

DESCRIPTION

VALVE OPENING AND CLOSING OPERATION LEVER DEVICE

TECHNICAL FIELD

The present invention relates to a valve opening and closing operation lever device in a valve device arranged in a piping path, for opening and closing control of a liquid flowing through the piping. More particularly, the invention relates to an opening and closing operation lever device for carrying out the opening and closing operation of a butterfly valve.

BACKGROUND

In butterfly valves, the valve is opened and closed using a driving device called an actuator. The simplest valve driving device is a device comprising an operation lever, coupled perpendicularly to the leading end of a valve rod, and which is turned through direct manual operation. As disclosed in, for instance, Japanese Patent Application Laid-open No. H09-178033 (Patent document 1), Japanese Patent Application Laid-open No. H08-178120 (Patent document 2) and Japanese Utility Model Application Laid-open No. S62-54379 (Patent document 3), valve driving devices having such an operation lever (hereinafter called an opening and closing operation lever or opening and closing lever device) comprise a plate-like lever manufactured by press molding to have a C-shaped cross section, or a step-like curved shape, with a view to increasing strength, wherein the valve rod is inserted and fixed in a shaft hole in the lever leading end, so that the lever extends perpendicularly to the valve rod, and wherein the valve is driven to be opened or closed through manual turning of the lever around the valve rod.

In such opening and closing operation levers, the plate material can be manufactured by press molding. Although this keeps manufacturing costs sufficiently low, lever strength is fundamentally insufficient on account of the plate-like shape of the lever, such that when high torque is required, the vicinity of the shaft hole, which is weakest in

terms of strength, may deform and be damaged. In Patent document 3, the leading end of the operation lever is bent back forming substantially a C-shape. Although this increases as a result the strength around the shaft hole, it may cause the handle portion of the plate-like lever to become bent. In cases of high torque, plate-like opening and closing operation levers formed by press molding are hard to operate by gripping, as it is difficult to apply a force to the lever. To allow withstanding substantial torque, thus, the plate must be made thicker, but this is problematic on account of the associated increased material costs and worse processability. When the plate of the operation lever is made thicker, moreover, it becomes more difficult to align the connection holes formed on the two plates that are bent back into a C shape.

Japanese Utility Model Laid-open No. S60-84868 (Patent document 4) discloses an opening and closing operation lever that can cope with substantial torque. In the opening and closing operation lever disclosed in Patent document 4, an opening and closing operation lever main body is formed of a casting that is molded in a casting mold, having on the leading end thereof a shaft hole for insertion of a valve rod. Such an opening and closing operation lever has higher strength and handleability, and is easier to have a force exerted upon, than a plate-like opening and closing operation lever.

The driving torque in valve devices changes with changes in bore size, so that the diameter of the valve rod must also change accordingly. This entails changes also in the size of an actuator coupling part of the valve rod and the opening and closing operation lever. In the opening and closing operation lever devices of Patent documents 1 to 3 it was necessary to prepare an opening and closing operation lever device for each of the sizes of an actuator coupling part.

With a view to solving the above problem, the opening and closing operation lever device in Patent document 4 comprises a bush that is detachably fitted in a shaft hole of

a lever main body. Such a bush is prepared with a plurality of inner-face shapes and sizes, in accordance with the shape and diameter of the valve rod, so that bushes can be exchanged. This allows, as a result, using fewer materials while carrying out opening and closing operations in more valve devices. Moreover, the opening and closing operation lever devices afforded thereby are strong enough to withstand substantial torque.

The opening and closing operation lever device of Patent document 4, however, is problematic in that the manufacture thereof requires using casting technology, which is expensive. Manufacturing costs are further driven up since the necessary bushes must be manufactured by milling.

