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(54) IMPROVEMENTS IN AND RELATING TO BUTTERFLY VALVES

(71) We, MILWAUKEE VALVE COMPANY, INC., a Corporation organised and existing under the laws of the State of Wisconsin, United States of America, of 2375 South Burrell Street, Milwaukee, Wisconsin 53207, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a butterfly valve and a method for making same.

Butterfly valves are known of the type comprising a body having a generally cylindrical bore defining a flow passage there-through, a stem rotatably mounted in said body and extending transversely of said flow passage, a generally circular disc member carrying a resilient sealing ring on the outer periphery and supported on said stem for rotary movement between an open position and a closed position wherein said sealing ring sealingly engages said bore to shut off flow through said flow passage.

Discs used in prior art valves usually are machined or die cast parts. Consequently, butterfly valves have not been widely used in systems requiring a small shutoff valve, e.g., in the 1/2 to 2 inch range, because the relatively massive disc adversely affects the flow characteristics of the valve. Also, machine or die cast discs represent a significant portion of the total fabrication and assembly costs for most butterfly valves. A requirement exists for a butterfly valve capable of being used in relatively small flow systems, and which can be conveniently fabricated from relatively thin and inexpensive materials and assembled by inexpensive techniques.

According to the present invention, there is provided a butterfly valve comprising a body having a generally cylindrical bore defining a flow passage therethrough, a stem rotatably mounted in said body and extending transversely of said flow passage, a generally circular disc member carrying a

resilient sealing ring on the outer periphery and supported on said stem for rotary movement between an open position and a closed position wherein said sealing ring sealingly engages said bore to shut off flow through said flow passage and wherein said disc member includes a pair of relatively thin generally circular disc halves disposed in confronting face-to-face relationship, each of said disc halves being formed with a diametrically extending semicylindrical groove portion cooperating with the corresponding semicylindrical groove portion of the other of said disc halves to define a hub receiving said stem and each of said disc halves also being formed with a peripheral flange spaced from a plane coincident with the confronting face and cooperating with the corresponding peripheral flange on the other of said disc halves to define a peripheral groove therebetween receiving said sealing ring, said cooperating flanges compressingly engaging said sealing ring to positively restrain said sealing ring from being twisted or dislodged from said peripheral groove during opening and closing of said disc member, both of said disc halves being secured to said stem.

The present invention also provides a method of making a butterfly valve including a body having a generally cylindrical bore defining a flow passage which extends substantially straight through the body, a coaxial aperture and recess in the body for rotatably journalling a stem which extends transversely of the flow passage, a generally circular disc member having a peripheral groove and mounted on the stem for rotatable movement between an open position and a closed position to shut off flow, and a sealing ring disposed in the disc member groove, comprising the steps of forming the sealing ring as a unitary member including a pair of opposed annular sections adapted to encircle the stem at locations adjacent to the valve body bore and a pair of semicircular sections respectively connecting the annular sections and adapted to sealingly engage the valve body bore when the disc

member is in the closed position, forming a pair of identically arranged disc halves from a relatively thin material, each of the disc halves including a semicylindrical groove portion which, upon face-to-face assembly of the disc halves, cooperates with the corresponding semicylindrical portion on the other of said disc halves to define a hub for receiving the stem and a peripheral flange which, upon face-to-face assembly of the disc halves, cooperates with the corresponding peripheral flange on the other of said disc halves to define the peripheral groove for receiving the sealing ring, assembling the disc halves together in facing relation with the sealing ring disposed between the flanges thereof, and fastening the thus assembled disc member to the stem.

In the accompanying drawings:—

Figure 1 is a side view of a butterfly valve, partially sectioned, in accordance with the invention;

Figure 2 is an enlarged, exploded view of the valve illustrated in Figure 1;

Figure 3 is a fragmentary end view of the valve illustrated in Figure 1;

Figure 4 is a sectional view taken along the line 4-4 in Figure 2;

Figure 5 is a sectional view taken along the line 5-5 in Figure 4;

Figures 6, 7 and 8 are fragmentary, cross-sectional views of the valve illustrated in Figure 1 shown at various stages of assembly; and

Figure 9 is a fragmentary sectioned view of an alternative arrangement for the valve illustrated in Figure 1.

