WELL SYSTEM AND METHOD OF PRIMING

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Filed Oct. 16, 1962, Ser. No. 230,098

19 Claims. (Cl. 163—6)

The invention relates to well systems of the type normally used in supplying water in rural areas for domestic consumption and similar purposes.

The invention further relates to the method of "priming" the storage tank of such a well system. "Priming" of the storage tank referred to hereinafter is defined as the process of building up the pressure within the storage tank from atmospheric or zero to the desired range while also accomplishing the desired water level to be maintained in the tank for normal operation.

In particular, the invention relates to the type of well system employing a pressurized storage tank in which an air volume control is utilized for releasing excess air from within the tank as desired. In a system of this type a charge of air is introduced into the water storage tank in each cycle of pump operation and a control device is necessary to effect a discharge of excess air.

The pumping device most commonly used in this type of well system would be of the submersible type wherein the pump is located within the well casing and the pump together with its motor is suspended from a drop or feed pipe which delivers the water from within the well casing to the storage tank.

In a system of this type the air volume control most commonly used incorporates a valve controlled by a float which responds to the condition of the water level in the storage tank. In pumping systems employing pressure ranges between 20 lbs. and 40 lbs. the weight of the float and the size of the valve, which it controls, does not present any undue problems, however, where the pressure range is increased to a 40 lbs. to 60 lbs. system, problems arise with reference to the weight of the float and the size of the valve which it controls. The problems are enhanced because such a well system, when initially installed, must go through a virgin cycle of pump operation in which the pressure within the storage tank is zero (atmospheric).

The principal object of the invention is to provide a well system in which the problems are minimized where the higher pressure ranges are involved.

A further object is to provide a method of improving and expediting the "priming" of the storage tank, particularly in the initial stage of introducing water therein when the air pressure is zero or atmospheric.

A further object is to provide an air volume control which functions more satisfactorily than prior art devices under higher pressure range conditions.

A further specific object is to provide in an air volume control a float which utilizes the water within the storage tank for establishing its weight characteristics.

A further object is to provide an air volume control in which the float can employ a variable weight as desired. With this type of float a larger size valve can be employed.

A further object is to provide an air volume control of the type which is generally improved over prior art types of controls.

The objects and advantages of the invention will be apparent from the ensuing specification and appended drawings in which:

FIGURE 1 is a schematic view of one type of well system and the air volume control employed therewith.

FIGURE 2 is an enlarged fragmentary sectional view of a portion of the system of FIGURE 1.

FIGURE 3 is an enlarged detailed view of the air volume control employed in the system of FIGURE 1.

FIGURE 4 is an enlarged sectional view of a modified form of air volume control for use in the system of FIGURE 1.

FIGURE 5 is a sectional detail view taken on the line 5—5 of FIGURE 4.

FIGURE 6 is a schematic view of a well system employing an air volume control of the horizontal type.

FIGURE 7 is an enlarged sectional view of the air volume control employed in the system of FIGURE 6.

FIGURE 8 is an enlarged sectional detail view of the valve shown in FIGURE 7.

FIGURE 9 is a sectional view taken on the line 9—9 of FIGURE 7.

FIGURE 10 is a sectional detail view taken on the line 10—10 of FIGURE 7.

The type of well system shown in FIGURE 1 includes the well casing A, which in practice would be made up of sections of pipe secured together to form a continuous pipe extending down into the ground to a depth sufficient to encounter the source of water. The well casing normally has a common inside diameter throughout its length to accommodate the pump and motor unit B which is submerged at all times below water level within the casing.

The pump and motor unit is suspended from the drop pipe C which, of course, is formed of sections connected together so as to extend throughout the length of the well casing continuously. The upper end of the drop pipe is connected to the water distributor D from whence the water enters the storage tank E and is dispersed into the house or other place of usage through the discharge pipe F (only a portion of which is shown).

Suitable electric wiring G leads from the source of electricity (not shown) into the interior of the well casing, down through the distributor head and on down through the well casing to the pump and motor unit. A pressure switch H of conventional construction is responsive to the air pressure within the storage tank for automatically controlling the operation of the pump and motor unit.

The distributor D may be formed of a single casting and suitable elastic O-ring seals 16 and 11 close off the upper and lower sections 12 and 13 of the well casing from the interior of the storage tank E. The water thus travels up through the drop or feed pipe C from the pump and motor unit through the passage 14 in the distributor and thence through the opening 15 in the well casing into the interior of the storage tank E.

It is necessary to introduce air into the interior of the storage tank as needed to provide a suitable air cushion above the water level in the tank for pressurizing the system and this air is introduced into the tank through appropriate bleeder lines 17 and 18 in a manner to be explained hereinafter. Excess air is discharged from the tank to atmosphere through the discharge pipe 20 at outlet 26a.

