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(54) **PDMS VALVE-LESS MICRO PUMP STRUCTURE AND METHOD FOR PRODUCING THE SAME**

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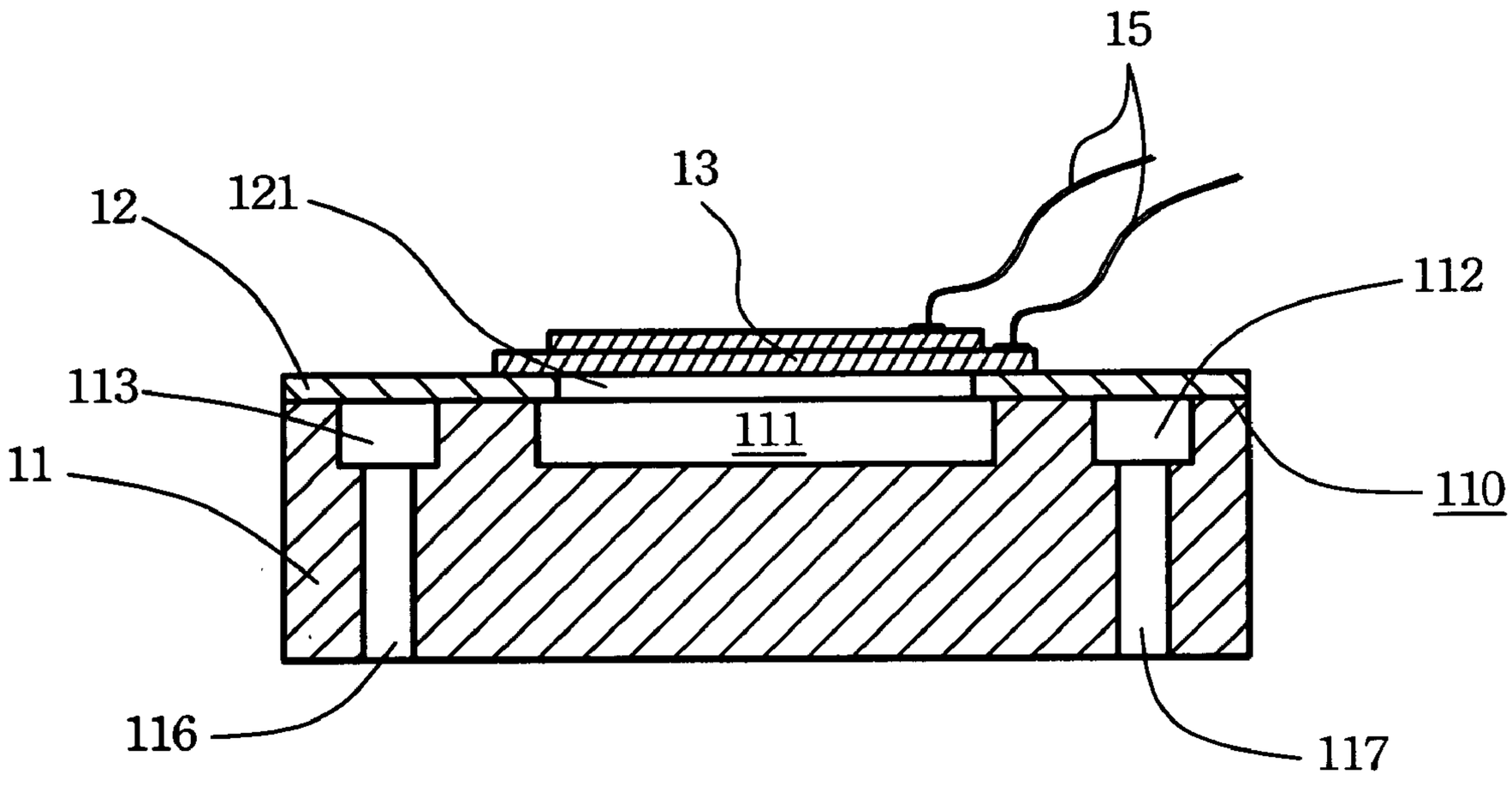
(57) **ABSTRACT**

A PDMS valve-less micro pump structure includes a PDMS body having a contour surface, a membrane covering the contour surface of the PDMS body, and a PZT actuator located on the membrane. The contour surface of the PDMS body to be sealed by the membrane and the PZT actuator has in series a lead-in cavity, a lead-in nozzle structure, a main cavity, a lead-out nozzle structure, and a lead-out cavity. The PZT actuator is located right above the main cavity. By providing the PDMS as a material to form the body of the micro pump, the micro pump can then be mass-produced with less cost and simpler structuring. Also, substantial elasticity and bio-compatibility for the micro pump can be achieved.



