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(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**
Suwon, Kyonggi-do 442-742 (KR)

(72) Inventors:
- **Ahn, Byung-sun**
  Paldal-gu, Suwon, Kyonggi-do (KR)
- **Nikolaevich, Dunaev Boris**
  Moscow, 111558 (RU)

(74) Representative:
Tunstall, Christopher Stephen et al
Dibb Lupton Alsop,
Fountain Precinct
Balm Green, Sheffield S1 1RZ (GB)

(54) Method for assembling micro injecting device and apparatus for the same

(57) A method for assembling a micro-injecting device and an apparatus for assembling the device are disclosed. A heater chip wafer on which a plurality of heater chips are formed is fixed onto a vacuum bench, and a membrane manufactured independently of a jet chip is aligned to be separated by a predetermined space from the heater chip wafer, and the membrane is fixed on the heater chip wafer. This avoids the membrane being moved frequently in the process of aligning and assembling, thus obtaining in-advance prevention against damage to the membrane, and elimination of the necessity to align the membrane to each heater chip, thereby reducing significantly the time required for assembling.

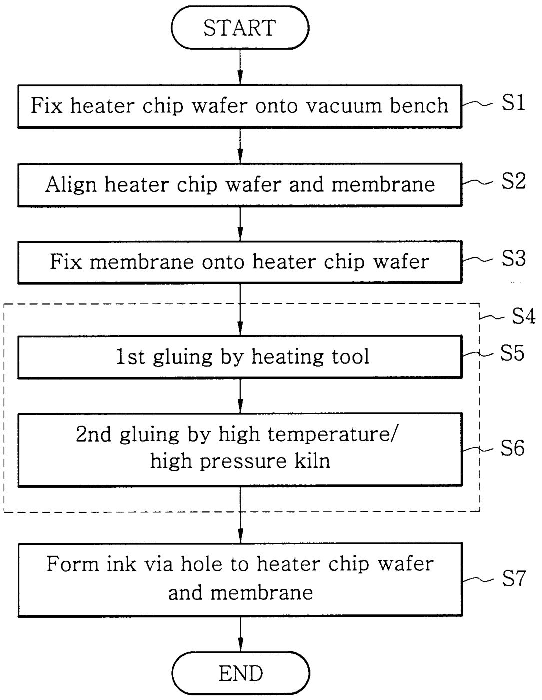

Fig. 1

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to the field of micro-injecting devices and ink jet print heads, and particularly to membrane-type micro-injecting devices, and more particularly to the assembly of these micro-injecting devices.

[0002] Generally, a micro-injecting device refers to a device which is designed to deliver a predetermined amount of liquid, for example, ink, injection liquid or petroleum to for example, printing paper, a human body or motor vehicles. The device uses a method in which a predetermined amount of electric or thermal energy is applied to the above-mentioned liquid, yielding a volumetric transformation of the liquid. This method allows the application of a small quantity of a liquid to a specified object.

[0003] Recent developments in electrical and electronic technology have enabled the rapid development of such micro-injecting devices. Thus, micro-injecting devices are widely used in daily life. One example of the use of micro-injecting devices in daily life is the inkjet printer.

[0004] The inkjet printer is a form of micro-injecting device which differs from conventional dot printers in its ability to perform print jobs in various colours by using cartridges. Additional advantages of inkjet printers over dot printers include a reduction in the noise level during printing and an enhanced quality of printing. For these reasons, inkjet printers are gaining immensely in popularity.

[0005] An inkjet printer generally includes a printhead having nozzles with a minute diameter. In such an inkjet printhead, the ink which is initially in a liquid state is transformed and expanded to a bubble state by turning on or off an electrical signal applied from an external device. The ink in the bubble state is then injected onto printing paper.

[0006] Examples of the construction and operation of several conventional ink jet print heads are described in the following U.S. Patents. U.S. Patent No. 4,490,728, Vaught et al., entitled *Thermal Ink Jet Printer,* describes a basic print head. U.S. Patent No. 4,809,428, Aden et al., entitled *Thin Film Device For An Ink Jet Printhead and Process For Manufacturing Same* and U.S. Patent No. 5,140,345, Komuro, entitled *Method Of Manufacturing a Substrate For A Liquid Jet Recording Head And Substrate Manufactured By The Method,* describe manufacturing methods for ink-jet printheads. U.S. Patent No. 5,274,400, Johnson et al., entitled *Ink Path Geometry For High Temperature Operation Of Ink Jet Printheads,* describes altering the dimensions of the ink-jet feed channel to provide fluidic drag. U.S. Patent No. 5,420,627, Keefe et al., entitled *Ink Jet Printhead,* shows a particular printhead design.

