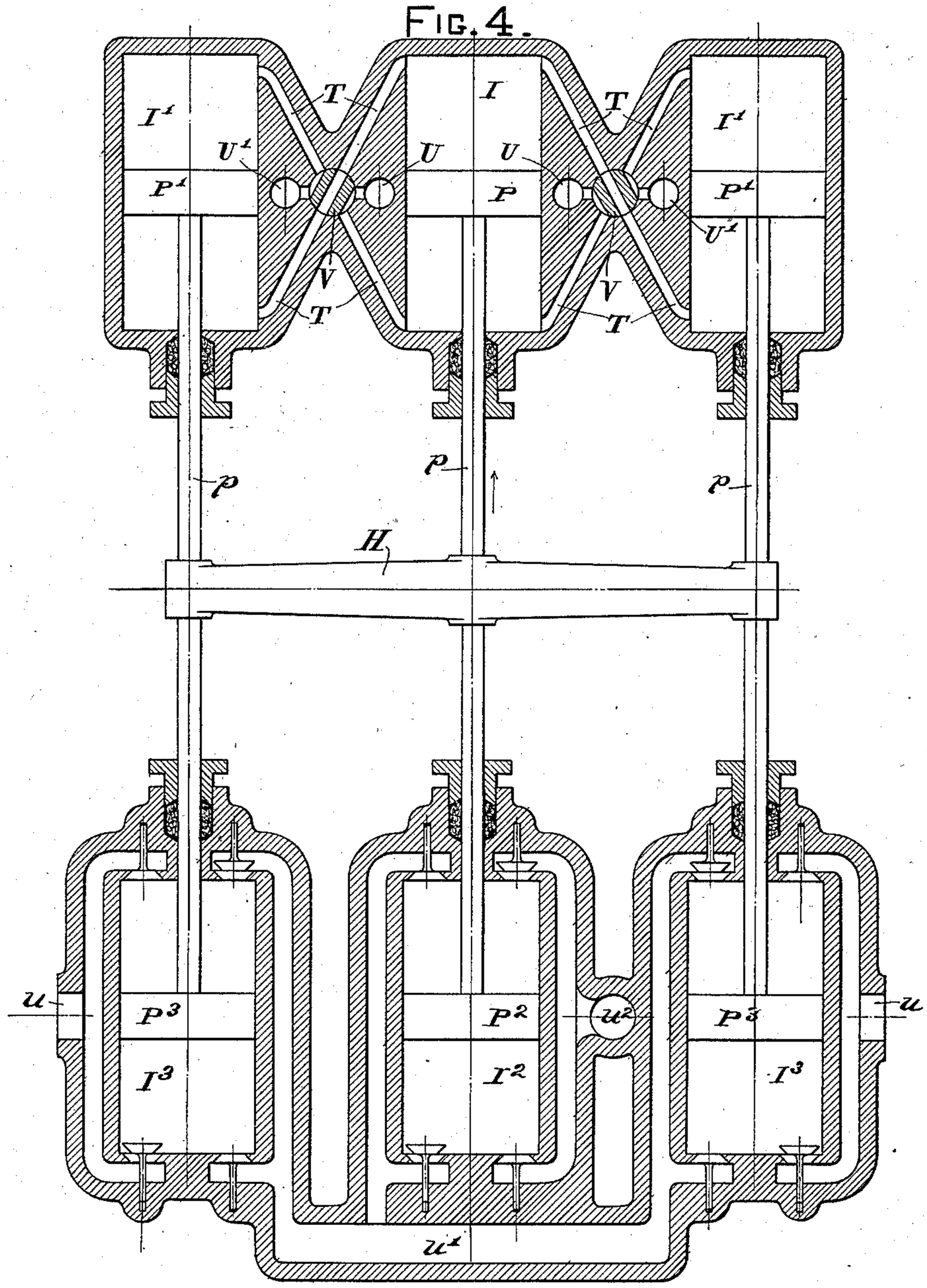
FIG. 4.



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UNITED STATES PATENT OFFICE.

FRANK H. MERRILL, OF PLAINFIELD, NEW JERSEY.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 670,000, dated March 19, 1901.

Application filed March 30, 1900. Serial No. 10,752. (No model.)

To all whom it may concern:

Be it known that I, FRANK H. MERRILL, of Plainfield, in the county of Union and State of New Jersey, have invented a new and Improved Air-Compressor, of which the following is a full, clear, and exact description.

