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AIR PRESSURE WATER SYSTEM

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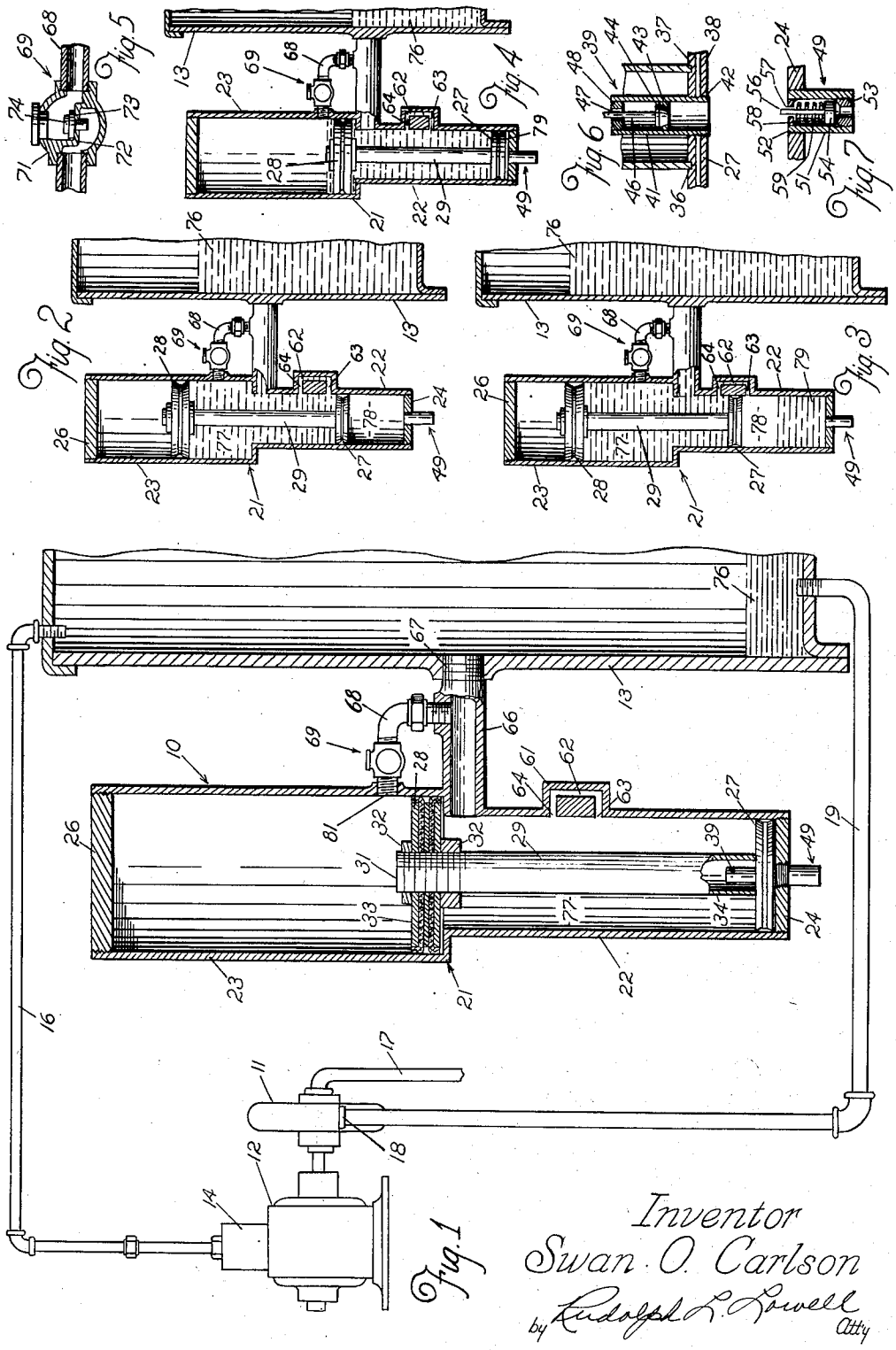


Fig. 1

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AIR PRESSURE WATER SYSTEM

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5 Claims. (Cl. 230—52)

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This invention relates generally to air-pressure water supply systems of the type embodying a pump for delivering water from a source of supply to a pressure tank from which the water is distributed by air pressure, and in particular to a device for feeding air into the tank to maintain a desired air pressure in the tank.

