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DESCRIPTION

Background Of the Invention

[0001] Diaphragm-type fluid control valves can provide controlled fluid separation and flow along a pipe-line, manifold or other piping network. Generally, the diaphragm-type valve includes a flexible diaphragm element to control fluid flow between the inlet and the outlet of the valve body. More specifically, in known diaphragm-type valves, the diaphragm element engages a seat formed within the valve body to separate the interior chamber of the valve body into three parts: (i) the inlet chamber which can hold the supply fluid, (ii) and outlet chamber which receives fluid from the inlet chamber for discharge out the outlet and (iii) a diaphragm chamber which can hold a fluid under pressure to urge and maintain the diaphragm element in the seated position. Upon release of fluid pressure from the diaphragm chamber, the diaphragm element can be displaced from the seated position by the pressure of fluid in the inlet chamber and fluid flow is permitted between the inlet and the outlet chambers. Known diaphragm elements and diaphragm-type control valves are shown and described in European Patent Application No. EP 0928917, U.S. Patent No. 6,095,484 and U.S. Patent No. 7,059,578. Another known diaphragm-type valve is shown and described in Tyco Fire & Building Products data sheet TFP 1305 entitled, "Model DV-5 Deluge Valve, Diaphragm Style, 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200), 1723.7kN/m2 (250 psi. (17.2 bar)) Vertical or Horizontal Installation" (March 2004) as described in U.S. Provisional Patent Application No. 60/887,040.

[0002] One particular application for using known diaphragm-control valves is in the control of fluid flow between a fluid source under pressure such as, for example, a water main, and another fluid volume such as, for example, a network of pipes filled with a air. When a diaphragm-type valve is used to separate two fluid volumes that are to be independently pressurized, a check- valve is typically employed downstream of the diaphragm valve to form a seat against which the air or other fluid pressure may build downstream of the valve. For example, dry preaction fire protection systems employ a riser check-valve downstream of the diaphragm control valve to provide a seat for pressurizing the downstream network of pipes and sprinklers with pressurized gas. Such preaction system installations are shown for example in the following Tyco Fire & Building Product data sheets, and described in U.S. Provisional Patent Application No. 60/887,040 respectively: (i) TFP 1420 "Preaction System with Model DV-5 Deluge Valve Single Interlock, Supervised - Electronic Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)" (Sept. 2004) showing a riser check valve 16 in Figure 1; (ii) TFP1 415 "Preaction System with Model DV-5 Deluge Valve Single Interlock, Supervised - Dry Pilot Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)" (Sept. 2004) showing a riser check valve 17 in Figure 1; (iii) TFP 1410 "Preaction System with Model DV-5 Deluge Valve Single Interlock, Supervised - Wet Pilot Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)" (Sept. 2004) showing a riser check valve 14 in Figure 1; (iv) TFP 1465 "Preaction System with Model DV-5 Deluge Valve Double Interlock -

Electronic/Electric Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)" (Sept. 2004) showing a riser check valve 16 in Figure 1; and (v) TFP 1460 "Preaction System with Model DV-5 Deluge Valve Double Interlock - Electronic/Pneumatic Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)" (Sept. 2004) showing a riser check valve 16 in Figure 1. Effectively, the check valve defines for the system two pressures between the control valve and the network of sprinklers: (i) a first pressure down stream of the check valve equivalent to the supervisory air of the system; and (ii) a second pressure upstream of the valve between the control valve and the check valve that is different than the first pressure. The second pressure is typically atmospheric pressure to provide for a drain and/or an alarm port to comply with the installation or operational requirements under one or more standards such as, for example, Factory Mutual (FM) LLC publication, "Approval Standard: For Automatic Water Control Valves - Class Number 1020" (April 2007) ("FM Standard 1020").

[0003] US5706859 discloses a diaphragm valve for controlling a flow of gaseous or liquid fluid.

[0004] GB52798 teaches diaphragm valves having substantially straight through bores in the valve bodies.

[0005] US5476118 discloses a non-stagnant piping system.

Summary of the Invention

[0006] According to a first embodiment of the present invention there is provided a fluid control valve for providing fluid control between a first fluid and a second fluid comprising:

a body having an inlet, an outlet and an inner surface defining a passageway between the inlet and the outlet, the body further including a port in communication with the passageway and located between the inlet and the outlet; and

a flexible member engaged with the inner surface by fluid pressure acting on the flexible member to dissect the passageway to define an inlet chamber in communication with the inlet for housing the first fluid, an outlet chamber in communication with the outlet for housing the second fluid and an intermediate chamber disposed between the inlet chamber and the outlet chamber and in communication with the port; and characterised in that the inner surface includes an elongated seat member for engagement with the flexible member, the seat member defining a groove forming part of the intermediate chamber that is in communication with the port.

In one aspect, the preferred control valve can be installed in piping systems, such as for example, the preaction fire protection systems described above without the need for a check valve downstream of the control valve. Instead, the intermediate chamber of the preferred control valve can provide for the drain and/or alarm port at atmospheric pressure. Thus, the preferred control valve can provide for a single and preferably substantially constant pressure between the control valve and the network of sprinklers. Preferably adjacent each of the two axially separated chambers is a diaphragm chamber for controlled operation of the diaphragm member. The preferred orientation of the diaphragm chamber relative to the axially spaced chambers provides that the diaphragm chamber can seal the axially spaced chambers from one another with a diaphragm fluid pressure that is almost at a preferred 1 : 1 ratio and more preferably at a 1 :1.2 ratio, with the fluid pressure in either one of the two axially separated chambers. Moreover, the preferred control valve, the diaphragm, and orientation of the chambers provide for a controlled seal between the axially spaced chambers that can compensate for fluctuations and surges in the fluid pressure in either of one of the two axially separated chambers.

[0007] In another preferred aspect a diaphragm-type control valve is provided for use in the separation and flow control between a first fluid volume at a first fluid pressure and a second fluid volume at a second fluid pressure. The preferred diaphragm-type control valve provides a chamber having a first sealed engagement for sealing the first fluid volume and a second sealed engagement for sealing the second fluid volume. The first sealed engagement is preferably spaced from the second sealed engagement so as to define an intermediate chamber therebetween. More preferably, the intermediate chamber is exposed to atmosphere so as to define an alarm port for detecting a breach in either the first or second sealed engagement. Accordingly, one preferred aspect of a fluid control valve includes a valve body having a first inner surface defining a chamber having a first axis and a second axis substantially perpendicular to the first axis. The chamber further includes an inlet and an outlet in communication with the chamber and substantially aligned along the first axis. The inner surface also preferably includes an elongated seat member substantially aligned along the second axis and preferably defining a groove. A portion of the body further preferably defines a port in communication with the groove. The preferred control valve also includes a diaphragm member disposed within the chamber for controlling communication between the inlet and the outlet. The diaphragm member has an upper surface and a lower surface. The lower surface preferably includes a pair of spaced apart elongated members defining a channel therebetween. The diaphragm member preferably has a first position permitting communication between the inlet and the outlet and at least a second position wherein the elongated members are in sealed engagement with the seat member such that the channel is in communication with the groove and the port.

[0008] In one preferred aspect of the diaphragm member, the diaphragm member defines a central axis substantially perpendicular to the first and second axis. Furthermore each of the elongated members includes an angled surface extending from the lower surface of the diaphragm member to define a surface of the channel and terminating in a peak. Accordingly, the elongated members preferably define a substantially triangular cross area.

[0009] In a preferred aspect of the valve body, the seat member defines a substantially planar surface extending along an arc length in its direction of elongation. Moreover, the valve body further includes a first brace member and a second brace member disposed about and engaged with the seat member. Preferably the first and second brace members are integrally formed with the seat member.

[0010] In another preferred aspect of the valve body, the valve body defines a central axis substantially perpendicular to the first and second axes, and the port is preferably substantially aligned with the central axis. The port further preferably has a first portion having a first width opening and a second portion axially aligned with the first portion, the second portion having a second width opening having a width smaller than the first width opening. More preferably, the first portion and the second portion are substantially cylindrical each having a central axis, the central axis of the first portion being spaced from the central axis of the second portion. In addition, the second width is defined along the first axis and the second portion defines a third width along the second axis greater than the second width. Furthermore, the port preferably defines a substantially elongated oval cross-section.

[0011] In another preferred aspect, provided is a valve including a body having an inlet, an outlet and inner surface defining a passageway between the inlet and the outlet. The body further includes an atmospheric port in communication with the passageway and located between the inlet and the outlet. Moreover, the valve includes a flexible member engaged with the inner surface to dissect the passageway to define an inlet chamber in communication with the inlet, an outlet chamber in communication with the outlet and an intermediate chamber in communication with the port. Preferably, the port includes a first portion defining a first width and a second portion axially aligned with the first portion and defining a second width, wherein further the first width is greater than the second width.

[0012] Another preferred embodiment provides a method of pressurizing a chamber in a fluid control valve having a diaphragm member, the method comprising:

seating the diaphragm member to form a gas chamber axially spaced from a liquid supply chamber;

forming a gas seat between the gas and liquid chamber; characterised in that the method further comprises forming the gas seat includes engaging elongated members of the diaphragm with a seat member formed along an inner surface of the valve; and includes placing a channel of the diaphragm defined by the elongated members in communication with a groove formed in the seat member.

[0013] Accordingly, the various preferred embodiments of the preferably hydraulically operated control valve, its diaphragm and method of use can provide one or more of the following features: a design that employs a minimum number of moving components to reduce wear, a construction that facilitates easy assembly and serviceability, and reliable performance. In addition, the preferred embodiments provide for piping systems, and more specifically fire protections systems, such as for example, preaction and non-preaction (deluge systems). In the case of preaction systems, the preferred control valve can minimize the number of components required for a complete system that is preferably compliant with applicable installation and operational standards and requirements by consolidating in a single valve the functions of: (i) controlled sealing between the "wet" region of the system and the "dry" region of the system; and (ii) providing a monitoring region, preferably exposed to atmosphere, between the "wet" and "dry" regions which can provide visual and/or audio indication of valve and/or system operation.

Brief Descriptions of the Drawings

[0014] The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate exemplary embodiments of the invention, and, together with the general description given above and the detailed description given below, serve to explain the features of the invention.

FIG. 1 is a perspective view of a preferred control valve.

FIG. 2 is an exploded view of the control valve of FIG. 1.

FIG. 2A is a cross-sectional view of the control valve of FIG. 1.

FIG. 2B is a plan view of the control valve of FIG. 1.

FIG. 2C is a detailed view of a preferred threaded stud assembly for use in the control valve of FIG. 1.

FIG. 3A is a plan-view of the upper surface of a preferred diaphragm for use in the control valve of FIG. 1.

FIG. 3B is a plan-view of the lower surface of the diaphragm in FIG. 3.

FIG. 3C is a cross-sectional view of the diaphragm along axis IIIC-IIIC in FIG. 3B.

FIG. 3D is another cross-section view of the diaphragm along axis IIIC-IIIC in FIG. 3B.

FIG. 4A is a plan-view of the lower valve body of the control valve in FIG. 1.

FIG. 4B is a cross-sectional detailed view of the lower valve body in FIG. 4A.

FIG. 4C is a cross-sectional view of the lower valve body along axis IVC-IVC in FIG 4A.

FIG. 4D is another cross-sectional view of the lower valve body along axis IVD-IVD in FIG. 4A.

FIG. 5 is cross-sectional perspective schematic view of the control valve of FIG. 1 installed in a preferred piping manifold.

FIG. 6 is a schematic view of another preferred installation of the control valve of FIG. 1.

Detailed Description

[0015] Shown in FIG. 1 is an illustrative embodiment of a preferred control valve 10. The valve 10 includes a valve body 12 through which fluid can flow in a controlled manner. More specifically, the control valve 10 provides a diaphragm-type hydraulic control valve for preferably controlling the release and mixture of a first fluid volume having a first fluid pressure, such as for example a water main, with a second fluid volume at a second fluid pressure, such as for example, compressed gas contained in a network of pipes. Accordingly, the control valve 10 can provide fluid control between fluids or various media including liquids, gasses or combinations thereof.

[0016] The control valve 10 is preferably configured for installation in a piping manifold or other piping assembly to separate and control fluid flow between the first fluid volume and the second fluid volume. The control valve 10 includes a valve body 12 preferably constructed in two parts: (i) a cover portion 12a and (ii) a lower body portion 12b. "Lower body" is used herein as a matter of reference to a portion of the valve body 12 coupled to the cover portion 12a when the control valve is fully assembled. Preferably, the valve body 12 and more specifically, the lower body portion 12b includes an inlet 14 and outlet 16. Each of the inlet and outlet 14, 16 of the body 12 includes an appropriate end fitting for coupling to the manifold. Thus, inlet 14 preferably includes a flanged end for coupling to a first fluid supply line, such as for example a water main, and the outlet 16 also preferably includes a flanged end for coupling to another pipe 9 fitting such as, for example, a discharge pipe coupled to a network of interconnected pipes. The control valve 10 can be installed in either a horizontal orientation such that fluid entering the inlet 14 at one elevation is discharged from the outlet 16 at the same elevation, or alternatively, the control valve can be installed in a vertical orientation such that fluid entering the inlet at one elevation is discharged from the outlet at a different elevation.

