No. 883,936. PATENTED APR. 7, 1908.

J. H. CHAMP.

HYDRAULIC AIR COMPRESSOR.

APPLICATION FILED MAY 6, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

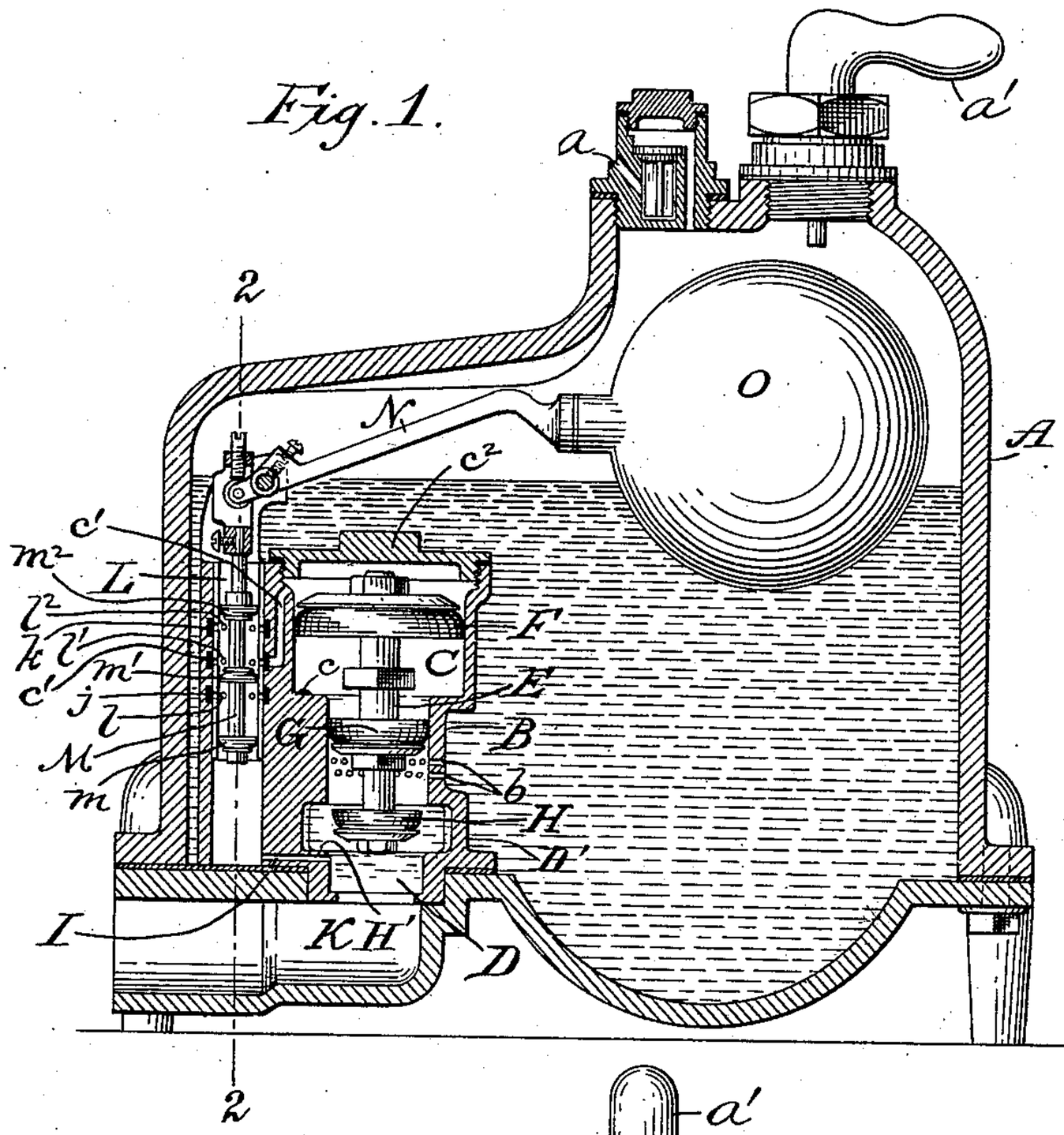


Fig. 3

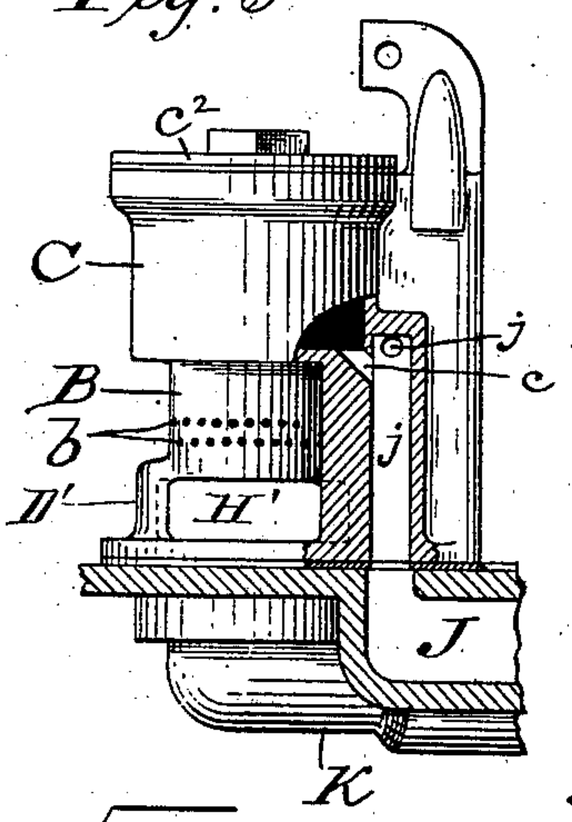
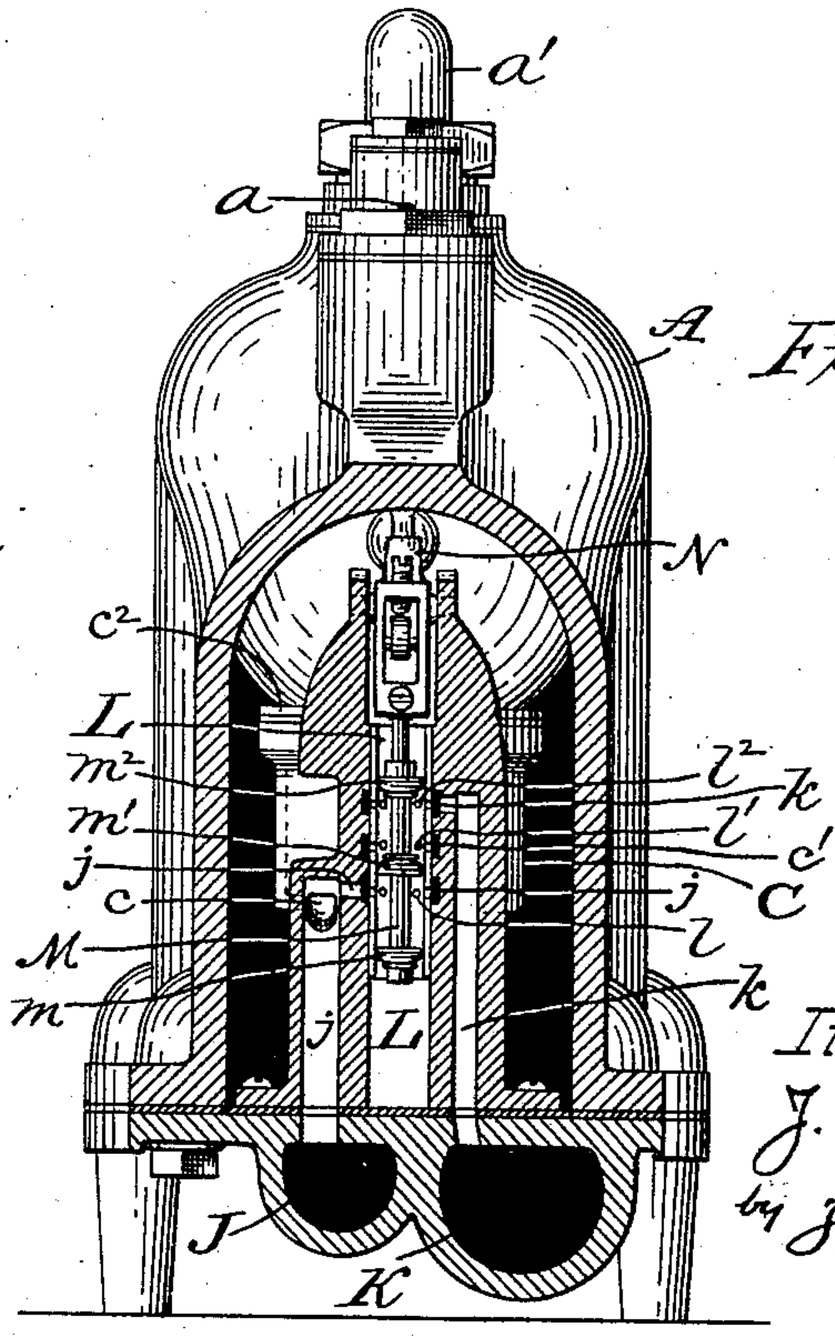