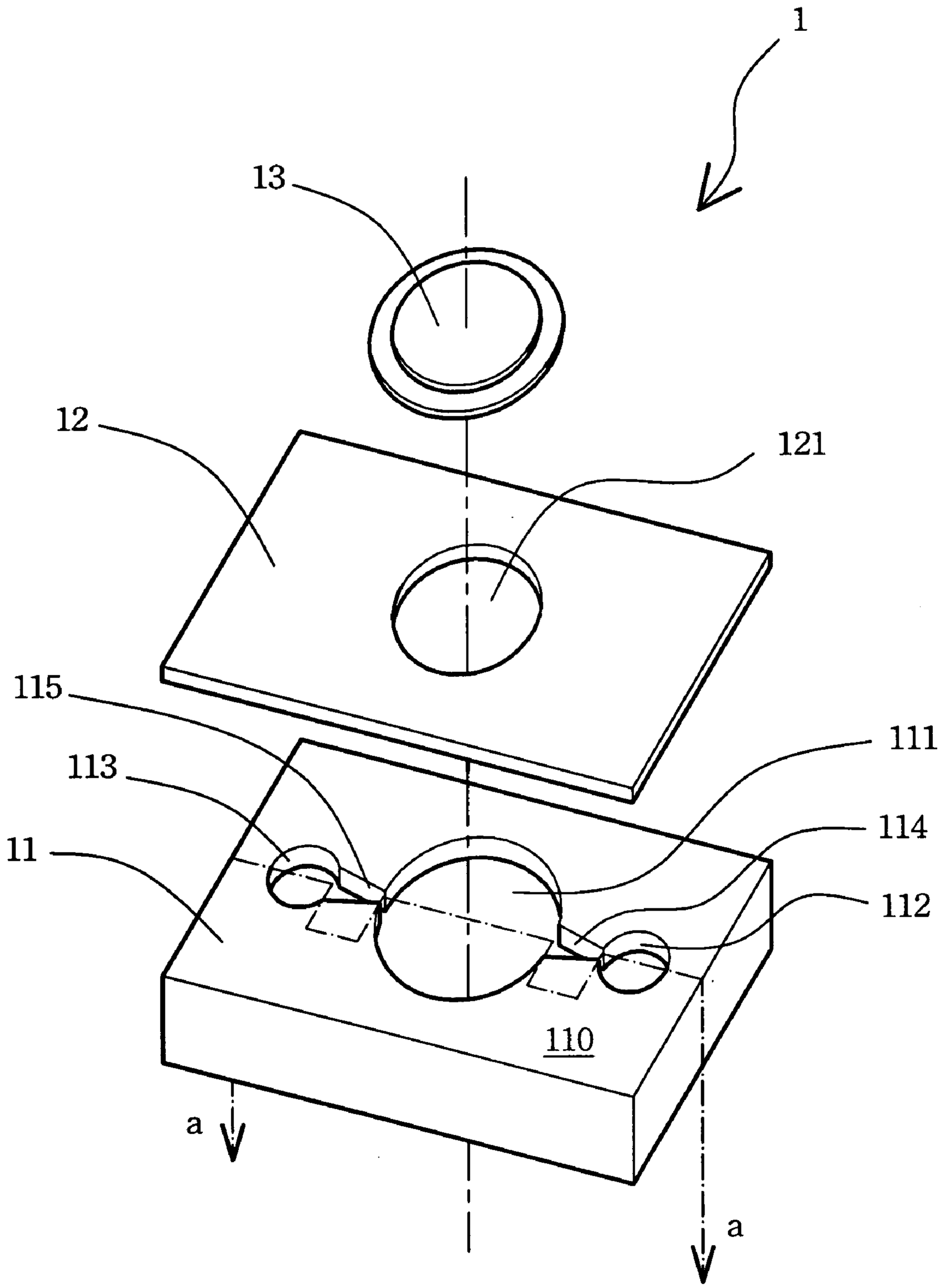


FIG. 1

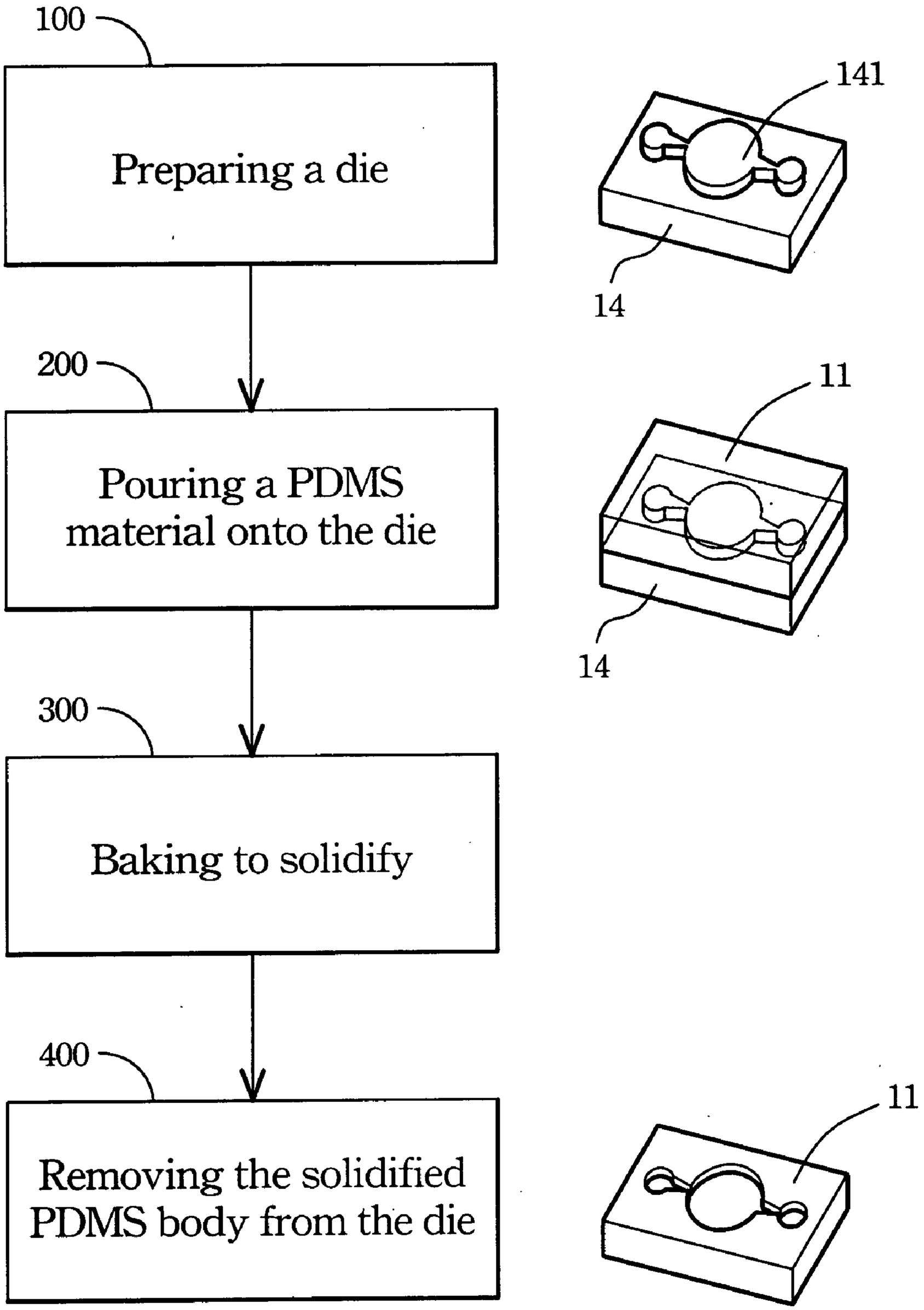
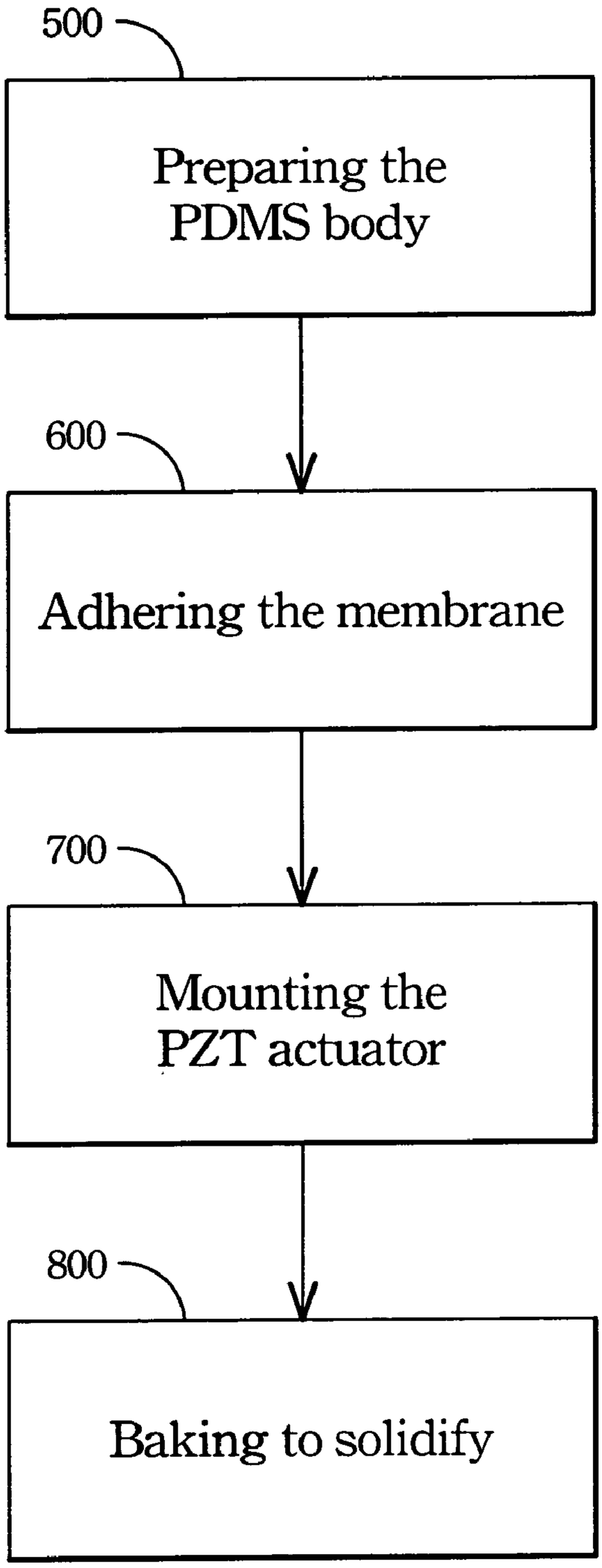
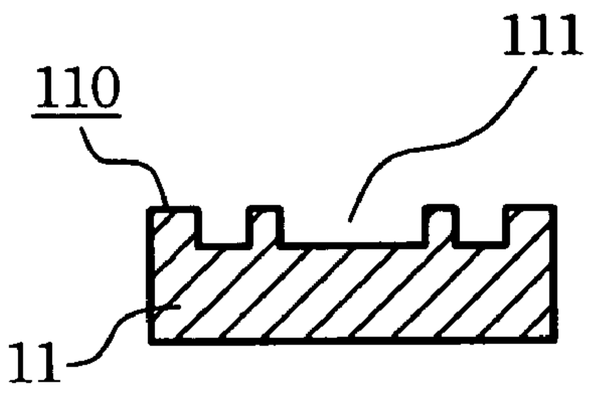
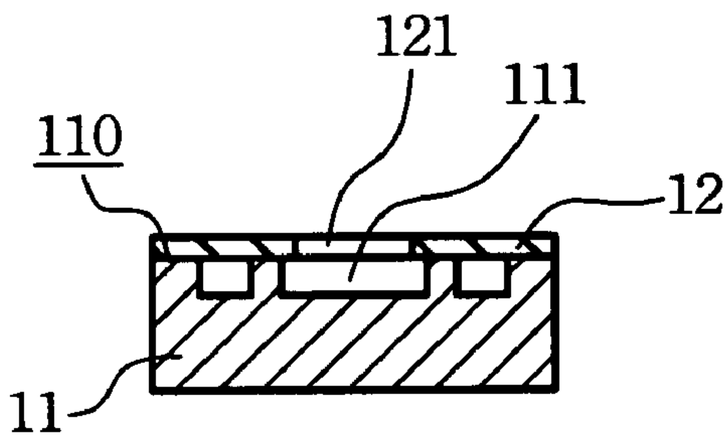