Patent document 1: Japanese Patent Application Laid-open No. H09-178033

Patent document 2: Japanese Patent Application Laid-open No. H09-178033

Patent document 3: Japanese Utility Model Application Laid-open No. S62-054379

Patent document 4: Japanese Utility Model Application Laid-open No. S60-084868

DISCLOSURE OF THE INVENTION

In the light of the above problems, the present invention aims at allowing the main components of an opening and closing operation lever device to be molded basically by pressing, while making the opening and closing operation lever device strong enough to withstand substantial torque, and at making the opening and closing operation lever device compatible with valve rods of a plurality of sizes by replacing an adapter component.

With a view to solving the above problems, the present invention comprises: a coupling adapter detachably mounted, in a unified rotation direction, on an actuator coupling part of a valve rod that turns integrally with a valve element in a valve device, and an operation lever that detachably covers the coupling adapter in a unified rotation direction, wherein the valve rod, the coupling adapter and the operation lever are integrated by clamping the actuator coupling part of the valve rod between the coupling adapter and screw

means screwed through the coupling adapter and the operation lever, the valve rod being driven-rotated through turning of the operation lever via the coupling adapter, and wherein valve rods of a plurality of shapes and sizes can be employed by replacing the coupling adapter.

The coupling adapter has a bottom plate portion and rising plate portions rising from both sides of the bottom plate portion; a shaft hole is formed on the bottom plate, for rotation direction unification through mounting of the actuator coupling part of the valve rod; the outer face of the rising plate portions on both sides fits against the inner face of a crown portion of the operation lever mounted on the coupling adapter, unifying thereby the rotation direction of the coupling adapter and the operation lever; one of the rising plate portions is formed with an abutting portion which is aligned with a perpendicular line of the shaft hole and abuts the actuator coupling part of the valve rod; and the other rising plate portion allows screw-insertion of screw means running through the operation lever, at a position opposite the abutting portion, to integrate the valve rod and the operation lever via the coupling adapter by clamping the actuator coupling part between the screw means and the abutting portion, so that the valve rod is freely driven-rotated through turning of the operation lever.

The coupling adapter is formed as a member having four planar portions by bending, through press molding, a flat plate-like metal material of substantially rectangular planar shape, substantially at right angles and along three mutually parallel bending lines having appropriate spacings therebetween and crossing perpendicularly a longitudinal direction of the metal material, into a bottom plate portion, two rising plate portions rising from both sides of the bottom plate portion, and a bent back portion obtained by bending one of the rising plate portions at a predetermined height, the leading end of the bent back portion being formed as an abutting portion set at a height position substantially identical to the height up to the center of a nut fitting hole formed beforehand on one rising portion opposite

the bent back portion, and a leading end of the abutting portion being positioned vertically and directly above one edge of the shaft hole, so that the actuator coupling part of the valve rod is clamped between the abutting portion and screw means screwed into the nut fitting hole.

In the present invention, the valve rod and the operation lever are coupled, via a freely replaceable coupling adapter, by making the operation lever for drive-rotating the valve rod that opens and closes the valve into a common component. As a result, this does away with the need for preparing several entire opening and closing operation lever devices in accordance with the diameter, shape and the like of the valve rod. That is, according to the present invention, valve rods having various sizes can be employed by simply replacing the coupling adapter, with little material usage. The invention allows thus cutting costs and reducing material usage. The various components of the opening and closing operation lever device, moreover, are obtained without resorting to casting technology in any way. In particular, the main components can be formed through pressing. This allows simplifying the forming operation and reducing forming costs. An appropriate nut, moreover, is embedded through pressing into the nut fitting hole formed in the coupling adapter, and is fastened so as not to come off therefrom. As a result, the opening and closing operation lever device can be obtained without any need at all for a cost-intensive process such as welding or the like. Sufficiently large torque can be withstood, even when the operation lever is formed by pressing of a relatively thin plate material, thanks to an assembly structure in which coupling with the valve rod is done via the coupling adapter.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective-view diagram of a valve opening and closing operation lever device in an embodiment.

Fig. 2 is a cross-sectional diagram illustrating an operational configuration of the main components of the device when mounted.

Fig. 3 is a diagram illustrating the configuration of the main components in the device.

