

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 I pray that a Patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement:—

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.

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.

It has previously been proposed to provide a diaphragm valve comprising a body traversed by a fluid passageway and having an opening in communication with the passageway, a diaphragm for controlling fluid flow through the passageway and extending across the opening, and a bonnet secured to the body with the peripheral portion of the diaphragm clamped between the bonnet and body, the body being provided around the opening with a diaphragm support face formed by two flat surfaces which extend normal to the passageway and are inclined relative to each other so as to be divergent in the direction of the opening, and the bonnet being provided with a diaphragm clamping face comprising two flat surfaces which are inclined relative to each other so as to converge at the bottom end of the bonnet.

Such an inclined clamping arrangement exerts an even clamping force on the periphery of the diaphragm independently of the magnitude of the gap between the flat

surfaces, and also permits the production of a diaphragm valve with straight through fluid flow.

With such a known diaphragm valve the bonnet, diaphragm and body are bolted together and this requires accurate drilling of the bolt-receiving holes in the bonnet and body. As the body may be lined with rubber, ceramic, plastics material or glass there is a danger that the lining can be cracked when the drilled bolt holes are cleared out. Also it necessitates accurate drilling of the diaphragm after moulding to provide passage for the bolts which can, of course, adversely affect the moulded diaphragm. It is known that with such a bolting arrangement leakage can occur down the bolt holes without detection.

It is an object of the present invention to provide a diaphragm valve which dispenses with the need of accurate drilling and in which any leakage from the valve is discernible before reaching the bolts.

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, and a bonnet bolted to the body with the peripheral portion of the diaphragm clamped between the body and bonnet, the body being provided around the opening with a diaphragm support face formed by two flat surfaces which are inclined relative to each other so as to be divergent in the direction of the opening, and the bonnet being provided with a diaphragm clamping face comprising two flat surfaces which are inclined relative to each other so as to converge at the bottom end of the bonnet, the valve being characterised in that the bonnet is formed with holes while the body has complementary open-sided lugs to receive the securing bolts, the diaphragm being recessed in the regions of the securing bolts.

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 present invention;

5 Figure 2 is an end view, partly in section, of the diaphragm valve of Figure 1;

Figure 3 is a partial side elevation of the diaphragm valve of Figure 1;

Figure 4 is a partial plan view of the 10 body showing the support face for the diaphragm;

Figure 5 is a side elevation, partly in cross-section of a modification of the diaphragm valve;

15 Figure 6 is a fragmentary detail view of the valve of Figure 5 showing diaphragm destruction; and

Figure 7 is a detail of a diaphragm-securing stud.

20 The diaphragm valve of Figures 1 to 4 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 15.

25 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

30 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

35 opening 16 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 support face 17 against which a peripheral flange portion 18 of the

40 diaphragm 11 seats. The support face 17 is formed by two flat surfaces 19 which are inclined relative to each other and diverge upwardly as viewed in Figure 1. The flat surfaces 19 are joined together by curved 45 surfaces 20.

The peripheral portion 18 of the diaphragm 11 seats on the surfaces 19 and 20 and the diaphragm 11 extends across the opening 16. The diaphragm 11 can be

50 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

55 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

60 really a displacement of elastomer. The required compression of the peripheral portion 18 will vary with the type of elastomer and reinforcing fabric used, the pressure

65 or vacuum in the passageway 14, the finish

of the body material (plain cast iron or glass lined) 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%.

70 The bonnet 12 is substantially bell-shaped and at its bottom end it is provided with flat surfaces 21 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 21 is identical 75 with that of surfaces 19. Housed in the bonnet 12 is the operating mechanism which consists of a bush 22 which is rotatably mounted in the bonnet 12 and is connected to a handwheel 23. The bore of the bush 22 is screw-threaded and in screw-threaded engagement therewith is a screw-threaded spindle 24. Mounted on the lower end of the spindle 24 is a member 25 which is 80 secured thereto by a pin 26. Fixed to the diaphragm 11 is a substantially U-shaped retainer member 27, the two limbs of which extend through holes 28 in the member 25 and are bent over at their outer end to hold the diaphragm 18 on the member 25. In 85 Figure 1 the operating mechanism and diaphragm 18 are shown in the valve open position and in Figure 2 the operating mechanism and diaphragm 18 are shown 90 in the valve closed position.