An object of this invention is to provide an improved air feed device for an air pressure water sytem of the above mentioned type.

Yet another object of this invention is to provide an air feed device for the pressure tank in an air pressure water system which is adapted for connection only to the tank and operable in response to pressure changes in the tank.

A further object of this invention is to provide an air feed device for the pressure tank in an air pressure water system which is comprised of a relatively few number of parts, of a compact construction adapted for assembly as a unit with a pressure tank, efficient in operation to continuously supply air to the tank to compensate for normal air losses from the tank, and capable of operating over prolonged periods of time with a minimum of servicing attention.

A feature of this invention is found in the provision of an air feed device for the pressure tank of an air pressure water supply system in which a check-valved piston for delivering air to the tank operates against and into a water head whereby all of the air acted upon by the piston is positively and completely exhausted during each full working stroke of the piston.

Yet another feature of this invention is found in the provision of an air feed device for an air pressure water supply system in which a single cylinder with a pair of cylinder portions of different diameters has a piston structure movable in one direction, in response to an increase of pressure in the tank, to effect a pressure build up in the larger cylinder portion, and movable in an opposite direction by the built up pressure as the pressure in the tank is decreased. Air admitted into the small cylinder, on movement of the piston structure in response to the pressure increase in the tank, is delivered to the large cylinder and then into the tank as the piston structure is moved in response to the pressure built up in the large cylinder portion. A bypass conduit in the small cylinder portion, after a predetermined travel of the piston structure, admits water from the tank into the small cylinder portion so as to eliminate the forming of an air pocket in the small cylinder portion.

Further objects, features and advantages of this

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invention will become apparent from the following description when taken in connection with the accompanying drawing in which:

Fig. 1 is a longitudinal sectional view of the air feed device of this invention shown embodied in an air pressure water supply system;

Fig. 2 is a reduced longitudinal sectional view of the air feed device with parts shown in changed position relative to their showing in Fig. 1;

Figs. 3 and 4 are illustrated similarly to Fig. 2 but with parts thereof shown in changed position; and

Figs. 5, 6 and 7 are sectional detail views of valve units illustrated generally in Fig. 1.

With reference to the drawings the air feed device of this invention, indicated generally as 10 in Fig. 1, is shown embodied in an air pressure water supply system including a pump 11, a motor 12 for operating the pump and a pressure tank 13. The motor 12 is an electric motor adapted to be connected in a well-known manner with a source of electrical supply, and includes a control switch 14 air connected with the top of the tank 13 through a pipe 16 and operable in response to the air pressure in the tank to provide for an automatic operation of the motor 12, and in turn of the pump 11, to maintain a desired water supply in the tank. The pump 11 has an inlet pipe 17, connectible with a source of water supply, and an outlet 18 connected to the bottom of the tank 13 by a pipe 19.

The air feed device 10 comprises a cylindrical casing 21 formed with a pair of co-axial cylinders 22 and 23 open to each other at their inner ends, and with the cylinder 22 of a smaller diameter than the cylinder 23. The outer ends of the cylinders 22 and 23 are closed by end walls 24 and 26, respectively.

Operable within the casing 21 is a piston structure comprising a piston 27 for the cylinder 22, and a piston 28 for the cylinder 23. A hollow member or tube 29 connects the pistons 27 and 28 for movement together. One end 31 of the tube 29 is extended through the piston 28 and is connected to such piston by locking nuts 32 threadable on the tube end 31 against opposite sides of the piston 28. With the tube end 31 extended through the piston 28 it is seen that the tube 29 is open to the cylinder 23 above the top side 33 of the piston 28 as viewed in Figs. 1, 2, 3, and 4. The other end 34 of the tube 29 is received in an annular recess 36 formed in the top side 37 of the piston 27, as viewed in Figs. 1–4, and 6. It is thus seen that the tube 29 is in a spaced relation within the casing 21 and rigidly connects the

pistons 27 and 28 for concurrent reciprocal movement.

Fluid communication between the tube end 34 and the lower side 38 of the piston 27 is controlled by a check valve 39 including a tube 41 having its lower end threadable in a threaded opening 42 in the piston 27. A valve seat 43, within the tube 41, cooperates with a valve member 44 having a stem 46 loosely extended through an opening 47 formed in a stop 48 carried in the upper end of the tube 41 and adapted to limit the upward movement of the valve member 44. On opening of the check valve 39, therefore, fluid is admitted from the lower side of the piston 27 into the tube 29 for passage into the cylinder 23 above the piston 28.

