

Description

The present invention relates to a valve having a first wafer machined to define a movable valve body, at least a second wafer mounted on said first wafer to define a valve seat facing the front of the valve body and a valve position detector. In this type of valve, the body of the valve is formed by machining a silicon plate by such micromachining techniques as photolithographic technology or similar technologies. The invention also relates to a micropump incorporating such a valve.

The document FR-A-2 639 085 discloses a valve of an electrostatic type according to the preamble of claim 1 which is not associated with a micropump. The valve functions upon electrical actuation of a driving means comprising driving electrodes for closing the valve by electrostatic attraction when voltage is applied to the electrodes. The valve opens elastically when the voltage is released. The valve comprises a further control electrode placed laterally and cooperating capacitively with one of the driving electrodes in order to detect the valve position. In this valve the electrodes are in contact with the fluid or liquid path.

Micropumps incorporating valves may be used notably for the in situ administration of medications, the miniaturization of the micropump optionally permitting the permanent implantation thereof into the body. These pumps enable a precise dosage of small quantities of fluids to be injected.

These micropumps, according to the preamble of claim 11, are in particular described in the article "A piezoelectric micropump based on micromachining of silicon" by H. van Lintel et al. which appeared in "Sensors and Actuators", No. 15, 1988, pages 153-167. These pumps essentially comprise a stack of three wafers, i.e. a silicon wafer is disposed between two glass wafers.

The silicon wafer is etched in order to form a cavity which together with one of the glass wafers defines a pump chamber, an inlet valve and an outlet valve, communicating the pump chamber respectively with an inlet channel and an outlet channel, and a regulating valve. A control element, e.g. a piezoelectric disc, is provided on one wall of the chamber. This piezoelectric disc may be deformed when it is subjected to an electrical voltage which causes deformation of the wall of the pump chamber and hence variation in the volume thereof.

The micropump functions as follows. At rest the inlet and outlet valves are in the closed position. When an electrical voltage is applied the wall of the pump chamber deforms and the pressure increases therein until the outlet valve opens. The fluid contained in the pump chamber is then driven towards the outlet channel. During this phase the inlet valve is held closed by the pressure prevailing

in the pump chamber. When, however, the electrical potential is removed or reversed, the pressure therein diminishes. This causes closure of the outlet valve and opening of the entry valve. Fluid is thereby drawn into the pump chamber.

As already indicated above, these micropumps are useful especially for the administration of medications. It is therefore important to be able to monitor the correct functioning of these micropumps. Moreover in some cases the pump flow rate may drop considerably, e.g. when bubbles of air are present in the pump chamber, or when the pressure in the exit channel becomes too high.

Obviously, such malfunctioning should be detected. It has been noted that the movement of a valve might be used for such a purpose. Therefore, an object of the present invention is to provide a valve having a position detector which is, in addition, simple, viable and inexpensive, which gives very precise results even by a small malfunctioning of the valve, and in which the liquid is not in contact with the electrodes.

In order to reach these objectives the valve according to the present invention is characterized in that said valve position detector has a first electrical contact facing the back of the valve body at such a distance that there is a mechanical contact between the valve body and said first electrical contact when the valve is in the open position and said mechanical contact is absent when said valve is in the closed position, a second electrical contact disposed such that it forms an electrical impedance with said first electrical contact, which impedance is influenced by said mechanical contact, and a detection circuit sensitive to the electrical impedance between said electrical contacts, the valve being adapted for use in a micropump for providing an output signal of the detection circuit representative of a duration of said mechanical contact capable of indicating a malfunction of the valve and/or of the micropump.

The mechanical contact between the valve body and the first electrical contact thus ensures the largest possible electrical impedance difference between the open and closed positions of the valve, in which the electrodes are completely separated from the liquid path.

It is also an object of the invention to provide a micropump equipped with such a valve having a position detector.

The characteristic features and advantages of the invention are better illustrated by the following description given for purpose of example, but which is not limiting and with reference to the accompanying drawings in which :

- Figure 1 shows a schematic cross-section along the line I-I of a micropump having a valve according to the invention,

- Figure 2 is a top view along the line II-II of the intermediate wafer of the micropump shown in Figure 1,
- Figures 3 and 4 show in section a valve according to a first embodiment of the invention, in the closed and open positions respectively,
- Figure 5 shows a schematic representation of a detection circuit suitable for use with a valve of Figures 3 and 4,
- Figures 6 and 7 show in section a valve according to a second embodiment of the invention, in the closed and open positions respectively,
- Figure 8 is a schematic representation of a detection circuit suitable for use with the valve of Figures 6 and 7,
- Figure 9a shows in section a valve according to a third embodiment of the invention, and Figure 9b is a top view along line IX-IX of Figure 9a, and
- Figure 10 shows in section a valve according to a fourth embodiment of the invention.