Fig. 2.



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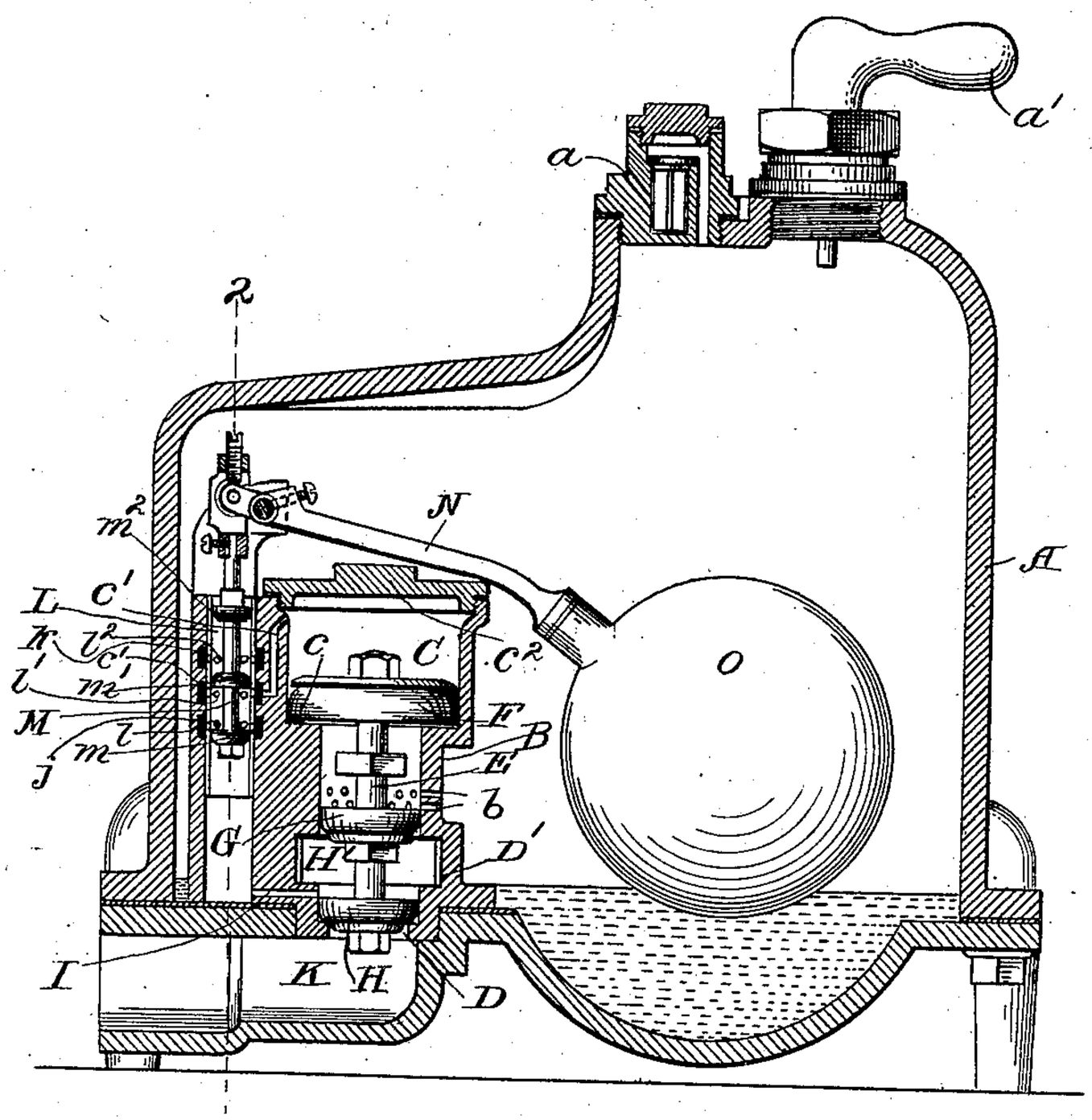
2 SHEETS—SHEET 2.

