April 24, 1962 S. M. TAYLOR 3,030,891

LIQUID SUPPLY PUMPING SYSTEM

Original Filed Dec. 28, 1959 2 Sheets-Sheet 1

Fig. 1.

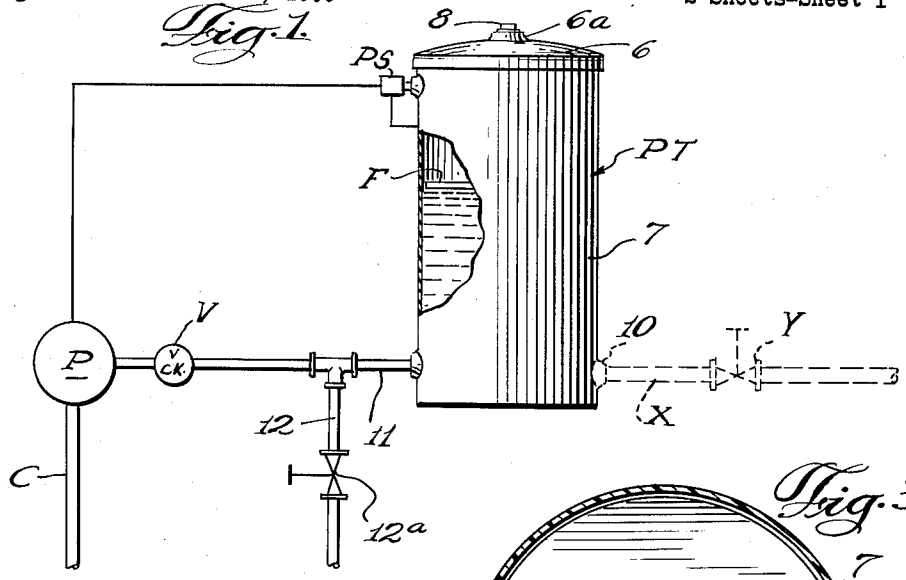


Fig. 3.

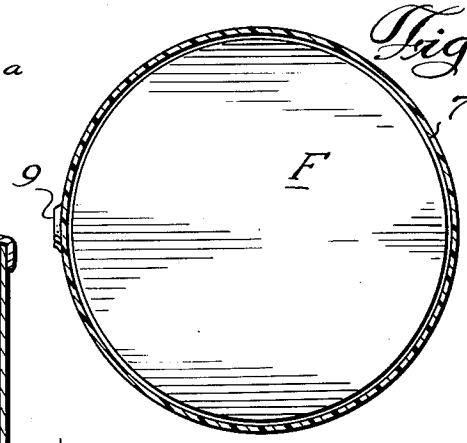


Fig. 2.

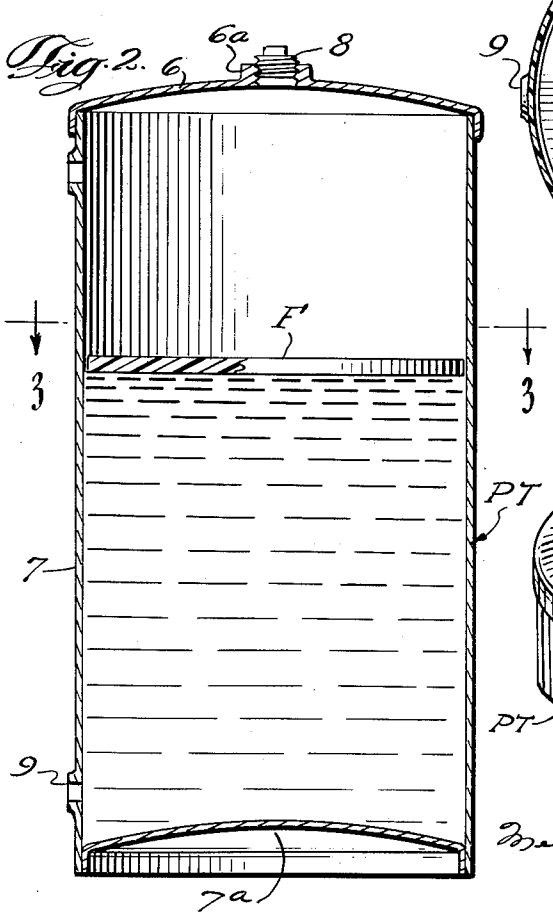
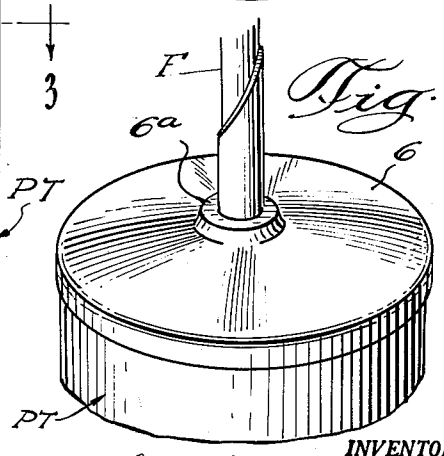


