

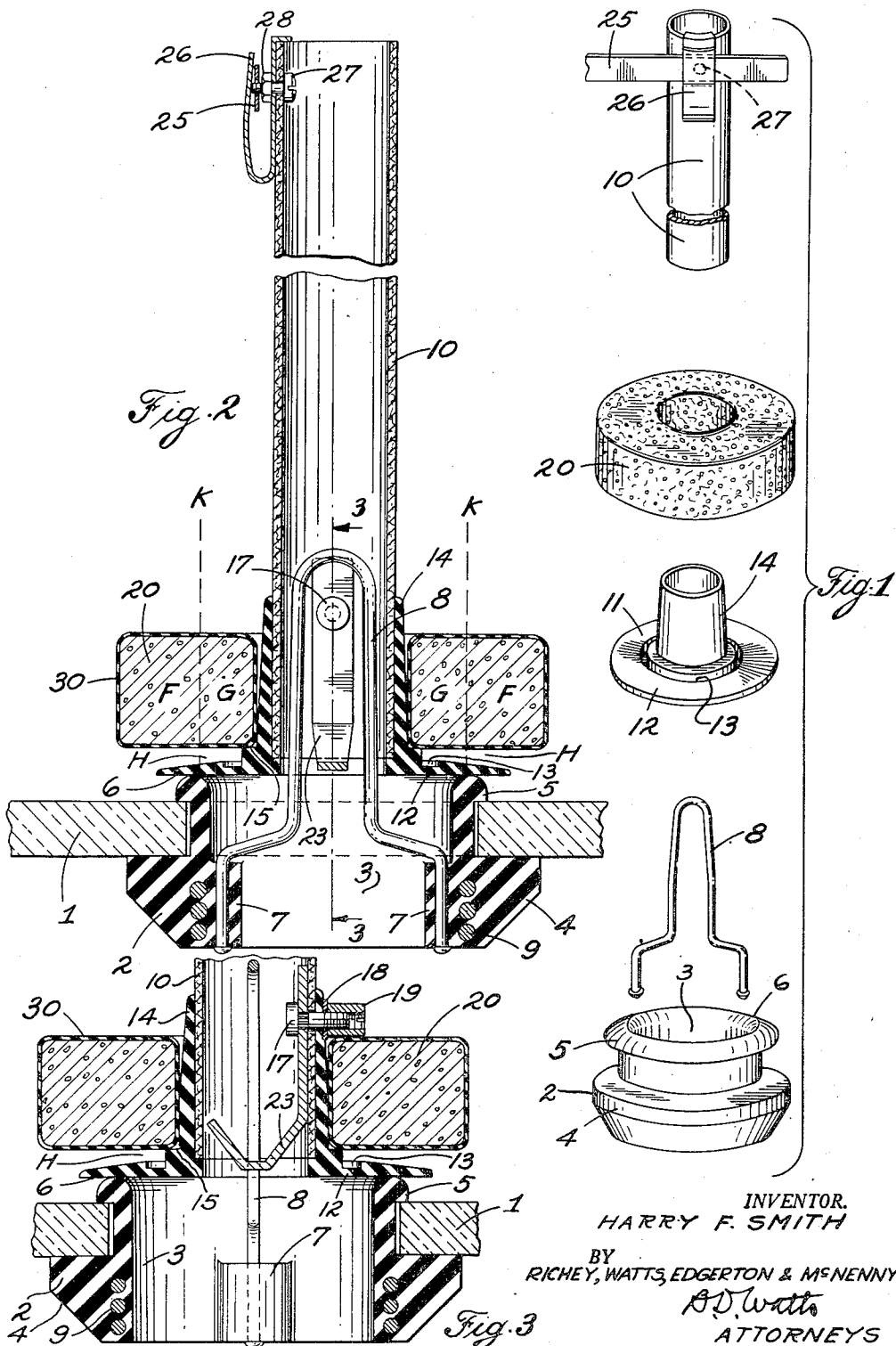
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FLUSH VALVE ASSEMBLY

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FLUSH VALVE ASSEMBLY

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This invention relates generally to flush valve assemblies of tanks for water closets and is particularly concerned with a flush valve assembly which makes possible marked economies in flush tank construction and in flush valve construction, replacement and repair.