Fig. 4



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UNITED STATES PATENT OFFICE.

JOSEPH H. CHAMP, OF CLEVELAND, OHIO.

HYDRAULIC AIR-COMPRESSOR.

No. 883,936. Specification of Letters Patent. Patented April 7, 1908.

Application filed May 6, 1904. Serial No. 206,720.

To all whom it may concern:

Be it known that I, JOSEPH H. CHAMP, a citizen of the United States, resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Hydraulic Air-Compressors, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The object of this invention is to provide an improved hydraulic air compressor.

Such invention consists of the means hereinafter fully described, and particularly pointed out in the claims.

In the hydraulic air compressor, forming the invention disclosed in United States Letters Patent No. 570,540, issued to me November 3, 1896, the main valve chamber, as it is there termed, is provided with an annular port consisting of two series, or annular rows, of perforations establishing communication between such valve chamber and the air and water chamber. Through this port, in other words, the pressure water is designed to be admitted to and discharged from the air and water chamber. Now the area of such annular port cannot practically be made larger than will work well with the packing of the valve whereby the admission and discharge of the pressure water is controlled. Hence, by the construction shown in said patent, the rate of flow of water through said port is unduly restricted particularly for larger sizes of the compressor. This restriction of the flow is especially objectionable in the discharge operation, since it is desirable, having regard to the mode of operation of the device, to discharge or empty the air and water chamber as expeditiously as possible since during such discharge stage of the operation the device is not working. It is with the object in view, then, of overcoming this difficulty or objection, in my earlier device, that I have made the invention hereinafter set forth.

The annexed drawings and the following description set forth in detail certain means embodying the invention, such disclosed means constituting but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings: Figure 1 is mainly a longitudinal vertical section, but showing certain members in side elevation; Fig. 2 is mainly a transverse vertical section on line 2—2, but showing certain members in side elevation; Fig. 3 is a detail, concerning the piston chamber and related parts; and Fig. 4 is a view of the device on the same section as shown in Fig. 2, but showing certain parts thereof positioned as in a different stage of operation from that shown in said first figure.

An air and water chamber A is provided with a valve controlled air-inlet *a*, and a valve controlled air-outlet *a'*, Fig. 1, to the latter of which a tubular air-connection may be attached for conveying the air to its destination. Supported upon the bottom of said air and water chamber and wholly contained within the same, is a substantially cylindrical structure, Figs. 1 and 3, in the upper portion of which is formed a piston chamber comprising two portions C and B of unlike diameters, the portion of larger diameter being located above the portion of smaller diameter. In the lower portion of said structure, and continuous with such smaller piston chamber portion B, is a second enlarged chamber D', having cylindrical outlet passage D in axial alinement with said piston chamber portions. Such outlet passage D communicates constantly and freely with a water waste passage K that leads away from the device. An annular port *b* is formed at about the middle of the piston chamber portion of smaller diameter, preferably by annular rows of perforations, whereby communication is established between such chamber portion and the air and water chamber A. Formed laterally in outlet chamber D', is an aperture or opening H' of sufficient size to afford free and unobstructed communication between said air and water chamber A and outlet chamber D, and thence with outlet passage D and water waste passage K.