Fig. 4.



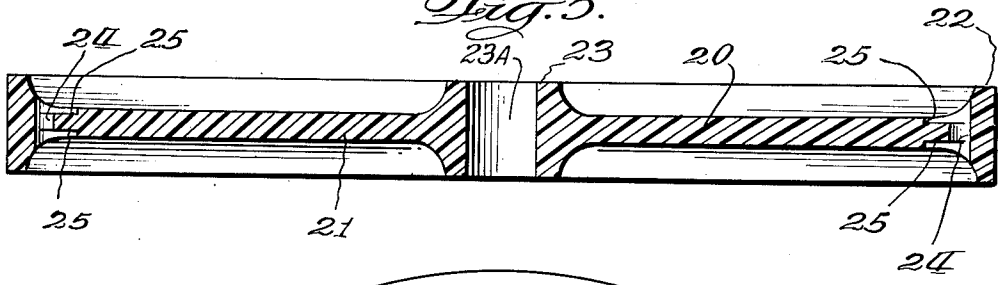
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Original Filed Dec. 28, 1959 2 Sheets-Sheet 2

Fig. 5.



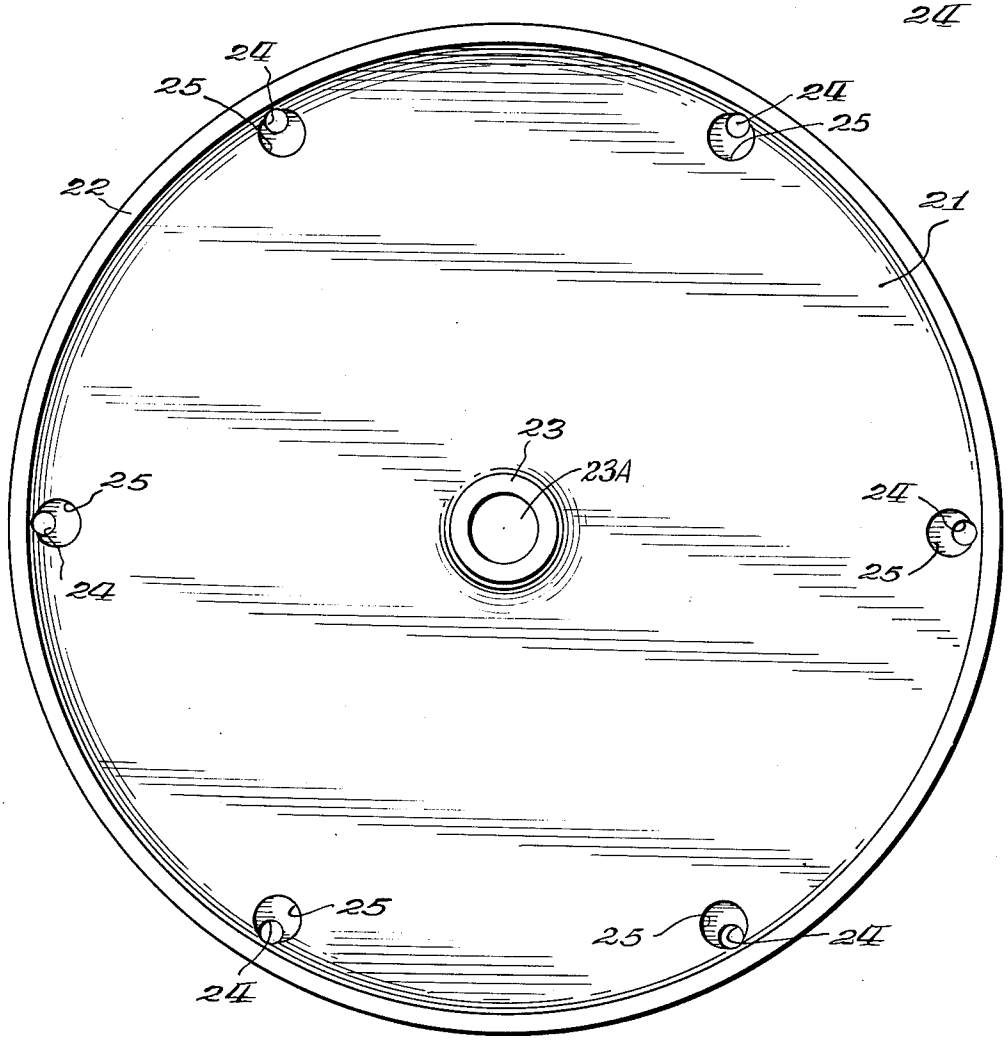


Fig. 6.

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3,030,891

LIQUID SUPPLY PUMPING SYSTEM

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Original application Dec. 28, 1959, Ser. No. 862,103. Divided and this application Sept. 22, 1960, Ser. No. 58,597

20 Claims. (Cl. 103—25)

This invention relates to an improved tank for a domestic water supply system and, more particularly, to a method of maintaining air head within the tank.

In the normal operation of a domestic water system in which water is pumped into a pressure tank, an air head is maintained against which the water is pumped until a predetermined air pressure has been reached. Because of the expansion of the air, water can be supplied by the system to the extent of the volume measured by the expansion of the air. Normally a pressure switch is employed which turns the pump on at a predetermined minimum pressure, such as 20 pounds, and turns it off at a predetermined maximum, such as 40 pounds. Obviously, the greater the volume of the air, the greater will be the volume of water displaced during the expansion of the air from 40 to 20 pounds.

Inasmuch as some air will dissolve in water, there is a tendency for the air cushion gradually to dissolve in the water with which it comes in contact in the pressure tank.

In accordance with the present invention means are provided in the tank in the form of a shape-retaining, disk-shaped, water- and air-impermeable float which has a density markedly less than water and a diameter slightly less than the tank, and which preferably is symmetrical about a horizontal axis, so that it may be used with either side up, and which is preferably rigid. The disk-shaped float is pre-inserted into the pressure tank before the tank is sealed.