100
Preparing a die
200
Pouring a PDMS material onto the die
300
Baking to solidify
400
Removing the solidified PDMS body from the die
141
14
11
14
11

FIG. 2


500
Preparing the PDMS body
600
Adhering the membrane
700
Mounting the PZT actuator
800
Baking to solidify


111
110
11


121
111
110
12
11

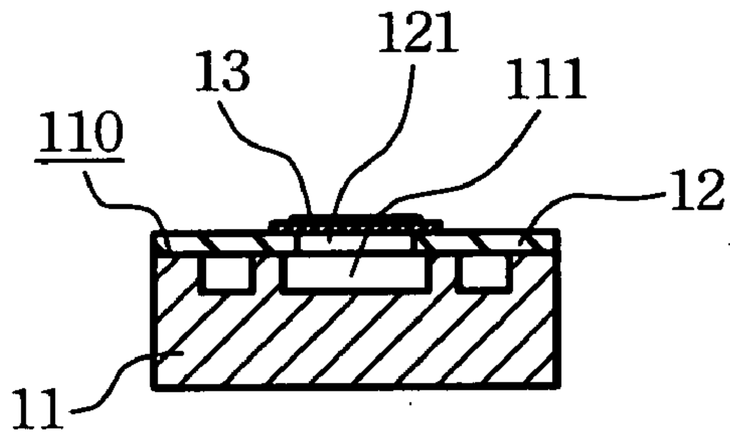

121
13
111
110
12
11

FIG.3

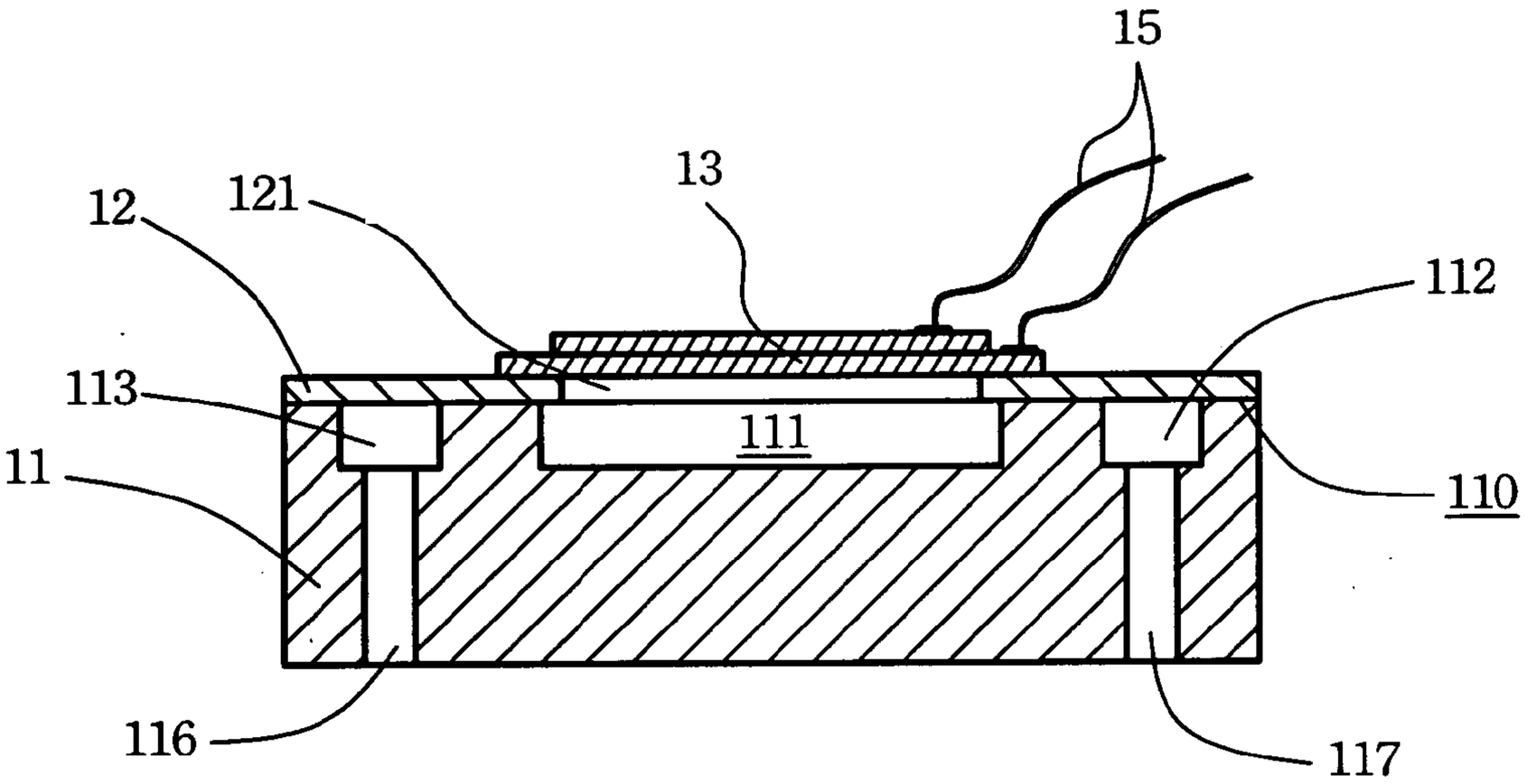

