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(54) IMPROVEMENTS IN FLUID FLOW SYSTEM DEVICES

(71) We. WHITEY RESEARCH TOOL CO., domiciled at 5679 Landregan Street, Emeryville, State of California 94662, United States of America, a corporation organised and existing under the laws of the State of California, United States of America, (assignee of FRANCIS JOSEPH CALLAHAN, Jr., BERNARD JOHN GALLAGHER, STEPHEN MATOUSEK and ULRICH HUBERT KOCH), 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:—

The invention relates to fluid flow system devices such as rotary valves, particularly ball valves, and to a method of making such devices.

The invention is especially suited for use in ball valves and will be described with particular reference thereto; however, as will become apparent, it could be used in many types of fluid flow system devices.

Many ball valves currently available comprise a main body section which houses the ball member and seal rings. Attached to the opposite ends of the main body are end fittings which provide means by which the valve can be connected to associated piping or tubing. Typically, as described in U.S.A. Patent No. 3,554,484 the end fittings and the body section are interconnected by a plurality of tie bolts passing longitudinally through aligned openings in both the body section and the end fittings. Appropriate seals are disposed between the end fittings and the body section.

In order to replace the seals, however, it is necessary to remove the tie bolts and slide the body section from between the fittings. This procedure is time consuming and, at times, presents difficulty in getting the body section properly realigned with the end fittings. Additionally, and with many designs, the associated piping must be moved before access to the seals is possible.

Although the arrangement is particularly suited for use in ball valves, the invention also contemplates that generally the same body section, end fitting, and tie bolt relationships can be employed in many different devices used in fluid flow systems, for example, filters, flow gauges, sight gauges and check valves.

Thus, the present invention in one aspect provides a fluid flow system device, preferably a ball valve, which comprises a body section having a longitudinal through-flow passage which extends between a pair of generally parallel end faces; a pair of end fittings each having a through-flow opening, said end fittings being positioned at opposed ends of the body section in engagement with the end faces and with their through-flow openings aligned with the through-flow passage; and at least three tie bolts connected between said end fittings and positioned circumferentially about said through-flow passage and extending generally parallel thereto, one of said tie bolts extending through said body section with the remaining tie bolts located radially outwardly of the body section. By removing one of the tie bolts adjacent to the bolt which extends through the body section, the body section can be pivoted outwardly from between the end fittings.

In the case of a ball valve, seal assemblies are preferably positioned about each end of said through-flow passage, said seal assemblies being axially removable from said body section.

The seal assemblies can be changed by removing only a single tie bolt. Moreover, through out the changing, the body section is held in position such that proper re-

alignment is achieved merely by rotating the body section back into its original position.

Preferably, at least one of the bolts which does not pass through the body section is positioned to engage the exterior surface of the body section when the latter is in an aligned position between the end fittings. Additionally, the body section is preferably of uniform cross-section through its length. Thus, the body section can comprise an extruded section in order to reduce machining time and manufacturing cost in a manner to be further discussed hereinafter. It is also contemplated that exterior portions of the body section will extend radially outward of the bolts an amount sufficient to permit the body section to be gripped by a wrench without engaging the bolts. This reduces the possibility of damaging the bolts while making connections to the end fittings.

Thus the invention includes a method of making a fluid flow system device comprising the steps of providing an extruded metal bar having a uniform cross-section in planes perpendicular to its longitudinal axis; cutting off a section of said extruded bar so that the section has a pair of parallel end faces spaced apart a desired distance, said end faces being perpendicular to said longitudinal axis; grinding said end faces to reduce said section to form a body section of desired length; forming a central bore axially through said section; forming a single bolt receiving opening through said section at a location radially outwardly of said central bore and parallel thereto; providing a pair of end fittings each having an end face and a through passage extending perpendicular thereto; forming a plurality of bolt receiving openings through said end fittings at locations radially outwardly of said through passage; positioning said end fittings with their end faces in engagement with the end faces of said body section; aligning one bolt receiving opening in each end fitting with the bolt receiving opening in said body section and passing a tie bolt therethrough to secure said end fittings to said body section; and passing additional tie bolts through the other bolt receiving openings in the end fittings with such additional tie bolts located radially outwardly of the body section.