My invention relates to an improvement in air-compressors; and it consists of certain novel parts and combinations of parts, which will be particularly pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a front elevation of my device. Fig. 2 is a sectional front elevation taken upon the center line of the compressor. Fig. 3 is a sectional side elevation taken upon the center line of the central cylinders, and Fig. 4 is a sectional elevation showing in a diagrammatic manner the principal elements of my compressor in order to better illustrate its principle of action.

In the accompanying drawings I have shown my invention embodied in the form at present preferred by me; but it will be understood that various modifications and changes may be made without departing from the spirit of my invention and without exceeding the scope of my claims.

The following is a description of the structures illustrated in the drawings.

One of the objects sought to be accomplished in this compressor is to provide a direct-acting compressor which may be run without having a fly-wheel attached thereto and which shall yet have a measure of economy greater than may be secured by ordinary compressors of this class. This compressor is designed to be compounded, so as to secure a certain measure of expansion of the steam and also to compress the air by two stages instead of one. It is also designed to produce a compressor which shall be simple to operate, cheap to make, and which is not likely to get out of order when handled by inexperienced persons.

In Fig. 4 the essential principles of the compressor are illustrated in a somewhat diagrammatic manner, many of the parts required for securing certain operations having been omitted in order to simplify the drawing and to more clearly bring out the pertinent features thereof. In this drawing three steam-cylinders I, I′, and I′ and three air-cylinders I^2, I^3, and I^3 are shown. These cylinders are arranged in pairs opposite each other and constitute two central high-pressure cylinders I and I^2, adapted, respectively, to receive the steam direct from the boiler and to receive the air as compressed by the other cylinders. The valves V are shown located one at each side of the high-pressure cylinder I. Alongside of the chamber containing these valves are two passages or ports U, which are connected with the steam-supply. On the other side of the valves are two ports or chambers U′, into which steam is exhausted from the low-pressure cylinders. The ends of the high-pressure cylinder I are connected diagonally with the opposite ends of the low-pressure cylinders I′ by means of ports T and the passages in the valve V. In the position of parts shown in Fig. 4 steam is being admitted from the passages U through recesses in the valves V and the ports T to the lower side of the high-pressure piston P. Steam which has previously been used in the upper end of the high-pressure cylinder to force its piston down is now being exhausted through the ports T to the lower ends of the two low-pressure cylinders I′ and is acting in coöperation with the live steam in the high-pressure cylinder to raise the piston upward. When the pistons reach the end of their stroke, the distribution of the steam is changed by shifting the valves V. For the present purpose the means by which these valves are shifted is immaterial and is not described. Means for securing this result will be described in connection with the description of the device as constructed and as shown in Figs. 1, 2, and 3. The air is admitted to the outside or low-pressure air-cylinders through the ports *u*. From these cylinders the air is discharged into a passage *u′*, from whence it enters the high-pressure air-cylinder I^2. From this high-pressure cylinder the air is discharged through the port or passage u^2. It will be noticed that the ports T, which supply the steam to the steam-cylinders, connect with the extreme lower portion of the high-pressure cylinder, but connect with the low-pressure cylinders at a short distance from their ends,

the object of this being to render certain the action of the steam upon the high-pressure cylinder to start the compressor and also to govern the motion of the pistons by forming a pocket in the ends of the low-pressure cylinders, and thus to prevent striking the pistons against the cylinder-heads. Steam is admitted to the high-pressure cylinder throughout the extent of its travel. When the valves V are shifted, this steam is exhausted into the low-pressure cylinders. As herein shown, each of the low-pressure cylinders is of the same size as the high-pressure cylinder, and consequently the steam is by this device expanded in each cylinder to twice its volume previous to entering said cylinder. Similarly the low-pressure air-cylinders I^3 are shown as of the same size as the high-pressure air-cylinder I^2. With the proportions of the cylinders herein shown the air delivered from the low-pressure cylinder will be compressed to two atmospheres—that is, to about fifteen pounds gage—and the air delivered from the high-pressure cylinder to about four atmospheres or about forty-five pounds gage. Of course the pressure of the air may be varied by changing the proportions of the parts or by other devices, and I do not wish to be understood as limiting myself to the particular proportions of parts above given, as this would be departed from whenever the conditions required it.

It is to be understood that the exact construction shown in Fig. 4 is neither a desired nor preferred construction, as, although this will work satisfactorily, a construction which differs from this in many ways is preferred. Such a construction is shown in Figs. 1, 2, and 3. In this construction the device is mounted upon a base A, which is hollowed out and which, in connection with chambers or passages formed in the section B about the air-cylinders I^2 and I^3, and passages within the section C which constitute the upper heads of the air-cylinders, serve to cool the cylinders by a current of water which is passed through the same. The water is introduced through a pipe J into the passages J′, formed in the base A. These passages or chambers are connected by suitable openings with passages J^2, formed outside of the air-cylinders, and these in turn are connected by suitable openings with the passages J^4, formed in the section C, and the water is discharged through a pipe J^3.

