

PATENT SPECIFICATION

DRAWINGS ATTACHED

L180,305



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COMPLETE SPECIFICATION

Improvements in and relating to Butterfly Valves

I, KAZUO KITAZAWA, a Japanese citizen, of No. 21—13, 2-Chome, Ohara, Setagaya-Ku, Tokyo, Japan, 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:—

The present invention relates to butterfly valves for use in a piping system intended to transport fluid under high pressure there-through.

In a prior art butterfly valve for use in a piping system for transporting fluid under high pressure, a disc assembly is rotatably mounted within a cylindrical casing extending transversely of the casing at right angles with respect to the axis of the casing, and in order to maintain a fluid tight sealing between the outer periphery of the disc assembly and the inner periphery of the casing it is necessary to provide an annular valve seat around the inner periphery of the casing for accommodating the edge of an elastomeric packing extending around the peripheral edge of the disc assembly. The annular valve seat serves, in the fully closed condition of the disc assembly, to maintain a fluid tight sealing relation throughout the interface between the outer periphery of the disc assembly and the inner periphery of the casing. For this purpose, it is necessary to precisely mount the annular valve seat around the inner periphery of the casing. However, in fact it is very difficult to precisely mount the valve seat in the manner mentioned just above.

Furthermore, in the prior art butterfly valve, the disc assembly, which includes a pair of discs secured to each other with a clearance defined therebetween and with an annular elastomeric packing disposed there-

between and projecting beyond the outer peripheral edge of the discs, has to be rotatably mounted within the casing by inserting an upper drive shaft through a bore formed on the top of the casing into the upper half portion of the clearance, inserting a lower driven shaft through a bore formed on the bottom of the casing into the lower half portion of the clearance, applying a blind cover against the bottom of the bottom bore of the casing covering the bore and the area surrounding the bore and finally securing the blind cover to the bottom of the casing by means of bolts or set screws. However, such mounting of the disc assembly within the casing of the prior art butterfly valve in most cases fails to provide a perfect fluid tight seal between the outer periphery of the disc assembly and the inner periphery of the casing, leading to the possibility of fluid leakage along the interface.

One object of the present invention is to provide a butterfly valve in which the difficulties inherent in the prior art butterfly valve are effectively eliminated.

Another object of the present invention is to provide a butterfly valve which does not require provision of any annular valve seat around the inner periphery of the casing of the valve for maintaining a fluid tight seal throughout the interface between the rotary disc assembly and the valve casing.

Another object of the present invention is to provide a butterfly valve which is simple in construction and in operation and in which the valve member disc assembly can be simply and easily mounted within the casing of the valve.

According to the present invention, there is provided a butterfly valve for use in a piping system for transporting fluid under high pressure comprising a hollow cylindrical

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casing having on the top a neck portion projecting upwardly therefrom and provided with a through bore communicating with the hollow interior of said casing and on the bottom a blind recess in alignment with said through bore of the neck portion; a lower driven shaft rotatably received in said recess and partially projecting upwardly therefrom; an upper drive shaft rotatably received in said through bore of the neck portion and partially projecting downwardly into said hollow interior of the casing; and a rotary disc assembly mounted within said interior of the casing for rotation about an axis extending transversely of the casing at right angles with respect to the axis of the casing and including a pair of similar discs secured together in a face-to-face relation with an annular-elastomeric packing interposed therebetween projecting radially of the outer peripheral edge of said discs for fluid tight sealing contact with the inner periphery of the casing, one of said pair of discs being provided with a pair of shaft receiving members on one side thereof in two diametrically opposite positions adjacent to the outer peripheral edge of the disc and said shaft receiving members having such dimensions and configuration that each of the shaft receiving members co-operates with said one side of the disc in defining rectangular section spaces having a length slightly greater than the width of the projecting portions of the respective shafts whereby said disc assembly can be displaced with respect to said shafts by the pressure of said fluid when in an at least partially open position.