In line with the previously discussed swing-out arrangement, the invention preferably includes combined ball seat and body seal assemblies which can be removed and replaced as a unit to facilitate changing. Thus, the seal assemblies can be adapted to be positioned in opposite ends of the through-flow passage of the body section and may comprise a seat ring member formed from a resilient material having a first surface arranged to engage the ball member and a second surface, preferably planar, facing outwardly of the through flow passage and a sleeve closely encircling the seat ring member and slidably received in a counterbore formed about the end of the through flow passage. A resilient seal ring, preferably an O-ring preferably encircles the sleeve to provide a seal between the central body section and the end fittings. The end fittings also include surfaces which engage the second face of the seat ring member and the seal ring when the body section is moved to its located position therebetween.

To simplify maintenance problems and to prevent improper reassembly, the seal assemblies on each side are preferably identical and/or interchangeable. However, for certain applications they could be different.

An additional preferred feature of the invention resides in the provision of a stem packing arrangement particularly suited for the valve hereinabove described. Such stem packing arrangement preferably includes a bore extending radially through the body section and provided with a flange or shoulder extending radially inwardly relative to the bore. The stem is sized so as to be freely rotatable within the bore flange and includes a stem flange extending outwardly beneath the bore flange. A thrust bearing ring is positioned between the bore flange and the stem flange and a seal assembly is located above the bore flange. Additionally, a compression gland member is positioned about the stem to engage the upper surface of the seal assembly. A gland nut is threadedly received on the outer end of the stem to compress the seal assembly and form a seal about the stem when tightened. Preferably, the thrust bearing ring is split so that it does not inadvertently form a seal. Because of the arrangement of the flanges, the stem is blow-out proof even when the gland packing member is removed.

The invention is further described, by way of example, with reference to the accompanying drawings, wherein:—

Fig. 1 is a side elevation of a ball valve in accordance with the invention;

Fig. 2 is an end view of the valve of Fig. 1 and shows in phantom, the central body section in a swing-out position;

Fig. 3 is a vertical cross-section through the valve of Fig. 1;

Fig. 3A is an enlarged view of the circled section of Fig. 3;

Fig. 4 is a cross-sectional view taken on line 4-4 of Fig. 3, and including in phantom a wrench for tightening the valve to the respective pipe end without damaging the tie bolts;

Fig. 5 is a view taken on line 5-5 of Fig. 1;

Fig. 6 is a cross-sectional view of a modified form of stem packing arrangement for the valve of Fig. 3, drawn to a large scale;

Fig. 6A is an enlarged view of the circled section of Fig. 6;

Figs. 7 and 8 are enlarged cross-sectional views through the ball and the seals rings showing the seal rings in the valve open and closed positions, respectively; and

Fig. 9 is an enlarged view of the circled portion of Fig. 7.

Referring to Figs. 1 to 4, a valve 10 has a main central body section 12 which is positioned between a pair of end fittings 14 and 16. As shown, the end fittings 14 and 16 are clamped to the body section by four longitudinally extending tie bolts 18.

In its preferred form, the central body section 12 is formed from a single section of extruded stock. As best seen in Fig. 4, the body section 12 has a uniform cross-sectional configuration with a circular flow passage 20 extending longitudinally therethrough. The passage 20 defines the valve chamber and houses a conventional ball member 22 having a through-flow opening 24. Positioned in opposite ends of the body section 12 are seal ring assemblies 26 (Fig. 3). Details of the seal ring assemblies 26 will subsequently be described in detail; however, for the present it is sufficient to note that the assemblies 26 include means for sealing between the ball member 22 and the end fittings 14 and 16 as well as between the central body section 12 and the end fittings.

Preferably, the central body section 12 is formed from bar stock extruded in the desired configuration and cut to the required length. The end faces 13 of the body section are preferably parallel to each other and perpendicular to the axis of the passage 20.

Extending generally radially into the body section 12 is an opening 28, which is located midway between and parallel to the end faces 13. An operating stem 30 passes through opening 28 into engagement with the ball member 22. The lower end of the stem 30 includes a narrow rib or web 32 which has a somewhat truncated end face reviewed in an arcuate slot 34 formed in the top surface of the ball member 22 in a direction generally perpendicular to the ball flow-through opening 24. This arrangement permits the ball to have some axial freedom when in the closed position.