It is desirable that when the bonnet 12 is bolted to the body 10 there is the minimum of compression of the diaphragm 11 at its peripheral flange 18, consistent with 100 sealing to atmosphere and preventing the edges of the diaphragm 11 being pulled inwardly when there is pressure inside the valve, in order to extend the life of the diaphragm 11. This is obtained with the 105 flat clamping flanges of the bonnet 12 and the body 10.

The V-shaped clamping surfaces of the valve provide an even clamping gap along the flanges except in the region X shown in 110 Figure 3 which corresponds with the small radius 20 at the apex of the Vee. In this region X only a small volume of elastomer is involved and the surrounding elastomeric material will accommodate to maintain an 115 even clamping pressure throughout the flange 18 of the diaphragm 11.

The V-shaped clamping surfaces automatically give a true positioning of the bonnet assembly 12 relative to the body 120 10.

In the present valve accurate drilling of holes in the body 10 and bonnet 12 for clamping bolts 30 is eliminated as the clamping bolts 30 do not have to locate 125 the body 10, the diaphragm 11 and the bonnet assembly 12 relatively to each other since they are self locating. As shown in Figure 4 the body 10 is provided with cast open-sided lugs 31 to receive the bolts 30. 130

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The V-shaped clamping surfaces locate the bonnet 12 and diaphragm 11 longitudinally of the body 10 during assembly and transverse location is obtained when the bolts 5 30 are tightened because the assembly is made with the member 25 in the valve closed position. The elimination of drilling holes in the body 10 is important where the body 10 is lined with rubber, ceramic, 10 plastics material or glass as the lining can be cracked when any holes which contain lining material are cleaned out.

The diaphragm clamping area defined by the body 10 and bonnet assembly 12 is, as 15 can be seen from Figure 4, of substantially regular width. In this valve the diaphragm 11 is formed with recesses 34 instead of holes for the bolts 30. This eliminates the need to drill holes in the diaphragm 11 after 20 moulding. It is important to note that this construction renders any leakage of fluid visible before it comes into contact with the bolts 30.

The diaphragm 11 has its flat peripheral 25 flange 18 kinked at its centre so that it can easily take up the V-shape. The diaphragm 11 can therefore be moulded with a flat flange 18 with considerable advantages in using cheaper moulds and can be faced with 30 a plastic material. By moulding a diaphragm 11 with a flat flange 18, the magnitude of the maximum stress in the elastomer is reduced, the maximum stress occurring when the diaphragm 11 is fully closed. The 35 action of folding the flat flange 18, on assembly, induces stresses in the elastomer which are relieved when the valve is closed, resulting in stresses of a lower magnitude. This results in reduced closure effort and 40 longer diaphragm life. It is possible to produce the diaphragm 11 as a standard diaphragm which can be used for different amounts of opening. The standard diaphragm 11 is moulded so that it is unstressed 45 in the open position for standard use. However such a diaphragm can be opened further than the standard use where a valve has to give the maximum throughput.

The diaphragm 11 is connected to the 50 member 25 by a U-shaped retainer member 27, the end of which is buried in the diaphragm 11 well away from the face which in use is in contact with the fluid in the valve and the limbs of the retainer member 27 extend through two holes 28 which 55 have a wide tolerance requiring only one machining operation. The ends of the limbs are bent to hook onto the member 25. The diaphragm 11 is accurately positioned 60 on the member 25 by a lozenge shaped boss 32 locating in a cast recess 33 provided in the member 25.

It is envisaged that the diaphragm may be constructed as an elastomeric backing 65 material bonded to a ductile metal such,

for example, as lead or copper. Alternatively, the diaphragm may be formed wholly of a ductile metal or hard plastics material without any elastomeric material between the member 25 or 43 and the 70 diaphragm.

Referring now to Figures 5 to 7 there is shown a diaphragm valve having the additional feature that sealing of the valve is maintained, i.e. no leakage to atmosphere, 75 even if the diaphragm is destroyed due to, for example, abrasion, chemical attack or fire.

In this instance, it can be seen that the rubber diaphragm 40 has areas 41 of greater 80 thickness than the general thickness of the diaphragm, which areas 41 are inboard of the diaphragm periphery and are remote from the sealing line between the body 42 and the diaphragm compressing member 43 85 when the valve is closed.

