73-290 CROSS REFERENCE SEARCH ROOM

June 29, 1965 S. M. TAYLOR 3,191,536

FLOAT AND HYDRO-PNEUMATIC TANK INCLUDING SAME

Filed April 18, 1962 3 Sheets-Sheet 1

Fig. 1.

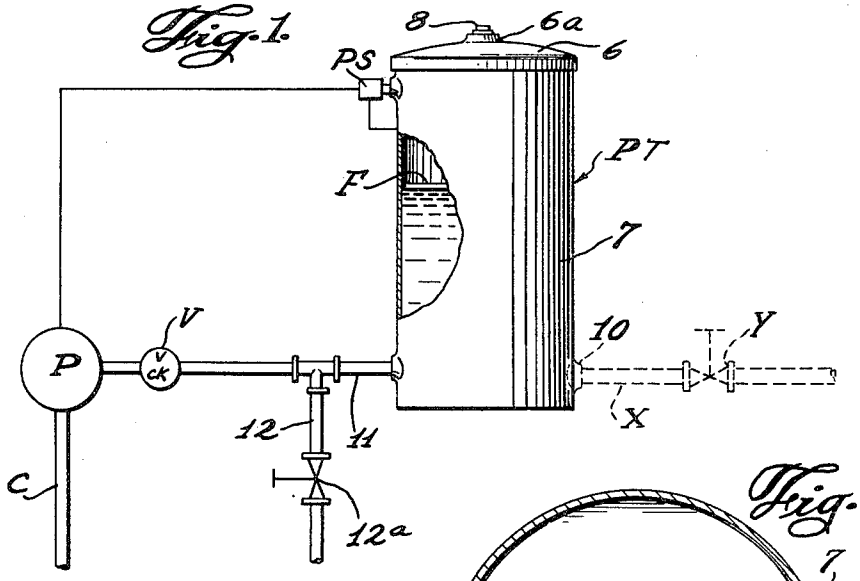


Fig. 3.

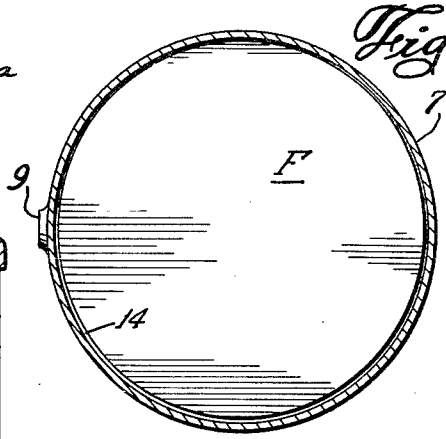
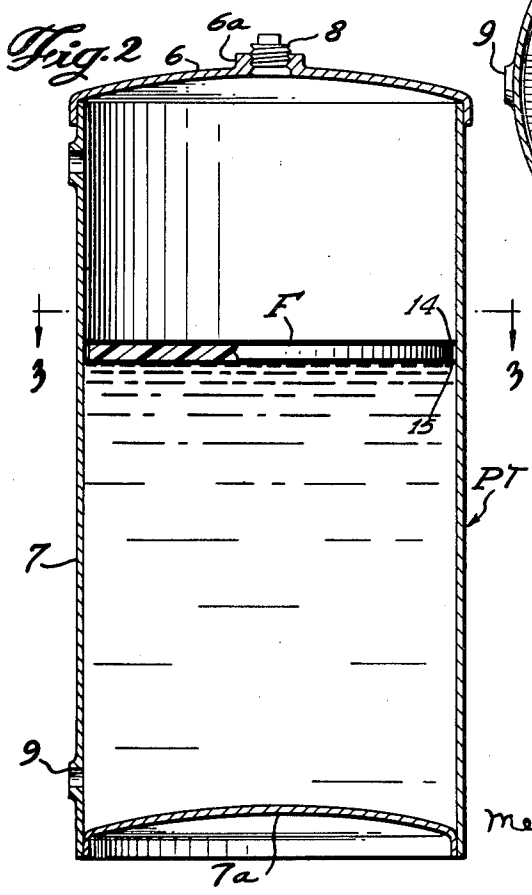