The electrical conductors G extend down through the casing section 12, thence through a passage (not shown) in the distributor D then on down through the well casing 13 to the pump and motor unit B.

As heretofore mentioned the air which is added into the tank enters an opening 22 at the upper end of casing section 12 and thence travels down through the passage in the distributor which accommodates the electrical conductors G and then into the interior of casing section 13.

When the pump is operating, water is being delivered up through the drop pipe and into the interior of the storage tank until the pressure switch opens the electrical circuit to the pump motor. When the pump ceases operating, a one way check valve 24 prevents the water in the storage tank from running back down through the drop pipe, however, the receding of the water within the drop pipe below the check valve 24 causes a suction
condition to commence building up within the drop pipe between the check valve 24 and the upper bleeder 17. The valve ball 26 within the chamber of bleeder 17 is sucked over against the inner wall of the chamber to the position as shown in FIGURE 2, however, the passage 27a is not blocked off and permits air to be drawn through (past the valve ball) and on into the interior of the drop pipe C. Air commences entering the drop pipe through the check valve 26 until there is still a column of water in the drop pipe between the check valve 24 and upper bleeder 17. When the water in the drop pipe recedes to the level of passage 27a, then it recedes considerably more rapidly (while draining out through the lower bleeder 18) until the water level reaches the bleeder 18. The water within the drop pipe will remain at a level in the vicinity of the second bleeder 18, check valve 29 at the pump motor unit preventing the water level from receding any further. The check valve 29 may be of the same general construction as the check valve 24 and bleeder 18 may be of the same general construction as the bleeder 17.

The check valves and bleeders are of conventional construction. Thus, with a column of air supplied within the drop pipe, when the pump next operates, a charge of air is forced through the check valve 24 and on into the storage tank ahead of the column of water coming up through the drop pipe. As has been previously explained, if too much air is introduced into the storage tank, the excess will be expelled out through the pipe 20 by operation of the air volume control.

Referring now to FIGURE 3, I have shown the air volume control in detail. It includes a cylindrical outer casing or sleeve 30 of tubular construction having a converging end portion 31 with opening 31a. The other end of the sleeve is telescopically mounted on the annular shoulder 32 of the fitting 33. The casing or sleeve is anchored to such fitting as by means of a suitable adhesive. The fitting has an externally threaded end 34 which is threaded into the coupling 35 into which the lower end of discharge pipe 20 is likewise threaded. The fitting 33 has an axial bore 36 which communicates with a restricted passage or air discharge opening 37 which terminates at the valve seat 38. The bore 39 receives the valve stem 40 which has a resilient valve block 41 secured in the end thereof. The float 42 includes a cylindrical shell or casing portion 43 closed off at its lower end by means of a circular cap 44 which is secured thereto by means of a suitable adhesive. A suitable circular cap 44a closes off the upper end of the shell 43 and also serves as a mounting for the cylindrical cap portion 46 at the upper end of the float. The cap 46 has an axially inwardly extending boss 47 into which the lower end 48 of the valve stem is secured. Suitable ribs 49 serve to strengthen the cap 46 and the boss 47. Thus, the upper end of the float is provided with a closed chamber 51 with air trapped therein above the circular partition wall 52. The inwardly converging end 31 of casing 30 prevents the float from dropping any appreciable distance so that the valve plunger is always maintained within the bore 39.

The casing 30 has an opening 55 near the upper end thereof to prevent any pressure build up within the casing 30 when the water in the storage tank is rising in the interior thereof. The casing section 45 of the float has an opening 56 in its wall to permit entry of water into the chamber 57 which is provided by the casing section 43. A pocket 58 exists within the casing 43 above the level of the opening 56 for reasons to be presented hereinafter. During the virgin cycle of the operation of the pump the air pressure within the tank is zero or atmospheric. As the tank level in the tank rises the float will be resting in the bottom of the shell 30 in the position as indicated by the dotted lines at 60. The valve is open and a small amount of air is escaping through passage 27, bore 36 and discharge pipe 20. The chamber 57 in the float is filled with air and hence the float is in its condition of lightest weight and will be of such buoyancy as to close off the water passage 54 against the valve seat 58 at an early time during the rising of the water level in the storage tank. That is, the float will close off the valve before the water level in the tank reaches the opening 56. Thus the escape of air through passage 27 will be cut off at an early stage during rising water level, thereby permitting a more rapid pressurizing of the interior of the storage tank.