The invention is by way of example hereinafter more fully described with reference to the accompanying drawings, in which:—

Fig. 1 is an end elevational view of a preferred form of butterfly valve constructed in accordance with the present invention;

Fig. 2 is a vertical sectional view taken along substantially the II—II line of Fig. 1 and as seen in the direction of the arrows, which also illustrates the manner in which a valve disc assembly is inserted into the hollow cylindrical casing of said butterfly valve;

Fig. 3 is a cross sectional view taken along substantially the III—III line of Fig. 2 illustrating said valve disc assembly in its fully opened position and in broken lines in its partially opened position;

Fig. 4 is similar to Fig. 3, but illustrates said disc assembly in its closed position;

Fig. 5 is similar to Fig. 3, but shows a prior art butterfly valve;

Fig. 6 and 7 are diagrammatic views which explain the operation of said valve disc assembly in the positions of the assembly as shown in Figs. 3 and 4, respectively;

Fig. 8 is a diagrammatic view which explains the operation of said valve disc

assembly in the position of the assembly as shown in Fig. 5;

Fig. 9 is an enlarged fragmentary elevational view in partial section illustrating the manner by which one shaft receiving member of said valve disc assembly is put on a lower driven shaft; and

Fig. 10 is a perspective view of an upper drive shaft and lower driven shaft respectively.

Referring now to the accompanying drawings, and especially to Figs. 1 to 4 thereof in which a preferred form of butterfly valve is illustrated, the butterfly valve comprises a casing or main body 1 with an open cylindrical chamber 1' therein. The casing 1 has at the opposite ends integral annular flanges 2 and 2 each having a plurality of spaced bores 2' for bolts or the like connecting said flanges to the flanges (not shown) of adjacent pipes (not shown) disposed in alignment with each other and with the butterfly valve casing in a piping system intended for transport hydraulic fluid under high pressure therethrough. The casing 1 is furthermore provided with an integral hollow neck portion 3 upwardly extending at the top on the outer periphery in a substantially centre position between the opposite end flanges 2 and the neck portion has an integral flange 3' at the upper end and a partially threaded centre bore 3'' extending through the length of the neck portion 3. The centre bore 3'' communicates at its lower end with the chamber 1' of casing 1 through a plain bore 4 formed in the casing right below the lower end of the centre bore 3'' and in alignment therewith but having a diameter smaller than that of the bore 3''. The cylindrical casing 1 is further provided with a boss 5 at the bottom on the outer periphery in alignment with the neck portion 3. A cylindrical recess 6 is formed on the inner peripheral surface of the casing 1 opposite to the top bore 4 and the recess has the diameter substantially the same as that of the top bore 4. The recess 6 is adapted to freely receive a lower driven shaft 7 in the form of a substantially circular section bar having a circular section shank 7' (see also Fig. 10) to enter the recess 6 and an integral rectangular section end portion 7'' one end edge of which is bevelled as shown by 7'''. When the butterfly valve is assembled, the lower driven shaft 7 is rotatably received in the cylindrical recess 6 with the shank 7' disposed within the recess 6 and its end portion 7'' projecting upwardly of the recess toward the axis of the chamber 1'.

A rotary valve disc assembly 8 comprising a pair of similar discs 9 and 9 each having a diameter slightly smaller than that of the chamber 1' is mounted within the chamber 1' for rotation about an axis extending transversely of the chamber at right angles with

respect to the axis of the chamber in the manner which will be described hereinbelow. Each of the discs 9 is of substantially U-shape in section with a centre circular deformation (not shown) therein, and in putting together the valve disc assembly 8, the two discs 9 are put together in a face to face relation with the bottoms of their deformations abutting each other so as to form an annular groove (not shown) between the opposite peripheral edges thereof. In fabricating the rotary disc assembly 8, an annular elastomeric packing 12 is placed in the above-mentioned annular groove between the discs 9, and then a plurality of set screws 13 are threaded through the discs and packing thereby to secure the elements together as a unitary unit. The annular elastomeric packing 12 has an outer diameter slightly greater than that of the discs 9 so that when the packing is seated within the groove its outer peripheral edge projects radially outwardly of the outer peripheral edges of the discs for the purpose as will be described hereinbelow.

