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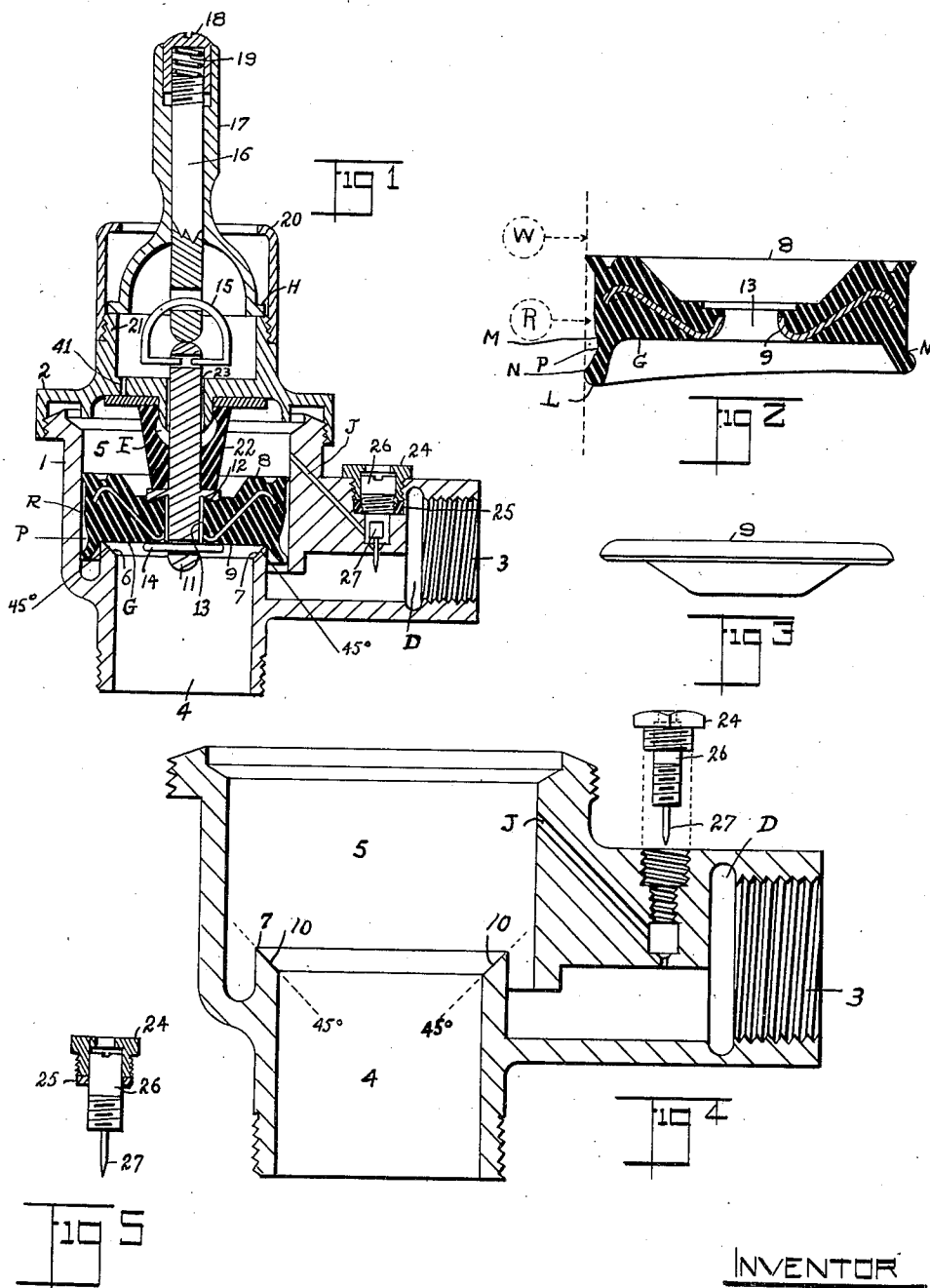
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PISTON AND FLUSH VALVE