As the water level rises in the tank above the level of opening 56, the chamber 57 commences filling with water thereby adding additional weight to the float. The valve will, hence, close off against the valve seat 58 at an early time since the water in the storage tank is common with the water inside of the float, the specific gravity of such water being constant. Since the air pressure in the tank was at zero, the water will continue rising in the tank to an abnormally high level before the tank pressure reaches 60 lbs. Several cycles of operation of the pump may be needed before an adequate quantity of air is trapped within the tank to complete the "priming" process. In other words, the first cycle of operation of the pump may result in the water level reaching a height in the tank such that the valve will remain closed through 55 and the float continues to extend out of the pump. Thus a new quantity of air is being added into the tank each time the pump operates without any air being expelled from the tank. The water level in the tank keeps receding to a new level after each cycle of pump operation until the desired water level is reached wherein the float operated valve will then maintain a substantially constant quantity of air in the tank. The "priming" process may then be considered completed.

With the "priming" process completed and the system operating as desired, then, whenever the pressure switch opens the electrical circuit, the pump will cease operating and subsequent usage of the water from the tank through discharge pipe F will cause the water level in the tank to recede until it drops below the opening 56. The water level within the chamber 57 will likewise recede to the lower level of opening 56 thereby tending to keep the valve closed slightly longer because of the decrease of the weight within the float chamber. The water within the chamber beneath the lower level of opening 56 is, however, permanently trapped and provides the necessary weight of the float for subsequent valve opening and closing purposes. It will be understood that since the pressure inside of the tank exceeds the pressure within pipe 20 (which is atmospheric), the valve will remain seated or closed until the weight within chamber 57 is adequate to overcome the effect of this pressure differential. Thus, in a 40 lb.-60 lb. pumping system, the minimum pressure within the tank is 40 lbs. greater than atmospheric (at 40 lbs. tank pressure, the pump commences operating and keeps operating until the pressure within the tank reaches 60 lbs., at which pressure the pump ceases operating and remains inoperative until tank pressure drops to 40 lbs.). The dotted line I in FIGURE 1 is intended to indicate the approximate desired water level wherein pump operation would be imminent for adding more water into the tank.

In the form of the invention shown in FIGURE 4 the float is made up of the upper and lower cylinders as shell sections 46a and 43a closed at their opposite ends by means of identically fabricated caps 44b, 44c and 44d (for cost cutting purposes). The closed chamber 51a functions the same as chamber 51 of FIGURE 3 and chamber 57a functions the same as chamber 57 of FIGURE 3. Opening 56a functions the same as opening 56 of FIGURE 3. The outer casing 30a and its inwardly converging flange portion 31a with end opening 31ac function the same as the corresponding components 30, 31 and 31a of FIGURE 3, and an opening (not shown) similar to opening 55 of FIGURE 3 would be provided in casing 30a to function the same as opening 55 of FIGURE 3.
3. The upper cap 44d provides a cylindrical pocket into which the cylindrical base 41a of the resilient valve block 41b is secured. The flat end face 41c of the valve block coats with the circular valve seat 30a. The valve block is provided with a combined guiding and scavenging pin 40a, which is the upper end of which projects into passage 57a which opens into counterbore 56b of fitting 32a. As described for FIGURE 4, pin 40a functions similarly to the valve stem 40 in guiding the up and down movement of the float 42a while simultaneously scavenging the passage 37a during opening and closing of the valve. The threaded end 34a of the fitting 32a functions as the threaded end 34 of fitting 33 of FIGURE 3. The pin 48b may have its lower end formed with a transverse loop 49b imbedded in the valve block base 41a (as best shown in FIGURE 5).

Throughout the foregoing specification, I have described a pumping system in which the tank pressure range is reduced to being 40 lbs. for commencing pump operation and 60 lbs. for terminating pump operation. It has been found that if the various components, chamber sizes, passage sizes and opening sizes of the float assembly are fabricated as shown in FIGURE 3, that the resultant air volume control will function satisfactorily in a well system in which the lower end of the side wall of the well casing is as high as 95 lbs.—that is, a system in which the pump commences operating when the interior tank pressure drops to 95 lbs. Thus, the showing of FIGURE 3 can be considered substantially actual size. As an example of materials to be used, the components shown in FIGURE 3 can be of synthetic resin except that the pin 40a may be of stainless steel and the valve block 41b may be of rubber or other resilient material having the characteristics of rubber.

