Oct. 6, 1953 T. A. GLASS 2,654,388

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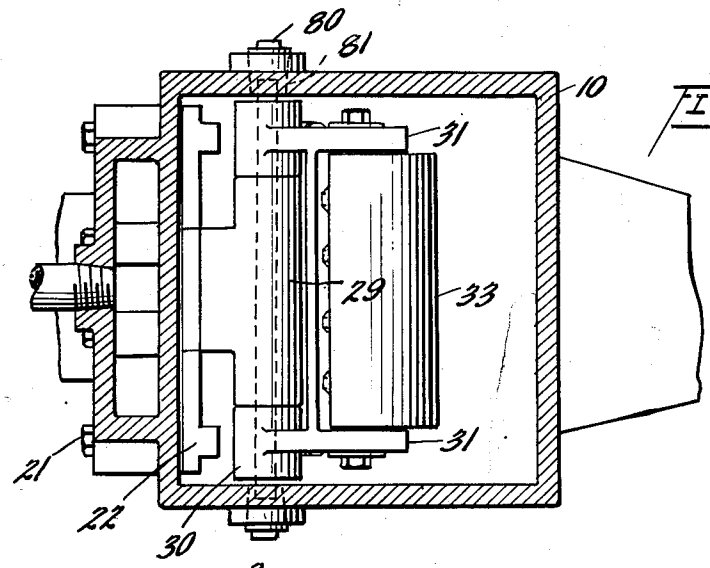


FIG. 2.

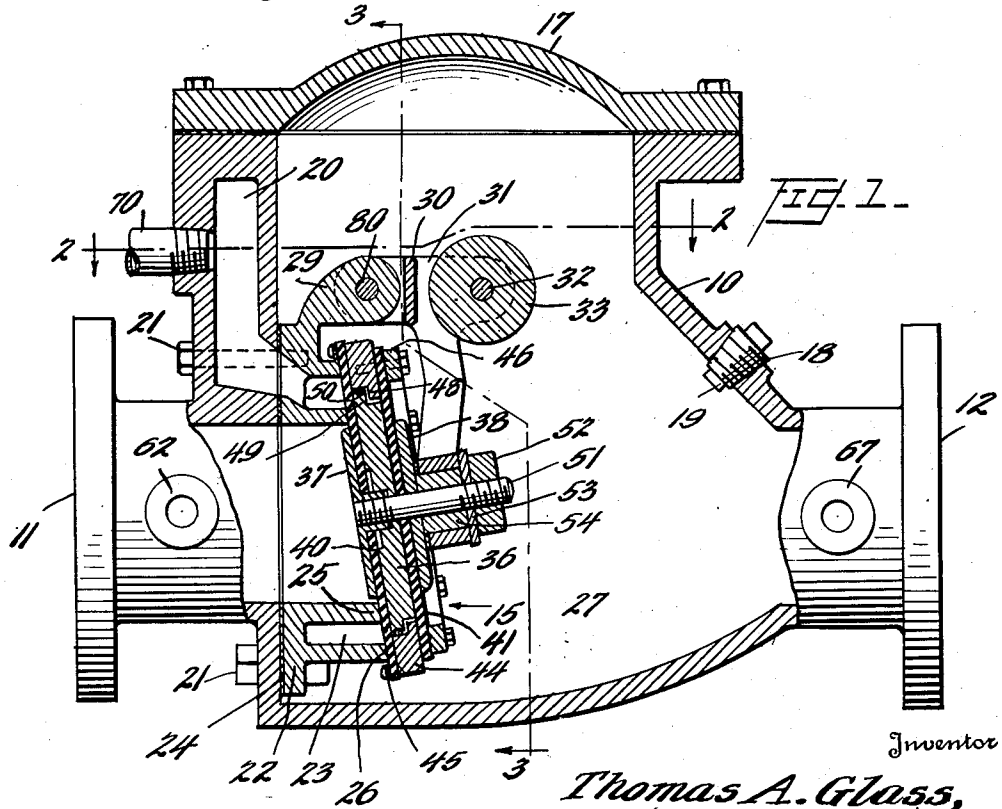


FIG. 1.

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FIG. 3.