[0007] In a conventional inkjet printhead, a high temperature which is generated by a heating resistor layer is used to eject the ink. If the ink contained in an ink chamber is exposed to the high temperature for a considerable time, thermal changes in the constituent parts of ink may occur, significantly reducing the lifespan of the device.

[0008] Recently, to overcome this problem, there has been proposed a new method for smoothly spraying ink from the ink chamber by disposing a substrate-shaped membrane between the heating layer and an ink chamber and inducing a volumetric transformation of the membrane under a pressure of a working fluid, for example, heptane. Since the membrane is disposed between the ink chamber and the heating layer, preventing the ink from contacting directly to the heating layer, the ink itself is subjected to little thermal transformation.

[0009] An example of this type of printhead is seen in U.S. Patent 4,480,259, Kruger et al., entitled *Ink Jet Printer With Bubble Driven Flexible Membrane.* Related patents involving membrane-containing pumps and inkjet printheads are U.S. Patent No. 5,681,152, Åhs, entitled *Membrane Type Fluid Pump,* and U.S. Patent No. 5,659,346 Moynihan et al., entitled *Simplified Ink Jet Head.*

[0010] In general, such a membrane is deposited on a jet chip consisting of a nozzle plate and an ink chamber barrier layer, by a predetermined deposition method, for example, by chemical vapour deposition. Then, the jet chip on which the membrane is deposited is integrally joined to a heater chip consisting of a heating resistor layer and a heating chamber barrier layer, to thereby complete the construction of an inkjet printhead. Here, the jet chip on which the membrane is deposited is independently integrated with each heater chip.

[0011] The above-described methods of forming a membrane and of joining a jet chip to a heater chip are disclosed in U.S. Patent No. 5,752,303, Thiel, entitled *Method For Manufacturing A Face Shooter Ink Jet Print Head,* and U.S. Patent No. 5,703,632, Arashmina et al., entitled *Ink Jet Head Orifice Plate Mounting Arrangement.*

[0012] However, this conventional method of manufacturing inkjet printheads has some problems. As described above, each jet chip on which a membrane is deposited is independently joined with a heater chip. Here, because the membrane is integrally associated with the jet chip, each joining of the membrane to a respective heater chip is correspondingly an independent step.

[0013] Since the membrane is independently joined to each heater chip, the time required for completing the assembly of an inkjet printhead is significant. Thus, the overall production system may not be able to flexibly deal with a sudden mass production request.

[0014] Moreover, as described above, a jet chip on which a membrane is deposited is united with a heater chip so as to complete an inkjet printhead. Here, to assemble the jet chip at the corresponding position of the heater chip, it is essential to perform an alignment process for correctly adjusting the relative position between the two chips.

[0015] However, the membrane inserted between a jet chip and a heater chip is generally formed as an extremely thin film. Therefore, when processes of aligning and assembling are performed on the jet chip on which a membrane is deposited and with which the membrane moves, such a membrane can be damaged by contacting various peripheral auxiliary tools, for example, tools for conveyance or for pressing. In this case, performance of the membrane is significantly lowered and thus its function of ink injection may not be properly performed.

[0016] Moreover, during assembly, the membrane is inserted between a jet chip and a heater chip in an orientation where the membrane is not exposed. Therefore, a worker may not readily recognize that damage has occurred on a portion of the membrane.

[0017] If an electronic device, for example, an inkjet printer, is provided with a printhead with unrecognised damage on a membrane, the electronic device can not produce excellent quality printing. As a result, due to above-described problems, overall print performance is significantly reduced.

SUMMARY OF THE INVENTION

[0018] It is therefore an object of the present invention to provide an improved method for assembling a micro-injection device.

[0019] It is a further object of the invention to provide a method for assembling a micro-injection device yielding devices with fewer defects.

[0020] It is a yet further object of the invention to provide a method for assembling a micro-injection device in which damage to the membrane is prevented.

[0021] It is a still further object of the invention to provide a method for assembling a micro-injecting device in which the production time for completing the device is reduced.

[0022] It is a still yet further object of the present invention to provide a method for assembling a micro-injecting device which allows the overall production system to flexibly respond to a mass production request.

[0023] It is another object of the invention to provide a method for assembling a micro-injecting device in which alignment of the membrane and the heater chip is not necessary.