Filed Oct. 6, 1936

2 Sheets-Sheet 1



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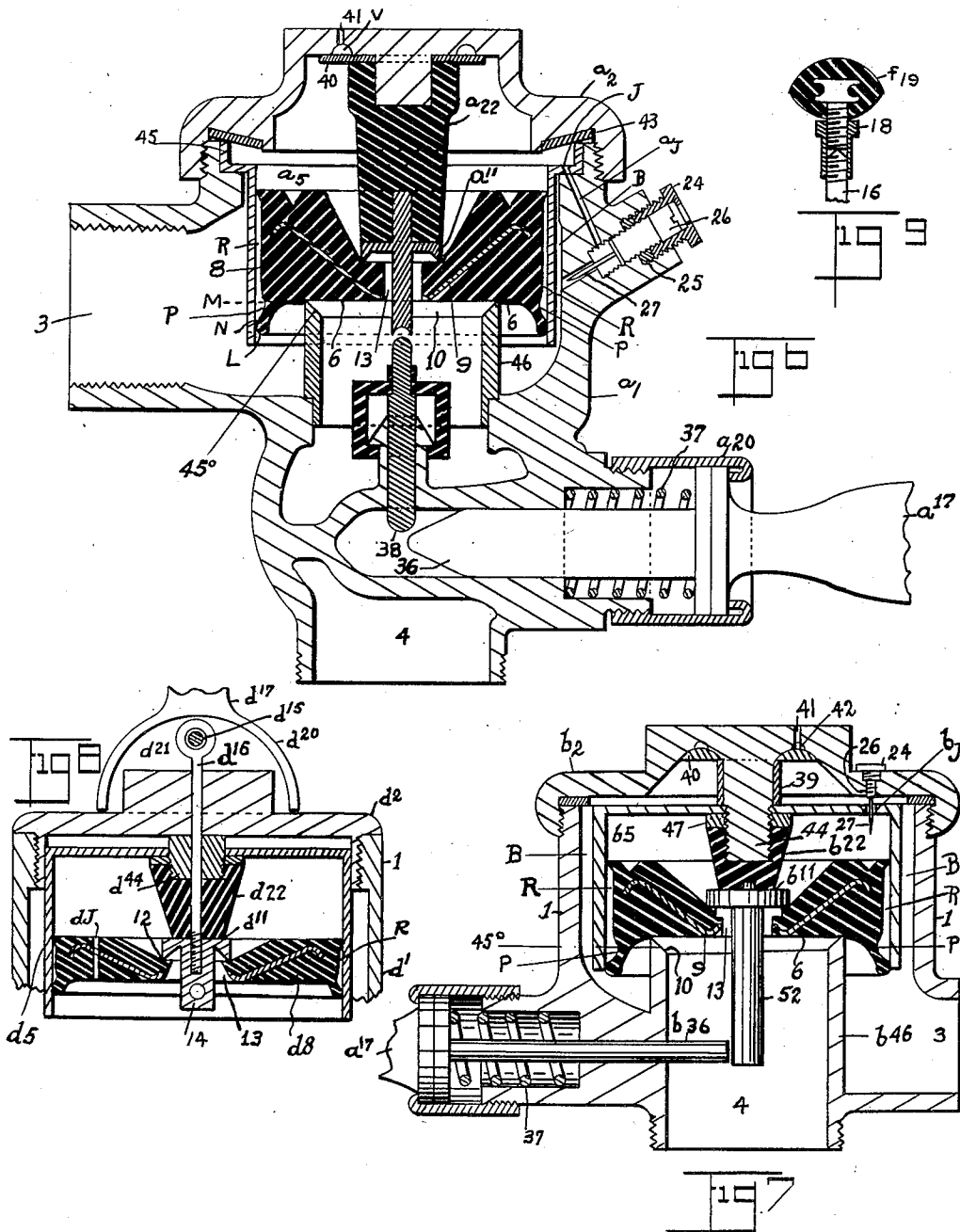
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PISTON AND FLUSH VALVE

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Application October 6, 1936, Serial No. 104,283

8 Claims. (Cl. 137-93)

This application is a continuation in part of United States application Serial No. 564,340, filed September 22, 1931, now Patent No. 2,074,698, of March 23, 1937.

In addition to the objects and purposes set forth in the above application, this application relates to the following improvements in pistons and flush valves.

The primary object of the invention is to provide improved forms of flush valves and pistons over that of the original application identified above.

A further object of the invention is to provide a piston of such form as to obviate the formation of a feather edge due to wear by providing a rounded bead or molding to form the contact edge of the piston.

