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(54) VALVE SEALS

(71) We, IMI KYNOCH LIMITED, formerly known as Imperial Metal Industries (Kynoch) Limited a British Company, of Kynoch Works, Witton, Birmingham B6 7BA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to valve arrangements in which sealing contact is to be made between a valve closure and a valve seat.

According to the present invention we provide, in or for a valve, an assembly including a valve seat with an opening therein and a pivotally mounted closure co-operable therewith, the closure having an annular ridge projecting towards the seat, and the seat having an annular resilient member mounted thereon, such that on closing the closure, the ridge engages the resilient member to provide a seal and in which a groove in the seat underlies part of the resilient member, said resilient member being deformable into said groove when the closure is closed.

The resilience of the member may be such that under high sealing pressure, the seal between the resilient member and the ridge extends on at least one side, and preferably both sides, of said ridge. A region of additional contact at higher pressures may be such that a space is left between itself and the ridge. The closure may have a flat sealing face adjacent the ridge to form said additional contact region or regions.

The ridge may be generally rigid, but it may be provided with a resilient facing to be engaged by the resilient member. The groove may be at least partially filled with a resilient material. The resilient member may be secured to the seat on only one side of the groove, preferably

on the side adjacent the opening. When the resilient member is secured on the side remote from the opening, means may be provided to impede access of fluid medium to the space between the resilient member and the closure. Means may be provided to vent the groove.

The sealing and mounting arrangements described above are intended particularly, but not exclusively, for use in a valve as described in our British Patent Specification 1 489 578. In that case, the valve is a backflow check valve which is, or can be, arranged so that the valve seat lies in a plane inclined to the vertical and a pivot axis for the closure is inclined in the same sense as the seat and also inwardly towards the axis of the flow passage. In the preferred form of the valve shown in British Patent Specification 1 489 578, the seat and closure are assembled as a unit to facilitate insertion in and removal from a valve housing. The full disclosure of the prior application is hereby incorporated in the present specification by reference.

However, it is not necessary to incline the valve seat as described in British Patent Specification 1 489 578 in order to obtain the advantage of a tendency of the valve to close under gravity for all positions of the closure on its path of travel towards and away from the seat. The sealing surface of the seat can be vertical, or capable of vertical orientation in use, while the pivot axis is inclined to the vertical in a sense tending to close the valve for all positions of the closure member in use.

In the accompanying drawings:

Figures 1 and 2 are respectively a vertical section and a plan view of a backflow check valve having a pivotally mounted valve closure,

Figure 3 is a side elevation of a valve closure forming part of the present invention,

Figure 4 is a diagrammatic view of certain

of the parts shown in Figure 3, and looking in the direction of the arrow A shown in that Figure.

Figure 5 is a sectioned side elevation through part of a valve closure and seat according to the invention,

Figure 6 is a section of an alternative design of valve seat in accordance with the invention, and

Figure 7 is an enlarged view of a detail of the sealing arrangement shown in Figure 5.

It should be noted that Figures 1 and 2 do not incorporate the present invention, but are included to show the general features of a back flow check valve.

The valve shown in Figure 1 comprises a valve housing 40 with an inlet 42 and an outlet 44 adapted to be secured into a gas pipeline. The particular valve is arranged to be incorporated in the pipeline so that the inlet and outlet are substantially horizontal, but this is not essential.

The inlet portion 42 is provided at its end adjacent the housing 40 with a socket 46 to receive a valve seat/closure unit 48. The latter comprises a valve seat member 50 with a valve closure member 52 mounted thereon for swinging movement about a spindle 72 (Figure 2) which will be described in further detail below. Seat member 50 has an integral spigot 54 which extends into socket 46. A seal is formed by means of a O-ring 56 mounted in a groove in the spigot 54.

