

The invention which relates to a switching microelectrovalve intended for all fluids and particularly for aggressive or impurity laden liquids, has more precisely as its subject a microelectrovalve with rocker and a single membrane.

It is known that the purpose of manual or motor driven two or three-way valves is to close off the passage of a fluid in a pipe or to orientate a fluid from a supply pipe to one or other of two distribution pipes. For this, the valve body at which these pipes terminate is usually provided with a movable assembly which, depending on its position, opens or closes an aperture. In a three-way valve, the movable assembly closes off one aperture while while [sic] opening another aperture and vice versa, and it is for example constituted by a pivoting plate bearing a flexible sealing member, or else by a closing valve having two faces in translation in a casing between two opposed apertures. These assemblies, especially if they are actuated by a motor, or - as is usually the case in electrovalves, by an electromagnet -, must be carefully constructed so that the leaktightness is correct, even after frequent use. This quite often implies additional adjustment systems associated with return springs, all arrangements which complicate the product and make it heavier. Although this is not too important for standard applications, when it is a question for example of orientating water at normal pressure from a main pipe towards a branch pipe, the same does not at all hold true in certain fields of use, such as in the medical field, or [sic] conventional electrovalves cannot be used. In this case of application in fact, the risk cannot be taken that the liquids in question may leak from the electrovalve, or that conversely they may be attacked or polluted by an external medium whatever it may be. Furthermore, the microvalves sought must often be of small size, be light, and capable of being actuated by an electromagnet of low power.

In order to solve these problems, the solution is known which consists in using a closing member which

uses two membranes made of plastic material, mounted on either side of a core which passes through a central well provided in the body of the electrovalve. These membranes which are flexible can be deformed in their casing and close apertures which open thereinto, while opening other apertures, this being under the action of the core of an electromagnet. It is thus known how to construct a microvalve as described in EP-A-0,250,298 in the name of the Applicant, which is capable of withstanding relatively high pressures although it is of reduced size, and which lends itself to the transfer of all liquids.

Microvalves of that type however - because of the existence of the two membranes - use two casings for the intake or discharge of fluid, and a leaktight connection device between the two, the membrane/connection assembly constituting a single movable assembly, driven by the same core. This necessitates the construction of several small-sized parts, which are awkward to assemble, and difficult to adjust so that the closures of the membranes onto their seatings are constant. Moreover, the dead volume of fluid subsisting in the casings of each membrane, is therefore not negligible, which may be a disadvantage for the transfer of very small fluid flow-rates.

In order to avoid this, the construction of a valve having a single membrane was considered.

Thus from DE-A-3,503,357 a valve is known using a single membrane as closing member of two pipes. But this membrane which is capable of occupying a rest position intermediate to its two closure positions is integral with a vertical shank serving for the actuation of the closing device from a button.

For use with all fluids and particularly aggressive or impurity laden liquids, the microvalve provided by the invention enables the disadvantages inherent in the abovementioned valves to be avoided and has the advantage of being of simpler construction and at the same time of much more reliable operation.

A subject of the present invention is therefore

a switching microelectrovalve having at least two ways, comprising a valve body in a compartment of which terminate fluid inlet and outlet pipes, and a movable member constituted by a single deformable membrane performing the function of closing device of one or other of these pipes, said member being actuated by the core of an electromagnet, according to which microelectrovalve a rocker pivoting about a pivot point disposed at the centre of the single membrane applies said membrane by means of a spring against one or against the other of two pipes and according to which the rocker is displaced from the one to the other of its only two positions of equilibrium corresponding to the two closure positions of the membrane by a control slide sliding under the action of the core of the electromagnet, said control slide being placed in a well passing through the valve body along its longitudinal axis, one of its ends being flush with a non-closed outlet aperture of said well, and its central part comprising an opening which passes through it over its entire thickness parallel with its axis.

Advantageously, the central part of the slide is cut along a plane perpendicular to the plane of the opening so as to form a flat part between the axis and a generating line of the slide, two slots being provided transversely to the flat part and at its centre.