[0024] It is still another object of the invention to provide a method for assembling a micro-injecting device in which any damage to the membrane can be readily recognised during the assembly.

[0025] To achieve the above objects and other advantages, in the present invention, a membrane is not integrally deposited on a jet chip, but is manufactured as an independent part. In this case, the membrane can be assembled to a heater chip by an additional process, rather than by movement of the jet chip, even when a process for assembling a micro-injecting device is underway. As a result, the frequent movement of the membrane in the process of alignment or assembling can be avoided thereby preveting damage which may occur to the membrane. In addition, because the membrane is assembled separately from the jet chip, the membrane is not inserted between the jet chip and the heater chip in the process of assembling. Thus, the membrane can be exposed so that a worker can easily recognize any damage to the membrane, which enables rapid measures to be taken to correct the damage.

[0026] Furthermore, in the present invention, a membrane is glued at the same time to a plurality of heater chips constituting a wafer unit instead of gluing membranes one by one to each heater chip. Thus, the membrane can be aligned to a plurality of heater chips at once. As a result, there is no need to align a membrane to each heater chip, and thus the time required to finish the entire process for assembling micro-injecting devices is considerably reduced. Due to the reduction in time required for assembling, a production system capable of flexibly handling a mass production request can be obtained.

[0027] To achieve this, in the present invention, a heater chip wafer on which a plurality of heater chips are formed is fixed to a vacuum bench. Then, a membrane which is manufactured as an individual part is aligned with the heater chips so as to be separated from the heater chips by a predetermined distance, $4\mu m$ to $6\mu m$. Then, the membrane is fixed onto the heater chip wafer and the heater chip wafer and the membrane are glued to each other. Thus, the membrane is aligned to a plurality of heater chips and assembled at one time.

[0028] To accomplish an object of the present invention, an additional assembling device is needed according to another aspect of the present invention. This assembling device includes a vacuum bench for fixing a heater chip wafer in a vacuum environment, a membrane-fixing ring for pressing the periphery of a membrane on the vacuum bench and fixing the membrane onto the heater chip wafer, a fixing ring supporting holder for supporting the membrane fixing ring, a membrane alignment table for fixing the fixing ring supporting holder and aligning the membrane to the heater chip wafer, and a heating tool for emitting infrared radiation to the membrane and the heater chip wafer so as to heat and glue the membrane and the heater chip wafer. The membrane can be assembled in a single process to a plurality of heater chips due to an operation of the assembling device described above.

[0029] As described above, in the present invention, a membrane is provided independently from a jet chip in the assembly process, and a plurality of heater chips are assembled to the membrane at one time. As a result, the time required for assembling a micro-injecting device is significantly reduced.

[0030] According to an aspect of the present invention, there is provided a method comprising the steps of fixing a heater chip wafer comprising a plurality of heater chips to a vacuum bench by means of a vacuum; depositing an adhesive on a membrane and aligning the membrane with the heater chip wafer, the membrane separated from the heater chip wafer by a predetermined gap; fixing the membrane to the heater chip wafer; and bonding the membrane to the heater chip wafer.

[0031] Preferably, the step of depositing adhesive on the membrane and aligning the membrane further comprises installing the membrane in a membrane fixing ring.

[0032] Preferably, the step of depositing adhesive on the membrane and aligning the membrane further comprises fixing the membrane fixing ring to a membrane alignment table.

[0033] Preferably, the step of depositing adhesive on the membrane and aligning the membrane further comprises aligning the membrane by driving the membrane alignment table with a driving cylinder.

[0034] Preferably, the step of bonding the membrane to the heater chip wafer further comprises heating the fixed membrane and heater chip wafer with infrared radiation from a heating device.

[0035] Preferably, the step of heating the fixed membrane and the heater chip wafer further comprises heating the fixed membrane and heater chip wafer to a temperature in the range of approximately 200 to 280°C for a time in the range of approximately 15 to 30 seconds.

[0036] Preferably, the step of bonding the membrane to the heater chip wafer further comprises a first bonding step of heating the fixed membrane and heater chip wafer with infrared radiation from a heating device; and a second bonding step, itself comprising the steps of placing the first bonded fixed membrane and heater chip wafer in a kiln; and applying heat and pressure to the first bonded fixed membrane and heater chip.

[0037] Preferably, the second bonding step comprises applying pressure to the first bonded fixed membrane in the range of approximately 1 to 15kg/cm^2, more preferably in the range of approximately 2 to 10 kg/cm^2.