A still further object in my invention is to provide a relatively indeformable piston core of such contour that pressure acting on the seating face of the piston body in a given direction will urge a portion of the body in a direction radially inward of the outer wall of said piston.

Another object of the invention is to construct a piston of deformable material and of such contour that pressure acting on the piston body in a given direction will urge a portion of that body in a direction opposite to said given direction.

Another object of the invention is to minimize the tendency of the piston contact area to vulcanize or stick to the adjacent surface of a cylinder by providing a rounded bead and means to roll said bead against the surface of a cylinder into which the piston may be inserted.

A still further object of the invention is to provide a valve of the class described with a cylinder and outlet seat having perfect concentric alignment to assure even opening and prevent tipping of a valve member in the valve when subjected to opening or closing pressure.

A still further object of my invention is to provide a valve of the class described having in unitary assembly a valve cap, cylinder, pressure chamber and by-pass leading thereto so that all the active mechanical parts of the valve may be removed with the valve cap.

Another object in my invention is to prevent back siphonage of the contents of a toilet bowl into the water supply line by providing a pressure equalizing inlet in the valve cap of such construction as to assure proper closing and opening of the inlet.

Other and further objects of the invention will appear as the descriptive matter proceeds and new results are shown, as illustrated by the draw-

ings, which are for the purpose of illustration only, it being understood that the forms used to illustrate reduction to practice may be changed within the scope of the claims.

Of the drawings:

Fig. 1 is a vertical section of the valve showing the extra clearance provided by the improved form of piston.

Fig. 2 is an enlarged vertical section of the improved piston showing on a much exaggerated scale one side distorted against the cylinder wall represented by dotted lines.

Fig. 3 is an edge view or elevation of the improved form of metal insert used in the piston as of Fig. 2.

Fig. 4 is a vertical section of a valve casing showing in detail the construction of the by-pass assembly in suspended alignment with the by-pass receiving recess disposed into the top side of the valve inlet portion of the casing.

Fig. 5 is a sectional detail showing the by-pass adjusting pin, packing and packing nut.

Fig. 6 is a vertical section of the improved form of valve having a side handle and embodying the other features similar to that of Fig. 1.

Fig. 7 is an alternative form showing the entire assembly attached to the valve cap.

Fig. 8 is a fragmentary portion of an alternative form of the valve and casing showing another modification with the handle disposed vertically from the cap as of Fig. 1.

Fig. 9 is the handle knob assembly in cross section together with a fragmentary portion of the handle stem.

Letter characters before corresponding numbers of the different figures indicate modified forms of the identical parts of each figure.

The valve as of Fig. 1 comprises the body 1 surmounted by a cap 2, the body 1 forming a casing having an inlet port 3 and an outlet port 4, a cylinder 5 disposed between the inlet port 3 and outlet port 4, a valve seat 6 having a sharp apex disposed next to the pressure side forming the outer wall of valve sleeve 46 upon which rests a rubber valve seating face G of the piston 8 which has molded therein a metal insert 9 formed with a convexity toward the center merging into a concavity inside of its peripheral edge and facing the outlet side of the piston 8. The insert 9 constitutes a core of relatively indeformable material whereby the deformable rubber-like material of the piston 8 is urged away from the wall of the cylinder 5 when subjected to the pressure of liquid passing across the valve seat 6, the entire piston 8 being made of deform-

able material molded about the relatively indeformable core 9. The face 10 tapers away from the sharp valve seat 6 and is preferably disposed at an angle of 45° forming a contour whereby water flowing toward the outlet 4 is suddenly relieved away from the seating surface G and the restriction exerted between the sharp apex 7 of seat 6 and the seating surface G, thus minimizing the noise as compared to that caused by the friction which occurs between two relatively flat surfaces. The face 10 also directs the flow of water below the end of the lower stem of the relief valve 11. The angular face 10 is particularly necessary to prevent the tipping open of the alternative relief valves *b11* or *d11* Figs. 7 and 8, which would occur in case of liquid passing across a flat valve seat. Each form of relief valve is provided with an apex similar to 7 which imbeds into the material of the piston and makes a tight, drip-proof seal against leakage at all times when the valve is closed. An angular face such as that at 10 also acts to limit the imbedment of a sharp edged seat into the material of the piston.

