Aug. 14, 1951 E. SJÖBERG 2,564,548

LIQUID PISTON AIR COMPRESSOR

Filed Dec. 3, 1947 2 Sheets-Sheet 1

FIG. 1.

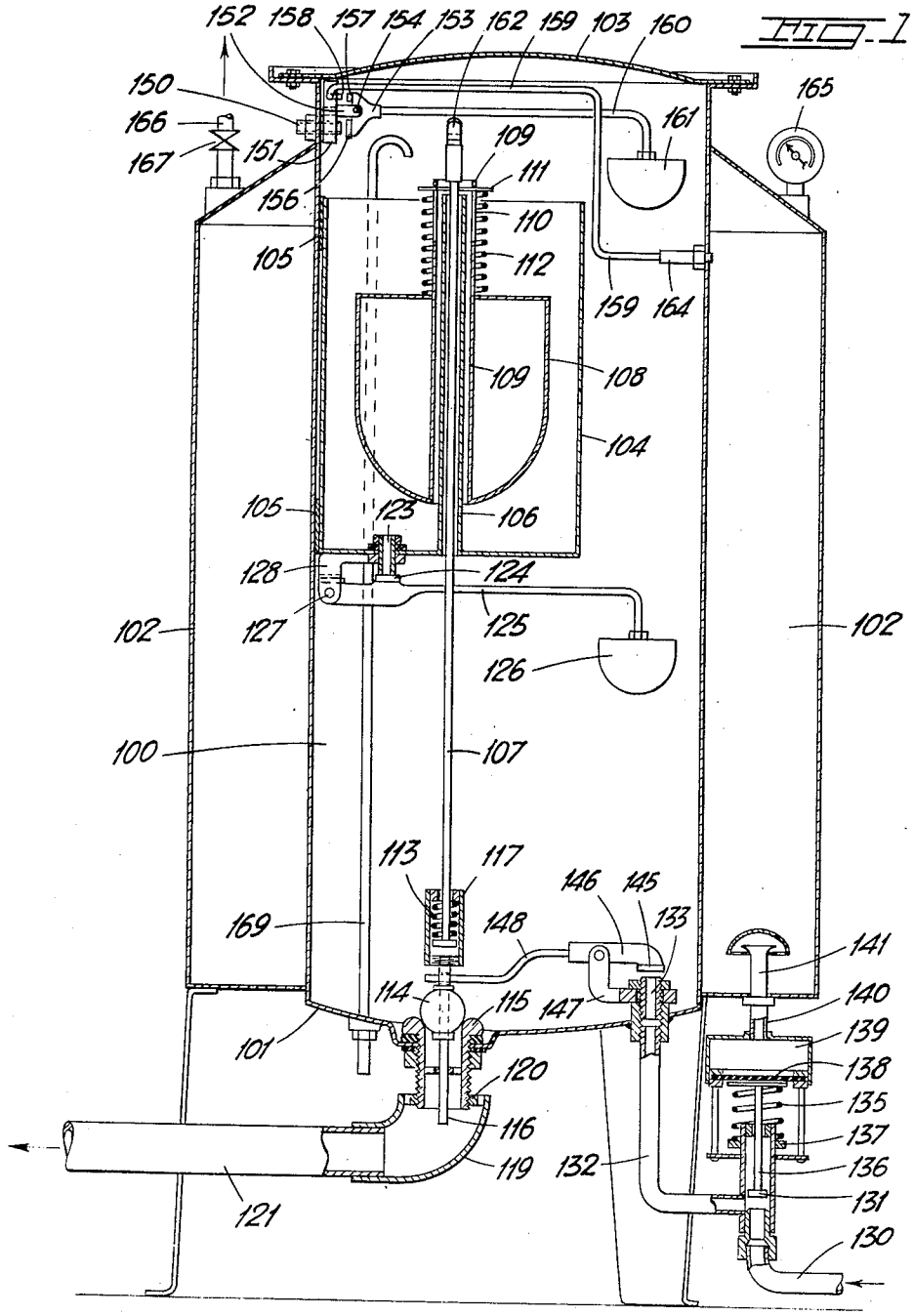


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FIG. 2.

