

PATENT SPECIFICATION

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(54) DIAPHRAGM VALVE

(71) We, WATERFIELD ENGINEERING LIMITED, a British Company of 71 Kingsway, Chandler's Ford, Hampshire, SO5 1FH, 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:—

10 This invention relates to a diaphragm valve in which at least part of a diaphragm is movable within a body defining a fluid passageway to prevent or restrict the passage of fluid therethrough.

15 Such a diaphragm valve usually has an opening in the body communicating with the passageway, the diaphragm extending across the opening in the body to prevent leakage to and from the atmosphere and to isolate the valve operating mechanism from the fluid. A bonnet assembly which houses the operating mechanism is bolted to the body with the periphery of the diaphragm clamped between the bonnet and the body. Such a valve may be manually operated or remotely operated by hydraulic, pneumatic or electrical means.

According to the present invention there is provided a diaphragm valve comprising a body traversed by a fluid passageway and having an opening in communication with the fluid passageway, a diaphragm for controlling fluid flow through the passageway and extending across the opening, a valve-operating mechanism including a member secured to the diaphragm and movable into the passageway so as to control opening of the latter through the intermediary of the diaphragm, resilient means associated with said member to urge the latter into sealing contact with the valve body if the diaphragm is destroyed, and a bonnet secured to the body to house the valve operating mechanism and with a peripheral portion of the diaphragm clamped between the bonnet and body.

An embodiment of the invention will now be described, by way of an example, with reference to the accompanying drawings, in which:—

Figure 1 is a side elevation, partly in cross-section of a diaphragm valve according to the invention;

Figure 2 is a fragmentary detail view of the valve of Figure 1 showing diaphragm destruction; and

Figure 3 is a detail of a diaphragm-securing stud.

The diaphragm valve comprises a body 10, a flexible diaphragm 11 and a bonnet 12. The body 10 is provided with end flanges 13 and a passageway 14 having a straight longitudinal axis. At each end region the passageway 14 is circular and this merges to an elliptical or substantially elliptical cross-section in its mid-length region. The configuration of the passageway between the circular inlet section and the elliptical mid-length section has been found to give much higher Cv values than known diaphragm valves when the valve is opened to a predetermined degree. The body 10 is provided with an opening 15 which may be oval or circular and which communicates with the passageway 14 and is surrounded on the outside of the body 10 by a seating against which a peripheral flange portion 16 of the diaphragm 11 seats. The seating is formed by two flat surfaces 17 which are inclined relative to each other and diverge upwardly as viewed in Figure 1. The flat surfaces 17 are joined together by curved surfaces.

The peripheral portion 16 of the diaphragm 11 seats on the flat surfaces 17 and the joining curved surfaces and the diaphragm 11 extends across the opening 15. The diaphragm 11 can be formed from any suitable elastomeric material, such as natural or synthetic rubber or a flexible plastics material and it may be reinforced by a suitable fabric. The diaphragm 11 may be of a composite construction, i.e. rubber faced with a plastics material such as polytetrafluoroethylene. Although some of these materials are not compressible in the true sense of this word the term "compression" used in the specification is intended to describe what is really a dis-

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placement of elastomer. The required compression of the peripheral portion 16 will vary with the type of elastomer and reinforcing fabric used, the pressure or vacuum in the passageway 14, the finish of the body material (plain cast iron or glass line) and manufacturing errors. As an example the compression of a natural rubber diaphragm 11 fitted to a cast iron body 10 will be approximately 20%.

The bonnet 12 is substantially bell-shaped and at its bottom end it is provided with flat surfaces 18 which are inclined relative to each other so as to converge at the bottom of the bonnet 12. The angle of inclination of the surfaces 18 is identical with that of surfaces 17. Housed in the bonnet 12 is the operating mechanism which consists of a bush 19 which is rotatably mounted in the bonnet 12 and is connected to a handwheel 20. The bore of the bush 19 is screw-threaded and in screw-threaded engagement therewith is a screw-threaded spindle 21.

It is envisaged that the diaphragm may be constructed as an elastomeric backing material bonded to a ductile metal such, for example, as lead or copper.

The diaphragm valve according to the invention has the feature that sealing of the valve is maintained, i.e. no leakage to atmosphere, even if the diaphragm is destroyed due to, for example, abrasion, chemical attack or fire.