Air for feeding into the tank 13 is admitted into the cylinder 22 to the lower side 38 of the piston 27 by an air check valve indicated generally in Fig. 1 as 49 and shown in detail in Fig. 7. The valve 49 is of a usual type and includes a tube 51 threadable into a threaded opening 52 in the outer end wall 24 of the cylinder 22. A valve seat 53, within the tube 51, is open to the atmosphere and is associated with a valve member 54 having a stem 56 loosely extended through opening 57 formed in a stop member 58 carried in the tube 51. The valve member 54 is normally retained in a seated position on the valve seat 53 by a spring 59 mounted about the valve stem 56. On an upward travel of the piston 27 the pressure within that portion of the cylinder 22 below the piston 27 is reduced to a sub-atmospheric pressure whereby the valve member 54 is opened to admit atmospheric air into the cylinder 22.

For a purpose which will appear later the cylinder 22 is provided intermediate its ends and on its outer periphery with a boss member 61 having a fluid passage 62 arranged with its opposite ends 63 and 64 at axially spaced positions on the cylinder 22 and open to such cylinder.

The casing 21 is supported on the tank 13 by a radially extended pipe 66 open at one end to the casing 21 at substantially the junction of the cylinders 22 and 23, and having its opposite end 67 open to the tank 13 and threadable in a sidewall thereof. The tube 66, and in turn the tank 13, is in fluid communication with the cylinder 23 at a position intermediate the ends thereof, by the provision of a fluid conduit or pipe member 68. Arranged in the pipe 68 is a check valve 69 (Figs. 1 and 5) adapted to control the flow of fluid from the cylinder 23 through the pipes 68 and 66 into the tank 13. The check valve 69 includes a casing 71 having a partition wall 72 formed with a valve seat 73. A valve member 74, responsive in operation to the pressures in the cylinder 23 and in the tank 13, is moved to a seated position with the valve seat 73 when the pressure in the tank 13 exceeds the pressure in the cylinder 23, and is unseated when the pressure in the tank 13 is less than the pressure in the cylinder 23.

In the operation of the device of this invention to feed air into the tank 13 to replace normal air losses from the tank, assume the tank 13 to be empty of water and the pistons 27 and 28 in their positions shown in Fig. 1. At these positions of the pistons the check valves 39, 49 and 69 are in their closed positions illustrated in Figs. 6, 7 and 5, respectively. On operation of the pump 11 by the motor 12 water is delivered to the tank 13 through the pipe 19. As the level of the water, indicated as 76, rises in the tank 13, the air within the tank is compressed between the water 76 and the top of the tank 13. It is apparent, of course, that the increase in air pressure within the tank 13 takes place progressively with an increase in the height of the water level within the tank.

Until the water reaches the level of the pipe or tube 66 air in the casing 21 between the pistons 27 and 28 is at the same pressure as the air in the tank 13. However, passage of air into the cylinder 23 through the pipe 68 is prevented by the check valve 69. Due to the difference in the surface areas of the pistons 27 and 28 the pressure of the air in the space 77, between the pistons 27 and 28, acts against the piston 28 to move the piston structure upwardly within the casing 21. This upward movement of the piston structure effects a sub-atmospheric pressure in the cylinder 22 between the lower side 38 of the piston 27 and the end wall 24 of the cylinder 22. As a result of this sub-atmospheric pressure the check valve 49 is opened to admit air at atmospheric pressure into the space 78 formed below the piston 27 by the upward travel of the piston structure.

When the water in the tank 13 reaches the level of the pipe 66 the air within the space 77 is replaced by water at the same pressure, with such air being exhausted from the casing 21 through the pipe 66 into the top of the tank 13. When this condition occurs the parts of the device are in their relative positions shown in Fig. 2. On a continued supply of water into the tank 13 the piston 27 continues to provide for a sub-atmospheric pressure on the space 78 and for the piston 28 to compress the air within the cylinder 23.

In the event the air pressure in the cylinder 23, when the piston 28 is below the level of the end 81 of the pipe 68, is greater than the pressure within the tank 13 the valve 69 will open to admit air from the cylinder 23 into the tank through the pipes 68 and 66. On movement of the piston 28 above the level of the pipe end 81 equal pressures exist at opposite sides of the valve 69 due to the fluid connection of the space 77 with the tank 13 through the pipe 66.