The relief valve 11 is disposed across the valve seat 12 and relief valve port 13 of the piston 8. A pressure chamber is formed in the cylinder 5 above the piston 8 and below the cap 2. The pressure chamber is sealed by the relief valve 11 which has a lower stem extending through the port 13 and is provided with a lift pin 14 disposed transversely through said lower stem. The relief valve 11 as of Fig. 1 and Fig. 8 has a stem extending upwardly through the cap 2 and is coupled to the handle by stem 16 and link 15 to form an universal joint between the relief valve 11 and the handle 17. An adjusting nut 18 is provided with tension means 19 between the nut 18 and the end of the handle stem 16 as of Figs. 1 and 10, to provide locking means. The alternative detail, Fig. 10 will maintain the described assembly in any desired position of adjustment.

The improved form of handle adjustment assembly as shown in Fig. 10 includes an insert molded into the material, preferably rubber, comprising the ball-shaped portion *f19*. The insert forms a set screw to impinge the end of handle stem 16 in place of spring 19 within the adjusting nut 18 which is designed to be held stationary while the portion 19 is turned to lock the end of the insert and handle stem 16 together. This adjustment governs the amount of lost motion between the relief valve 11 and the handle 17. A handle cowl 20 is threadedly disposed around the handle 17 and rests on the extension 21 of the cap 2 to limit the lateral movement of handle 17 and hold the same in position. A rubber compression sleeve 22 is disposed between the relief valve 11 and valve cap 2 and within the pressure chamber of cylinder 5. The sleeve 22 is made of deformable material and has a clearance space E formed inside to prevent the material being forced between the stem of relief valve 11 and guide 23 of Fig. 1.

The bypass assembly disclosed by Figs. 1, 4 and 5 consists of a packing nut 24, packing 25 and adjusting plug 26 and needle valve 27 formed separately or integrally with plug 26. The packing nut 24 is provided with an internal shoulder to prevent the plug 26 from being screwed out of the valve without first removing the nut 24. A bypass J leads from the needle valve recess in the inlet portion 3 to the pressure chamber of cylinder 5. The needle valve 27 adjusts the

amount of bypass opening by the movement of adjusting plug 26.

The operation of the various valves illustrated is substantially the same as that of Fig. 1 with the exception of the functions served by the modified form of the similar parts of the various figures. As of Fig. 1 when the handle 17 is moved in any direction laterally or pulled upwardly, the relief valve 11 is lifted from its seat on the piston 8 above port 13 relieving the pressure in the chamber above piston 8 in cylinder 5 allowing the pressure from the inlet port 3 to force the piston 8 upwardly from the seat 7 to open the outlet port 4. A further lifting of relief valve 11 is mechanically accomplished by the pin 14 which impinges piston 8, thus accomplishing a greater opening than would occur by the action of pressure alone against the end of piston 8.

When handle 17 is released the water passing through bypass J gradually fills the pressure chamber in cylinder 5 causing the piston 8 to return to closed position.

The piston illustrated by Fig. 2 shows the lip L of the piston 8 compressed against the dotted wall line W of the cylinder 5, the opposite side of the piston 8 being in normal position.

It will be noted that there is a clearance space at R between the cylinder wall and the wall of the piston 8, and an additional wider clearance space is formed at point P due to the abrupt rounded bead N being compressed inwardly and stretching the wall of the piston 8 above the bead N which is forced radially inward by the cylinder wall W to affect the form of the piston as illustrated and described.

The bead N is rounded to achieve the following new results: 1. The provision of a rounded or curved leading edge to prevent the doubling back of lip L when piston 8 is inserted into a cylinder and facilitate entry into the cylinder bore; 2. To prevent the formation of a feather edge ordinarily formed by the effect of pressure, friction and wear at the extremity of a flared piston, and prevent sticking of the piston due to the adhesion of the thin feather edge thus formed against the cylinder wall; 3. To minimize the contact area over that of an angular flare by the use of a beaded leading extremity formed around the edge of the piston; 4. To stiffen the extremity of the piston and form a maximum more abrupt clearance space at P; 5. To increase the elongation of the piston and the movement of the extremity of the lip L due to the internal outward radial pressure against the area coinciding between the points N and M forcing the lip of the piston radially outward; 6. Permitting the extremity of the lip L to roll away from the piston wall W when pressure is exerted between N and M.

