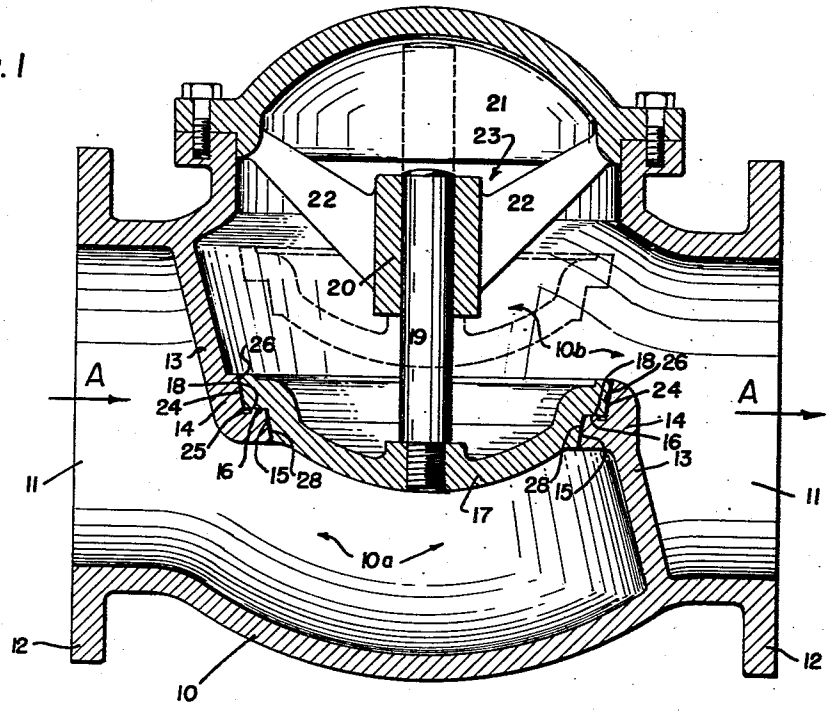
Aug. 24, 1954 G. J. HORNSBY 2,687,276

CUSHIONING STRUCTURE FOR VALVES AND THE LIKE

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Fig. 1



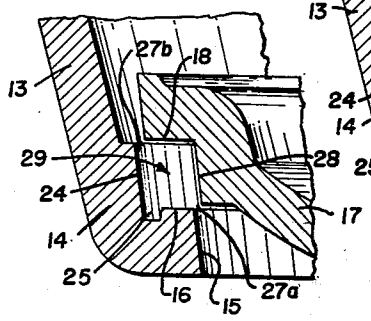


Fig. 3

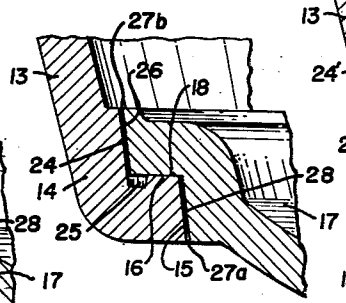
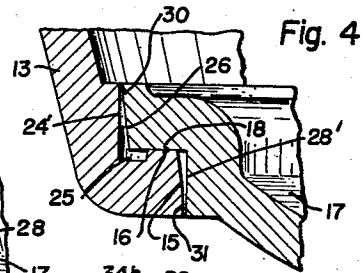