15
13
121
12
112
113
111
11
110
116
117

FIG. 4

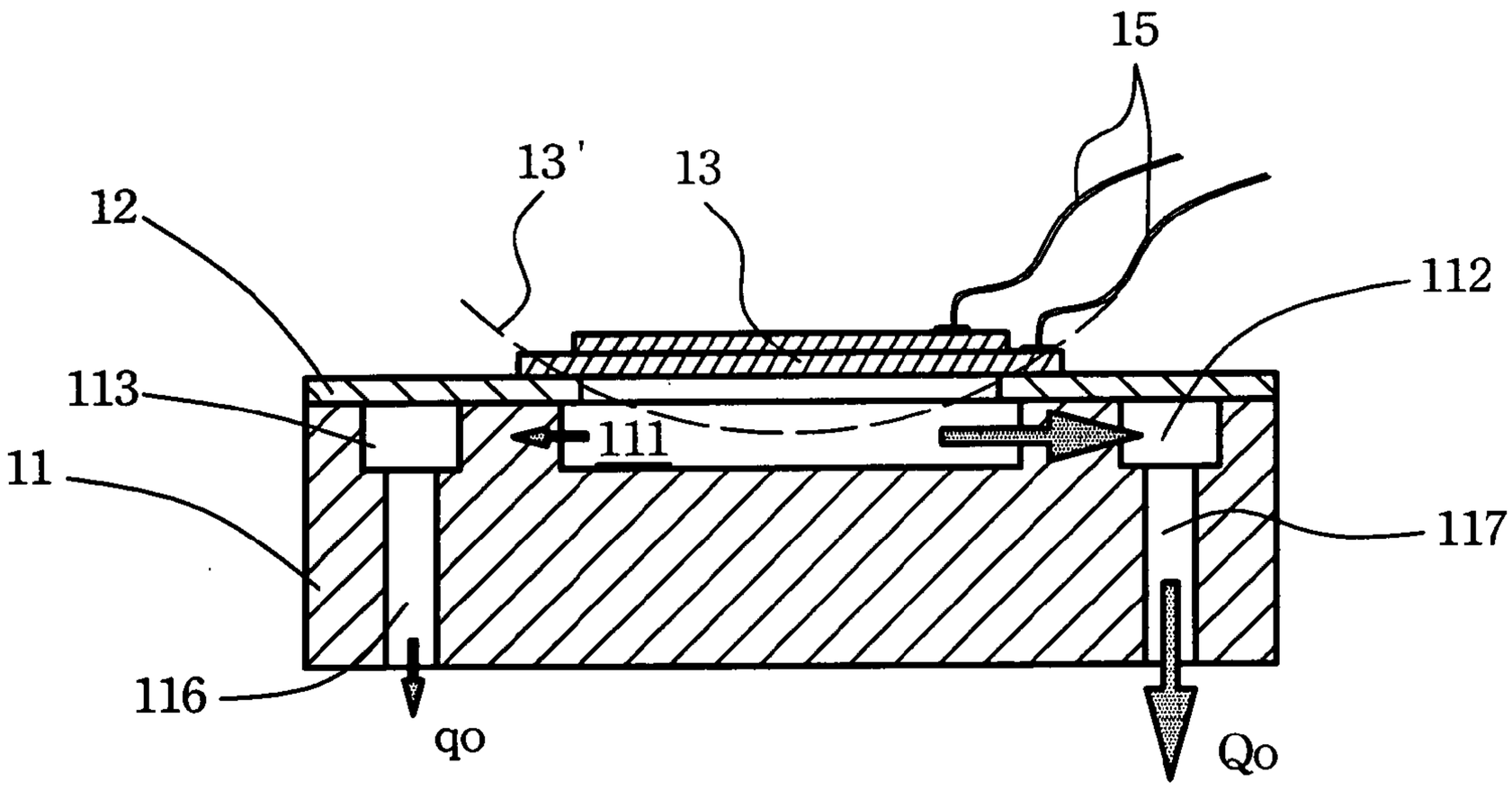

15
13'
13
12
112
113
111
11
117
116
qo
Qo

FIG. 5

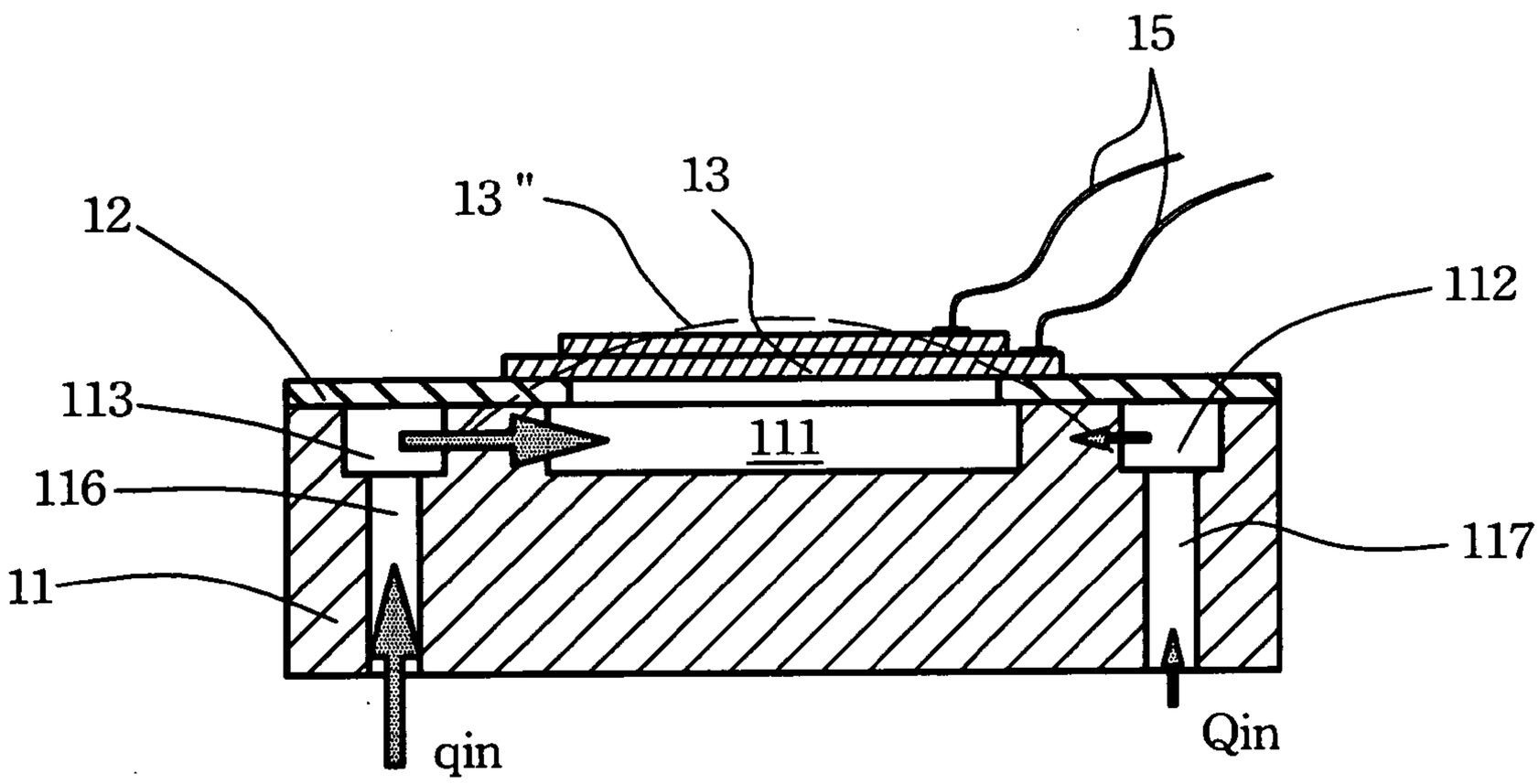

15
13 "
13
12
112
113
111
116
117
11
qin
Qin

FIG. 6

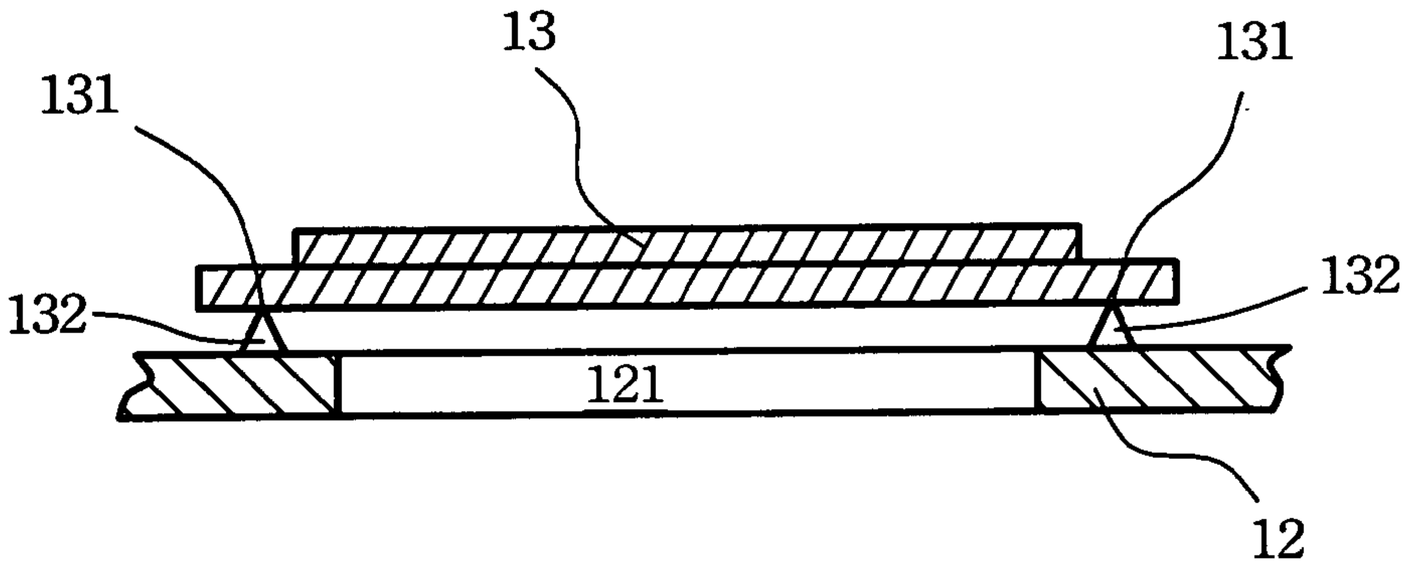

13
131
131
132
132
121
12

FIG. 7

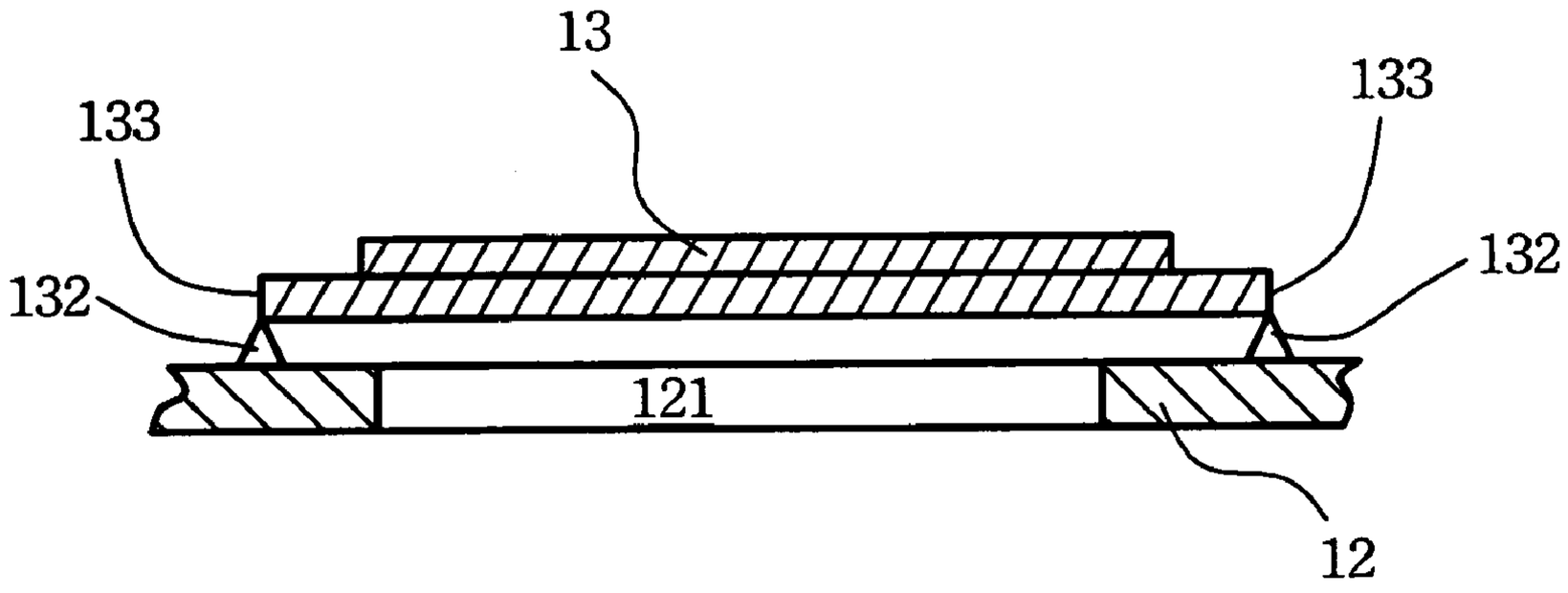


FIG.8

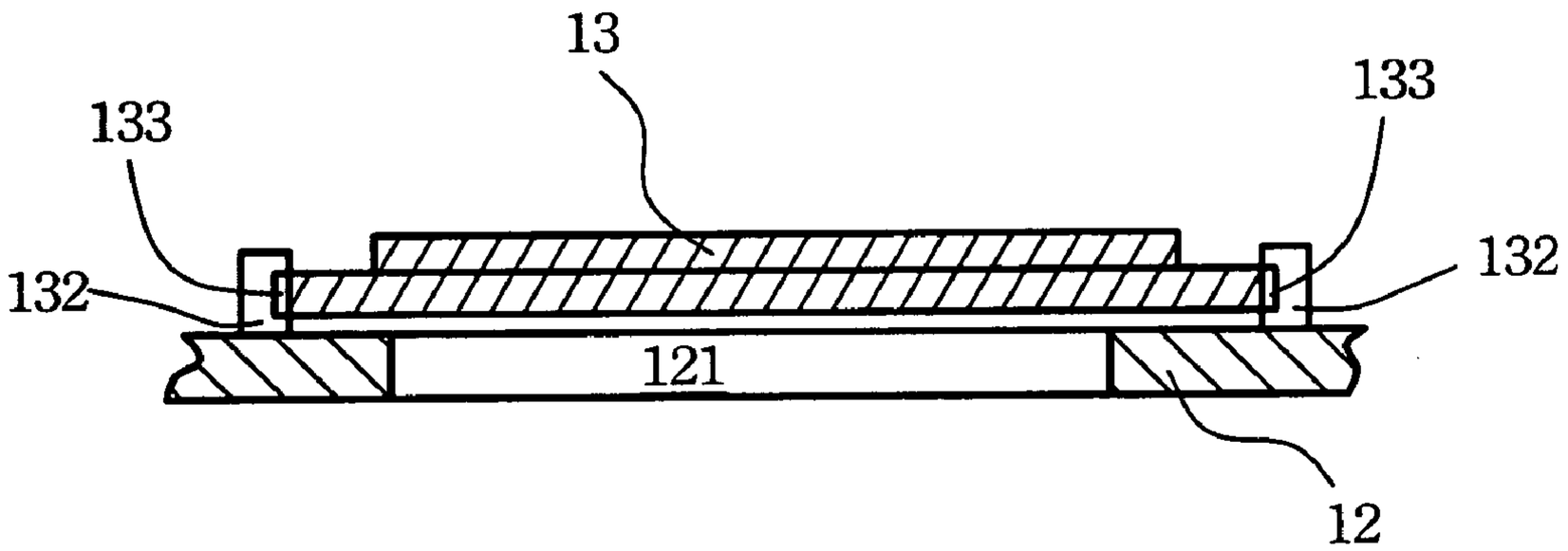