Fig. 4 is a cross-sectional diagram of a relevant portion of the device when in use, viewed from the front.

EXPLANATION OF REFERENCE NUMERALS

- 1 valve body
- 2 valve element
- 3 drive-side valve rod
- 4 valve shaft tube
- 5 opening and closing operation lever device
- 6 mounting plate
- 7 notches
- 8 opening-degree plate
- 9 scale plate
- 10 fixing bolt/nut
- 11 operation lever
- 12 claw
- 13 lock lever
- 14 coupling adapter
- 15 metal base material
- 16 crown portion
- 17 grip
- 18 mounting hole
- 19 fixing locking screw

20 pivot screw
21a pivot hole
21b pivot hole
22 fitting part
23 coil spring
24 metal base material
25 fitting part
26 grip
27 metal base material
28 nut fitting hole
29 actuator coupling part
30 shaft hole
31 nut
32 shaft screw fastener
33 lock nut
L1 bending line
L2 bending line
L3 bending line
S1 first planar portion
S2 second planar portion
S3 third planar portion
S4 fourth planar portion

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention is explained next with reference to accompanying drawings. In the figures, the reference numeral (1) is a valve body of a centric

butterfly valve. As is conventionally known, a plate-like valve element (2) is pivotably supported in the interior, with valve rods mounted on the turning center of the valve element (2). One of the valve rods, as a drive-side valve rod (3), extends outwards running through a valve shaft tube (4). An opening and closing operation lever device (5) is mounted on the outer end of the drive-side valve rod (3). A mounting plate (6) is integrally mounted on the outer end of the valve shaft tube (4). An opening-degree plate (8), having notches (7) on the top face, and a scale plate (9), indicative of the opening degree, are removably fixed, by way of fixing bolt/nuts (10), to the topside of the mounting plate (6). On an operation lever (11) forming the opening and closing operation lever device (5), there is mounted a lock lever (13) having on the leading end thereof a claw (12) that is engaged in the notches (7) of the opening degree plate (8), so as to be capable of lever-like pivoting on a pivoting point substantially midway in the longitudinal direction of the lock lever (13). The lock lever (13) is normally urged in the direction in which the claw (12) is engaged in the notches (7), in such a way that the claw (12) can turn in the direction of release from the notches (7) through gripping of the rear end of the lock lever (13) and the operation lever (11). Such a mechanism for indicating the opening degree of a butterfly valve is a well-known mechanism.

As illustrated in Fig. 1, the valve opening and closing operation lever device (5) of the present embodiment comprises mainly the operation lever (11), the lock lever (13) and a coupling adapter (14). The operation lever (11) applies a drive force to the drive-side valve rod (3). The operation lever (11), which is obtained by press molding of a thin metal base material (15) shaped as a flat plate, has overall a substantially elongated linear rod-like shape. The operation lever (11) has on the front end side thereof a crown portion (16), having a width and height bulging slightly with respect to the rear end, to be attached to the coupling adapter (14) so as to cover it. On the rear of the operation lever (11) there is provided a handle-like slim grip (17). The width, length and height of the crown portion (16) are formed

to such sizes as allow exact insertion of the coupling adapter (14) in a predetermined orientation. On one side face of the crown portion (16), there is opened a mounting hole (18) that runs between the front and reverse of the crown portion (16), in such a way that a fixing locking screw (19), for holding the coupling adapter (14) in an attached state, can be inserted through the mounting hole (18). A pivot hole (21), for inserting a pivot screw (20), is opened substantially in the center of the longitudinal direction of the slim handle-like portion of the operation lever (11), running from one side face to the opposing side face of the operation lever (11). Further, a fitting part (22) of substantially cylindrical shape, and protruding out towards the lock lever (13), is formed on substantially an intermediate position between the pivot hole (21a) and the rear end of the operation lever (11); in such a way so as to allow fitting of an urging coil spring (23). With reference to Figs. 2 and 4, the transversal cross-sectional shape of the operation lever (11) has a substantial C-shape along virtually the entire longitudinal direction thereof. During use, an opening portion in the crown portion (16), having a transversal cross-sectional C shape, is used against the leading end of the drive-side valve rod (3).