One of the pair of discs has a pair of similar shaft receiving members 10 and 10 each having a substantially U-shape and secured thereto by means of welding or any other suitable way. The pair of shaft receiving members 10 are disposed on one side of the one disc 9 in diametrically opposite and spaced positions adjacent to its outer peripheral edge. Each of the shaft receiving members 10 is secured in such a manner that their outwardly extending opposite leg portions 10' and 10' abut against the side of the disc 9 with the intermediate portion 10'' spaced therefrom so defining a rectangular space 11. The shaft receiving members 10 have such a shape and configuration that when they are secured to the side of the disc 9, the side of the disc and the inner side of the intermediate portion 10' of the U-shape construction are spaced from each other by a distance substantially corresponding to the thickness of the rectangular section end portion 7'' of the above-mentioned lower driven shaft 7. Thus the rectangular space 11 has its width substantially corresponding to the thickness of the lower shaft end portion 7'', whilst its length is slightly greater than the width of the wider sides of the rectangular section portion of the lower shaft end portion 7''.

The threaded bore 3'' of the neck portion 3 threadably receives a tubular upper shaft holding member 14 having an annular flange 14' at its upper end and a thread 14'' on its outer periphery, for the purpose as will be described hereinbelow. A stack of annular packings 16 is disposed around the upper shaft 15 between the lower end of the tubular member 14 and the top of the casing 1 around the bore 4.

In mounting the valve disc assembly 8 into the chamber 1' of the casing 1, the lower

driven shaft 7 is first inserted within the recess 6 with its end portion 7'' having the bevelled edge 7'', projecting upwardly of the recess toward the axis of the chamber. Then, the valve disc assembly 8 is forced into the chamber 1' with sliding down of one of the diametrically opposite shaft receiving members 10 onto the end portion 7'' of the lower shaft 7 until that shaft receiving member 10 abuts against the shoulder formed at the juncture between the circular section shank 7' and the end portion 7''. Such sliding of the shaft receiving member 10 onto the flattened end portion 7'' is facilitated by the fact that the end portion 7'' is provided with the bevelled one edge 7''' and that the length D of the rectangular space 11 is greater than the width d of the rectangular section of the end portion 7'' (see Fig. 9). When the particular shaft receiving member abuts against the above-mentioned shoulder on the lower driven shaft 7, simultaneously the other shaft receiving member 10 is positioned substantially in alignment with the plain bore 4 in the cylindrical casing 1.

An upper drive shaft 15 comprises a circular section shank 15' (see Fig. 10) provided at one end with a rectangular section portion 15'' and at the opposite end with a hexagonal section portion 15''' which when inserted through the centre opening 14'' and the top bore 4 in the casing 1 has its rectangular end portion 15'' directed downward until the shoulder formed at the juncture between the shank 15' and end portion 15'' abuts against the shaft receiving member 10 with the end portion 15'' entered within that, now upper, shaft receiving member. The end portion 15'' of the upper drive shaft 15 has the same dimensions and rectangular shape as those of the end portion 7'' of the lower driven shaft 7 (except that the upper shaft end portion 15'' has no bevelled edge). When the upper drive shaft 15 has been inserted in the manner as mentioned just above, the valve disc assembly 8 is held in its operative position within the casing 1 and may be rotated in either direction about an axis at right angles to the axis of the chamber 1' from closed position in which the annular packing 12 makes a fluid tight seal with the inner peripheral surface of the casing 1. As mentioned above, since the two diametrically opposite shaft receiving members 10 have the same configuration and size, the positions of these members may be easily inverted without affecting upon the operation of the disc assembly 8. Although the annular packing 12 has the diameter greater than that of the discs 9, the mounting of the disc assembly 8 into the chamber 1' can be effected without difficulties because the packing is formed of elastomeric material which yields elastically when the assembly is inserted into the casing 1.