Spigot 54 has two parallel external grooves, which are vertical in the disposition shown in Figure 1 and cannot be seen in that Figure. These grooves align with corresponding groove portions of openings 62 (Figure 2) formed in the socket 46. The remainder of each opening 62 is formed as a passage to receive securing bolts (not shown), the upper ends of the passages being screw-threaded so that the bolts can be secured therein. The grooves in the spigot co-operate with the groove portions in the socket to complete the bolt receiving passages, so that after insertion of the bolts the spigot is secured in the socket 46. It will be noted that when the valve has been correctly inserted in the pipeline, the passages 62 open upwardly, so that it is easy to insert securing bolts. The housing cover 66 can then be secured to the housing 40 by bolts co-operating with openings 68 (Figure 2). The spigot could have complete openings for alignment with openings 62 in place of the grooves.

The swinging axis for the valve closure 52 is provided by a spindle 72 carried by a projection 70 on the seat member 50. A carrier arm 74 is mounted on the spindle 72 for swinging movement relative to the projection 70. The spindle 72 is so arranged in relation to the grooves in the spigot that when the unit is correctly inserted and secured in a correctly installed housing, the spindle 72 is inclined to the vertical. Thus, as viewed in Figure 1, the spindle 72 extends

upwardly and rearwardly in relation to the direction of flow, and as viewed in Figure 2, the spindle extends upwardly and inwardly in relation to the valve seat. Accordingly, the valve closure member 52 is urged towards the seat 50 under the force of gravity in any position of the valve closure member on its permitted path of travel, including the fully open and fully closed positions. In the illustrated embodiment, the sealing face of the seat has a rearward inclination corresponding with that of the spindle, but this is not essential. The seat face could be vertical.

In the embodiment of the valve illustrated in Figures 1 and 2, the valve closure 52 is secured to the arm 74 by means of a circlip 100 engaging a stub projecting from the closure through a suitable opening in the arm 74.

Embodiments of the present invention, which may be incorporated in a back flow check valve of Figures 1 and 2, will now be described by way of example only with reference to Figures 3 to 7.

In Figure 3, the arm is again indicated by the numeral 74, and the closure member by the numeral 52. Closure 52 has a pair of projections 102, 104 extending away from the face opposite seat member 50. The projection 102 is located vertically above the projection 104 when the valve unit is mounted in the housing as described above. The projections carry respective metal pins 106, 108 which extend generally towards each other in a predetermined manner which will be described further below.

Arm 74 is provided with cut-out sections 110, 112 to receive the pins 106, 108 respectively. Cut-out 110, which is uppermost in the assembled valve, as indicated in Figure 3, is provided with a plane bearing surface 114 upon which the part-spherical lower end of pin 106 rests. The closure 52 is thus suspended under gravity from the bearing provided by pin 106 and surface 114 on the arm. However, there is a degree of play between the pin 106 and the cut-out 110 which permits movement of the closure 52 on the arm 74. The permitted movement is determined partially by engagement of the closure 52 with an abutment 118 secured to the arm 74 in a manner described further below. When clear of the seat, the closure tends to rotate in an anti-clockwise direction (as viewed in Figure 3), in contact with the part-spherical abutment surface 118. The limit to this movement is determined by engagement of pin 106 with the surface 116 at the front of cut-out 110.

The modified mounting for the closure 52 includes a bias block 126 which assists the closing movement. Block 126 is formed integral with a stub 128, the end surface of which provides said abutment 118. The block is secured to the arm 74 by press fitting stub 128 in an opening 130 formed in the arm. The position of the abutment 118 relative to the surface 116 in the cut-out 110 is determined by engagement between the block 126 and the surface 131 on the

adjacent part of the arm.

The closure 52 can pivot about a centre within the end of abutment 118, rolling on the outer surface of the abutment. Thus, if the closure does not make simultaneous contact with the seat around its full periphery, there will be a reaction force at a region of first contact tending to pivot the closure on the abutment. For pivoting to occur, frictional forces at the various contact surfaces must of course be overcome, sufficient play must be left at the supports for the closure and the contact surfaces should be of low friction material.

