2 Sheets--Sheet 1.

H. J. BAILEY.

Air-Compressing Apparatus.

No. 161,090. Patented March 23, 1875.

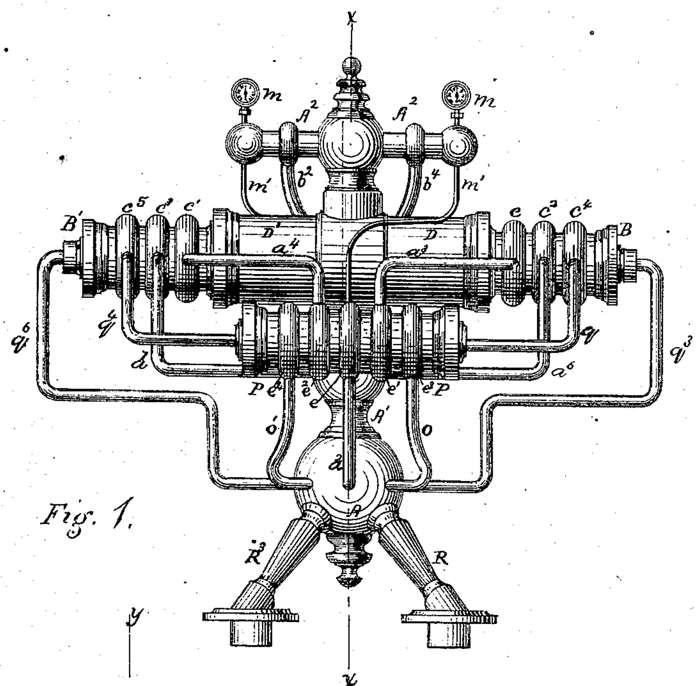

Fig. 1.

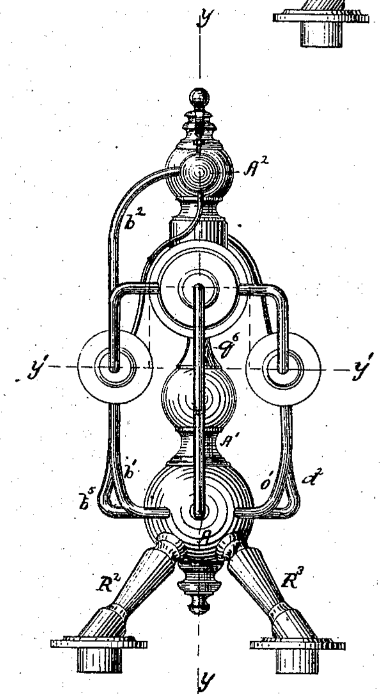

Fig. 2.

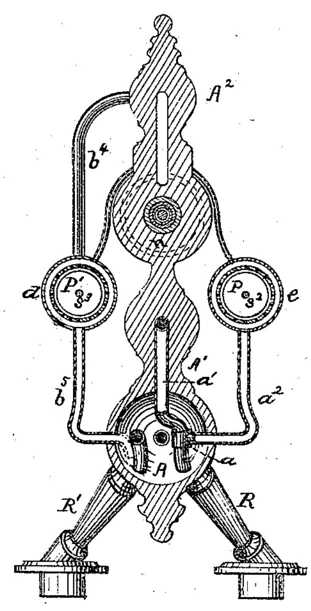

Fig. 3.

Witnesses: Chas. G. Page, C. L. Parker.

Inventor: Harry J. Bailey by George H. Christy his atty.

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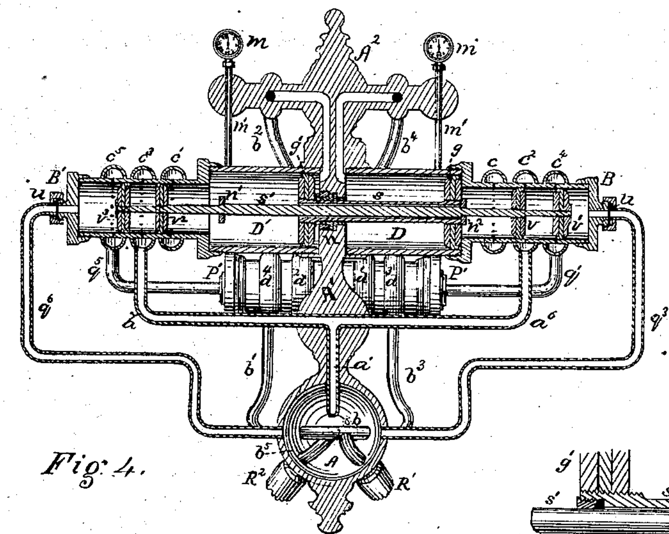

Fig. 4.