As best shown in Fig. 3A, the opening 28 has a radially inwardly extending flange 36 which forms a downwardly facing shoulder 37. A similar, radially outwardly extending flange 38 is formed about the lower end of the stem 30. Positioned between the flanges 36 and 38 is a thrust bearing ring 40 preferably formed from a relatively rigid polymeric material for example, molybdenum disulphide or ceramic-filled polytetrafluoroethylene (PTFE). Preferably the thrust bearing ring 40 does not form a seal; and for this reason, the ring 40 is preferably split as shown at 41 in Fig. 3A. By splitting the bearing ring 40, the pressures exerted on opposite sides of the flange 38 are balanced. In this manner, the effective pressure acting outwardly on the stem is determined by the stem diameter. Typically, this can result in a 50 percent reduction in pressure on the thrust bearing ring 40. Also, the split reduces the possibility of virtual leak problems when the valve is used in vacuum systems.

Located above the flange 36 is a packing or stem seal assembly 42 which comprises three rings 43, 44 and 45. The ring 44 is the primary seal element and is, for example, formed from unfilled PTFE. The rings 43 and 45 are arranged to be closely received within the annular space between the stem and the opening 28 and serve as confining members to prevent cold flow of the ring 44. The rings 43 and 45 are preferably formed from a filled polytetrafluoroethylene having a substantial hardness when compared to the unfilled PTFE 44. The packing assembly 42 is placed under a predetermined compression by a packing gland member 46 which is sized so as to be freely receivable in the upper end of the opening 28. A nut 48 is received on the threaded outer end of the stem 30 and, upon tightening, compresses the thrust bearing ring 40 and the packing assembly 42.

An operating handle 50 is connected to the outer end of the stem 30 by a nut 52. The laterally opposite sides of the stem 30 are provided with flats 54 to receive the handle 50 and prevent it from turning relative to the stem 30. Similarly, the opening in the handle 50 through which the stem passes is of non-circular shape generally corresponding to the shape of the stem portion provided with the flats 54 so as to assure stem movement upon handle rotation and to hold the stem during tightening or adjustment of the packing nut 48.

Although forming no particular part of the invention, a spring 56 may be positioned between the under surface of the handle 50 and the upper surface of the body section 12. The spring 56 electrically connects the handle to the body to prevent static electrical discharges which could be dangerous in connection with certain processes for which the valve is used.

Referring again to Fig. 4, the body section 12 has a radially outward extending

portion 47 through which the lower right-hand tie bolt 18 passes as viewed therein. The remaining tie bolts 18 are located radially outwardly of the central body section 12. However, as shown in both Figs. 2 and 4, the end fittings 14 and 16 are each provided with openings through which all of the tie bolts pass. The configuration of the body section is such that by merely loosening the tie bolts, and removing the upper right-hand tie bolt 18, the body section 12 can be pivoted outwardly in a clockwise direction as shown in Fig. 2. Preferably, the upper right hand tie bolt 18 is marked with some indicia to clearly distinguish it from the remaining three bolts. For example, it can be colour-coded or have a head or nut configuration different from that of the remaining bolts.

The smooth, generally parallel, end faces of the central body section 12 enable the tilt-out movement to take place without axial movement of the associated piping. Additionally, when the body section 12 is pivoted outwardly, the seal assemblies 26 can be removed axially from the ends of the body section 12. Similarly, while in the tilt-out position, rotation of the operating handle 50 to the valve closed position allows the ball member 22 to be slid longitudinally out of the body section. The stem 30 can then be changed by releasing the nuts 52 and 48. Also, the stem, which can be withdrawn from inside the body section, releases the thrust ring 40 and the seal assembly 42 so that they can be changed as necessary.

Although the end fittings 14 and 16 are preferably identical, they could have varying configurations and different types of pipe connection means. In Fig. 3 illustrating the present embodiment, the pipe connection means are shown as standard pipe threads 62 and 64, respectively.

To facilitate holding of the body section 12 during installation or removal of the associated piping, means are provided to allow the body section to be gripped without relying on the tie bolts. As best seen in Fig. 4, the body section includes a portion 49 extending outwardly beyond the left hand side tie bolts 18 to establish a wrench flat 51. A conventional wrench can thus be used to grip the body section between the flat 51 and the portion 47 as shown in phantom in Fig. 4.