Reference is made first of all to Figures 1 and 2 which show a micropump having a valve according to the invention.

It should be noted that for the sake of clarity the thicknesses of the various wafers in the micropumps have been greatly exaggerated in the drawings.

This micropump has a base wafer 2 of for example glass which is pierced by two channels 4 and 6 which constitute the inlet and outlet channels respectively of the pump. These channels communicate respectively with the connectors 8 and 10.

The connector 8 leads to a tube 12 which is itself joined to a reservoir 14 containing the liquid substance to be pumped. The reservoir is sealed by a pierced cap and a movable piston 16 isolating the useful volume of the reservoir 14 from the exterior. This reservoir may contain a medicament, for example in the situation where the pump is to be used to inject a precise dosage of this medicament into the human body. In this application the micropump may be carried on the patient's body or may be implanted.

The outlet connector 10 may be connected to an injection needle (not shown) which is connected thereto by a tube 18. The use in this manner of the micropump is particularly suitable for treating certain forms of cancer with peptides, where medication is preferably given in a precise dosage at regular intervals in small amounts. Another possible application is the injection of insulin for the treatment of diabetics.

A wafer 20 of silicon or any other material capable of being etched by photolithographic technology is bonded to the glass wafer 2. This wafer

20 is machined so as to form an inlet valve 22, a pump chamber 24 and an outlet valve 26 (which forms the regulating valve). A glass sealing wafer 28 is bonded to the wafer 20 above the inlet valve 22, a piezoelectric disc 30 to the wall of the pump chamber 24 and a glass support 32 above the outlet valve.

The inlet valve 22 comprises a membrane 34 of substantially circular form with near its center an orifice 36 and, adjacent to the side of an inlet channel 4, an annular sealing ring 38. This latter is covered with a thin oxide layer which confers on the membrane 36 a certain preconstraint tending to press the sealing ring towards the glass wafer 2, this latter thereby serving as the valve seat 22. When this valve is open, the inlet channel 4 is in communication with the pump chamber 24 by the orifice 36 and another orifice 40.

The outlet valve 26 also has a membrane 42 of generally circular form which is without any orifice therein and an annular sealing ring 44 which, as is the case with the inlet valve, is covered with a thin oxide layer. Opening this outlet valve enables direct communication between the pumping chamber 24 and the outlet channel 6.

Finally, it should be noted that the piezoelectric disc which brings about the variations in volume of the pump chamber, is connected by two electrical conductors 46 and 48 through electrodes (not shown) situated on the faces of the piezoelectric disc to a voltage source 50.

In accordance with the invention the outlet valve 26 is equipped with a position detector. The projection 56 shown on the reverse face (i.e. the side that, in this embodiment, is not in contact with the fluid to be pumped) of the valve as well as the support 32 form part of this detector. Two special embodiments of the detector will now be described.

A first embodiment in which the detector is of the capacity type is shown in Figures 3 to 5.

Notice that for good shape control, the effective lateral membrane dimensions are defined by the shallow etching from the front of the valve. Also, here the valve has thermal oxide on the membrane as well. This provides sufficient pre-tension with thin membranes. With thin membranes, the deflection can be large.

The support 32, which may for example be of glass, may have a groove 52 on its face bonded to the wafer 20. An electrode 54 for example of Au, Al or of Indium-Tin Oxide (ITO) is formed on the support 32. The distance between the electrode 54 and the upper part of the back face of the valve 26, that is to say the surface of the projection 56, is such that there is a mechanical contact between the valve body and the electrode 54 when the valve is in the open position. In order to reduce

parasitic capacitance between the electrode 54 and the silicon wafer 20 one may increase the distance between them by also forming a groove 55 in the wafer 20. The upper surface of the projection 56 may be insulated, for example using a thin oxide layer (in the order of 1 μm thickness).

Thus, when the valve 26 is closed (Figure 3) the distance between the valve and the electrode 54 (the detector gap 53) is of the order of 5 μm , whereas when the valve 26 is open (figure 4) the valve and the electrode are in contact with each other.