[0038] Preferably, second bonding step itself comprises applying heat to the first bonded fixed membrane and heater chip wafer at a temperature in the range of approximately 150 to 400°C. The temperature is more preferably in a range of approximately 200 to 350°C.

[0039] The step of depositing adhesive glue membrane and aligning the membrane preferably further comprises aligning the membrane with a gap of in the range of approximately 4 to 6μm from the heater chip wafer.

[0040] The method preferably further comprises the step of forming ink via holes on the bonded heater chip and membrane after the bonding step.

[0041] Preferably, the membrane is manufactured as an independent part and is assembled to the heat chip wafer.

[0042] The membrane is preferably adhered to and aligned to a plurality of wafer chips constituting the heater chip wafer at the same time.

[0043] The ink via holes may be formed using a CO_2 gas laser.

[0044] According to a further aspect of the present invention, there is provided an apparatus for assembling a micro-injecting device. The apparatus comprises a vacuum bench for fixing a heating chip wafer using suction; a membrane alignment table having holes perforating the table, the membrane alignment table orientated above the vacuum bench, for holding a membrane; a fixing ring supporting holder having members penetrating the holes of the membrane alignment table, for supporting a membrane fixing ring; and a membrane fixing ring, for pressing the periphery of a membrane against the upper surface of the heater chip wafer, the membrane fixing ring supported by the fixing ring supporting holder.

[0045] The membrane alignment table preferably comprises an aperture for allowing infrared irradiation of the membrane.

[0046] The apparatus may, further comprise a heating device mountable above the aperture for providing infrared radiation.

[0047] The apparatus may further comprise a driving cylinder attached to the membrane alignment table, for orienting the membrane alignment table.

[0048] The membrane may be manufactured as an independent part and assembled to the heat chip wafer.

[0049] The membrane may be adhered to, and aligned to, a plurality of wafer chips constituting the heater chip wafer at the same time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] A more complete appreciation of the invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or similar components, wherein:

> Figure 1 is a flow diagram showing a method for assembling a micro-injecting device according to the present invention;
>
> Figure 2 is an exploded perspective view of an assembling apparatus for the micro-injecting device according to another aspect of the present invention;
>
> Figure 3 is a sectional view of the micro-injecting device shown in Figure 2;
>
> Figure 4 is a view showing an embodiment of high

temperature and high pressure kiln according to an assembling method of the present invention.

Figure 5 is a view showing an embodiment of a micro-injecting device assembled according to the present invention; and

Figures 6 and 7 are views of operational states of the micro-injecting device shown in Figure 5.

DETAILED DESCRIPTION OF THE INVENTION

[0051] The present invention will now be described more fully with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. As the terms mentioned in the specification are determined based upon the function of the present invention, and they can be changed according to the technician's intention or a usual practice, the terms should be determined considering the overall contents of the specification of the present invention.

[0052] An apparatus for assembling a micro-injecting device of the present invention is constituted as follows. FIGs 2 and 3, illustrate an assembling apparatus 200 according to a further aspect of the present invention, in which a vacuum bench 201 fixes via a vacuum air hole 205 a heater chip wafer 100 provided with a plurality of heater chips 101. Each vacuum air hole 205 is connected to a vacuum pump 208, so as to maintain excellent suction.

[0053] A membrane fixing ring 202 is installed above the vacuum bench 201. The membrane fixing ring 202 serves for handling and pressing a periphery of the membrane 20 so that the membrane 20 can be fixed in place at a predetermined space from the heater chip wafer 100. Here, the membrane 20 to be fixed by the membrane fixing ring 202 has a wide thin film layer structure so that it can cover all of the heater chip wafer 100.

[0054] The membrane fixing ring 202 is supported by a fixing ring supporting holder 204 which in turn is inserted by a predetermined length to a bottom surface of the membrane 20 so that the membrane 20 can keep a predetermined space with respect to the heater chip wafer 100.

[0055] The fixing ring supporting holder 204 is fixed by penetrating through holes 220 in a membrane alignment table 203. The membrane alignment table 203 is connected to a driving cylinder (not shown) so as to allow movement smoothly in every direction. If the membrane 20 is aligned to the heater chip wafer 100, the membrane alignment table 203 may be rapidly moved in every direction by operation of the driving cylinder. Thus, movement of the membrane alignment table 203 can be correctly delivered to the membrane 20 through the fixing ring supporting holder 204. As a result, the membrane 20 can be rapidly aligned to the relevant position of the heater chip wafer 100.