In its preferred form the disk-shaped float is provided with an annular flange and a plurality of small openings permeable to water and air are provided at spaced points around the circumference of the float adjacent to the flange so that water will not be held on the upper side of the float and air will not be held on the lower side of the float.

The invention is illustrated in the drawings in which:

FIG. 1 is a somewhat diagrammatical view showing in full lines a pressure tank, pumping system, embodying my invention, with dotted lines indicating additional connections and discharge as required in most conventional pumping systems in use at this time;

FIG. 2 is a vertical longitudinal section taken through a pressure tank and separator-float embodying my invention;

FIG. 3 is a cross section taken on the line 3—3 of FIG. 2;

FIG. 4 is a perspective view illustrating a method of inserting a flexible air-separator float in a conventional tank through the plug opening at the top thereof;

FIG. 5 is a sectional elevation of the improved float; and

FIG. 6 is a plan view of the improved reversible float.

In the practice of this invention, air is almost entirely separated from the water in the pressure tank of the pumping system at all variable water levels during operation of the system.

To this end, I have discovered that a float constructed of material substantially impervious to air and water and of a configuration similar to the interior cross-sectional shape of the pressure tank and properly related dimensionally thereto, will constitute an air-separating medium within the tank throughout variable water levels

to the ends that substantially no absorption of air by the water of the tank takes place and turbulence at the surface is substantially eliminated. This air-separator float has a close combinative relation with the pressure tank.