It has long been the aim of those skilled in this art to reduce the cost of tanks for water closets and to reduce the cost of construction, maintenance, replacement and repair of flush valve assemblies for such tanks but, so far as I am aware, none of the many expedients proposed has satisfactorily attained these aims except at prohibitive cost.

Since a certain quantity of water is required for flushing the bowl of a water closet, the minimum size of the tank is fixed thereby and any reduction in the size of the tank can be expected only by decreasing the depth of the water remaining in the tank after flushing. This depth of water is determined in part by the conventional valve seat which also serves as an overflow pipe and which, for that reason, projects some distance above the inside surface of the bottom wall of the tank. This residual or excess water is a nuisance when repairs are being made for it must be removed, as by means of a sponge or the like, and the fact that it is present means that the tank must be deep enough to hold not only the amount of water required for flushing, but also this excess quantity. It has long been obvious to those skilled in the art that the cost of the tank could be reduced in proportion to the saving in tank depth which could be effected by reducing the quantity of this excess water, but, so far as I know, very little reduction in the amount of this excess water has been brought about by any of the expedients proposed for that purpose.

The present invention attains the foregoing objects by providing new and improved valve apparatus. This apparatus, briefly described, includes a valve seat which projects only a short distance above the bottom inside surface of the tank and a valve assembly comprising a stem which also serves as an overflow and refill tube, a valve which will be held in seated position by the pressure of a small amount of water in the tank and which will effectively seal the outlet even though the seat may be distorted or misshaped or the valve guide may not be accurately aligned with the seat, and a buoyant member which will cause the valve assembly to float in the water from the time when the valve is opened until the surface of the water in the tank falls to a predetermined low level. This assembly consists of a few inexpensive parts which may be assembled and disassembled by hand without the aid of tools.

The invention will be better understood by those skilled in the art from the drawings which accompany and form a part of this specification and in which:

Fig. 1 is an exploded, perspective view of a float valve apparatus embodying the present invention;

Fig. 2 is a central, vertical, cross-sectional view, taken through the apparatus of Fig. 1 in a tank with the parts in valve closed position; and

Fig. 3 is a fragmentary, sectional view taken on line 3—3 of Fig. 2.

In the figures, the bottom wall of a flush tank is fragmentarily shown at 1. This wall has an opening in which a rubber ring 2 is located. This ring has a cylindrical opening 3 therethrough and lower and upper, annular, parallel spaced ribs or flanges 4 and 5 projecting outwardly from its exterior to engage the inner and outer surfaces of the bottom wall of the tank. The upper end surface 6 of ring 2 constitutes a valve seat disposed

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just above the upper surface of the tank bottom. At diametrically opposite points the ring has inwardly projecting portions 7 provided with longitudinally extending holes through which extend the portions of a guide 8 in the form of a U-shaped wire. The ends of this wire are upset to prevent accidental removal of the wire from the ring. A coiled wire 9 is embedded in ring 2 near its lower end and serves to prevent undue distortion when clamped between the tank and a bowl therebelow.

The valve assembly comprises a stem 10, a valve 11, and a buoyant member 20. The stem which is hollow and also serves as an overflow and refill tube is preferably composed of light-weight material, for example, Bakelite. The valve 11 includes a disk-shaped, valve-seat-engaging portion 12 having a groove 13 in its top and a tubular portion 14 extending at substantially right angles thereto. The overflow pipe 10 fits snugly into the tubular portion 14 and abuts at its end against an inwardly extending flange. A shoulder 15 extends outwardly at the intersection of the disk 12 and tubular portion 14 to act as a stop for the buoyant member. The portion 12 is composed of resilient material, preferably rubber. It increases in thickness from its edge to groove 13 and is sufficiently rigid in radial directions to resist folding under by the outgoing water, is sufficiently flexible circumferentially to adapt itself to the variations in the valve seat, and is weakened, as by annular groove 13, so as to permit misalignment of the overflow pipe and the tubular part of the valve with the valve seat, without resultant leakage. It will be understood that the bottom of the tank may be warped during firing so that the top of the valve seat may not be perpendicular to the vertical axis of the overflow pipe, and also that the overflow pipe does not necessarily always move with its axis in a vertical position and, hence, that the valve may first engage one part of the valve seat while out of contact with an opposite part as the valve is being closed.