[0056] Meanwhile, a heating device 207 which serves to emit infrared radiation is placed above the membrane alignment table 203. The heating device 207 emits infrared radiation to the membrane 20 and the heater chip wafer 100 so that the membrane 20 strongly adhere to the heater chip wafer 100. An adhesive 21 is deposited to a predetermined thickness, for example, 1μm, to the bottom surface of the membrane 20. The adhesive 21 is melted by the infrared radiation emitted from the heating tool 207 so that the membrane 20 strongly adheres to the heater chip wafer 100.

[0057] Preferably, infrared radiation emitted from the heating tool 207 passes through a penetrating aperture 206 in the alignment table 203 and reaches the membrane 20 and the heater chip wafer 100 without being hindered by obstacles.

[0058] Hereafter, a method for assembling a membrane and a heater chip wafer employing the above described assembling apparatus will be explained in detail. As shown in FIG.1, a worker first conveys the heater chip wafer 100 to the assembling apparatus 200 through a conveying apparatus (not shown) and fixes the heater chip wafer 100 so conveyed onto the vacuum bench 201 at a step S1. Here, as described above, a plurality of heater chips 101 are arrayed on the heater chip wafer 100. The vacuum bench 201 draws air from the bottom surface of the heater chip wafer 100 through the vacuum pump 208 connected to the vacuum air hole 205 so that the heater chip wafer 100 can be fixed more strongly on the vacuum bench 201.

[0059] The membrane 20 is pressed by the membrane fixing ring 202 and supported by the fixing ring supporting holder 204. Thus, the membrane 20 is fixed and separated from the heater chip wafer 100 by a predetermined gap, preferably in the range of approximately 4μm to 6μm. In this case, the membrane 20 has a wide thin film layer structure so as to be assembled to a plurality of heater chips 101 formed on the heater chip wafer 100 all at once.

[0060] Preferably, in the present invention, membrane 20 and heater chips 101 in which patterns, such as ink via holes, will later be formed, are used in the assembly process. That is, in the present invention, the assembly of the membrane 20 and heater chips 101 is performed prior to the formation of ink via holes in the membrane 20 and each heater chip 101.

[0061] In the present invention, a method of assembling the membrane 20 to each heater chip 101 is performed prior to the formation of ink via holes . The membrane 20 is assembled to a plurality of heater chips 101. A process for forming an ink via hole is performed to the membrane 20 and the heater chips 100. In the invention, the necessity for forming ink via holes individually to each of the membrane 20 and the heater chips 101 is eliminated, thereby reducing the effort and time of the entire process.

[0062] The membrane alignment table 203 moves in the appropriate directions by the operation of a driving cylinder so as to rapidly align the membrane 20 to the relevant position of the heater chip wafer 100 at a step S2. Preferably, the heater chip wafer 100 and the membrane 20 are aligned with each centre point being matched correctly. Thus, in the present invention, because the membrane 20 is attached at the same time to a plurality of heater chips 101, only the process of matching the respective centre point of the heater chip wafer 100 and the membrane 20 is necessary to rapidly complete an otherwise complicated alignment process.

[0063] When the above described alignment process is complete, the membrane alignment table 203 stops moving and fixes the membrane 20 to a relevant position of the heater chip wafer 100 at the step S3. Accordingly, the membrane 20 is fixed above the heater chip wafer 100 without changing position and thus is integrally assembled to the heater chip wafer 100. In addition, the adhesive 21 inserted between the membrane 20 and the heater chip wafer 100 is rapidly melted in the adhering process which will be described later. Thus, the membrane 20 and the heater chip wafer 100 can be more strongly adhered to each other.

[0064] When step S3 is complete, a process for adhering the membrane to the heater chip wafer 100 is performed at step S4. In the first adhering process, the heating tool 207 emits light radiation, more preferably infrared radiation, to the membrane 20 and the heater chip wafer 100 placed on the vacuum bench 201, to thereby rapidly melt the adhesive 21 deposited to the bottom surface of the membrane 20 at step S5. Thus, the membrane 20 can be strongly adhered all over the heater chip wafer 100 due to a heating operation of the heating tool 207.

[0065] Preferably, a first step of heating the membrane 20 and the heater chip wafer 100 by infrared radiation emitted from the heating tool 207, is performed at a temperature in the range of approximately 200°C to 280°C and for in the range of approximately 15 to 30 seconds. When the first adhering process is complete, the second adhering process is performed. Here, a worker conveys through a conveying apparatus a membrane and heater chip wafer assembly which is integrally assembled through the first adhering process, to a high temperature and high pressure kiln 300 shown in FIG, 4 at a step S6.