According to another feature of the invention a profiled side plate which closes a cylindrical opening provided on a lateral face of the valve body and through which pass three small fluid supply or outlet pipes, has a dished profile the central part of which, of conical profile, receives a ball.

According to yet another feature of the invention the rocker has the general shape of a top, the lower conical face of which bears against the upper face of the membrane under the action of a spring and pivots on the ball provided on the side plate, and the upper part of which comprises a shank which fits into the opening provided on the slide.

An advantageous arrangement of the invention

consists in that the conical face of the rocker possesses a central compartment permitting its positioning on the ball, and in that the said rocker comprises on the side opposite to its conical face, a cross-piece intended to be set in the slots of the slide.

Other special features and advantages of the invention will become apparent from the following description of one embodiment taken as a non-limiting example, in which reference is made to the drawings which show :

Figure 1 a diagrammatic view in section of the microelectrovalve in the rest position.

Figure 2 a perspective view of the control slide.

Figure 3 a perspective view of the rocker.

Figure 4 a diagrammatic view in section of the micro-electrovalve in the working position.

The microelectrovalve shown in the drawings has the general shape of a rectangular casing made of plastic material which constitutes the valve body 1. Through it, along its longitudinal axis AA' passes a well 2 of cylindrical shape within which is placed a control slide 3 also evident in Figure 2. One cylindrical end 4 of the slide slides in the valve body and is flush with a non-closed outlet aperture of the well 2. The opposite end 5 of the slide is also flush with the other outlet aperture of the well 2 closed moreover by a connecting part 6 screwed to the valve body and which serves as a support to the coil of an electromagnet (not shown). The movable core 7 of this electromagnet passes through the connecting part and terminates with a core head forming a coupling pin 8 which is placed in an indentation 9 provided on the end 5 of the slide 3. A spring 10 is additionally inserted between a step 11 provided on the slide 3 close to the indentation 9, and a sleeve 22 for guiding the core 7 interposed between the part 6 and the valve body 1. The central part of the slide 3 between its cylindrical end 4 and another cylindrical part 15 close to the step 11, which both slide in the well 2, comprises an opening 12 which passes through this central part of

the slide over its entire thickness and which is parallel with the axis AA'. The central part between the two cylindrical ends 4 and 5 is also cut along a plane perpendicular to the plane of the opening 12, so as to form a flat part 13 between the axis AA' and a generating line of the slide. Lastly, transversely to this flat part and at its centre are provided two slots 14.

A lateral face of the valve body 1 is additionally provided with a cylindrical opening closed by a side plate 16. Between the side plate and the edges of the opening of the valve body is gripped a leaktight membrane 23 which delimits with the said side plate a chamber of small volume 17. Through the side plate 16 pass three small fluid supply or outlet pipes 18, 19 and 20. Each of these small pipes opens into the said chamber 17. Two pipes 18 and 19 open onto the chamber 17 inside a ring forming a relief on the bottom of the side plate. The third pipe 20 opens directly onto the bottom of the side plate. Figure 1 shows that the side plate 16 has a very special dished profile the central part of which, of conical profile, receives a ball 21, interposed at the centre of the membrane.

According to a variant embodiment not shown the ball may be integral with the side plate 16 and obtained directly by moulding of the latter, and optionally the pipes 18, 19 and 20 as well.

For this purpose, the membrane 23 is pierced by a small central aperture. Between the membrane 23 and the flat part 13 of the slide 3, a free space is left in the well 2, which serves as a housing for a rocker 24. The rocker 24 also shown in Figure 3 has the general shape of a top the conical lower face 25 of which is bonded onto the upper face of the membrane 23. The membrane therefore presents a profile similar to this face 25 and depending on the orientation of the latter, is deformed as will become apparent later. This face 25 has a central compartment permitting the positioning of the rocker on the ball. The said rocker also comprises, on the side opposite to its conical face 25, a cross-piece 26 which

comes to be set in the slots 14. Above this cross-piece, a shank 27 of the rocker fits into the opening 12 provided on the slide and terminates with a peg 28.