[0017] The inlet 14, outlet 16 and valve body 12 can be sized so as to provide a range of nominal valve sizes for coupling to corresponding pipe size. Preferably, the inlet 14, outlet 16 and valve body 12 define nominal valve sizes of 1 inch and larger and more specifically nominal valve sizes of (38.mm, 50.8mm, 76.2mm, 101.6mm, 152.4mm and 203.2mm (1-1/2 inch, 2 inch, 3 inch, 4 inch, 6 inch and 8 inch), however other nominal valve sizes can be provided. Preferably, construction of the valve 12, the cover 12a and the lower valve body 12b are separately cast and machined to provide the preferred openings and surface treatments such as threaded openings. However, other processes for construction and manufacturing can be used. The valve body 12 is preferably cast from ductile iron however other materials may be used provided they are suitable for a given fluid flow application.

[0018] The valve body 12 also includes a drain 18 for diverting the first fluid entering the valve 10 through the inlet 14 to outside the valve body. The valve body 12 further preferably includes an input opening 20 for introducing the second fluid into the body 12 for discharge out the outlet 16. An exemplary cover 12a, and lower body 12b with an inlet 14, an outlet 16, a fluid drain 18 and an input opening 20, is shown and described in U.S. Patent Nos. 6,095,484 and 7,059,578. However, unlike the valves shown and described in U.S. Patent Nos. 6,095,484 and

7,059,578, the preferred diaphragm-type control valve 10 further includes a valve body 12 with a port 22. The inventors have discovered that the inclusion of a port 22 in the valve body 12 can provide means for an alarm system monitoring the valve for any undesired fluid communication from and/or between the inlet 14 and the outlet 16. For example, the port 22 can be used for providing an alarm port to the valve 10 so that individuals can be alerted as to any gas or liquid leak from the valve body 12. More specifically, the port 22 can be coupled to a flow meter and alarm arrangement to detect the fluid or gas leak in the valve body. In addition, the port 22 is preferably open to atmosphere and in communication with an intermediate chamber disposed between the inlet 14 and the outlet 16. Each of the fluid drain 18, input opening 20 and port 22 can include an appropriately threaded opening or other mechanical fastening member for coupling an appropriate pipe fitting or nipple to the given orifice.

[0019] Shown in FIG. 2 is an exploded view of the preferred valve 10 showing the internal components of the valve 10. The cover 12a and the lower body portion 12b are preferably coupled together by a plurality of bolts distributed in a bolt pattern about the body 12. Shown in FIG. 2B is a plan view of the control valve 10 and a preferred bolt pattern that includes eight nut and bolt assemblies. In an alternative bolt assembly, shown for example in FIG. 2C, a threaded stud nut and assembly 50 can be utilized. The stud assembly 50 preferably includes a threaded stud 52 engaged with the corner bolt holes of the cover 12a and the lower valve body 12b. To secure the cover 12a to the assembly, the washer and nut can be threaded onto and tightened about the stud 52. The stud assembly 50 can facilitate the assembly of the control valve 10 when installed in the vertical orientation. More specifically, preferably four threaded studs 52 can be equally spaced about the bolt pattern engaged with the lower valve body 12b. The studs can be permanently or temporarily fixed to the lower valve body 12b. The cover 12a can then be disposed over the threaded studs 52 and permitted to hang supported by the threaded studs 52 thereby freeing an assembler's hands to complete the control valve assembly with the necessary threaded bolt and nut assemblies. Preferably, each of the threaded studs 52 are preferably rated to support a transverse load of between 22.7kg to 45.4kg (fifty to one hundred pounds (50-100 lbs.)). To further facilitate assembly of the control valve 10, the cover 12a can include one or more eyelets to which a hook and cable or chain may be secured for lifting the cover 12a into position adjacent the lower valve body 12b.

[0020] The cover 12a and the lower body 12b each include an inner surface such that when the cover and lower body portion 12a, 12b are joined together, the inner surfaces further define a chamber 24. The chamber 24, being in communication with the inlet 14 and the outlet 16, further defines a passageway through which a fluid, such as water, can flow. Disposed within the chamber 24 is a flexible preferably elastomeric member 100 for controlling the flow of fluid through the valve body 12. The elastomeric member 100 is more preferably a diaphragm member configured for providing selective communication between the inlet 14 and the outlet 16. Accordingly, the diaphragm has at least two positions within the chamber 24: a lower most fully closed or sealing position and an upper most or fully open position.

[0021] In the lower most closed or sealing position, as seen for example in FIG. 2A, the diaphragm 100 engages a seat member 26 constructed or formed as an internal rib or middle flange within the inner surface of the valve body 12 thereby sealing off communication between the inlet 14 and the outlet 16. With the diaphragm 100 in the closed position, the diaphragm 100 preferably dissects the chamber 24 into at least three regions or sub-chambers 24a, 24b and 24c. More specifically formed with the diaphragm member 100 in the closed position is a first fluid supply or inlet chamber 24a in communication with the inlet 14, a second fluid supply or outlet chamber 24b in communication with the outlet 16 and a diaphragm chamber 24c. The cover 12a preferably includes a central opening 13 for introducing an equalizing fluid into the diaphragm chamber 24c to urge and hold the diaphragm member 100 in the closed position. Preferably, the equalizing fluid is provided from the first fluid source such that any surges in flow or pressure experienced at the inlet chamber 24a is also experienced in the diaphragm chamber 24c such that diaphragm chamber can react and compensate with a diaphragm pressure to maintain the diaphragm member 100 in the closed position.

[0022] Moreover, the preferred relative orientation of the sub-chambers 24a, 24b, 24c is such that the each of the inlet and outlet chambers 24a, 24b are adjacent the diaphragm chamber 24c which, in combination with the flexibility of the diaphragm member 100, contributes to the ability of the diaphragm chamber 24c to compensate for surges in the flow or pressure experienced in either the inlet or outlet chambers 24a, 24b. In addition, the preferred orientation can further facilitate the performance of the valve 10 to maintain the sealed engagement of the diaphragm member 100 under the preferred ratio of equalizing fluid pressure to primary fluid pressure in a manner described in greater detail below. Known fluid control valves that use either a more rigid type of diaphragm or mechanical latching clapper are believed to require an increased mechanical force or equalizing pressure to maintain a seal within the valve in order to compensate for any possible surges or fluctuations in the fluid being conveyed.

[0023] In operation of the control valve 10, the equalizing fluid can be relieved from the diaphragm chamber 24c in preferably a controlled manner to urge the diaphragm member 100 to the fully open or actuated position, in which the diaphragm member 100 is spaced from the seat member 26 thereby permitting the flow of fluid between the inlet 14 and the outlet 16. The fluid release from the diaphragm chamber 24c can be regulated by way of, for example, an electrically controlled solenoid valve, such that the diaphragm member 100 can achieve regulated positions between the fully closed position and the fully open position. Accordingly, the diaphragm member 100 is preferably electrically actuated between the open and closed positions. Alternatively, the diaphragm can be actuated, regulated and/or closed or latched by other mechanisms such as, for example, a mechanical latching mechanism.

[0024] Shown in FIGS. 3A-3D is an illustrative embodiment of the diaphragm member 100. The diaphragm member 100 includes an upper surface 102 and a lower surface 104 preferably circumscribed by a flange portion 101 having a bolt pattern for being compressed and secured between the cover 12a and lower valve body 12b. Each of the upper and lower surface areas 102, 104 are generally sufficient in size to seal off communication of the inlet and outlet chamber 24a, 24b from the diaphragm chamber 24c. The upper and lower surface areas 102, 104 are preferably substantially circular in plan view however other geometries are possible depending on the geometry of the chamber 24 and provided that the surfaces effectively dissect and seal the chamber 24. An exemplary configuration of the upper surface 102 of the diaphragm member 100 is shown and described in U.S. Patent No. 7,059,578. Accordingly, the upper surface 102 preferably includes a centralized or interior ring element 105 and radially extending therefrom are one or more tangential rib members 106. The tangential ribs 106 and interior ring 105 are configured to urge the diaphragm 100 to the sealing position upon, for example, application of an equalizing fluid to the upper surface 102 of the diaphragm member 100. The diaphragm 100 preferably defines a central axis A-A about which the rib members 106 are preferably disposed. Alternate configurations of the upper surface 102 is possible.

[0025] Additionally, the diaphragm 100 preferably includes an outer elastomeric ring element 108 to further urge the diaphragm member 100 to the closed position. In the complete assembly of the valve 10, as seen for example in FIG. 2A, the outer preferably angled surface of the flexible ring element 108 engages and provides pressure contact with a portion of the valve body 12 such as, for example, the interior surface of the cover 12a. Thus, the flexible ring element 108 assists in urging the diaphragm 100 towards its sealing position to permit closure of the valve.

[0026] Another exemplary configuration of the upper surface 102 of the diaphragm member 100 is shown and described in U.S. Patent No. 6,095,484. More specifically, the upper surface can include a plurality alternatively or in addition to a plurality of ribs (not shown) in a ring arrangement and located centrally atop the upper surface 102 of the diaphragm member 100. The ring arrangement is preferably configured to engage the inner surface of the cover 12a and apply a force urging the diaphragm member 100 toward its closed position.

[0027] In its closed position, the lower surface 104 of the diaphragm member 100 preferably defines a centralized bulged portion 110 to avoid excessive stretching of the diaphragm material during diaphragm cycling and to enhance stability in both the upper and lower positions. The lower surface 104 thus preferably presents a substantially convex surface, and more preferably a spherical convex surface, with respect to the seat member 26, having an area *A1,* and the upper surface 102 presents a substantially concave surface, and more preferably a spherically concave surface with respect to the diaphragm chamber 24c, having an area *A2.* Upper surface *A2* is preferably about equal to *A1.* Portions of the lower surface 104 act to seal off fluid communication from the other chambers, i.e. a portion of lower surface 104 seals the inlet chamber 24a from the outlet chamber 24b and the diaphragm chamber 24c. Accordingly, substantially convex surfaces are preferably presented to seal off the inlet and outlet chambers 24a and 24b. Moreover, the preferred geometry of the sub-chambers 24a, 24b, 24c relative to one another preferably provides that the areas sealing the inlet and outlet chambers 24a, 24b are about equal, and that the inlet chamber 24a is sealed off by a portion of the lower surface 104 having an area of about ½*A1*, and the outlet chamber is sealed off by a portion of the lower surface 104 having an area of about ½ *A1*. In one preferred embodiment of the diaphragm 100, the lower surface 104 defines a first radius of curvature and the upper surface 102 defines a second radius of curvature. Where the diaphragm 100 includes a middle layer 103, the middle layer can further define a third radius of curvature. The various radii of curvatures can be measured from a common central point or alternatively from different center points. The ratio of the radius of curvature of a lower layer to the radius of curvature of an upper layer is preferably greater than 1 and sufficient to permit the lower surface 104 to engage the seat member 26 when the diaphragm 100 is in the lower position to adequately seal off the inlet and outlet chambers 24a, 24b. Alternatively or in addition to, the lower surface 104 can further define more than one radius of curvature such that the lower surface 104 engages the seat member 26 in a sealing manner.

[0028] In one preferred aspect of the diaphragm member 100 for use in a valve body having a nominal valve size of 101.6mm (four inches (4 in.)), the middle layer defines a radius of curvature of about 196.9mm to about 203.2mm (about 7.75 inches to about eight inches (8 in.)) and is preferably about 201.9mm (about 7.95 inches). The upper surface 102 preferably defines a radius of curvature of about 190.5mm to about 196.9mm (about 7.5 inches to about 7.75 inches) and is preferably about 193mm (about 7.6 inches). Each of the radii of curvatures for the middle layer 103 and the upper surface 102 is preferably measured from a common central point along the central axis A- A of diaphragm member 100. Thus, the ratio of the radii of curvatures of the middle layer 103 to the upper surface 102 in a preferred 101.6mm (four inch (4 in.)) valve is about 1.05: 1. In addition, the lower surface 104 preferably defines at least one radius of curvature ranging from about 108mm to about 114.3mm (about 4.25 inches to about 4.5 inches) and is preferably about 110mm (about 4.33 inches) measured from a center point offset from the central axis A-A of the diaphragm member 100. More preferably, the center point is horizontally off-set from the central axis by about about 35.6mm (1.4 inches) and vertically off-set from the elastomeric ring by about 53.3mm (about 2.1 inches). Moreover, the bulged portion 110 preferably defines a diameter ranging from about 256.5mm to about 281.9mm (about 10.10 inches to about 11.10 inches) and is preferably about 265.9mm (about 10.47 inches). The elastomeric ring element 108 preferably defines an outer diameter ranging from about 259mm to about 206.7mm (about 10.20 inches to about 10.5 inches) and is preferably about 260.1mm (about 10.24 inches) and more preferably about 262.6mm (about 10.34 inches). The elastomeric ring element 108 preferably defines an inner diameter of about 235mm to about 241.3mm (about 9.25 inches to about 9.5 inches) and is preferably about 240mm (about 9.45 inches) and more preferably about 236mm (about 9.29 inches). The overall height of the diaphragm from the upper surface of the elastomeric ring element 108 to the lower surface 104 ranges from about 88.9mm to about 69.9mm (about 3.5 inches to about 2.75 inches) and preferably ranges from about 74.9mm to about 85.1mm (about 2.95 inches to about 3.35 inches).