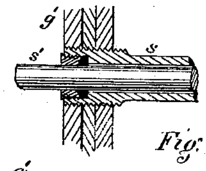

Fig. 8.

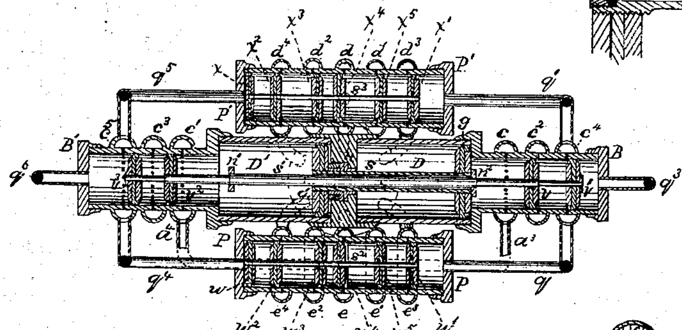

Fig. 5.

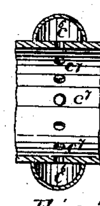

Fig. 7

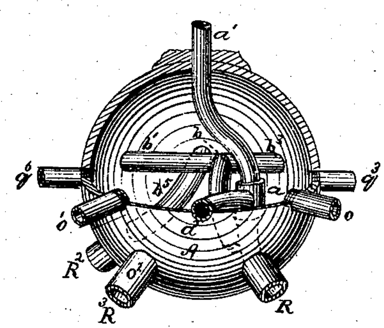

Fig. 6.

Witnesses { Chas G. Page
{ C L Parker.

Inventor: Harry J. Bailey
by Geo. H. Christy
his atty.

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UNITED STATES PATENT OFFICE.

HARRY J. BAILEY, OF PITTSBURG, PENNSYLVANIA.

IMPROVEMENT IN AIR-COMPRESSING APPARATUS.

Specification forming part of Letters Patent No. **161,090**, dated March 23, 1875; application filed January 12, 1875.

To all whom it may concern:

Be it known that I, HARRY J. BAILEY, of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful Improvement in Air-Compressing Apparatus; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawing making a part of this specification, in which like letters indicate like parts.

Figure 1, Sheet 1, is a front elevation of my improved apparatus. Fig. 2 is an end elevation thereof. Fig. 3 is a sectional elevation along the plane *x x*, Fig. 1. Fig. 4, Sheet 2, is a sectional elevation along the plane *y y*, Fig. 2. Fig. 5 is a sectional plane view along the plane *y′ y′*, Fig. 2; and Figs. 6 to 8 are detached views, enlarged, of separate parts of the apparatus, as hereinafter explained.

For domestic, as well as other purposes in the arts, a power is desired such as is best supplied by compressed air. To compress such air and so store up such power, the water-pressure existing in connection with private or public water-works is perhaps the most available; and such water-power for the purposes of my present invention may be obtained in any known way from an elevated head or supply, or a supply furnished under pressure, either natural or artificial.

By my present improvement I use such water-power, either supplied to the pump for that express purpose or allowed to flow into and through it in its regular flow from the source of supply to the place of use or escape, for the purpose of compressing and storing air, and I so construct the compressing apparatus that on the opening of the escape or discharge cock or valve, say of a hydrant or water-faucet in a house, the water flowing through the compressor from the source of supply under pressure will automatically operate the compressor, and compress and store air, without materially, if at all, interfering with the freedom or abundance of the discharge of water.