The schematic circuit shown in Figure 5 shows the position of the valve. It comprises a resistor 58 connected on the one hand to an alternating current source and on the other hand to an electrode 54; a transistor 60 of which the collector is connected to a source of direct current at 3 V and the base to the electrode 54; and a resistor 62 placed between the transmitter of the transistor 60 and ground. The valve 26 acts as switch 64, which according to the device used, may be either of a resistive and/or capacitive nature. The silicon plate 20 is directly connected to the apparatus or, as shown, by way of a conductor 46 of the control circuit of the piezoelectric disc; in this case, the capacitor 66 represents the capacity therebetween.

In this embodiment, the conductor 46 forming one of the electrical contacts is connected to the wafer 20. It could equally well only be connected electrically thereto, for example to form an air capacitor.

A high-frequency signal, for example of 30 KHz (so that the detection signal is sufficiently modulated as a function of the position of the valve, taking into account the impedances of the components and to avoid interference with the control signal of the piezoelectric disc) is applied to the electrode 54 by way of the resistor 58. The signal detected by the transmitter of the transistor 60 is a function of the open or closed position of the valve.

The duration of the signal also enables distinction to be made between malfunctioning due to the presence of an air bubble in the pump chamber, which could result in incomplete opening, but also a rapid reclosing of the valve after it had been opened by a signal applied to the piezoelectric disc, and malfunctioning due to elevated pressure in the outlet channel of the micropump resulting in prolonged opening of the valve.

The pump may also be constructed or operated in such a way that during normal pumping the valve does not reach the open position, but only when the pressure on the outlet is too high. In such a case, one takes full advantage of the invention only for detecting a too high outlet pressure or blockage.

A circuit of the passive detection type may also be employed in certain cases. When a control signal is applied to the piezoelectric disc (ca. 130 V DC signal) a short interference signal appears on the transmitter of the transistor 60 when the valve is in the open position (Figure 4). However, this signal is less reproducible. To eliminate this signal, one may add a small capacitor in series with the detection line.

A second embodiment in which the position detector is of the resistor type is shown in Figures 6 to 8.

Figures 6 and 7 are identical to Figures 4 and 5 except that a supplementary electrode 68 is provided on the back face of the valve 26 opposite the electrode 54. This electrode may for example be of Au, Al or Indium-Tin Oxide, and it is connected to a conductor 70 of the same material which is accommodated in groove 52.

A detection circuit is shown schematically in Figure 8. It comprises a resistor 72 placed between the electrode 54 and a voltage source, for example alternating voltage at 30 kHz. The presence or absence of an alternating voltage on the conductor 54 indicates the open or closed position of the valve. As with the circuit of Figure 5, detection of the closing of the circuit and measurement of the duration of this closing gives information on the presence and nature of malfunctioning of the micropump.

In the embodiment of Figures 6 and 7, one of the electrodes is provided on the back face of the valve. There is a way to avoid an independent forming or deposition of the electrodes; one may simply provide both electrodes on support 32, spaced apart one from the other in such a way that they are both in contact with the valve when the latter is in the open position. Such a structure is shown on Figure 9a, on which same elements as the ones of Figures 6 and 7 bear the same reference numerals. The electrodes 54 and 74 may have a semi-disc shape, as shown on Figure 9b; the electrical connections are made through grooves (like groove 52 in figures 3 and 6) or through electroplated through holes 76, 78 in support 32.

The detection of the open position of the valve, i.e. when the valve is in contact with the electrodes may be of resistive type or capacitive type. In the latter case, the contact is less critical and has the advantage of a strongly reduced by-pass current through the liquid, compared to the first embodiment.

The micropumps according to the invention are intended to be used notably for the injection of medicaments. Such micropumps require therefore a precise control of the opening and of the closing of the valves. However, while it is relatively easy to

control the depth of the etching of the silicon wafer, it is more difficult to control the thickness of the membrane of the valves since the thickness of a silicon wafer is not constant over its whole surface, but on the contrary shows certain variations. The thickness of the membrane governs the amount of pre-tension and hence ultimately the parameters for the opening and the closing of the valves. This is particularly important in the case of the outlet valve which requires a greater pre-tension.