The operating handle 50 may be formed from a simple metal stamping. The outer end of the handle is preferably covered with a resilient material to provide a suitable grip. The handle can be colour-coded for process identification, safety, or the like. The handle is further provided with a pair of downwardly extending stop portions 70 and 72 arranged to define the full open and full closed positions of the valve. The stops are located to engage the lateral sides of an upwardly extending central rib 74 which extends throughout the axial length of the body section 12. The configuration of the stops is best shown in Figs. 1, 2 and 5. The stop portion 70 extends downwardly from the side of the handle 50 and the stop portion 72 is bent downwardly from the end of the handle. In the full open position, the inner surface 73 of the stop portion 72 engages the right hand end of the rib 74 as viewed in Fig. 1. The configuration of the stop portion 72 is such that the forces acting thereagainst when it is moved to the full open position do not act against the respective bend of the handle. At this time, the stop portion 70 is spaced outwardly a short distance from the inside of the rib 74 as can be seen in Fig. 2. However, when the handle is rotated to the full closed position as shown in phantom in Fig. 5, the stop portion 70 engages as shown at 70'. That is, it engages the right-hand end of the rib 74. Thus, it is also loaded in the most satisfactory direction so that an outward bending force is not applied against the normal bend of the stop portion. The stop portion 72 is, however, at this time spaced outwardly from the rib so that no bending forces are applied to it.

As will be appreciated from the foregoing, the stop positioning and design is such that the stop portions of the simple bent metal handle are always loaded in their direction of greatest strength and there is substantially no tendency for them to be inadvertently bent back into the plane of the handle as would be the case if they engaged at both the open and closed positions of the valve. Because of the symmetrical construction of the body section, the handle is reversible, that is, it can be positioned to extend in either direction relative to the valve body. Thus the handle can be arranged to indicate flow direction. Also, because the handle can be a simple metal stamping, a wide variety of handle types can be provided. For example, the handle length can be changed without any major change in patterns or the like or the handles can be designed for reversed position or so that they can be mechanically actuated or locked with minimum complexity.

In the embodiment under consideration, and with reference to Figs. 7 to 9, each of the seal assemblies 26 include a seat ring member 80 which is formed from any suitable material such as PTFE, nylon, rubber, synthetic elastomers, asbestos, carbon, graphite, metals, and/or combinations of these materials. The ring member 80 includes a main radially extending body por-

tion 81 and a lip portion 82 which extends axially inwardly toward the valve ball member 22. The inner surface 83 of the ring member 80 is a spherical section having a radius *r* slightly smaller than the radius R of the ball member. The ring member 80 is sized such that when is position in the valve with the ball member generally centered, it sealingly engages the ball member along a line 84. This relationship is shown in Fig. 7. The opposite side of the body portion 81 is preferably flat and engages the end face of the corresponding end fitting.

As best seen in Figs. 7 and 9, a cylindrical sleeve 86 circumferentially surrounds the outer peripheral edge of the seat ring member 80. The sleeve 86 has a shallow, axially extending recess 87 which has a depth axially less than the thickness of the ring body portion 81. Preferably, the sleeve engages the ring member 80 rather tightly. Although the sleeve 86 is preferably formed from metal, it should be appreciated that it can be formed from any material having suitable rigidity. Referring more particularly to Fig. 9, it will be seen that the bottom of the recess 87 is inclined to provide a sharp edge 89 which, when the seat ring member 80 is engaged by the associated end fitting, provides a good seal at this point. The body section 12 in the region surrounding the outer end of the through-flow passage 20 is counterbored to slidably receive the sleeve 86, and the inner end of the sleeve 86 is inclined slightly so that somewhat of a line contact is made with the bottom 91 or corner of this counterbore to similarly provide a seal. As best seen in Figs. 7 and 8, the outer edge of the ring member 80 is clamped between the bottom of the recess 87 and associated face of the respective end fitting.

Resiliently encircling the sleeve 86 is an O-ring 92. A corresponding recess 90 is formed in the body section 12 to receive the O-ring 92. The axial dimension of the O-ring 92 is slightly greater than the depth of the recess 90. The entire seal assembly 26 can be inserted and removed as a unit. The sleeve 86 serves to locate and hold the seat ring 80 while, additionally, completing the groove for the O-ring 92.