Fig. 2

Fig. 4



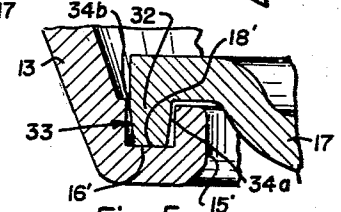


Fig. 5

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CUSHIONING STRUCTURE FOR VALVES AND THE LIKE

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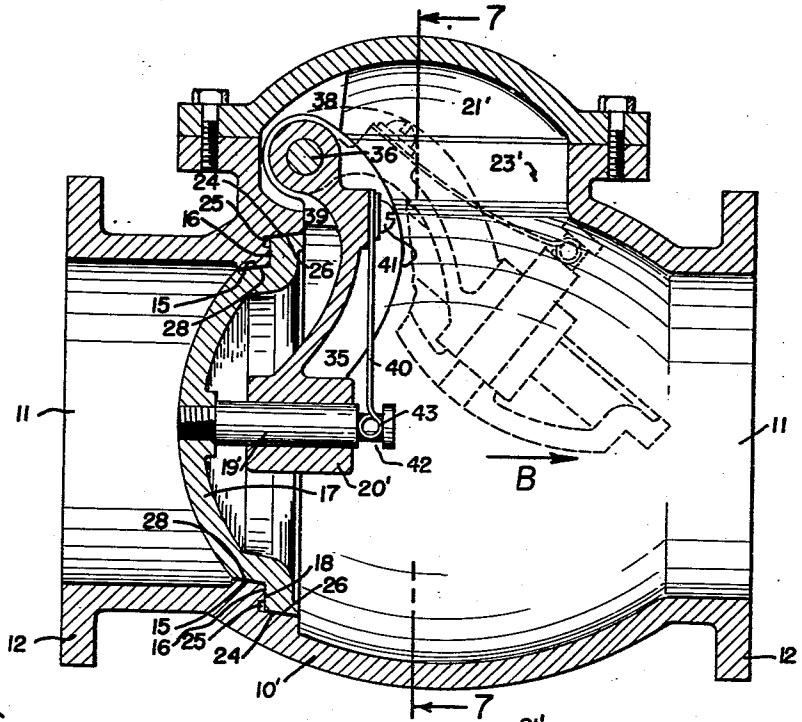