Fig. 2



INVENTOR.
Stephen M. Taylor
BY
Merriam, Smith & Marshall
ATTORNEYS

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Fig. 4

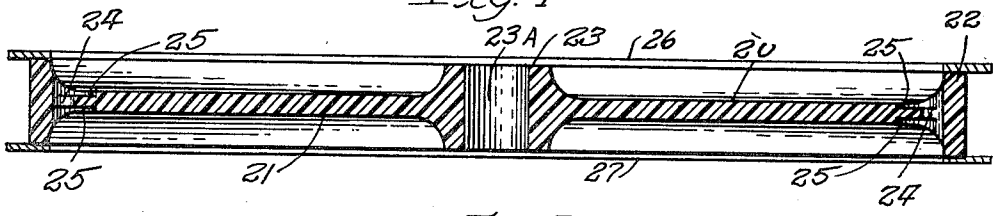
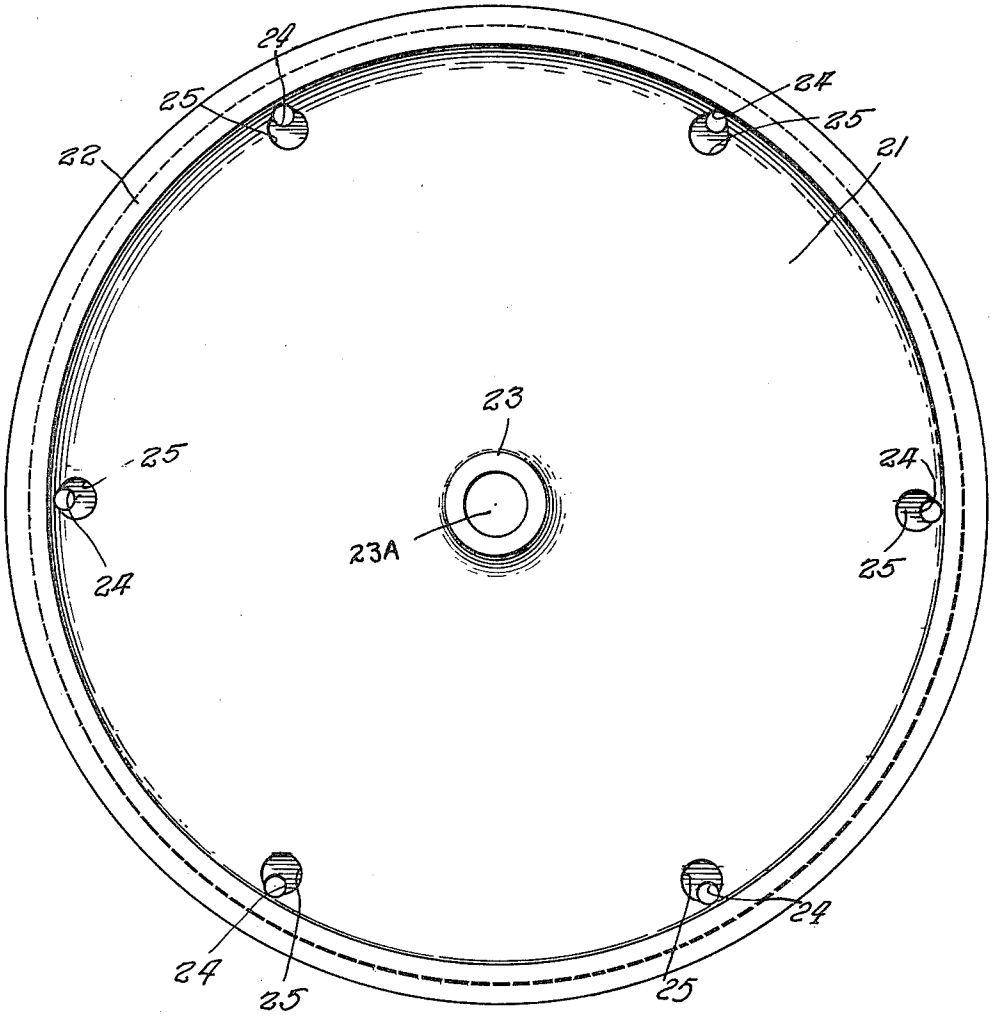


Fig. 5



Inventor:
Stephen M. Taylor,
By Merriam, Smith & Marshall
Attys.