My compressor contains two pumping-cylinders, D D′, arranged in line with each other, so that the same stem, passing through a stuffing box or boxes in the diaphragm *n*, which separates them, or in their heads, may carry a piston in each. At the outer end of these cylinders are the valve-chambers B B′. Two other valve-chambers, P P′, are arranged, one in the front and the other in the rear. A hollow globe, A, affords a place of confluence for all the through way pipes and passages. Its stem A^1 supports the upper parts of the apparatus, and it, for convenience, is supported by four legs, R R^1 R^2 R^3, which legs are hollow like pipes, and have the proper connections, so as to constitute supply and exhaust or escape pipes, for the inflow and outflow of water and air. The valve-chambers B B′ have on their outer surfaces a series of half-annular rings, c c^2 c^4, on B, and c^1 c^3 c^5 on B′. They are composed each of the exterior half of an annular ring, and are so attached that inside each shall be an annular space, which I shall designate as a ring-passage, from which, by a series of ports, (shown in the drawing,) communication is effected with the inside of the chamber. This feature of construction is more fully shown in Fig. 7, where c^6 represents the annular or ring passage, and c^7 the ports communicating with the inside. The valve-chamber P has a like series of rings, e, e^1, e^2, e^3, and e^4, with like annular passages and ports, and a like series, d, d^1, d^2, d^3, and d^4, with like passages and ports, is made on the valve-chamber P′. The pumping-cylinders D D′ contain two stems, of which the outer one, s, is tubular in form, and works on and outside of the other, s^1, so that each can move independently of the other. The outer hollow stem s carries on its opposite ends the plungers g g', packed as against a pressure acting from without, as illustrated in Fig. 8. These plungers have each a motion equal or about equal to the inside length of its cylinder D or D′. The inner stem s^1 extends into the valve-chambers B B′, and carries at or near each end two piston-valves, v v^1, in B, and v^2 v^3 in B′. The valves v v^1 are packed as against a pressure acting between them, as are also the valves v^2 v^3. These valves v v^1 v^2 v^3 are so arranged on their stem s^1, at such distances apart, and in such positions and with such length of throw or motion, that at one end of their stroke the ring-passages c^2 and c^4 are in communication, as in Fig. 4, and at the other end of their stroke the ring-passages c^3 and c^5 are in communication, but no others. The valve-chamber P has like valves on the stem s^2, of which the end ones w w^1 are packed as against an outside end pressure, w^2 w^3 are packed as against a pressure acting between them, and w^4 w^5, in like manner, as against a pressure acting between them; and these valves are so arranged, and with such length of stroke, that when at one end of their stroke the ring-passages e^2 and e^4 will be in communication, and also e and e^1, as in Fig. 5; and at the other end of their stroke, e^1 and e^3, and also e and e^2. The other valve-chamber, P′, has like valves x x^1 x^2 x^3 on the stem s^3, similarly packed with relation to each other, and operating in a similar manner with reference to its ring-passages, the arrangement of which is the same as in P. The plungers g g' are packed as represented in Fig. 8, so as to prevent fluid communication from one chamber, D, to the other, D′, along between the stems s s^1. At suitable points on the stem s^1 are the knockers n^1 n^2, so arranged that, as the plungers g g^1 approach the end of their stroke in either direction, one or the other of them will engage a knocker, and so shift the position of the piston-valves v v^1 v^2 v^3 from the position shown in Fig. 4 to the opposite position, as hereinbefore stated, or vice versa. The supply-pipe, passing up through the leg R, enters the globe A, where it branches by a **T**-joint. (Shown at a.) One branch, a^2, passes out and up, and opens into the ring-passage e of the valve-chamber P. Like pipes, a^3 and a^4, lead, the one a^3 from the ring-passage e^1 to the ring-passage c of the valve-chamber B, and the other, a^4, from the ring-passage e^2 to the ring-passage c^1 of the valve-chamber B^1. The other branch, a^1, leaves the **T** a, passes up through the hollow stem A^1, and branches into two pipes, a^6 and a^7, the former of which opens into the ring-passage c^2 of the valve-chamber B, and the latter to the ring-passage c^3 of the valve-chamber B^1. These are the water inlet and inflow pipes. The leg R^1 is open to the atmosphere, and its tubular passage leads to a **T**-joint, b, in the globe A, where it branches. One branch, b^1, leads to the ring-passage d^4 on the valve-chamber P′. A like pipe, b^2, leads from the ring-passage d^2 through ports in the cross-support A^2 and stem A^1, into the pumping-cylinder D′. The other branch, b^3, leads to the ring-passage d^3 of the valve-chamber P′, and a pipe, b^4, leads from the ring-passage d^1, through the cross-support and stem above named, to the opposite pumping-cylinder D. These are the air entrance and inflow pipes. The same pipe communications—that is, b^2 and b^4—act as air-outflow pipes from the cylinders D D′ to the valve-chamber P′ as the air is compressed and forced out of such cylinders by the reverse stroke of the plungers g g'. Thus the air, as compressed, reaches the valve-chamber P′. From the ring-passage d of this valve-chamber the pipe b^5 leads through the globe A to the leg R^2, and thence to the reservoir where it is to be stored, or to the place of use. A check-valve should be inserted in this pipe b^5 at any suitable point, so as to prevent the back or reverse action of the air in the reservoir.