[0029] In one preferred aspect of the diaphragm member 100 for use in a valve body having a nominal valve size of 152.4mm (six inches (6 in.)), the middle layer 103 defines a radius of curvature of about 215.9mm to about 228.6mm (about 8.5 inches to about 9 inches) and is preferably about 223mm (about 8.78 inches) and even more preferably about 230.1mm (about 9.06 inches). The upper surface 102 preferably defines a radius of curvature of about 209.6mm to about 222.2mm (about 8.25 inches to about 8.75 inches) and is preferably about 217.9mm (about 8.58 inches). Each of the radii of curvatures for the middle layer 103 and the upper surface 102 is preferably measured from a common central point along the central axis A-A of diaphragm member 100. Thus, the ratio of the radii of curvatures of the middle layer 103 to the upper surface 102 in a preferred 152.4mm (six inch (6 in.)) valve is about 1.03: 1. In addition, the lower surface 104 preferably defines at least one radius of curvature ranging from about 133.3mm to about 139.7mm (about 5.25 inches to about 5.5 inches) and is preferably about 134.6mm (about 5.3 inches) measured from a center point off-set from the central axis A-A of the diaphragm member 100. More preferably, the center point is horizontally off-set from the central axis by about 40.6mm (about 1.6 inches) and vertically off-set from the elastomeric ring by about 61mm (about 2.4 inches). Moreover, the bulged portion 110 preferably defines a diameter ranging from about 316.2mm to about 349.2mm (about 12.45 inches to about 13.75 inches) and is preferably about 327.7mm (about 12.9 inches). The elastomeric ring element 108 preferably defines an outer diameter ranging from about 292.4mm to 343.2mm (about 11.51 inches to about 13.51 inches) and is preferably about 304.8mm (about 12 inches) and more preferably about 317.8mm (about 12.51 inches). The elastomeric ring element 108 preferably defines an inner diameter of about 264.7mm to about 315.5mm (about 10.42 inches to about 12.42 inches) and is preferably about 304.8mm (about 12 inches) and more preferably about 290mm (about 11.42 inches). The overall height of the diaphragm from the upper surface of the elastomeric ring element 108 to the lower surface 104 ranges from about 88.9mm to about 114.3mm (about 3.5 inches to about 4.5 inches) and preferably ranges from about 97mm to about 106.9mm (about 3.82 inches to about 4.21 inches). The preferred diaphragm member 100 is configured to engage and cooperate with the inner surfaces of the cover 12a and lower body 12b to define the three chambers 24a, 24b, 24c in an orientation that can provide for a diaphragm chamber 24c that can effectively compensate for fluctuation and/or surges in fluid pressure in either one of the inlet and outlet chambers 24a, 24b.

[0030] The lower surface 104 of the diaphragm member 100, as seen more specifically in FIG. 3B, preferably includes one or more support pads or elements 112 for supporting the diaphragm member 100 when the diaphragm cycles between the open and closed positions within the chamber 24. More specifically, the support pads 112 are configured to engage a portion of the inner surface of the lower valve body 12b to support the diaphragm 100.

[0031] The lower surface 104 of the diaphragm member further preferably includes a pair of elongated sealing elements or projections 114a, 114b to form a sealed engagement with the seat member 26 of the valve body 12. The sealing elements 114a, 114b preferably extend in a parallel fashion along the lower surface 104 for a length about equivalent to the maximum arc length defined by the surface 104. Each of the elongated sealing elements 114a, 114b preferably taper narrowly in cross-section (perpendicular to the axis of elongation) having a first angled surface 116a and a second angled surface 116b each extending from or contiguous with the lower surface 104, as seen for example in FIG. 3C. Alternatively, the sealing elements 114a, 114b can define any cross-sectional geometry provided the sealing element provides the sealing function provided herein. The first angled surface 116a preferably defines an included angle α with a line parallel to the central axis A-A of about forty-five degrees. The second angled surface 116b preferably defines an included angle β with a line parallel to the central axis A-A of about fifteen degrees. Disposed between the first and second angled surfaces 116a, 116b is a terminal surface 116c to terminate the sealing element and thereby define the height of the projection. Preferably, the terminal surface 116c defines a surface having one or more radii of curvature over its length from the first angled surface to the second angled surface. More preferably, the terminal surface 116c defines a peak of the sealing element having at least one radius of curvature.

[0032] The sealing elements 114a, 114b are preferably spaced apart so as to define a void or channel 118 therebetween. The parallel first angled surfaces 116a of the sealing elements 114a, 114b along with a portion of the lower surface 104 disposed therebetween further define the sidewalls of the void or channel 118 and its channel height. The sealing elements 114a, 114b are configured to engage the seat member 26 of the valve body 12 when the diaphragm is in the closed position so as to seal off communication between the inlet 14 and the outlet 16 and more specifically seal off communication between the inlet chamber 24a and the outlet chamber 24b. Furthermore, the sealing members 114a, 114b engage the seat member such that the channel 118 cooperates with the seat member 26 to form an intermediate chamber 24d to axially space the inlet chamber 24a and the outlet chamber 24b in a manner described in greater detail herein below. The lower surface 104 of the diaphragm can include more than two sealing elements 114a, 114b provided that the additional sealing elements cooperate with the seat member 26 in a sealing fashion and allow for the formation of the intermediate chamber. Moreover, the lower surface 104 can be formed or constructed with any other surface formation, such as a convolution, provided that the formation can effectively form a sealed engagement with the seat member 26 and further provide for the channel 118 to facilitate formation of the intermediate chamber 24d.

[0033] The material to be used for manufacturing the diaphragm 100 is dependent on the type of fluid being carried and on the temperature range to which the diaphragm is to be exposed. Preferably, the upper and lower surfaces 102, 104 of the diaphragm 100 are constructed from layers of natural rubber material having a durometer hardness or shore value of about seventy-five (75) and further a pressure rating of about 17,650kN/m^2 (about 2560 pounds per square inch (2560 psi.)). Suitable materials for use at the upper and lower surfaces 102, 104 include, for example, nitrile butadiene rubber and neoprene. Materials that can be used for reinforcements between the upper and lower surface layers at middle layer 103 of the diaphragm 100 include, for example, cotton and nylon and more preferably, nylon no. 2 reinforced material.

[0034] The sealing elements 114a, 114b of the diaphragm member 100 are configured to form a sealed engagement with the seat member 26 of the valve body 12. Shown in FIGS. 4A-4D are detailed views of the preferred lower valve body portion 12b of the control valve 10. The lower control valve body 12b preferably defines a first valve axis IVC-IVC. The inlet and outlet 14, 16 of the control body are preferably centered about, coaxial with and spaced apart along the first valve axis IVC-IVC. Further centered along, spaced apart and substantially orthogonal to the first axis IVC-IVC are the fluid drain pipe 18 and the input opening 20 each respectively in communication with the fluid supply chamber 24a and the pressurized gas supply chamber 24b. Also extending along the first axis IVC-IVC are brace or support members 28a, 28b. The support members 28a, 28b are preferably aligned for engagement with the support pads 112 disposed or formed on the lower surface 104 of the diaphragm member 100. The support members 28a, 28b preferably extend from the flanges of the inlet and outlet 14, 16 to intersect the support member 26. The support members 28a, 28b preferably form a unitary construction with the support member 26 and the rest of the lower valve body 12b, or alternatively, the support members 28a, 28b can be joined to the support member 26 and the body 12 by other joining techniques such as, for example, welding.

[0035] The lower control valve body 12b further preferably defines a second axis IVD-IVD which is substantially orthogonal to the first axis IVC-IVC. Preferably aligned with the second axis IVD-IVD is the seat member 26 extending the width of the valve body 12 so as to effectively divide the chamber 24 in the lower valve body 12 into the preferably spaced apart and preferably equal sized sub-chambers of the inlet chamber 24a and the outlet chamber 24b. Moreover, the elongation of the seat member 26 preferably defines a curvilinear surface or arc having an arc length to mirror the convex surface of the lower surface 104 of the diaphragm 100. Further extending along the preferred arc length of the seat member 26 is a groove 30 constructed or formed in the surface of the seat member 26. The groove 30 preferably extends the full length of the seat member 26 so as to extend the width of the lower valve body 12b. Furthermore, the groove 30 preferably tapers narrowly at its ends. In addition, the walls of the seat member 26 that define the groove 30 are preferably parallel. Alternatively, the groove 30 can be formed such that the walls forming the groove 30 are angled relative to one another, another reference line or other surface in the valve body 12. The portion of the seat surface 26 defining the bottom of the groove 30 preferably forms a semi-circular arc in the plane perpendicular to the direction of elongation for the groove 30. Other geometries are possible provided the channel 30 delivers the desired fluid and pneumatic characteristics described herein. Moreover, the depth of the groove 30 can vary along its length such that the groove 30 is preferably deepest at its center and becomes more shallow toward its lateral ends. The groove 30 further bisects the engagement surface of the seat member 26 preferably evenly along the seat member length. With the support pads 112 of the diaphragm member 100 aligned to engage the support members 28a, 28b when the diaphragm member 100 is in the closed positioned, the elongated sealing members 114a, 114b are preferably aligned to engage the bisected surface of the seat members 26. Engagement of the sealing members 114a, 114b with the engagement surfaces 26a, 26b of the seat member 26 further places the channel 118 of the diaphragm 100 in communication with the groove 30.

[0036] Shown in FIG. 4B is a detailed view of the seat member 26 and its intersection with the support members 28a, 28b. Preferably, the engagement surfaces 26a, 26b of the seat member 26 are substantially planar, and the width of the engagement further preferably widens in a direction from the center of the engagement seat 26 to the lateral ends of the seat member 26. Generally, the surfaces 26a, 26b are configured sufficiently wide over their entire length so as to maintain sealing contact with the sealing elements 114a, 114b. Moreover, the surfaces 26a, 26b are configured wide enough so as to maintain sealing contact with the sealing elements 114a, 114b regardless of any movement of the sealing elements 114a, 114b along the longitudinal axis IVC-IVC. Accordingly, the surfaces 26a, 26b can maintain sealed engagement with the sealing elements 114a, 114b despite changes in fluid pressure in either the inlet or outlet chamber 24a, 24b which can impose forces on the diaphragm 100 and sealing elements 114a, 114b in a direction along the axis IVC-IVC.

[0037] The seat member 26 is preferably formed with a central base member 32 that further separates and preferably spaces the inlet and outlet chambers 24a, 24b and diverts fluid in a direction between the diaphragm 100 and the seat member engagement surfaces 26a, 26b. As seen, for example, in FIGS. 4C and 4D, the base member 32 is preferably broader in the direction along the first axis IVC-IVC than along the second axis IVD-IVD. The base member 32 is preferably substantially aligned with the central axis B-B of the valve body 12 which intersects substantially orthogonally the plane formed by the intersection of the first axis IVC-IVC and the second axis IVD-IVD. Preferably formed in the base member 32 between the drain 18 and the input opening 20 is the port 22.

[0038] The port 22 is preferably constructed as an alarm port from one or more voids formed in the base member 32. Preferably, the port 22 includes a first cylindrical portion 22a formed in the base member 32. The first cylindrical portion 22a preferably defines a central axis off-set or spaced from the central axis B-B of the lower valve body 12. The first cylindrical portion 22a is further preferably wider in the direction along the first axis IVC-IVC than in the direction along the second axis IVD-IVD. Accordingly, the first cylindrical portion 22a is preferably oblong in cross-section.

[0039] Axially in communication with the first cylindrical portion 22a is a second cylindrical portion 22b formed in the base member 32. The second cylindrical portion 22b is preferably wider in the direction along the second axis IVD-IVD than in the direction along the first axis IVC-IVC. Accordingly, the second cylindrical portion 22b is oblong in cross-section and preferably elongated in a direction substantially orthogonal to the direction of elongation of the first cylindrical portion 22a. The second cylindrical portion 22b preferably defines a central axis preferably aligned with the central axis B-B of the lower valve body 12. Moreover, the second cylindrical portion 22b preferably axially extends along the central axis B-B so as to intersect and be in communication with the groove 30. Accordingly, the port 22 preferably intersects and is in communication with the groove 30, and wherein when the diaphragm member 100 is in the closed position, the port 22 is further preferably in sealed communication with the channel 118 formed in the diaphragm member 100.