The degree of this pre-tension depends notably on the pre-tension due to the thickness of the oxide layer on the sealing ring. This pre-tension corresponds to the third power of membrane thickness. It is added to the pre-tension which is caused by, for example, an oxide layer on the membrane and which also depends on the membrane thickness, but there only to the first power. In this conventional case, a too thick a membrane will cause an increase in both the pre-tension due to the oxide on the sealing ring, and in the pre-tension due to the oxide on the membrane. The variation of the overall pre-tension is the sum of both pre-tension variations. The pre-tension caused by the oxide on the sealing ring can play an important role in this variation, due to the third order variation.

Figure 10 shows a fourth embodiment of the invention in which the pre-tension is less dependant on the membrane thickness, and in which an additional etching step to obtain this is used to provide all or part of the detector gap 53. By way of example, the detector is of capacitive type, as in the embodiment of Figures 3 to 5, with the electrode 54 on support 32 being connected to the detector circuit via an electroplated through hole 76 provided in support 32. In this embodiment there has been etching of the sealing ring in a additional etching step (during which the membrane may also been etched, and in this case has been etched and that on both sides) and the oxide layer on it is less thick than the depth of the etching, so that the effective thickness of the sealing ring is less than its nominal thickness. Thus if there is oxide on the sealing ring only, and not on the membrane, the sealing ring will not come into contact with the valve seat. In the same way as in the conventional case, it is clear that the sealing ring creates a pre-tension, now a negative one, whose absolute value is equal to the pressure which would have been exerted on the membrane for the sealing ring to be flush with the valve seat. But in this case an oxide layer is also formed on the membrane (oxide layer can be provided on one side of the membrane or, as shown in Figure 10, on both sides), the pre-tension to which the valve is subjected will be equal to the pre-tension caused by the curvature of the membrane diminished by this negative pre-tension. In this situation, the variation in the mem-

brane oxide pre-tension is approximatively compensated by the variation in the negative sealing ring gap pre-tension.

The dimensions are chosen so that the overall pre-tension remains substantially constant for a certain range of membrane thicknesses. Moreover, the dimensions may be chosen such as to match the required detector gap with the additional etching in order to obtain the required gap with the same additional etching step. In this example, the projection 56 is thereto etched as well, simultaneously.

Simulations have shown that micropumps equipped with an outlet valve according to the embodiment of Figure 10 show substantially the same pre-tension and thus nearly the same behaviour despite differences of $\pm 2.5 \mu\text{m}$ in the membrane thickness of the valves having a mean thickness of $25 \mu\text{m}$ (depth of sealing ring etching approximatively $4 \mu\text{m}$; oxide layer approximatively $1 \mu\text{m}$ thick).

The position detector according to the invention has the following properties :

- no mechanical calibration is necessary since the detector only has to distinguish between two values of the signal which correspond respectively to the open and closed positions (or incomplete opening) of the valve,
- insensitive to interference with exterior signals (for example a control signal for the piezoelectric disc),
- simple, inexpensive components and fabrication.

In relationship to the embodiments described above, it may be added that the position detector of the capacitive type (Figures 3 to 5) functions in a satisfactory manner even if there is not a good electrical contact between the valve and the electrode 54, whereas the electric circuits of the detector of the resistive type (Figures 6 to 8, and 9a, 9b) is particularly simple.

Claims

1. A valve having a first wafer (20) machined to define a movable valve body (26), at least a second wafer (2) mounted on said first wafer (20) to define a valve seat facing the front of the valve body (26) and a valve position detector characterized in that said valve position detector has a first electrical contact (54) facing the back of the valve body (26) at such a distance that there is a mechanical contact between the valve body (26) and said first electrical contact (54) when the valve is in the open position and said mechanical contact is absent when said valve is in the closed position, a second electrical contact (46;68;74) dis-



control the depth of the etching of the silicon wafer, it is more difficult to control the thickness of the membrane of the valves since the thickness of a silicon wafer is not constant over its whole surface, but on the contrary shows certain variations. The thickness of the membrane governs the amount of pre-tension and hence ultimately the parameters for the opening and the closing of the valves. This is particularly important in the case of the outlet valve which requires a greater pre-tension.

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brane oxide pre-tension is approximatively compensated by the variation in the negative sealing ring gap pre-tension.

The dimensions are chosen so that the overall pre-tension remains substantially constant for a certain range of membrane thicknesses. Moreover, the dimensions may be chosen such as to match the required detector gap with the additional etching in order to obtain the required gap with the same additional etching step. In this example, the projection 56 is thereto etched as well, simultaneously.

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- insensitive to interference with exterior signals (for example a control signal for the piezoelectric disc),
- simple, inexpensive components and fabrication.

