

CHANGEOVER VALVE

This invention relates to a poppet changeover valve.

A poppet changeover valve of a known type for use in e.g. hydraulically or pneumatically operated industrial machines is shown in Fig. 8. The valve comprises a valve body 1 of elastic material, such as synthetic rubber, fastened over a circular projection 5 provided on a valve rod 4 so that the openings at the valve seats 6 and 7 are opened and closed as the valve rod 4 reciprocates axially.

A valve body 1 of this type, however, often comes off from the projection 5 when thrust upward by the penetration of compressed air flowing between the valve ports into the space left between the valve body and the rod 4. This trouble occurs when part of the compressed air surrounding the valve body 1 penetrates therebeneath. As the pressure around the valve body 1 drops when the compressed air is discharged, the entrapped air causes a sudden pressure buildup that thrusts up the valve body. As such, this trouble occurs frequently where major pressure variation takes place around the valve body.

A conventional solution adopted for preventing the valve body 1 from coming off the projection 5 of the valve rod is to increase the bore diameter difference d (see Fig. 8) between the middle portion 3 of the valve body and the end portions 2 on both sides thereof by reducing to a minimum the diameter of the bore in the latter portions. When the bore diameter difference d is thus increased, however, it becomes difficult during manufacture of the valve body by molding to remove an inner forming mold placed inside the valve body 1. Excessive force applied in an attempt to take out the inner mold could break the formed valve body 1. Even a successfully formed valve body then presents considerable

difficulty in fitting onto the valve rod. Consequently, the bore diameter difference d cannot be increased beyond certain limits. Within such limits, no valve bodies completely free of the aforementioned problem of keeping
5 the valve bodies in place on the valve rod have so far been available.

The present invention has been made from a consideration of the foregoing, and provides in a poppet changeover valve having a slidable valve rod carrying a
10 valve body of elastic material adapted to switch the flow of fluid between a plurality of ports in a valve casing by coming in and out of contact with two opposed valve seats provided therein, the improvement which comprises:

an annular projection, on which the valve body
15 is fitted, being provided in a portion of the valve rod between said two valve seats, a first annular groove being provided on each side of the annular projection by reducing the diameter of the valve rod and a second annular groove being provided at the center of the
20 annular projection;

said valve body being formed as two separate segments which are individually mounted one on each side of said second annular groove;

each of the said valve body segments having
25 integrally formed first and second fitting projections fitting into the respective first groove and said second groove, respectively; and

said second fitting projection on each said valve body segment comprising an annular, inwardly
30 projecting flange.

In the poppet changeover valve of this invention, the first and second fitting projections can have considerably different bore diameters to fit into the first and second annular grooves respectively,
35 thereby to prevent the first fitting projections from getting thrust upwards by compressed air.

Advantageously, the second fitting projections provided on each segment of the valve body segments extends inwards, i.e. towards the valve rod so as to leave the smallest possible bore at the center thereof.

5 When fitted into the second annular groove, therefore, the second fitting projections extend deep enough into the valve rod to provide adequate resistance to axial thrust. Even if axially thrust, the second fitting projection on one valve body segment would simply be
10 pressed against that on the other, without being moved radially. Consequently, neither valve body segment will come off from the valve rod on the side of its second fitting projection.

Further, forming the valve body as two separate
15 segments facilitates detachment of the segments from forming molds and their fitting onto the annular projection on the valve rod.

Preferred embodiments of poppet changeover valve in accordance with the present invention will now
20 be described with reference to the accompanying drawings, in which:

Fig. 1 is a vertical cross-sectional front view of a first embodiment of this invention;

Fig. 2 is a partially cross-sectional vertical
25 front view of an individual segment of the valve body of this embodiment;

Figs. 3 to 5 are vertical cross-sectional views showing parts of three further embodiments of this invention;

30 Fig. 6A is a vertical cross-sectional view showing part of a fifth embodiment of this invention;

Figs. 6B and 6C are perspective views showing examples of a reinforcing ring for use in the fifth embodiment;

35 Fig. 7 is a vertical cross-sectional view showing part of a sixth embodiment of this invention; and

Fig. 8 is a cross-sectional view of a valve body of a conventional poppet changeover valve.

Referring now to the drawings, Figs. 1 and 2 show a first preferred embodiment of this invention, in which a valve casing 10 has an inlet port 11, an outlet port 12 and an exhaust port 13. The ports 11, 12 and 13 communicate with each other by means of a bore 14 provided in the valve casing. The diameter of the bore 14 is increased to form a valve chamber 15 at the junction with the outlet port 12. A first valve seat 16 leading to the inlet port 11 and a second valve seat leading to the exhaust port 13 are provided at axially opposite ends of the valve chamber 15.