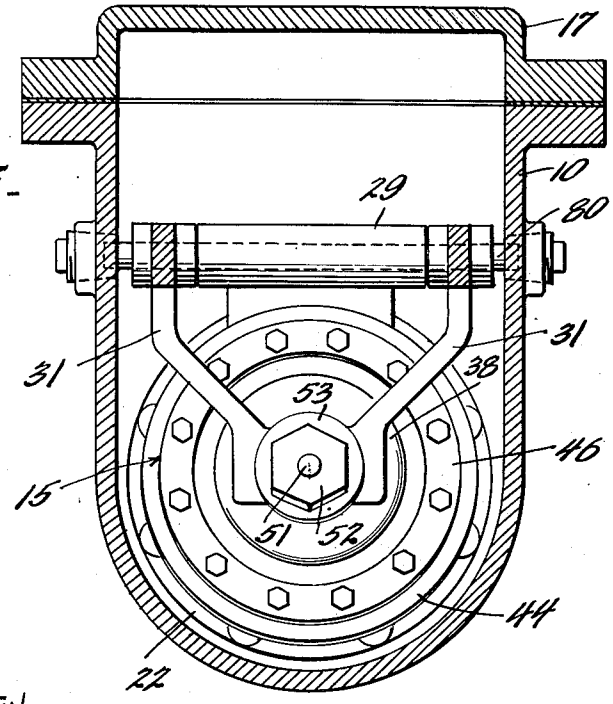


FIG. 5.

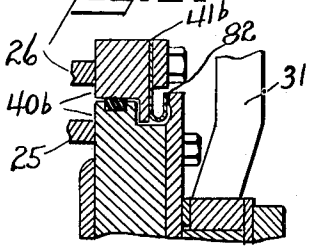
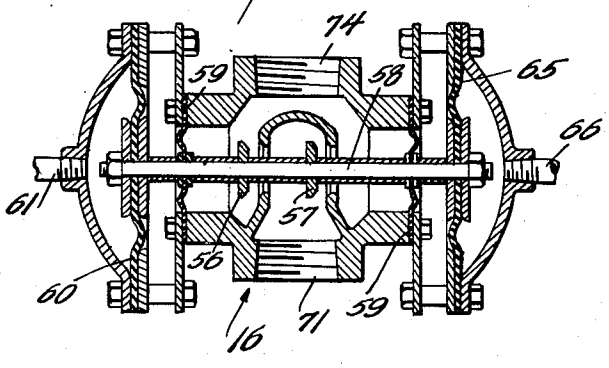


FIG. 4.



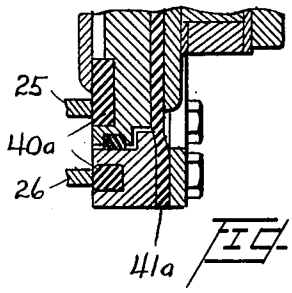


FIG. 9.

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FIG. 5.

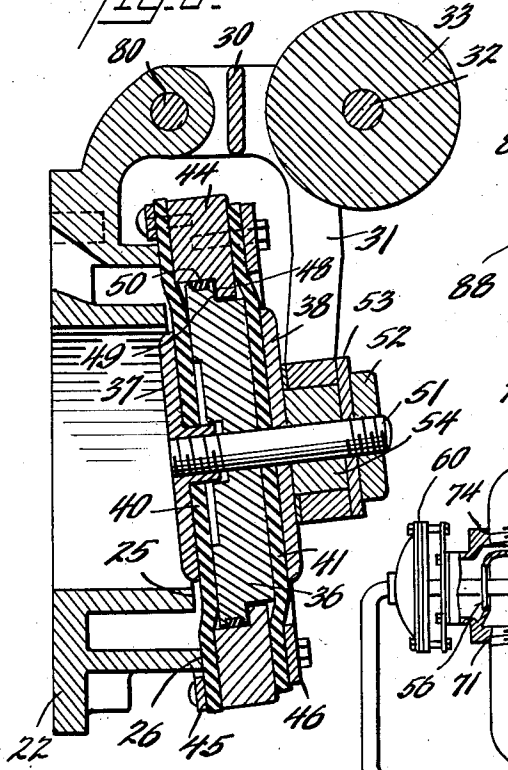


FIG. 10.