In relationship to the embodiments described above, it may be added that the position detector of the capacitive type (Figures 3 to 5) functions in a satisfactory manner even if there is not a good electrical contact between the valve and the electrode 54, whereas the electric circuits of the detector of the resistive type (Figures 6 to 8, and 9a, 9b) is particularly simple.

Claims

1. A valve having a first wafer (20) machined to define a movable valve body (26), at least a second wafer (2) mounted on said first wafer (20) to define a valve seat facing the front of the valve body (26) and a valve position detector characterized in that said valve position detector has a first electrical contact (54) facing the back of the valve body (26) at such a distance that there is a mechanical contact between the valve body (26) and said first electrical contact (54) when the valve is in the open position and said mechanical contact is absent when said valve is in the closed position, a second electrical contact (46;68;74) dis-



- posed such that it forms an electrical impedance with said first electrical contact (54), which impedance is influenced by said mechanical contact, and a detection circuit sensitive to the electrical impedance between said electrical contacts, the valve being adapted for use in a micropump for providing an output signal of the detection circuit representative of a duration of said mechanical contact capable of indicating a malfunction of the valve and/or the micropump.
2. A valve according to claim 1, characterized in that a support (32) is mounted on said first wafer (20) facing the back face of the valve body (26), said support accommodating said first electrical contact (54).
 3. A valve according to claim 1 or claim 2, characterized in that the back face of the valve comprises a projection (56) opposite said first electrical contact.
 4. A valve according to any one of claims 1 to 3, characterized in that said second electrical contact (46) is fixed or connected to said first wafer (20).
 5. A valve according to claim 4, characterized in that the second electrical contact is a second electrode (68) placed opposite the first electrical contact (54), the detection circuit (72) being sensitive to the electrical resistance between said electrical contacts.
 6. A valve according to claim 4, in which said first wafer (20) is of a semiconductor material, characterized in that said second electrical contact (46) is connected to said first wafer and conductively insulated from said first electrical contact (54) and in that the detection circuit is sensitive to the electrical capacitance between said electrical contacts.
 7. A valve according to any one of claims 2 and 3, characterized in that said second electrical contact (74) is provided on said support (32), facing the back face of the valve body (26) and being electrically isolated from said first electrical contact (54).
 8. A valve according to any one of claims 1 to 7, characterized in that the detection circuit comprises an alternating current generator applying a high-frequency input signal to one of said electrical contacts.
 9. A valve according to any one of claims 1 to 8, having a membrane (42) and a sealing ring (44), at least the membrane being provided with a layer inducing a pre-tension keeping the valve in the closed position, in the absence of external influence, characterized in that at least the sealing ring (44) is so machined that, if the membrane layer would be omitted, the valve would be in the open position in the absence of external influence.
 10. A valve according to claim 9, in which a detector gap (53) is machined by etching of the valve body, characterized in that said machining is done simultaneously with, and at least partially by, said machining of the sealing ring (44).
 11. A micropump having a first wafer (20) machined so as to define with at least one second wafer (2) mounted face to face to a first wafer, a pump chamber (24), means for taking in a fluid in said pump chamber through an inlet (4) of the micropump, and an outlet valve (26) by means of which said pump chamber can selectively communicate with an outlet (6) of the micropump, means (30, 46, 48, 50) being provided to induce a periodic variation in the volume of said pump chamber, characterized in that the outlet valve (26) is as defined in any one of claims 1 to 10.

Patentansprüche

1. Ventil mit einem ersten Plättchen (20), das so bearbeitet wurde, dass es einen bewegbaren Ventilkörper (26) definiert, zumindest einem zweiten Plättchen (2), das auf dem ersten Plättchen (20) angebracht ist, um einen der Vorderseite des Ventilkörpers (26) zugekehrten Ventilsitz zu definieren, sowie einem Ventilstellungsdetektor, dadurch gekennzeichnet, dass der benannte Ventilstellungsdetektor einen ersten elektrischen Kontakt (54) hat, der der Rückseite des Ventilkörpers (26) in einem solchen Abstand zugekehrt ist, dass mechanische Berührung zwischen dem Ventilkörper (26) und dem benannten ersten elektrischen Kontakt (54) besteht, wenn das Ventil in der geöffneten Stellung ist, und dass die benannte mechanische Berührung nicht besteht, wenn das benannte Ventil in der geschlossenen Stellung ist; einen zweiten elektrischen Kontakt (46; 68; 74), der so angeordnet ist, dass er eine elektrische Impedanz mit dem benannten ersten elektrischen Kontakt (54) darstellt und diese Impedanz durch die benannte mechanische Berührung beeinflusst wird; sowie einen Detek-