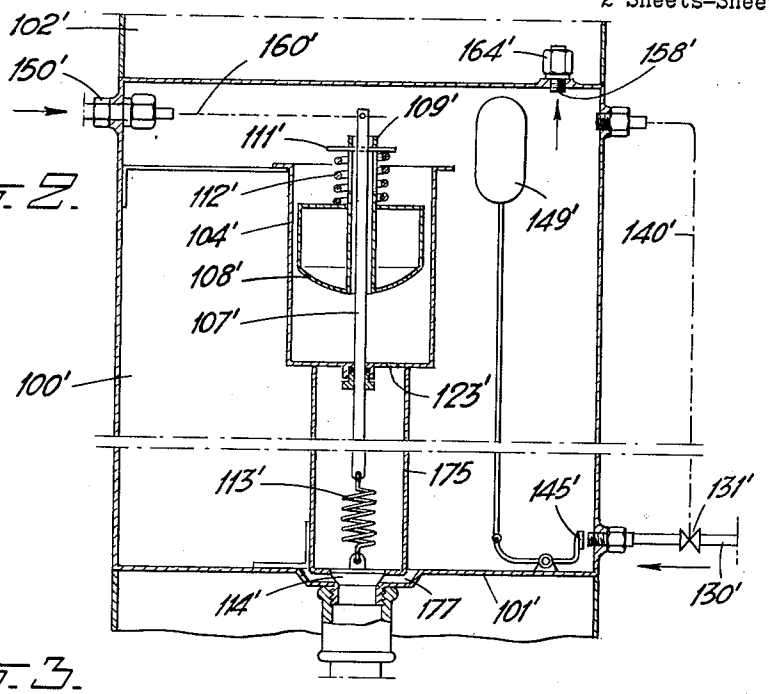
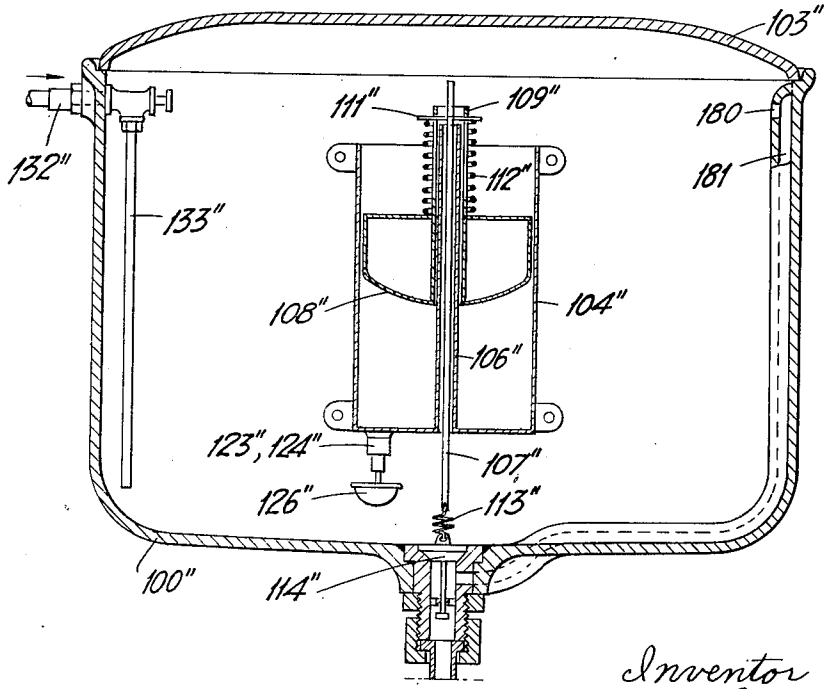



FIG. 3.

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Patented Aug. 14, 1951

2,564,548

# UNITED STATES PATENT OFFICE

2,564,548

## LIQUID PISTON AIR COMPRESSOR

Edvin Sjöberg, Mariehall, near Stockholm, Sweden

Application December 3, 1947, Serial No. 789,492
In Sweden November 13, 1944

Section 1, Public Law 690, August 8, 1946
Patent expires November 13, 1964

14 Claims. (Cl. 230—83)

1

The present invention relates to water receptacles or water tanks having means supplying water into the receptacle or tank and a discharge valve provided in the bottom of the receptacle or tank.

A broad object of the invention is to provide a device effective for opening a discharge value automatically when the receptacle is substantially filled with water, and a special object is to effect this by means of mechanisms which are of simple design and are reliable in operation.