5 According to variant embodiments not shown, the membrane and the rocker may be constructed in a single piece produced by moulding.

10 Figure 1 shows that a spring 29 bears against the shank 27, and extends into the opening 12 of the slide 3 as far as an adjustable stop 30 located in a tapped aperture 31 provided on a lateral face of the valve body 1, opposite to the chamber 17. The cross-piece 26 set with a slight clearance inside the slots 14 enables the rocker to adopt a certain inclination with respect to a plane perpendicular to the axis AA', depending on the position of the slide 3. The spring 29 therefore exerts a pressure on the end of the shank 27, inclined with respect to this plane, and in a way locks the rocker 24 in its position. Instead of the spring, a resilient plate could also be used performing the same function.

20 The electrovalve shown functions in the following manner:

25 In the rest position shown in Figure 1, the electromagnet is not energised and under the action of the spring 10, the slide 3 is kept displaced to the right, its end 4 being flush with the opening of the well 2. The rocker 24 is inclined to the right so that the membrane 23 closes off the pipe 19 but frees the pipe 18. The fluid admitted into the chamber 17 via the pipe 20 passes freely towards the pipe 18. The bearing pressure exerted by the spring 29 on the shank 28 [sic] is passed onto the face 25 of the rocker in the direction of the pipe 19, the membrane being compressed onto the ring of said pipe so as to maintain an excellent leaktightness. As soon as the electromagnet is energised, the core 7 exerts a traction on the end 5 of the slide 3 through the intermediary of its coupling head 8, against the force of the spring 10. The slide 3 then moves so as to occupy the position shown in Figure 4. In the course of this movement the edges of the slots 14 have attacked the edge of

the cross-piece 26 and produced the pivoting of the rocker 24. The peg 28 of the end 27 of the said rocker has moved inside the spring 29 which itself has rocked to the left. As soon as the rocker has passed an intermediate position along a plane perpendicular to the axis AA', the spring 29 has accentuated this rocking movement, rendered possible by the clearance subsisting between the slots 14 and the cross-piece 26. The membrane 23 has thereby rapidly been deformed following the inclination of the rocker; it then disengages itself from the pipe 19 and flattens itself onto the pipe 18. Fluid communication is then established between the pipe 20 and the pipe 19. As the membrane can be compressed onto its seating in this manner, there is no risk of poor closure due to impurities. The switching is rapid and sharp because of the rocker 24, which passes from the first position of equilibrium shown in Figure 1 to the second position of equilibrium shown in Figure 4, each corresponding to one of the two possible positions of the membrane.

As soon as the energising of the electromagnet ceases, the spring 10 pushes the slide 3 back into the original position of Figure 1. There is automatic locking of switching in this position. It will be noted that the user can also act himself in order to actuate the slide by pressing on the end 4 which is flush with one side of the electrovalve, that is to say that the valve remains usable manually in case of failure of the electromagnet.

Since the chamber 17 between the membrane 23 and the side plate 16 is of small size, the dead volume of fluid is not very large, which facilitates flushing. Furthermore the single membrane performs not only the function of a valve for closure on its seating but also ensures perfect leaktightness with the external medium and with the internal well 2 in which slides the slide 3. This leaktightness is ensured equally for liquids under pressure and for gaseous fluids at high or low pressure, or even under vacuum. The overall dimensions of the valve body 1 are reduced without thereby reducing the cross-section for passage of the fluid through the

pipes 18, 19 and 20.

On account of the clearance existing between the slide 3 and the rocker 24, in the region of the slots 14, there is no rigidity between the control of the electro-magnet and the closure system, and therefore no risk of maladjustment. Furthermore, the force of closure of the membrane onto one or other of the seatings is adjustable by means of the stop 30 independently of the attraction force of the electromagnet. Because the rocker 24 is attacked by the slots of the slide 3 at a high level with respect to its pivot point constituted by the ball 21, the lever arm is such that the attraction force of the core 7 and consequently the power of the electromagnet, may be weak whereas the closure force of the membrane is strong.