- torkreis, der auf die elektrische Impedanz zwischen den benannten Kontakten anspricht, wobei das Ventil für seinen Einsatz in einer Mikropumpe geeignet ist, um ein Ausgangssignal des Detektorkreises zu liefern, das die Dauer der benannten Berührung darstellt und schlechtes Funktionieren des Ventils und/oder der Mikropumpe anzeigen kann.
2. Ventil gemäß Anspruch 1, dadurch gekennzeichnet, dass eine Abstützung (32) der Rückseite des Ventilkörpers (26) zugekehrt auf dem benannten ersten Plättchen (20) angebracht ist, wobei die benannte Abstützung den benannten ersten elektrischen Kontakt (54) aufnimmt. 5
 3. Ventil gemäß Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, dass die Rückseite des Ventils gegenüber dem benannten ersten elektrischen Kontakt einen Vorsprung (56) aufweist. 10
 4. Ventil gemäß jedem beliebigen der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass der benannte zweite elektrische Kontakt (46) an dem benannten ersten Plättchen (20) befestigt oder mit ihm verbunden ist. 15
 5. Ventil gemäß Anspruch 4, dadurch gekennzeichnet, dass der zweite elektrische Kontakt eine dem ersten elektrischen Kontakt (54) gegenüberliegend angeordnete zweite Elektrode (68) ist und der Detektorkreis (72) auf den elektrischen Widerstand zwischen den benannten elektrischen Kontakten anspricht. 20
 6. Ventil gemäß Anspruch 4, worin das benannte erste Plättchen (20) aus halbleitendem Material ist, dadurch gekennzeichnet, dass der benannte zweite elektrische Kontakt (46) mit dem benannten ersten Plättchen verbunden und von dem benannten ersten elektrischen Kontakt (54) galvanisch isoliert ist und dass der Detektorkreis auf die elektrische Kapazität zwischen den benannten elektrischen Kontakten anspricht. 25
 7. Ventil gemäß jedem beliebigen der Ansprüche 2 und 3, dadurch gekennzeichnet, dass der benannte zweite elektrische Kontakt (74) auf der benannten Abstützung (32) angeordnet, der Rückseite des Ventilkörpers (26) zugekehrt und von dem benannten ersten elektrischen Kontakt (54) isoliert ist. 30
 8. Ventil gemäß jedem beliebigen der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass der Detektorkreis einen Wechselstromgenerator einschliesst, der ein hochfrequentes Eingangssignal an einen der benannten elektrischen Kontakte anlegt. 35
 9. Ventil gemäß jedem beliebigen der Ansprüche 1 bis 8 mit einer Membran (42) und einem Dichtungsring (44), wobei zumindest die Membran mit einer Schicht versehen ist, die eine Vorspannung hervorruft, die in Abwesenheit äusserer Einflüsse das Ventil in der geschlossenen Stellung hält, dadurch gekennzeichnet, dass zumindest der Dichtungsring (44) so herausgearbeitet ist, dass in Abwesenheit äusserer Einflüsse das Ventil in der offenen Stellung wäre, sofern die Membranschicht weggelassen würde. 40
 10. Ventil gemäß Anspruch 9, worin eine Detektorlücke (53) durch Ätzen aus dem Ventilkörper herausgearbeitet ist, dadurch gekennzeichnet, dass die benannte Herausarbeitung gleichzeitig mit und zumindest teilweise durch die benannte Herausarbeitung des Dichtungsringes (44) erfolgt. 45
 11. Mikropumpe mit einem ersten Plättchen (20), das so bearbeitet wurde, dass es mit zumindest einem zweiten, flächig auf dem ersten Plättchen befestigten Plättchen (2) eine Pumpenkammer (24) definiert, mit Organen, um ein Fluid durch einen Einlass (4) der Mikropumpe in die benannte Pumpenkammer aufzunehmen, sowie mit einem Austrittsventil (26), vermittels dessen die benannte Pumpenkammer wahlweise mit einem Auslass (6) der Mikropumpe in Verbindung gebracht werden kann, wobei Organe (30, 46, 48, 50) vorgesehen sind, um eine periodische Veränderung des Volumens der Pumpenkammer hervorzurufen, dadurch gekennzeichnet, dass das Austrittsventil (26) wie in jedem beliebigen der Ansprüche 1 bis 10 definiert ist. 50
- Revendications** 55
1. Valve ayant une première plaquette (20) usinée pour délimiter un corps mobile de valve (26), au moins une seconde plaquette (2) montée sur ladite première plaquette (20) pour délimiter un siège de valve faisant face à l'avant du corps de valve (26) et un détecteur de position de valve, caractérisée en ce que ledit détecteur de position de valve a un premier contact électrique (54) faisant face à l'arrière du corps de valve (26) à une distance propre à assurer un contact mécanique entre le corps de valve (26) et ledit premier contact 5