According to a generic feature of the invention the water discharge valve is operated from a float by means of an actuator mechanism comprising a vertical rod and two different spring connections, of which, one is arranged between said discharge valve and the lower end of said rod and the other is arranged between said float and the upper end of said rod, this last-mentioned spring connection being more elastic or weaker than is the resilient connection of the discharge valve, to allow this valve to open with a delay in relation to the lifting movement of the float.

According to another feature of the invention a chamber housing said float is provided with discharge means adapted to discharge the float chamber only when the water receptacle is substantially discharged, so as to cause the float to close the discharge valve of the water receptacle after the water receptacle has been substantially discharged.

In this broad aspect of the invention the discharge device may be used for discharging water receptacles of any kind, for instance flushing cisterns for urinals.

According to a more specific feature of the invention the water receptacle is hermetically closed or sealed and has an air inlet opening provided in the upper portion of the water receptacle, as well as a valve controlling this air inlet, and a conduit connected to said upper portion of the receptacle, to constitute a consumption conduit for air under pressure compressed by the rising water column within the receptacle.

In this more restricted form the receptacle provided with the devices according to the invention, constitutes a hydraulic air compressor delivering a clean and odorless air under such pressure, that this air may be used for retailing drinks, for instance milk, furthermore in dentists' equipments, divers' equipments and the like, where a clean and non-smelling pressure air is important.

The features of the invention and further objects of the same will be more clearly understood by the following detailed description of embodiments illustrated diagrammatically in the accompanying drawings, in which:

2

Fig. 1 is a sectional elevation of an embodiment of a hydraulic air compressor according to the invention;

Fig. 2 is a similar elevation of a modified embodiment of an air compressor according to the invention, wherein substantially only the modified details are shown;

Fig. 3 is a sectional elevation of an embodiment of a flushing cistern for urinals, according to the invention.

In the drawings corresponding details of the discharge device are indicated by similar reference numerals throughout the several embodiments.

In Fig. 1, the hydraulic air compressor comprises a receptacle 100 having a bottom 101 and an airtight closure or cover 103. Said receptacle is preferably made as a cylinder. In connection with this cylinder there is arranged an air reservoir 102 which could be made as a part of said cylinder, for instance by a partition in the upper portion of said cylinder, but which in this embodiment is shown as an annular chamber surrounding said cylinder. Said airtight receptacle 100 serves as a water container in which a rising column of water supplied at the bottom 101, compresses the air admitted into the upper portion of the cylinder 100, the air reservoir 102 being supplied with the air so compressed.

The water receptacle 100 is provided with a float chamber 104 which is arranged within the cylinder, near the upper end of the same, and is secured to the cylindrical wall by suitable fastening means, for instance intermediate bodies 105 attached to the cylindrical wall and to the float chamber by welding or the like. Said float chamber is open at the upper end surface of the same. Thus, the float chamber is filled only in the way that the rising water of the cylinder ultimately flows over the rim of the float chamber, and this rim lies at a level comparatively high in the cylinder 100. Through said float chamber a vertical tube 106 extends which is sealed to the bottom of said chamber and in which a rod 107 is slidable with some clearance. The float 108 is guided upon said tube 106 by means of a tube 109 which projects from the upper face of the float and is provided with two slots 110 which are in diametrically opposed positions and which terminate a short distance below the upper end of the tube 109. By means of the slotted tube 109 the float 108 is suspended on a cross pin 111 secured in a radial aperture made through the rod 107.

A helical spring 112 is arranged between said pin 111 and the upper face of the float 108. The lower end of the rod 107 is by means of a second helical spring 113 connected with a valve 114 controlling a discharge opening from the water container, this valve being normally closed. This discharge opening may be the central opening of a sleeve 115 which is securely mounted in the container bottom 101. The valve 114 may be a ball composed of an elastic material, secured on a guiding stem 116. This valve stem has on its upper end an extension made as a sleeve 117 constituting a housing for the spring 113. It is to be noted that the spring 112 is lighter or weaker than is the spring 113. From the discharge sleeve 115 the water flows into an outlet chamber 119 in which the lower end of the sleeve 115 is secured by means of a positioning ring 120 having openings through which the interior of this chamber communicates with the ambient air. From the discharge chamber 119 an outlet or discharge pipe 121 extends. A discharge opening 123 is provided also in the bottom of the float chamber. This discharge opening is controlled by a valve 124 supported by a lever 125. This lever is operated by a float 126 secured to one end of this lever. The other end of said lever is journalled on a horizontal axis 127 supported in a bracket 128 on the float chamber, means being provided to allow only a limited movement of the lever 125 downwards, for instance stop surfaces on the lever and in the bracket, respectively.