The details of construction and the arrangements of the components set forth in the following description or illustrated in the drawings, are given by way of example only and the invention is capable of other embodiments and of being practiced and carried out in various ways.

Illustrated in the drawing is a butterfly valve 10 including a body 12 having a generally cylindrical bore 14 which defines a flow passage extending substantially straight through body 12. The opposite ends of valve body 12 can be threaded as shown or otherwise formed for connection with associated plumbing.

A generally circular disc member 16 is mounted on a shaft or stem 18 for rotatable movement within bore 14. Disc member 16 has a diametrically extending, enlarged central portion 20 defining a hub 22 for receiving stem 18 and opposed annular bosses 24 surrounding hub 22 (See Figures 1 and 7). Disc member 16 is secured to stem 18 by a suitable means, such as by spot welding.

Stem 18 includes an inner end which is rotatably received, i.e., journaled, in a recess 30 provided in valve body 12 and an outer end which rotatably extends through an

aperture 34 provided in valve body 12 coaxially with recess 30. A suitable actuator means, such as a handle 42, is fastened to the outer end of stem 18, such by a nut 44, for rotating disc member 16 about the transverse pivot axis provided by stem 18 between a closed or flow-shutoff position where the plane of disc member 16 is generally at a right angle to the direction of flow (See Fig. 3) and an open position where the plane of the disc is substantially aligned with the direction of flow (See Fig. 1). Rotational movement of disc member 16 at the fully opened and fully closed positions is limited by a stop lug 46 provided on the exterior of valve body 12 and which is engaged by an inturned flange 48 located on the end of handle 42.

Valve bore 14 includes diametrically opposed, flattened wall portions 50 in the vicinities surrounding recess 30 and aperture 34 and diametrically opposed, generally semi-circular wall portions 52 extending circumferentially between flattened portions 50 (See Figs. 1 and 3). Bore portions 50 and 52 serve as seating surfaces as explained in more detail below. The outer surface of each disc boss 24 is flat and is spaced inwardly a small distance from the corresponding flattened bore portion 50. The circular portions of disc member 16 have an outer radius which is slightly less than the radius of the corresponding bore semicircular portion 52.

For receiving a sealing ring 54, disc member 16 has a continuous peripheral recess or groove including opposed annular portions 56 (See Fig. 7) which are located in bosses 24 and encircle stem hub 22 and opposed generally semicircular portions 58 (See Figs. 7 and 8) which extend between bosses 24 and connect annular portions 56. Semicircular groove portions 58 have a dovetailed or generally inverted, V-shaped cross-section.

Sealing ring 54 is formed as a unitary assembly and includes annular sections 60 which fit into annular portions 56 of the disc groove and semicircular sections 62 which connect annular sections 60 and fit into semicircular portions 58 of the disc groove. Sealing ring 54 is made from a relatively resilient material suitable for the type of service in which the valve is to be used, such as natural rubber, synthetic elastomers, fluorocarbon-materials and the like. Annular sections 60 of sealing ring 54 have a generally elliptical cross-section (See Fig. 5) and semicircular sections 62 of sealing ring 54 have a generally trapezoidal cross-section (See Fig. 4).

In order to provide an interference fit between annular sections 60 of sealing ring 54 and flattened bore portions 50, each annular sealing ring section 60 extends out-

wardly from annular groove portion 56 by a dimension which exceeds the clearance between the outer surface of boss 24 and the flattened bore portion 50. This interference fit, which is maintained throughout all positions of disc member 16, causes annular sections 60 of sealing ring 54 to be compressed radially into sealing engagement with stem 18 (See Fig. 7). Thus, the annular portions of the sealing ring provide fluid tight stem seals at all positions of disc member 16.