[0040] The communication between the diaphragm channel 118, the groove 30 and the port 22 is preferably bound by the sealed engagement of the sealing elements 114a, 114b with the seat member surfaces 26a, 26b, to thereby define a preferred fourth chamber, intermediate chamber 24d, as seen, for example, in FIG. 2A. The intermediate chamber 24d is preferably open to atmosphere thereby further defining a fluid seat, preferably an air seat to separate the inlet and outlet chambers 24a, 24b. The inventors have discovered that providing an air seat between the inlet and outlet chambers 24a, 24b allows each of the inlet and outlet chambers to be filled and pressurized while avoiding failure of the sealed engagement between the sealing element 114 and the seat member 26. Each sealing element 114 is acted upon by a fluid force on only one side of the element and preferably atmospheric pressure on the other, the fluid pressure in the diaphragm chamber 24c is effective to maintain the sealed engagement between the sealing elements 114 and the seat member 26 during pressurization of the inlet and outlet chambers 24a, 24b. Accordingly, the preferred diaphragm-type valve 10 can eliminate the need for a check valve downstream of the control valve, unlike, for example, the installations of the preaction fire protection systems shown and described in U.S. Provisional Patent Application No. 60/887,040. Moreover, the preferred control valve 10 and the preferred intermediate chamber 24d exposed to atmosphere can comply with the installation and/or operational requirements such as for example, FM Standard 1020, by providing a port for drainage or an alarm.

[0041] The ability to pressurize both the inlet and the outlet chambers 24a, 24b is particularly useful where it is desirable to control release of a primary fluid such as, for example, water, into a normally closed system while providing and maintaining the system with a pressurized secondary fluid such as, for example, compressed air. For example, the control valve 10 can be installed and operated in a liquid/gas manifold in the following manner. The control valve 10 is disposed between the primary fluid source, such as for example, a water main and a the secondary fluid source, such as for example, a compressed air feed or a source of compressed nitrogen gas. More specifically, as schematically shown, for example, in FIG. 5, the control valve 10 is preferably coupled to the primary fluid main at the inlet 14. The fluid drain 18 is preferably closed off by connection of an appropriate shut-off piping element such as, for example, a manual-shut off valve. The secondary fluid or compressed gas source is coupled to the input opening 20, and the outlet 16 is preferably coupled to the system to be filled and pressurized by the compressed gas.

[0042] The control valve 10 and the manifold can be placed into service by preferably bringing the valve 10 to the normally closed position and subsequently bringing the inlet chamber 24a and the outlet chamber 24b to operating pressure. In one preferred installation, the primary fluid source is initially isolated from the inlet chamber 24a by way of a shut-off control valve such as, for example, a manual control valve located upstream from the inlet 14. The secondary fluid source is preferably initially isolated from the outlet chamber 24b by way of a shut-off control valve located upstream from the input opening 20. An equalizing fluid, such as water from the primary fluid source is then preferably introduced into the diaphragm chamber 24c through the central opening 13 in the cover 12a. Fluid is continuously introduced into the chamber 24c until the fluid exerts enough pressure *P1* to bring the diaphragm member 100 to the closed position in which the lower surface 104 engages the seat member 26 and the sealing elements 114a, 114b form a sealed engagement about the seat member 26.

[0043] With the diaphragm member 100 in the closed position, the inlet and outlet chambers 24a, 24b can be pressurized respectively by the primary and secondary fluids. More specifically, the shut-off valve isolating the primary fluid can be opened so as to introduce fluid The shut-off valve isolating the compressed gas can be opened to introduce the secondary fluid through the input opening 20 to pressurize the outlet chamber 24b and the normally closed system coupled to the outlet 16 of the control valve 10 to achieve a static pressure P3.

[0044] As described above, the presence of the intermediate chamber 24d separating the inlet and outlet chamber 24a, 24b and which is normally open to atmosphere, maintains the primary fluid pressure P2 to one side of the sealing member 114a and the secondary fluid pressure *P3* to one side of the other sealing member 114b. Thus, diaphragm member 100 and its sealing members 114a, 114b are configured so as to maintain the sealed engagement with the seat member 26 under the influence of the diaphragm chamber pressure *P1*. Accordingly, the upper and lower diaphragm surface areas *A1, A2,* and *A3* are preferably sized such that the pressure *P1* is large enough to provide a closing force on the upper surface of the diaphragm member 100 so as to overcome the primary and secondary fluid pressures P2, *P3* urging the diaphragm member 100 to the open position. However, preferably the ratio of the diaphragm pressure to either the primary fluid pressure *P1:P2* or the secondary fluid pressure *P1:P3* is minimized such that the valve 10 maintains a fast opening response, i.e. a low trip ratio, to release fluid from the inlet chamber when needed. More preferably, every 6,894 kN/m^2 (1 psi) of diaphragm pressure *P1* is at least effective to seal about 8,2728 kN/m^2 (1.2 psi) of primary fluid pressure *P2*. This is an advantage over known diaphragm valves that are believed to require a 1: 2.5 pressure ratio of diaphragm pressure to primary fluid pressure because in such known valves, the chambers are oriented such that the diaphragm pressure is directed completely in the normal direction to the diaphragm seat and the incoming fluid. Known mechanical latching deluge valves also are believed to require a 1: 2.5 ratio because of similar chamber orientation and the need for a mechanical latch or linkage. Because the preferred control valve 10 can use a lower diaphragm pressure P1 to primary fluid pressure P2, the valve 10 can be constructed smaller than the known control valves of similar nominal valve size. Moreover, the low pressure ratio, in combination with the chamber orientation and flexible diaphragm provides for the preferred control valve 10 that is capable of providing effective surge control or resistance to minimizing or more preferably eliminate false trips.

[0045] To actuate the valve 10, fluid is preferably released from the diaphragm chamber 24c at a faster rate than it can be replenished into the chamber 24c. For example, a solenoid control valve coupled to the chamber inlet 13 can be electrically actuated to release fluid from the diaphragm chamber 24c. The loss of pressure on the upper surface 102 of the diaphragm member 100 permits the fluid pressure in the adjacent fluid supply chamber 24a to urge the diaphragm member to the open position spaced from the seat member 26. Fluid is permitted to flow past the support members 28a, 28b (support members 28a, 28b not shown in FIG. 5 for clarity) to displace the compressed gas in the outlet chamber 24b for discharge out the outlet 16 and into the system coupled to the control valve 10. Fluid is further permitted to fill the groove 30 and flow out the alarm port 22. With an appropriate flow alarm coupled to the port 22, fluid flow can be detected and appropriate personnel can be notified of the operation of the valve 10.

[0046] Accordingly, the control valve 10 can be installed in a preaction fire protection systems with its outlet 16 in communication with a riser pipe that is coupled to a network of sprinklers interconnected by pipes and pressurized by the compressed gas or air. More specifically, the control valve 10 can be installed in any one of the preaction fire protection systems shown and described in U.S. Provisional Patent Application No. 60/887,040 without the need for a check valve located down stream of the valve 10. Schematically shown in FIG. 6A is the preferred controlled valve 10 installed in a preaction fire protection system 200. In addition to the control valve 10, the preaction system 200 includes a piping network of one or more fire protection devices, such as for example, fire protection sprinklers 210 distributed along a feed main 215 in accordance with one or more fire sprinkler installation standards, such as for example, National Fire Protection Association (NFPA) publication, "NFPA 13: Standard for the Installation of Sprinkler Systems" (2007).

[0047] In accordance with the preferred installation described above, the control valve 10 is installed in the fire protection system with its outlet coupled to the network of sprinklers 210 and feed main by a riser pipe 220. A compressed gas or air source 225 is placed in controlled communication with the input opening 20 for pressurizing the network of sprinklers with supervisory air or gas preferably ranging from about 55.158 - 82.737 kN/m^2 (8 - 12 psi) and more preferably about 68,947 kN/m^2 (10 psi). Alternatively, the preferred control valve 10 can be installed in a deluge fire protection system in which the network of sprinklers is open to atmosphere. The inlet 14 of the control valve 10 is preferably placed in controlled communication with a preferred liquid supply source, such as for example, a water main 230. Accordingly, the control valve 10 is installed such that the "wet" or liquid portion of the system is at the inlet side of the valve 10 and the "dry" or gas portion of the system is on the outlet side of the valve 10. The control valve 10 and the system 200 can be placed into service in a manner as described above such that the diaphragm member 100 provides controlled sealed communication between the water main 230 and the network of sprinklers 210. Moreover, the diaphragm can be brought to the sealed position by the introduction of the fluid, preferably appropriately piped and trimmed from the fluid source 230 through an appropriate restriction 233, into the diaphragm chamber 24c, and each of the inlet and outlet chambers 24a, 24b can be brought to pressure by respective introduction of water into the inlet 14 and compressed air into the outlet 14. More preferably, the diaphragm 100 is held in its sealed position with the inlet chamber 24a under static pressure from the water such that the sealing pressure and the static water pressure define the preferred ratio of *P1:P2* substantially equal to about 1:1.2. Because the preferred control valve 10, upon seating in the sealed position, forms the intermediate chamber 24d to act as an air seat, the outlet chamber 24b and the network of normally closed sprinklers define a closed system in the preaction system in which incoming compressed air can fill the riser 220, the main feed 215 and provide supervisory air to the network of sprinklers at the preferred pressure without the use of a check valve anywhere down stream of the valve 10. Accordingly, between the outlet chamber 24b of the control valve 10 and the network of sprinklers 210 a single and preferably substantially constant air pressure can be defined equivalent to the supervisory air of the system 200.

[0048] The system 200 can be configured for single or double interlock operation of the control valve 10. Furthermore, the operation of the control valve 10 can be electrically, pneumatically, hydraulically actuated or a combination thereof. For example, the system 200 can be configured as a single interlock system having a detector 235a for detection of heat or smoke to send a detection signal, preferably through a control panel 240, to a solenoid valve 236, vented to atmosphere, that releases water from the diaphragm chamber 24c for actuation of the control valve 10 as discussed above. The detector 235a can be any one of a heat sensitive thermostat, smoke detector or electric manual pull station. Alternatively, the system 200 can be configured as a single interlock system having dry pilot for actuation of the control valve 10. More specifically, the system 200 can include a dry pilot line 245 that is pneumatically pressurized having one or more pilot sprinklers 250 acting as heat detectors disposed along the line 245. Upon actuation of the pilot sprinklers 250 in the presence of a fire, the release of pneumatic pressure can be configured to operate a dry pilot actuator 255, vented to atmosphere, which can be coupled to the control valve 10 to release water from the diaphragm chamber 24c. Further in the alternative, the pilot line can be configured as an appropriately installed wet pilot line pressurized with water and coupled to the diaphragm chamber 24c. Actuation of the pilot sprinkler 250 in the presence of a fire releases water from the wet pilot line 245 and from the diaphragm chamber 24c for operation of the control valve 10.

[0049] Any one of the above single interlock systems can be alternatively configured as a double interlock system. For example, the system 200 can be configured as a double interlock system having a detector 235a for detection of heat or smoke to send a detection signal and a second detector 235b for detecting low air pressure in the network of sprinklers 210. Each of the detectors 235a, 235b can be coupled to a releasing panel in which actuation of each of the detectors is required to operate the releasing panel to release water from the diaphragm chamber 24c and operate the control valve 10. Alternatively, the system 200 can be configured as a double interlock system having dry pilot and an electrical interlock for actuation of the control valve 10. More specifically, the system 200 can include a dry pilot line 245 that is pneumatically pressurized having one or more pilot sprinklers 250 acting as heat detectors disposed along the line. Upon actuation of the pilot sprinklers 250 in the presence of a fire, the release of pneumatic pressure can be configured to operate a dry pilot actuator 255. To operate the control valve 10 the system can incorporate the heat detector for energizing a solenoid valve that in series with the dry pilot actuator 255 operates the control valve 10. In the alternative, the pilot line of the double interlock system can be configured as a wet pilot line pressurized with water and coupled to the diaphragm chamber 24c. Anyone of the above preaction systems preferably includes an alarm connected to the alarm port 22 of the control valve 10 in order to detect the flow of fluid upon actuation of the control valve 10. Further in the alternative, the control valve 10 can be installed in a non-interlock preaction fire protection system.

[0050] While the present invention has been disclosed with reference to certain embodiments, numerous modifications, alterations, and changes to the described embodiments are possible without departing from the scope of the present invention, as defined in the appended claims.