Consider now a closing movement in which the closure does not engage the seat simultaneously all around the opening. For simplicity of illustration, assume first that a side edge portion of the closure engages the seat before the horizontally and diametrically opposite side edge portion. The part-spherical bearing portion on pin 106 then permits pivotal movement at the region of contact between the pin and the bearing surface 114. Such movement is limited in one direction by engagement of the closure member 52 with the arm 74. In order to limit such movement in the opposite direction, closure 52 is provided with a projection 120 which extends through an opening 122 provided in the arm, and carries an outwardly projecting flange 124 on the side of the arm 74 remote from the closure 52. Anti-clockwise movement of the closure 52, as viewed from above, relative to the arm is thus limited by engagement between the flange 124 and the arm 74.

Pin 108 is provided only to ensure retension of the closure 52 on the arm 74. It is only necessary therefore to ensure sufficient clearance between the pin 108 and the cut-out 112 to prevent interference with the pivoting and bearing functions associated with the pin 106.

Assume now that the bottom edge of the closure strikes first. In this case, the freedom to slide, roll and/or pivot at both the suspension point and the point of engagement with the abutment will permit the closure to move on the arm to bring the upper edge portion also into engagement with the seat. However, because of the tendency of the closure to swing anti-clockwise as viewed in Figure 3, it is more likely that the top edge of the closure will strike first. In order to move the closure on its arm in response to engagement at its top edge, it is necessary to raise the centre of gravity of the closure.

For a given angle of inclination, the axis of spindle 72 (on which arm 74 is mounted), whether or not the centre of gravity can be raised will depend upon the relationship between the weight of the closure and the weight of the arm together with its block 126. If the arm and block together are heavy in relation to the closure, so that the net effect of a pivotal movement on the arm is a continued downward movement of the centre of

gravity of the combined closure, arm and block then the closure will be able to pivot in response to first engagement of its top edge with the seat. If, however, the closure is relatively heavy so that a clockwise pivotal movement, as viewed in Figure 3, would result in raising of the centre of gravity of the combination, then the closure will not be able to pivot in response to first contact at its top edge. In these circumstances, the valve should be arranged so that in use the closure will engage the seat substantially simultaneously at its top and bottom edges or at least to avoid first contact at the top edge. This can be arranged in the assembly operation, for example by eliminating clearance between pin 106 and face 116 on the arm with the closure aligned in the required manner. Alternatively, there may be a separate setting member (not shown) extending between the arm and closure to maintain the latter in a desired alignment. In any case, it will be understood that the closure remains free to pivot from side to side, and it is easier to align the closure correctly on the arm than to assemble the spindle 72 at a precise angle such as to enable the closure to seat correctly.

It follows from the above that the weight of the closure should be minimised. The weight of the closure will be determined by the back pressure it has to withstand, and the strength of the material available. A plastics material such as that sold under the Registered Trade Mark "Kematal" offers high strength for low weight. The maximum weight of the arm together with its block will be determined by the angle of the axis of spindle 72 to the vertical and the allowable pressure drop through the valve.

If the closure engages at its top or bottom edge first as the valve shuts, there will be sliding motion between the pin 106 and the bearing surface 114 on the arm. It is desirable that such relative motion between the pin 106 and the surface 114 occurs in a generally horizontal plane. In order to ensure this, bearing surface 114 is formed at an angle to the spindle 72 such that the bearing surface is generally horizontal (as shown in Figure 3), when the valve closure is in the closed position. Further, pin 106 is mounted in the projection 102 so as to lie substantially vertically when the closure is in the valve closed position. The side walls of the cut-out 110 must therefore be arranged at an angle to the spindle 72 (see Figure 4), supporting the pin 106 in the upright position as the closure approaches the valve closed position.

In an alternative embodiment (not shown), bearing surface 114 on the arm 74 may be made part-spherical, centred on the region of the abutment 118 about which the closure 52 will pivot in use. By this means, the centre of gravity of the closure 52 remains at approximately the same height for all pivotal positions relative to the abutment 118. Therefore, the difficulties described above in relation to a plane bearing surface may be avoided, depending upon

frictional forces involved. If the arm 74 is moulded of a plastics material, there will be no difficulty in producing the required part-spherical bearing surface 114.