A valve rod 21 inserted in the bore 14 has a sealing end 23 carrying a seal 22 at each end thereof and an annular projection 24 having a substantially trapezoidal axial cross-section in the middle portion thereof situated between the two valve seats. A first annular groove 26 is provided on each side of the annular projection 24 by reducing the diameter of the valve rod itself, while a second, common, annular groove 27 having a substantially larger bore diameter than the first annular grooves 26 is provided at the center of the annular projection 24.

A valve body to be fitted onto the annular projection is formed as two identical segments 28 which are adapted to be individually fitted onto the annular projection one on each side of the second annular groove 27 cut therein. Made of elastic material, such as synthetic rubber, the valve body segments 28 open and close the openings at the valve seats 16 and 17 by coming in an out of contact therewith. Each valve body segment comprises, as best shown in Fig. 2, a main portion 28a whose inner profile matches the outer profile of the annular projection 24, and integrally formed with the main portion 28a, a first fitting projection 28b and a

second fitting projection 28c one on each side of the main portion 28a. As shown in the drawings, the first fitting projection 28b is formed as a cylinder of smaller diameter than the remainder of the valve body segment, while the second fitting projection 28c comprises an annular, inwardly projecting flange. Each segment 28 is attached to the annular projection 24 by fitting the first cylindrical fitting projection 28b into one of the first groove 26 and the second fitting projection 28c into the common second groove 27 (see Fig. 1). The bore diameter of the annular flange of the second fitting projection is as small as possible consistent with not preventing easy detachment of the valve body segment from forming molds. The relatively large difference in the diameter between the first and the second grooves prevents the first fitting projection 28b from getting pushed up by compressed air.

More particularly, the second fitting projection 28c bites sufficiently radially deep into the valve rod, so that any compressed air entrapped between the valve disc segment 28 and the valve rod 21 hardly pushes away the body segment 28 radially. Any movement that might be caused by such entrapped air will be in the direction of the axis of the valve rod 21 or in which the second fitting projection on one of the segments 28 is pressed against that on the other. Therefore, the valve body segments will not come off from the valve rod 21. Furthermore, the mutual interference of the second fitting projections 28c on the two valve body segments 28 resulting from their being fitted into a common groove prevents the segments 28 from slipping away therefrom.

Providing the valve body as two separate segments facilitates both detachment from forming molds and fitting on the projection on the valve rod.

The valve rod 21 slidably inserted in the bore 14 in the valve casing 10 is urged in the reset direction

by means of a reset spring 29 interposed between the end surface of the valve rod 21 and the bottom of the valve bore 14. When driven against the urging force of the reset spring 29 by an operating mechanism (not shown) provided at the opposite end, the valve rod 21 switches the flow of fluid between the individual ports. The valve rod driving mechanism may be mechanical, hydraulic, magnetic or otherwise.

The valve rod 21 carrying the valve body segments 28 is inserted from one end of the valve bore 14 into the valve casing 10 while compressing the valve body segments 28 by means of an appropriate jig.

Fig. 3 shows a modified form of the embodiment of Figs. 1 and 2, in which the second annular groove 33 cut in the projection 32 on the valve rod 31 has a dovetail-like cross-section. The second fitting projection 34c provided on each valve body segment 34 is so shaped as to come in contact with only the side wall of the second groove 33, and not with the bottom wall thereof. The space left between the radially innermost end of each second fitting projection 34c and the second groove 33 prevents the entrapping of air during assembling. In assembling the valve body segments, air is likely to penetrate between the second fitting projections 34c and the side walls of the second groove 33. But the space left between the radially inner end of each second fitting projection 34c and the second groove 33 as mentioned above is conducive to preventing the entrapping of such air and the inflow of compressed air from outside. To prevent the entrapping of such air, air should be allowed to flow freely between the two second fitting projections 34c placed face-to-face. Accordingly, clearance to allow the passage of air is usually provided between the adjoining second fitting projections 34c. The facing surfaces of the two second fitting projections 34c may be roughened so that the

passage of air is always maintained even when one of them is pressed against the other. Alternatively, many indentations or radial grooves or other appropriate means may be provided on the facing surfaces. Such provision
5 further secures the fastening of the valve body segments 34 to the valve rod 31.

The clearance left between the second fitting projections 28c of the first embodiment shown in Fig. 1 also functions similarly. So does the clearance in each
10 of the embodiments to be described hereafter, as well.

Other structural details and functions of the embodiment of Fig. 3 are substantially the same as those of that of Figs. 1 and 2, and to the extent necessary are designated in Fig. 3 by similar reference characters.

15 Figs. 4-7 likewise illustrate only the significant modifications to which the embodiments shown relate.

Fig. 4 shows another preferred embodiment of this invention, in which the first annular grooves 37 cut
20 in the valve rod 36 each have the side wall thereof closer to the projection 38 of the valve rod 36 being tapered toward the base of the projection 38, with a first fitting projection 39b on each valve body segment 39 being formed to come in contact with said tapered side
25 wall. In this embodiment, the valve body segments 39 are fastened to the valve rod with greater force as a result of the engagement of the first fitting projection 39b with the tapered surface of the first groove 37.