FIG.9

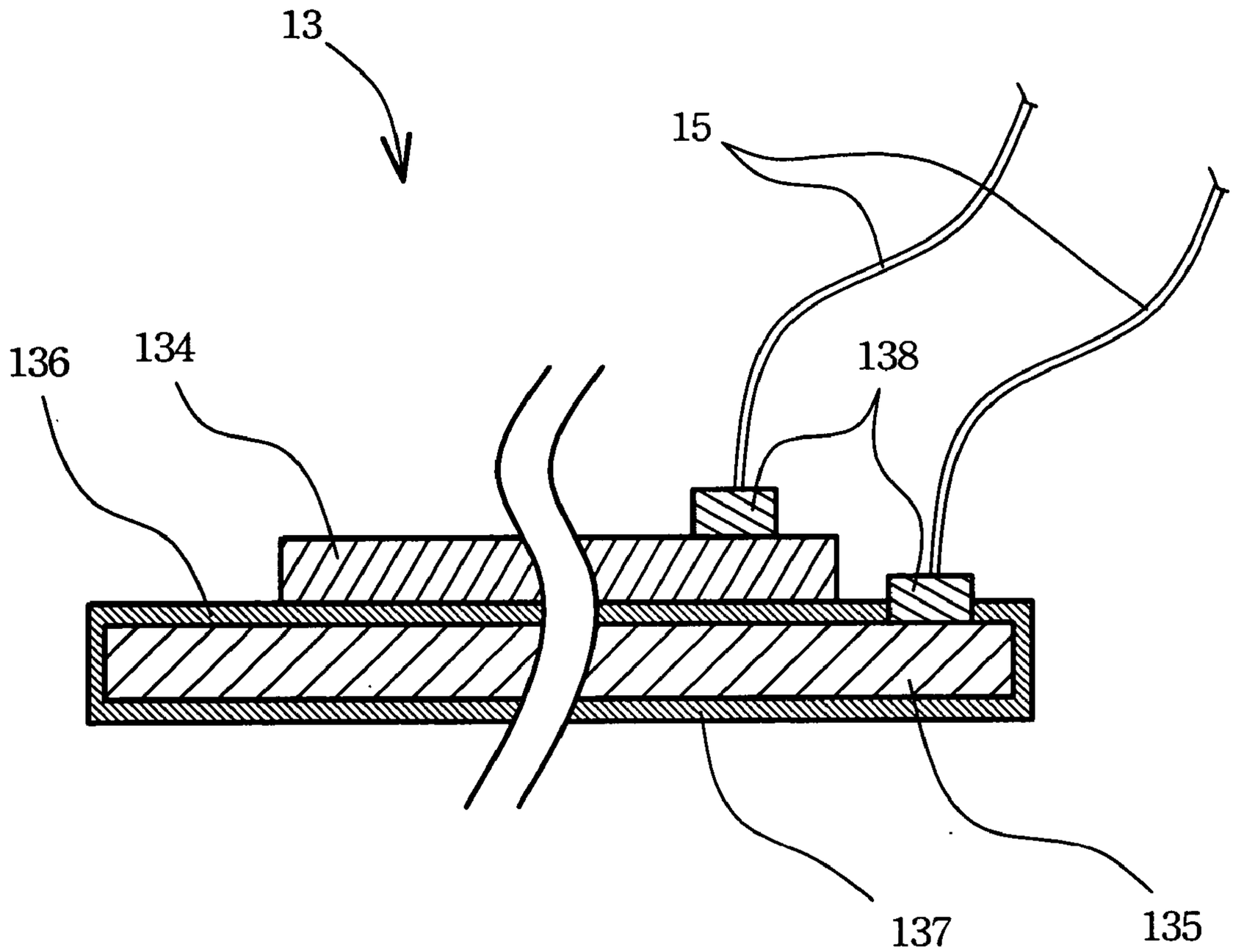


FIG.10

PDMS VALVE-LESS MICRO PUMP STRUCTURE AND METHOD FOR PRODUCING THE SAME

BACKGROUND OF THE INVENTION

[0001] (1) Field of the Invention

[0002] The invention relates to a valve-less micro pump structure and a method for producing the same, and more particularly to the structure that includes an elastomer main body made of polydimethylsiloxane (PDMS).