The presence of the sleeve 86 prevents the ring 80 from cold flowing between the body section and the end fittings. Additionally, as noted earlier, the fame 80′ of the ring member 80 seals against the respective end fitting to provide additional sealing between the body section and the end fittings. It should be noted, however, that the primary seals between the centre body section 12 and both end fittings 14 and 16 are provided by the O-rings 92. The sealing between the ball member and the end fittings is assured by the ring member 80.

Fig. 7 shows the general position of the elements when the ball member is in the full open position. When the ball member is moved to a closed position (see Fig. 8) under little or no fluid pressure, the position of the ball member and the lips of the seat ring members 80 will be substantially the same as illustrated in Fig. 7. The upstream seat ring member 80 contacts the ball member about diameter D with substantially line contact. This provides a low-pressure seal. However, a wedge opening is left between the inner periphery of the seat ring member and the ball member for fluid pressure to act on the area of the ball member within the diameter D. As line fluid pressure increases, the ball member will be displaced in a downstream direction away from the upstream seat ring member, and the seal between the upstream seat ring member and the ball member breaks as at 84′ in Fig. 8. As the ball member is displaced in a downstream direction, the downstream seat ring member flexes increasing the area of contact (the seal area) between the ball member and the seat ring member. The design of the lip portion 82 is such that it can flex somewhat like a cantilevered beam. Increasing contact area between the seat ring member and the ball member with increasing fluid pressure serves to provide adequate support for the ball member.

Fig. 6 shows a modified form of stem packing for the valve. This packing is basically the same as that described hereinabove with reference to the Figure 1 embodiment. The difference, however, is that the intermediate ring 44 (Fig. 3A) is replaced by an O-ring 96. The space between the upper and lower confining rings 43 and 45 in which the O-ring 96 is retained is controlled by the design of the packing gland member 98. As shown, the gland member 98 has an outwardly extending shoulder 100 which engages the top of the valve body section 12 to prevent the gland member 98 from being improperly tightened to compress the O-ring 96 and destroy the effectiveness of the seal. As shown in Fig. 6A, the gland member 98 rides on a thrust ring 99 so that it may turn freely.

The three-piece body section and end fitting assembly described hereinabove could be formed by many different manufacturing methods. For example, bar stock is available in many standard configurations and could be used for forming the three main components. Also, forgings or castings could be used. These particular methods are not, however, particularly desirable. First, the use of standard bar stock

provides only a limited number of starting shapes which would require considerable machining and substantial loss in material. Forgings or castings likewise have distinct disadvantages. For example, with either a forging or a casting, draft angles must be provided and tolerances of ± 1/32" are about the best obtainable. Also. flashing is generally present, and it is very difficult to provide parallel surfaces. Because of the tolerance problems and the lack of parallelism, machining difficulties are encountered since there are no surfaces which can readily be used for locating. Also, forging or cast components often have lower hardness and tensile strength than desirable.

According to the preferred method of the present invention, extruded bar stock having the cross-sectional configuration shown in Fig. 4 is used for forming the central body section. Likewise, extruded bar stock is preferred for the end fittings. The advantages over the previously discussed methods are the following:

1. Close tolerances (± 0.5 mm if hot extruded, or ± 0.13 mm if cold drawn).
2. Better and more uniform strength.
3. Substantial material savings.
4. Substantial savings in machining time and setup because of the close tolerances.

To form the central body section from an extruded bar of the general type mentioned, it is only necessary to take the extruded bar and saw it to the required lengths. Thereafter, the opposed end faces of each length can be ground or machined to the required final thickness and surface finish. When the opposed end faces have been finished, the central through-flow passage can be bored. The centrebore can then be used for chucking the body section internally while the counterbore operation is carried out. Similarly, the centerbore can be used for exact location of the bolt hole for the swing-out arrangement.

By the use of an extruded bar, tolerances are close enough to allow the external surfaces to be used for most locating. Additionally the extruded bar eliminates milling operations which would normally be required for providing handle stops of the type described or for providing the above-described wrench surfaces.