- électrique (54) lorsque la valve est dans la position ouverte, ledit contact mécanique étant absent lorsque ladite valve est dans la position fermée, un second contact électrique (46;68;74) disposé de façon à ce qu'il forme une impédance électrique avec ledit premier contact électrique (54), laquelle impédance est influencée par ledit contact mécanique, et un circuit de détection sensible à l'impédance électrique entre lesdits contacts électriques, la valve étant prévue pour une utilisation avec une micropompe, pour fournir un signal de sortie du circuit de détection représentatif de la durée dudit contact mécanique, capable d'indiquer un mauvais fonctionnement de la valve et/ou de la micropompe.
2. Valve selon la revendication 1, caractérisée en ce qu'un support (32) est monté sur ladite première plaquette (20) faisant face à la face arrière du corps de valve (26), ledit support recevant ledit premier contact électrique (54). 20
 3. Valve selon la revendication 1 ou la revendication 2, caractérisée en ce que la face arrière de la valve comporte une saillie (56) opposée audit premier contact électrique. 25
 4. Valve selon l'une quelconque des revendications 1 à 3, caractérisée en ce que ledit second contact électrique (46) est fixé ou connecté à ladite première plaquette (20). 30
 5. Valve selon la revendication 4, caractérisée en ce que le second contact électrique est une seconde électrode (68) placée à l'opposé dudit premier contact électrique (54), le circuit de détection (72) étant sensible à la résistance électrique entre lesdits contacts électriques. 35
 6. Valve selon la revendication 4, dans laquelle ladite première plaquette (20) est en un matériau semi-conducteur, caractérisée en ce que ledit second contact électrique (46) est connecté à ladite première plaquette en étant isolé électriquement dudit second contact électrique (54) et en ce que le circuit de détection est sensible à la capacité électrique entre lesdits contacts électriques. 40
 7. Valve selon l'une quelconque des revendications 2 et 3, caractérisée en ce que ledit second contact électrique (74) est prévu sur ledit support (32) en face de la face arrière du corps de valve (26) en étant isolé électriquement dudit premier contact électrique (54). 45
 8. Valve selon l'une quelconque des revendications 1 à 7, caractérisée en ce que le circuit de détection comprend un générateur de courant alternatif appliquant un signal d'entrée à haute fréquence à un desdits contacts électriques. 50
 9. Valve selon l'une quelconque des revendications 1 à 8, ayant une membrane (42) et un joint d'étanchéité (44), la membrane au moins étant pourvue d'une couche de pré-tensionnement maintenant la valve en position fermée en absence d'influence externe, caractérisée en ce qu'au moins le joint d'étanchéité (44) est usiné de telle sorte que, si la couche de la membrane était omise, la valve serait en position ouverte en absence d'une influence externe. 55
 10. Valve selon la revendication 9, dans laquelle un détecteur d'espacement (53) est usiné par une attaque chimique du corps de valve, caractérisée en ce que ledit usinage est réalisé simultanément ou en partie simultanément avec ledit usinage du joint d'étanchéité (44).
 11. Micropompe ayant une première plaquette (20) usinée de manière à délimiter avec au moins une seconde plaquette (2) montée face à face avec la première plaquette, une chambre de pompe (24), un moyen pour faire entrer un fluide dans ladite chambre de pompe par une entrée (4) de la micropompe et une valve de sortie (26) grâce à laquelle ladite chambre de pompe peut communiquer sélectivement avec une sortie (6) de la micropompe, des moyens (30, 46, 48, 50) étant prévus pour induire une variation périodique dans le volume de ladite chambre de pompe, caractérisée en ce que la valve de sortie (26) est comme défini dans l'une quelconque des revendications 1 à 10.