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FLOAT AND HYDRO-PNEUMATIC TANK INCLUDING SAME

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Fig. 6

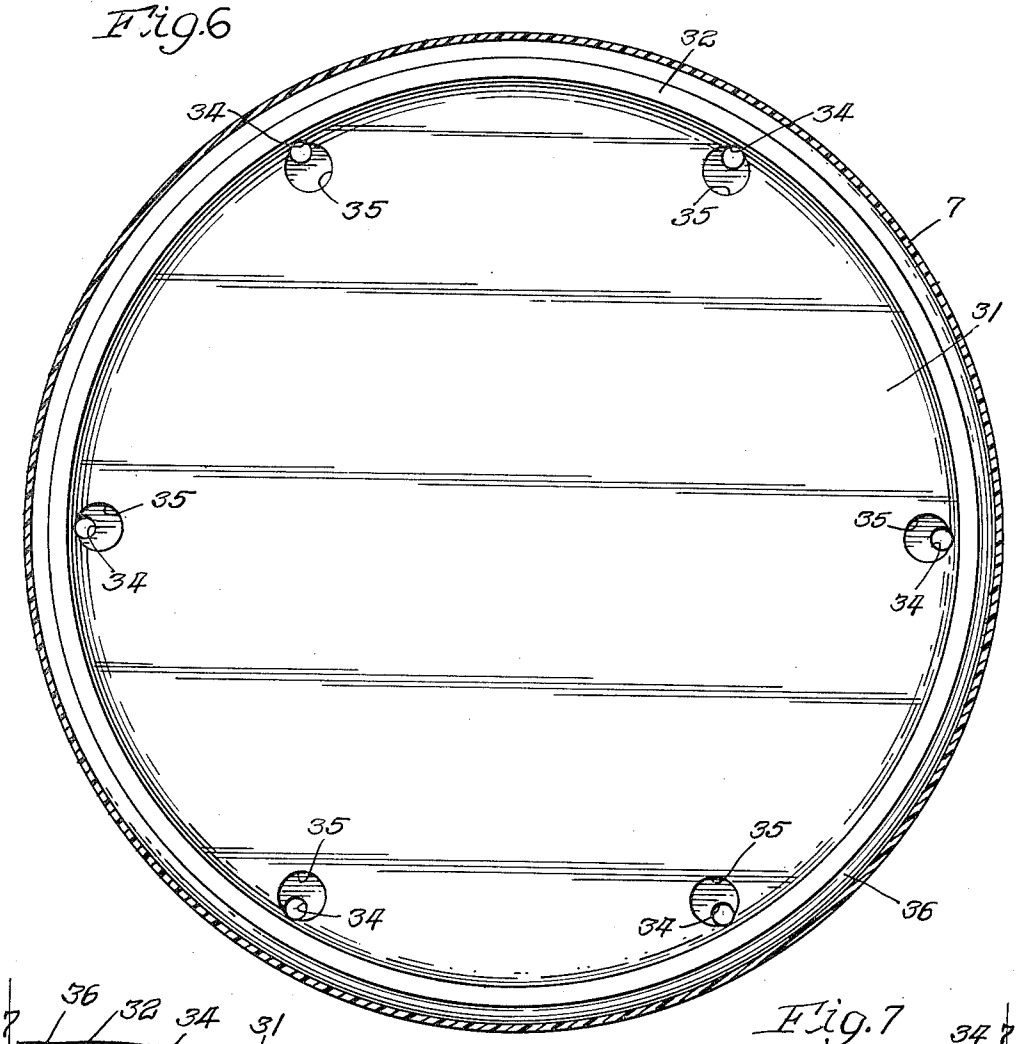


Fig. 7

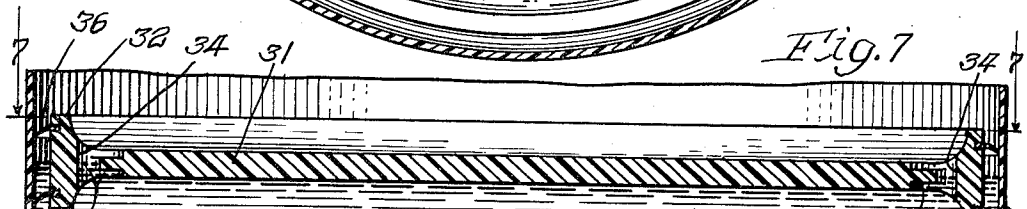


Fig. 8.