REFERENCES CITED IN THE DESCRIPTION

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- Preaction System with Model DV-5 Deluge Valve Single Interlock, Supervised - Electronic Actuation 38.1mm to 203.2mm (1-1/2 thru 8 Inch) (DN40 thru DN200)TFP 1420, 2004, [0002]
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- NFPA 13: Standard for the Installation of Sprinkler SystemsNational Fire Protection

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Patentkrav

1. Ventil til fluidstyring (10) til tilvejebringelse af fluidstyring mellem en første fluid og en anden fluid, der omfatter:
et legeme (12), der er forsynet med et indløb (14), et udløb (16) og en indvendig overflade, der definerer en gennemgang mellem indløbet (14) og udløbet (16), hvilket legeme (12) desuden indbefatter en åbning (22), der står i forbindelse med gennemgangen og er placeret mellem indløbet (14) og udløbet (16); og
et eftergivende element (100), der er i indgreb med den indvendige overflade ved hjælp af et fluidtryk (P1), der virker på det eftergivende element (100) for at opdele gennemgangen for at definere et indløbskammer (24a), der står i forbindelse med indløbet (14), til at rumme den første fluid, et udløbskammer (24b), der står i forbindelse med udløbet (16), til at rumme den anden fluid, og et mellemliggende kammer (24d), der er placeret mellem indløbskammeret (24a) og udløbskammeret (24b) og står i forbindelse med åbningen (22); og er kendetegnet ved, at den indvendige overflade indbefatter et langstrakt sædeelement (26) til indgreb med det eftergivende element (100), hvilket sædeelement (26) definerer en rille (30), der udformer en del af det mellemliggende kammer (24d), der står i forbindelse med åbningen (22).

2. Ventil til fluidstyring (10) ifølge krav 1, ved hvilken det eftergivende element (100) har en øvre overflade (102) og en nedre overflade (104), hvor den nedre overflade (104) indbefatter i det mindste et par af langstrakte elementer (114a,114b) i en indbyrdes afstand, der definerer en kanal (118) imellem disse, hvor det eftergivende element (100) indtager en første position, der muliggør en forbindelse mellem indløbet (14) og udløbet (16), og en anden position, hvor de langstrakte elementer (114a,114b) går i indgreb med sædeelementet (26), således at kanalen (118) står i forbindelse med rillen for at definere et mellemliggende

kammer (24d), der står i forbindelse med åbningen (22).

3. Ventil til fluidstyring (10) ifølge krav 2, ved hvilken den øvre overflade (102), når det eftergivende element (100) befinder sig i den anden position, definerer en i det væsentlige konkav overflade, og den nedre overflade (104) definerer en konveks overflade.

4. Ventil til fluidstyring (10) ifølge krav 2, ved hvilken sædeelementet (26) definerer en kurvelineær overflade, der har en buelængde til indgreb med den nedre overflade (104) på det eftergivende element (100), hvor rillen (30) strækker sig langs den kurvelineære overflade over i det væsentlige hele buelængden.

5. Ventil til fluidstyring (10) ifølge krav 2, ved hvilken den øvre overflade (102) på det eftergivende element (100) indbefatter et ringelement, der afgrænser den øvre overflade (102) for at aktivere den indvendige overflade af ventillegemet (12) til at forspænde membranen i den anden position.

6. Ventil til fluidstyring (10) ifølge krav 1, ved hvilken åbningen (22) er forsynet med en første del, der definerer en første bredde, og en anden del, der er orienteret efter den første del i aksial retning og definerer en anden bredde, hvor den første bredde endvidere er større end den anden bredde.

7. Ventil til fluidstyring (10) ifølge krav 1, ved hvilken det eftergivende element (100) indbefatter et ringelement, der afgrænser det eftergivende element (100) for at aktivere den indvendige overflade af ventillegemet (12) til at forspænde membranen i den anden position.

8. Fremgangsmåde til tryksætning af et kammer i en ventil til fluidstyring (10), der er forsynet med et membranelement (100), hvilken fremgangsmåde omfatter:
anbringelse af membranelementet (100), således at det udformer

et gaskammer, der har en afstand i aksial retning fra et væskeforsyningskammer;
udformning af et gassæde mellem gas- og væskekammeret;
kendetegnet ved, at fremgangsmåden desuden omfatter udformning af gassædet og indbefatter aktivering af de langstrakte elementer (114a,114b) af membranen (100) med et sædeelement (26), der er udformet langs en indvendig overflade af ventilen (10); og indbefatter placering af en kanal (118) i membranen (108), der er defineret af de langstrakte elementer (114a,114b), i en forbindelse med en rille (30), der er udformet i sædeelementet (26).

9. Fremgangsmåde ifølge krav 8, ved hvilken udformningen af gassædet indbefatter, at gassædet udsættes for atmosfærisk tryk.

10. Fremgangsmåde ifølge krav 8, ved hvilken anbringelsen af membranelementet (100) omfatter:
påføring af et fluidtryk på en del af en øvre overflade (102) på membranen (100);
påføring af et væsketryk på en del af en første nedre overflade (104) på membranen (100) inden i væskekammeret;
påføring af et gastryk på en del af en anden nedre overflade (104) på membranen (100) inden for gaskammeret;
hvor forholdet mellem fluidtryk og væsketryk er ca. 1 psi fluidtryk til ca. 1,2 psi væsketryk.

11. Fremgangsmåde ifølge krav 8, ved hvilken anbringelsen af membranelementet (100) indbefatter forspænding af membranelementet (100), således at de langstrakte elementer (114a114b) går i indgreb med sædeelementet (26), hvor forspændingen indbefatter aktivering af et ringelement, der afgrænser membranelementet (100), med en indvendig overflade af ventillegemet (12).

12. Fremgangsmåde ifølge krav 8, ved hvilken anbringelsen af membranelementet (100) desuden indbefatter udformning af en konkav overflade med en øvre overflade (102) på

membranelementet (100) og definering af en konveks overflade med en nedre overflade (104) på membranelementet (100).