Fig. 5 shows yet another preferred embodiment
30 of this invention, in which the projection 42 provided on the valve rod 41 has a rectangular cross-section. The first fitting projections 43b and the second fitting projections 43c on the valve body segments 43 are shaped so as to come in contact with the side wall of the
35 projection 42 and the inner wall of the second groove. This design also increases the force with which the valve body segment 43 is fastened to the projection 42.

Fig. 6A shows a further preferred embodiment of this invention, in which the second fitting projection 46c on each valve body segment 46 has a bent portion 46d adapted to come in contact with the bottom of the second groove 49 provided in the projection 48 on the valve rod 47. The two segments 46 are securely fastened to the valve rod 47 by tightening the bent portions 46d by means of an elastic reinforcing ring 50 interposed between the annular flanges of the second fitting projections 46c provided thereon.

Alternatively, the elastic reinforcing ring 50 used in this embodiment can be omitted if the second fitting projection 46c itself is so shaped as to prevent falling off. The thinner second fitting projections 46c and bent portions 46d and a very small clearance (0.1 mm or thereabout) left between the two bent portions 46d permit easy assembling because the second fitting projections 46c on the adjoining valve body segments 46 are thus allowed to change their shape with greater ease, without interfering with each other.

The reinforcing ring 50 may be either a ring of elastic material whose elasticity is increased by means of narrowed portions provided thereon as shown in Fig. 6B, or a ring of springy material having a notch cut therein as shown in Fig. 6C. In this embodiment too, surface irregularities are provided on the mating faces of the second fitting projections 46c and the bent portions 46d to prevent the valve body segments 46 from getting thrust upward by compressed air.

Fig. 7 shows a yet further preferred embodiment of this invention, in which each valve body segment 51 has a groove 52 cut in the first fitting projection 51b. The valve body segments 51 is securely fastened to the valve rod 54 by means of a reinforcing ring 53 similar to the one shown in Fig. 6C fitting in the groove 52.

Other structural details and functions of the embodiments of Figs. 4-7 are the same as those of the

first embodiment, and therefore no detailed description will be given thereof.

5 This invention is by no means limited to the preferred embodiments illustrated in Figs. 1-7 and described above. For example, the second fitting projection 28c of the first embodiment may be made slightly shorter than the depth of the second groove 33, thereby preventing the entrapping of air that might otherwise be caused by the second fitting projection 28c.

10 Different features of the individual embodiments may be combined appropriately, too.



CLAIMS:

1. In a poppet changeover valve having a slidable valve rod carrying a valve body of elastic material adapted to switch the flow of fluid between a plurality of ports in a valve casing by coming in and out of contact with two opposed valve seats provided therein, the improvement which comprises:

an annular projection, on which the valve body is fitted, being provided in a portion of the valve rod between said two valve seats, a first annular groove being provided on each side of the annular projection by reducing the diameter of the valve rod and a second annular groove being provided at the center of the annular projection;

said valve body being formed as two separate segments which are individually mounted one on each side of said second annular groove;

each of the said valve body segments having integrally formed first and second fitting projections fitting into the respective first groove and said second groove, respectively; and

said second fitting projection on each said valve body segment comprising an annular, inwardly projecting flange.

2. A valve according to Claim 1, in which said annular projection on the valve rod has a substantially trapezoidal axial cross-sectional profile, and said second annular groove having a larger inside diameter than either of said first annular grooves.

3. A valve according to Claim 1, in which said second annular groove has a dovetail-like cross-section, and the second fitting projection on each said valve body segment being shaped so as to contact the side walls of



said second annular groove without contacting the bottom wall thereof.

4. A valve according to Claim 1 or Claim 2, in which provision is made for free passage of air between the second fitting projections of said valve body segments.

5. A valve according to Claim 1, in which the side wall of each said first annular groove on the valve rod closer to the projection thereon is tapered toward the base of the projection, and said first projection of each said valve body segment is shaped to match a respective one of said tapered side walls.

6. A valve according to Claim 1, in which said annular projection formed on the valve rod has a rectangular cross-section, and said first fitting projection on each said valve body segment is shaped to contact a respective side wall of said projection.

7. A valve according to ^{sub}Claim 1, in which said second fitting projection of each said valve body segment comprises a bent portion adapted to come in contact with the bottom surface of said second annular groove, and said valve body segments are adapted to be fastened to the valve rod by tightening the bent portion with an elastic reinforcing ring interposed between the second fitting projections of the two adjoining valve body segments.

8. A valve according to Claim 1, in which each said valve body segment is fastened to the valve rod by a reinforcing ring fitted into a groove cut in the first fitting projection thereof.



9. A poppet changeover valve, substantially as hereinbefore described with reference to Figs. 1 and 2, Fig. 3, Fig. 4, Fig. 5, Figs. 6A-6C or Fig. 7 of the accompanying drawings.