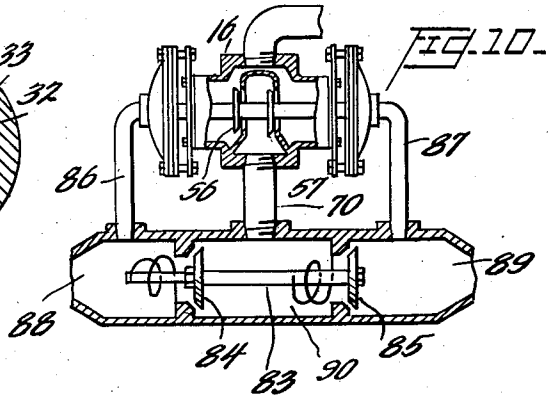


FIG. 6.

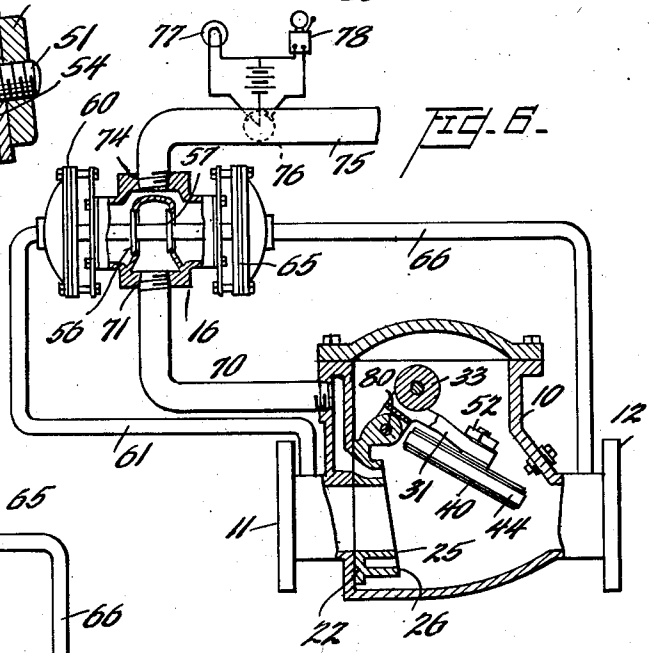
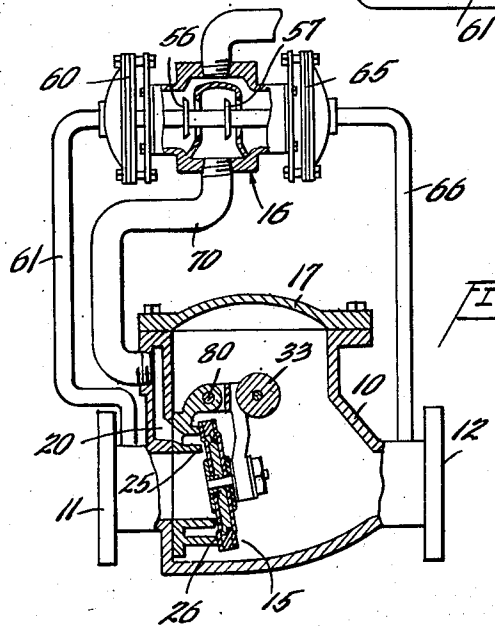


FIG. 7.



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UNITED STATES PATENT OFFICE

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BACKFLOW PREVENTER

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Application November 7, 1944, Serial No. 562,304

8 Claims. (Cl. 137—312)

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This invention relates to back-flow preventers and has for its principal object the provision of a simple and efficient device of this nature which will prevent contamination of the main supply when the inlet pressure drops below the outlet pressure, as, for example, when an emergency demand, such as might occur with an extensive fire, might rob the water mains of their normal pressure.