The air-valves (shown in Figs. 1, 2, and 3) are placed in the side of the cylinders, as clearly shown in Fig. 3. These open into ports which connect with the air-cylinders at their extreme ends, or rather into the counterbores formed in the ends of the cylinders. The valves i are puppet-valves, which are held in and seated upon a removable plug i^2, which is screwed in place. The admission-valves are provided with an exterior spring to hold them in place and open inwardly. They are also covered by a conical cap i' to prevent leakage of air. The discharge-valves are mounted in similar plugs, but have a spring on the inner side thereof, and do not need the inclosing cap i', as the stem of the valve does not project entirely through the plug. Air is admitted through the pipe R into suitable passages in the base A and connects with the passage R′, which leads upwardly into the section B, where the admission-valves are located.

The piston-rods p of all the cylinders are connected by a cross-bar H, so that all of them move synchronously and as a single piston. The section E, which forms the upper heads of the steam-cylinders P and P′, has a series of ports therein, by means of which steam is distributed from the valve to the different cylinders. This consists of a central exhaust-port d^3, two intermediate ports d^2, which connect the central or high-pressure cylinder with the two low-pressure cylinders, and the ports d', which connect the steam-chamber with the high-pressure cylinder. The valve used is an ordinary D-valve having a port extending within its body from one face to the other and adapted to communicate with the ports d^2 and the ports d'. This valve is actuated by means of a differential piston consisting of the two parts O′ and O^2, the former being the larger. This piston is mounted in the valve-casing F, to which the live steam is admitted by means of a pipe M. The outer end of the smaller section O^2 of this differential piston is connected by means of a passage f^4, formed in the valve-casing and the cylinder-head section D, with the outer air, so that the pressure therein will never exceed the atmosphere. The outer surface of the opposite end of the piston is connected by means of small ports near its lower side with an auxiliary-valve chamber L. This valve-chamber is connected by means of a port f with a main-valve chamber O^3 and is consequently at all times charged with live-steam. Within this auxiliary-valve chamber is the auxiliary valve L′, which is provided with small grooves or ports in its sides, adapted when the valve is rocked upon its axis to connect either with the port opening into the space at the outer end of the section O′ of the differential piston or to connect said space with the outer air through the ports f^2 and f^3. In one position the pressure of steam is admitted behind the differential piston, so as to quickly force it to the right from the position shown in Fig. 3. In the other position steam is exhausted from this space through the port f', and the left end of the piston being the larger the steam within the central valve-chamber O^3 will act to force the piston to the left.

The auxiliary valve L′ is mounted upon a rod K, which is supported in bearings K′, so that it may rock, but not slide lengthwise. This rod is provided with two arms k, extending to opposite sides and each carrying a friction-roller k'. These friction-rollers are en-

gaged to rock the valve by means of cam inclines or wedges *h*, which are carried on the outer ends of an arm H′, which is secured to the bar H, connecting the various piston-rods. The operation of the valve is thus positive in all its steps, the movement of the pistons being relied upon to rock the auxiliary valve L′. As soon as this valve is shifted it admits steam to the differential piston to shift the latter and with it the valve O.

In practice the exhaust of the steam which operates the differential piston would be conveyed through suitable passages in the valve-casing and between said valve-casing and the piston-head section E into the exhaust-passage d^3, thus preventing any escape of steam into the room in which the air-compressor is placed. As this point is not in itself considered of any very great importance, ports f^3 have been shown which communicate with the outer air. In Fig. 2 at *n* is shown a portion of the port which would be used in the other form of construction, so as to discharge the steam from the differential pistons into the exhaust-passage d^3.

By the method of connection of the various cylinders herein shown and described I am enabled to use steam expansively in a direct-connected air-compressor without using a fly-wheel, and thus to secure a measure of economy with great simplicity of construction. By admitting steam to the high-pressure cylinder throughout the length of its stroke I am also enabled to start my compressor at any point by simply opening a throttle-valve. The compressor therefore partakes of the simplicity and reliability of an ordinary direct-acting steam-pump.

It will be noticed that the two sections C and C′, which respectively form the upper cylinder-heads of the air-cylinders and the lower heads of the steam-cylinders, are alike in construction, being simply reversed in position. These are connected by means of rods G, which are preferably of steel or wrought-iron.