As the air pressure in the tank 13 approaches a value of about forty pounds per square inch, which is a usual maximum pressure in a water supply system of the type illustrated in Fig. 1, the piston 27 moves above the level of the lower end 63 of the bypass 62, as illustrated in Fig. 3. Water from the space 77 is thus admitted through the bypass 62 into the space 78 below the piston 27. As a result the pressure within the space 78 is increased above atmospheric pressure to the pressure in the tank 13 by virtue of its connection with the tank through the pipe 66, the space between the pistons 27 and 28, and the bypass 62. When the piston 27 is substantially between the ends 63 and 64 of the bypass 62 the air pressure within the tank 13 is at substantially forty pounds per square inch, whereby the motor 12 is shut-down by the action of the air pressure control 14. The tank 13 is thus supplied with water for delivery at a maximum pressure of about forty pounds per square inch.

As water is removed from the tank 13 through any suitable outlet means (not shown) the level of the water 76 in the tank is decreased to in turn effect a decrease in pressure of the air between the water 76 and the top of the tank. Since the pressure of the air within the cylinder 23 above the piston 28 is also at a maximum value of about forty pounds per square inch, when the motor 12 is stopped, the piston structure, on removal of

water from the tank 13, is moved downwardly by the air pressure acting on the top of the piston 28. As the piston 27 moves below the level of the end 63 of the bypass 62 the air within the space 78 is compressed against the water, indicated as 79 in Figs. 3 and 4, which water 79 is trapped within the space 78. When the pressure of the air in the space 78 exceeds the pressure of the air in the cylinder 23 acting on the piston 28, the check valve 39 opens to admit air from the space 78 and through the tube 29 into the cylinder 23. As the piston structure continues to move downwardly, under the pressure of the air in the cylinder 23, the piston 28 moves below the level of the end 81 of the pipe 68, to its position illustrated in Fig. 4. If the pressure within the cylinder 23, when the piston 28 is at its position shown in Fig. 4, is greater than the pressure within the tank 13 the valve 69 opens to feed air from the cylinder 23 to the tank 13.

By virtue of the body of water 79 within the space 78 the piston 27 is capable of moving against and into the water 79 so as to completely exhaust any air from the air space 78 into the tube 29 for passage into the cylinder 23. Should the piston 27 travel downwardly into the water 79 a portion of such water will pass through the valve 39 and the tube 29 into the cylinder 23, as illustrated in Fig. 4. The piston 27, therefore, is movable against and into the body of water 79, which functions as a non-compressible cylinder head for the piston, so that all of the air in the space 78 is completely exhausted at each full stroke of the piston 27 whereby to positively eliminate any dead air pockets within the cylinder 22. Air is thus positively fed into the tank 13, through the tube 29, cylinder 23, and pipes 68 and 66, during each downward stroke of the piston structure.

With the parts of the feed device in their positions shown in Fig. 4, it is contemplated that the pressure of the air within the tank 13 be about twenty pounds per square inch. At this pressure the control switch 14 starts the motor 12 whereby water is again supplied to the tank 13. On an upward travel of the piston structure, in response to an increased pressure in the water tank 13, the piston 27 is moved upwardly from the body of water 79. The operation of the device then proceeds in all respects as fully explained above in connection with Figs. 1–4. In the practice of this invention it is contemplated that the cylinder 22 have a diameter of about two inches so that when a sub-atmospheric pressure is produced in the space 78 the valve 49 will open against the weight of the water 79 to admit atmospheric air through the water 79 and into the air space there above.

From a consideration of the above description it is seen that the invention provides a device for feeding air into the pressure tank of an air pressure water supply system which is comprised of a minimum number of parts assembled in a compact relation and adapted to be carried as a unit on the pressure tank through a single connection. The device is completely operable in direct response to pressure variations in the tank and capable of positively supplying air into the tank, to replenish normal air losses therein, during each cycle of water removal from the tank. In one commercial embodiment of the invention the cylinders 22 and 23 are about eight inches in length, with the cylinder 23 having a diameter of three inches, and the cylinder 22 a diameter of two inches. In this embodiment the lower end 63 of the bypass 62 is located about four and one-half inches from the closed end 24 of the cylinder 22.

