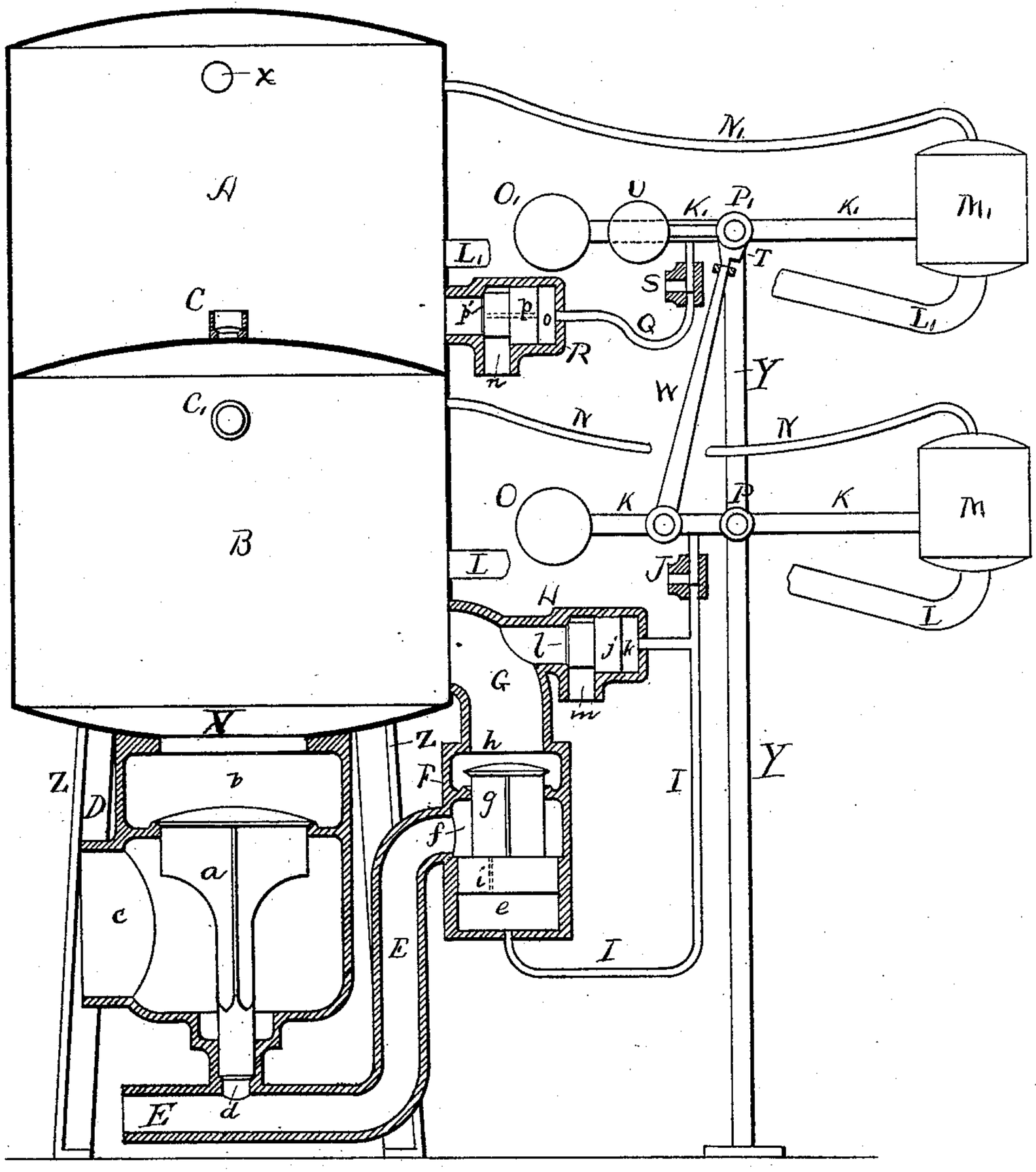
(No Model.)

# W. R. PHILLIPS.

## HYDRAULIC AIR COMPRESSOR.

No. 452,283. Patented May 12, 1891.