Semicircular sections 62 of sealing ring 54 extend outwardly beyond the outer periphery of disc member 16 and sealingly engage the corresponding semicircular bore portions 52 when disc member 16 is in the closed position (See Figs. 3, 7 and 8). The dove-tailed or inverted, V-shaped cross-section of disc groove portions 58 and the trapezoidal shaped cross-section of sealing ring sections 62 cooperate to provide a positive restraint against the sealing ring being twisted or being dislodged from the disc groove by high velocity flow during valve operation.

Any leakage past the stem seal into recess 30 might cause a build up of pressure behind the inner end of stem 18 tending to force the stem out of valve body 12. This potential problem can be eliminated by venting recess 30 to the atmosphere, such as by extending recess 30 completely through the valve body or by providing a small vent port (not shown) which communicates with recess 30.

In the embodiment illustrated in Figs. 1-3, the torque required to rotate disc member 16 between a fully open position and a nearly closed position is controlled by the surface area contact and the degree of interference between section 60 of sealing ring 54 and the flattened bore portions 50. This torque can be quite low, particularly when the sealing ring 54 is made from a material having a relatively low coefficient of friction. A low torque can be quite desirable for some applications particularly when the valve is manually operated and used solely for shutoff purposes. However, in other applications, such as where the valve is used to meter flow and the disc member is disposed at an intermediate position, the frictional drag provided by the annular sealing ring sections may not be sufficient to prevent the disc member from being rotated by fluid forces.

To eliminate this problem, means can be provided for selectively varying the rotational drag on the stem. While various arrangements can be used, in the alternate embodiment illustrated in Fig. 9, valve body 12 is provided with an annular recess 59 which is coaxial with stem-receiving aperture 34 and receives a packing material 61. The packing material 61 is compressed into engagement with the outer surface of stem 18

by a gland nut 63 threaded into recess 59. The frictional drag imposed on stem 18 by packing material 61 is adjusted by tightening gland nut 63 (to increase drag) or loosening gland nut 63 (to decrease drag). Packing material 61 can be the same general type commonly used for valve glands, except it has a high coefficient of friction in order to be capable of imposing a relatively high rotational drag on stem 18. For example, the packing material can be a braided asbestos impregnated with material having a relatively high coefficient of friction. Thus, in addition to acting as a drag producing means for stem 18, the packing material also serves as a secondary stem seal.

In order to reduce fabrication and assembly costs and to minimize the flow restriction produced by the disc member, disc member 15 is constructed from two separate halves 64 (See Fig. 1). Disc halves 64 are mirror images, and preferably identically arranged, with each including a generally semicylindrical central portion 66 and a peripheral flange 68 which, upon face-to-face assembly of the two disc halves, define stem hub 22 and groove portions 56 and 58, respectively.

With this arrangement, disc halves 64 can be conveniently and economically fabricated from a relatively rigid, inexpensive thin sheet material, such as metal, plastic or the like. While other materials and forming techniques can be used, disc halves 64 are preferably formed from a thin sheet (e.g., 1/32 inch thick) of stainless steel (e.g., 7,000 series) by a conventional metal stamping process.

Disc member 16 and sealing ring 54 can be assembled either outside or inside valve body 12. In the former case, disc halves 64 are first secured together in face-to-face relationship with sealing ring 54 disposed between flanges 68. After the disc member/sealing ring assembly has been installed inside valve body bore 14 with bosses 24 and annular sealing rings sections 60 axially aligned with the corresponding recess 30 and aperture 34, stem 18 is installed, disc member 16 fastened to stem 18, and the remaining assembly steps are completed in the usual manner.

Referring to Figs. 6-8, an exemplary method for assembling valve 10 in the latter manner will be described. Sealing ring 54 is first installed into valve body bore 14, such as with a suitably arranged holding fixture (not shown), with annular sections 60 in coaxial alignment with recess 30 and aperture 34 and semicircular sections 62 located in a position corresponding to a closed position of disc member 16 (See Fig. 6). Stem 18 is thereafter inserted through aperture 34, passed through the openings of both sealing ring sections 60 and the

inner end moved into recess 30. The two disc halves 64 are then installed.