The water-exit pipes remain to be designated; and, first, to exhaust the water alternately from the pumping-cylinders D D′, after each pumping stroke is completed. For this purpose I make use of the pipes a^3 and a^4, above described, as water-inflow pipes, so as to convey such water back to the valve-chamber P. To complete the exit communication I connect the ring-passages e^3 and e^4 of the valve-chamber P by pipes o o^1 with the globe A. This globe is hollow. The water waste-pipes open directly into it, and thence the water is carried off or is led into its regular line of discharge by a pipe, o^2, through the leg R^3. Secondly, to exhaust the water in front of the piston-valves in chambers P and P′, when such valves are to receive a forward throw, I connect the right-hand end of each by pipes q q^1 with the ring-passage c^4 of the chamber B, and from the end of such chamber carry a pipe, q^3, to the globe A, into which it opens. From the opposite or left-hand ends of the valve-chambers P P′ like pipes, q^4 q^5, lead to the ring-passage c^5 on the chamber B′, and from the outer end of this latter the pipe q^6 also discharges into the globe A.

In Fig. 4 I have shown the position of the valves v v^1 v^2 v^3 at the end of their stroke or motion to the right. At the opposite stroke the valve v^3 merely passes and uncovers the ports leading into the ring-passage c^5. To arrest the stroke or motion of these valves at these points, I make use of any suitable stop device, the construction and operation of which are so well known in various forms that I deem it unnecessary to show the same in detail.

The devices being in the position shown in Figs. 4 and 5, and water entering by the leg R, with air in the cylinder D and water in D′, the operation is as follows: The water from R follows, or supposing the pipes are full, exerts its pressure along the pipes a^1, a^6, and a^7. From a^7 it passes, by the ring-passage c^3 and its ports, into the valve-chamber B′, between the valves v^2 and v^3, and, pressing equally both ways, produces no effect. But from a^6 it passes into the ring-passage c^2, and by its ports into the valve-chamber B, between the valves v and v^1, and, acting equally against both valves, produces no effect thereon, but, flowing through the ports of and into the valve-ring c^4, passes thence, by the pipes q and q^1, to the right-hand ends of the valve-chambers P P′, and, acting against the valves w^1 and x^1 therein, holds the piston-valves of these valve-chambers in the position shown in Fig. 5, or, if not already in that position, as supposed, throws them over till they occupy such position. At the same time the water entering at R follows the other branch, a^2, enters the ring-passage e of the valve-chamber P, passes through its ports into such chamber, between the piston-valves w^4 and w^5, (exerting an equal pressure on both,) passes by the ports of and into the ring-passage e^1, and thence, by the pipe a^3, Fig. 1, into the ring-passage c on the valve-chamber B, and through its ports into the latter chamber.

