

This invention relates to a switching micro-solenoid valve intended for all fluids, particularly for aggressive liquids of those containing impurities. More precisely, the invention relates to a micro-solenoid valve comprising a rocker and a single diaphragm.

Known micro-valves exist which employ two flexible diaphragms made of plastic material and capable of deforming under the action of the core of an electromagnet in order to close certain apertures and open others. However, these may have disadvantages arising from the difficulty of controlling them due to the multiplicity of components employed. A micro-solenoid valve intended to obviate these disadvantages is known from EP-A-277 055 (FR-A-2609518). The said switching micro-solenoid valve, which has at least two ways, comprises a valve body having a compartment in which fluid inlet and outlet ducts terminate and a movable member acting as a closure member for one or the other of the said ducts and actuated by the core of an electromagnet. In the said micro-solenoid valve the movable member is a diaphragm having an oriented deformation, and is applied by means of a rocker on to one or the other of the ducts to be closed. The rocker is displaced from one to the other of its equilibrium positions corresponding to the two closure positions of the diaphragm by a control member which is displaced within the valve body under the action of the core of the electromagnet.

This control member advantageously comprises a control slide which slides within the valve body, and which is located within a well passing through the valve body along the longitudinal axis of the latter. One of its ends is flush with an outlet aperture of the said well which is not closed, and its central part comprises an aperture intended to receive a rod which is integral with the rocker. EP-A-277 055 (FR-A-2609518) describes a preferred embodiment, according to which the rocker is shaped as a top, one face of which is advantageously conical in shape and

bears on the corresponding face of the closure diaphragm under the action of a spring, in order to apply the said diaphragm on to one or more apertures whilst releasing one or more adjacent apertures. The diaphragm which is linked to the movement of the rocker in this manner must be able to swing on a pivot, and for this purpose a ball is provided which is located in a cup in the valve body so that it can be centred on the diaphragm.

In order to restrict the number of components with the object of further facilitating assembly, it was envisaged that the end-plate supporting the duct could be produced directly together with its ball by moulding, and that the diaphragm and its rocker could also be produced in one piece.

The progress of the researches carried out with this object by the applicant led the latter to fashion a solenoid valve according to EP-A-277 055 (FR-A-2609518) but which constitutes an improvement of the latter valve as regards miniaturisation, simplicity of manufacture and reliability of operation.

Accordingly, the present invention relates to a switching micro-solenoid valve having at least two ways, comprising a valve body having a compartment in which fluid inlet and outlet ducts terminate, and a single diaphragm, acting as a closure member for the said ducts and actuated by the core of an electromagnet via a rocker which applies the said diaphragm on to one or the other of the said ducts, the rod of the rocker which is perpendicular to the plane of the diaphragm being located in a recess of a control slide which is displaced within the valve body under the action of the core of the electromagnet.

According to the invention, the diaphragm is formed by an external flexible part which is slightly profiled and is oval in shape, and an elongated central part within which the rocker is embedded, a lower face of the rocker mating with the profile of the diaphragm, the diaphragm-rocker assembly being articulated about a spindle passing through an orifice of oblong cross-

section provided transversely in the rocker and bearing on wings integral with the valve body.

The recess of the movable slide is of a shallow depth which is less than the thickness of the slide and is radially oriented with respect to the axis of the valve body.

The diaphragm is advantageously pinched between the sides of an aperture provided in a side face of the valve body and a profiled end-plate which closes the said aperture, the said side face having an overall profile in the shape of a very flat V, two longitudinal flanges of which are also V-shaped and frame the aperture.

Other particular characteristics and advantages of the invention will be apparent from the text of the following description of an embodiment and with reference to the accompanying drawings, where:

- Figure 1 is a schematic sectional view of the micro-solenoid valve;
- Figure 2 is a sectional view of the valve body;
- Figure 3 is a plan view of the lower face of the valve body;
- Figure 4 is a sectional view on a larger scale of the end-plate mounted on the valve body;
- Figure 5 is a plan view on a larger scale of the upper face of the end-plate shown in Figure 4; and
- Figures 6 and 7 are plan views and sectional views of the diaphragm with its rocker.