Moreover owing to this particular assembly arrangement, the replacement of the switching system and of the membrane is possible from the outside without necessarily having to remove the valve from the equipment in which it is used.

As a result of these advantages, these switching microvalves may be mounted and banked in a restricted space, the pipes disposed on the same side facilitating their installation. They are advantageously constructed in materials capable of withstanding aggressive fluids and find a preferred application in medical analysis equipment as well as in food and other industries.

In particular according to one embodiment (not shown), the slide 3 could be replaced by a mechanism for example of the spring type which is adapted to ensure the movement of the rocker in a similar manner.

CLAIMS

1. Switching microelectrovalve having at least two ways, comprising a valve body (1) in a compartment of which terminate fluid inlet and outlet pipes (18, 19, 20), and a movable member (23, 24) constituted by a single deformable membrane performing the function of closing device of one or other of these pipes, said member being actuated by the core (7) of an electromagnet, characterised by the fact that a rocker (24) pivoting about a pivot point (21) disposed at the centre of the single membrane (23) applies said membrane, by means of a spring (29), either against one pipe (18), or against the other pipe (19), and by the fact that it is displaced from the one to the other of its only two positions of equilibrium corresponding to the two closure positions of the membrane by a control slide (3) sliding under the action of the core (7) of the electromagnet, said slide being placed in a well (2) passing through the valve body (1) along its longitudinal axis AA', one of its ends (4) being flush with a non-closed outlet aperture of said well (2).

2. Microelectrovalve according to Claim 1, characterised in that the other outlet aperture of the well (2) in the direction of the core (7) is closed by a connecting part (5) [sic] enclosing a sleeve (22) for guiding of the core.

3. Microelectrovalve according to Claim 1, characterised in that the end (5) of the control slide (3), in the direction of the core (7) bears an indentation (9) receiving the coupling pin (8) of said core.

4. Microelectrovalve according to Claims 1 and 2, characterised in that in the direction of the core (7) a spring (10) is inserted between a step (11) provided on the slide (3) and the sleeve (22).

5. Microelectrovalve according to Claim 1, characterised in that the central part of the slide (3) comprises an opening (12) which passes through it over its entire thickness parallel with the axis AA'.



6. Microelectrovalve according to Claim 5, characterised in that the central part of the slide (3) is cut along a plane perpendicular to the plane of the opening (12) so as to form a flat part (13) between the axis AA' and a generating line of the slide.

7. Microelectrovalve according to Claim 6, characterised in that two slots (14) are provided transversely to the flat part (13) and at its centre.

8. Microelectrovalve according to Claim 1, comprising a profiled side plate which closes a cylindrical opening provided on a lateral face of the valve body and through which pass the three small fluid supply or outlet pipes (18, 19, 20), characterised in that the side plate (16) has a dished profile the central part of which, of conical profile, receives a ball (21).

9. Microelectrovalve according to Claims 1, 5 and 8, characterised in that the rocker (24) has the general shape of a top, the lower conical face (25) of which bears against the upper face of the membrane (23) under the action of the spring (29) and pivots on the ball (21), and the upper part of which comprises a shank (27) which fits into the opening (12) provided on the slide (3).

10. Microelectrovalve according to Claim 9, characterised in that the conical face (25) of the rocker (24) is bonded onto the upper face of the membrane (23).

11. Microelectrovalve according to Claim 9, characterised in that the conical face (25) of the rocker (24) has a central compartment permitting the positioning of the rocker on the ball.

12. Microelectrovalve according to Claims 7 and 9, characterised in that the rocker (24) comprises on the side opposite to its conical face (25), a cross-piece (26) intended to be set in the slots (14) of the slide (3).

13. Microelectrovalve according to Claim 9, characterised in that the spring (29) passes through the opening (12) and bears against an adjustable stop (30) provided on another lateral face of the valve body (1).