A prime object of the invention is to provide a back flow preventer which will have one or more of the following features which define it over the somewhat similar devices of he prior art: *a*. The outlet pressure controls the opening and the closing of the inlet closure; *b*. The opening and the closing of the inlet closure is governed by outlet pressure exerted on an area of the inlet closure; *c*. The portion of the inlet closure which is exposed to the outlet pressure is rigidly secured to the portion of the inlet closure which is not exposed to the outlet pressure; *d*. The outlet pressure and the inlet pressure simultaneously act on a single closure element in opposite directions; *e*. The inlet closure and the outlet closure are flexibly connected together to form a single closure element sealing the central zone from the inlet and outlet chambers; *f*. A single closure element first opens the inlet seat and then the outlet seat, and, in closing, closes the outlet seat and finally seals the inlet from the central zone and the outlet; *g*. The central zone is so located as always to be filled with water, and the water is at atmospheric pressure when there is no flow, and *h*. There are two spaced valves at opposite ends of the central zone and these are constrained to move as a unit so the inlet valve may never leave its seat unless the outlet valve opens at the same time, and hence the inlet valve is governed by the outlet pressure and the valve assembly is subject on one side to the inlet pressure and on the opposite side to the outlet pressure.

Other important features of the invention are the minimizing of head loss in back flow preventers where the pressure in the central zone is atmospheric when there is no flow, the maintenance of a constant pressure drop or differential thru the valve at all rates of flow whereby the relief valve may be kept closed when either or both seats are uncovered, and the provision of a simple and efficient device of this kind in which the central zone pressure may be kept equal to, or lower than, the inlet pressure at all times, and be at atmospheric pressure when the central zone is sealed from both the inlet and the outlet chambers.

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A still further object of the invention is to provide a device of this kind in which a signal will be given in case an obstruction should prevent the valve from closing, in which case the water main will be protected, but the consumer's supply will leak thru the open valve until the trouble has been corrected.

Aside from the fire pumps robbing the main, there are a number of other causes of back flow, including heavy demands for water during dry weather in the summer, the reverse pressure due to tanks on tops of tall buildings and filled thru check-valves by pumps on the premises, and the frequent increase in building along a street where the original street main was properly designed but is no longer of sufficient size to maintain the required pressure during peak loads. The avoidance of back flow has received much study and in recent years the Office of Scientific Research and Development considered recommendations that all back flow preventers which operate under pressure shall have a central zone; that this central zone be provided with a relief device to open the central zone to the atmosphere such that leakage up to 20% of the full open capacity of the preventer on the unpotable side would be carried to atmosphere; that the head loss thru the device will be within the Board of National Fire Under Writers requirements; and, in addition, that the device shall meet one of the following requirements:

#1. Pressure on the central zone shall not, when no flow exists, exceed more than 3 lbs. the pressure on the potable side.

#2. Pressure on the central zone shall at all times be maintained at equal or less than the pressure on the potable side.

#3. Pressure on the central zone shall at all times be maintained at 2 lbs. less than the pressure on the potable side.

#4. Pressure on the central zone when no flow exists shall be at atmospheric pressure.

It is an object of this invention to provide a device meeting the fourth requirement, this being the hardest to meet, while keeping the head loss within permissible limits. As far as I know, no other back flow preventer has been built having these two features.

In the drawings:

Fig. 1 is a central vertical section thru the valve.

Fig. 2 is a section on line 2—2, Fig. 1.

Fig. 3 is a section on line 3—3 of Fig. 1.

Fig. 4 is a central section thru the relief valve.

Fig. 5 is a detail.

Figs. 6 and 7 show the device in full open and in nearly closed positions, respectively.

Figs. 8 and 9 show modified forms of the disk and ring.

Fig. 10 shows a modified valve.

In Fig. 1 is shown my preferred form of back flow preventer, including a main valve body 10 thru which fluid passes from the inlet 11 to the outlet 12, past a check valve 15 which is closed during periods of no flow and whenever the outlet pressure equals or exceeds the inlet pressure. In keeping with the suggested requirements the relief valve 16 is of a capacity to discharge up to one-fifth of the normal flow in case of leakage into the main valve body. This relief valve 16 is acted upon by opposed pressures of the inlet and outlet sides of the main valve. Referring particularly to Figure 4, while it seems from the figure that the diaphragms 60 and 65 are the same size, there is a very slight difference and the diaphragm 65 has a slightly greater area. Hence, since the outlet pressure is exerted upon a larger area than is the inlet pressure, the relief valve 16 will be opened to the atmosphere whenever the two opposing pressures are equal in head or in pounds per square inch. The difference in area is very slight, for example, in the 4'' size the diaphragm 60 which is subjected to the inlet pressure, would be 4'' in diameter and the outlet diaphragm 65, subjected to the outlet pressure, would normally be $4\frac{1}{16}$'' in diameter.