The micro-solenoid valve illustrated in the drawings has the overall shape of a rectangular box made of plastic material, which forms the valve body 1. It is bored out along its longitudinal axis AA' to form a well 2 of cylindrical shape, inside which a control slide 3 is located. One cylindrical end 4 of the slide, which slides in the well 2, can be flush with the outlet aperture thereof. A chamber 6 is disposed between the base of the well and the other end of the slide 3. This chamber 6 communicates with the exterior of the valve body via an aperture which houses the movable core 7 of an electromagnet, which is not shown. This core ends in a core head forming a catch for engaging a profiled jaw 5 provided at the end of the slide 3. In addition, a spring 10 is interposed between the base of the chamber 6 and the slide. The slide has a recess 12, which is of shallow depth less than the thickness of the slide and is radially oriented with respect to the axis AA'.

In addition, a side face 34 of the valve body 1 having an overall profile in the shape of a very flat V is bored to form an oblong aperture 32 at right angles to the aperture 12 of the slide. As may be seen more precisely in Figures 2 and 3, this oblong aperture 32 is itself centred in a cup 33 having a generally oval shape and hollowed out by moulding in the said side face 34 of the valve body 1. The cup 33 and the aperture 32 are centred on the tip of the V. Accordingly, two V-shaped longitudinal flanges are disposed on parts of the longitudinal edges of the hollow cup 33; these flanges overhang and frame the hollow cup 33 and the aperture 32 along its longitudinal edge. The edges of the cup 33 are profiled so as to form a seat for the fluid-tight diaphragm 23 which is pinched between the valve body 1 and a closure end-plate 16 which is screwed on to the latter. The diaphragm and the closure end-plate delimit a chamber 17 having a small volume. Three small fluid supply or discharge ducts 18, 19 and 20 pass through the end-plate 16. Each of these ducts leads into the said chamber 17. Two ducts 18 and 19 terminate in the chamber 17 inside a collar forming a relief on the base of the end-plate. The third duct 20 leads directly into the base

of the end-plate. The shape and the profile of the end-plate 16 are more clearly apparent from Figures 4 and 5. There is shown an upper face 40 having a V-shaped profile which corresponds to the face 34 of the valve body. The three ducts 18, 19 20 lead into the base of an oblong hollow cup 41 which can also accommodate the diaphragm 23. In addition, side ribs 42 are provided on two side faces of the end-plate 16 on opposite sides of the hollow cup 33, the purpose of which ribs is to cooperate with corresponding recesses in the side face 34 of the valve body. This is to ensure perfect positioning of the end-plate on the said valve body and to maintain the spindle 21 in place axially.

The diaphragm 23 has a particular configuration which is more apparent from Figures 6 and 7. It is formed from an external flexible part 36 which is very pliable, slightly profiled in the form of a V in an identical manner to the profile of the valve body, and is oval in shape and of a size which corresponds to that of the cup 33, and from an elongated central part 37 within which a rocker 24 is embedded. A lower face 25 of the rocker mates with the profile of the diaphragm, and the upper part 27 of the rocker in the form of a rod perpendicular to the plane of the diaphragm is engaged through the aperture 32 and penetrates the recess 12 of the slide 3. The rocker 24 is bored to form a transverse aperture 38. This orifice is oblong to prevent displacement of the diaphragm. When the diaphragm 23 is pinched between the valve body 1 and the end-plate 16, the aperture 38 is aligned with apertures 39 provided in the V-shaped vertex of the longitudinal flanges of the valve body which form lateral wings 35 overhanging the hollow up 33. A spindle 21 passing through the two apertures 39 and the aperture 38 in the rocker ensures the positioning of the diaphragm and constitutes its pivoting axis. It will be noted that the axis is located on the side of the diaphragm which is not in contact with the liquid.

As shown in Figure 1, the rod 27 of the rocker is in a slightly inclined position inside the recess 12 and is thus maintained in

abutment with the edge of the recess. This inclination results in a corresponding inclination of the diaphragm 23, the pliable part 37 of which is then applied against the aperture of the duct 19 which it is closing off, whereas the duct 18 communicates freely with the chamber 17. This position is the rest position of the solenoid valve, in which the electromagnet is not energised. Under the action of the spring 10 the slide 3 is maintained in its position displaced to the right, as illustrated, with its end 4 flush with the aperture of the well 2. The fluid admitted to the chamber 17 via the duct 20 can therefore flow freely towards the duct 18.