A vertical stem E operates longitudinally in a vertical line passing centrally through said piston chamber portions and extending through into said outlet chamber D'. Such stem bears at its upper end a piston F that together with a second piston member G mounted thereon substantially midway of its ends forms in effect a differential piston construction, the said members being adapted to reciprocate in piston chamber portions C and B, respectively. In addition to func-

tioning as a part of such differential piston structure, piston member G is designed to serve as a valve for controlling aforesaid annular port *b*, as will hereinafter more fully appear. Upon the lower end of vertical stem E is mounted a piston valve H, that is adapted in the lowermost position of said stem to enter outlet passage D, to close the same. The relative spacing of said piston members F, G, and piston valve H, is such that, when the structure thus occupies its lowermost position member F lies against the lower end of piston chamber portion C, and piston member G lies below annular port *b*, as shown in Fig. 4. When on the contrary said stem E occupies its raised or uppermost position, Fig. 1, piston member F lies in the upper part of chamber portion C, member G lies above port *b*, and piston valve H is lifted out of outlet passage D and a sufficient height thereabove to permit perfectly free and unobstructed connection between said outlet passage D and the opening H in the side of outlet chamber D′. A water inlet passage J, supplying the actuating water under any desired pressure, constantly communicates with the larger portion C of piston chamber by a channel *j* and a port *c*, leading therefrom, Figs. 1 and 3.

Apart from, but laterally contiguous to, the structure just described, is a vertically disposed valve chamber L, which, by virtue of such disposition, is obviously parallel with the axis of piston chamber portions C B. Valve chamber L is open at its upper end, constantly communicating with air and water chamber A. It has three transverse annular ports, each comprising a series of perforations as in the case of port *b*,—such three ports being severally *l*, *l′* and *l²*. The lower port *l* has constant communication with the water inlet passage J by means of the aforesaid channel *j*; the middle port *l′* has constant communication with the upper end of larger chamber portion C by means of a channel *c′*; the upper port *l²* has constant connection with the water waste passage K by means of a channel *k*. Of said ports the lower and upper ones, *l*, *l²* will hereafter be respectively denominated the inlet and outlet ports, the intermediate one, the distributing port,—of the valve chamber L. In addition to the aforesaid upper end opening and ports, *l*, *l′*, *l²*, valve chamber L has its lower end connected by a channel I with outlet passage D. Such channel I is formed independent of the structure inclosing the differential piston chamber portions C, B, and outlet chamber D′, and of all water connection between such chambers and the air and water chamber A, and furthermore connects with the free outlet passage D at a point lower, and nearer to the water waste passage K than does the free discharge aperture H′ of chamber A.

A vertical stem *m* operates within valve chamber L, and carries three piston valves as follows: *m*, at its lower portion, *m′* at its middle portion, *m²* at its upper portion. Such construction of stem and pistons is termed the controlling valve. Such three pistons are so spaced, in their relation to one another, and to the ports, *l*, *l′*, *l²*, of the valve chamber, that said distributing and inlet ports are connected together when the valve is raised to its highest normal position, and said distributing and outlet ports are connected together when the primary valve is depressed to its lowest normal position.

A lever N has its short arm adapted loosely to engage, under certain adjustable free play of vertical movement, with the upper end of the controlling valve, just described, and has its long arm provided with a float O, the construction being such as to cause the rising and falling of the float with the water in the water and air chamber to cöoperate with the controlling valve in the manner adapted to effect the aforesaid several connections between the ports leading from valve chamber L, in order to carry out the desired operation of the air compressor.

The water inlet passage J may be connected to an ordinary water service pipe, or other source of water under pressure. A suitable fluid-pressure regulator may be connected to such inlet passage, so as to regulate the pressure under which the actuating water enters the compressor. The water waste passage K may be connected to a sewer or other waste.