Years of use have proved that any piston having a sharp leading edge capable of wearing to lie flatly against the contour of a cylinder wall will cause a sort of capillary adhesion between the thin wall formed at the leading edge of the piston and the cylinder wall. Thus a rounded leading edge for the extremity of the piston prevents the formation of a parallel wall to lie against the cylinder and cause sticking in the manner described.

Ordinarily the space R—P between the cylinder wall W and the piston 8 is filled with liquid so that any pressure exerted radially outward between the points M and N is transferred via the medium of said liquid in the space R—P in a manner to force the body of the piston radially

inward in the opposite direction to the pressure exerted radially outward against the inside of the lip L. Thus it will be seen that during the process of equalizing pressure between the extremity of lip L and the upper lip or flare adjacent to the pressure chamber certain portions of the piston 8 are urged in diametrically opposite directions.

Due to the lesser pressure or the presence of only atmospheric pressure being exerted over the area circumscribed by valve seat 7, the tendency of the material of piston 8 is to "flow" or "pile" toward the outlet 4 when used in a valve. Any pressure built up in the area provided by clearance space R—P tends to compress the piston toward the center and reduce the diameter at that point by urging some of the material to bulge into the outlet port 4. This action is enhanced by metal insert 9 which has a forwardly disposed convexity toward the center merging into a concavity toward the periphery forming a circumferentially disposed concavity disposed toward and facing substantially parallel with the seating area G of the piston 8 as related to the internal surface of the extended lip L. Thus it will be seen that the core 9 being made of relatively hard material as compared with the body of the piston 8 serves to guide the flowing or piling of material incident to the distortion of the piston toward the outlet port 4. Even though the deformable material of the piston has made a homogeneous union with the disc 9 the material is of such a nature that it must either flow or pile upon itself in order to distort.

A notable difference between Fig. 1 of the original application above identified is that the piston as now used in the valve is illustrated as having a continuous clearance between the end beads of the piston. This construction of the piston provides more space for liquid around the piston which becomes substantially a floating valve member with the two opposite extremities surrounding the ends of the piston contacting the internal wall of the cylinder. The liquid between the piston and the cylinder wall provides more lubrication than would be provided if the space were more limited.

The modification illustrated by Fig. 6 includes substantially the same operating mechanism as of Fig. 1 except that handle a17 is substituted for handle 17 and has a flanged end contacting a corresponding flanged end of the plunger 36 held in contact by spring 37 so that when handle a17 is actuated the plunger 36 is moved to force the trip pin 38 upward to release the relief valve a11 and open the valve. Otherwise the operation of the valve is substantially the same as described as of Fig. 1.

The structure of Fig. 6 differs from Fig. 1 in that the cylinder a5 is pressed into position being held by a narrow shoulder at the top while the outlet seat sleeve 46 is pressed into a concentrically corresponding narrow bore in the outlet 4 resting on a narrow shoulder. Both the cylinder a5 and member 46 are capable of being inserted by use of a single tool, thus insuring perfect alignment between the cylinder and outlet bore because both the cylinder a5 and the member 46 rest in such shallow bores that any misalignment can be compensated for with absolute accuracy due to the narrowness of the seating surfaces and shallow respective bores.

This perfect alignment is extremely important to the operation of the valve because misalignment of the cylinder a5 and the outlet port 4

causes a greater area to be disposed against pressure exerted against the piston 8 around the valve seat 7 on one side or the other of the seat thus causing the piston 8 to tip and raise more quickly at the side where the greatest area is disposed when the valve is opened.

Ordinarily the valve body used is made of cast brass and the size and concentricity of the two bores is variable. Therefore, due to the difference in the load exerted on the relative cutting edges for the cylinder bore and the outlet bore a "shift" invariably occurs which makes two concentric bores well nigh impossible on a rapid production basis even when the cylinder and outlet are bored with a single tool. It will therefore be seen that the arrangement of the cylinder a5 and member 46 described is of advantage from the standpoint of operation and also that of manufacture and production.

The position of the bypass in Fig. 6 is particularly advantageous for the reason that the cylinder a5 is extended partly across the inlet port 3, thus breaking the flow of water through the valve causing the by-pass J to take off from relatively dead water thus permitting the use of a by-pass opening much larger than that ordinarily required for the same timing of the valve. Therefore, the by-pass is much less liable to clog or corrode shut and the timing range of the valve adjustment is greatly increased. Under the old arrangement the by-pass opening as of Fig. 1 is exposed to more pressure impact of liquid passing at high velocity through the inlet port 3.