The water-pressure now acts against the plunger g, and gives it and the plunger g' a throw or stroke to the left, by which the air in D is pumped out or compressed into the reservoir. This line of communication is, by the port and pipe b^4, into the ring-passage d^1 of the valve-chamber P′; thence, by the ports of the latter, into the chamber between the valves x^5 and x^4; thence by the ports of and into the ring-passage d, and by the pipes b^5 through the globe A to the leg R^2, and thence to the reservoir. At the same time this is being done, the water in the cylinder D′ must be allowed to escape, and air at atmospheric pressure must be admitted back of the plunger g'. For the former purpose the water enters the passage c^1, follows the pipe a^4 through the ring-passage e^2 into the chamber P; thence by the ring-passage e^4 into and along the pipe o^1 to the globe A. And for the latter purpose, air enters by the leg R^1, follows the branch b^1 into the ring-passage d^4 on the valve-chamber P′, enters the chamber, passes out by ring-passage d^2 into the pipe b^2, and follows it to the cylinder D′. As the plungers g g' approach the end of their stroke, the latter engages the knocker n^1, and shifts the position of the valves v v^1 v^2 v^3, and by so doing automatically reverses the action of the apparatus. The water-supply, by which pressure was kept up in the right-hand ends of the valve-chambers P and P′ is now cut off, and the water therein is free to escape, by the pipes q q^1, into the ring-passage c^4, through its ports into the right-hand end of the valve-chamber B, and thence by the pipe q^3 to the globe A. Also, the ring-passages c^3 and c^5 on the valve-chamber B′ are brought into communication, and the water flowing from a^1 by a^7 enters through c^5, and, by the pipes q^4 and q^5, acts on the pistons w and x in the left-hand ends of the chambers P and P′, and shifts them, and also all the valves on the same stems, to the right, and holds them in that position. The water-supply now follows the pipe a^2 to the ring-passage e, as before, and enters the valve-chamber P, but being cut off from e^1 by the shifting of the valves, and having an open communication with e^2, and thence by the pipe a^4 of Fig. 1, enters the ring-passage c^1, and through it the chamber B′, and there acting against the plunger g^1, which is at that end of its stroke, starts on a reverse motion, so as to pump out and compress the air now in D′. This air passes out, by the port and pipe b^2, into the ring-passage d^2 of the chamber P′; thence, by the chamber and ring-passage d and pipe b^5, to the reservoir. At the same time the water in D in front of the plunger g passes out through the ring-passage c, and by the pipe a^3, Fig. 1, into the ring-passage e^1 of the chamber P, enters the chamber, passes out by the ring-passage e^3, and thence, by pipe o, to the globe A, and air at atmospheric pressure is supplied to the cylinder D, back of plunger g, (which is now making a forward stroke,) by the pipe b^3, ring-passage d^3, chamber P′, ring-passage d^1, and pipe b^4. As the plunger g nears the end of its stroke it engages the other knocker, n^2, which, at the previous stroke, had been brought forward into the chamber D, and thereby again reverses the position of the valves v v^1 v^2 v^3, reverses the action, and thus the pumping goes on continuously and automatically so long as the water is permitted to flow.

As the inflowing-water pressure is always acting through the ring-passage e, and the outgoing-air pressure goes through the ring-passage d, I attach to these ring-passages, whenever it is desirable to know the pressure of each, pressure-gages m m, which may be arranged in any convenient position, and connected to the ring-passages named by pipes m' m', while additional air-chambers for cushioning purposes, or other suitable cushioning devices, may be attached, if so desired. I have found that, if the apparatus is properly constructed, such chambers are unnecessary.

The water in the ends of the chambers P P′, in being forced out by the forward stroke of the pistons therein, will meet with some resistance, and such resistance will be sufficient to prevent a jolt or jar at the ends of the stroke; and the resistance which such valves meet with toward the end of their stroke will gradually increase, so as to accomplish the desired result. The comparative slowness of the motion of the pistons also renders this result more easy of attainment. It will also be observed that the water-supply which operates the plungers g g' cannot be cut off or changed until such plungers have made a full stroke, and thereby shifted the valves in B B′, by means of which water is supplied to the chambers P P′, so as thereby to effect such cut-off or change at the ring-passage e. Hence there is no dead-point at which the motion of the apparatus can be arrested, so as not to start automatically.

The water-supply to one of the cylinders D or D′ is cut off by the valve w^4 or w^3 passing the ports in the ring-passage e at the same time that the water-escape from the other cylinder is closed by the valves w^2 or w^5 passing the ports of the ring-passage e^4 or e^3, and vice versa as to the reopening of said ports to change the direction of inflow and outflow, and reverse the operation of the plungers. Hence I always have an ingoing flow of water under pressure acting against an outgoing flow free from artificial pressure, so that with a comparatively slow motion no injurious jar or jolt will be experienced.

The relative proportions of the several plungers, pistons, and piston-valves may be varied at pleasure with reference to water-pressure employed, air-pressure desired, or the quantity of each, in accordance with rules well known or readily ascertained in pneumatics and hydraulics; and, while I have been somewhat specific in describing the devices I employ, I do not limit myself to form and proportion in the construction of the devices named.

Instead of the ring-passages described and their communicating ports, with piston-valves, any suitable port communication from pipe to chamber may be employed, with any known suitable form of valve, such devices being considered as mechanical equivalents.

The pipe-connections are made with any suitable form of coupling or union, one of which is shown at *u u*. At other points in the apparatus I have not shown them, simply in order to attain greater clearness of illustration.