Water under pressure is supplied to the water container 100 through a conduit 130, which may contain a shut-off valve (not shown), over a regulator valve 131, a second conduit 132, and a water inlet 133 provided in the container bottom. The regulator valve 131 is automatically operated in dependence on the air pressure in the air reservoir 102 and thus in dependence on the air pressure in the upper portion of the water container 100. In the embodiment shown the regulator valve 131 is normally held in open position by a spring 135, against the action of said air pressure. For instance, the spring 135 is disposed between a foot plate on the valve stem 136 and screw means 137 serving to adjust the tension of the spring, and said foot plate rests against a piston or other movable wall portion of an air pressure chamber 139, such as an elastic diaphragm 138 constituting one wall of said chamber 139. The interior of this pressure chamber is connected to the air reservoir 102 through an air conduit 140, an air tapping or discharging means 141 being provided within said reservoir in connection with said conduit. Thus, the arrangement is such, that a certain pressure of the air above atmospheric, enclosed within the upper portion of the water container and within the air reservoir, will cause closing of the regulator valve 131.

The water inlet opening 133 arranged in the bottom of the water container 100, is controlled by a valve 145 operating in dependence on the water level within the water container in a manner so as to avoid overfilling of the water container. For this purpose the water inlet valve 145 may be operated from a special float arranged within the upper portion of the water container and connected with said valve by means of a lever mechanism, but it will also be possible to operate said valve from the main float 108, for instance in the following way. The water inlet valve 145 is supported by one end of a lever 146 journalled in a bracket 147. The other end of said lever has an extension consisting of a rod 148 which extends through a radial aperture made in the stem 116 of the discharge valve 114, or is coupled with this stem in any other way. The arrangement is such that the water inlet 133 is open when the valve 114 is in the closed position, and vice versa. Thus, the water inlet valve 145 is operated automatically by the water discharge valve 114 and thereby in dependence of the water level within the water container.



Into the upper portion of the water container 100 fresh air is supplied through an air filtering apparatus (not shown), through an air inlet 150 which extends through a body 151 securely mounted within the container 100 and being shaped like a plate. This body 151 carries a bracket 152 in which a valve element 153 is journalled on a horizontal axis 154. Said valve element is provided with two valves 156 and 157. One of these two valves, in this instance, the lower valve 156, cooperates with the opening of the air inlet 150. The other, thus the upper valve 157, cooperates with an air outflow opening 158 communicating with a channel (not shown) made in said body 151 and being connected with a conduit 159 extending into the air reservoir 102. The air inlet valve 156 is operated in dependence on the water level in the float chamber 104 in such manner, that said valve 156 is normally closed but is brought to open position when the water container and the float chamber 104 are substantially filled; at the same time the air outflow valve 157 is either in open position or in closed position.

This may be effected by means of a lever mechanism connecting said valve element 153 directly with the float rod 107, but according to the embodiment shown in Fig. 1 the following arrangement is used. The valve element 153 carries an extension rod 160 which supports a float 161 and which cooperates with the upper end of the vertical rod 107, this upper end being provided with a fork-shaped member 162, adapted to lift the valve lever 160 and thus to open the air inlet 156, at the same time as the air outflow opening 158 is closed. In the opposite position of the valve element 153, controlled by the weight of the elements 160 and 161, the air inlet 151 is closed and the air outflow 158 is open, allowing the air compressed by the rising water column to flow through the conduit 159 into the air reservoir 102. The conduit 159 may comprise a back pressure valve 164 closing backwards against the water container. The air reservoir is provided with a pressure gauge 165 as well as a consumption conduit or pipe line 166 comprising a shut-off valve 167. In order to securely avoid dangerous pressures of the air, the air space in the upper portion of the water container may be connected to the atmosphere through a conduit 169 comprising a safety valve (not shown).