5 In further modified embodiments (not shown), the lower pin 108 may be formed integral with the closure member. An alternative hook arrangement to the pin 120 and flange 124 may be used to prevent undue
10 pivoting movement of the closure relative to the mounting arm. Alternatively, the arm may be formed with an extension to the left of stub 128 (as viewed in Figure 4) to engage the closure and limit sideways pivoting movement. Further, the mounting for the seat/
15 closure unit may be varied from the spigot type illustrated in the drawings. The abutment 118 may be formed integral with the arm 74 as may the bias block 126.

20 In many uses of valves which incorporate the assembly shown in Figures 3 and 4 it will be desired to form a seal between the closure and seat under very low back pressures, for example as little as 0.2 inch water gauge. It is difficult to
25 form an adequate seal between the closure and seat under these conditions, but this can be facilitated by a seal arrangement as illustrated in Figures 5 or 6.

As seen in Figure 5, the forward face of
30 seat 50 is provided with a resilient facing 80 extending all around the opening 82 through the valve seat. The valve closure 52 is provided on its reverse face with an endless ridge 84 which is the first part of the closure to engage
35 the resilient facing 80 on the seat.

The provision of the ridge 84, in combination with the resilience of the facing 80, has a number of advantageous effects. Firstly, should the ridge 84 tend to contact one region of the
40 facing 80 before another, the facing can deform in the contacted region to permit continued movement of the closure 52 to ensure contact all around the opening 82. For example, if the upper part of the ridge 84 engages the facing 80
45 at the point X in Figure 7 before the lower part of the ridge can contact the facing, the previously planar facing is deformed to the dished shape 86 shown in Figure 7. This enables the continued forward movement of the lower
50 part of the ridge 84 into contact with the facing 80. This is further facilitated in that the back pressure acts over the full forward face of the closure 52, producing a force on the closure which is converted into a relatively high pressure
55 over the limited area of contact between the ridge 84 and the resilient facing 80.

It will be noted also that deformation of the facing 80 causes the material to "wrap around" the adjacent face of the ridge 84, forming a good
60 seal therewith. As the pressure increases, the resilient material may be deformed further to contact closure 52 at regions 88 (Figure 7) on either side of the ridge 84, with further improvement in the sealing effect. As the pressures increase further still, there will eventually be

substantially planar face to face contact between the closure 52 and the facing 80 on either side of the ridge 84.

In the embodiment of the invention illustrated in Figure 5, a seat 50 is provided with a
70 groove 90 underlying the region of facing 80 contacted by the ridge 84. The provision of the groove 90 facilitates deformation of the facing in response to the pressure of the closure flap 52. If it is found that the facing 80 tends to
75 "take a set" in response to repeated sealing engagement by the ridge 84, then the groove may be at least partially filled with a resilient material to urge the facing 80 outwardly again, after it has been depressed into the groove by
80 the ridge 84.

The facing 80 is preferably secured to the seat on only one side of the groove, that is, either radially inwardly or radially outwardly thereof. This permits the facing to flex easily
85 into the groove when engaged by the ridge. In Figure 5, the facing 80 is secured to the seat 50 by a metal ring 92 which is press-fitted into the seat 50 and has an outwardly projecting flange 94 to engage the facing and clamp it to the seat. 90 Ridge 84 is provided on a rearwardly projecting edge portion of closure 52 arranged to provide sealing faces 96 to either side of the ridge.

The arrangement in accordance with the invention shown in Figure 6 is similar, but the
95 clamping ring is now provided at the outer edge of the facing 80. In this case, it may be found that the fluid passing through the valve passes between facing 80 and the seat 50. Resultant deformation of the facing may impede opening of the valve, and it may cause repeated opening and closing at low pressures. The problem can be mitigated by providing a flow deflector in the form of a sleeve press-fitted into an annular
100 groove 97. The sleeve may extend past the inner edge of the facing 80, and direct flow of fluid medium away therefrom. The sleeve may extend beyond the seat, into a suitable recess (not shown) in the valve closure 52. However,
105 it is preferred to clamp the facing at its inner edge as shown in Figure 5. The groove may be vented to the atmosphere, as indicated by the dotted line passages 91 in Figures 5 and 6.