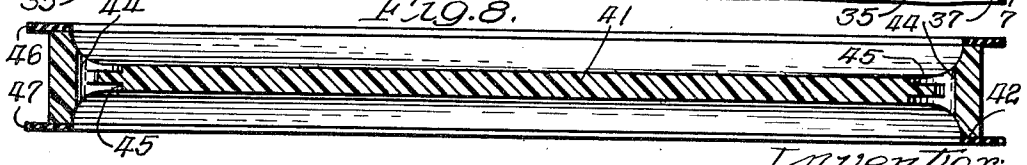
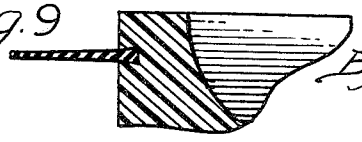


Fig. 9



Inventor:
Stephen M. Taylor,
By Merriam, Smith & Marshall,
Attys.

United States Patent Office 3,191,536 Patented June 29, 1965

3,191,536

FLOAT AND HYDRO-PNEUMATIC TANK INCLUDING SAME

Stephen M. Taylor, Minneapolis, Minn., assignor to Metal Coating Corporation, Chicago, Ill., a corporation of Delaware

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12 Claims. (Cl. 103—25)

This application is a continuation-in-part of my copending allowed application Ser. No. 58,597, filed September 22, 1960, now Patent No. 3,030,891, issued April 24, 1962 which was filed as a division of my copending application Ser. No. 862,103, filed December 28, 1959, now abandoned, which, in turn, was a continuation-in-part of my copending application Ser. No. 606,132, filed August 24, 1956, now abandoned.

This invention relates to an improved liquid-gas separating float for use in a domestic water supply tank, a hydro-pneumatic tank assembly having such a float and a liquid supply pumping system which includes said hydro-pneumatic tank assembly.

In the normal operation of a domestic water supply system in which water is pumped into a hydro-pneumatic tank, an air head is maintained in the top of the tank against which the water is pumped until a predetermined pressure has been reached. As the air in the tank expands in response to the opening of a water outlet (e.g., faucet) in the system, water is forced from the hydro-pneumatic tank and the pressure in the system correspondingly decreases. Pressure-responsive means is used to actuate the pump to on-off conditions in response to predetermined pressure variations in the tank. For example, the pump may be actuated at a predetermined minimum pressure, such as 20 p.s.i.g., and water pumped into the hydro-pneumatic tank until a predetermined maximum pressure, such as 40 p.s.i.g., is reached.

The air in the hydro-pneumatic tank will be absorbed by the water with which it comes in contact in the pressure tank, and normally must be replenished at frequent intervals either by shutting down the system and draining the tank or by providing auxiliary air-charging equipment.

I solved satisfactorily this long existing problem without the need of frequently shutting down the system and draining the tank or providing auxiliary air-charging equipment.

In the accompanying diagrammatical drawings:

FIGURE 1 illustrates a liquid supply pumping system that includes a hydro-pneumatic tank assembly having a float;

FIGURE 2 is a partial sectional view of a hydro-pneumatic tank having a float;

FIGURE 3 is a sectional plan view along the line **3—3** of FIGURE 2;

FIGURE 4 is a sectional elevational view of an improved float having a peripheral flange;

FIGURE 5 is a plan view of the improved float shown in FIGURE 4;

FIGURE 6 is a sectional plan view along the line **6—6** of FIGURE 7 showing another improved float in a hydro-pneumatic tank wherein the float has two flexible sealing wipers for contacting and wiping the wall of the hydro-pneumatic tank;

FIGURE 7 is a sectional elevational view of the float and tank shown in FIGURE 6;

FIGURE 8 is a sectional elevational view of still another improved float having two flexible sealing wipers for contacting and wiping the wall of a hydro-pneumatic tank; and

FIGURE 9 is an enlarged, fragmentary, sectional elevational view of an upper peripheral portion of the improved float shown in FIGURES 6 and 7.