Figs. 1, 6, 7 and 9 are provided with an air inlet 41 into the top of the valve bodies or the valve cap to permit the ingress of air to offset the effect of a vacuum exerted at the inlet side of a flush valve. The cap a2 as of Fig. 6 is provided with a groove V extending around the internal side of the valve cap. This groove provides an extra air pressure area against a washer 40 disposed tightly across the groove V and held in operative position by compression sleeve a22. When vacuum is exerted through inlet 3 atmospheric pressure enters through inlet 41, passes around groove V, forces washer 40 inwardly and equalizes the pressure on both sides of piston 8 over the entire area in the pressure chamber of the cylinder 5 and the port 4, thus converting the piston 8 into a check valve. The V groove exposing additional surface of the washer 40 to atmospheric pressure insures forcing said washer inwardly to overcome any possible vulcanization or sticking of the washer 40 to the material of the cap 2.

The alternative form of valve illustrated by Fig. 7 includes the use of the relief valve b11 which is adapted to open by plunger b36 impinging the stem 52 to tip the valve b11. The cylinder b5 is secured to the cap by nut 47 threadedly disposed on extension 44. Otherwise the valve is substantially the same as that of Figs. 1 and 6, and operates in the manner described except for the changes of structure indicated.

Fig. 8 is another alternative structure having characteristics common to Figs. 1, 6 and 7 except the top handle d17 is modified by the use of a handle stem a16 which is loosely mounted on the transverse pin d15 forming a connection allowing for universal movement. Adjustment as to the amount of lost motion between the relief valve d11 and the handle d17 is accomplished by changing the amount of play between the flange d20 and the top of the cap d2. By holding the lower

stem of the relief valve *d11* and turning the handle *d17* the distance between the relief valve *d11* and the handle *d17* is changed to any desirable extent.

I claim:

1. A flush valve comprising a casing having inlet and outlet ports, a one piece cylinder stamped of sheet metal having a closed end disposed in said casing with the open end toward the outlet port, a space for fluid provided around said cylinder within said casing, the closed end of said cylinder having an adjustable bypass disposed therethrough, a piston in said cylinder having a pressure releasing port therethrough, a relief valve disposed across said pressure releasing port, a sleeve of compressible and longitudinally deformable material subject to be elongated by pressure within a pressure chamber formed by said cylinder, said pressure tending to overcome any tipping movement of said relief valve or piston and normalize the seating alignment of said relief valve and said piston.
2. For use with a valve of the nature described, a bypass assembly comprising a needle valve, an adjusting plug, to actuate said needle valve, a packing gland around said adjusting plug, including a packing nut having a shoulder therein formed at the end of a passage through said packing nut, said shoulder adapted to impinge said adjusting plug when said adjusting plug is inserted into said packing nut.
3. A valve of the class described, including a body comprising a casing having an inlet port and an outlet port, a cylinder disposed between said inlet port and outlet port, a piston in said cylinder having narrow beaded marginal extremities disposed radially outward of the wall of said piston and providing a clearance space between the outer wall of said piston and the internal wall of said cylinder, at least one of said beaded extremities being rounded, said clearance space extending over the entire area of said piston wall between said beads and between the entire area of the piston wall and the internal cylinder wall not contacted by said beads, said piston having an active valve seating surface disposed across a sharp valve seat surrounding said outlet port and having an apex formed by an abrupt wall disposed radially outward toward the inlet port of said valve, said sharp apex adapted to imbed in the active seating face of said piston, said seat being tapered away from said active seating face toward the center, the taper forming a seating shoulder to limit the imbedment of the sharp apex into the active seating face of the valve and allow a portion of the material of said active seating face to engage the outer wall of the sharp valve seat to seal the valve against dripping of liquid when said valve is closed, said valve provided with a pressure closing chamber above said piston and a bypass between said pressure chamber and the inlet port of said valve, a relief valve disposed through a central port in said piston including means to open said relief valve and set said valve into operation.
4. The combination in a valve of the class described of a body having inlet and outlet ports, a cylinder disposed between said ports and having a pressure chamber formed at one end by a piston in the cylinder, an air inlet having a circumferential groove contiguous thereto inside the cylinder and covered by a flexible sealing washer inside said cylinder to allow the ingress of atmospheric pressure and prevent the egress