The body 10 has an arched cover 17 and may carry a plug 18 having an inserted rubber bumper 19 acting as a stop for the valve 15 when fully open. The cored passage 20 in the body forms the middle portion of the central zone. The central zone extends from the inner seat 25 to the outer seat 26 and includes a waste pipe controlled by the valve 16 governed by the pressures in the inlet zone. The inlet zone is up to the inner seat 25 and the outlet zone includes the piping beyond outer seat 26 including the chamber 27 of body 10 and the outlet 12. Detachably secured to the body 10, as by bolts 21, is a bronze casting 22 having an annular recess 23 forming the inlet section of the central zone bounded by an inner seat 25 and an outer seat 26 preferably lying in a single plane, although the outer seat may extend further into the chamber 27 of the main valve body 10, it being important that the outer seat 26 be closed before the inner seat 25 and opened later so that the central zone is first closed to the outlet water and then closed to the inlet water and that the central zone be opened to the inlet water before being put in communication with the outlet water which may be non-potable, as when the consumer has an emergency tank filled from a nearby stream.

While the bracket 29 might extend from the body, it is more convenient to form this as an extension of the casting 22 so that the entire assembly may be removed as a unit when the top cover 17 is off. The hinge 30 is in the form of a yoke and having widely spaced arms 31 loosely receiving a mounting pin 32 carrying a weight 33 to maintain a pressure drop in excess of two pounds to insure that the differential relief valve shall stay closed when either or both of the seats are uncovered, that is, that the relief valve be closed at all times when there is a flow in the normal direction thru the main valve. The extra weight mounting pin 32 may be kept in place in any conventional manner.

The valve closure 15 may be of any convenient type and is shown in Fig. 1 as composed of a disk 36 held by two clamp plates 37 and 38 in engagement with a rubber facing 40 engaging both of the annular seats 25 and 26, and a flexible member 41 which might be of laminated metal, but is preferably of a sheet membrane. The facing 40 is secured to the ring 44 as by the clamp ring 45 and the membrane 41 is similarly secured to the ring 44 by the clamp ring 46. Since both 40 and 41 are flexible, the ring 44, which is thicker axially than the disk, has a slight movement axially of the common axis of the disk, ring, and closure. The ring and the disk have engaging shoulders 48 and 49 to limit the outward movement of the disk when the closure starts to open and one or the other of these closure members carries a small annular rubber seal 50 to prevent foreign particles getting into the space between the shoulders 48 and 49 to lessen the relative movement of the disk and ring. The axial pin 51 is threaded at both ends, as shown, but might be integral with either the clamp plate 37 or the nut 52 which engages the washer 53 holding in place the yoke of the hinge 30 and the sleeve 54.

Considering now the differential relief valve 16, the body is of standard construction having a pair of valves 56 and 57 on a common stem 58 which, however, extends thru flexible sheet membranes 59 on opposite sides of the body and is secured at one end to a diaphragm 60 acted upon by the inlet pressure transmitted by pipe 61 leading from a connection 62 near the inlet flange. The other end of the valve stem 58 is secured to a diaphragm 65 acted upon by the outlet pressure transmitted by a pipe 66 leading from a connection 67 near the outlet flange of the main valve body 10. A pipe 70 much larger than pipes 61 and 66, leads from the cored passage 20 to the relief valve inlet 71 so that when the relief valves are open the central zone fluid may be discharged thru the relief valve outlet 74, preferably thru a pipe 75 having therein a flow responsive element 76 controlling a visual indicator 77 for a slight flow and an audible indicator 78 for a larger flow so as to notify the attendant of abnormal conditions.

It is advisable to have the relief valve outlet 74 at a level well above the main line so that the central zone is always filled with water, if that be the fluid passing the main valve. By this the draining of the central zone every time there is no flow is avoided and also the relief valve is protected from sand and sediment sifting into it as would occur with the relief valve located beneath the main valve. It is advisable to coat the bodies of the valves with porcelain enamel to avoid corrosion and incrustation.