[0003] (2) Description of the Prior Art

[0004] In micro electric mechanical engineering, particularly that of biomedical field, micro fluid-detection and control components are crucial in utilization related to the precision automation industry. Among all the micro components, the micro pump as a fluid-control element is one of the key elements to make a micro fluid mechanism work.

[0005] In the art, micro pumps with micro valve structures are usually made of a silicon-base material by a semiconductor manufacturing process. These micro pumps often have the following weakness.

[0006] 1. The semiconductor manufacturing process for producing the micro pumps cannot meet a rapid production requirement.

[0007] 2. Cost for the silicon-base material for producing the micro pumps is high.

[0008] 3. For the silicon-base material for producing the micro pumps is brittle, inherent problems in fatigue and pitting can never be neglected.

[0009] Also, it is well known that a brittle material is not suitable for application in the biomedical engineering.

[0010] 4. The brittle silicon-base material for producing the micro pumps is vulnerable to impact and thus crack.

[0011] 5. The silicon-base material for producing the micro pumps has poor bio-compatibility, and so limits the application of the micro electric mechanical components.

[0012] Therefore, to overcome various disadvantages from adopting the silicon-base material to the micro pumps by a semiconductor manufacturing process, a substitute material and an improved method for forming the micro pumps are definitely welcome to the skilled persons in the art.

SUMMARY OF THE INVENTION

[0013] Accordingly, it is an object of the present invention to provide a PDMS valve-less micro pump structure and a method for producing the same, in which the PDMS material is widely used to have the production of the micro pumps to be simply structured, low cost, flexible, and more bio-compatible.

[0014] The PDMS valve-less micro pump structure includes a PDMS body, a membrane, and a piezoelectric (PZT) actuator.

[0015] The PDMS body, as an elastomer made of a PDMS material, has a contour surface. The contour surface further is curved to form a main cavity, a lead-in cavity and a lead-out cavity. The lead-in cavity can be located aside to the main cavity and in spatial communication with the main cavity through a lead-in nozzle. Also, the lead-out cavity can be located also aside to the main cavity and in spatial communication with the main cavity through a lead-out nozzle.

[0016] The membrane having a center hole is layered on top of the PDMS body (i.e. on the contour surface) to seal the lead-in cavity, the lead-in nozzle, the lead-out nozzle and the lead-out cavity, but have the center hole positioned on top of the main cavity so as to expose the main cavity through the center hole.

[0017] The PZT actuator is mounted on top of the membrane by a predetermined peripheral sealing way that can seal the main cavity by covering the center hole of the membrane.

[0018] In one embodiment of the present invention, the membrane of the PDMS valve-less micro pump structure can be made of a PDMS material, and preferably have a thickness ranged between 200 μm and 300 μm.

[0019] In one embodiment of the present invention, the PZT actuator can further include a PZT plate, a copper plate layered under the PZT plate, an insulation layer sandwiched between the PZT plate and the copper plate to avoid electrically shorting in between, and a bottom layer layered under the copper plate to prohibit direct contact between the copper plate and a fluid in the main cavity. Preferably, the insulation layer and the bottom layer are both layers made of the PDMS material.

[0020] In one embodiment of the present invention, the predetermined peripheral sealing way to mount the PZT actuator onto the membrane can be a sealing way having supports at nodes of the PZT actuator, having supports at a periphery of the PZT actuator, or having bonding at the periphery of the PZT actuator.

[0021] In the present invention, the PDMS valve-less micro pump structure, i.e. the PDMS body as described above, can be produced in accordance with a method having the following steps of:

[0022] (1) Preparing a die, the die having a profiling protrusion forming on a top surface to configure concavely the main cavity, the lead-in cavity, the lead-in nozzle, the lead-out cavity, and the lead-out nozzle of the PDMS body;

[0023] (2) Pouring a PDMS material in a fluid state onto the top surface of the die by covering fully the profiling protrusion;

[0024] (3) Performing a predetermined baking process on the die and the PDMS material so as to solidify the PDMS material for forming the PDMS body; and

[0025] (4) Removing the solidified PDMS material from the die to complete the production of the PDMS body, i.e. the PDMS valve-less micro pump structure of the present invention.

[0026] In the present invention, the die for forming the PDMS body is preferably made of a polymethylmethacrylate (PMMA) material.

[0027] In one embodiment of the present invention, the fluid-state PDMS material for forming the PDMS body can be prepared by mixing a Sylgard 184 base (having short-chain PDMS molecules) and a Sylgard 184 agent at a 10:1

ratio. Preferably, the mixing can be achieved by blending the Sylgard 184 base and the Sylgard 184 agent in a magnetic stirrer for a predetermined period at a predetermined speed and then slowing the speed of the magnetic stirrer to de-bubble the PDMS material.

[0028] In one embodiment of the present invention, the predetermined baking process for solidifying the fluid-state PDMS material on the die can be a vacuum-baking process including a 20-30 minute low-pressure de-bubbling step, a heating step at 110-130° C. for 2-4 hours, and a free cooling step.

[0029] In the present invention, the PDMS valve-less micro pump can be produced by a method comprising the following steps of:

[0030] (1) Preparing the PDMS body, the PDMS body already having the main cavity, the lead-in cavity, the lead-in nozzle, the lead-out cavity and the lead-out nozzle formed concavely on the contour surface of the PDMS body;

[0031] (2) Adhering the membrane having the center hole onto the contour surface of the PDMS body by having the membrane seal the lead-in cavity, the lead-in nozzle, the lead-out nozzle and the lead-out cavity but having the center hole pf the membrane positioned on top of the main cavity;

[0032] (3) Mounting the PZT actuator onto the membrane by a predetermined peripheral sealing way so as to seal the main cavity that is exposed in the previous step; and

[0033] (4) Performing a baking process to solidify the combination of the PDMS body, the membrane, and the PZT actuator.

[0034] In one embodiment of the present invention, the predetermined baking process to confirm the combination among the PDMS body, the membrane and the actuator can be is a vacuum-baking process including a heating step at 110-130° C. for 2-4 hours.

[0035] All these objects are achieved by the PDMS valve-less micro pump structure and the method for producing the same described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The present invention will now be specified with reference to its preferred embodiment illustrated in the drawings, in which:

[0037] **FIG. 1** is a perspective exploded view of a preferred embodiment of the PDMS valve-less micro pump in accordance with the present invention;

[0038] **FIG. 2** is a flowchart showing a preferred method for producing the PDMS body in accordance with the present invention;

[0039] **FIG. 3** is a flowchart showing a preferred method for producing the valve-less micro pump in accordance with the present invention;

[0040] **FIG. 4** is a cross-sectional view of a preferred valve-less micro pump in accordance with the present invention;

[0041] **FIG. 5** is an application state of **FIG. 4**;

[0042] **FIG. 6** is another application state of **FIG. 4**;

[0043] **FIG. 7** is a schematic view to show a predetermined sealing way for mounting the PZT actuator on the membrane in accordance with the present invention;

[0044] **FIG. 8** is a schematic view to show another predetermined sealing way for mounting the PZT actuator on the membrane in accordance with the present invention;

[0045] **FIG. 9** is a schematic view to show a further predetermined sealing way for mounting the PZT actuator on the membrane in accordance with the present invention; and

[0046] **FIG. 10** is an enlarged cross-sectional view of the PZT actuator of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0047] The invention disclosed herein is directed to a PDMS valve-less micro pump structure and a method for producing the same. In the following description, numerous details are set forth in order to provide a thorough understanding of the present invention. It will be appreciated by one skilled in the art that variations of these specific details are possible while still achieving the results of the present invention. In other instance, well-known components are not described in detail in order not to unnecessarily obscure the present invention.

[0048] Referring now to **FIG. 1**, a perspective exploded view of a preferred PDMS valve-less micro pump in accordance with the present invention is shown to mainly have a PDMS body **11**, a membrane **12**, and a PZT actuator **13**.

[0049] The PDMS body **11** of the present invention is an elastomer that can be made of a PDMS material. The PDMS body **11** has a contour surface **110**. As shown, the contour surface **110** is curved to form a main cavity **111**, a lead-in cavity **113** and a lead-out cavity **112**. The lead-in cavity **113** can be located aside (for example, left-hand side in the figure) to the main cavity **111** and be in spatial communication (or say, in a channel-wise connection) with the main cavity **111** through a lead-in nozzle **115** also formed in the PDMS body **11**. Similarly, the lead-out cavity **112** can be located aside (for example, right-hand side in the figure) to the main cavity **111** and in spatial communication with the main cavity **111** through a lead-out nozzle **114** formed in the PDMS body **11**.