The facing 80 should be made of a material which is compatible with the medium to be
115 passed through the valve, and which will retain its resilience for a suitable period. One suitable material is oiled goatskin which is at present incorporated in backflow check valves employed in gas mains. Alternative materials are neo-
120 prene, and nitrile rubbers, where they are compatible with the fluid flow medium.

The dimensions of the ridge 84 are preferably as large as possible to obtain the desired
125 sealing effect, thereby to minimise the chance of damage to the ridge by abrasion in use. It has been found, for example, that on a valve having a nominal 2" flow passage, a ridge of circular cross-section with a 1/32" radius is suitable. The
130 shape of the ridge, however, is not believed to

be critical, and it could have a more pointed cross-section than the illustrated part circular section.

To facilitate sealing at very low back pressures, of the order of 0.2" water gauge, the facing 80 should be applied in such manner as to avoid the formation of radially extending channels therein, for example such as might be formed by radial "puckers" in the material. The structure of the valve closure 52 may be such as to resist a backflow pressure of the order of 100 lb/sq in. A suitable material for formation of the closure 52 and seat 50 is plastics, for example that sold under the Registered Trade Mark "Kematal".

Any of the sealing arrangements of Figures 5 to 7 can of course be applied to the embodiment of Figures 3 and 4, and closure 52 of Figure 3 is shown with a ridge 132 for this purpose.

Further modifications are possible, for example, the ridge could be provided by a separate member assembled to the valve closure. There may, if required, be a plurality of ridges on the seat or the valve closure with corresponding resilient members on the other part if required.

WHAT WE CLAIM IS:—

1. In or for a valve, an assembly including a valve seat with an opening therein and a pivotally mounted closure co-operable therewith, the closure having an annular ridge projecting towards the seat, and the seat having an annular resilient member mounted thereon such that on closing of the closure the ridge engages the resilient member to provide a seal, and in which a groove in the seat underlies part of the resilient member, said resilient member being deform-

able into said groove when the closure is closed.

2. An assembly as claimed in Claim 1 wherein the resilient member is secured to the seat on one side only of the groove.

3. An assembly as claimed in Claim 2 wherein said side is the side closer to the flow opening through the valve seat.

4. An assembly as claimed in Claim 2 wherein said side is the side remote from the flow opening through the valve seat and means are provided to impede access of fluid medium to the space between the resilient member and the closure.

5. An assembly as claimed in any preceding claim wherein the groove contains resilient material to be contacted by the resilient member during deformation thereof and to urge the resilient member outwardly of the groove.

6. An assembly as claimed in Claim 1 wherein the resilient member is adapted to wrap around the ridge after initial sealing contact has been made.

7. An assembly as claimed in Claim 6 wherein the resilient member is adapted to contact the closure on either side of the ridge at high sealing pressures.

8. An assembly as claimed in any preceding claim in which the groove is vented through the seat body to atmosphere.

9. In or for a valve, an assembly including a valve seat and closure substantially as hereinbefore described with reference to Figures 5 to 7 or Figures 3 and 4 as modified by Figures 5 to 7.