When the electromagnet is energised the core 7 exerts a pull on the end 5 of the slide 3 via its engagement head 8, in opposition to the force of the spring 10. The slide 3 then moves to the left from the position shown in Figure 1. During this movement the edge of the recess 12 contacts the edge of the rod 27 and causes the rocker 24 to pivot. By pivoting about its axis 21 the diaphragm 23 then becomes inclined in a position which is the reverse of its previous position, and in which it is disengaged from the duct 19 in order to become seated against the duct 18. Communication of fluid is thus established between the duct 20 and the duct 19. Due to the raised position of the ends of ducts 19 and 20 with respect to the base of the cup, the portion 37 of the diaphragm 23 can be squashed on its seat, thus preventing inadequate closure due to contaminants.

When energisation of the electromagnet ceases, the spring 10 pushes the slide 3 back to its original position as shown in Figure 1, and the pressure of the spring ensures that it is locked in this position. It will be noted that the user may also operate the slide himself by pushing on the end 4 which is flush with one side of the solenoid valve, i.e. the valve can still be operated manually in the event of failure of the electromagnet.

Since the chamber 17 between the diaphragm 23 and the end-plate 16 is of small size, the dead volume of fluid is small, which

makes flushing easy. Moreover, the single diaphragm not only acts as a shut-off valve on its seat, but also ensures a perfect seal in relation to the external environment ~~and the internal~~ well 2 in which the slide 3 moves. This seal is provided just as reliably for liquids under pressure as for gaseous fluids under high or low pressure. The overall bulk of the valve body 1 is reduced without reducing the flow cross-section of the fluid through ducts 18, 19 and 20.

This switching micro-solenoid valve may be mounted and fixed as part of a bank of such switches in a restricted space, the ducts disposed on the same side facilitating installation. The micro-valves are advantageously constructed of materials which are capable of withstanding aggressive fluids, preferred applications being in equipment used for medical analyses, and also in the food industry and others.



Claims:

1. A switching micro solenoid valve having at least two ways, comprising a valve body (1) having a compartment in which fluid inlet and outlet ducts (18, 19, 20) terminate, and a single diaphragm (23), acting as a closure member for the said ducts (18, 19, 20) and actuated by the core (7) of an electromagnet via a rocker (24) which applies the said diaphragm on to one or the other of the said ducts, the rod (27) of the rocker (24) which is perpendicular to the plane of the diaphragm (23) being located in a recess (12) of a control slide (3) which is displaced within the valve body (1) under the action of the core (7) of the electromagnet, the diaphragm (23) being formed by an external flexible part (36) which has a profile in the form of a shallow V and is oval in shape, and an elongated central part (37) within which the rocker (24) is embedded, a lower face (25) of the rocker mating with the profile of the diaphragm, and the diaphragm-rocker (23, 24) assembly being articulated about a spindle (21) passing through an orifice (38) of oblong cross-section provided transversely in the rocker (24) and bearing on wings (35) integral with the valve body (1).

2. A micro-solenoid valve according to claim 1, characterised in that the recess (12) of the slide (3) is of a shallow depth less than the thickness of the slide (3) and is radially oriented with respect to the axis AA' of the valve body (1).

3. A micro-solenoid valve according to claim 1, characterised in that the diaphragm (23) is pinched between the sides of an aperture (32) provided in a side face (34) of the valve body and a profiled end-plate (16) which closes the said aperture, the said side face (34) has an overall profile in the shape of a very flat V, two longitudinal flanges (wings 35) of which are also V-shaped and frame the aperture (32).



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4. A micro-solenoid valve according to claim 3, characterised in that the aperture (32) is centred in a cup (33) having a generally oval shape and hollowed out by moulding-in the side face (34) of the valve body (1), the said cup acting as a seat for the fluid-tight diaphragm (23).

5. A micro-solenoid valve according to claim 3, characterised in that side ribs (42) are provided on two side faces of the end-plate (16) to cooperate with corresponding recesses in the side face (34) of the valve body.