Similarly to the operation lever (11), the lock lever (13) is obtained through press molding of a thin metal base material (24) shaped as a flat plate. The lock lever (13) has overall an elongated rod-like form shaped as an L. At the leading end, the lock lever (13) has a claw (12) forming substantially a flat claw shape. A pivot hole (21b), for inserting the pivot screw (20), is opened in the vicinity of the apex of the lock lever (13) substantially shaped as an L, running from one side face to the opposing side face of the lock lever (13). A fitting part (25) of substantially cylindrical shape is formed on substantially the central upper portion of the longitudinal direction of the long side of the L-shape, protruding out, to allow fitting of the urging coil spring (23). The lower end face of the long side of the lock lever (13) is formed to a wavy shape in which a plurality of wave faces are strung together, to form a

grip (26) that can be easily grasped by fingers. With reference to Figs. 1 and 2, the transversal cross-sectional shape of the operation lever (11) has a substantial C-shape along virtually the entire longitudinal direction thereof. During use, an opening portion, having a transversal cross-sectional C shape, is attached facing toward the operation lever (11). The lock lever (13) is attached in such a way that the apex of the substantial L-shape thereof becomes inserted into the position of the pivot hole (21) of the operation lever (11) having substantially a transversal cross-sectional C-shape. Therefore, the inner width of the substantially C-shape in the transversal cross section of the operation lever (11), at the position of the pivot hole (21), is set to have an equivalent or larger size, preferably an equivalent size, to the outer width of the apex of the lock lever (13) having substantially an L-shape.

As illustrated in Fig. 3(A), the coupling adapter (14) is formed of a metal base material (27) shaped as a flat plate and forming a rectangular plane. The metal base material (27) has four planar portions (S1) (S2) (S3) (S4), delimited by three mutually parallel bending lines (L1) (L2) (L3) (fictional lines), bent through press molding, and arranged at right angles to one another, with appropriate spacings between them. The bending lines (L1) (L2) (L3) extend between both ends of the metal base material (27) so as to cross the latter perpendicularly to the longitudinal direction thereof. The four planar portions (S1) (S2) (S3) (S4) comprise, from the right, a first planar portion (S1), relatively wide and shaped substantially as a rectangle, a second planar portion (S2) next, delimited substantially in the same way as the first planar portion (S1), an elongated and relatively narrow third planar portion (S3) next, and on the leftmost side, an elongated and relatively narrow fourth planar portion (S4) similar to the third planar portion (S3). A nut fitting hole (28) is opened through substantially the central portion of the first planar portion (S1), to a flat hexagonal shape having a surface area sufficiently smaller than the surface area of the first planar portion (S1).

A shaft hole (30), for insertion of an actuator coupling part (29) at the leading end of the drive-side valve rod (3), is opened in substantially the center of the second planar portion (S2). The transversal cross-sectional shape of the shaft hole (30) is substantially identical to that of the actuator coupling part (29) of the drive-side valve rod (3). In the valve opening and closing operation lever device (5) of the present embodiment, the shaft hole (30) has a flat square shape. The nut fitting hole (28) and the shaft hole (30) opened through the metal base material (24) that makes up the coupling adapter (14) are formed by punching, and not by milling or the like.

The metal base material (24) that makes up the coupling adapter (14) formed as described above is bent, by pressing, into a right-angle bending configuration along the three bending lines (L1) (L2) (L3). Fig. 3(B) illustrates the bent state of the metal base material (24). The positions and mutual spacings of the bending lines (L1) (L2) (L3) should be set so as to satisfy the following conditions, as illustrated in Fig. 3(B).