Suitable means are provided for holding disc halves 64 so they can be installed, in facing relation, through opposite ends of bore 14. While other arrangements can be used, in the specific method illustrated, such means includes separate fixtures 70 and 72, each having a hollow jig 74 adapted to carry a disc half 64 on the outer end and a centrally apertured clamping bracket 76 (See Fig. 7). The disc halves 64, carried on fixtures 70 and 72, are moved into place inside valve bore 14 with semi-cylindrical portions 66 adjacent to the opposite edges of sealing ring 54.

Fixtures 70 and 72 are illustrated in a horizontal position in Figs. 7 and 8, in which case a suitable means, such as a magnet or the like, is used to temporarily retain disc halves 64 in place on the outer ends of jigs 74. In actual practice, it may be more desirable for the fixtures to be in a vertical position during installation of the disc halves. When the fixtures are in this position, the valve body is moved down over the jig of a first fixture carrying one of the disc halves, rotated 180° with the first fixture being held in place, and then moved down the jig of a second fixture carrying the other disc half.

After the disc halves have been installed, fixtures 70 and 72 are clamped together, such as by tightening a plurality of bolts 78 (one shown) connecting clamping brackets 76. The resultant clamping action on disc halves 64 moves semicylindrical portions 66 into engagement with stem 18 and causes flanges 68 to compress both the annular sections 60 and the semicircular sections 62 of sealing ring 54.

Semicylindrical portions 66 of disc halves 64 are then secured to stem 18 in a suitable manner. While other techniques can be employed, in the specific method illustrated, a pair of oppositely disposed welding electrodes 80 of a conventional spot welding machine (not shown) are inserted through the openings of fixture 70 and 72 and moved into engagement with the outer surfaces of semicylindrical portions 66. The welding machine is energized to spot weld each disc half 64 to stem 18 at one or more locations.

If desired, other fastening means, such as rivets, bolts, pins and the like, can be used to fasten the disc member to the stem. When made from a plastic material, the disc member can be secured to a metallic stem 1 by an adhesive, such as an epoxy material which is suitable for that purpose. When both the disc halves and the stem are made from a thermoplastic material, the disc member can be fused to the stem by a suitable thermoplastic welding technique.

The disc for very high pressure applications is preferably made more rigid by spot

welding the disc halves to each other in addition to spot welding them to the shaft. This renders the valve capable of withstanding operation at 700 pounds per square inch.

The thin plates utilized in making up the disc have the clamping grooves extending away from the confronting faces of the disc. This, in turn, makes it possible to minimize the size of the sealing ring which, in turn, renders it substantially impervious to being blown out from between the disc halves.

From the above detailed description, it can be seen that a butterfly valve arranged in accordance with the invention has many advantages. The disc member is formed from two halves which can be identically arranged and fabricated from relatively thin materials. The resultant thinness of the disc member minimizes the flow restriction produced thereby, permitting the butterfly valve to be used advantageously in small flow systems, e.g., 1/2 to 2 inches. Instead of requiring expensive machining or die casting operations, the disc halves can be fabricated by conventional inexpensive forming techniques which reduces the overall fabrication and assembly costs of the valve. The sealing ring does not have to be stretched for mounting into the disc member groove; thus, the sealing ring can be made from seal materials which ordinarily tend to become permanently deformed by stretching. The sealing ring is positively restrained against being dislodged from the disc member groove by high velocity flow, moreover, the disc member can be conveniently assembled either outside or inside the valve body bore.