As a construction refinement to increase the ease of inspection and repairs, the seat and central zone casting 22, together with the disk and ring assembly 15, can be removed from the valve body thru its open top. This can be done by removing the valve body cover 17 and the outside cap screws 21 that hold the seat and central zone casting. A new gasket 24 of suitable sheet material between the casting and the valve body will seal the joint against leakage when the seat casting is secured in place with the holding cap screws. To facilitate the removal of the disk assembly 15 without removing the seat casting 22, the hinge pin 80 can be withdrawn thru the hole 81 opposite the pin. The disk assembly can then be lifted free of the valve body for inspection or replacement.

In Fig. 10 there are two spring pressed valves 84 and 85 having a common stem 83 and, there-

fore, acting as a unit. The relief valve 16 as before is governed by opposing inlet and outlet pressures thru pipes 86 and 87 communicating with the inlet chamber 88 and the outlet chamber 89, respectively. The central zone 90 in this type is cylindrical and vents thru the relief valve 16 by the waste pipe 70.

The closure 15 is much more efficient than if the rubber facing 40 were backed by a solid member, as the latter would require too great a drop in outlet pressure before the valve could open. Assuming a 4" size, seats of 4¾" and 6¾" diameter, and an inlet pressure of 60 pounds, it would necessitate the momentary fall of the outlet pressure to 20 pounds before the flow could start from static pressure. This naturally would prevent the use of faucets located higher than 46 feet above the main line. But by making the closure in two pieces with the disk 4½ inches in diameter, it would necessitate the momentary fall of outlet pressure to 47½ pounds to raise the disk off its seat. When the outer seat only is closed and the outlet pressure is 47½ pounds, the force holding the ring to its seat is only about 200 pounds and the force holding the disk off its seat is about 196½ pounds. The resultant force then, that is holding the ring to its seat, is a force of but 3½ pounds. A further drop in pressure of a few ounces will force the ring from its seat and flow will start and these few ounces will continue to hold the close assembly just free of the seats.

We will now consider the operation of the back flow preventer, starting with the position shown in Fig. 7 which illustrates the mechanism as it would appear just after the demand for water had ceased in the house, factory, or other consumer's property. With the cessation of flow, the pressure in the body 10 starts to built up. The closure 15, aided by extra weight 33, tends to turn about its pivot 80 on bracket 29 and close flow of water from the body 10 across the central zone. The seat 26 is closed prior to the closing of the seat 25 of the inlet pipe, hence the inlet is still open to the central zone. The chamber 20 and valve 16 are filled, but the relief valve is not yet wasting as the pressure in the body 10 has not quite risen to the point where the greater exposed area of the membrane 65 is able to overcome the lesser area of membrane 60 where the pressure is substantially the inlet pressure, as the flow is so slight. Almost immediately after the first closing of the valve 15 the body pressure reaches the necessary point to overcome the somewhat higher pressure at the left of the valve 16 so the relief valves 56 and 57 open, as shown in Fig. 7, and this is followed by the complete closure of the valve 15, both of the concentric seats being now engaged by their respective facings, so that no water flows from the inlet or from the outlet. The central zone is then open to atmospheric pressure, as it always is when there is no flow thru the system. This incidentally takes care of any possible leakage from the body and insures that such leakage cannot pass to the main.

Although the relief valve 16 is open to atmosphere during all periods of no flow, it closes promptly when a faucet is opened in the consumer's premises, and remains closed during all of the flow. The demand causes a slight drop in pressure in the body 10. This is immediately reflected at chamber 65, so that pressure on the opposite side closes the relief valve. At the same time the pressure of the water on the inlet side

of the closure 15 opens this disk assembly in part, water now flowing from the inlet to the central zone building up pressure therein as the water cannot escape as long as the valve 16 is closed. The portion of the disk assembly 15 in rising from the first or inner seat moves to its back position, and in the preferred construction contacts firmly with the shoulder of the outer ring of closure 15. This closure now opens to allow flow from inlet to outlet. The extra weight 33 is so located to cause a higher pressure differential at the angle at which the closure hangs from its pivot 80 when the rate of flow of the water is low. The relief valve is consequently held closed until after the demand for water in the consumer's premises has ceased, as just explained.