The buoyant member indicated at 20 is ring or doughnut-shaped and is of substantial thickness. It has a central hole therethrough so as to be slid over the tubular portion 14 of the valve and into abutting engagement with shoulder 15. The float ring 20 may be held in assembled position on the valve by any suitable means, the means shown including a bolt 17 extending through one wall of pipe 10 and portion 14 of the valve and washer 18 and nut 19 located just above ring 20.

As indicated in Fig. 2, the guide 8 extends upwardly into pipe 10 and serves to guide the pipe in its movement toward and away from the bottom of the tank, the space between the guide and the inner surfaces of the pipe and valve being sufficient to insure absence of binding engagement between the guide and these parts. The upward movement of pipe 10 is limited by hook 23 which is secured in place in pipe 10 by bolt 17 and which has an upturned lower end to project into the U-shaped wire 8 and engage it at the predetermined top of the stroke of pipe 10. The hook is spaced far enough away from the pipe to permit wire 8 to move past it into pipe 10. Since the upward movement of pipe 10 is limited by hook 23, the stop conventionally employed at the pivot end of the flush lever may be omitted. Thus the lever may pivot freely in the tank wall.

Near its upper end pipe 10 is provided with means by which it may be connected to a flush valve lever 25. This means comprises a narrow U-shaped spring clip 26 which may be clamped against the outside of the pipe 10 as by bolt 27 and nut 28 with the bolt extending through and beyond the nut almost to the opposite portion of the clip and projecting through a hole in the lever 25. Thus the lever is loosely mounted on the bolt for free relative rotational movement and the clip prevents excessive rotation of the pipe 10 about a vertical axis and restores it to its normal position when some slight rotation occurs.

The main purpose of ring 20 is to maintain the valve out of contact with the valve seat until most of the water has run out of the tank. To that end the ring must exert a buoyant effect on the assembly. A ring suitable for this purpose should have a density of less than about ten pounds per cubic foot, should be sufficiently rigid to resist forces encountered in actual use

and tending to deform it and should be unaffected by water. Many of the materials which may be obtainable in the form of foams are suitable for use as such a ring. These foam articles are characterized by having a multiplicity of closed, non-communicating cells. Materials which have been found to be suitable for this purpose include glass, preferably with a baked enamel coating thereon, polystyrene, and polyvinyl chloride. These materials possess sufficient strength and rigidity and low weight and are water resistant. When polystyrene is used, it may be desirable to cover the ring with an impervious cover, such as a coating of water-resistant paint as indicated at 30 in Fig. 2. The sole purpose for using this paint coating is to decorate or color the polystyrene so that stains which the white polystyrene would acquire in handling will not be visible.

The apparatus above described operates substantially as follows:

When there is water in the tank and the lever 25 is actuated to lift pipe 10 and thereby move disk portion 12 of the valve off seating surface 6, the assembly comprising the pipe 10, valve 11 and ring 20 rises until hook 23 engages stop 8. Due to its buoyancy, the ring causes the valve assembly to float in this position until the water level falls below the top of float ring 20. As the water level continues to fall thereafter the float and valve descend with the water until the level of the water in the tank has fallen so low that the flexible valve comes into the outflowing water and is drawn down onto the seat by that water. When the weight of the valve assembly and the buoyant effect of the ring are of the proper values, the valve once seated will remain in seated position due to pressure of water on the upper surface of part 12 beneath float ring 20. This pressure is sufficient, as the level of water rises in the tank, to insure continued sealing action despite some distortion of the seating surface 6 on flange 5 of ring 2 and some misalignment of the tube 10 with respect to that ring.