In the form of the invention as shown in FIGURES 6 through 10, an air volume control is provided in the side wall 65 of the storage tank 66 and the float assembly lies generally in a horizontal plane. The pumping system may, for example, be of the submersible type in which the well casing 67 extends downwardly into the ground to the subterranean water level and the pump and the motor unit (not shown) would, of course, be submerged in the water within the well casing. The drop pipe 68 may be provided with the bleeders 69 and 70 which function in the same manner as bleeders 17 and 18. A check valve 71 functions in the manner of check valve 24. The water distributor 72 may be in the form of a coupling which is removably connected to the side wall of the well casing, the coupling 72 may be of the type shown in my Patent No. 2,918,972.

The float 75 may consist of similar castings 76 and 77 which are telescopically mounted on and secured to the cylindrical stubs 78 and 79 of the partition member 80. The casings 76 and 77 can be fabricated identically to the end cap 46 of FIGURE 3 to permit tooling cost reduction. The partition member 89 is likewise fabricated identically to the item 44 of FIGURE 3 for the purpose of reducing tooling costs. The chamber 81 is thus closed off to the casings 76 and 77 by means of partition member 89.

One end of the float has a stem 83 threaded into the boss 84. The other end of the stem projects through an opening 86 in lever 87 and is bent at 89 so as to extend through an opening 88 in the base 91 of the lever. A washer 90 holds the stem secure with reference to the lever. The lever 87 supports on a fork a valve stem 83 on a head 91 and laterally projecting fulcrum arms 92 and 93 which are loosely mounted in the side bores of fulcrum screws 94 and 95. The valve stem 83 is threaded securely into the side bosses 56b and 57c of the casing 90. The lever 87 is thus free to rock about the axis of the fulcrum 92 and 93. A valve 102 is provided with its opposite end of the lever and embraces valve stem 101 between the washers 102 and 103 which are anchored to the stem. A valve seat 104d is secured within washer 104b and engages the valve seat 104 for closing off communication between atmosphere and the interior of the tank. The valve seat 104 is formed at the end of valve casing 105 which is secured within the nut 106 which is threaded into the casting 98.

Viewing FIGURE 7 the float is shown in a position in which the valve is open. The outermost half of the float 77 has an opening 108 in the wall thereof to permit the entry of water into the chamber 82 in the same manner as opening 56 of FIGURE 3 functions. In the virgin cycle of operation of the pumping system of FIGURE 6, the chamber 82 is empty and consequently the float rises more rapidly to close the valve. As the valve seat 104 thereby assures a larger quantity of air in the upper cap 44a would otherwise be possible. When the water rises above the float, the chamber 83 becomes substantially filled and remains so on subsequent operations of the pump.

A pressure responsive switch 110 may be connected to the casting 98 by having a hollow fitting 111 threaded into the boss 112 thereby establishing communication between the interior of the switch and the interior of the storage tank. The pressure switch is of conventional construction as is pressure switch H of FIGURE 1. If desired, a pressure gauge 113 may have its fitting 114 threaded into the side of the casting 98 so as to have communication with the interior of the storage tank.

I claim:

1. A water pumping and storing apparatus comprising: a hollow casing extending down into the ground to the source of water; a water feed pipe within the casing; a water and air storage tank, said tank having an inlet in communication with the feed pipe for receiving the water from the feed pipe; pumping apparatus connected with the feed pipe for pumping the water from the source through the feed pipe and into the storage tank; means connected with the feed pipe for admitting air into the storage tank during activation of the pumping apparatus and control means for expelling excessive air from the storage tank; said means including a valve and a float connected with the valve for effecting opening and closing thereof in accordance with the water level within the tank, said float having a walled chamber with an opening in the wall establishing communication between the interior of the storage tank and the interior of the chamber, whereby the water within the storage tank enters the chamber to add weight to the float.

2. A water pumping and storing apparatus comprising: a hollow casing extending down into the ground to the source of water; a water feed pipe within the casing; a water and air storage tank, said tank having an inlet in communication with the feed pipe for receiving the water from the feed pipe; pumping apparatus connected with the feed pipe for pumping the water from the source through the feed pipe and into the storage tank; said storage tank having an air discharge opening for establishing communication between the interior of the tank and the atmosphere; means connected with the feed pipe for adding air into the storage tank and control means for expelling excessive air from the storage tank, said control means including: a valve mounted at the air discharge opening; a float connected with the valve for effecting the opening and closing of the air discharge opening in accordance with the water level within the tank, said float having a walled chamber with an opening in the wall establishing communication between the interior of the storage tank and the interior of the chamber, whereby the water within the storage tank enters the chamber to add weight to the float.