Referring now to the liquid supply pumping system diagrammatically illustrated in FIGS. 1–3, a vertical hydro-pneumatic tank PT having sheet metal steel walls of cylindrical form is shown, having a dished top or header **6** which usually telescopes concave inwardly over the upper end of the usually rolled tank body **7** and is welded in close relation therewith. A dished bottom **7A** encloses the bottom of body **7**. A reinforced or bossed central portion **6***a* may be provided in the top header tapped to receive, in sealed relation, a suitable removable plug **8**. Tanks such as PT are conventionally used and are usually provided with inlet and/or outlet passage or opening **9** and outlet passage or opening **10** (shown in dotted or broken lines). Passage or opening **9** is usually connected with the supply pipe **11** from the pump P. In most presently used conventional systems, the discharge of water is taken from pressure tank PT through a fitting or 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, which is shown interposed in the supply line from the pump to the tank, prevents the backward flow of water or liquid into the pump when the pump is inoperative. This valve may be included in the pump assembly.

A pressure limit switch is included in the system. A pressure-responsive element of conventional structure is located within the upper interior portion of the tank and controls the operation of the pump, shutting it off 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. The upper pressure level in most conventional systems is within a range of between 40 p.s.i.g. 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 forces the water from the tank for use as desired in the system. As the air expands, the pressure is lowered and upon reaching a predetermined point, the pressure limit switch PS, through electrical circuit, causes the pump to again start. The predetermined lower pressure level is usually within a range of from 20 p.s.i.g. 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 by-pass eliminates the need for the outlet opening **10**.

It has been found expedient in using the 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 p.s.i super-atmospheric, that is, five to fifteen p.s.i.g., before introducing any water. The effect of this is to provide a greater air cushion for expansion, since it can be mathematically demonstrated that the more air there is in the hydro-pneumatic tank, the more water it will displace on any given pump cycle. In other words, if the pressure limits are twenty and forty p.s.i.g., there will be twice as much volumetric change between these limits where there is twice as much air in the tank. Fur-

thermore, the pre-charging lengthens the time required for absorption, which will take place very slowly even in my system.

As previously stated, an air-separating free-floating float, indicated as F, is freely disposed within the tank. The float F has a configuration similar to the cross-sectional configuration of the tank.

There should be some clearance between the periphery of the disk F and the inside surface of the side wall of the tank. 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 to allow for irregularities in the construction of the tank. These irregularities may occur from the bowing of the side sheets during welding of the tank, internal weld splatter, irregularity of the internal galvanized tank surface, and the build-up of foreign materials (e.g., iron oxides, sulphur, maganese, and carbonates of calcium and magnesium) from the water upon the inner side wall of the tank. The annular space between the periphery of the tank PT and the inner surface of the sidewall **7** is further sealed by a sealing wiper **14** and **15** which laterally extends from the periphery of the disk F in order to further enhance the effectiveness of the float F as will hereinafter be more fully discussed.

I have found that when the liquid-gas separation float substantially conforms to the cross-sectional shape of the hydro-pneumatic tank but is slightly smaller in size, an annular column of water is formed between the periphery of the float which, when sufficiently narrow, tends to obviate the ready ingress of air to beneath the float.

Further, I have found that by providing a sufficiently narrow annulus between the peripheral edge of the float and the side walls of the tank and sufficiently extending the depth or height of this water annulus, the small annulus about the float tends to become saturated with air and serves as a barrier that inhibits the further infiltration or absorption of air to the barrier itself and to the water beneath the float. If this air-saturated barrier is disrupted by water being introduced into the tank, a new air-saturated annulus must be formed which, of course, removes additional air from above the float.