The diaphragm 40 is secured to the member 43 at the areas 41 by studs 44. The positioning of the securing studs 44 in the side of member 43 has the advantage 90 that the mechanical interlock between diaphragm and stud has a better resistance to destruction than the case where the stud is centrally located where an upward vertical force would tend to pull the stud 95 out of the diaphragm 40.

The mechanical interlock between stud and diaphragm is substantially improved if the stud 44 is formed with a number of spaced discs 45 between which the diaphragm 100 material can flow. Such a stud 44 would be machined with the discs 45 parallel and they would then be dished as shown after coating with a bonding chemical. It will be manifest that this 105 stud construction can be used in any other situation where a stud is called for and is not limited in use to the diaphragm valve of the present invention.

The member 43 is preferably provided 110 with a secondary seal which becomes effective as the diaphragm 40 is destroyed. This secondary seal is formed of a non-destructible material, such for example as asbestos, copper or aluminium. Such sealing 115 material may be set into a machined groove in the member 43 or may be incorporated in the valve body 42.

Additionally, the diaphragm-adjacent face of the member 43 may be provided with 120 gasketting or other sealing material.

A seal of non-destructible material is preferably also provided between bonnet and body; i.e. between the body 42 and lip 49 hereinafter referred to, suitable recessing in the body and/or lip preferably 125 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 130

leakage to atmosphere. Leakage through the stud holes in the member 43 is prevented by the provision of sealing caps 46.

A spring arrangement 47 held in a cap 5 48 urges the member 43 and body 42 into sealing engagement upon diaphragm destruction.

It can be seen from Figures 5 and 6 that the peripheral edge of the diaphragm 40 is shrouded by a depending lip 49 of the 10 bonnet 50. This lip 49 also assists in ensuring no leakage from the valve upon valve destruction.

The V-shaped clamping surfaces of the 15 body and bonnet 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 20 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 this invention 25 includes non-straight through fluid flow arrangements.

In the above described diaphragm valves, the diaphragm support faces on the valve body and the complementary flat clamping 30 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.

Our copending Patent Application No. 40 8025360, Serial No. 1 601 210 divided out of the present Application discloses a diaphragm valve comprising a body traversed by a fluid passageway and having an opening in communication with the fluid 45 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 50 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 55 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.

60 WHAT WE CLAIM IS:—

1. A diaphragm valve comprising a body traversed by a fluid passageway and having an opening in communication with the fluid 65 passageway, a diaphragm for controlling fluid flow through the passageway and ex-

tending across the opening, and a bonnet bolted to the body with the peripheral portion of the diaphragm clamped between the body and bonnet, the body being provided around the opening with a diaphragm support face formed by two flat surfaces 70 which are inclined relative to each other so as to be divergent in the direction of the opening, and the bonnet being provided with a diaphragm clamping face comprising 75 two flat surfaces which are inclined relative to each other, so as to converge at the bottom end of the bonnet, the valve being characterised in that the bonnet is formed with holes while the body has complementary 80 open-sided lugs to receive the securing bolts, the diaphragm being recessed in the regions of the securing bolts.

2. A valve as claimed in claim 1 in which the diaphragm seating of the body is such 85 as to provide a straight-through fluid passageway.

3. A valve as claimed in claim 1 or 2, in which the body is configured to provide at each end a circular section passageway, 90 these being joined by an elliptical or substantially elliptical section passageway.

4. A valve as claimed in any one of claims 1 to 3, in which the opening is of 95 oval or circular shape.

5. A valve as claimed in any one of claims 1 to 4, in which the flat support surfaces of the body are joined together by curved surfaces.

6. A valve as claimed in any one of 100 claims 1 to 5, in which the bonnet houses a valve-operating mechanism including a member secured to the diaphragm and movable normally to the longitudinal axis of the passageway so as to control opening of 105 the latter through the intermediary of the diaphragm.

7. A valve as claimed in any one of claims 1 to 6, in which the diaphragm is formed with a flat peripheral flange which 110 is clamped between the inclined flat seating surfaces of the body and bonnet and which is kinked along its centre to conform with the configuration determined by said surfaces. 115

8. A valve as claimed in claim 7, in which the diaphragm is formed of an elastomeric material with or without textile reinforcement.