[0050] In the present invention, the PDMS material is an elastic polymer featuring in hydrophilic and transparent property. The contact angle between a PDMS molecule and a water molecule is about 108 degree. For having an acceptable bio-compatibility, the PDMS material is much suitable for producing the bio-medical components. The PDMS material has an excellent electric-insulation property and a damper property to absorb any foreign impact. Also, the dielectric strength of the PDMS material is also acceptable to most applications. Importantly, the aforesaid properties of the PDMS material can be maintained under any environmental temperature and moisture situation.

[0051] The PDMS material itself is an inertial material that is damp to the O_3 and the ultraviolet ray. Yet, the PDMS material can be easily adhered to an ordinary smooth surface, for example a surface of a silicon wafer, a glass, or a PMMA object.

[0052] As shown in **FIG. 1**, the lead-in cavity **113** and the lead-out cavity **112** are located to opposite sides of the main cavity **111**. However, such an arrangement doesn't imply that the present invention prohibits other arrangements of the lead-in cavity **113** and the lead-out cavity **112** with respect to the main cavity **111**. Basically, any arrangement that separates the lead-in cavity **113** from the lead-out cavity **112** around the main cavity **111** can be acceptable to the present invention.

[0053] As shown, an end of the lead-in nozzle **115** that has a larger cross section is connected with the lead-in cavity **113**, while another end having a smaller cross section is connected with the main cavity **111**. On the other hand, the end of the lead-out nozzle **114** that has a larger cross section is connected with the main cavity **111**, while another end having a smaller cross section is connected with the lead-out cavity **112**.

[0054] In **FIG. 1**, the membrane **12** of the present invention for adhering or layering on the contour surface **110** of the PDMS body **11** has a center hole **121**. The membrane **12** is used to seal or cover the lead-in cavity **113**, the lead-in nozzle **115**, the lead-out nozzle **114** and the lead-out cavity **112** so that the curved-in structures of the lead-in cavity **113**, the lead-in nozzle **115**, the lead-out nozzle **114** and the lead-out cavity **112** can be formed as flow channel structures. Also, it is noted that the main cavity **111** is still exposed to the membrane **12** by having the center hole **121** of the membrane **12** positioned right on top of the main cavity **111**.

[0055] In the present invention, the membrane **12** is preferably made of a PDMS material, and preferably has a thickness ranged between 200 μm and 300 μm.

[0056] The PZT actuator **13** of the present invention is mounted on top of the membrane **12** by a predetermined peripheral sealing way that can seal the main cavity **111** by sitting on or covering the center hole **121** of the membrane **12**.

[0057] Referring now to **FIG. 2**, a flowchart for a preferred method for producing the PDMS body **11** is shown. The method can include the following steps.

[0058] Step **100**: Preparing a die **14**. The die **14** has a profiling protrusion **141** forming on a top surface of the die **14**. By properly providing the profiling protrusion **141**, the aforesaid concave structures of the PDMS body **11** such as the main cavity **111**, the lead-in cavity **113**, the lead-in nozzle **115**, the lead-out cavity **112**, and the lead-out nozzle **114** can be formed by the following molding.

[0059] Step **200**: Pouring a PDMS material in a fluid state **11** onto the top surface of the die **14** by covering fully the profiling protrusion **141**.

[0060] Step **300**: Performing a predetermined baking process on the assembly of the die **14** and the PDMS material **11** so as to solidify the PDMS material **11** for forming the aforesaid PDMS body **11**.

[0061] Step **400**: Removing the solidified PDMS material **11** from the die **14** to complete the production of the PDMS body **11** for the PDMS valve-less micro pump of the present invention.

[0062] In the present invention, the die **14** for forming or molding the PDMS body **11** is preferably made of a PMMA material.

[0063] In the present invention, the PDMS material can be obtained in a Sylgard 184 Silicone Elastomer Kit provided by the Dow Coing Company in the United States. In this kit, the PDMS material for molding the PDMS body **11** can be prepared by mixing a Sylgard 184 base (having short-chain PDMS molecules) and a Sylgard 184 agent at a 10:1 ratio. Preferably, the mixing can be performed by blending the Sylgard 184 base and the Sylgard 184 agent in a magnetic stirrer for a predetermined period at a predetermined speed and then slowing the speed of the magnetic stirrer to de-bubble the fluid-state PDMS material.

[0064] In the present invention, the predetermined baking process for solidifying the fluid-state PDMS material **11** molded on the die **14** can be a vacuum-baking process that includes a 20-30 minute low-pressure de-bubbling step, a heating step at 110-130° C. for 2-4 hours, and a free cooling step for cooling down the PDMS material **11** to the room temperature.

[0065] Referring now to **FIG. 3**, a flowchart for a preferred method for producing the PDMS valve-less micro pump in accordance with the present invention is shown. The method comprises the following steps.

[0066] Step **500**: Preparing the PDMS body **11**. The PDMS body **11** already has the main cavity **111**, the lead-in cavity **113**, the lead-in nozzle **115**, the lead-out cavity **112** and the lead-out nozzle **114** formed concavely on the contour surface **110** of the PDMS body **11**.

[0067] Step **600**: Adhering the membrane **12** having the center hole **121** onto the contour surface **110** of the PDMS body **11**. The adhering is done by having the membrane **12** seal the lead-in cavity **113**, the lead-in nozzle **115**, the lead-out nozzle **114** and the lead-out cavity **112**, but having the center hole **121** of the membrane **12** positioned on top of the main cavity **111**.

[0068] Step **700**: Mounting the PZT actuator **13** on the membrane **12** by a predetermined peripheral sealing way. Thereby, the main cavity **111** can be sealed by the PZT actuator **13** and thus form as a central tank of the fluid channel that includes in series the lead-in cavity **113**, the lead-in nozzle **115**, the main cavity **111**, the lead-out nozzle **114** and the lead-out cavity **112**.

[0069] Step **800**: Performing a baking process to solidify the combination of the PDMS body **11**, the membrane **12**, and the PZT actuator **13**. After the baking, a production of the PDMS valve-less micro pump according to the present invention is done.

[0070] In the present invention, the predetermined baking process to confirm the combination among the PDMS body **11**, the membrane **12** and the actuator **13** can be also is a vacuum-baking process including a heating step at 110-130° C. for 2-4 hours.

[0071] Referring now to **FIG. 4**, a cross-section view of a preferred PDMS valve-less micro pump along line a-a of **FIG. 1** is shown, in which the lead-in nozzle **115** and the lead-out nozzle **114** are not shown. In **FIG. 4**, a lead-in channel **116** and a lead-out channel **117** are constructed under the lead-in cavity **113** and the lead-out cavity **112**, respectively. The lead-in channel **116** is provided so that a fluid outside the PDMS body **11** can be sent into and/or out off the lead-in cavity **113**. Similarly, the lead-out channel **117** is there so that the fluid outside the PDMS body **11** can be sent into and/or out off the lead-out cavity **112**.

[0072] In the present invention, for the PDMS material is a soft elastomer, the forming of the lead-in channel **116** and

the lead-out channel **117** can be directly done by piecing a needle or a like piecing structure into the PDMS body **11** at the application site of the micro pump. This channel-forming work is well known to a skilled person in the related art, and so details will be omitted herein.

[**0073**] As shown in **FIG. 4**, before the PDMS valve-less micro pump of the present invention works, proper wiring **15** should also be established between the actuator **13** and a foreign power device (not shown in the figure). Thereby, the PZT actuator **13** can thus be controlled to perform its up-and-down action upon the main cavity **111**.

[**0074**] Referring now to **FIG. 5**, a down (or concave) state of the PZT actuator **13** is shown by a dashed line **13'**. In this state, the PZT actuator **13** is controlled to present a concave configuration **13'** so as to depress the main cavity **111** or say to reduce the volume inside the main cavity **111**. Thereby, the fluid inside the main cavity **111** would be squeezed out to both the lead-in cavity **113** and the lead-out cavity **112** through the lead-in nozzle **115** and the lead-out nozzle **114**, respectively. For the directional arrangement of the nozzles **114** and **115** (referred to **FIG. 1**), the fluid amount qo leaving the main cavity **111** through the lead-in nozzle **1115**, the lead-in cavity **113** and the lead-in channel **116** would be less than the fluid amount Qo leaving the main cavity **111** through the lead-out nozzle **114**, the lead-out cavity **112** and the lead-out channel **117**.