[0066] The kiln 300 applies a pressure in the range of approximately 1 kg/cm^2 to 15 kg/cm^2, more preferably 2 kg/cm^2 to 10 kg/cm^2, at a temperature in the range of approximately 150°C to 400°C, and more preferably 200°C to 350°C, so that a predetermined chemical or physical reaction can occur at a boundary surface of the above mentioned membrane and heater chip wafer assembly. Thus, the membrane and heater chip wafer assembly can be adhered more strongly in a second adhering process. When both the first and second adhering processes are complete, the membrane and the heater chip wafer which were separate in the membrane and heater chip wafer assembly are strongly adhered, to thereby obtain a single membrane and heater chip wafer assembly.

[0067] To summarize, in the present invention, the membrane 20 is manufactured as a part independent of a jet chip and is joined to the heater chip 101 without concern as to the movement of the jet chip. Thus, vibration of the membrane 20 caused by movement of jet chip can be prevented. As a result, damage to the membrane 20 by contacting peripheral auxiliary tools can be prevented in advance.

[0068] In addition, the membrane 20 is joined to the heater chip 101 independently of jet chip so that the membrane 20 can be widely exposed as the membrane is not inserted between the jet chip and the heater chip 101 during a process for assembling. As a result, a worker can easily recognise any damage on the membrane and rapidly take countermeasures for the recognised damage.

[0069] Furthermore, in the present invention, the membrane 20 is adhered at the same time to a plurality of heater chips 101 constituting a wafer unit instead of adhering membranes one by one to each heater chip. As a result, the time required for assembling a micro-injecting device can be significantly reduced.

[0070] If the present invention is adapted to a practical manufacturing, the time for completing the product is reduced, to thereby easily accomplish mass production. Meanwhile, after the step of adhering the heater chip wafer and the membrane, a step for forming ink via holes both to the heater chip wafer 100 and the membrane 20 is additionally performed.

[0071] Accordingly, each component that constitutes the membrane and heater chip wafer assembly, for example, the membrane 20 and the heater chip wafer 100, is etched to a specific shape through a laser emission from a CO_2 gas laser (not shown), preferably so that an ink via hole can be formed in a predetermined portion of the heater chip wafer 100 at step S7. In this case, the necessity of a worker forming ink via holes one by one for the membrane 20 and the heater chip 101 is eliminated. Instead, the worker can form ink via holes in a plurality of heater chips 101 and the membrane 20 integrally assembled to the heater chips 101 at the same time. As a result, the effort and time of the entire process is significantly reduced.

[0072] The membrane and heater chip wafer assembly in which the membrane and the heater chip wafer are integrally joined through the processes of alignment, assembling and forming ink via holes, is joined, through a general process for assembling, to a jet chip manufactured through a separate process. As a result, a micro-injecting device having a complete structure as shown in FIG.5 can be obtained.

[0073] In such a micro-injecting device, a protection film 2 made of SiO_2 is formed on a substrate 1 made of Si and a heating resistor layer 11 heated by electrical energy applied from an external device is formed on the protection film 2. In addition, an electrode layer 3 for providing the heating resistor layer 11 with electric energy applied from an external device is formed on the heating resistor layer 11. The electrode layer 3 is connected to a common electrode 12, and the electric energy provided from the electrode layer 3 is converted to thermal energy by the heating resistor layer 11.

[0074] A heating chamber 4 defined by a barrier layer 5 is formed on the electrode layer 3 so as to isolate the heating resistor layer 11, allowing heat converted by the heating resistor layer 11 to be delivered to the heating chamber 4. The heating resistor layer 11 and the heating chamber barrier layer 5 form a plurality of layers and constitute the above-described heater chips 101.

[0075] At this time, working liquid from which vapour pressure is easily generated fills the heating chamber 4, and the working liquid is rapidly vapourized by the heat delivered from the heating resistor layer 11. In addition, the vapour pressure generated from the vapourization of the working liquid is delivered to the membrane 20 formed on the heating chamber barrier layer 5. The membrane 20 is assembled to a plurality of heater chips 101, thereby accomplishing a stable structure.