As will be understood from the foregoing, when the valve disc assembly 8 is mounted in the chamber 1' of the casing 1 in the manner as mentioned above, the vertical axis of rotation of the disc assembly is disposed eccentric with respect to the axis of the lower and upper shafts 7 and 15 by the distance shown with reference character S in Fig. 7. In Fig. 3 reference character A denotes the diameter of the chamber 1' and in Fig. 6 reference character *n* denotes the difference in length between the rectangular section construction of the flattened end portion 7'' or 15'' (or the distance by which the disc assembly is allowed to displace with respect to the lower and upper shafts) and the rectangular section configuration of each space 11 while reference character Q in Fig. 7 denotes the difference between the diameter of each disc 9 and the diameter A of the chamber 1'.

In operation of the valve, an operator grips an operation handle (not shown), having a hexagonal opening and received on the mating hexagonal end portion 15''' of the upper drive shaft 15, and then turns the handle in a desired direction so as to rotate the upper drive shaft 15 which in turn rotates disc assembly 8 in the same direction. The rotational movement of the disc assembly 8 is transferred to the lower drive shaft 7 to rotate the shaft in the same direction whereby the shafts and disc assembly may rotate in unison with one another. In Fig. 3, the fully opened position of the disc assembly 8 is shown by the solid line and a partially opened position of the assembly is shown by the two dot-chain line. In this partially opened position, fluid under pressure which flows into the butterfly valve in the direction indicated by the arrow in Fig. 3 flows over the valve assembly in the direction as indicated by the arrow P in the same Fig. In Fig. 4, the disc assembly is shown in its fully closed or fluid tight sealing position in which no fluid can pass through the butterfly valve.

Although the shafts 7 and 15 and disc assembly 8 rotate together, the disc assembly can be displaced with respect to the shafts by the pressure of fluid against the disc assembly because of the length of the spaces 11 relative to the end portions 7'' and 15'' of the shafts 7 and 15 respectively.

Fig. 5 illustrates a prior art butterfly valve in section and this prior art butterfly valve is substantially similar to the butterfly valve shown in Figs. 1 to 4 except for the dimensions of the spaces defined between one side of one particular disc having a pair of U-shape section shaft receiving members secured thereto and the adjacent side of the intermediate portion of each shaft receiving member. In this prior art butterfly valve, each of the shaft receiving members 110

is so dimensioned that the inner side of the intermediate portion 110'' connecting the outwardly and laterally extending opposite leg portions 110'' co-operate with the adjacent side of the particular one disc 109 in defining a rectangular section space which has substantially the same configuration and dimensions as those of the end portions of the lower and upper shaft (in Fig. 5, the end portion 107'' of the lower shaft 107 is shown) whereby there is no clearance *n* present between the rectangular space and the shaft as in the new butterfly valve (see Fig. 8) and as a result, the valve disc assembly 108 cannot be displaced with respect to the shafts while they are rotating together. And since the vertical axis of the disc assembly is mounted eccentric with respect to the axis of the shafts, if the discs of the disc assembly have a diameter to allow the packing disposed therebetween to directly contact the inner peripheral surface of the casing, without the provision of any annular valve seat around the inner peripheral surface of the casing for accommodation of the outer peripheral edge of the packing, the disc assembly would firmly abut against the inner peripheral surface of the casing during the rotation of the disc assembly and the rotation of the disc assembly would be arrested by the casing (see Fig. 8). In order to eliminate the above difficulty, in the prior art butterfly valve as illustrated in Fig. 5, the discs of the disc assembly have to be designed so as to have a rather small diameter to such a degree that the packing may not be allowed to directly contact the inner peripheral surface of the casing and the provision of an annular valve seat around the inner peripheral surface of the casing is necessary to compensate for the reduction in the diameter of the discs in order to obtain a fluid tight sealing relation between the outer periphery of the disc assembly and the inner periphery of the casing while allowing the disc assembly to rotate smoothly.

Since however, as mentioned above, the disc assembly 8 is so designed that the discs have a diameter sufficiently large to allow the packing to directly contact the inner peripheral surfaces of the casing and the assembly may displace with respect to the shafts 7 and 15 by the distance *n* provided by the difference between the length of the rectangular configuration of the space 11 and the width of the rectangular configuration section of the end portions 7'' and 15'' of the shafts 7 and 15, the disc assembly may rotate smoothly with part of its packing 12 always in direct contact with the inner peripheral surface of the casing 1 without the necessity for provision of any annular valve seat around the inner periphery of the casing whereby the operation of the butterfly valve may be greatly facilitated and the construction of the butterfly valve may be simplified resulting in reduc-

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tion of expenses for manufacturing the butterfly valve.