Still further, I discovered that by providing the liquid-gas separation float with a peripheral flange that extends below the lower face of the disk, I could increase the depth of the water annulus and thereby prevent air from being absorbed below the float and provide an effective annular barrier. Although one might also increase the depth of this air-saturated annular barrier by providing a flat disk of increased thickness and proper density, the water annulus tends to become disrupted when water is introduced into the tank and an additional loss of air occurs. This disturbance is obviated by providing the float with a peripheral flange that serves as a turbulence deflector for incoming water, as well as its other function of providing an extended annular, air-saturated water barrier.

When my flanged disk is symmetrical about its horizontal axis and the flange extends above the upper face as well as below its lower face, a portion of the flange projects below the lower face even if the disk turns over inside the tank, which sometimes occurs in shipment.

The flanged disk should, preferably have air- and water-permeable holes that extend therethrough adjacent its peripheral edge. These openings permit water that may accumulate on top of the disk to run off the disk. They also permit air that may collect beneath the disk (for example, air is often introduced with water from gaseous wells) to escape to the air space above the disk.

The tank and/or float should have means that permit the escape of water from below to above the disk, thereby preventing the disk from being permanently crushed at the top of the tank. In the event there is a leak in the tank which permits air to escape and the water level to rise, the disk could be urged upwardly and permanently

crushed at the top of the tank unless means were provided for permitting the water to pass through or by the disk.

The tank may include means, such as a pivoting pin, at the top of the tank that will tip the float and prevent it from being permanently deformed when the water level rises to the top of the tank. On the other hand, the float itself may include means such as an escape opening or flexing means that permit water to escape from below to above the float when the float is at the top of the tank.

Still further, I have discovered that when my float includes flexible sealing wiper means that wipe the side wall of the tank entirely around the float, one can prevent or further inhibit the loss of the water annulus between the float and tank and decrease the exposure of the water in the tank to the air, thereby providing added means for preventing the loss of the air head.

Referring to the drawings and more particularly to the flanged disk shown in FIGURES 5 and 6, the flanged float shown therein 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**. The openings **24** are actually partially within the flange **22** as shown particularly in FIGURE 6. The openings **24** are provided with upper and lower circular depressed areas **25** which are shallow at the inside and deeper at the outside.

The central flange relief opening **23A** may have a diameter of approximately $1\frac{3}{16}$-inch, the web may be about ¼-inch thick, and the flanges **23** are the same height as the outer flange **22** which, for the usual domestic water tank, may be 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 areas **25** are 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 openings **23A** is to prevent crushing of the disk in the event that there is a leak in the upper portion of the tank, 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 without the central opening 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. 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 $15\frac{3}{8}$ inches of a 16-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. In order to further reduce air absorption in the water the float is fitted with flexible sealing wipers **26** and **27** which extend laterally from the periphery of the float as hereinbefore disclosed. These wipers decrease the exposure of the water in the tank to air and further prevent loss of the air head. The flexible sealing wipers **26** and **27** contact and wipe the internal sidewall of the hydro-pneumatic tank entirely around the float yet are sufficiently flexible that they do not interfere with the normal upward and downward movement of the float during normal service conditions.

In connection with the flange **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.

The disk shown in FIGURES 5 and 6 is constructed of substantially rigid material having a density less than water (e.g., 10 lbs./ft.^{3}) and air- and water-impervious cells that are proportioned and shaped to prevent the float from being compressed or water-logged and submerging its upper face during usual pressure changes in the hydro-pneumatic tank. Thus, the lower face of the disk floats in water while exposing an upper face substantially above the water during usage so that the upper face remains normally dry. I have found that materials having closed discrete cells, such as expanded polystyrene (e.g., specific gravity below 0.25) have these properties. The term "closed discrete cells" herein refers to cells, with or without common walls, that are separated or maintained distinct from each other by some wall structure so as not to provide a path for air or water through or between the cells.

FIGURES 7, 8 and 10 are directed to an improved float having flexible sealing wipers that contact and wipe the internal side wall of the hydro-pneumatic tank entirely around the float. FIGURE 9 shows a still different float with flexible sealing wipers that coact with the tank in the same manner.