[0076] An ink chamber 9 defined by the ink chamber barrier layer 7 is formed on the membrane 20 so as to be placed at the same axis with respect to the heating chamber 4, and the ink chamber 9 thus formed is filled with an appropriate amount of ink. A nozzle 10 is formed on the ink chamber barrier layer 7 so as to cover the ink chamber 9 and serves as a jet gate for ink droplets to be ejected. The nozzle 10 is formed penetrating a nozzle plate 8 so as to be coaxial with the heating chamber 4 and the ink chamber 9. The nozzle plate 8 and the ink chamber barrier layer 7 form a plurality of layers so as to constitute the jet chip 102.

[0077] In operation, as shown in FIG.6, if an electrical signal is applied to the electrode layer 3 from an external power source, the heating resistor layer 11 that contacts the electrode layer 3 is provided with electrical energy and thus heated rapidly to a temperature of 500°C or above. During this process, the electric energy converts to a thermal energy of 500°C to 550°C.

[0078] Then, the converted thermal energy is delivered to the heating chamber 4 connected to the heating resistor layer 11. The working liquid contained in the heating chamber 4 is rapidly vapourized by the thermal energy so delivered, to thereby generate a vapour pressure having a predetermined size.

[0079] Then, the vapour pressure is delivered to the membrane 20 placed on the heating chamber barrier layer 5, and accordingly, an impact power P having a predetermined size is applied to the membrane 20. Then, the membrane 20 expands rapidly as shown by the arrow mark in FIG.6 and is bent into a rounded shape. A strong impact is then delivered to ink 400 contained in the ink chamber 9, and the ink 400 is discharged.

[0080] At this point, as shown in FIG.7, the electrical signal applied from an external device is cut off and the heating resistor layer 11 rapidly cools down. Thus, the vapour pressure in the heating chamber 4 is rapidly decreased and the inside of the heating chamber 4 is depressurized. Then, the vacuum contained in the heating chamber 4 applies strong 'buckling' power B (corresponding to the impact described above) to the membrane 20 which then contracts and returns to its initial shape. In this case, the membrane 20 is rapidly contracted as shown by the arrow mark of FIG.7, so as to deliver a strong 'buckling' power to the inside of the ink chamber 4.

[0081] Accordingly, the ink 400 which is discharged by the expansion of the membrane 20 is transformed, due to its own weight, to ovoid and spherical shapes in turn and is discharged to external printing paper. Thus, a rapid printing can be performed on the printing paper.

[0082] As described above, in the present invention, a membrane is assembled independently of a jet chip, and a plurality of heater chips are joined to the membrane at the same time, to thereby reduce significantly the time required for assembling a micro-injecting device. The present invention is not limited to a process for assembling the above-described micro-injecting device, and the invention can be used on various micro-injecting devices which employ a membrane, for example, micro-pumps or fuel-injecting devices, etc.

[0083] As described above, in a method and an apparatus for assembling micro-injecting device according to the present invention, a heater chip wafer on which a plurality of heater chips are formed is fixed on a vacuum bench. Then a membrane manufactured as a part independent of a jet chip is aligned so as to be separated by a predetermined space from the heater chip wafer. Then, the membrane is fixed on the heater chip wafer and the membrane and the heater chip wafer are adhered to each other.

[0084] Therefore, a method for assembling a micro-injecting device and an apparatus for assembling the device are disclosed. A heater chip wafer on which a plurality of heater chips are formed is fixed onto a vacuum bench, and a membrane manufactured independently of a jet chip is aligned to be separated by a predetermined space from the heater chip wafer, and the membrane is fixed on the heater chip wafer. This avoids the membrane being moved frequently in the process of aligning and assembling, thus obtaining in-advance prevention against damage to the membrane, and elimination of the necessity to align the membrane to each heater chip, thereby reducing significantly the time required for assembling.

[0085] The method of the present invention avoids frequent movement of the membrane during the process of alignment and assembling. Thus, prevention of damage to the membrane can be obtained in advance. In addition, the necessity of aligning the membrane to each heater chip is eliminated. Thus, the time required for completing a micro-injecting device can be significantly reduced.

[0086] This invention has been described above with reference to the aforementioned embodiments.

[0087] It is evident, however, that many alternative modifications and variations will be apparent to those having skill in the art in light of the foregoing description. Accordingly, the present invention embraces all such alternative modifications and variations as fall within the spirit and scope of the appended claims.

Claims

1. A method for assembling a micro-injection device, comprising the steps of:

fixing a heater chip wafer (100) comprising a plurality of heater chips (101) to a vacuum bench (201) by means of a vacuum;

depositing an adhesive on a membrane (20) and aligning the membrane with the heater chip wafer, the membrane (20) separated from the heater chip wafer (100) by a predetermined gap;

fixing the membrane (20) to the heater chip wafer (100); and

bonding the membrane (20) to the heater chip wafer (100).