Some portions of my apparatus may be employed separately from the rest—as, for example, the apparatus for the automatic supply of water alternately to the opposite ends of the pumping-cylinder may be combined with other mechanical means for securing an alternate escape of water, or vice versa; or the apparatus embodying the automatic action, wholly or in part, may, with modifications easily constructed, be fitted up to a single-acting air-pump with obvious advantage.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a double-acting double-cylinder air-compressor, an apparatus for automatically and simultaneously supplying water under pressure to, and taking the water-waste from, the outer ends of the pumping-cylinders, the construction being substantially as set forth.

2. In a double-acting double-cylinder air-compressor, an apparatus, operating automatically by water-pressure, for automatically and simultaneously supplying air at atmospheric pressure to and conducting compressed air off from the inner and adjacent ends of the cylinders, such operations of air inflow and outflow being simultaneous in the two cylinders, but alternating on each, the construction being substantially as set forth.

3. Valve-chambers B B′, arranged on the outer opposite ends of a double-acting double-cylinder air-compressor, such valve-chambers containing a system of valves, pistons, ports, and connections for supplying automatically and alternately water-pressure to and conducting it from the plungers, the construction being substantially as set forth.

4. In a double-cylinder air-compressor, a pumping-plunger in each cylinder, attached to a common stem, in combination with a valve-stem, having valves that govern the water-supply, arranged on the outer ends of the same, both stems moving in or near the axial line of the pumping-cylinder, substantially as set forth.

5. In combination with a pair of pumping-cylinders, D D′, a system of pipes, a^2 a^3 a^4 o o^1, with suitable ports supplying water to and exhausting it from the pumping-plungers, and a valve-motion operated by water-pressure to change the direction of inflow and outflow, substantially as set forth.

6. In combination with a pair of pump-cylinders, D D′, a system of pipes, b^1 b^2 b^3 b^4 b^5, with suitable ports for supplying and carrying off air to and from the pumping-cylinders, and a valve-motion operated by water-pressure to change the direction of ingress and egress, substantially as set forth.

7. As a means of effecting the movement of the valves by which water is supplied to the pumping-plungers, a system of pipes, a^1 a^6 a^7 q q^4, in combination with valves v^1 v^3, valve-chamber P, and pistons w w^1, and intermediate ports, substantially as described.

8. A system of pipes, a^1 a^6 a^7 q^1 q^5, in combination with valves v^1 v^3, valve-chamber P′, and pistons x x^1, and intermediate ports, substantially as and for the purposes described.

9. A valve-chamber, P, containing an arrangement of valves and ports for automatically regulating the water supply and escape to and from the pumping-cylinders, a piston or pistons for moving such valve or valves, and pipe-connections for the supply and escape of water in the automatic operation of such pistons, substantially as set forth.

10. A valve-chamber, P′, containing an arrangement of valves and ports for automatically regulating the air supply and exhaust to and from the pumping-cylinders, a piston or pistons for moving such valve or valves, and pipe-connections for the supply and escape of water in automatic operation of such pistons, substantially as set forth.

11. The combination of one or more air-compressing cylinders, the pistons of which are operated by water-pressure, a valve-motion for governing the water supply and escape, arranged in a separate chamber or cylinder, and automatically operated by water-pressure acting independently of the water-pressure in the main cylinder, substantially as set forth.

12. The combination of one or more air-compressing cylinders, the pistons of which are operated by water-pressure, a valve-motion for governing the air inflow and outflow, arranged in a separate chamber or cylinder, and automatically operated by water-pressure acting independently of the water-pressure in the main cylinder, substantially as set forth.

13. Valves v^1 v^3, arranged one in each cylinder B B′, with suitable ports and pipe-connections to and in combination with the water valve-chamber P and valves therein, for regulating the water supply and exhaust to and from the main pumping-cylinder, substantially as set forth.

14. Valves v^1 v^3, arranged one in each chamber B B′, with suitable ports and pipe-connections to and in combination with the air

valve-chamber P′ and valves therein, for regulating the air ingress and egress to and from the main pumping-cylinder, substantially as set forth.

15. Piston-valves v v^1 v^2 v^3, arranged with communicating ports and pipes to and in combination with the water valve-chamber P, and valves and ports therein, substantially as set forth, whereby, at the completion of the stroke of the plungers g g', the pistons in P will be subject to a preponderance of water-pressure on one side, so as to give the valves a complete throw, and thus avoid danger of stoppage at a dead-point.

In testimony whereof I have hereunto set my hand.

HARRY J. BAILEY.

Witnesses:

W. N. PAXTON,

G. H. CHRISTY.