Fig. 6

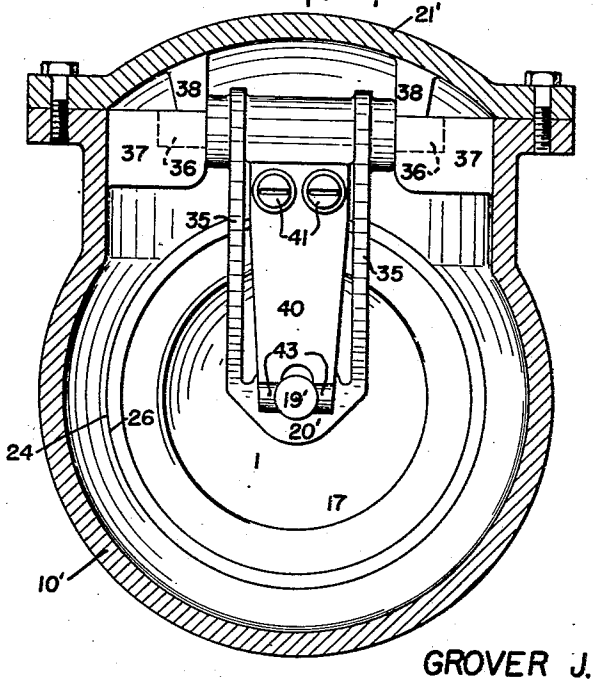


Fig. 7

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CUSHIONING STRUCTURE FOR VALVES AND THE LIKE

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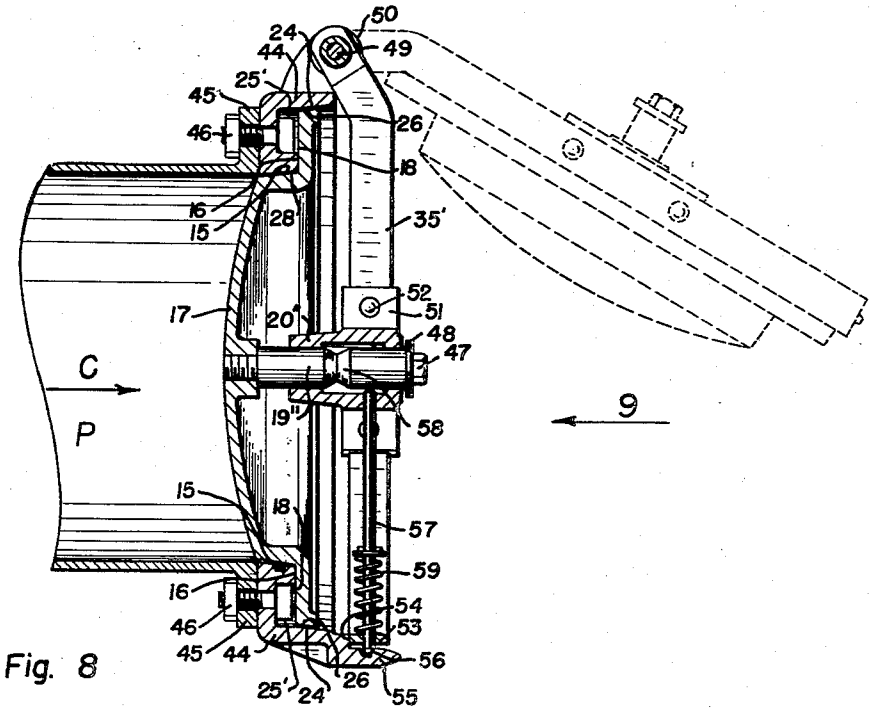


Fig. 8

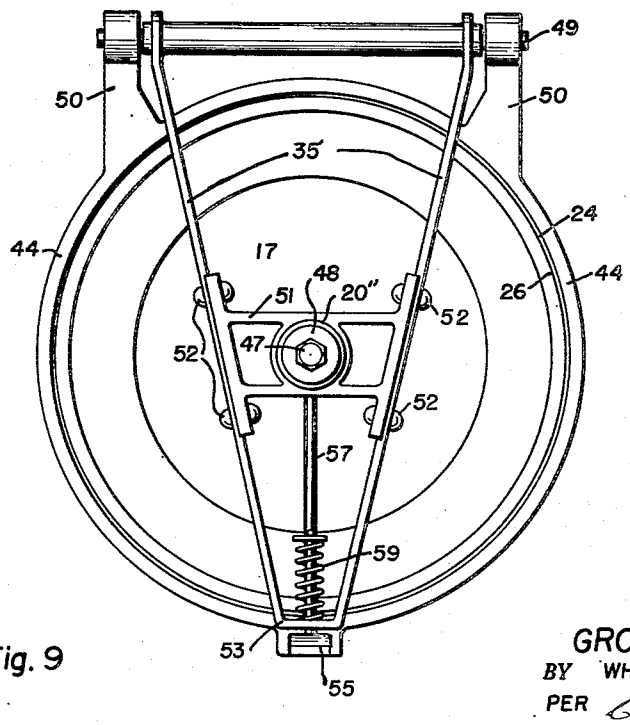


Fig. 9

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UNITED STATES PATENT OFFICE

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CUSHIONING STRUCTURE FOR VALVES AND THE LIKE

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Application December 3, 1949, Serial No. 130,902

10 Claims. (Cl. 251—113)

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This invention relates to valves and closure means for conduits and more particularly to check valves, flap gates and other devices which are operable to close a passage upon a reversal of flow therein of substantially incompressible liquids, herein referred to as water, the invention having as an object to provide means associated with such valves and gates for the elimination of shock resulting from the closure operation.

Another object of this invention is to provide a water cushion which retards the closing movement of the disc of a check valve as it is about to become seated.

Another object of this invention is to provide, in a flap gate, a water cushion associated with the gate which retards and decelerates its closing movement as it approaches its seat.

Another object of this invention is to provide means associated with a flap gate or with the disc of a check valve, whereby a water cushion is formed as the valve closes, which retards and decelerates the movement of the disc as it approaches its seat, thereby reducing the intensity of water hammer shock in a pipe line.

Yet another object of this invention is to provide, in apparatus of the class described, means to obtain a water cushion which are exceedingly simple and economical in construction, rugged and durable over a long period of actual use.

With the foregoing and other objects in view, all of which more fully hereinafter appear, my invention comprises certain novel constructions, arrangements and combinations of parts as shall now be described and as defined in the appended claims and illustrated, in preferred embodiment, in the accompanying drawings in which:

Figure 1 is a central longitudinal section of a check valve, embodying the invention, shown in closed position, the open position thereof being shown by the broken lines.