The float shown in FIGURES 7, 8 and 10 has a disk with a web portion **31**, a peripheral flange **32**, air- and water-permeable openings **34** adjacent the flange having upper and lower depressed areas **35**. The peripheral flange **32** has upper and lower peripheral grooves that accommodate resilient, annular, snap-on sealing wipers **36** and **37**, respectively. The wipers may be made of rubber, synthetic elastomers, or the like.

Since the diameter of the inner thickened portion of the wipers is somewhat smaller than the diameter of the innermost deepest portion of the grooves, the wipers must be stretched and permitted to snap into the grooves. Each wiper **36** and **37** may be fitted to the flange by pushing or inserting an inner thickened edge portion of the wiper into the groove, stretching the remaining portion of the wiper around the flange, and inserting the stretched portion into the groove entirely around the flange.

FIGURE 10 shows a portion of the peripheral flange **32**, a portion of the upper sealing wiper **36** with its thickened portion seated in the peripheral groove **38**, and a sealing or wiping portion **39** of the wiper **36** extending outwardly beyond the flange.

The float shown in FIGURE 9 has a disk with a web portion **41**, a peripheral flange **42**, air- and water-permeable openings **44** adjacent the flange having upper and lower depressed areas **45**, and annular rings **46** and **47** of flexible material such as rubber bonded to the upper and lower portions, respectively, of the peripheral flange **42** by means of an adhesive. Adhesives such as "R–575–T," a product of B. F. Goodrich Industrial Product Company, may be used. This particular adhesive may be applied with a brush and contains about 40% solids comprising reclaimed rubber and about 60% unleaded gasoline as a solvent. The peripheral portions of the rubber rings **46** and **47** that extend outwardly beyond the peripheral flange **42** of the float serves as sealing wipers and coact with the internal wall of the hydro-pneumatic tank in the same manner as sealing wipers **36** and **37** described above.

Each of the floats having sealing wipers may be used, for example, in a hydro-pneumatic tank having a side wall with an inner diameter of 15⅞ inches; in which case, the outside diameter of the peripheral flange of the float should be about 15⅜ inches, the flexible sealing wipers should be of such width that about ⅜-inch of each wiper extends outwardly beyond the peripheral flange, and the outer peripheral edge of each sealing wiper should have a diameter that is, preferably about ⅛-inch (e.g., 31/32–31/32-inch) larger than the average inner diameter of the tank.

The wipers contact and wipe the inside surface of the side wall of the tank entirely around the float as the float is raised and lowered in response to the changes in the water level in the tank.

In each of these wiper-floats, the flange coacts with the wall of the tank and serves the same purpose as the flange **22** of the float shown in FIGURES 5 and 6.

It is important that each of the illustrated wiper-floats float at the surface of the water in the tank during the normal operation of the system. Therefore, the flexible sealing wipers should not cling to the side wall of the tank in a manner that would either prevent the float from actually floating at the surface of the water when the water level in the tank is being raised or lowered.

The sealing wipers of each of the wiper-floats serve the dual function of assisting the flange in preventing air from being absorbed by the water beneath the float and, in addition, reducing the loss of water from the air-saturated annulus when the water level in the tank changes. With respect to the latter function, the upper sealing wiper projects above the water level and prevents the loss of water from the annulus to the side wall of the tank when the water level in the tank is lowered; on the other hand, a lower sealing wiper projects below the water level and tends to keep the water in the annulus in a quiescent state.

When the water level in the tank is lowered, for example, droplets of water from the air-saturated water annulus tend to cling to the side wall of the tank. This same volume of water must be replaced in the annulus by unsaturated water from beneath the float. When the water level again rises, the droplets from the side of the tank are transferred to the water annulus which in turn displaces air-saturated water from the annulus to the water beneath the float. This transfer is eliminated to the extent that the upper wiper wipes the droplets from the side wall of the tank back into the air-saturated water annulus. The lower wiper assists the peripheral flange in maintaining the air-saturated water annulus.