Witnesses.
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# UNITED STATES PATENT OFFICE.

WILLIAM R. PHILLIPS, OF SEATTLE, WASHINGTON.

## HYDRAULIC AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 452,283, dated May 12, 1891.

Application filed August 26, 1889. Serial No. 322,028. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM R. PHILLIPS, of Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Hydraulic Air-Compressors, of which the following is a specification, reference being had to the accompanying drawing.

The object of my invention is to produce an improved machine for compressing air by means of water acting directly upon an inclosed volume of air, and so arranged that the water, after it has performed its office, will be automatically discharged and the operation of compression automatically renewed, so that the work of the machine will be practically continuous.

My machine is adapted to utilize the power of high water falls, for instance; but it may be used wherever a sufficient force of water can be obtained.

In the accompanying drawing is illustrated a central vertical section of my machine, showing portions of the working parts in elevation.

Referring to the letters on the drawing, B indicates a lower chamber, which may be called the "compression" chamber, and above this is located an air-reservoir A of corresponding form, the two being preferably in the shape of a single cylinder and separated by a central partition. The cylinder may be made of metal and should be air-tight.

C indicates a check-valve secured to the partition between the compression-chamber and the reservoir, and C′ a valve-controlled opening communicating with the outside air. The compression-chamber B communicates through the opening V in its lower end with the valve-casing D, to which it is secured. Within this casing is located the valve *a*, which is provided at its lower end *d* with a piston-bearing, which is fitted into the bottom of the casing D, so that there is a perfect joint between the two. The head of the valve is also provided with bearings, which cause it to move evenly up and down within the valve-seat in the casing D. The head *b* of the valve is made of much greater diameter than the end *d*.

*c* indicates an outlet-opening.

Z indicates supporting-legs for the chamber and reservoir.

E indicates a pipe adapted to supply water under pressure. It communicates with the lower end of the interior of the valve-casing D and discharges into the valve-casing F. The upper part of the valve-casing F is joined to the chamber B by means of the pipe G, which establishes communication between the interiors of those parts.

*g* indicates a valve which is seated in the interior of the casing F. It is provided with a head *h*, adapted to shut off communication between the pipes E and G, and has at its opposite end a piston-head which is closely fitted into the interior of the casing F. This piston-head is of larger diameter than the valve-head *h*, and is pierced with an opening *i*.

H indicates a valve-casing which is provided with a drain-passage *m*. The interior of this casing is supplied with a closly-fitting piston-head *j*, that carries the valve *l*.

J indicates a discharge-valve, and I a pipe that communicates with the bottom of the valve-casing F, and branching at its other end discharges through one branch into the valve-casing H at its mouth *k* and communicates through its other branch with the valve J.

Y indicates an upright support, to which at P is pivoted the arm K, which presses against the valve J.

O indicates a weight secured to one end of the arm K, and adapted to hold the valve J closed by its pressure.

M indicates a tank secured to the other end of the arm K, and adapted when filled with water to overcome the weight O and open the valve J. The interior of the chamber B is connected with the interior of the tank M by means of the flexible tube L, which enters the tank at the bottom, and the smaller flexible tube N, that enters it from the top.

R indicates a valve-casing communicating with the interior of the reservoir and provided with the outlet-opening *n*. It is fitted with the piston-head *p*, that carries the valve *p′*, which is adapted to close the drain-passage *n*.

S indicates a valve corresponding to the valve J, which communicates through the mouth *o* by means of the pipe Q with the interior of the valve-casing R.

To the top of the support Y is pivoted at P′ the arm K′, which is provided in similar manner to the arm K with the weight O′ at one end and the tank M′ at the other.

L′ and N′ indicate flexible tubes that connect the interior of the reservoir with the interior of the tank M′.

W indicates a connecting-rod pivoted at its lower end to the arm K and engaging at its upper end with the pawl T, which is pivoted to the axis of the arm K′, with which it is in operative connection, and bears upon an arm extending at nearly right angles to it with the weight J. By means of this arrangement the arm K is held stationary until the end M′ of the arm K′ is caused to drop, when the end M of the arm K will simultaneously descend.