Figure 2 is a fragment, on an enlarged scale, of seating and closure elements of the structure illustrated at Fig. 1.

Figure 3 is similar to Fig. 2, but showing the illustrated elements in partially open position.

Figure 4 is similar to Fig. 2 but illustrates an alternate construction of said elements.

Figure 5 is similar to Fig. 2 but illustrates yet another construction of said elements.

Figure 6 is a central longitudinal section of another type of check valve into which the invention is incorporated, the open position thereof being shown in broken lines.

Figure 7 is a transverse section of the valve

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illustrated at Fig. 6, as taken on the indicated line 7—7 at Fig. 6.

Figure 8 is a central longitudinal section of a flap gate attached to the end of a pipe, as modified to incorporate the present invention, the open position thereof being shown in broken lines.

Figure 9 is an elevation view as from the indicated arrow 9 at Fig. 8.

In closed conduits, such as pipe lines, where it is desirable to restrict the flow of water to a given direction, various types of check valves may be used in the line, or a flap gate may be used at the exit. Such valves or gates operate by the movement of the water through the pipe, the regular flow opening a valve, and a reverse flow closing it. In ordinary operation of such valves and gates, the opening cycle proceeds smoothly enough, but the closing cycle may be rather sudden and result in a slamming jar or shock. With a fluid in the vapor state the sudden closure may not be especially serious except where the impact of the closure element against its seat causes undesirable noise. However, where the fluid is a substantially incompressible liquid, as water, other complications arise in that the closure by such moving water may cause a water hammer impact due to the inertia of the moving water. If the momentum of the water is sufficiently great, a vapor lock or cavitation pocket may be formed which will subsequently collapse to cause repeated shocks. In either case the attendant shock may be exceedingly severe and may be very dangerous in large structures.

One method of avoiding the possible shocks which result from a closure of check valves or flap gates is to decelerate the movement of the disc or flap as it approaches the seating position to permit a gradual slowing down of the moving water body. A number of devices have been developed for such purpose, which are, in general, of the cylinder-dashpot type adapted more for the control of vapors such as gas or steam; however, such devices have not been entirely satisfactory with incompressible liquids, as water, because of large forces which are involved where the sudden closure is critical and because such devices are accessories to the valves and require special designing to install. Moreover, such devices are expensive, both in initial cost and in maintenance. The need for an improved means for decelerating the movement of the disc or flap thus led to the present invention, which by an exceedingly simple and novel expedient may be incorporated into any of the conventional types

of check valves and flap gates with only slight modifications in their design.

The check valve illustrated at Fig. 1 might be considered as a globe type because of its similarity to a common globe valve. The body 10 is formed as a spherical enlargement within a short pipe section 11, the ends of which are adapted for the connection of pipes thereto as by flanges 12. This body is divided into two compartments 10a and 10b by a partition 13 which extends diagonally across the body but is distorted at the center to provide a shelf 14 which lies in a plane parallel with the longitudinal axis of the valve. In this shelf there is an orifice defined by an annular wall 15 concentrically circumscribed by a seat 16 which lies parallel to the plane of the shelf 14, the common longitudinal axis of the orifice and the seat 16 being perpendicular to and intersecting the longitudinal valve axis. A closure disc 17 is provided with a flattened circular base 18 which registers with the seat 16, and in operation of the valve, movement of the disc is along the orifice longitudinal axis with the base 18 held in spaced parallelism with the seat 16 at all open positions. To hold and move this disc in the above-described manner, a circular stem 19 is centered along the orifice longitudinal axis with one end rigidly attached to the disc 17, and slidably engaged in a guide 20, whereby all movements of the disc are restricted by this guide. The guide 20 is attached to a cap 21 by a spider 22, and this assembly is seated to the body 10 within and against a flanged rim encircling the opening 23, holding it in proper alignment at all times. By removal of the cap 21 the valve may be opened and inspected.