The end fittings, when made from an extruded bar, can be quickly machined on a conventional multiple spindle machine. Additionally the described advantages are even more important when it is noted that the same basic body section and end fitting structure can be used in a wide variety of fluid flow system devices. This produces additional savings because of volume and reduction of inventory requirements for a complete line of fluid flow devices.

Reference is made to co-pending patent application No. 19642/76 (Serial No. 1 477 042) in which is described and claimed a rotary valve having a body defining a valve chamber; a rotatable valve member mounted therein; an operating stem extending out of the body; and a handle connected to said stem for rotation thereof between first and second spaced positions, first and second stop surfaces being provided on the exterior of said valve, said surfaces being positioned on laterally opposite sides of said stem and said handle including first and second depending stop portions bent downwardly from the plane of said handle, said first and second stop portions being positioned to engage said first and second stop surfaces at said first and second positions of handle rotation respectively and each of said stop portions being located such that when they engage their respective stop surfaces, the contact forces act parallel to the line of bend of the respective stop portion.

Reference is also made to co-pending patent application No. 19643/76 (Serial No. 1 477 043) in which is described and claimed a ball valve comprising a body section terminating in end faces and having a longitudinally extending bore connected between said end faces; a ball member positioned in said bore and mounted for rotation therein to control flow of fluid therethrough; seal assemblies positioned in opposite end of said bore; and end fittings connected to said body section at each end thereof, each of said seal assemblies comprising a seat ring formed from a resilient material and having a first surface arranged to engage said ball member and a second surface facing out of said bore, a relatively rigid sleeve closely encircling said seat ring and slidably received in a counterbore formed about the end of said bore and a resilient seal ring encircling said sleeve, said end fittings each including surfaces engaging the second surface of the seat ring and said seal ring of the seal assembly at its respective end.

WHAT WE CLAIM IS:—

1. A fluid flow system device comprising a body section having a longitudinal through-flow passage which extends between a pair of generally parallel end faces; a pair of end fittings each having a through-flow opening, said end fittings being positioned at opposed ends of the body section in engagement with the end faces and with their through-flow openings aligned with the through-flow passage; and at least three tie bolts connected between said end fittings and

provides only a limited number of starting shapes which would require considerable machining and substantial loss in material. Forgings or castings likewise have distinct disadvantages. For example, with either a forging or a casting, draft angles must be provided and tolerances of ± 1/32" are about the best obtainable. Also. flashing is generally present, and it is very difficult to provide parallel surfaces. Because of the tolerance problems and the lack of parallelism, machining difficulties are encountered since there are no surfaces which can readily be used for locating, Also, forging or cast components often have lower hardness and tensile strength than desirable.

According to the preferred method of the present invention, extruded bar stock having the cross-sectional configuration shown in Fig. 4 is used for forming the central body section. Likewise, extruded bar stock is preferred for the end fittings. The advantages over the previously discussed methods are the following:

1. Close tolerances (± 0.5 mm if hot extruded, or ± 0.13 mm if cold drawn).
2. Better and more uniform strength.
3. Substantial material savings.
4. Substantial savings in machining time and setup because of the close tolerances.

To form the central body section from an extruded bar of the general type mentioned, it is only necessary to take the extruded bar and saw it to the required lengths. Thereafter, the opposed end faces of each length can be ground or machined to the required final thickness and surface finish. When the opposed end faces have been finished, the central through-flow passage can be bored. The centrebore can then be used for chucking the body section internally while the counterbore operation is carried out. Similarly, the centerbore can be used for exact location of the bolt hole for the swing-out arrangement.

By the use of an extruded bar, tolerances are close enough to allow the external surfaces to be used for most locating. Additionally the extruded bar eliminates milling operations which would normally be required for providing handle stops of the type described or for providing the above-described wrench surfaces.

The end fittings, when made from an extruded bar, can be quickly machined on a conventional multiple spindle machine. Additionally the described advantages are even more important when it is noted that the same basic body section and end fitting structure can be used in a wide variety of fluid flow system devices. This produces additional savings because of volume and reduction of inventory requirements for a complete line of fluid flow devices.