X indicates a pipe for allowing egress of air from the reservoir A, and in practice is controlled by an air-valve, which, however, being preferably located at a distance from the reservoir, is not shown in the drawings, especially as the valve may be of any well-known and ordinary construction.

The operation of my machine is as follows: Suppose the valves *g* and *a* to be closed and the others open, and water under pressure to be introduced through the pipe E. Its tendency will be to raise the valve *a*, but the main current and force of the water will pass into the interior of the valve-casing F, and a portion of it will be forced through the opening *i* beneath the piston-head *e* of the valve *g*. Thereupon, by reason of a well-known law of transmission of force through liquids, the pressure upon the under side of the piston-head will be equalized with that upon the top, but the area of the bottom subject to pressure is greater than the area of the top subject to pressure. Consequently the piston-head will be lifted, the valve-head *h* raised, and the valve *g* open for the passage of water through the pipe G into the interior of the chamber B, as illustrated. In passing through the pipe G a portion of the water will seek an exit through the drain-passage *m* of the casing H; but its discharge will be prevented by the valve *l*, because the initial pressure of the water will have been communicated through the pipe I against the piston-head *j* of that valve, and this head being larger than the end of the valve opposed to the pressure of water in the pipe G will keep the valve in the closed position. By this means the water from the pipe G will flow into the interior of the chamber B. Passing through the opening V it will depress the valve *a* by reason of the head *b* of the valve being larger than its lower end *d*, which is also under pressure from the water. Thereupon the level of the water in the chamber B will be gradually raised until it reaches the pipe L, when a portion of the water will pass into the tank M, the air in the tank being driven through the pipe N into the chamber B above the water-line. As above explained, when the tank M is full it will tend to depress its end of the arm K and open the valve J; but it is prevented from acting by the connecting-rod W communicating with the arm K′, by which it holds the arm K stationary. As the air in the chamber B is compressed it is driven up through the check-valve C into the reservoir A, from which it is conducted by the pipe X away for use. Gradually the water will rise into the reservoir A, driving the air before it. A portion of it will enter the valve-casing R, and, passing through the opening in the piston-head *p*, will by means of the valve close the drain-passage *n*. The water rising will pass through the pipe L′ into the interior of the tank M′, driving the air out into the reservoir A through the tube N′ in the manner explained with reference to the tank M. When the tank M′ is full, the weight of it will depress its end of the arm K′, whereupon the valve S will be open, the connecting-rod W relieved, and the tank M on the end of the arm K allowed to descend. By this means the valve J is also opened. By the opening of the valves S and J the pressure behind the piston-heads *p j*, respectively, will be diminished, so that the drain-passages *m* and *n*, respectively, will be opened and the water from both the reservoir and the chamber will be partially drained away. A partial vacuum will be produced in the chamber and a supply of air will rush in through the valve-controlled opening C′. Simultaneously with the opening of the valve J the pressure beneath the piston-head *e* will be relieved, the valve G closed by the pressure of the water in the pipe E, and the water-supply shut off. The water in the chamber B is lowered until the pressure of the weight of water upon the area of the head *b* of the valve *a* is less than the pressure exerted upon the lower end *d* of the valve, when the valve *a* will be lifted and the water discharged entirely from the chamber B through the outlet-opening *c* in the valve-casing D. At the same time the mechanism will be relieved from strain that would be occasioned by a too sudden stoppage of the flow of the water under pressure in the pipe E by its passing out through the opening *d*. The machine should be so arranged that by the time the water is discharged from the chamber B the tanks M and M′ will have emptied themselves. Thereupon the weights O and O′ will press down their ends of the arms K and K′, respectively, and close the valves S and J. Then the mechanism is in position to repeat the operation, as above described, and the work of the machine will proceed as before. The act of discharging and repeating its operation may be performed in a comparatively short space of time, so that the pressure of the air remaining in the reservoir A may not be entirely exhausted before a new supply is forced in. This makes the machine practically continuous in its operation. The water in the reservoir is never all exhausted, so that it may

always close the outlet of the valve-casing R as soon as the tank M′ is emptied and prevent the escape of air.