In operation, at the beginning of the cycle, the regulator valve 131 and the water inlet valve 145 are both in the open positions, the discharge valve 114 is closed, the discharge valve 124 is open, the air inlet valve 156 is closed, the air outflow valve 157 is open, and the back pressure valve 164 is closed. Now, the level of the water supplied through the water inlet 133, will rise successively, compressing the air to the normal or maximum pressure of working, the back pressure valve 164 thereby being opened. During this operation also the air receptacle is being filled with air under pressure. When the rising water column arrives at the level of the float 126, the discharge opening 123 from the float chamber 104 is closed. The normal maximum pressure of working may be at-

tained when the water outside of the float chamber has attained a certain level, for example, the plane of the bottom surface of the float chamber. Then, the regulator valve 131 is shut by the air pressure, and the supply of water is shut off. According to the consumption of air, the air pressure decreases, until the regulator valve 131 is again opened. Now, the water column within the water container rises a further distance until the normal maximum pressure of working is again attained. Thus, the level of the water column rises step by step according to the consumption of the air under pressure.

Finally, the rising water flows into the float chamber 104 over the upper edge or brim of this chamber which is successively filled. The float 108 begins to lift, tensioning the spring 112, and ultimately lifting the valve rod 107. Now, the air inlet 150 is opened under the action of the valve rod fork 162, and the air outflow opening 158 is closed. Thereby, the air under pressure enclosed in the air space of the container 100, is blown out through the opening 150. The float 161 is a safety means serving to operate the valves 156 and 157 in the event that the float 108 should fail to operate. In the lifting motion of the valve rod 107 the spring 113 is tensioned, but the discharge valve 114 does not open until the pressure of the air has been reduced sufficiently to cause the tension of the spring 113 to balance and overcome the air pressure acting upon the discharge valve 114. Thus, the discharge valve 114 is opened with a small delay in relation to the lift motion of float 108 and valve rod 107. When the discharge valve 114 is opened, the water inlet 133 is closed by the valve 145. Thus, no water is supplied during the discharge of the water container, in spite of the fact that the regulator valve 131 might be open at this time.

The water column in the water container 100 is now sinking, and during this operation fresh air is introduced through the open inlet 150 in dependence on the suction action caused by the sinking water column, but the water within the float chamber will not sink at this time. Not until the water outside the float chamber has allowed the float 126 to open the valve 124, will the water of float chamber begin to discharge through the opening 123, and then only at a comparatively low rate. The float 108 moves downwards and the air inlet 150 is closed. Ultimately the discharge valve 114 is closed and the water inlet valve 145 is brought to open position, allowing water to be supplied into the water container. Then, the cycle of operation is repeated.

In the embodiment illustrated in Fig. 2, the reference numeral 100' indicates the water container, 101' is the bottom of the same, 102' the air reservoir, 104' the float chamber, 107' the vertical valve rod, 108' the main float, 109' the float tube, 111' the cross pin, 112' the light spring, 113' the heavy spring, 114' the water discharge valve, 123' a restricted non-controlled discharge opening in the bottom of the float chamber, 130' the water supply conduit, 131' the regulator valve, 140' the air control conduit for said valve, connected from the upper portion of the water container, 145' the water inlet valve operated by a separate float and lever mechanism 149', reference numeral 150' indicates the air inlet controlled over a lever mechanism 160' from the vertical rod 107', and reference numeral 158' is the air outflow opening which is non-controlled per se but which communicates with the air reservoir 102' over a back pressure valve 164'.



The float chamber 104' is securely mounted upon the upper end of a vertical sleeve 175 extending upwards from the bottom 101' of the water receptacle, the restricted opening 123' constituting a connection from the float chamber to the interior of said sleeve 175. The discharge opening is located centrally below said sleeve and is in connection with the interior of said sleeve as well as with the space surrounding said sleeve. The discharge valve 114' has its upper portion located within said sleeve and is arranged to control not only the discharge from the sleeve 175 but even a discharge opening from the space of the water container 100', which discharge opening extends below the lower end of the sleeve 175 and may comprise a number of channels 177. On account of the restricted area of the opening 123' the float chamber 104' is discharged only when the water container 100' has been substantially discharged. Generally this embodiment operates in the same manner as does the embodiment illustrated in Fig. 1.