In the present invention the shelf 14 is of dimensions sufficient to provide a comparatively extensive orifice wall 15 and to permit the seat 16 to be recessed and bounded by a circular wall 24 concentric with the orifice wall 15 and of similar extent. A trough 25 separates the seat 16 from the wall 24 to upstand the seat sufficiently to facilitate finishing operations in forming it. Both the wall 24 and the orifice wall 15 are tapered in the direction of the closing movement for purposes hereinafter disclosed. The disc periphery is shaped to nest in the opening formed by the orifice wall 15 and wall 24, and is divided into two parts with the base 18 therebetween. An outer rim 26 circumscribes the base 18 and is tapered to nest against the wall 24 with a selected gap or clearance 27b therebetween; a concentric inner rim 28, circumscribed by the base 18, is tapered to nest against the orifice wall 15 with a selected gap or clearance 27a therebetween.

The height or extent of the wall 24 and of the orifice wall 15 corresponds respectively with rims 26 and 28. It follows that the step-like construction of the shelf 14 and with the nesting step-like construction of the disc 17, a chamber 29 is formed between the shelf and the disc whenever the disc is unseated to an extent not greatly exceeding the wall, seat or rim extent, as illustrated at Fig. 3. This chamber 29, circumjacent to the disc 17, is in communication with the compartments 10a and 10b through passages formed by the tapered construction and the clearances 27a and 27b. It is to be noted that the size of the said passages will vary and decrease to a minimum as the disc approaches the seat, and may be predetermined by variation of the taper of the walls and their respective rims, all as clearly shown in Figs. 2 and 3.

The normal flow through this valve is indicated by the arrows A, and with such flow the disc is moved away from the seat 16 as indicated by the broken lines in Fig. 1, as the pressure of the moving water acts on the bottom of the disc to lift it. However, a reversal of flow is accompanied by a reversal of pressure upon the disc, and it is normally accelerated towards the seated position. The function of the above-described elements is to decelerate the movement of the disc as it approaches its seat, and as the annular chamber 29 is formed as the disc moves towards the shelf, the water in the chamber must be discharged therefrom through the passages formed by the clearances 27a and 27b. With these passages suitably restricted, in accordance with the nature and viscosity of the water, the water in the chamber 29 is subjected to an increasing pressure and a force is exerted against the disc tending to decelerate its movement toward the seat. This force is related directly to the velocity of the approach of the disc to the seat, because the pressure increases in the chamber 29 as the velocity increases, as the water must be displaced at an increased rate. It is further apparent that by reason of the tapered construction above mentioned the size of the passages descreases as the disc approaches the seat, thereby providing a complete and effective deceleration of the disc.

Variations in the construction of the wall, orifice wall and the respective rims are possible, one such variation being illustrated at Fig. 4. In this modification the wall 24' is not tapered, and the outer tapered rim 26 does not nest against the wall 24' except along a flat edge 30 at the top of the rim; nor is the inner rim 28' tapered, and the tapered orifice wall 15 does not nest against the rim 28' except along a flat edge 31 at the bottom of the orifice. Such alterations of passage may be designed to conform with various closure requirements.

Another variation of this construction is illustrated at Fig. 5. In this construction the base 18' on the disc is turned on an annular boss 32, and the seat 16' is formed in a recessed groove 33 concentric with the orifice wall 15', the boss 32 extending within the groove 33 to provide an annular chamber with small openings similar to chamber 29 in the Fig. 3 embodiment. Both the boss and groove may be suitably tapered to form variable side clearances 34a and 34b for purposes hereinbefore described.

The check valve illustrated at Figs. 6 and 7 is a gate type, where the body 10' is constructed with a continuous passage therethrough, and the closure disc 17 is centrally mounted transversely to the longitudinal valve axis when in closed position. In this construction the seat 16 is formed in the pipe section 11 at the edge of the body 10', and the orifice wall 15 longitudinal axis coincides with the longitudinal valve axis; otherwise, the construction of the orifice wall 15, seat 16, wall 24 and trough 25 is identical to construction hereinbefore described. Likewise, the construction of the disc 17, base 18, and the inner and outer rims 28 and 26 are of the same construction as hereinbefore described.