WHAT I CLAIM IS:—

1. A butterfly valve for use in a piping
5 system intended to transport fluid under high pressure comprising a hollow cylindrical casing having on the top a neck portion projecting upwardly therefrom and provided with a through bore communicating with the hollow
10 interior of said casing and at the bottom a blind recess in alignment with said through bore of the neck portion; a lower driven shaft rotatably received in said recess and partially projecting upwardly therefrom; an upper
15 drive shaft rotatably received in said through bore of the neck portion and partially projecting downwardly into said hollow interior of the casing; and a rotary disc assembly mounted within said casing for rotation about
20 an axis extending transversely of the casing at right angles with respect to the axis of the casing and including a pair of similar discs secured together in a face to face relation with an annular elastomeric packing interposed therebetween to project beyond the
25 outer peripheral edge of said discs for fluid tight sealing contact with the inner peripheral surface of the casing, one of said pair of discs being provided with a pair of shaft
30 receiving members on one side thereof in two diametrically opposite positions adjacent to the outer peripheral edge of the disc and said shaft receiving members having such dimen-

sions and configuration that each of the shaft receiving members co-operates with said one
35 side of the disc in defining a rectangular space having a length greater than the width of the projecting portions of the respective shafts whereby said disc assembly can be displaced with respect to said shafts by the pressure of
40 said fluid when in an at least partially open position.

2. A butterfly valve as claimed in claim 1, in which said lower drive shaft has a circular section shank receivable in said recess and an
45 upper flattened end portion upwardly projecting from the recess and provided with one bevelled end edge and the upper drive shaft, rotatably received in said through bore of the neck portion and partially and downwardly
50 projecting into said hollow interior of the casing, has a circular section shank and a lower flattened end portion projecting downwardly into said hollow interior of the casing.

3. A butterfly valve constructed, arranged, and adapted to operate substantially as hereinbefore described with reference to Figs. 1
55 to 4, 9 and 10 of the accompanying drawings.

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tion of expenses for manufacturing the butterfly valve.

WHAT I CLAIM IS:—

1. A butterfly valve for use in a piping system intended to transport fluid under high pressure comprising a hollow cylindrical casing having on the top a neck portion projecting upwardly therefrom and provided with a through bore communicating with the hollow interior of said casing and at the bottom a blind recess in alignment with said through bore of the neck portion; a lower driven shaft rotatably received in said recess and partially projecting upwardly therefrom; an upper drive shaft rotatably received in said through bore of the neck portion and partially projecting downwardly into said hollow interior of the casing; and a rotary disc assembly mounted within said casing for rotation about an axis extending transversely of the casing at right angles with respect to the axis of the casing and including a pair of similar discs secured together in a face to face relation with an annular elastomeric packing interposed therebetween to project beyond the outer peripheral edge of said discs for fluid tight sealing contact with the inner peripheral surface of the casing, one of said pair of discs being provided with a pair of shaft receiving members on one side thereof in two diametrically opposite positions adjacent to the outer peripheral edge of the disc and said shaft receiving members having such dimen-

sions and configuration that each of the shaft receiving members co-operates with said one side of the disc in defining a rectangular space having a length greater than the width of the projecting portions of the respective shafts whereby said disc assembly can be displaced with respect to said shafts by the pressure of said fluid when in an at least partially open position.

2. A butterfly valve as claimed in claim 1, in which said lower drive shaft has a circular section shank receivable in said recess and an upper flattened end portion upwardly projecting from the recess and provided with one bevelled end edge and the upper drive shaft, rotatably received in said through bore of the neck portion and partially and downwardly projecting into said hollow interior of the casing, has a circular section shank and a lower flattened end portion projecting downwardly into said hollow interior of the casing.

3. A butterfly valve constructed, arranged, and adapted to operate substantially as hereinbefore described with reference to Figs. 1 to 4, 9 and 10 of the accompanying drawings.

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