It can be seen that the rubber diaphragm 11 has areas 22 of greater thickness than the general thickness of the diaphragm 11, which areas 22 are inboard of the diaphragm periphery and are remote from the sealing line between the body 10 and the diaphragm compressing member 23 when the valve is closed.

The diaphragm 11 is secured to the member 23 at the areas 22 by studs 24. The positioning of the securing studs 24 in the side of member 23 has the advantage that the mechanical interlock between diaphragm 11 and stud 24 has a better resistance to destruction than the case where the stud 24 is centrally located where an upward vertical force would tend to pull the stud out of the diaphragm 11.

The mechanical interlock between stud 24 and diaphragm 11 is substantially improved if the stud 24 is formed with a number of spaced discs 25 between which the diaphragm material can flow. Such a stud 24 is machined with the disc 25 parallel and they are then dished as shown after coating with a bonding chemical.

The member 23 may be provided with a secondary seal which becomes effective as the diaphragm 11 is destroyed. This secondary seal is formed of a non-destructible material, such for example as

asbestos, copper or aluminium. Such sealing material is set either into a machined groove in the member 23 or is incorporated in the valve body 10.

Additionally, the diaphragm-adjacent face of the member 23 may be provided with gasketing or other sealing material.

A seal of non-destructible material is preferably also provided between the bonnet 12 and the body 10, i.e. between the body 10 and a lip 26 hereinafter referred to, suitable recessing in the body 10 and/or the lip 26 being provided to accommodate same.

Upon diaphragm destruction, therefore, the secondary seal comes into play and there is thus no loss in fluid control nor leakage to atmosphere. Leakage through the stud holes in the member 23 is prevented by the provision of sealing caps 27.

The diaphragm compressing member 23 is secured to the spindle 21 by a pin 28 which passes through an elongate slot 29 in the member 23. A spring arrangement 30 held in a cap 31 fast with the member 23 and axially movable relative to the spindle 21 due to the provision of the slot 29 serves to urge the member 23 into sealing engagement with the body 10 upon diaphragm destruction.

As aforesaid, the peripheral edge of the diaphragm 11 is shrouded by the depending lip 26 of the bonnet 12. This lip 26 also assists in ensuring no leakage from the valve upon valve destruction.

The V-shaped clamping surfaces of the body and bonnet of the above described valves gives the advantage that they are easier to produce compared with those having curved clamping surfaces. The patterns and jigs are easier to produce due to the flat surfaces, production standards can be more easily maintained and there is a saving on machining and assembly time.

While reference has been made to straight through fluid flow it is to be clearly understood that the scope of the invention includes non-straight through fluid flow arrangements.

In the above described diaphragm valve, the diaphragm seating faces on the valve body and the complementary flat faces on the bonnet are symmetrically disposed about a plane centrally traversing the valve. This need not be so and a non-symmetrical arrangement is envisaged by the present invention.

By suitably offsetting these faces and mounting the valve with the bonnet axis horizontal there can be obtained a self-draining valve.

WHAT WE CLAIM IS:—

1. A diaphragm valve comprising a body traversed by a fluid passageway and having

placement of elastomer. The required compression of the peripheral portion 16 will vary with the type of elastomer and reinforcing fabric used, the pressure or vacuum in the passageway 14, the finish of the body material (plain cast iron or glass line) and manufacturing errors. As an example the compression of a natural rubber diaphragm 11 fitted to a cast iron body 10 will be approximately 20%.

The bonnet 12 is substantially bell-shaped and at its bottom end it is provided with flat surfaces 18 which are inclined relative to each other so as to converge at the bottom of the bonnet 12. The angle of inclination of the surfaces 18 is identical with that of surfaces 17. Housed in the bonnet 12 is the operating mechanism which consists of a bush 19 which is rotatably mounted in the bonnet 12 and is connected to a handwheel 20. The bore of the bush 19 is screw-threaded and in screw-threaded engagement therewith is a screw-threaded spindle 21.

It is envisaged that the diaphragm may be constructed as an elastomeric backing material bonded to a ductile metal such, for example, as lead or copper.

The diaphragm valve according to the invention has the feature that sealing of the valve is maintained, i.e. no leakage to atmosphere, even if the diaphragm is destroyed due to, for example, abrasion, chemical attack or fire.

It can be seen that the rubber diaphragm 11 has areas 22 of greater thickness than the general thickness of the diaphragm 11, which areas 22 are inboard of the diaphragm periphery and are remote from the sealing line between the body 10 and the diaphragm compressing member 23 when the valve is closed.