However, in this construction the stem 19', centered along the disc longitudinal axis, is slidably engaged in a guide 20' which is affixed to an arm 35 hingedly attached to the valve body by a pin 36 above the disc 17. This arm and disc assembly, forming a swinging gate, is positioned within the valve through a suitable opening 23' encircled by a flanged rim in the body 10 with the pin

36 mounted in open journal boxes 37 integral with the body 10 at the edge of the opening 23', lugs 38 being provided on the cap 21' to hold the pin in position when the valve is closed by the cap.

The movement of the arm 35 swings the gate outwardly and away from the closed position as illustrated by the broken lines at Fig. 6, the outward movement being restricted by the boundaries of the body 10', and the inward limit of the arm movement being restricted by a stop 39 on the arm 35 contacting a portion of the body 10' as clearly shown at Fig. 6. This inward limit of movement positions the guide 20' in alignment with the longitudinal valve axis, but to effect seating of the disc, the stem 19' must be moved to an extended position in the guide 20'. The stem is normally held out of such position by a spring 40 mounted on the arm 35 as by bolts 41 to resiliently engage the stem 19' at its end remote from the disc. This engagement is made positive by providing a groove 42 in the stem 19' and by forming the spring end as a rounded yoke 43 slidable within the groove 42.

In operation of this valve the normal flow, as indicated by the arrow B, and the tension of the spring 40 pull the disc against the guide 20', and the assembly then swings outward. In closing, as by a reversal of flow, the assembly swings inwardly with the disc resiliently held against the guide until the arm 35 attains its limited position as determined by the lug 39, whereupon fluid pressure causes continued movement of the disc in alignment with the seat, as hereinbefore described, to form a chamber 29 between the disc and seat, whereupon the fluid within the chamber retards the movement of the disc to obviate the shock of closure.

The operative elements of the flap gate illustrated at Figs. 8 and 9 are similar to those of the valve illustrated at Figs. 6 and 7, although the flap gate is actually a valve attached to the end of a conduit P as illustrated at Fig. 8, and the body does not enclose the gate. In the construction illustrated the body is formed as a seating ring 44 attached to the pipe flange 45 by a ring of bolts 46, the trough 25' being enlarged to provide sufficient depth to permit insertion of the bolt heads. In this seating ring there is an orifice wall 15, a seat 16, a wall 24 and the enlarged trough 25', all as hereinbefore described. The flap gate assembly comprises a disc 17 having a base 18, and inner and outer rims 26 and 28, the disc being attached to an arm 35' through a stem 19'' slidably engaging a guide 20'' and held thereon by a bolt 47 and washer 48. The arm is hingedly mounted above the seating ring 44 by a pin 49 inserted in lugs 50 upstanding from the seating ring.

The arm 35' is suitably made up as an inverted A-frame extending diametrically across the gate to increase the rigidity of the structure, and a cross-bar 51 is attached thereto to carry the guide 20'' and may be adjustably positioned for alignment of the guide and disc with the seating ring elements, and then securely attached to the arm elements as by rivets 52. The downward movement limit of the arm 35' is restricted by the lower edge 53 contacting an abutment 54 of the seating ring 44. With the arm so positioned it is necessary to extend the stem 19'' in its guide to effect a closure as hereinbefore described, and with the stem so positioned it is desirable that the arm be locked in its downward limited position. A lip 55 extends outwardly

below the abutment 54 and is provided with a notch 56 therein. A shifting bar 57, is slidably mounted in guide 20'' and the arm lower edge 53 and adapted to extend within the notch 56 and be held therein by the stem 19'' bearing against its upper end. A circumferential notch 58 is provided in the stem 19'' whereby the bar 57 may leave the notch 56 when the disc is removed from its seated position and against the guide 20'', a spring 59 being placed around the bar to resiliently force it against the stem 19''. In this manner whenever the gate is opened the bar 57 lodges in the notch 58 to hold the disc against the guide.