[**0075**] Referring now to **FIG. 6**, an up (or convex) state of the PZT actuator **13** is shown by another dashed line **13"**. In this state, the PZT actuator **13** is controlled to present a convex configuration **13"** so as to dilate the main cavity **111** or say to suddenly enlarge the volume inside the main cavity **111**. Thereby, the fluid in the lead-in cavity **113** and the lead-out cavity **112** would be sucked into the main cavity **111** through the lead-in nozzle **115** and the lead-out nozzle **114**, respectively. For the directional arrangement of the nozzles **114** and **115** (referred to **FIG. 1**), the fluid amount qin entering the main cavity **111** through the lead-in channel **116**, the lead-in cavity **113** and the lead-in nozzle **115** would be larger than the fluid amount Qin entering the main cavity **111** through the lead-out channel **117**, the lead-out cavity **112** and the lead-out nozzle **114**.

[**0076**] In the present invention, after an operational stroke of the PZT actuator **13** (including a down state and an up state), a preset amount of the fluid, (Qo-Qin) or (qin-qo), can then be transported from the lead-in channel **116** to the lead-out channel **117** of the PDMS body **11**.

[**0077**] In the present invention, the PZT actuator **13** is fixed air-tightly onto the membrane **12** through the predetermined peripheral sealing way. In practice, the predetermined peripheral sealing way can be a sealing way as shown in **FIG. 7** that provides annular supports **132** at nodes **131** of the PZT actuator **13**, a sealing way as shown in **FIG. 8** that provides annular supports **132** at a periphery **133** of the PZT actuator **13**, or a sealing way as shown in **FIG. 9** that provides annular bonding **132** at the periphery **133** of the PZT actuator **13**. It should be noted that different sealing ways would cause different state appearance of the PZT actuator **13**. However, for the supports **132** in all three cases stand on the membrane **12**, so different sealing ways of the PZT actuator **13** can only render minor difference in state appearance of the PZT actuator **13**. That is to say that the configuration of the PZT actuator **13** shown in **FIG. 5** or **FIG. 6** can still prevail no matter what kind of the sealing way is applied.

[**0078**] Referring now to **FIG. 10**, an enlarged cross-sectional view of the PZT actuator **13** of the present invention is shown. The PZT actuator **13** can include a PZT plate **134** and a copper plate **136** layered under the PZT plate **135**. In operation, for the PZT plate **134** and the copper plate **135** need to connect with respective electrodes **138** so as to act as a positive end and a negative end, respectively, so an insulation layer **136** is introduced to be sandwiched between the PZT plate **134** and the copper plate **135** for avoiding possible electrically shorting in between. On the other hand, to prevent the copper plate **135** from directly contacting the fluid in the main cavity **111** of the PDMS body **11**, a bottom layer **137** coated or layered under the copper plate **135** is provided to prohibit such direct contact between the copper plate **135** and a fluid in the main cavity **111**.

[**0079**] Preferably in the present invention, both the insulation layer **136** and the bottom layer **137** can be made of the PDMS material. By introducing the elastic PDMS material to wrap the copper plate **135** in a thin layer wise, the copper plate **135** can then have better flexibility to satisfy the concave and convex operations of the PDMS valve-less micro pump. Thereby, the throughput of the PDMS valve-less micro pumps can be increased.

[**0080**] In the present invention, prior to mounting the PZT actuator **13** onto the membrane **12**, the bottom of the PZT actuator **13** can be brushed and thus coat a layer of a PDMS solution for adhering the PZT actuator **13**.

[**0081**] In the present invention, for all the inner surfaces of the formed channel structures in the PDMS body are made as PDMS surfaces, the applicability of the PDMS valve-less micro pumps in the biomedical or chemical industry can be increased.

[**0082**] By providing the PDMS valve-less micro pump structure and the molding method for producing the same in accordance with the present invention, the production of the micro pumps can be simply, low cost, and flexible, and the product can be more bio-compatible.

[**0083**] While the present invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be without departing from the spirit and scope of the present invention.

I claim:

1. A PDMS valve-less micro pump structure, comprising:

a PDMS body, having a contour surface, the contour surface further being curved to form thereof:

a main cavity;

a lead-in cavity, located aside to the main cavity and in spatial communication with the main cavity through a lead-in nozzle; and

a lead-out cavity, located also aside to the main cavity and in spatial communication with the main cavity through a lead-out nozzle;

a membrane having a center hole, layered on top of the PDMS body by sealing the lead-in cavity, the lead-in nozzle, the lead-out nozzle and the lead-out cavity but having the center hole positioned on top of the main cavity; and

a PZT actuator, mounted on top of the membrane by a predetermined peripheral sealing way so as to seal the main cavity.

2. The PDMS valve-less micro pump structure according to claim 1, wherein said membrane is made of a PDMS material.

3. The PDMS valve-less micro pump structure according to claim 1, wherein said membrane has a thickness ranged between 200 μm and 300 μm.

4. The PDMS valve-less micro pump structure according to claim 1, wherein said predetermined peripheral sealing way is a sealing way having supports at nodes of said PZT actuator.

5. The PDMS valve-less micro pump structure according to claim 1, wherein said predetermined peripheral sealing way is a sealing way having supports at a periphery of said PZT actuator.

6. The PDMS valve-less micro pump structure according to claim 1, wherein said predetermined peripheral sealing way is a sealing way having bonding at a periphery of said PZT actuator.

7. The PDMS valve-less micro pump structure according to claim 1, wherein said PZT actuator has a bottom coated with a PDMS material.

8. The PDMS valve-less micro pump structure according to claim 1, wherein said PZT actuator further comprising:

a PZT plate;

a copper plate, layered under the PZT plate;

an insulation layer, sandwiched between the PZT plate and the copper plate to avoid electrically shorting in between; and

a bottom layer, layered under the copper plate to prohibit direct contact between the copper plate and a fluid in said main cavity.

9. The PDMS valve-less micro pump structure according to claim 8, wherein said insulation layer is made of a PDMS material.

10. The PDMS valve-less micro pump structure according to claim 8, wherein said bottom layer is made of a PDMS material.

11. A method for producing a PDMS valve-less micro pump structure, comprising the steps of:

preparing a die, the die having a profiling protrusion forming on a top surface thereof;

pouring a PDMS material in a fluid state onto the top surface of the die to cover fully the profiling protrusion;

performing a predetermined baking process on the die and the PDMS material to solidify the PDMS material; and

removing the solidified PDMS material from the die to complete a production of the PDMS valve-less micro pump structure;

wherein the profiling protrusion of the die is characterized to form concavely a main cavity, a lead-in cavity, a lead-in nozzle, a lead-out cavity and a lead-out nozzle in the PDMS material.

12. The method for producing a PDMS valve-less micro pump according to claim 11, wherein said die is made of a PMMA material.

13. The method for producing a PDMS valve-less micro pump according to claim 11, wherein said PDMA material in the fluid state is prepared by mixing a Sylgard 184 base and a Sylgard 184 agent at a 10:1 ratio.

14. The method for producing a PDMS valve-less micro pump according to claim 13, wherein said Sylgard 184 base and said Sylgard 184 agent are blended by a magnetic stirrer by stirring a predetermined period at a predetermined speed and then slowing to de-bubble said PDMS material.

15. The method for producing a PDMS valve-less micro pump according to claim 11, wherein said predetermined baking process is a vacuum-baking process including a 20-30 minute low-pressure de-bubbling step, a heating step at 110-130° C. for 2-4 hours, and a free cooling step.

16. A method for producing a PDMS valve-less micro pump, comprising the steps of:

preparing a PDMS body, the PDMS body having a main cavity, a lead-in cavity, a lead-in nozzle, a lead-out cavity and a lead-out nozzle formed concavely on a contour surface thereof;

adhering a membrane having a center hole onto the contour surface of the PDMS body by sealing the lead-in cavity, the lead-in nozzle, the lead-out nozzle and the lead-out cavity but having the center hole positioned on top of the main cavity;

mounting a PZT actuator onto the membrane by a predetermined peripheral sealing way so as to seal the main cavity; and

performing a baking process to solidify the combination of the PDMS body, the membrane, and the PZT actuator.

17. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said membrane is made of a PDMS material.

18. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said membrane has a thickness ranged between 200 μm and 300 μm.

19. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said predetermined baking process is a vacuum-baking process including a heating step at 110-130° C. for 2-4 hours.

20. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said predetermined peripheral sealing way is a sealing way having supports at nodes of said PZT actuator.

21. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said predetermined peripheral sealing way is a sealing way having supports at a periphery of said PZT actuator.

22. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said predetermined peripheral sealing way is a sealing way having bonding at a periphery of said PZT actuator.

23. The method for producing a PDMS valve-less micro pump according to claim 16, wherein said "mounting a PZT actuator onto the membrane by a predetermined peripheral sealing way" is performed by coating a PDMS solution to a bottom of said PZT actuator.

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