The principles involved in the above described operation and in the selection of proper values of weights and buoyant effects are readily seen from a brief consideration of a few simple facts.

Let it be assumed, solely for example, that the weight of a given valve assembly including lever 25, pipe 10, valve 11, float 20 and hook 23 is $3\frac{1}{2}$ ounces. Obviously, if this assembly is to float the buoyant effect must be somewhat greater than that weight. Since water weighs about $\frac{1}{2}$ ounce per cubic inch, a displacement of about 7 cubic inches would be required simply to offset the weight of the assembly. If a safety factor of say 1 ounce is included to insure that the assembly will float in the water, a displacement of another 2 cubic inches would be required. Assuming that the area of the opening through the valve is 1 square inch, the total displacement required would be 10 cubic inches. If it be assumed that the outside diameter of the float 20 is $2\frac{1}{2}$ inches, its area will be 5 square inches and, accordingly, it would have to be 2 inches thick to have the necessary 10 cubic inch volume. Such a float would project about $\frac{1}{4}$ inch above the level of the water and the valve would close with $2\frac{1}{2}$ to 3 inches of residual water remaining in the tank.

Since the depth of water remaining in the tank after the valve is closed will vary with the thickness of the float, it is obvious that the float should be larger in diameter and less in thickness than stated in the above illustration.

When the valve is fully closed it is quite obvious that the only lifting effect of the float is that due to the portion marked FF on the drawing, and which lies outside the line of the valve seat.

This lifting effect must be kept below the weight of the valve assembly (in the case assumed below $3\frac{1}{2}$ ounces) or else the valve assembly would float off the seat, allowing water to escape from the tank, which would never fill. Since this lift would occur with a displacement of 7 cubic inches, it is plain that the volume of this portion of the float ring must never exceed this figure. The limiting outside diameter of the float for the example given, if of one-inch thickness, would therefore be approximately 4 inches. Floats of greater displacement would render the valve inoperative.

In practice it has been found that floats of 4 inches diameter are usable if the thickness is kept from $\frac{3}{4}$ inch

to $\frac{7}{8}$ inch. We prefer, however, to use floats of about $3\frac{3}{4}$ inch in diameter and of a thickness approximating 1 inch for valve assemblies weighing about $3\frac{1}{2}$ ounces.

The operation of the above described apparatus will be better understood by reference to Fig. 2 where broken lines KK indicate a cylinder whose circumference is the same as the circle on which the valve 11 has seating contact with surface 6; GG and FF indicate, respectively, cylindrical parts of the float 20 lying inside and outside of the cylinder KK and HH indicates the space between the lower side of float 20 and the upper side of valve 11.

When the valve is closed and the surface of the water is not above the top surface of float 20, the water will not exert enough lifting force on the valve assembly to lift the valve off its seat. At such time the force of the water exerted on the under surface of the float in spaces HH within cylinder KK tending to lift the valve assembly will be offset by an equal pressure of water on the top surface of part 12 of the valve in spaces HH within cylinder KK tending to press the valve against its seat. The pressure of the water exerted upwardly on the float and downwardly on the valve outside of cylinder KK will balance each other over equal areas and thus the net lifting effect of the water will be traceable to the pressure it applies to the narrow ring of the lower surface of the float outside of the projection of the valve disk 12. This ring should be so narrow as not to afford lifting force enough to overcome the weight of the valve assembly.

When the water level rises above the top of the float, the water will exert a downward pressure over the entire top of the float which will maintain the valve on its seat and this downward pressure will increase as the depth of the water increases. Hence, once closed the valve remains closed during refilling of the tank and until the valve is again opened by actuation of the valve lever.