The action of this gate is otherwise the same as the aforedescribed valves, the gate opening with flow from the pipe in the direction of the arrow C, but closing by a reverse of flow. The latter part of the closure is retarded by a chamber similar to chamber 29 of Fig. 3 forming between the disc and seat elements to avoid a slam of the gate.

While I have illustrated and described herein many details of construction, alternatives or equivalents will occur to those skilled in the art and I am not to be limited in my protection to the details illustrated or described, but only by the appended claims.

I claim:

1. A flap valve, for incompressible liquids, adapted to open responsive to flow of liquid in a normal direction and to close responsive to reversal of flow, comprising, in combination, a body having a circular orifice therein, a flat annular seat circumscribing said orifice, the wall of said orifice tapering inwardly of the orifice from the inner seat edge, a concentric circular wall beyond the other side of the seat, circumscribing, and tapering outwardly from the outer seat edge, hinge means mounted upon the body, shifting means mounted upon the hinge means, a closure disc having a flat annular base adapted to comate with said seat, a circular outer rim at the outer edge of said base tapering outwardly therefrom and being adapted to nest within but be spaced slightly from said seat-circumscribing wall when the base is comated with the seat, and a concentric inner rim at the inner edge of said base tapering therefrom inwardly of the orifice and being adapted to nest within but be spaced slightly from the orifice wall when the base is comated with the seat, said disc being mounted upon the shifting means, said hinge and shifting means being adapted to swing the disc to a position of alignment in front of the orifice with the base in spaced parallelism and on a common longitudinal axis with the seat, said shifting means being thereupon adapted to shift the base into comating relation with the seat, along said longitudinal axis whereby to form a substantially closed chamber having release passages leading in opposite directions from said chamber which passages diminish in cross sectional area as the base approaches the seat.

2. A flap gate, for controlling the flow of incompressible liquids from a conduit, adapted to open responsive to flow of liquid in a normal direction and to close upon a reversal of flow, comprising, in combination, a body having a circular orifice therein aligned with the end of the conduit, an annular seat circumscribing said orifice, a closure disc having an annular base adapted to comate with the seat, hinge means mounted upon the body, a guide member integral with said hinge means, a stem mounted upon the disc

at the disc longitudinal axis and slidably carried within said guide member, said hinge means being adapted to swing the disc from an open position, away from the orifice, to a position in alignment in front of the orifice with the base in spaced parallelism and on a common longitudinal axis with the seat, whereby movement of the stem in the guide member effectuates movement of the disc to comate the base with the seat, a notch in the stem, a pin slidably carried upon said hinge means and adapted to move against the stem and engage the notch when the disc is moved away from the comating position, but to move out of the notch whenever the disc is in alignment with the seat, and lock means on the body including a notch adapted to be engaged by said pin when the pin is moved out of the stem notch to thereby lock the flap gate structure in closed position, and resilient means to force said pin from the lock and into the stem notch when the stem notch is aligned with the pin to thereby release the gate structure upon movement of the stem notch to alignment with the pin.

3. The gate defined in claim 2, including configurations in the disc and body adapted to nest together during said shifting movement and form an annular chamber with relief passages to thereby retard the shifting movement of the disc to the seating position.

4. The apparatus defined in claim 3, wherein said configurations comprise the wall of the orifice at the inner seat edge, a concentric circular wall beyond the outer seat edge, a circular rim extending beyond the inner edge of said base and adapted to comate with the orifice and a concentric rim at the outer edge of the base adapted to comate with said outer-seat-edge wall, said orifice and inner base rim being tapered inwardly from the seat and base respectively and said outer wall and outer rim being tapered outwardly therefrom.