DRAWINGS

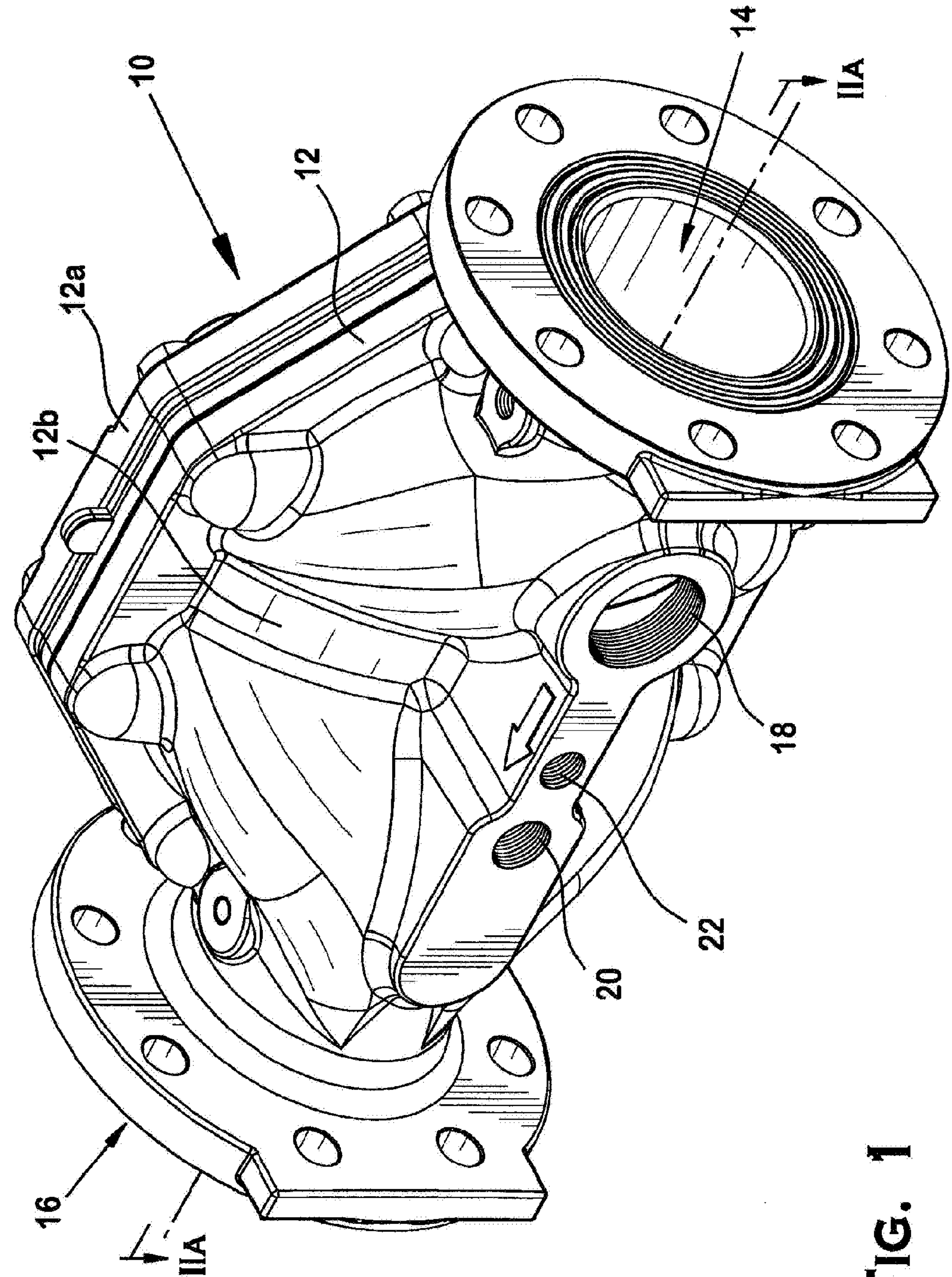

FIG. 1

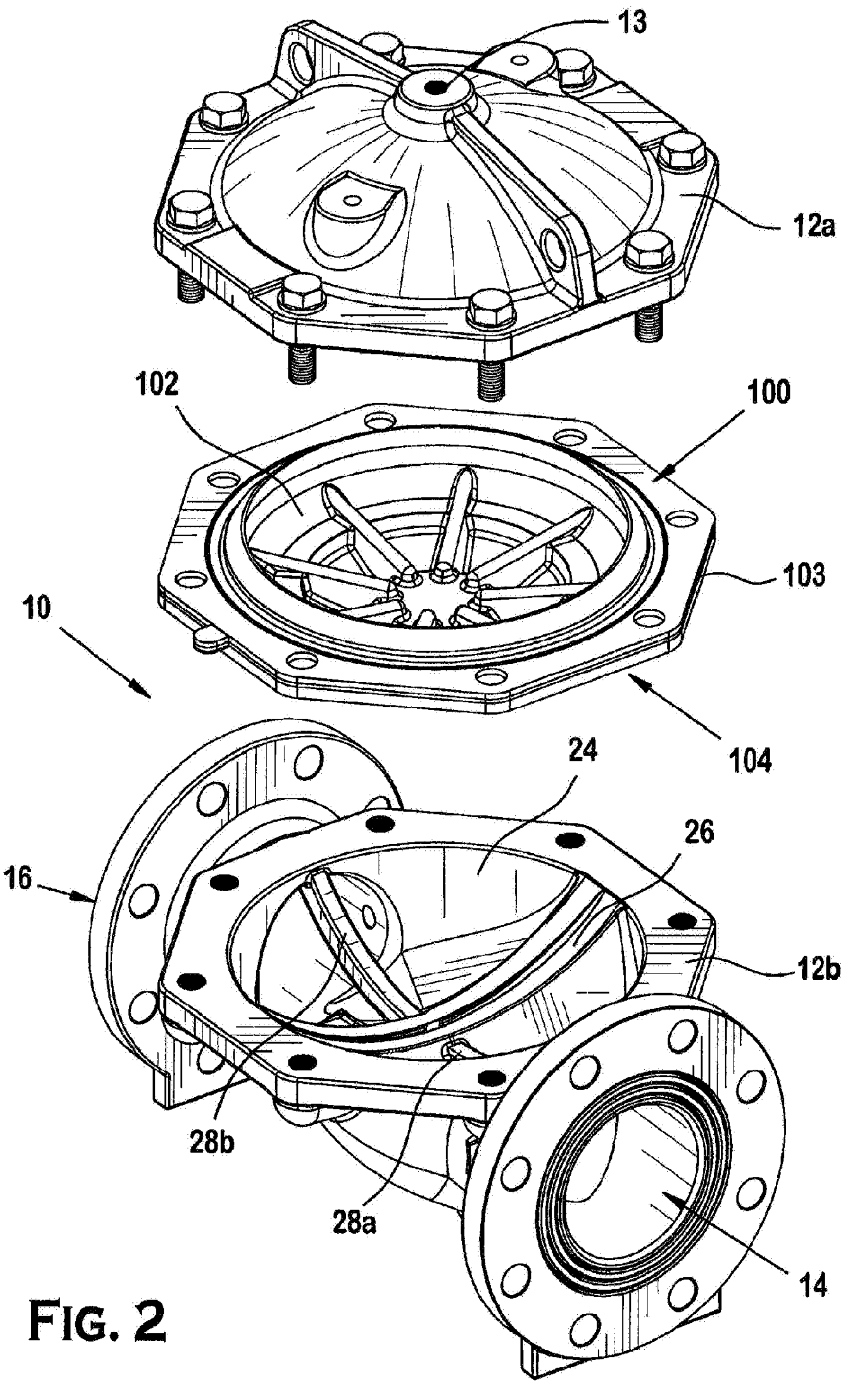

FIG. 2

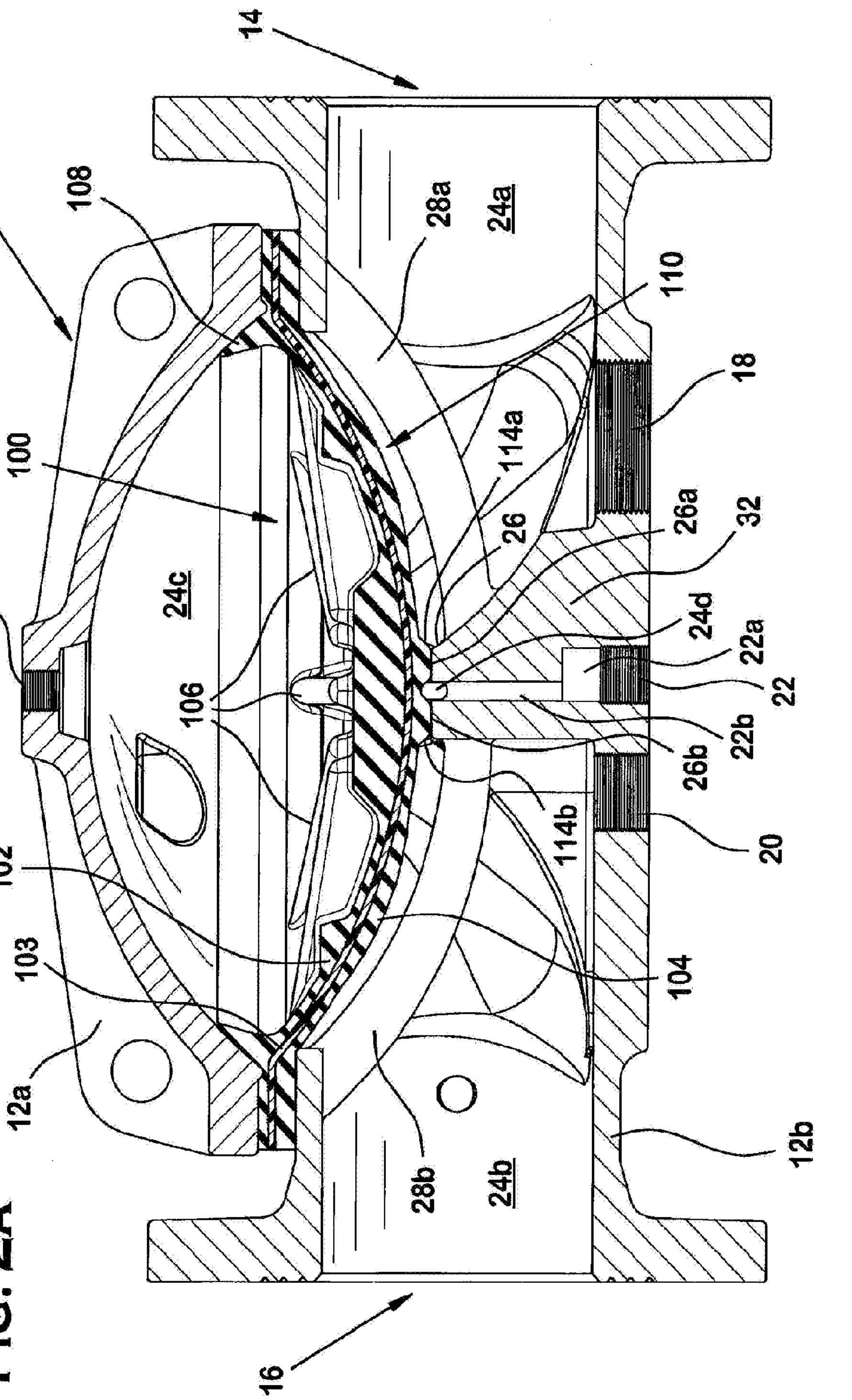
14
10
108
28a
24a
110
18
100
114a
26
26a
32
13
24c
24d
22a
106
22
22b
26b
114b
20
102
104
103
12a
28b
24b
12b
16

FIG. 2A

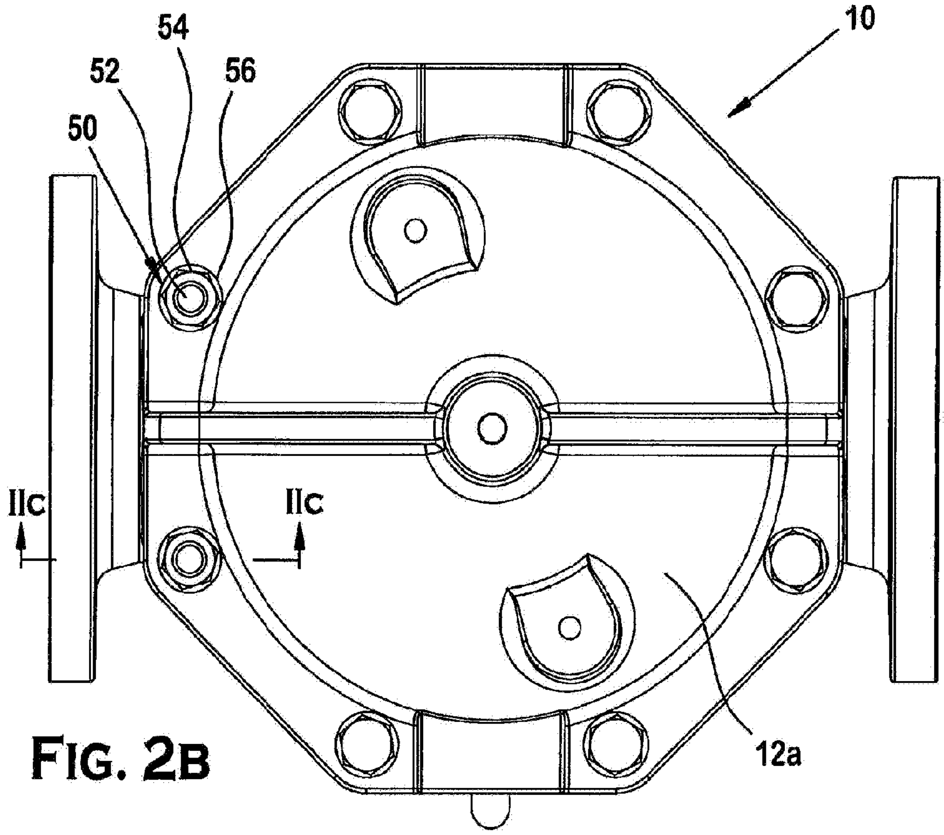

FIG. 2B

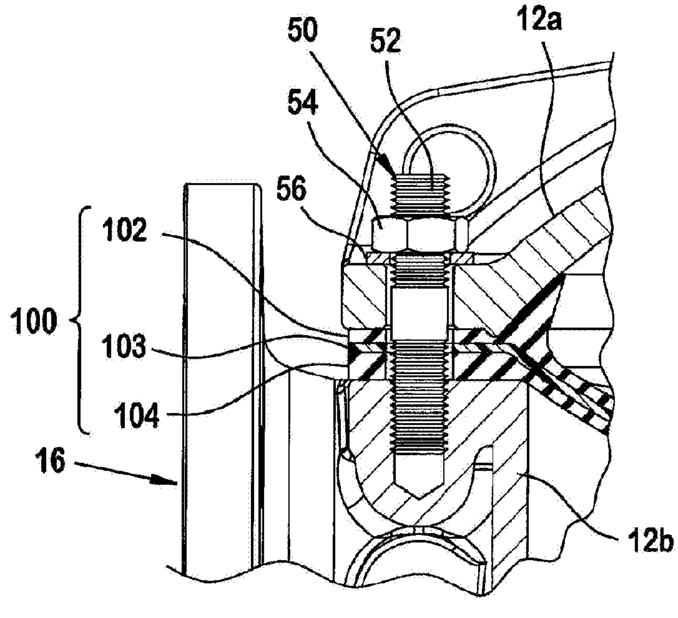

FIG. 2C

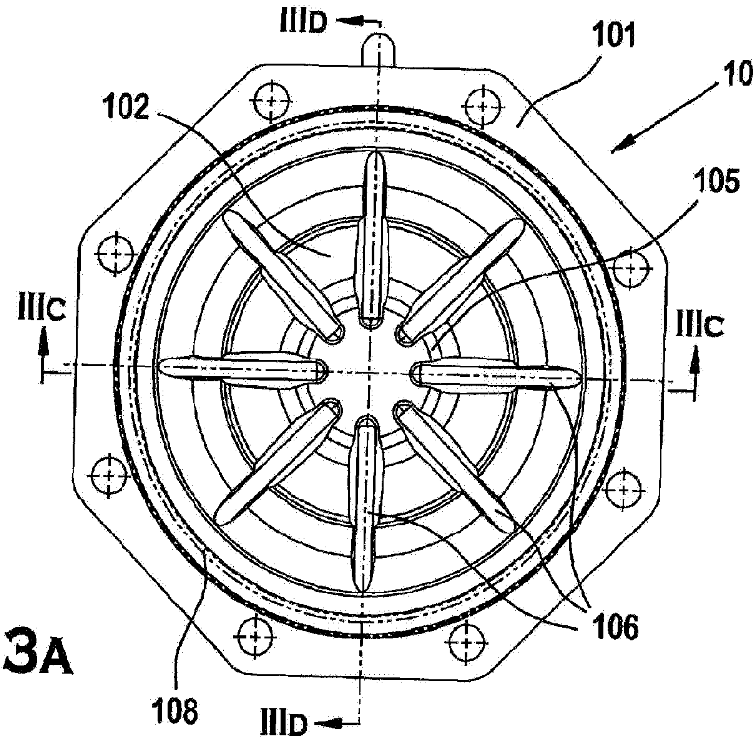
IIID
101
10
102
105
IIIC
IIIC
106
108
IIID