of fluid pressure from within said pressure chamber, a sharp tubular valve outlet seat projecting upward and into said cylinder and having an apex formed at the confluence of the wall of the tubular outlet and a bevel extending away from the end of the tubular outlet seat, said piston having an active seating face surrounded by a forwardly projecting peripheral lip forming a concavity for said active seating face normally resting on the sharp seat adapted to imbed in the seating face, said piston composed of resilient deformable material molded about a relatively indeformable core having a convex portion forwardly disposed toward said seating face at the center and flaring radially outward and merging into a concave portion formed inside the peripheral edge of said core and facing in the same direction as said convex portion, said piston having a narrow bead surrounding each of its marginal extremities bordering each end and contacting the inner wall of said cylinder and forming a clearance space for liquid extending over the entire area around the piston between the beads, providing means whereby the wall of said piston is surrounded by liquid in said cylinder and pressure will act to urge the deformable material of the piston toward the outlet of the valve and tend to decrease the diameter of the piston between said beads.

5. A valve of the class described comprising a body surmounted by a cap and having inlet and outlet ports, a cylinder having a narrow shoulder at one end adapted to be compressed and expanded into a shallow bore recessed in the top of said body, the balance of said cylinder clearing the internal side of said body and extending partly across the inlet port, a piston in said cylinder supported by narrow beaded marginal extremities disposed against the internal bore of said cylinder forming a liquid space around the entire piston wall between said narrow beaded marginal extremities and the adjacent cylinder wall, said piston having an end forming a seating face resting upon a sharp valve seat having its apex formed at the top end of a sleeve and its apex disposed toward the inlet side of the valve, the outer wall of said sleeve being substantially vertical, said sleeve being pressed into a bore constituting the outlet port, said cylinder and sleeve being pressed into respective shallow bores to permit perfect concentric alignment of said cylinder and valve seat to assure the exposure of an equal area of the seating face of the piston all around the apex of said valve seat.

6. A piston molded of deformable material flexible enough to be distorted and capable of resuming its molded contour after being deformed, said material being molded about a core of relatively indeformable material, said piston having a flexible lip extending beyond each end thereof, at least one of said lips having an abrupt convex beaded peripheral extremity disposed radially outward of the piston wall near the end of the piston, said beaded extremity comprising an apex for a point of contact for said piston when disposed in a cylinder and, in conjunction with the other lip, providing a clearance space around the entire piston wall and an extra clearance space immediately next to said point of contact.

7. A piston molded of deformable material around a relatively indeformable core and formed with lips extending radially outward at each end thereof whereby when the piston is inserted in a cylinder a clearance space is formed

between said cylinder and the surface of the piston between said lips, at least one of said lips comprising an abrupt bead having a contact point disposed radially outward of the wall of the piston, a portion of said wall adapted to recede inwardly when the piston is inserted into said cylinder, said bead constituting means whereby the piston is distorted to form an additional more abrupt clearance space to that provided by the normal molded form of said piston, said abrupt bead being rounded to minimize friction and provide a curved apex and contact point to allow said contact point to roll slightly when the piston is in motion and subjected to liquid pressure within said cylinder.

8. A piston having a normal molded form comprising a cylindrical outer wall having lips extending radially outward beyond each end thereof, the lip disposed around the marginal extremity of the piston end facing toward the inlet when the piston is assembled in the cylinder bore

of a valve of the nature described comprising a bead, said bead presenting a convex contacting surface against the wall of said cylinder bore, the outer wall portion of the piston clearing the inner wall of the cylinder bore and forming a space for liquid bounded by said lips, the cylindrical wall of said piston and the adjacent cylinder bore, said bead constituting means to force the portion of the outer wall of said piston immediately adjacent said bead radially inward to form an additional abruptly curved clearance space, said bead constituting means to prevent folding back of the marginal extremity of said piston when being inserted into a cylinder bore and providing a rounded leading edge to minimize friction against the wall of said cylinder bore when said piston is moved in said bore, said piston adapted to substantially float in liquid except for the narrow marginal contact of the bead against the cylinder bore.

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