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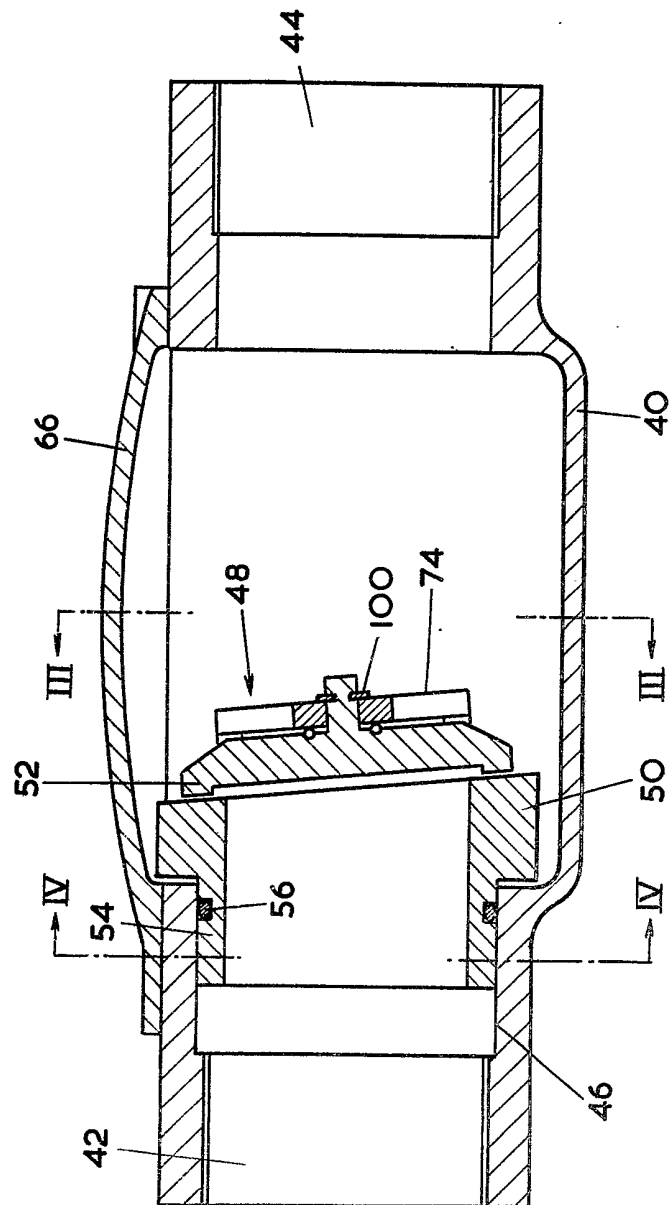