WHAT WE CLAIM IS:—

1. A butterfly valve comprising a body having a generally cylindrical bore defining a flow passage therethrough, a stem rotatably mounted in said body and extending transversely of said flow passage, a generally circular disc member carrying a resilient sealing ring on the outer periphery and supported on said stem for rotary movement between an open position and a closed position wherein said sealing ring sealingly engages said bore to shut off flow through said flow passage and wherein said disc member includes a pair of relatively thin generally circular disc halves disposed in confronting face-to-face relationship, each of said disc halves being formed with a diametrically extending semicylindrical groove portion cooperating with the corresponding semicylindrical groove portion of the other of said disc halves to define a hub receiving said stem and each of said disc halves also being formed with a peripheral flange spaced from a plane coincident with the confronting face and cooperating with the corresponding peripheral flange on the other of said disc halves to define a peripheral groove there-

inner end moved into recess 30. The two disc halves 64 are then installed.

Suitable means are provided for holding disc halves 64 so they can be installed, in facing relation, through opposite ends of bore 14. While other arrangements can be used, in the specific method illustrated, such means includes separate fixtures 70 and 72, each having a hollow jig 74 adapted to carry a disc half 64 on the outer end and a centrally apertured clamping bracket 76 (See Fig. 7). The disc halves 64, carried on fixtures 70 and 72, are moved into place inside valve bore 14 with semi-cylindrical portions 66 adjacent to the opposite edges of sealing ring 54.

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After the disc halves have been installed, fixtures 70 and 72 are clamped together, such as by tightening a plurality of bolts 78 (one shown) connecting clamping brackets 76. The resultant clamping action on disc halves 64 moves semicylindrical portions 66 into engagement with stem 18 and causes flanges 68 to compress both the annular sections 60 and the semicircular sections 62 of sealing ring 54.

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The disc for very high pressure applications is preferably made more rigid by spot

welding the disc halves to each other in addition to spot welding them to the shaft. This renders the valve capable of withstanding operation at 700 pounds per square inch.

The thin plates utilized in making up the disc have the clamping grooves extending away from the confronting faces of the disc. This, in turn, makes it possible to minimize the size of the sealing ring which, in turn, renders it substantially impervious to being blown out from between the disc halves.

From the above detailed description, it can be seen that a butterfly valve arranged in accordance with the invention has many advantages. The disc member is formed from two halves which can be identically arranged and fabricated from relatively thin materials. The resultant thinness of the disc member minimizes the flow restriction produced thereby, permitting the butterfly valve to be used advantageously in small flow systems, e.g., 1/2 to 2 inches. Instead of requiring expensive machining or die casting operations, the disc halves can be fabricated by conventional inexpensive forming techniques which reduces the overall fabrication and assembly costs of the valve. The sealing ring does not have to be stretched for mounting into the disc member groove; thus, the sealing ring can be made from seal materials which ordinarily tend to become permanently deformed by stretching. The sealing ring is positively restrained against being dislodged from the disc member groove by high velocity flow, moreover, the disc member can be conveniently assembled either outside or inside the valve body bore.

WHAT WE CLAIM IS:—

1. A butterfly valve comprising a body having a generally cylindrical bore defining a flow passage therethrough, a stem rotatably mounted in said body and extending transversely of said flow passage, a generally circular disc member carrying a resilient sealing ring on the outer periphery and supported on said stem for rotary movement between an open position and a closed position wherein said sealing ring sealingly engages said bore to shut off flow through said flow passage and wherein said disc member includes a pair of relatively thin generally circular disc halves disposed in confronting face-to-face relationship, each of said disc halves being formed with a diametrically extending semicylindrical groove portion cooperating with the corresponding semicylindrical groove portion of the other of said disc halves to define a hub receiving said stem and each of said disc halves also being formed with a peripheral flange spaced from a plane coincident with the confronting face and cooperating with the corresponding peripheral flange on the other of said disc halves to define a peripheral groove there-



between receiving said sealing ring, said co-operating flanges compressingly engaging said sealing ring to positively restrain said sealing ring from being twisted or dislodged from said peripheral groove during opening and closing of said disc member, both of said disc halves being secured to said stem.

2. A butterfly valve according to claim 1 wherein said semicylindrical portions are welded to opposite sides of said stem.