9. A valve as claimed in claim 7, in 120 which the diaphragm is of rubber faced with a plastics material.

10. A valve as claimed in Claim 7 in which the diaphragm comprises an elastomeric backing bonded to a ductile metal. 125

11. A valve as claimed in claim 7, in which the diaphragm is made wholly of a ductile metal or hard plastics material.

12. A valve as claimed in claim 6, in which the diaphragm-moving member has 130

leakage to atmosphere. Leakage through the stud holes in the member 43 is prevented by the provision of sealing caps 46.

A spring arrangement 47 held in a cap 48 urges the member 43 and body 42 into sealing engagement upon diaphragm destruction.

It can be seen from Figures 5 and 6 that the peripheral edge of the diaphragm 40 is shrouded by a depending lip 49 of the bonnet 50. This lip 49 also assists in ensuring no leakage from the valve upon valve destruction.

The V-shaped clamping surfaces of the body and bonnet 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 this invention includes non-straight through fluid flow arrangements.

In the above described diaphragm valves, the diaphragm support faces on the valve body and the complementary flat clamping 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.

Our copending Patent Application No. 8025360, Serial No. 1 601 210 divided out of the present Application discloses 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.

WHAT WE CLAIM IS:—

1. 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 ex-

tending across the opening, and a bonnet bolted to the body with the peripheral portion of the diaphragm clamped between the body and bonnet, the body being provided around the opening with a diaphragm support face formed by two flat surfaces which are inclined relative to each other so as to be divergent in the direction of the opening, and the bonnet being provided with a diaphragm clamping face comprising two flat surfaces which are inclined relative to each other, so as to converge at the bottom end of the bonnet, the valve being characterised in that the bonnet is formed with holes while the body has complementary open-sided lugs to receive the securing bolts, the diaphragm being recessed in the regions of the securing bolts.

2. A valve as claimed in claim 1 in which the diaphragm seating of the body is such as to provide a straight-through fluid passageway.

3. A valve as claimed in claim 1 or 2, in which the body is configured to provide at each end a circular section passageway, these being joined by an elliptical or substantially elliptical section passageway.

4. A valve as claimed in any one of claims 1 to 3, in which the opening is of oval or circular shape.

5. A valve as claimed in any one of claims 1 to 4, in which the flat support surfaces of the body are joined together by curved surfaces.

6. A valve as claimed in any one of claims 1 to 5, in which the bonnet houses a valve-operating mechanism including a member secured to the diaphragm and movable normally to the longitudinal axis of the passageway so as to control opening of the latter through the intermediary of the diaphragm.

7. A valve as claimed in any one of claims 1 to 6, in which the diaphragm is formed with a flat peripheral flange which is clamped between the inclined flat seating surfaces of the body and bonnet and which is kinked along its centre to conform with the configuration determined by said surfaces.

8. A valve as claimed in claim 7, in which the diaphragm is formed of an elastomeric material with or without textile reinforcement.

9. A valve as claimed in claim 7, in which the diaphragm is of rubber faced with a plastics material.

10. A valve as claimed in Claim 7 in which the diaphragm comprises an elastomeric backing bonded to a ductile metal.

11. A valve as claimed in claim 7, in which the diaphragm is made wholly of a ductile metal or hard plastics material.

12. A valve as claimed in claim 6, in which the diaphragm-moving member has



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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

5 member when the valve is closed.

13. A valve as claimed in claim 12, in which the periphery of the diaphragm-moving member and/or the flat support faces are provided with a secondary seal to

10 allow sealing therebetween if the diaphragm is destroyed.

14. A valve as claimed in claim 12 and 13 in which each stud comprises a plurality of spaced discs between which diaphragm

15 material can flow to increase mechanical interlock between the diaphragm and its moving member.

15. A valve as claimed in claim 13 or 14, comprising a spring arrangement associated

20 with the diaphragm-moving member to urge it into body-contact if the diaphragm is destroyed.

16. A valve as claimed in any one of

claims 13 to 15 in which sealing caps are provided for the stud holes in the diaphragm-moving member to prevent fluid leakage if

17. A valve as claimed in any one of claims 12 to 16, in which the diaphragm periphery is shrouded.

18. A valve as claimed in any one of the preceding claims, in which the inclined flat support and clamping surfaces of the body and bonnet are non-symmetrially arranged relative to a central plane travers-

35 ing the valve body.

19. A diaphragm valve, substantially as hereinbefore described with reference to Figs. 1 to 4 or Figs. 5 to 7 of the accom-

40 panying drawings.

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