FIG. 1

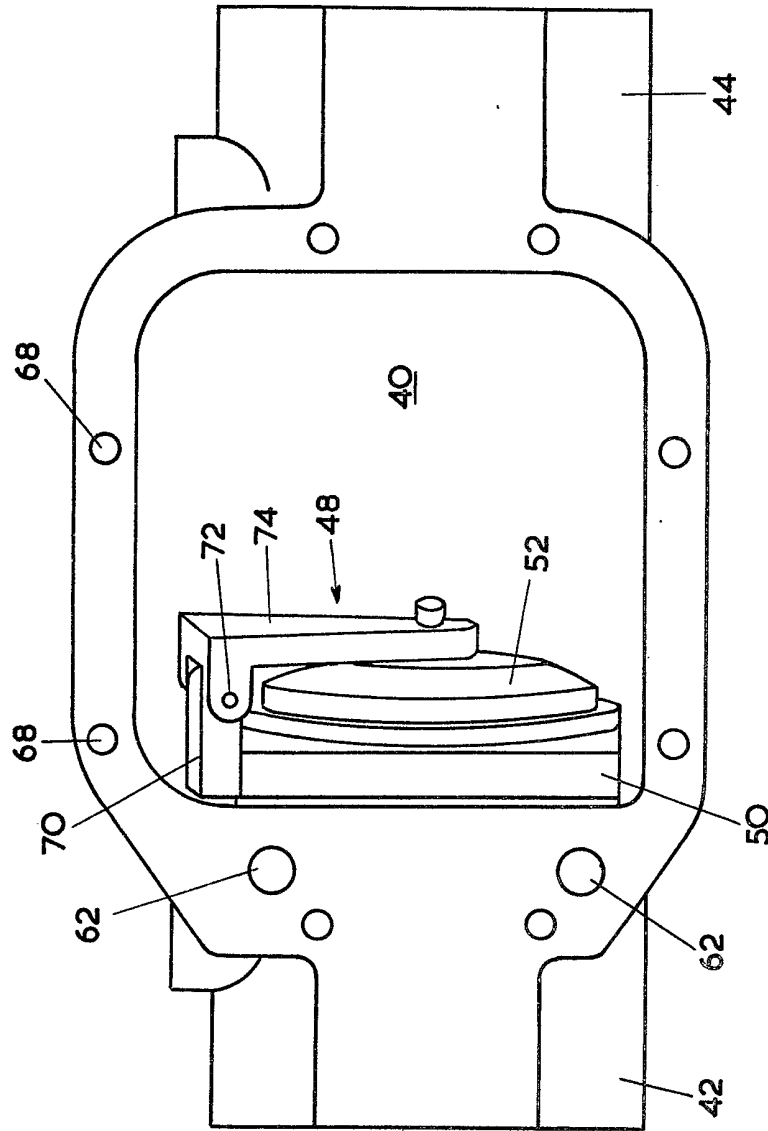


FIG. 2

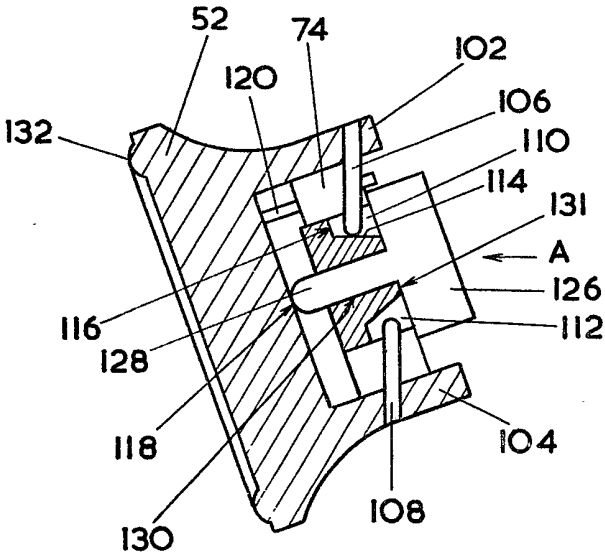


FIG. 3

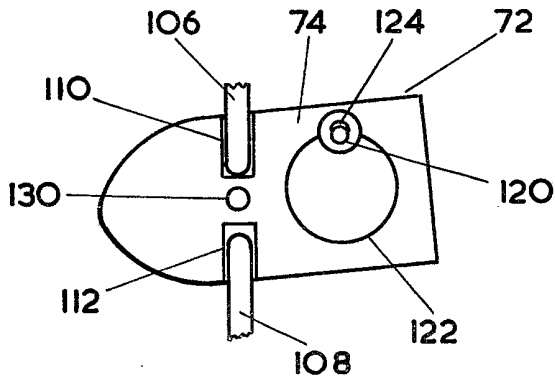


FIG. 4

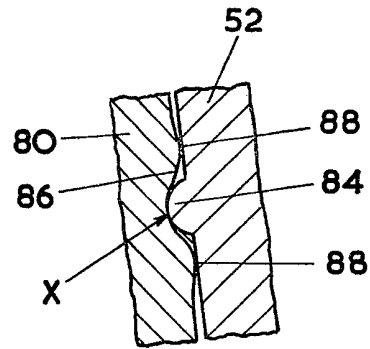


FIG. 7

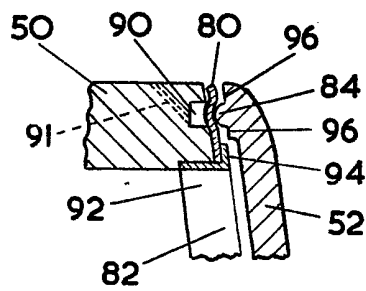


FIG. 5

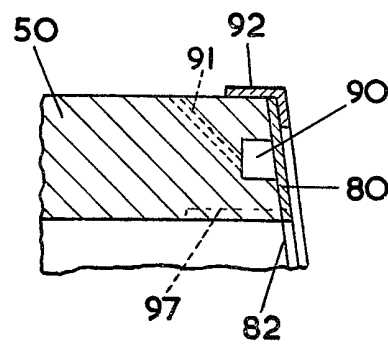


FIG. 6