Referring now to the pressure-type pumping system diagrammatically illustrated in FIG. 1, a vertical pressure tank PT having sheet metal steel walls of cylindrical form is shown, having a domed top or header 6 which usually telescopes over the upper end of the usually rolled tank body 7 and is welded in closed relation therewith. A reinforced or bossed central portion 6*a* is usually provided in the top header tapped to receive in sealed relation, a suitable removable plug 8. Such tanks PT are conventional at the present time and are usually provided adjacent the lower end with communication passages or inlet and/or outlet opening 9 and outlet opening 10 shown in dotted or broken lines, opening 9 usually being connected for communication with the supply pipe 11 from the pump P while in most presently used conventional systems, the discharge of water is taken from pressure tank PT through a fitting or an opening 10, by means of a valved discharge pipe X shown in dotted lines in FIG. 1. The intake of pump P is connected with a supply conduit C which may be submerged in a well or be connected with some other source of water or other liquid supply such as a reservoir, lake or the like. A check valve V is interposed in the supply line from the pump to the tank to prevent backward flow of water or liquid into the pump when the pump is inoperative.

A pressure limit switch mounted in the system for example on the pump and having a pressure-responsive element of conventional structure located within the upper interior of the tank controls operation of the pump, shutting off the same when the air pressure in the tank is raised to a predetermined level. The pressure limit switch of the system of FIG. 1 is indicated in its entirety by the designation PS. This level in most conventional systems is within a range of between 40 or 50 p.s.i.g. In conventional systems, when the outlet valve Y shown in dotted lines in FIG. 1 is open, the compressed air, of course, forces the water from the tank for use as desired in the system. As the air expands, the pressure lowers and upon reaching a predetermined point, the pressure limit switch PS through electrical circuit, causes the pump to again start. The predetermined low pressure starting point is usually wthiin a range of from 20 to 30 p.s.i.g.

In conventional systems, all water or liquid pumped is normally passed through the pressure tank as opposed to by-passing the same or simply riding on the line. The reason for this is that in many systems, the pump or some apparatus in the pump line constantly forces in some additional air as the pump is in operation. When my system is delivering water with the pump operating, the discharge from the pump may flow directly out through a discharge conduit 12, thereby effectively by-passing the tank; my float may equally well be employed in the conventional system employing the separate water outlet 10 which is controlled by a valve Y. The use of a bypass eliminates the need for the outlet opening 10.

As previously stated, in my method and system, an air-separating float indicated as F, is freely disposed within the tank for up and down sliding movement and has a similar configuration to the cross-sectional configuration of the tank, in the form of the invention illustrated constituting a disk, having a working clearance (overall) between its periphery and the inner periphery of the tank, preferably within a range of from one-fourth to one inch. There must be sufficient clearance between the periphery of the float or disk in the tank to permit free rise and fall of the disk when operating upon the water surface

and taking into consideration sufficient tolerance to allow for irregularity in tank construction such as happens from bowing of the side sheets during welding of the tank, internal weld splatter, irregularity of the internal galvanized tank surface and build-up of foreign materials from the water upon the inner periphery of the tank, such materials including oxide of iron, sulphur and manganese and carbonates of calcium and magnesium.

The air-separating float or disk must be constructed of a material which is buoyant in the water or other liquid of the system; which is sufficiently rigid not to cling the to the sides of the tank and sufficiently resistant to abrasion so as not to be worn by rubbing on the sides of the tank in operation. At least the external surfaces of the float must be impervious to water or the other liquid used in the system and substantially impervious to air. Various materials, lamination and exterior coatings may be utilized to perform satisfactorily in accordance with my method and invention.

The preferred form of float is illustrated in FIGS. 5 and 6 and comprises a disk **20** having a webbed portion **21**, an external flange **22**, a central escape opening **23A**, having a flange **23**, and a plurality of air and water permeable openings **24** regularly spaced through the web adjacent to the flange **22**.