In practice it is often desirable to employ a battery of compressors composed of a series of compression-chambers and reservoirs with valves *a*, and in this arrangement it may be unnecessary to employ more than one valve-casing F and its valve and one set of arms K and K′ and their valves S and J, which in that case, instead of being connected directly with the valve-casings F, H, and R, would be connected with an intermediate valve and casing constructed like the casing R and its valve.

Where large air-inclosures are used it may be necessary to provide additional means of drawing off the water. In that case I employ a number of valve-casings D and their necessary parts and unite them all to a single set of valve-casings F and H, if desired.

What I claim is—

1. In a hydraulic air-compressor, the combination, with a compression-chamber and a supply-pipe having a drain-passage, of a piston-valve located in the supply-pipe, a similar valve located in the drain-passage, a water-passage operatively connecting the valves, and means for opening and closing the water-passage, whereby the compression-chamber is adapted to be alternately filled and emptied of water, substantially as set forth.

2. In a hydraulic air-compressor, the combination, with the compression-chamber, the valve-casing D communicating therewith, the valve *a* in said casing, and the valve casings F and H, both provided with piston-valves, and the casing H, provided with a drain-passage, of the pipe I, operatively connecting the valves in the casings F and H, and a gravity-valve J, connected with the pipe I, whereby water is supplied to the compression-chamber as long as the valve J is closed and the chamber is emptied by the opening of the valve J, substantially as set forth.

3. The combination, with a compression-chamber, of a supply-pipe and drain-pipe, a valve in each of said pipes automatically acting by hydraulic pressure, a passage I between said valves, a valve J, adapted to actuate said valve through said passage in the manner set forth, the pivotally-supported arm K, provided with a weight O, adapted to keep the valve J closed, and a tank N, communicating by means of flexible tubes with the interior of the compression-chamber and adapted, by becoming filled with water, to overcome the weight O and open the valve J, as and for the purpose specified.

4. The combination, with an air-reservoir and a compression-chamber, of a supply-pipe communicating with the interior of the compression-chamber and provided with a valve *g*, acting automatically by hydraulic pressure, of the drain-valve casing H and its valve, a communicating passage between said valve, a valve J, joined to said passage, and a pivotally-supported arm K, provided with a weight for closing the valve J, the valve-casing R, communicating with the interior of the air-reservoir and provided with a valve, the valve S, operatively connected therewith, the pivotally-supported arm K′ and its weight O, and a connecting-piece between the arms K and K′, whereby the swinging of the arm K is dependent upon that of the arm K′, substantially as set forth.

5. In a hydraulic air-compressor, the combination, with a compression-chamber, a supply-pipe communicating therewith, and a valve located in the supply-pipe and adapted to regulate the supply of water to the chamber, of the valve-casing D, communicating with the compression-chamber and the supply-pipe and provided with an outlet-opening *c*, a valve *a*, provided with a head *b*, and a piston-bearing at its opposite end, said head being larger than the other end, whereby pressure of the water admitted into the compression-chamber upon the head of the valve *a* will close the valve while the machine is in operation, and pressure upon the end *d* will open it when the chamber has been filled with water, substantially as set forth.

6. In a hydraulic air-compressor, the combination, with a compression-chamber and a water-supply pipe communicating therewith, of the valve-casing F, located within the pipe between the chamber and the source of water-supply and provided with a valve *g*, that carries at one end a piston-head *e* within the valve-casing, an opening *i* in said piston-head, a discharge-pipe I behind the piston-head, and means for opening and closing the same, said piston-head being larger than the valve-head, whereby the valve may be operated through the water-supply, substantially as set forth.

7. In a hydraulic air-compressor, the combination, with a compression-chamber, of a supply-pipe communicating therewith and provided with a valve for regulating the supply of water, the valve-casing H, communicating with the supply of water and provided with a piston-headed valve *l* and a discharge-opening *m*, the pipe I, connecting the supply-pipe with the valve-casing behind the piston-head, the valve *l*, and means for opening and closing the pipe I, whereby the valve *l* may be opened and closed for the passage of water from the compression-chamber, substantially as set forth.

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