When the valve is lifted off its seat by actuation of the valve lever, water immediately rushes into the space beneath the valve, filling it and exerting an upward lifting pressure over the entire area of the valve except for the central opening therein. Thus the water moves the valve assembly upwardly until the hook 23 engages stop 8. When the valve assembly moves downwardly with the water, the portion 12 of the valve comes into the out-rushing stream of water and interferes with the volume of flow of that stream. As the volume of that stream decreases, the level of the water in the space below the valve falls with progressively lessened buoyant force being exerted on the under side of the valve. Thus the fall in supporting pressure and the force of the out-rushing water move the valve onto its seat where it remains as above described until lifted by actuation of lever 25.

Having thus described the present invention so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. A flush valve for a water closet tank comprising an annular valve seat in the bottom wall of the tank, a non-metallic overflow pipe, means to attach the pipe for limited relative motion to a flush lever, a guide carried by said seat and extending up into said pipe, means attached to said pipe and engageable with said guide to limit the extent of upward movement of said pipe, a valve having a disk-shaped flexible portion of greater diameter than said seat to engage said seat and seal it against outflow of water and a tubular portion to fit around the lower end of said pipe, a float ring surrounding said pipe and spaced from said flexible portion of the valve, and means holding said float ring and valve in assembled position on said pipe, said float ring being sufficiently light in weight and buoyant to float the pipe assembly in the water, said float ring having a structure characterized by a multiplicity of separate, closed cells.

2. A flush valve for a water closet tank comprising an annular ring in a hole in the bottom wall of the tank, said ring having parallel spaced flanges projecting from its exterior to engage the inner and outer surfaces of said bottom wall about said hole, the end surface of said ring within the tank being close to the inner surface of the bottom wall of the tank and constituting a valve seat, an overflow pipe, a U-shaped guide carried by said seat and extending up into said pipe, a deformation-resisting coiled wire embedded in said annular ring outside of the tank, a flat, flexible rubber valve on the pipe at its lower

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end to engage said seat, and a buoyant float on said pipe spaced above said valve.

3. A valve seat ring for a flush valve of a water closet tank, said ring having inwardly extending projections and having parallel, spaced flanges projecting outwardly from its exterior to engage the inner and outer surfaces of the bottom wall of such a tank around a hole in said wall, the end of the ring which is to be within the tank having an end surface constituting a valve seat, and a U-shaped guide having end portions extending into said inwardly extending projections and projecting from the valve seat end of said ring.

4. A valve seat ring for a flush tank of a water closet, said ring having a surface at one end thereof constituting a valve seat, and inwardly extending projections, a U-shaped guide having end portions extending into said projections and projecting beyond the valve seat end of the ring to enter an overflow pipe, and a distortion-resisting coiled wire embedded in the ring in the end opposite said seat.

5. A flush valve assembly for a water closet tank comprising an overflow pipe-receiving tube, a flat disk extending outwardly from said tube at substantially right angles thereto, said disk being of greater diameter than the seat it is to engage and seal and having an annular weakened portion adjacent to said tube, a radially stiffened, circumferentially flexible, outer portion, an overflow pipe secured in and projecting from said tube away from said disk, a buoyant float ring around said pipe and spaced from said disk, and stop means in and secured to the overflow pipe and fixed means engageable with said stop means to limit the upward movement of said pipe.

6. A flush valve assembly for a water closet tank comprising an overflow pipe, a U-shaped spring clip having an inner portion positioned against the pipe near its upper end and having an outer portion spaced apart from the inner portion to provide a space for a flush lever between the two portions, means for securing said clip against said pipe, said means including a bolt extending through the pipe, the inner portion of the clip, into said space and nearly into contact with the outer portion of the clip, a flush lever mounted on said bolt and adjacent to said outer portion of the clip for free rotational movement, said outer portion of the clip being engageable with said lever during endwise movement of the pipe to insure substantially no movement of the upper end of the pipe laterally relative to the lever and only restrictive rotational movement of the pipe relative to the lever.

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