It will be noticed that the openings **24** are actually partially within the flange **22** as shown particularly in FIG. 6, and that they are provided with a circular depressed area **25** which is shallowest at the inside and deeper at the outside, and whose projected circumference encloses the opening inside of its outermost point.

The central flanged relief opening **23A** is illustrated as approximately $1\frac{3}{16}$ of an inch in diameter, and the flanges **23** are the same height as the outer flange **22** which, for the usual domestic water tank, is about 1 inch high. The water- and air-permeable openings **24** are made as small as will serve the purpose and, for example, are ¼ of an inch in diameter. It has been found that there is a tendency for a water diaphragm to form across such small openings, and the purpose of the depressed area **25** is to break that diaphragm, and thus permit the use of smaller openings.

The purpose of the openings **24** is to permit any water which accumulates on top of the disk to run below and to permit any air which collects beneath the disk to escape. Water collects on top of the disk when the tank is first filled because the disk is below the inlet level. It may also collect to a limited extent in case for any reason the disk becomes tipped. Air may collect beneath the disk on tipping or in the event that there is any free air in the water introduced to the tank.

The function of the escape opening **23A** is to prevent crushing of the disk in the event that there is a leak in the tank's upper portions, which permits air to escape, thus allowing water to rise. If this rise is slow, the openings **24** will handle it, but if it is rapid, the disk could be crushed into the domed top of the tank unless means were provided for the water to pass through this central opening. This same result may be obtained by providing pivoting pins in the side of the vessel near the top, so that if the disk ever rises to that height, it will be tipped and permit the water to go by one side of it.

The flange **22** is of particular importance in reducing the passage of air from the gas space in the upper portion of the tank into the water through the annular area between the disk and the sides of the tank. Since the tanks are never exactly circular and since their cross-section will vary at one level compared to another, the disk cannot completely close the opening and will always leave an air space, which is of relatively minor importance. Normal clearance will be about ¼ of an inch. However, it has been found that with a flat disk there is a tendency for diffusion of air to occur under the pan or disk at a fairly rapid rate, and it has been found that the use of the flange will cut down diffusion by a remarkable percentage. A typical disk has a diameter of about $11\frac{3}{8}$ inches for a 12 inch tank and the use of a 1 inch flange on such a disk has been found to reduce air absorption in the water by about 50 percent as compared to a similar disk without the flange.

Flange **22** also greatly reduces circulation of the water to and from the marginal areas of the tank adjacent to the disk and thus, also reduces the absorption of water in this manner. In other words, the flange serves to maintain a narrow annulus of air-saturated water between the flange and the tank, and reduces disturbance of this annulus.

My hydro-pneumatic tank assembly is adapted for use in a water supply system that includes pressure regulating means in operative association with a hydro-pneumatic tank. The assembly includes a hydro-pneumatic tank having side walls, a top and bottom, inlet and outlet means at the lower portion thereof of relatively small size as compared to the cross-sectional area of the tank. The inlet and outlet means is constantly open and valveless and provides free egress of water and gas from the tank when the water level in the tank is lowered to communication with the inlet and outlet means. Pressure-responsive means is operatively associated with the tank and is responsive to predetermined pressure variations in the assembly. The tank has a water-air separation float therein in the form of a disk having a peripheral edge that substantially conforms to the cross-sectional shape of the tank but is slightly smaller in size. The peripheral edge of the disk cooperates with the side walls to obviate the ready ingress of air from above the float to beneath the float. The hydropneumatic tank assembly includes means for coaction between said disk and said tank at the upper portion of said tank to prevent the disk from being permanently deformed at the top of the tank by upward movement of the water level in the tank. For example, as pointed out above, the disk itself may include means, such as exemplified by escape opening **23A** or the upper portion of the tank may include means, such as pivoting pin, that enables water to pass from below to above the disk when the disk is raised to the upper portion of the tank.

The composition of the material in the disk is of great importance. It must be light; it must be impervious to air and water; it must be inert to chemicals in the water; it must not set up electric currents with the shell of the tank; it must be rigid and shape-retaining so that it will stay in position and particularly will not be disturbed by the inrush of water, or go down the drain when the tank is emptied. It must not inject taste or odor to the water.