3. A butterfly valve according to claim 1 or claim 2 wherein said bore includes diametrically opposed flattened wall portions in the vicinity of said stem and diametrically opposed, generally semicircular wall portions joining said flattened wall portions; said peripheral groove includes a pair of diametrically opposed annular portions respectively encircling the opposite ends of said stem hub and a pair of diametrically opposed generally semicircular portions extending circumferentially between corresponding ones of said annular portions, said sealing ring includes a pair of opposed annular sections disposed in corresponding ones of said annular groove portions, said annular sealing ring sections being in an interference fit with the corresponding flattened wall portions of said bore throughout all positions of said disc member, and said sealing ring further includes a pair of opposed, generally semicircular sections integral with and interconnecting said annular sections and disposed in corresponding ones of said semicircular groove portions.

4. A butterfly valve according to claim 3 wherein the portions of said peripheral flanges defining said semi-circular portions of said peripheral groove converge radially outwardly, and said semicircular portions of said sealing ring have a generally trapezoidal cross-section and include a smaller outermost portion extending radially beyond the peripheries of the corresponding disc flanges.

5. A butterfly valve according to any preceding claim wherein each of said disc halves is formed from a thin sheet of stainless steel.

6. A butterfly valve according to any preceding claim wherein said disc halves are formed by stamping.

7. A butterfly valve according to any preceding claim wherein said disc halves are mirror images of each other.

8. A butterfly valve according to any preceding claim having a drag device for selectively imposing sufficient rotational drag on said stem to retain said disc member at positions intermediate the open and closed positions whereby said disc member can throttle flow through said flow passage and yet can be moved to the open and closed positions.

9. A butterfly valve according to claim 8 wherein said drag device comprises an annular recess in said body and encircling

one end portion of said stem, a material having a high coefficient of friction disposed in said recess and compressingly engaging said stem, and a gland nut threadably received in said body and disposed in compressive engagement with said material for selectively adjusting the compression of said material with said stem.

10. A method of making a butterfly valve including a body having a generally cylindrical bore defining a flow passage which extends substantially straight through the body, a coaxial aperture and recess in the body for rotatably journalling a stem which extends transversely of the flow passage, a generally circular disc member having a peripheral groove and mounted on the stem for rotatable movement between an open position and a closed position to shut off flow, and a sealing ring disposed in the disc member groove, comprising the steps of forming the sealing ring as a unitary member including a pair of opposed annular sections adapted to encircle the stem at locations adjacent to the valve body bore and a pair of semicircular sections respectively connecting the annular sections and adapted to sealingly engage the valve body bore when the disc member is in the closed position, forming a pair of identically arranged disc halves from a relatively thin material, each of the disc halves including a semicylindrical groove portion which, upon face-to-face assembly of the disc halves, cooperates with the corresponding semicylindrical portion on the other of said disc halves to define a hub for receiving the stem and a peripheral flange which, upon face-to-face assembly of the disc halves, cooperates with the corresponding peripheral flange on the other of said disc halves to define the peripheral groove for receiving the sealing ring, assembling the disc halves together in facing relation with the sealing ring disposed between the flanges thereof, and fastening the thus assembled disc member to the stem.

11. A method according to claim 10 including the steps of installing the sealing ring inside the bore with the annular sections coaxially aligned respectively with the stem-receiving aperture and recess and the semicircular sections located in a position corresponding to the closed position of the disc member, inserting the stem through the aperture, through the annular sealing ring sections, and into the recess, installing the disc halves in facing relationship through the opposite ends of the bore, moving the two disc halves into juxtaposition with the hub-defining portions thereof engaging the outer surfaces of the stem and the flanges thereof compressively engaging the sealing ring, and fastening both the disc halves to the stem.

12. A method according to claim 15 wherein said fastening comprises spot weld-



ing the hub-defining portions of the disc halves to the stem.

- 5 13. A butterfly valve substantially as described herein with reference to the accompanying drawings.

14. A method of making a butterfly valve substantially as herein described.

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