The first bending line (L1) positioned between the first planar portion (S1) and the second planar portion (S2) is set to have a height h from the lower end of the second planar portion (S2) that forms the bottom during bending, up to the central position of the nut fitting hole (28) formed in the first planar portion (S1). The bending line (L2) positioned between the second planar portion (S2) and the third planar portion (S3) is set in such a way that a horizontal distance w , from the edge of the shaft hole (30) formed on the second planar portion (S2), on the side of the third planar portion (S3), up to the outer edge of the third planar portion (S3) during raising of the latter through bending, is equal to a horizontal distance w' between the outer edges of the fourth planar portion (S4) upon right-angle bending of the fourth planar portion (S4) relative to the third planar portion (S3) along the bending line (L3) positioned between the third planar portion (S3) and the fourth planar portion (S4). Further, the bending line (L3) positioned between the third planar portion (S3)

and the fourth planar portion (S4) is set in such a way that a height h' , extending from the lower end of the second planar portion (S2) that forms a bottom, up to the central position, in the thickness direction, of the leading end of the fourth planar portion (S4), which is parallel to second planar portion (S2), is identical to the above-described height h , upon formation of a substantial C-shape through respective right-angle bending along the bending line (L2) between the second planar portion (S2) and the third planar portion (S3), and the bending line (L3) between the third planar portion (S3) and the fourth planar portion (S4).

The coupling adapter (14) is bent by pressing to form right angles at locations corresponding to the pre-set bending lines (L1) (L2) (L3) satisfying the above conditions, whereupon a substantially hexagonal tubular nut (31) is press-fitted into the nut fitting hole (28) of the metal base material (24) formed as illustrated in Fig. 3(B). The nut (31) is embedded in the metal base material (24) in such a way so as to lie flush, without protruding beyond the outer surface of the first planar portion (S1) that rises perpendicularly to the bottom. This situation is illustrated in Fig. 3(C). As can be seen in Fig. 3(C), the height of the nut (31) is about twice the thickness of the metal base material (27). The nut (31), which protrudes beyond the inward surface of the first planar portion (S1), is fastened so as not to come off. Fig. 3(D) is a plan view illustrating the coupling adapter (14) in such a situation, viewed from above. As Fig. 3(D) shows, the abutting portion at the leading end of the fourth planar portion (S4) is configured to stand at a position vertically and directly above the end of the shaft hole (30), on the side of the third planar portion (S3), punched to a substantial flat square shape in the second planar portion (S2).

With reference to Fig. 1, the portion of the pivot hole (21) drilled through the apex of the lock lever (13) is disposed at the portion of the pivot hole (21) of the operation lever (11). The pivot screw (20) is inserted through these pivot holes (21) and is fixed by way of a shaft screw fastener (32) to be freely pivotable. One end of the coil spring (23) is fitted

into the fitting part (25) of the lock lever (13), then the other end of the coil spring (23) is fitted into the fitting part (22) formed in the operation lever (11). As a result, the grips (17) (26) of the operation lever (11) and the lock lever (13) are urged in the opening direction, i.e. in the direction such that, during use, the opening and closing operation lever device (5) is normally locked to the opening-degree plate (8).

Upon use of the valve opening and closing operation lever device (5) of the present embodiment obtained as described above, firstly the coupling adapter (14) is attached to the crown portion (16) of the operation lever (11), as illustrated in Fig. 4. In doing so, the position of the nut (31) embedded in the first planar portion (S1) of the coupling adapter (14) is matched to the position of the mounting hole (18) that runs through one side of the crown portion (16), and then the fixing locking screw (19) is lightly screwed into the nut (31). In this state, the upper end portion of the drive-side valve rod (3) protruding out of the mounting plate (6) fixed to the valve body (1), i.e., the actuator coupling portion (29) that couples the drive-side valve rod (3) and the opening and closing operation lever device (5), is fitted into the shaft hole (30) of the coupling adapter (14). The height H2 of the inner space of the crown portion (16) of the operation lever (11) is set, as a matter of course, so as to fully cover the height H1 of the portion of the drive-side valve rod (3) that protrudes out of the mounting plate (6). Needless to say, the levels of the lower end of the crown portion (16) and the lower end of the coupling adapter (14) are set so as to become equal and flush with each other.