The operation is as follows: Assuming the air and water chamber A to be empty, the float O at its lowermost position, the controlling valve in its highest position and the stem E in its highest position; the actuating water entering through water inlet passage J will pass by channel *j* and port *c*, into the lower part of piston chamber portion C, pressing downward upon the lower piston member B, and upward against upper piston member F. The actuating water from such inlet passage will also, at the same time, enter valve chamber L through inlet port *l* by means of distributing port *l′* and thence by channel *c′* to the space above piston member F, pressing downward upon the latter. As the actuating water is thus on both sides of piston member F, the pressure upon the latter will be equalized; and the downward pressure upon the smaller piston member G will tend to force the differential piston structure to its lowermost position, in which, as has been described, such smaller piston member lies below the annular port *b* and piston valve H closes outlet passage D. The water entering through passage *c* is hence allowed to pass, through port *b* into air and water chamber A and there to be retained so as to gradually fill the latter, thus pressing the air

within the same, and forcing it out through the valve controlled air outlet a'. During this stage of the operation, inasmuch as outlet chamber D′ is in constant and free communication with the lower portion of air and water chamber A by means of lateral opening H′ in such chamber, and inasmuch as piston valve H is in its lowest position with its upper portion lower than the connection I leading to the outlet valve chamber, the actuating water as it is admitted into the air and water chamber may pass freely from chamber D into channel I and thence into the lower portion of valve chamber L; so that there is an equal pressure respectively at the top and bottom upon the controlling valve in such valve chamber. As the water thus rises into the air and water chamber, it will raise the float O, and the latter, when it rises to the proper height, will force the controlling valve downward. The effect of such downward movement of the controlling valve is to break the communication between inlet port l and distributing port l' and to establish communication instead between such distributing port and the outlet port l^2. This will relieve the water above the piston member F; the water above such piston escaping by channel k, out through the waste K. The pressure of the actuating water admitted through channel c into the piston chamber against the under side of piston member F now overbalances the pressure exerted upon the upper face of the smaller member G, with the result that the differential piston structure, together with stem E, is raised to its uppermost position. As a consequence of such upward movement, not only is port b cut off from the water supply and instead connected with the water outlet, but by the lifting of piston valve H out of water outlet passage D, the aforesaid free communication between air and water chamber A and the waste K is established through opening H′. At the same time water channel I, by virtue of the location of the point of its connection with the water outlet chamber, permits the water beneath the controlling valve also to escape out into the waste passage K, so that the pressure of the water upon the upper piston valve m^2 of the controlling valve structure may thereupon force the latter completely down shifting it into the position illustrated in Fig. 1. In the position here illustrated, full communication is established between the upper portion of the piston chamber C and the waste water passage K, quickly and certainly. So that the smaller piston member G may be fully raised to cut off all further supply of pressure water into the air and water chamber A. And so that the piston valve H may be fully raised to cause immediate and unobstructed communication to be established between such air and water chamber and the waste water passage K. If said channel I were not provided, the float O might rise to a certain level and might push the controlling valve downward to just sufficient distance to partly uncover the distributing port l'; and thus establish only a partial connection between such distributing port and outlet port l^2. This would admit of stem E being but slightly raised; in which event, absolute cut off of further passage of pressure water from the piston chamber portion into the air and water chamber would not obtain, and full communication between the air and water chamber and the waste would not be established. As, however, the slight rising of the water outlet-passage controlling valve H establishes communication between the lower portion of the valve chamber L and the waste K, the pressure of the actuating water upon the upper piston m^2 of the controlling valve will thereupon be sufficient to force the latter valve fully down, irrespective of the downward forcing action of the float and float lever. Whereupon, the pressure water under piston member F carries it, together with stem E and member G and valve H, all to highest normal position; the member C thus entirely shutting off further passage of pressure water into the air and water chamber; and the valve H establishing complete communication between the latter chamber and the waste through aperture H. When the water in the air and water chamber A reaches its lowest level, the float O will have reached its lowermost position, and will thereby have raised the controlling valve to its highest position,—as assumed at the beginning of this described operation and illustrated in Fig. 2. Such foregoing described operation will thereupon be repeated.

The invention as constructed and operated in accordance with the foregoing description, is capable of quickly discharging the water from the air and water chamber, after the piston member C has shut off further passage of pressure water into such chamber. A large hydraulic air compressor is thus provided with a waste water outlet that can carry off a correspondingly large volume of water, its operation consequently made more rapid and efficient.