FIG. 3A

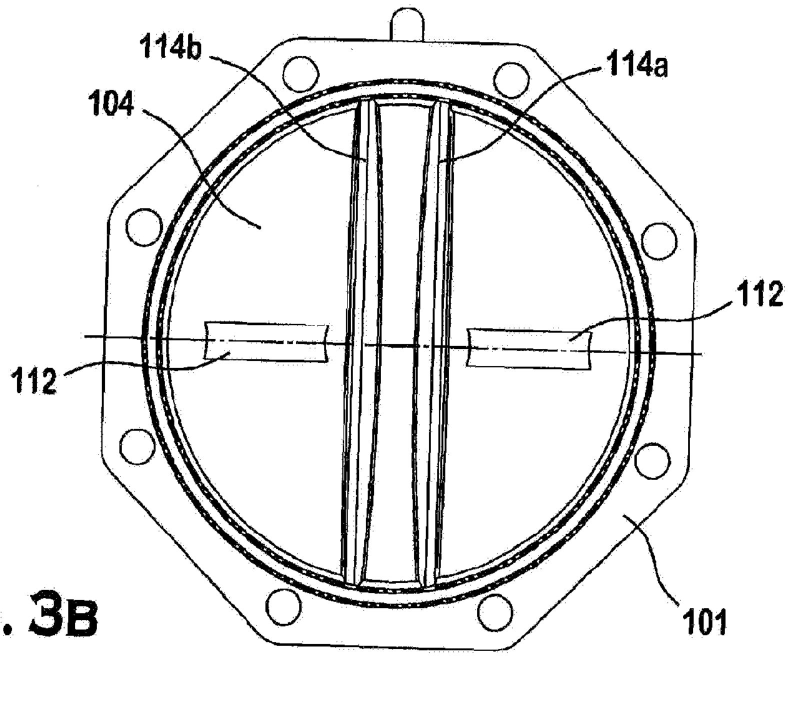
114b
114a
104
112
112
101

FIG. 3B

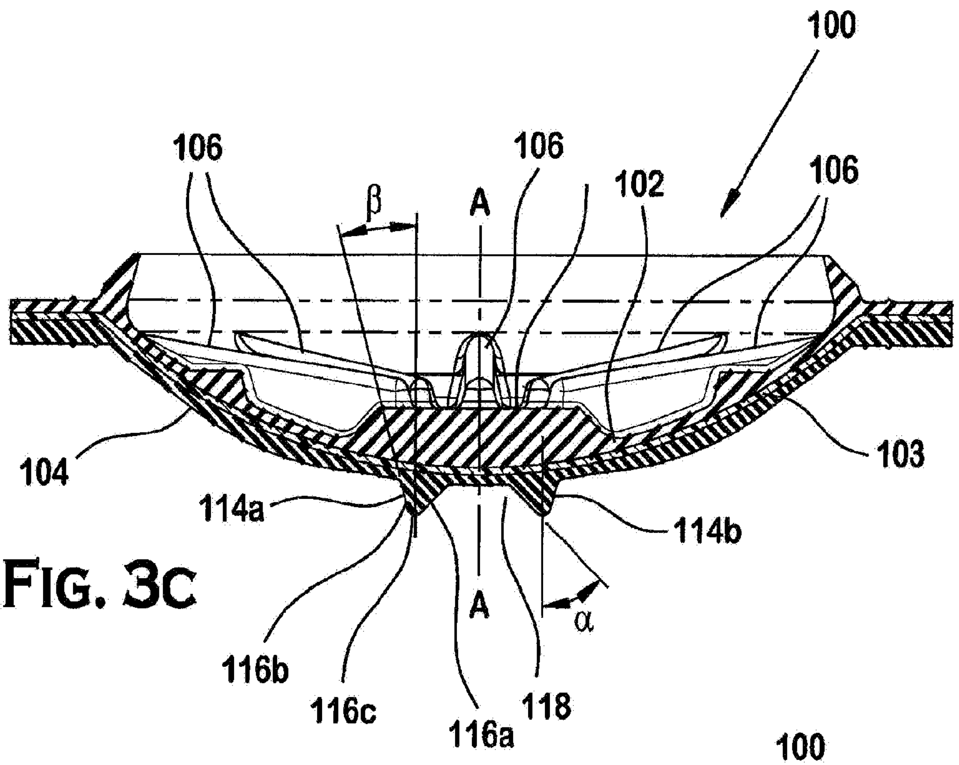
100
106
106
102
106
β
A
104
103
114a
114b
116b
116c
116a
118
A
α