The diaphragm 11 is secured to the member 23 at the areas 22 by studs 24. The positioning of the securing studs 24 in the side of member 23 has the advantage that the mechanical interlock between diaphragm 11 and stud 24 has a better resistance to destruction than the case where the stud 24 is centrally located where an upward vertical force would tend to pull the stud out of the diaphragm 11.

The mechanical interlock between stud 24 and diaphragm 11 is substantially improved if the stud 24 is formed with a number of spaced discs 25 between which the diaphragm material can flow. Such a stud 24 is machined with the disc 25 parallel and they are then dished as shown after coating with a bonding chemical.

The member 23 may be provided with a secondary seal which becomes effective as the diaphragm 11 is destroyed. This secondary seal is formed of a non-destructible material, such for example as

asbestos, copper or aluminium. Such sealing material is set either into a machined groove in the member 23 or is incorporated in the valve body 10.

Additionally, the diaphragm-adjacent face of the member 23 may be provided with gasketting or other sealing material.

A seal of non-destructible material is preferably also provided between the bonnet 12 and the body 10, i.e. between the body 10 and a lip 26 hereinafter referred to, suitable recessing in the body 10 and/or the lip 26 being provided to accommodate same.

Upon diaphragm destruction, therefore, the secondary seal comes into play and there is thus no loss in fluid control nor leakage to atmosphere. Leakage through the stud holes in the member 23 is prevented by the provision of sealing caps 27.

The diaphragm compressing member 23 is secured to the spindle 21 by a pin 28 which passes through an elongate slot 29 in the member 23. A spring arrangement 30 held in a cap 31 fast with the member 23 and axially movable relative to the spindle 21 due to the provision of the slot 29 serves to urge the member 23 into sealing engagement with the body 10 upon diaphragm destruction.

As aforesaid, the peripheral edge of the diaphragm 11 is shrouded by the depending lip 26 of the bonnet 12. This lip 26 also assists in ensuring no leakage from the valve upon valve destruction.

The V-shaped clamping surfaces of the body and bonnet of the above described valves gives the advantage that they are easier to produce compared with those having curved clamping surfaces. The patterns and jigs are easier to produce due to the flat surfaces, production standards can be more easily maintained and there is a saving on machining and assembly time.

While reference has been made to straight through fluid flow it is to be clearly understood that the scope of the invention includes non-straight through fluid flow arrangements.

In the above described diaphragm valve, the diaphragm seating faces on the valve body and the complementary flat faces on the bonnet are symmetrically disposed about a plane centrally traversing the valve. This need not be so and a non-symmetrical arrangement is envisaged by the present invention.

By suitably offsetting these faces and mounting the valve with the bonnet axis horizontal there can be obtained a self-draining valve.

WHAT WE CLAIM IS:—

1. A diaphragm valve comprising a body traversed by a fluid passageway and having



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an opening in communication with the fluid passageway, a diaphragm for controlling fluid flow through the passageway and extending across the opening, a valve-operating mechanism including a member secured to the diaphragm and movable into the passageway so as to control opening of the latter through the intermediary of the diaphragm, resilient means associated with said member to urge the latter into sealing contact with the valve body if the diaphragm is destroyed, and a bonnet secured to the body to house the valve operating mechanism and with a peripheral portion of the diaphragm clamped between the bonnet and body.

2. A valve as claimed in claim 1, in which the diaphragm-moving member has inclined sides to which the diaphragm is attached by studs engaging in thicker areas of the diaphragm, which areas are remote from the sealing line between the body and member when the valve is closed.

3. A valve as claimed in claim 1 or 2, in which the periphery of the diaphragm-moving member and/or the diaphragm seating faces of the body are provided with a secondary seal to allow sealing therebetween if the diaphragm is destroyed.

4. A valve as claimed in claim 2, in which each stud comprises a plurality of spaced discs between which diaphragm material can flow to increase mechanical interlock between the diaphragm and its moving member.

5. A valve as claimed in claim 1, in which the resilient means is a spring arrangement carried in a cap connected to the diaphragm-moving member and serving to urge the latter axially of the valve operating mechanism if the diaphragm is destroyed.

6. A valve as claimed in claim 2 in which sealing caps are provided for the stud holes in the diaphragm-moving member to prevent fluid leakage if the diaphragm is destroyed.

7. A valve as claimed in claim 1 in which the diaphragm periphery is shrouded.

8. A diaphragm valve substantially as hereinbefore described with reference to the accompanying drawings.

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