3. A water pumping and storing apparatus comprising: a hollow casing extending down into the ground to the source of water; a water feed pipe within the casing; a water and air storage tank, said tank having an inlet in communication with the feed pipe for receiving the water from the feed pipe; pumping apparatus connected with the feed pipe for pumping the water from the source.
through the feed pipe and into the storage tank; said storage tank having an air discharge opening for establishing communication between the interior of the tank and the atmosphere; means connected with the feed pipe for adding air into the storage tank and control means for expelling excessive air from the storage tank, said last means including: a valve mounted at the air discharge opening; a float connected with the valve for effecting the opening and closing of the air discharge opening in accordance with the water level within the tank, said float comprising a hollow casing having a chamber closed to the interior of the storage tank and an additional chamber with an opening in the casing to establish communication between the interior of the storage tank and the interior of the additional chamber, whereby the water within the storage tank enters the additional chamber to add weight to the float.

4. A water pumping and storing apparatus comprising: a hollow casing extending down into the ground to the source of water; a water feed pipe within the casing; a water and air storage tank; said tank having an inlet in communication with the feed pipe for receiving the water from the feed pipe; pumping apparatus connected with the feed pipe for pumping the water from the source through the feed pipe and into the storage tank; said storage tank having an air discharge opening for establishing communication between the interior of the tank and the atmosphere; means connected with the feed pipe for adding air into the storage tank and control means for expelling excessive air from the storage tank, said last means including: a valve mounted at the air discharge opening; a float connected with the valve for effecting the opening and closing of the air discharge opening in accordance with the water level within the tank, said float comprising a hollow casing having a chamber closed to the interior of the storage tank and an additional chamber with an opening in the casing to establish communication between the interior of the storage tank and the interior of the additional chamber, said opening being situated in the casing, whereby the quantity of water within the additional chamber varies in accordance with the water level within the tank.

5. A water pumping and storing apparatus comprising: a hollow casing extending down into the ground to the source of water; a water feed pipe within the casing; a water and air storage tank; said tank having an inlet in communication with the feed pipe for receiving the water from the feed pipe; pumping apparatus connected with the feed pipe for pumping the water from the source through the feed pipe and into the storage tank; said storage tank having an air discharge opening for establishing communication between the interior of the tank and the atmosphere; control means for expelling excessive air from the storage tank; said last means including: a valve mounted at the air discharge opening; a float connected with the valve for effecting the opening and closing of the air discharge opening in accordance with the water level within the tank, said float having a walled chamber with an opening in the wall establishing communication between the interior of the storage tank and the interior of the chamber, whereby the water within the storage tank enters the chamber to add weight to the float, said opening being situated in the chamber wall whereby the quantity of water within the chamber varies in accordance with the water level within the tank.

6. For use in controlling the opening and closing of an air discharge opening in a liquid storage tank in accordance with the change of the level of the liquid within the tank; a valve and float assembly comprising: a stationary sleeve having an opening at its lower end and having a passage at its upper end communicating with the tank air discharge opening; a valve seat in the passage; a hollow casing telescopically received within and capable of movement relative to the sleeve; a valve member on the casing for engaging the valve seat to close off the sleeve passage when the liquid within the tank reaches a predetermined level; said casing having an opening therein for establishing communication between the interior of the casing and the interior of the storage tank, whereby the liquid within the tank enters the casing opening and said sleeve having an opening therein near its upper end for establishing communication between the interior of the tank and the interior of the sleeve.

7. Apparatus as set forth in claim 6 wherein the casing opening is situated below the uppermost end of the casing, whereby the quantity of liquid within the casing decreases when the level of the liquid in the tank recedes below the uppermost end of the casing.

8. Apparatus as set forth in claim 6 wherein the casing and valve member are freely received within the sleeve and means on the sleeve limit the movement of the casing and valve member in valve opening direction.

9. For use in controlling the opening and closing of an air discharge opening in a liquid storage tank in accordance with the change of the level of the liquid within the tank; a valve and float assembly comprising: a sleeve having a closure wall at the upper end thereof with means for securing the sleeve relative to the tank; said closure wall having a passage therein communicating with the tank air discharge opening; a valve seat in the passage; a hollow casing telescopically received within and capable of rectilinear movement relative to the sleeve; a valve member anchored at the end of the casing for engaging the valve seat to close off the closure wall passage when the liquid within the tank reaches a predetermined level; said casing having an opening therein for establishing communication between the interior of the casing and the interior of the storage tank, whereby the liquid in the tank enters the casing opening and said sleeve having an opening beyond the valve seat for establishing communication between the interior of the tank and the interior of the sleeve and said sleeve having an additional opening at the lower end thereof establishing communication between the interior of the sleeve and the interior of the tank.

10. Apparatus as set forth in claim 9 wherein the outer wall of the casing is spaced from the inner wall of the sleeve to accommodate a column of liquid between the sleeve and casing.

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