FIG. 3C

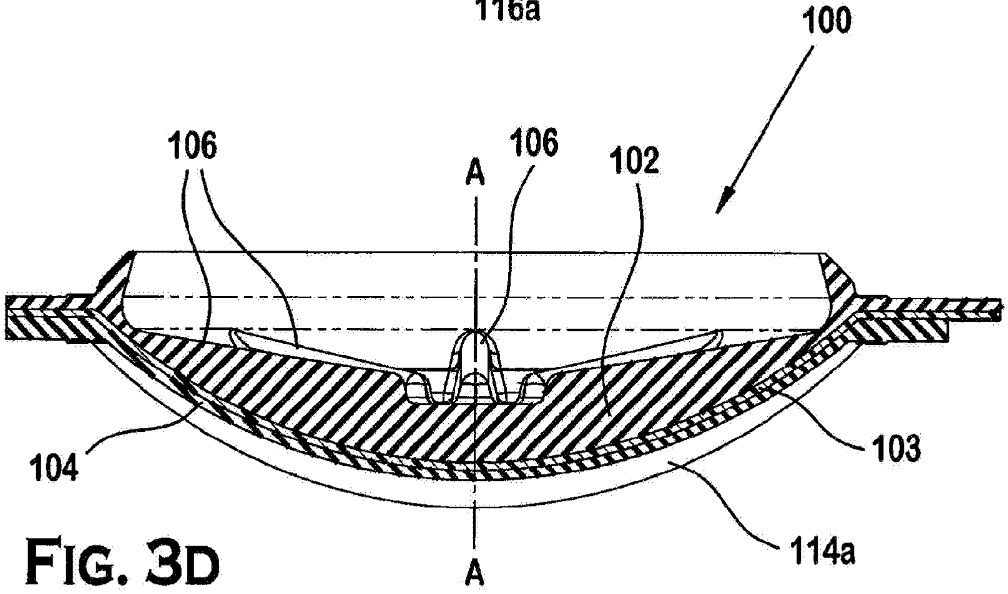
100
106
106
102
A
104
103
114a
A

FIG. 3D

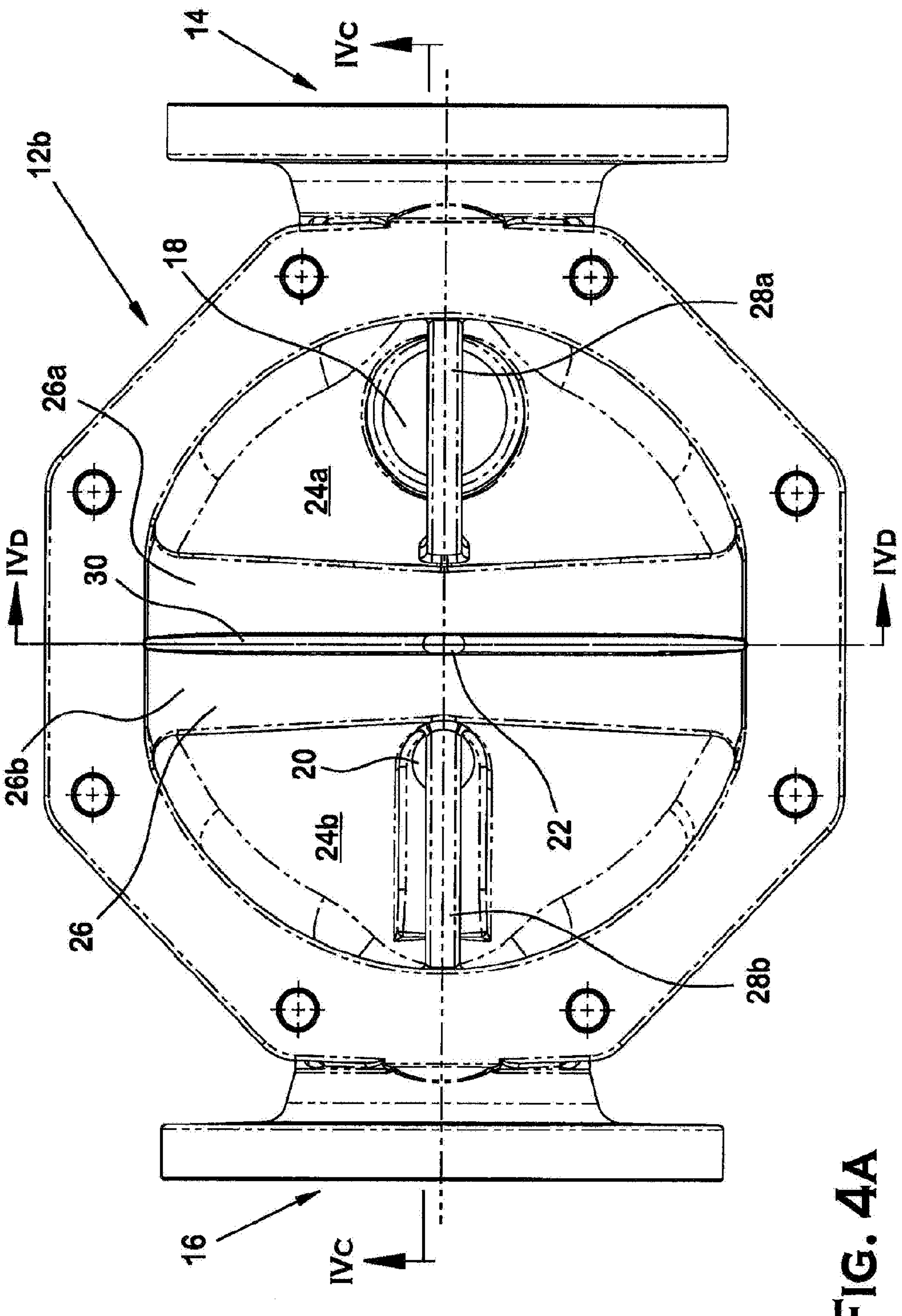

FIG. 4A

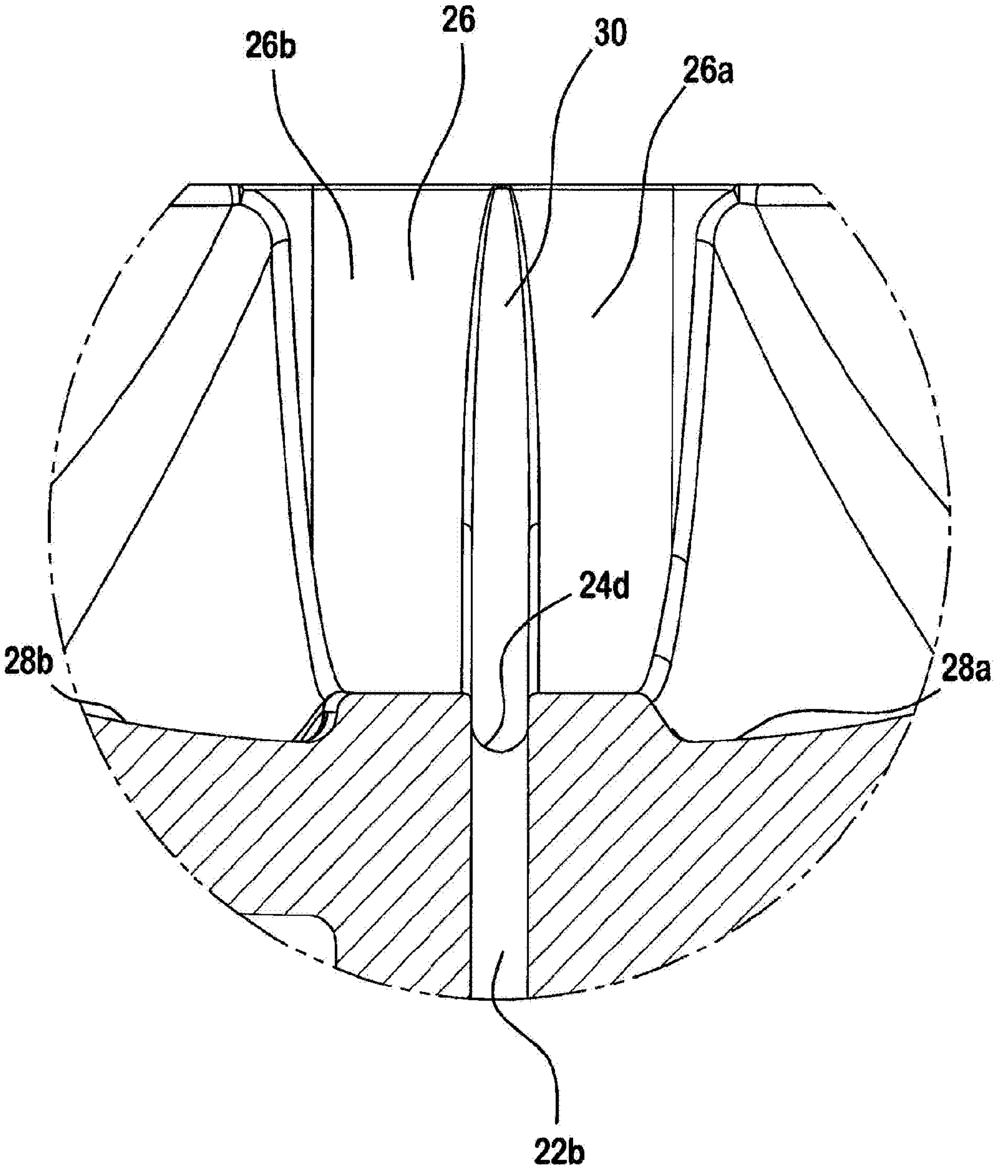

FIG. 4B

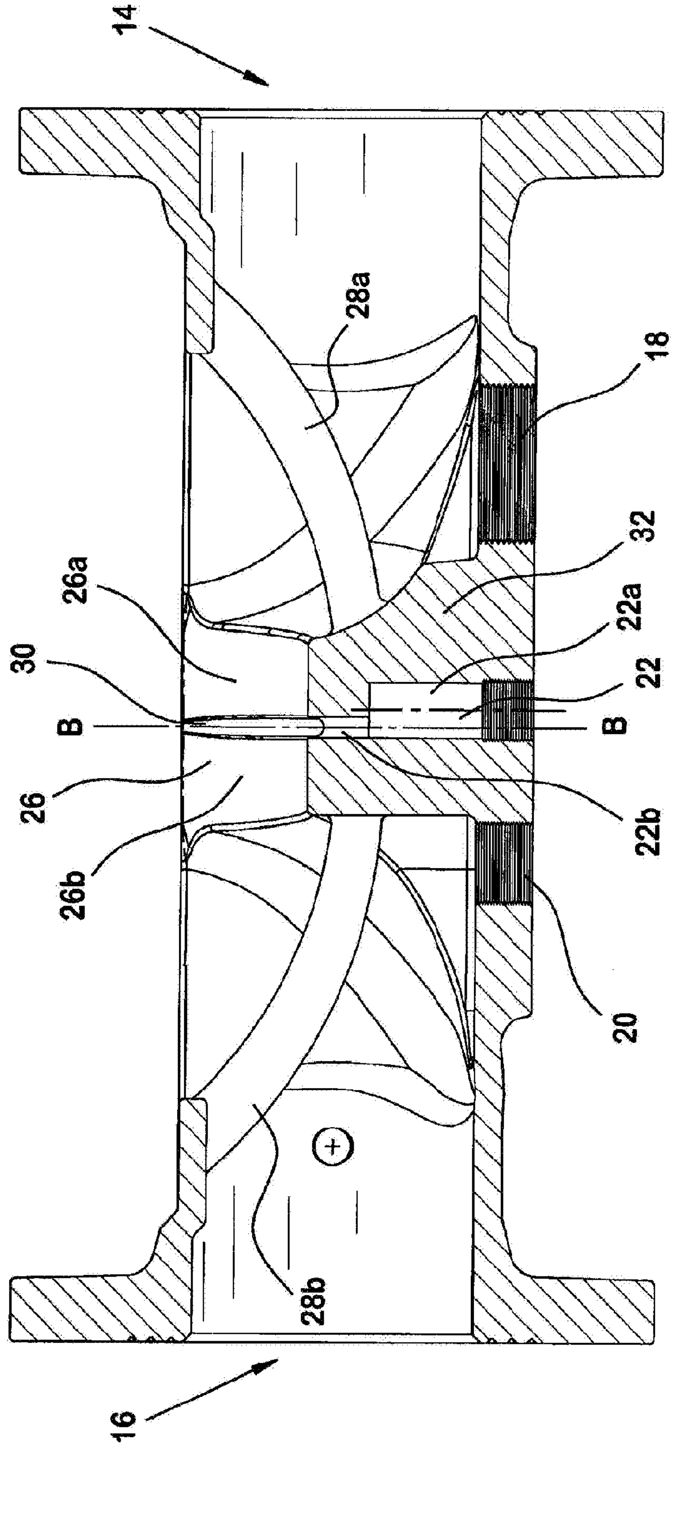

FIG. 4C

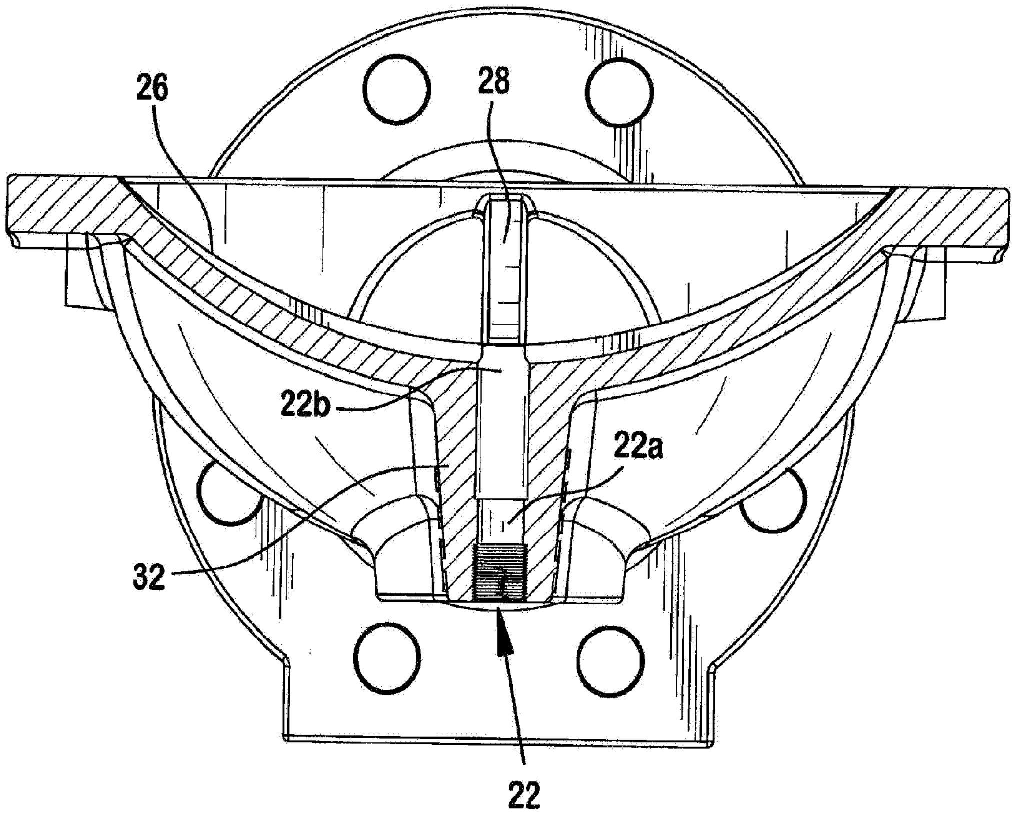

FIG. 4D

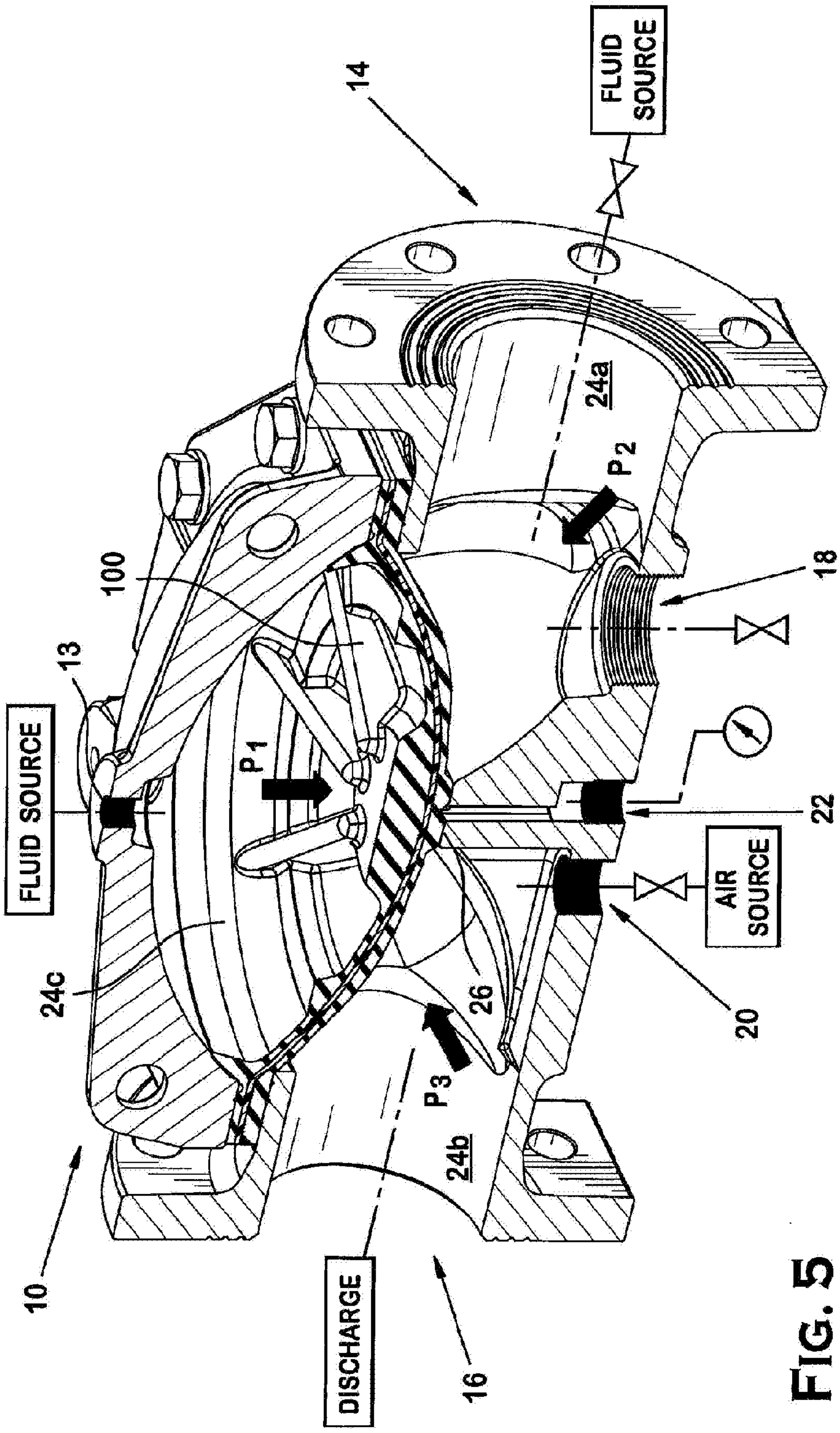
14
FLUID SOURCE
24a
P_2
18
100
13
FLUID SOURCE
P_1
22
AIR SOURCE
24c
26
20
P_3
10
24b
DISCHARGE
16

FIG. 5

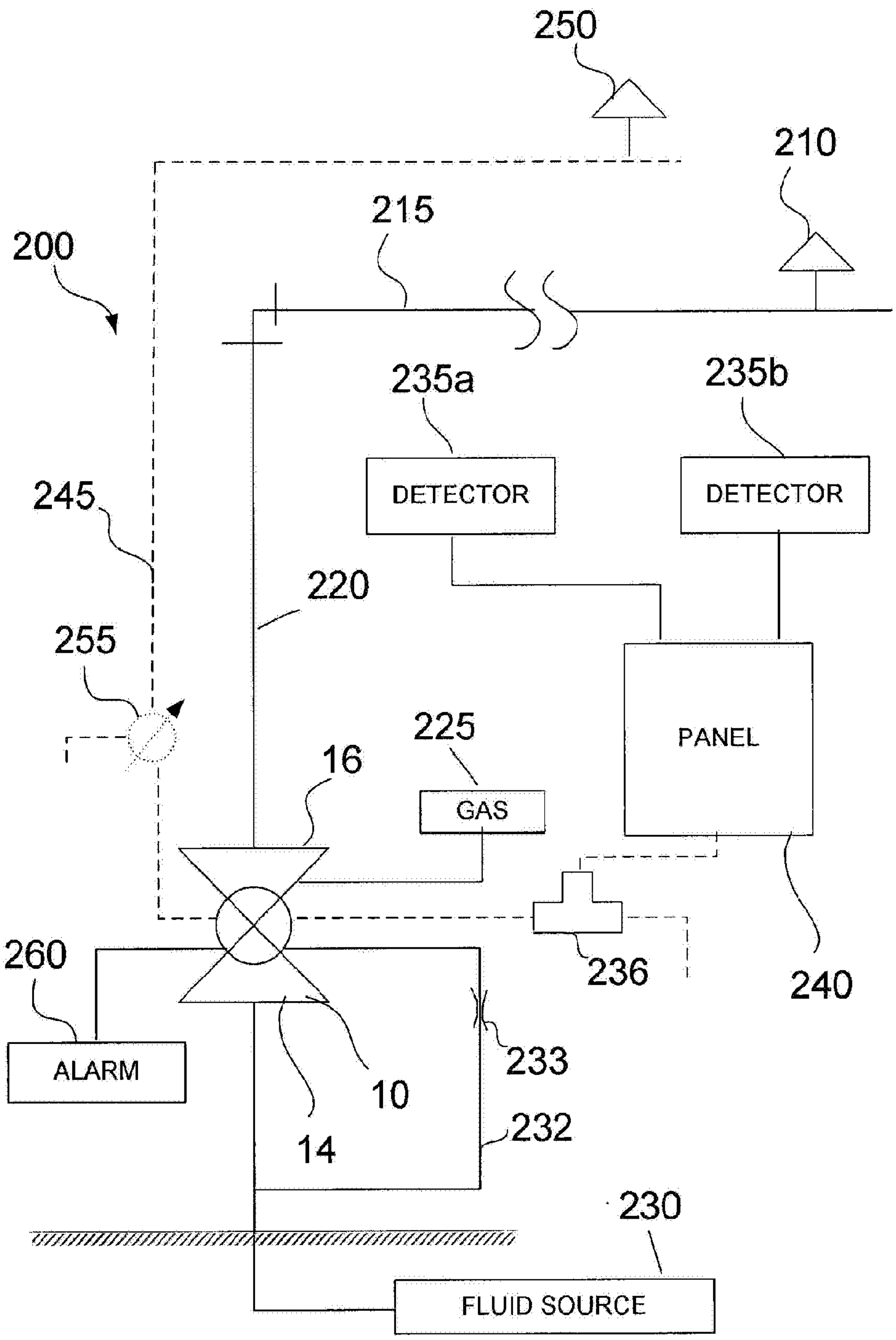
250
210
215
200
235a
235b
DETECTOR
DETECTOR
245
220
255
PANEL
225
16
GAS
260
236
240
233
ALARM
10
232
14
230
FLUID SOURCE

FIG. 6