Reference is made to co-pending patent application No. 19642/76 (Serial No. 1 477 042) in which is described and claimed a rotary valve having a body defining a valve chamber; a rotatable valve member mounted therein; an operating stem extending out of the body; and a handle connected to said stem for rotation thereof between first and second spaced positions, first and second stop surfaces being provided on the exterior of said valve, said surfaces being positioned on laterally opposite sides of said stem and said handle including first and second depending stop portions bent downwardly from the plane of said handle, said first and second stop portions being positioned to engage said first and second stop surfaces at said first and second positions of handle rotation respectively and each of said stop portions being located such that when they engage their respective stop surfaces, the contact forces act parallel to the line of bend of the respective stop portion.

Reference is also made to co-pending patent application No. 19643/76 (Serial No. 1 477 043) in which is described and claimed a ball valve comprising a body section terminating in end faces and having a longitudinally extending bore connected between said end faces; a ball member positioned in said bore and mounted for rotation therein to control flow of fluid therethrough; seal assemblies positioned in opposite end of said bore; and end fittings connected to said body section at each end thereof, each of said seal assemblies comprising a seat ring formed from a resilient material and having a first surface arranged to engage said ball member and a second surface facing out of said bore, a relatively rigid sleeve closely encircling said seat ring and slidably received in a counterbore formed about the end of said bore and a resilient seal ring encircling said sleeve, said end fittings each including surfaces engaging the second surface of the seat ring and said seal ring of the seal assembly at its respective end.

WHAT WE CLAIM IS:—

1. A fluid flow system device comprising a body section having a longitudinal through-flow passage which extends between a pair of generally parallel end faces; a pair of end fittings each having a through-flow opening, said end fittings being positioned at opposed ends of the body section in engagement with the end faces and with their through-flow openings aligned with the through-flow passage; and at least three tie bolts connected between said end fittings and

positioned circumferentially about said through-flow passage and extending generally parallel thereto, one of said tie bolts extending through said body section with the remaining tie bolts located radially outwardly of the body section.

2. A fluid flow system device as claimed in claim 1 wherein said body section has seal ring assemblies positioned about each end of said through-flow passage, said seal ring assemblies being axially removable from said body section.

3. A fluid system device as claimed in claim 1 or 2 wherein at least one of said tie bolts which does not pass through said body section is positioned to engage the exterior surface of said body section.

4. A fluid flow system device as claimed in claim 1, 2 or 3 wherein said body section has a uniform cross-sectional configuration in all planes perpendicular to the axis of said through-flow passage.

5. A fluid flow system device as claimed in any of claims 1 to 4 in which one only of said remaining tie bolts has to be completely removed to enable said body section to be swung outwardly about said one tie bolt extending through the body section, after all the tie bolts have been loosened.

6. A method of making a fluid flow system device comprising the steps of providing an extruded metal bar having a uniform cross-section in planes perpendicular to its longitudinal axis; cutting off a section of said extruded bar so that the section has a pair of parallel end faces spaced apart a desired distance, said end faces being perpendicular to said longitudinal axis; grinding said end faces to reduce said section to form a body section of desired length; forming a central bore axially through said section; forming a single bolt receiving opening through said section at a location radially outwardly of said central bore and parallel thereto; providing a pair of end fittings each having an end face and a through passage extending perpendicular thereto; forming a plurality of bolt receiving openings through said end fittings at locations radially outwardly of said through passage; positioning said end fittings with their end faces in engagement with the end faces of said body section; aligning one bolt receiving opening in each end fitting with the bolt receiving opening in said body section and passing a tie bolt therethrough to secure said end fittings to said body section; and passing additional tie bolts through the other bolt receiving openings in the end fittings with such additional tie bolts located radially outwardly of the body section.

7. A method as claimed in claim 6 wherein said end fittings are formed from an extruded metal bar.

8. A method as claimed in claim 6 or 7 wherein said central bore is used for locating the bolt receiving opening in said body section.

9. A ball valve comprising a body section having a longitudinal through-flow passage which extends between a pair of generally parallel end faces; a valve ball member positioned in said through-flow passage for controlling fluid flow therethrough; a pair of end fittings each having a through-flow opening; said end fittings being positioned at opposed ends of the body section in engagement with the end faces and with their through-flow openings aligned with the through-flow passage; and at least three tie bolts connected between said end fittings and positioned circumferentially about said through-flow passage and extending generally parallel thereto, one of said tie bolts extending through said body section with the remaining tie bolts located radially outwardly of the body section.