The material, of course, must be resistant to the changes in pressure which occur. It must also, of course, be buoyant even under the greatest pressure to which it will be subjected. It must also retain its characteristics during the life of the water tank.

The lower surface of the disk must, of course, not be above the water level because otherwise air will pass beneath it.

The preferred material is an expandable polystyrene such as that marketed under the trade name "Dylite." This material is supplied as beads. These beads are expanded by heat before putting into the mold, and the density of the disk can be controlled by the degree of this pre-expansion. The mold is filled with the pre-expanded beads, and further heat is then applied, which consolidates the beads and further expands them so as to produce a smooth, tough skin on all exterior surfaces. The internal cells are not interconnected, so that any puncture of the skin will not provide a continuous path for air or water.

The preferred density is approximately ten pounds per cubic foot. For practical purposes, it is preferred that the disk be as light as possible, consistent with appropriate strength and abrasive resistance.

It is also important that the web of the disk be in contact with the water and its density and shape as well as thickness and the items of flange are coordinated to provide this contact. It should be noted, however, that using the material designated there is a very considerable affinity for water and the surface, so that a disk which has been warped will be brought back into proper alignment even though the warpage is considerable.

For a disk of the thickness hereinbefore described, a thickness of about ¼ inch in the web has proved satisfactory.

In assembling the tank, the particular rigid and shape-retaining disk shown in FIGURES 5 and 6 must be inserted before at least one of the top or bottom of the tank is assembled.

It has also been found expedient in using the present system to precharge the pressure vessel with air. This may, for example, be done to bring the pressure within the vessel to five to fifteen pounds super atmospheric, that is, five to fifteen pounds gauge, before introducing any water. The effect of this is to provide a greater cushion for expansion, since it can be mathematically demonstrated that the more air there is in the vessel, the more water it will displace on any given pump cycle. In other words, if the pressure limits are twenty and forty pounds, there will be twice as much volumetric change between these limits when there is twice as much air in the container. Furthermore, the pre-charging lengthens the time required for absorption which will take place very slowly even in my system.

In the present system the conventional air tap midway up the tank side may be eliminated.

In connection with the flanged opening 23 it appears that the shape provided by the flange has some value in directing circulation of incoming water so that it does not disturb the air-saturated annulus of water which accumulates between the flange 22 and the wall of the vessel. This also has some value in reducing absorption of air. It also has some considerable value in making the web rigid, thus permitting the use of somewhat less thickness in the web.

With my apparatus and system, turbulence is substantially eliminated due to the separation physically of air and water within the pressure tank. Furthermore, as will be seen from FIG. 1, the discharge may be derived intermediate of the pump and tank through a conduit 12 connected with the branches of the discharge system, whereby the flow may by-pass or ride the tank for the most part minimizing agitation of the water and, consequently, oxidation of iron and other minerals contained in the water.

Another highly important result attainable from my invention is that with my method and system, subsequent removal of iron and other metals which are inherent in the water, is most advantageously carried out.

At present, there are two basic methods of removing iron from water, to-wit:

(1) Iron-bearing water may be aerated thus introducing oxygen which results in oxidation of iron previously in solution. Iron oxides are insoluble in water and will precipitate. When the iron is precipitated, the water may be passed through a filter bed consisting of fine fractured structure grain to separate off the iron oxide precipitate.

(2) The preferred method is to, as far as possible, keep the iron or iron salts in solution in the water until through subsequent ion exchange through common water softeners operating on the sodium exchange cycle, the iron ions may be removed. With my method and apparatus, the iron is most effectively kept in solution by substantially preventing contact of the water with air and substantial elimination of any turbulence.

Today, most homes where water pumping systems are utilized are provided with water softeners utilizing Zeolite or the like which operate upon the sodium-ion exchanger cycle. Zeolite operates effectively upon iron salts to exchange sodium ions for iron ions and the Zeolite may be regenerated by the conventional use of sodium chloride which effectively changes the iron combined with the ion exchanger for sodium as it does with calcium, passing iron chloride to waste.

This is a division of my copending application Serial No. 862,103, filed on December 28, 1959, which was a continuation-in-part of Serial No. 606,132, filed August 24, 1956, now abandoned.