Although the invention has been described with respect to a preferred embodiment thereof it is to be understood that it is not to be so limited since changes can be made therein which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. In an air pressure water supply system including a pressure tank, an air feed device for said tank comprising a cylinder formed with a pair of coaxial cylinder portions of different diameters, and open at their inner ends, a pair of pistons for said two cylinder portions, a hollow rod connected between said two pistons with its ends open to the outer ends of said two cylinder portions, a first fluid conduit connected with said cylinder between said two pistons and with said pressure tank, a second fluid conduit connected between said first conduit and one of said cylinder portions, a check valve in said second conduit providing for a fluid flow from said one cylinder portion to said first conduit, a second check valve in the end of said rod which is open to the second one of said cylinder portions, providing for a fluid flow into said rod, an air admission check valve in the outer end of said second cylinder portion, and a by-pass conduit having opposite ends thereof open to said second cylinder portion at axially spaced positions thereon, with said pistons being movable together in response to pressure changes in said pressure tank.

2. In an air pressure water supply system including a pressure tank, an air feed device for said tank including a pair of co-axial cylinders of different diameters, open to each other at their inner ends and closed at their outer ends, a piston structure including a pair of pistons for said cylinders and having a fluid passage therein open at its ends to the outer ends of said cylinders, first means fluid connecting said cylinders at a position between said pistons with said pressure tank, second means fluid connecting one of said cylinders with said first fluid connecting means, a check valve in said second fluid connecting means opening to said first fluid connecting means, a second check valve in said fluid passage opening to said one cylinder, an air admission check valve in the outer end of said other cylinder, and a by-pass conduit having opposite ends thereof open to said other cylinder at axially spaced positions thereon, with said piston structure being movable in response to pressure changes in said pressure tank.

3. In an air pressure water supply system including a pressure tank, an air feed device for said tank including a first cylinder, a second cylinder, with said two cylinders being coaxial and having their inner ends in fluid communication, and said first cylinder being of a larger diameter than said second cylinder, a piston structure including a pair of pistons for said cylinders and a fluid conduit extended between said pistons with its ends open to the outer ends of said cylinders, a check valve means for introducing air into said second cylinder adjacent the outer end thereof, a check valve in said fluid conduit for admitting fluid from said second cylinder into said first cylinder, a second fluid conduit connected with said tank and with said cylinders at a position between said pair of pistons, a third fluid conduit connected with said tank and said first cylinder having a fluid check valve therein opening to said tank, and a by-pass conduit for equalizing the

pressures acting on opposite sides of the piston in said second cylinder, having the opposite ends thereof open to said second cylinder at positions spaced axially of said second cylinder, with said piston structure being movable in response to pressure changes in said pressure tank.

4. In an air pressure water supply system including a pressure tank, an air feed device for said tank comprising a single closed cylinder having two portions of different diameters, a piston structure for said two cylinder portions including a first piston for the cylinder portion of larger diameter and a second piston for the cylinder portion of smaller diameter, a fluid passageway in said piston structure having its ends extended through said pistons for fluid communication with said cylinder portions, a first fluid conduit connected with said small cylinder portion between said two pistons and with said pressure tank, a second fluid conduit connected between said large cylinder portion and said first fluid conduit and having a check valve therein opening to said tank, a second check valve carried in said fluid passageway at said second piston and opening to said fluid passageway to admit fluid from said small cylinder portion into said large cylinder portion, an air admission check valve in the closed end of said small cylinder portion, and fluid by-pass means having its opposite ends in axially spaced positions on said small cylinder portion, with said piston structure being movable in response to variations of the pressure in said pressure tank.

5. In an air pressure water supply system including a pressure tank, an air feed device for said pressure tank comprising a single cylinder closed at its ends and having a large cylinder portion and a small cylinder portion open to each other, a first piston for said large cylinder portion and a second piston for said small cylinder portion, a piston connecting tube extended through said pistons to fluid connect said two cylinder portions, with said tube being in a spaced relation within said cylinder, a first fluid conduit connecting the space between said two pistons with said pressure tank, a second fluid conduit connecting said large cylinder portion with said pressure tank and having one end intermediate the ends of said large cylinder portion, a check valve in said second fluid conduit opening to said pressure tank, an air admission check valve in the closed end of said small cylinder portion, a fluid admission check valve in the end of said tube extended through said second piston, and a fluid by-pass means having its opposite ends open to said small cylinder portion at axially spaced positions thereon, with said pistons being movable in response to the pressures in said pressure tank to provide for the actuation of said check valves.

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