5. A flap valve, for incompressible liquids, adapted to open responsive to flow of liquid in a normal direction and to close responsive to reversal of flow, comprising, in combination, a body having a circular orifice therein, a flat annular seat circumscribing said orifice, the wall of said orifice tapering inwardly of the orifice from the inner seat edge, a concentric circular wall beyond the other side of the seat, circumscribing, and tapering outwardly from the outer seat edge, hinge means mounted upon the body, shifting means mounted upon the hinge means, a closure disc having a flat annular base adapted to comate with said seat, a circular outer rim at the outer edge of said base tapering outwardly therefrom and being adapted to nest within but be spaced slightly from said seat-circumscribing wall when the base is comated with the seat, and a concentric inner rim at the inner edge of said base tapering therefrom inwardly of the orifice and being adapted to nest within but be spaced slightly from the orifice wall when the base is comated with the seat, said disc being mounted upon the shifting means, said hinge and shifting means being adapted to swing the disc to a position of alignment in front of the orifice with the base in spaced parallelism and on a common longitudinal axis with the seat, said shifting means being thereupon adapted to shift the base into comating relation with the seat, along said longitudinal axis whereby to form a substantially closed chamber having release passages leading in opposite directions from said chamber which passages diminish in cross sectional area as the base approaches the seat, said hinge means including a hinged arm, a stop to limit the movement of the hinged arm toward the orifice and said shifting means including a guide associated with said hinged arm adapted to be concentric with the orifice-longitudinal-axis coincident with the limitation of the arm movement by the stop, a stem carried by the disc concentric with the disc-longitudinal-axis and slidable within said guide, and means adapted to normally hold the stem within the guide when the disc is away from the seat but to permit the disc to move towards, and comate with the seat subsequent to contact of the arm with the stop.

6. A flap valve, for incompressible liquids, adapted to open responsive to flow of liquid in a normal direction and to close responsive to reversal of flow, comprising, in combination, a body having a circular orifice therein, a flat annular seat circumscribing said orifice, the wall of said orifice tapering inwardly of the orifice from the inner seat edge, a concentric circular wall beyond the other side of the seat, circumscribing, and tapering outwardly from the outer seat edge, hinge means mounted upon the body, shifting means mounted upon the hinge means, a closure disc having a flat annular base adapted to comate with said seat, a circular outer rim at the outer edge of said base tapering outwardly therefrom and being adapted to nest within but be spaced slightly from said seat-circumscribing wall when the base is comated with the seat, and a concentric inner rim at the inner edge of said base tapering therefrom inwardly of the orifice and being adapted to nest within but be spaced slightly from the orifice wall when the base is comated with the seat, said disc being mounted upon the shifting means, said hinge and shifting means being adapted to swing the disc to a position of alignment in front of the orifice with the base in spaced parallelism and on a common longitudinal axis with the seat, said shifting means being thereupon adapted to shift the base into comating relation with the seat, along said longitudinal axis whereby to form a substantially closed chamber having release passages leading in opposite directions from said chamber which passages diminish in cross sectional area as the base approaches the seat, said hinge means includes a pivot carried by the body, an arm hingedly mounted upon the pivot adapted to swing toward the orifice, a stop carried upon the arm adapted to limit the swinging movement toward the orifice and said shifting means includes a guide associated with said arm and a stem upon said disc slidable within the guide, and resilient means carried by the arm and adapted to normally draw the disc away from its seated position but will permit movement of the disc toward and comate with the seat.

7. A valve for incompressible liquids, adapted to open responsive to flow of liquid in a normal direction and to close responsive to a reversal of flow, including, in combination, a body having a circular orifice therein, a wall circumscribing the orifice, a flat annular seat circumscribing the orifice wall and a wall circumscribing the seat; and a closure disc having a base adapted to comate with said seat and circumferential walls at the inner and outer edges of the base adapted, respectively, to loosely nest within said orifice wall and said seat-circumscribing wall, at least one of each pair of said nesting walls being inclined relative to the disc axis whereby the nest-

spacing between the walls of each pair reduces as the base approaches the seat.

8. The valve defined in claim 7 wherein said walls of both pairs have parallel inclinations.

9. The valve defined in claim 7 including a stem axially outstanding from said disc and guide means associated with the body slidably holding said stem in axial alignment with said orifice.

10. The valve defined in claim 9 wherein said guide means includes a hinged arm slidably carrying said stem.

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