What is claimed is:

1. A liquid supply pumping system comprising in combination a liquid pressure tank having inlet and outlet means at the bottom thereof, said tank being sealed to prevent undesired escape of gas to the atmosphere, pump and conduit means communicating with said inlet and outlet means of the tank for supplying liquid under pressure to said tank and increasing the pressure therein, said inlet and outlet means of said tank being constantly open and valveless, check valve means operatively associated with said pump and conduit means so that the liquid cannot flow from the pressure tank to the pump, pressure-responsive means constructed and arranged with said tank and pump to actuate said pump to on-off conditions in response to predetermined pressure variations in said system, said tank having a liquid-gas separation float therein in the form of a disk having a peripheral edge conforming to the cross-sectional shape of the tank but being slightly smaller in size, the peripheral edge of said float being spaced inwardly of the tank to provide a narrow, substantially annular column of water between the tank and the peripheral edge of the float, the spacing between said peripheral edge and the tank and said substantially annular column of water being sufficiently narrow to obviate the ready ingress of air to beneath the float, said float comprising a free-floating disk of air- and water-impervious, substantially rigid material and being buoyant in water, said disk having a lower face that floats in water while exposing an upper face substantially above water during continued usage so as to be normally dry, said air- and water-impervious, substantially rigid float material preventing the float from being compressed or waterlogged and lowering its upper face to the extent that it is no longer substantially above the level of the liquid of the tank during usual pressure changes in the tank over an extended period of operation.

2. The system of claim 1 wherein the disk material is made of synthetic plastic having closed discrete cells.

3. The system of claim 1 wherein the disk material is expanded polystyrene.

4. The system of claim 1 wherein the disk has a central web and a flanged peripheral edge extending below the web.

5. The system of claim 1 wherein the disk has a central web, a flanged peripheral edge extending above and below the web, and said web has air- and water-permeable holes that extend therethrough.

6. The system of claim 1 wherein the disk has a central web, a flanged peripheral edge extending above and below the web, said web has a central opening extending therethrough that permits the escape of water from below to above the web, and said web has air- and water-permeable holes that extend therethrough adjacent the flange to provide for run-off of water.

7. The system of claim 1 wherein the diameter of the disk is about ⅝ inch less than the diameter of the pressure tank.

8. The system of claim 1 wherein the thickness of the disk at its peripheral edge is at least about 1 inch.

9. The system of claim 1 wherein the diameter of the disk is not more than about ⅝ inch less than the diameter of the pressure tank and the thickness of the disk at its peripheral edge is at least about 1 inch.

10. The system of claim 1 and including means to

permit the escape of liquid from below the disk to above the disk when the disk approaches the top of the tank.

11. An air- separating water float for use in a hydro-pneumatic tank of a water supply system that includes pressure regulating means in operative association with said tank, said float comprising a cellular free-floating disk of air- and water-impervious, substantially rigid material having a density less than water, said disk having a central web and a flanged peripheral edge extending below the web, said peripheral flange cooperating with the side walls of a water-containing hydro-pneumatic tank to provide a narrow extended, substantially annular, air-saturated column of water that serves as an air barrier and to provide a turbulence deflector, said web defining a lower face that floats in water while exposing an upper face substantially above the water during usage so as to be normally dry, said material having air- and water-impervious cells proportioned and shaped to provide rigidity and prevent the float from being compressed or waterlogged and submerging its upper face during usual pressure changes in the hydro-pneumatic tank.

12. The float of claim 11 wherein said peripheral edge extends above and below the web, and said web has air- and water-permeable holes that extend therethrough.