It will be noticed that the high-pressure cylinder has the low-pressure cylinders placed on opposite sides thereof—that is, they are grouped symmetrically about the high-pressure cylinder. It is evident that the same principle might be employed in a three-stage compressor as well as in a two-stage, extra cylinders being added for the compressor of the air in the additional stage. The object of grouping cylinders in this manner is to enable strains in the device to be transmitted as much as possible in straight lines and to prevent side or buckling strains. It is therefore desirable that the cylinders for the different stages or steps of expansion or compression have a common center of moment, as has been secured in the construction shown by making the two low-pressure cylinders of the same size and placing them on directly opposite sides and at equal distances from the high-pressure cylinder.

Having thus fully described my invention, I claim as new and desire to secure by Letters Patent—

1. An air-compressor composed of three steam-cylinders and three air-cylinders, and steam and air pistons therein having a common connection so as to move together, both said steam and air cylinders being compounded and consisting of one high-pressure and two low-pressure cylinders, substantially as described.

2. An air-compressor composed of three steam cylinders and pistons and three air cylinders and pistons arranged oppositely in pairs, each pair being in line and consisting of one air and one steam cylinder and rods connecting the pistons of each pair, a connecting member for all of said rods, a steam-distributing mechanism delivering steam to one of the steam-cylinders, and from that cylinder to both of the other steam-cylinders, and an air-distributing mechanism discharging from two air-cylinders into the other air-cylinders, substantially as described.

3. An air-compressor composed of three steam cylinders and pistons and three air cylinders and pistons arranged oppositely in pairs, each pair being in line and consisting of one air and one steam cylinder and rods connecting the pistons of each pair, a connecting member for all of said rods, a steam-distributing mechanism delivering steam to one of the steam-cylinders, and from that cylinder to both of the other steam-cylinders, and an air-distributing mechanism discharging from two air-cylinders into the other air-cylinders, the high-pressure cylinders being located between their corresponding low-pressure cylinders, substantially as described.

4. A direct-acting air-compressor composed of three steam cylinders and pistons and three air cylinders and pistons, said cylinders and pistons being arranged oppositely and connected in pairs, each pair consisting of an air and steam cylinder and their pistons, a common connection between the rods of all of said pistons, both said air and steam cylinders being joined to form one high-pressure and two low-pressure cylinders, the high-pressure cylinders being between and in line with the low-pressure cylinders, substantially as described.

5. A direct-acting compound air-compressor, the steam and air ends each consisting of a high-pressure cylinder and plural low-pressure cylinders arranged symmetrically about the same, and a synchronizing connection between the pistons, substantially as described.

6. A direct-acting compound air-compressor, the steam and air ends each consisting of a high-pressure cylinder and plural low-pressure cylinders arranged symmetrically about the same, a rigid connection between all the pistons, a steam-valve having an actuating-piston connected therewith, an auxiliary valve controlling the pressures upon said valve-actuated piston, and an operating de-

vice therefor actuated by the reciprocations of the steam and air pistons, substantially as described.

7. A direct-acting compound air-compressor, the steam and air ends each consisting of a high-pressure cylinder and plural low-pressure cylinders arranged symmetrically about the same and a rigid connection between all the pistons, a steam-valve having an actuating-piston connected therewith, a rocking or oscillating auxiliary valve controlling the pressures upon said valve-actuating piston, a valve-rod connected with the auxiliary valve and extending adjacent the piston-rods, arms extending from said auxiliary-valve rod, and an arm carried by the piston-rods and having cam surfaces or inclines adapted to engage the said arms to rock the auxiliary valve, substantially as described.

8. A direct-acting compound air-compressor, the steam and air ends each consisting of a high-pressure cylinder and plural low-pressure cylinders arranged symmetrically about the same and a rigid connection between all the pistons, a single steam-valve mounted upon the head of the high-pressure steam-cylinders, and ports leading from said valve to opposite ends of all the steam-cylinders, substantially as described.

9. A direct-acting compound air-compressor, the steam and air ends each consisting of a high-pressure cylinder and plural low-pressure cylinders arranged symmetrically about the same, and a rigid connection between all the pistons, the ports to the high-pressure steam-cylinder connecting with the extreme ends of the cylinder and those to the low-pressure steam-cylinders being covered by their pistons at their extreme travel, substantially as described.

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

FRANK H. MERRILL.

Witnesses:
H. L. REYNOLDS,
CHARLES J. RATHJEN.