Fig. 3 illustrates a water container 100'' made as a flushing cistern for urinals. The water container 100'' is provided with a cover 103'' which is not hermetically sealed to the container. Thus, no air inlet with associate details is necessary, and of the float mechanism only the following details are used: the float chamber 104'' which is securely mounted by suitable means (not shown), the guide tube 106'', the valve rod 107'', the float 108'', the float tube 109'', the cross pin 111'', the light spring 112'', the heavy spring 113'', the float chamber outlet 123'', the corresponding control valve 124'', and the corresponding float 126''. This discharge devices operates in the same manner as has been described in connection with Fig. 1.

The water inlet 132'' is connected to the upper portion of the cistern and communicates with a tube 133'' extending downwards within the cistern. In the upper portion of the cistern there is provided an overflow outlet 180 which communicates through a channel 181 with the space below the discharge valve 114'', thus preventing the cistern from being overfilled.

In all embodiments there is used a water discharge device of generally the same type, this device being of a simple design and reliable in operation. When adopted for an hydraulic air compressor, such compressor will deliver an air under pressure which is absolutely clean and odorless, this in contrast to engine compressors in which the air is contaminated by lubricating oil.

Although this invention has been described and illustrated in relation to specific arrangements, it is to be understood that it is capable of application in other organizations and is, therefore, not to be limited to the particular embodiments disclosed.

What I claim is:

1. A water receptacle, comprising, in combination, a water inlet, a water discharge opening provided at the bottom of said receptacle, a valve controlling said discharge opening, a float chamber secured within said receptacle and having an opening at its upper end, a float vertically guided in said chamber, a vertical rod extending from the interior of said chamber through the bottom of the same downwards to the proximity of said discharge valve, a resilient connection between the lower end of said rod and said discharge valve, a resilient connection between the upper end of said rod and said float, which last-mentioned connection is more elastic than is the re-

silient connection of the discharge valve, to allow the discharge valve to open with a delay in relation to the lifting movement of the float and discharge means at the float chamber for discharging said float chamber only when the water receptacle has been substantially discharged.

2. A water receptacle, comprising, in combination, a water inlet, a water discharge opening provided at the bottom of said receptacle, a valve controlling said discharge opening, a float chamber secured within said receptacle and having an opening at its upper end, a float vertically guided in said chamber, a vertical rod extending from the interior of said chamber through the bottom of the same downwards to the proximity of said discharge valve, a resilient connection between the lower end of said rod and said discharge valve, a resilient connection between the upper end of said rod and said float, which last-mentioned connection is more elastic than is the resilient connection of the discharge valve, to allow the discharge valve to open with a delay in relation to the lifting movement of the float, and a discharge opening at the bottom of the float chamber which opening is of such restricted area that the float chamber is discharged only when the water receptacle has been substantially discharged, to cause the float to close the discharge valve only after the water receptacle has been substantially discharged.

3. A water receptacle, comprising, in combination, a water inlet, a water discharge opening provided at the bottom of said receptacle, a valve controlling said discharge opening, a float chamber secured within said receptacle and having an opening at its upper end, a float vertically guided in said chamber, a vertical rod extending from the interior of said chamber through the bottom of the same downwards to the proximity of said discharge valve, a resilient connection between the lower end of said rod and said discharge valve, a resilient connection between the upper end of said rod and said float, which last-mentioned connection is more elastic than is the resilient connection of the discharge valve, to allow the discharge valve to open with a delay in relation to the lifting movement of the float, a discharge opening at the bottom of the float chamber, a valve controlling said discharge opening of the float chamber, and an auxiliary float controlling this last-mentioned discharge opening and being provided within the water receptacle, to open said valve when the water in the receptacle has sunk below said auxiliary float.

4. A water receptacle, comprising, in combination, a water inlet, a water discharge opening provided at the bottom of said receptacle, a valve controlling said discharge opening, a float chamber secured within said receptacle and being open at its upper end, a first tube secured in the bottom of said chamber and extending upwards through said chamber, a float arranged within said chamber and sliding on said tube, a vertical rod extending through said chamber and the bottom thereof to the proximity of said discharge valve, a spring connection between the lower end of said rod and said discharge valve, a second tube secured on the upper side of the float and extending upwards, two diametrically opposed slots in said second tube which slots extend from the lower portion of said second tube and to a point near the upper end of said second tube, a cross pin secured in said rod and projecting through said slots, and a helical spring arranged between said cross pin and the upper side of said float, which spring is weaker than is the resilient connection of the discharge valve, to allow the discharge valve to open with a delay in relation to the lifting movement of the float.