13. The float of claim 11 wherein the disk material is a synthetic plastic having closed discrete cells.

14. An air-separating water float for use in a hydro-pneumatic tank of a water supply system that includes air volume control means and pressure regulating means in operative association with said tank, said float comprising a cellular free-floating disk of air- and water-impervious, substantially rigid, polystyrene material having closed discrete cells and a density less than water, said disk being symmetrical about a horizontal plane and having a central web and a flanged peripheral edge extending above and below the web, said peripheral flange cooperating with the side wall of a water-containing hydro-pneumatic tank to provide a narrow, extended, substantially annular, air-saturated column of water that serves as an air barrier and to provide a turbulence deflector, said web defining a lower face that floats in water while exposing an upper face above the water during usage, said web having a plurality of spaced transverse air- and water-permeable holes that extend therethrough adjacent the flange, said material having air- and water-impervious cells proportioned and shaped to provide rigidity and prevent the float from being compressed or waterlogged and submerging its upper face during usual pressure and air volume changes in the hydro-pneumatic tank.

15. A hydro-pneumatic tank assembly adapted for use in a water supply system that includes pressure regulating means in operative association with said tank, said assembly comprising a hydro-pneumatic tank having side walls, a top and bottom, inlet and outlet means at the lower portion thereof of relatively small size as compared to the cross-sectional area of the tank, said inlet and outlet means being constantly open and valveless and providing free egress of water and gas from the tank when the water level in the tank is lowered to communication with said inlet and outlet means, and pressure-responsive means operatively associated with said tank that is responsive to predetermined pressure variations in said assembly, said tank having a water-air separation float therein in the form of a free-floating disk having a peripheral edge substantially conforming to the cross-sectional shape of the tank but being slightly smaller in size and cooperating with said side walls of the tank to obviate the ready ingress of air from above the float to beneath the float, said hydro-pneumatic tank assembly including means for coaction between said disk and said tank at the upper portion of said tank to prevent the disk from being permanently deformed at the top of the tank by upward movement of the water level in the tank, said float being buoyant in water and comprising a free-floating disk of air- and water-impervious, non-liquid material, said disk having a lower face that floats in water while exposing an upper face above the water level in the tank during continued usage, said air- and water-impervious float material preventing the float from being waterlogged and submerging its upper face below the level of the water in the tank during the usual pressure changes in the hydro-pneumatic tank over an extended period of operation.

16. The assembly of claim 15 wherein the upper and lower faces of the disk are defined by a central web, and a flanged peripheral edge extends below the web to provide an extended, substantially annular column of water outwardly thereof.

17. The assembly of claim 15 wherein the upper and lower faces of the disk are defined by a central web, a flanged peripheral edge extends above and below the web, said flange provides a turbulence deflector and an extended, substantially annular column of water outwardly thereof, said web has air- and water-permeable passages that extend therethrough adjacent said flanged edge, said passages comprising a depression on at least one face of the disk and extending to the periphery of an aperture of reduced width, said aperture being defined by walls having different axial lengths, and said disk material has closed discrete cells.

18. The assembly of claim 15 wherein the disk material is a synthetic plastic material having closed, discrete cells.

19. The assembly of claim 15 wherein the diameter of the disk is not more than about 5/8 inch less than the diameter of the circular side walls of the tank.

20. An air-separating water float for use in a hydro-pneumatic tank of a water supply system that includes pressure regulating means in operative association with said tank, said float comprising a cellular, free-floating disk of air- and water-impervious, substantially rigid, synthetic material having a density less than water, said disk having upper and lower faces defined by a central web, a flanged peripheral edge extending above and below the web, said flange providing a turbulence deflector and an extended, substantially annular column of water outwardly thereof, said web having air- and water-permeable passages that extend therethrough adjacent said flanged edge, said passages comprising a depression on at least one face of the disk and extending to the periphery of an aperture of reduced width, said aperture being defined by walls having different axial lengths, said material having air- and water-impervious, closed discrete cells proportioned and spaced to provide rigidity and prevent the float from being compressed or waterlogged and submerging its upper face during the usual pressure changes in the hydro-pneumatic tank.

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Disclaimer

3,030,891.—*Stephen M. Taylor*, Minneapolis, Minn. LIQUID SUPPLY PUMPING SYSTEM. Patent dated Apr. 24, 1962. Disclaimer filed Mar. 22, 1976, by the assignees, *Stephen M. Taylor* and *Walter S. Carpenter*.

Hereby enter this disclaimer to claims 1, 2, 3, 7, 8, 9, 10, 15, 18 and 19 of said patent.

[*Official Gazette May 4, 1976.*]