It is apparent from the above that no back flow can occur normally, as a greater outlet pressure would merely hold the closure all the tighter against its two seats and hold the relief valve in wide open position. Under extraordinary conditions, such, for example, as would occur if a foreign body were caught between the closure and the seats, the relief valve would open wide and its chamber would continuously waste thru pipe 15. This, however, would be indicated, first, by the lamp 17 and then by the bell 18, bringing prompt attention.

In the modified forms shown in Figures 8 and 9 are shown slight modifications of the facing material and the flexible membrane. The form of Fig. 9 is somewhat preferred over that of Fig. 8, and shows the body seats 25 and 26 touching inserted facings 40a of semi-hard rubber composition facing material. In Fig. 8 the facing material 40b is bronze and in this figure the flexible material is of the metallic type as shown at 41b. This in conveniently silver soldered as at 82 at the end of the bend so as to provide the necessary movement.

I claim:

1. A guided closure plate for a back flow preventer, consisting of a disk, a ring coaxial with the disk and having a shouldered engagement therewith, a facing formed of a single piece engaging both the disk and the ring, a flexible sheet carrying the ring and engaging the disk on the side opposite the facing, clamping means for securing together the facing, disk, ring, and sheet, and means for guiding the closure plate.

2. In a back flow preventer, a body having a plurality of concentric ports, means carried by the body for closing the ports in sequence including a single closure, and means tending to hold the closure in port-closing position with constantly lessening force as the closure opens under urge of the inlet pressure at the central port.

3. A back flow prevention valve for insertion between a potable water intake and a discharge pipe which might be connected to non-potable water, comprising a valve body or casing having a major chamber and a communicating passage forming part of a central zone, a removable multiple valve seat and closure detachably secured within the body having concentric seats so that the inner seat is the sole port admitting intake water and the space between the two seats is the sole communication between the major chamber and said part of the central zone, said body having an opening of such size as to receive the removable valve seat and closure for withdrawal, a cover for said opening, said closure being hinged and including a ring to engage the outer seat, a disk to engage the inner seat and flexible means connecting the ring and the disk so they will

normally move together but the disk will have lost motion so as to move with respect to the ring when the inlet pressure exceeds the pressure in the central zone, said body having an inlet member communicating with the intake and having an opening therein for transfer of pressure and also having an outlet member leading from the major chamber and having an opening therein for transfer of pressure.

4. In a valve comprising a body having a pair of concentric, adjacent ports, a closure unit mounted adjacent said ports and movable toward said ports for closing one of said ports and subsequently closing the other port, said closure unit comprising a portion of relatively large area exposed to pressure within the body for closing the first mentioned port, a portion of smaller area for closing the second mentioned port, said last mentioned area being protected from pressure within the body by the closing of the one port, said one port being the outer of the two concentric ports, and flexible means joining the portions whereby pressure within the body greater than the pressure in the other or inner port exerted on the closure unit to move it toward the ports will cause the portion of larger area to move into port closing position in advance of the portion of smaller area, as the portion of smaller area is moved away from port closing position by the pressure in the body of the valve.

5. The device of claim 4 in which the closure unit comprises a disk of relatively large area on the seat side and a ring of relatively smaller area on the seat side surrounding the disk and movable relative thereto.

6. In a back flow preventer a valve body having an inlet, an outlet, a chamber communicating with the inlet and the outlet and a waste discharge passage communicating with the chamber in spaced concentric relation to the inlet, an inner seat within the chamber surrounding the inlet, a disk within the chamber and movable into engagement with the inner seat to interrupt communication between the chamber and the inlet when the pressure within the chamber

exceeds the pressure within the inlet, an outer seat within the chamber surrounding the waste discharge passage in spaced concentric relation to the inner seat, a ring surrounding the disk and movable therewith for engaging the outer seat and interrupting the passage of fluid from the chamber into the waste passage, and means carried by the disk and connected to the ring for supporting said ring for movement relative to the disk.

7. The device of claim 6 in which the disk and ring contacting faces of the inner and outer seats lie in the same plane, and the disk and ring are pivoted to move as a unit progressively and sequentially into closing relation with the inner and outer seats respectively when fluid pressure in the chamber equals or exceeds the pressure of fluid in the inlet.

8. The device of claim 6 in which the area of the disk exceeds the area of the ring whereby when the inlet and waste discharge passage are closed the pressure of the disk against its seat exceeds the pressure of the ring against its seat.

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