5. Water receptacle discharge control and air compressing apparatus, comprising, in combination, a water receptacle, a hermetic closure for said receptacle, a water supply conduit, a valve controlling said water supply, a water discharge opening provided at the bottom of said receptacle, a valve controlling said discharge opening, a float chamber secured within said receptacle and being open at its upper end, a float vertically guided in said chamber, a vertical rod extending through said chamber and its bottom to a point near said discharge valve, a first resilient connection between the lower end of said rod and said discharge valve, a second resilient connection between the upper end of said rod and said float, this last-mentioned resilient connection being more elastic than is the resilient connection of the discharge valve, to allow the discharge valve to open with a delay in relation to the lifting movement of the float, discharge means at the bottom of the float chamber, to discharge said chamber only after the water receptacle is substantially discharged and, thus, to cause the float to close the discharge valve of the water receptacle only after the water receptacle has been substantially discharged, an air inlet opening provided in the upper portion of the water receptacle, a valve controlling this air inlet, and a conduit connected to said upper portion of the receptacle, to constitute a consumption conduit for air under pressure, compressed by the rising water column within the receptacle.

6. Apparatus according to claim 5, and comprising, in combination, means for an automatic operation of said water supply valve in dependence on the air pressure in the upper portion of the water receptacle, to open this valve at an air pressure below the normal pressure of working and to close this valve at the normal pressure of working, the water level in the receptacle thus rising step by step according to the consumption of air under pressure.

7. Apparatus according to claim 5, and also comprising, in combination, a spring normally holding said water supply valve in open position, an airtight chamber connected with the upper portion of the water receptacle, a movable wall element in said air tight chamber, connected with said water supply valve to close the same when the air pressure within said airtight chamber attains a higher value.

8. Apparatus according to claim 5, and also comprising, in combination, a shut-off valve in said water supply conduit, which valve is normally in open position, and means operating in dependence on the water level in the water receptacle to cause said shut-off valve to cut off the water supply when the receptacle is substantially filled.

9. Apparatus according to claim 5, and also comprising, in combination, means operating said air inlet valve in dependence on the water level in said float chamber, to open said air inlet valve when the float chamber is substantially filled, whereby any air under high pressure is blown out before the delayed discharge of the receptacle and fresh air is supplied when the water level sinks.

10. Apparatus according to claim 5, and also comprising, in combination, means under con-

trol by said float and connected with said air inlet valve to open said air inlet valve when the float chamber is substantially filled, whereby any air under pressure is blown out before the delayed discharge of the receptacle and fresh air is supplied when the water level sinks.

11. Apparatus according to claim 5, and also comprising, in combination, an air reservoir, a conduit supplying air from the upper portion of the water receptacle into said air reservoir, and a back pressure valve in said conduit.

12. Apparatus according to claim 5, and also comprising, in combination, an air reservoir, a conduit supplying air from the upper portion of the water receptacle into said reservoir, a supply valve in said supply conduit, and means operating said supply valve in dependence on the water level in said float chamber to close said valve when the water receptacle is substantially filled with water.

13. Apparatus according to claim 5, and also comprising, in combination, an air reservoir, a conduit supplying air from the upper portion of the water receptacle into said reservoir, a valve controlling the flow of air in said air supply conduit, an air consumption conduit connected to said air reservoir, and a shut-off valve in said consumption conduit.

14. A water receptacle, comprising, in combination, a water inlet, a vertical sleeve extending upwards from the bottom of said receptacle, a discharge opening located concentrically below said sleeve and in connection with the interior of said sleeve as well as with the space surrounding said sleeve, a valve controlling said discharge



opening, a float chamber secured on the upper terminal of said sleeve within said receptacle and open at its upper end surface, a float vertically guided in said chamber, a vertical rod extending from the interior of said chamber through said sleeve to a point near said discharge valve, a first resilient connection between the lower end of said rod and said discharge valve, a second resilient connection between the upper end of said rod and said float, which second resilient connection is more elastic than is the first resilient connection, to allow the discharge valve to open with a delay in relation to the lift movement of the float, and a discharge opening in the bottom of the float chamber which opening is of a restricted area such as to cause the float chamber to be discharged only when the water receptacle has been substantially discharged, and thus to cause the float to close the discharge valve only when the water receptacle has been substantially discharged.

EDVIN SJÖBERG.


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