10. A ball valve as claimed in claim 9 wherein at least one of said tie bolts which does not pass through said body section is positioned to engage the exterior surface of said body section.

11. A ball valve as claimed in claim 9 or 10 which has four tie bolts.

12. A ball valve as claimed in claim 9, 10 or 11 in which only one of said remaining tie bolts has to be completely removed to enable said body section to be swung outwardly about said one tie bolt extending through the body section after all the tie bolts have been loosened.

13. A ball valve as claimed in any of claims 9 to 12 wherein said body section has seal assemblies positioned about each end of said through-flow passage, said seal assemblies being axially removable from said body section.

14. A ball valve as claimed in claim 13 wherein said seal assemblies include a first portion for sealing between said body section and said end fittings and a second portion for sealing between said body section and said ball member.

15. A ball valve as claimed in claim 14 in which each of said seal assemblies comprises a seat ring of resilient material and a relatively rigid sleeve encircling said seat ring, said first and second portions of each seal assembly being portions of said seat ring and having surfaces respectively engaging the respective end fitting and said ball member.

16. A ball valve as claimed in claim 15 wherein said rigid sleeve includes an axially extending recess which receives the outer peripheral surface of said seat ring.

17. A ball valve as claimed in claim 15

or 16 in which said sleeve is slidably received in said through-flow passage and is sealed thereto by a resilient seal ring encircling said sleeve.

18. A ball valve as claimed in claim 17 wherein said resilient seal ring has an axial dimension slightly greater than the depth of a recess formed about the end of said through-flow passage to receive the resilient seal ring.

19. A ball valve as claimed in any of claims 15 to 18 wherein said second portion of said seat ring comprises a lip portion extending towards said ball member in a radially outward direction.

20. A ball valve as claimed in any of claims 9 to 19 wherein said ball member is engaged by a stem, which extends radially through said body section, said stem being slidably coupled to said ball member whereby said ball member can be removed axially from said through-flow passage.

21. A ball valve as claimed in any of claims 9 to 20 wherein said body section has a uniform cross-sectional configuration in all planes perpendicular to the axis of said through-flow passage.

22. A ball valve as claimed in claim 21 in which a rib extends outwardly of said body section and a or the ball actuating stem extends through an opening in said rib into engagement with said ball member.

23. A ball valve as claimed in claim 22 including a packing ring carried in said rib and located about said stem and means carried on said stem for compressing said packing ring.

24. A ball valve as claimed in claim 22 or 23 in which a flange of said body section extends towards said stem in said opening, said stem having a outwardly extending flange located radially inwards of said body flange portion and a bearing member positioned between said flanges.

25. A ball valve as claimed in claim 22, 23 or 24 in which a handle is connected to the outer end of said stem and stop members extend from said handle for engagement with said rib at predetermined points of handle rotation.

26. A ball valve as claimed in any of claims 9 to 24 in which a handle is connected to a or the stem, which extends through the body section and is coupled to the ball member, said handle having first and second depending stop portions bent downwardly from the plane of the handle to engage first and second stop surfaces at respective positions of the ball member and such that the contact forces act parallel to the line of bend of the respective stop portion lies.

27. A ball valve as claimed in claim 26 wherein said stop portions are bent along lines which are generally perpendicular to one another.

28. A ball valve as claimed in claim 26 or 27 wherein said stop surfaces are located equal distances from and at opposite sides of said stem.

29. A ball valve as claimed in claim 26, 27 or 28 wherein said stop portions are each tapered from their line of bend towards their lowermost end.

30. A ball valve as claimed in any of claims 26 to 29 wherein said first stop portion is formed on the end of said handle and the second stop portion is formed on the side of said handle.

31. A ball valve as claimed in any of claims 26 to 30 wherein said stop surfaces are defined by radially opposite sides of a or the rib extending longitudinally of said body section.

32. A ball valve as claimed in any of claims 26 to 31 wherein said stop portions are located such that they engage said body section only at first and second positions of rotation.

33. A ball valve as claimed in any of claims 26 to 32 wherein said handle has a uniform thickness throughout its length.

34. A ball valve constructed and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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