Each of the floats with the flexible sealing wipers may have body portions constructed, for example, of cellular synthetic plastic material having closed discrete cells, as described above with respect to the float shown in FIGURES 5 and 6, and have flexible wiper elements made of flexible or resilient material such as rubber and the like. In addition, these floats may also have a central opening with a central flange such as opening **23A** and flange **23** shown in FIGURE 6. Still further, the flexible sealing wipers may be secured to the peripheral flange of the float shown in FIGURES 5 and 6 in the same manner as described above with respect to the floats shown in FIGURES 7, 8 and 10 and FIGURE 9.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

I claim:

1. An air-separating water float for use in a hydropneumatic tank of a water supply system that includes pressure regulating means in operative association with said tank, said float comprising a cellular free-floating float of air- and water-impervious, substantially rigid material having a density less than water, said float 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, said float having at least one flexible peripheral liquid air sealing wiper means to provide an additional turbulence deflector extending normal and adjacent to the peripheral edge of the bottom portion of said float flange.

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

3. The float of claim 1 wherein said wiper means includes a plurality of flexible wipers.

4. The float of claim 1 wherein said wiper means includes a flexible wiper that is positioned both above and below the water level in the tank.

5. An air-water separating float for use in a hydropneumatic tank of a water supply system, said float consisting essentially of a free-floating, air and water impervious imperforate disk being buoyant in water such that the lower face of said float is in direct and substantially continuous contact throughout its extent with the water in said tank during usage to prevent the entrapment of air under said float while exposing an upper face above the water level in said tank and having a periphery substantially conforming to but being slightly smaller in size than the cross-sectional configuration of said tank, said float having at least one thin substantially flat, continuous, flexible, liquid-gas sealing wiper means having a periphery substantially conforming to the sectional shape of the tank for contacting and wiping the tank surrounding said float during usage, said wiper being mounted integrally on said disk, being sufficiently flexible to avoid affecting the free-floating action of the float, and being located on the periphery of said disk and extending radially therefrom such that during usage the periphery of said wiper is in direct and substantially continuous contact with the sidewall of said tank and the bottom face of said wiper is in contact with the water in said tank.

6. A float in accordance with claim 5 in which the disk is fabricated from a rigid synthetic plastic and has a plurality of closed discrete cells.

7. A float in accordance with claim 5 in which said wiper means includes a plurality of flexible wipers.

8. A float in accordance with claim 7 in which said wiper means includes a first flexible wiper that is positioned above and a second flexible wiper that is positioned below the water level in the tank.

9. A hydropneumatic tank assembly adapted for use in a water supply system said assembly comprising a hydropneumatic tank having a tubular shell, a dished-top mounted concave inwardly on and enclosing one end of said shell and a dished-bottom mounted on and enclosing the other end of shell, inlet and outlet means disposed adjacent said bottom head, being of a relatively small size as compared with the cross-section of the tank, and being constantly open and valveless and providing free egress of air and water from said tank when the water level in the tank is lowered to communication with said inlet and outlet means, and an air-water separation float consisting essentially of a free-floating, air and water impervious disk having a cellular construction and being buoyant in water such that the lower face of said float is in direct and substantially continuous contact throughout its extent with the water in said tank during usage to prevent the entrapment of air under said float while exposing an upper face above the water level in said tank and having a periphery substantially conforming to but being slightly smaller in size than the cross-sectional configuration of said tank, said float having at least one thin substantially flat, continuous, flexible, liquid-gas sealing wiper means having a periphery substantially conforming to the sectional shape of the tank for contacting and wiping the tank surrounding said float during usage, said wiper being mounted integrally on said disk, being sufficiently flexible to avoid affecting the free-floating action of the float, and being located on the periphery of said disk and extending radially therefrom such that during usage the periphery of said wiper is in direct contact with the sidewall of said tank and the bottom face of said wiper is in contact with the water in said tank.

10. A hydropneumatic tank assembly in accordance with claim 9 in which the disk is fabricated from a rigid synthetic plastic and has a plurality of closed discrete cells.

11. A hydropneumatic tank assembly in accordance with claim 9 in which said wiper means includes a plurality of flexible wipers.

12. A hydropneumatic tank assembly in accordance with claim 9 in which said wiper means includes a first flexible wiper that is positioned above and a second flexible wiper that is positioned below the water level in the tank.

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ROBERT M. WALKER, *Primary Examiner.*

LAURENCE V. EFNER, *Examiner.*