With the coupling adapter (14) inserted thus beforehand into the crown portion (16), the actuator coupling part (29) of the drive-side valve rod (3) is inserted in the shaft hole (30) formed in the coupling adapter (14), up to the base of the actuator coupling part (29). The fixing locking screw (19) that is slightly screwed beforehand into the mounting hole (18) is then further screwed so as to firmly push the leading end of the fixing locking screw (19), to press against the actuator coupling part (29) from the side of the latter. The actuator

coupling part (29) becomes thus fixed by being pinched between the leading end of the fixing locking screw (19) and the abutting portion of the fourth planar portion (S4) of the coupling adapter (14). A lock nut (33) is screwed on the fixing locking screw (19) that protrudes out of the mounting hole (18) of the crown portion (16), to afford thereby a yet stronger fixing of the opening and closing operation lever device (5) onto the drive-side valve rod (3).

Ordinarily, the claw (12) at the leading end of the lock lever (13) is engaged in the notches (7) at an appropriate position of the opening-degree plate (8), so that the opening and closing operation lever device (5) turns in a locked state. Upon gripping of the grips (17) (26) of the operation lever (11) and the lock lever (13), the coil spring (23) becomes compressed, whereupon the claw (12) turns around the position of the pivot screw (20), downward of the notches (7), to release thereby the engagement state as well as the lock state of the opening and closing operation lever device (5), and to allow the valve element (2) to be adjusted to a desired opening.

For using the opening and closing operation lever device (5) of the present embodiment in a valve body (1) having an actuator coupling part (29) of different size, the coupling adapter (14) is replaced by a corresponding coupling adapter (14) having a shaft hole (30) that matches the size of the new actuator coupling part (29).

CLAIMS

1. A valve opening and closing operation lever device, comprising: a coupling adapter detachably mounted, in a unified rotation direction, on an actuator coupling part of a valve rod that turns integrally with a valve element in a valve device; and an operation lever that detachably covers the coupling adapter in a unified rotation direction, the valve rod being driven-rotated through turning of the operation lever via the coupling adapter, and valve rods of a plurality of shapes and sizes being employable by replacing the coupling adapter,

wherein the coupling adapter has a bottom plate portion and rising plate portions rising from both sides of the bottom plate portion; a shaft hole is formed on the bottom plate, for rotation direction unification through mounting of the actuator coupling part of the valve rod; the outer face of the rising plate portions on both sides fits against the inner face of a crown portion of the operation lever mounted on the coupling adapter, unifying thereby the rotation direction of the coupling adapter and the operation lever; one of the rising plate portions is formed with an abutting portion which is aligned with a perpendicular line of the shaft hole and abuts the actuator coupling part of the valve rod; and the other rising plate portion allows screw-insertion of screw means running through the operation lever, at a position opposite the abutting portion, to integrate the valve rod and the operation lever via the coupling adapter by clamping the actuator coupling part between the screw means and the abutting portion, so that the valve rod is freely driven-rotated through turning of the operation lever.

2. The valve opening and closing operation lever device according to claim 1, wherein the coupling adapter is formed as a member having four planar portions by bending, through press molding, a flat plate-like metal material of substantially rectangular planar shape, substantially at right angles and along three mutually parallel bending lines having appropriate spacings therebetween and crossing perpendicularly a longitudinal direction of the metal material, into a bottom plate portion, two rising plate portions rising from both sides of the bottom plate portion, and a bent back portion obtained by bending one of the rising plate portions at a predetermined height, and wherein the leading end of the bent back portion is formed as an abutting portion set at a height position substantially identical to the height up to the center of a nut fitting hole

formed beforehand on one rising portion opposite the bent back portion, a leading end of the abutting portion being positioned vertically and directly above one edge of the shaft hole, so that the actuator coupling part of the valve rod is clamped between the abutting portion and screw means screwed into the nut fitting hole.