The invention may be used with any suitable actuating fluid under pressure. Wherever the term water occurs in the foregoing description or the following claims, the same should be understood as including, under the rule of equivalents, any suitable fluid, as a known substitute for water.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, pro-

vided the means stated by any one of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In a hydraulic air compressor, the combination of an air and water chamber; a piston chamber comprising two alined cylindrical portions of different diameters, the smaller of said portions being provided with an annular port communicating with said air and water chamber; a differential piston mounted in said piston chamber, the piston member in said smaller portion serving as a valve to control said port; a second chamber continuous with said smaller piston chamber portion, such second chamber communicating freely with said air and water chamber and having a cylindrical outlet passage in axial alinement with said piston chamber; a piston valve borne by said piston and spaced with respect to the smaller piston member so as to enter said outlet passage to close the same when said piston is at the end of one stroke and to entirely clear said passage when said piston is at the end of its other stroke; and means for supplying water to said piston chamber to reciprocate said differential piston.

2. In a hydraulic air compressor, the combination of an air and water chamber, a piston chamber comprising two alined cylindrical portions of different diameters, the smaller of said portions being provided with an annular port comprising a plurality of perforations and communicating directly with said air and water chamber; a differential piston mounted in said piston chamber, the piston member in said smaller portion serving as a valve to control said port; a second enlarged chamber continuous with said smaller piston chamber portion and opening laterally directly into said air and water chamber, whereby free communication is had therewith, such second chamber having a cylindrical outlet passage in axial alinement with said piston chamber; a piston valve borne by said piston and spaced with respect to the smaller piston member so as to enter said outlet passage to close the same when said piston is at the end of one stroke and to entirely clear said passage when said piston is at the end of its other stroke; and means, controlled by the water level in said air and water chamber, for supplying water to said piston chamber to reciprocate said differential piston.

3. In a hydraulic air compressor, the combination of an air and water chamber; a piston chamber comprising two alined cylindrical portions of different diameters, the smaller of said portions being provided with an annular port communicating with said air and water chamber; a differential piston mounted in said piston chamber, the piston member in said smaller portion serving as a valve to control said port; a second chamber continuous with said smaller piston chamber portion, such second chamber communicating freely with said air and water chamber and having a cylindrical outlet passage in axial alinement with said piston chamber; a piston valve borne by said piston and spaced with respect to the smaller piston member so as to enter said outlet passage to close the same when said piston is at the end of one stroke and to entirely clear said passage when said piston is at the end of its other stroke; a valve chamber apart from said aforesaid chambers, such valve chamber having inlet and outlet ports and intermediate thereof a port having communication with the upper end of the larger portion of said piston chamber; a piston valve reciprocable in said valve chamber and adapted alternately to connect said intermediate port with said inlet and outlet ports, respectively; and means operable by the level of water in said air and water chamber for reciprocating said valve, the lower end of said larger piston chamber portion being connected with the water supply and the lower end of said valve chamber with said second, or outlet, chamber, substantially as set forth.

4. In a hydraulic air compressor, the combination of an air and water chamber comprising two alined cylindrical portions of different diameters, the smaller of said portions being provided with an annular port comprising a plurality of perforations and communicating directly with said air and water chamber; a differential piston mounted in said piston chamber, the piston member in said smaller portion serving as a valve to control said port; a second enlarged chamber continuous with said smaller piston chamber portion and opening laterally directly into said air and water chamber, whereby free communication is had therewith, such second chamber having a cylindrical outlet passage in axial alinement with said piston chamber; a piston valve borne by said piston and spaced with respect to the smaller piston member so as to enter said outlet passage to close the same when said piston is at the end of one stroke and to entirely clear said passage when said piston is at the end of its other stroke; a valve chamber apart from aforesaid chambers, such valve chamber having inlet and outlet ports and intermediate thereof a port having communication with the upper end of the larger portion of said piston chamber; a piston valve reciprocable in said valve chamber and adapted alternately to connect

said intermediate port with said inlet and outlet ports, respectively; and means operable by the level of water in said air and water chamber for reciprocating said valve, the lower end of said larger piston chamber portion being connected with the water supply and the lower end of said valve chamber with said second, or outlet, chamber, substantially as set forth.

Signed by me, this 4th day of May, 1904.

JOSEPH H. CHAMP.

Attested by—

D. T. DAVIES,

E. H. WEATHERHEAD.