2. A method according to claim 1, in which the step of depositing adhesive on the membrane and aligning the membrane further comprises:
installing the membrane (20) in a membrane fixing ring (202).

3. A method according to claim 1 or 2, in which the step of depositing adhesive on the membrane and aligning the membrane further comprises:
fixing the membrane fixing ring (202) to a membrane alignment table (203).

4. A method according to claims 1 or 2 or 3, in which the step of depositing adhesive on the membrane and aligning the membrane further comprises:
aligning the membrane (20) by driving the membrane alignment table (203) with a driving cylinder.

5. A method according to any of the preceding claims in which the step of bonding the membrane to the heater chip wafer further comprises:
heating the fixed membrane (20) and heater chip wafer (100) with infrared radiation from a heating device (207).

6. A method according to claim 5, in which the step of heating the fixed membrane (20) and the heater chip wafer (100) further comprises:
heating the fixed membrane (20) and heater chip wafer (100) to a temperature in the range of approximately 200 to 280°C for a time in the range of approximately 15 to 30 seconds.

7. A method according to any of the preceding claims in which the said step of bonding the membrane to the heater chip wafer further comprises:
a first bonding step of heating the fixed membrane (20) and heater chip wafer (100) with infrared radiation from a heating device (207); and
a second bonding step, comprising the steps of:

placing the first bonded fixed membrane (20) and heater chip wafer (100) in a kiln (300); and

applying heat and pressure to the first bonded fixed membrane and heater chip.

8. A method according to claim 7, in which the second bonding step comprises:
applying pressure to the first bonded fixed membrane in the range of approximately 1 to 15kg/cm^2.

9. A method according to claim 8, in which the pressure applied to the first bonded fixed membrane is in the range of approximately 2 to 10 kg/cm^2.

10. A method according to claims 7 or 8 in which the second bonding step comprises:
applying heat to the first bonded fixed membrane (20) and heater chip wafer (100) at a temperature in the range of approximately 150 to 400°C.

11. A method according to claim 10, in which the temperature is in a range of approximately 200 to 350°C.

12. A method according to any of the preceding claims in which the step of depositing adhesive glue membrane and aligning the membrane further comprises:
aligning the membrane (20) with a gap of in the range of approximately 4 to 6μm from the heater chip wafer (100).

13. A method according to any of the preceding claims further comprises the step of:
forming ink via holes on the bonded heater chip and membrane after the bonding step.

14. A method according to any of the preceding claims in which the membrane (20) is manufactured as an independent part and assembled to the heat chip wafer (100).

15. A method according to any of the preceding claims in which the membrane (20) is adhered to and aligned to a plurality of wafer chips (101) constituting the heater chip wafer (100) at the same time.

16. A method according to claim 13 in which the ink via holes are formed using a CO_2 gas laser.

17. An apparatus for assembling a micro-injecting device, comprising:

a vacuum bench (201) for fixing a heating chip wafer (100) using suction;

a membrane alignment table (203) having holes perforating the table, the membrane alignment table orientated above the vacuum bench, for holding a membrane (20);

a fixing ring supporting holder (204) having members penetrating the holes of the membrane alignment table (203), for supporting a membrane fixing ring (202); and

a membrane fixing ring (202), for pressing the periphery of a membrane (20) against the upper surface of the heater chip wafer (100), the membrane fixing ring (202) supported by the fixing ring supporting holder (204).

18. An apparatus according to claim 17 in which the membrane alignment table (203) comprises an aperture (206) for allowing infrared irradiation of the membrane (20).

19. An apparatus according to claims 17 or 18, further comprising:
a heating device (207) mountable above the aperture (206) for providing infrared radiation.

20. An apparatus according to claim 19, further comprising:
a driving cylinder attached to the membrane alignment table (203), for orienting the membrane alignment table.

21. An apparatus according to any of claims 17 to 20 in which the membrane (20) is manufactured as an independent part and assembled to the heater chip wafer (100).

22. An apparatus according to any of claims 17 to 21 in which the membrane (20) is adhered to and aligned to a plurality of wafer chips (101) constituting the heater chip water (100) at the same time.

23. A method for assembling a micro-injection device being substantially as described herein with reference to and/or as illustrated in figures 1 to 7 of the accompanying drawings.

24. An apparatus for assembling a micro-injecting device being substantially as described herein with reference to and/or as illustrated in figures 1 to 7 of the accompanying drawings.

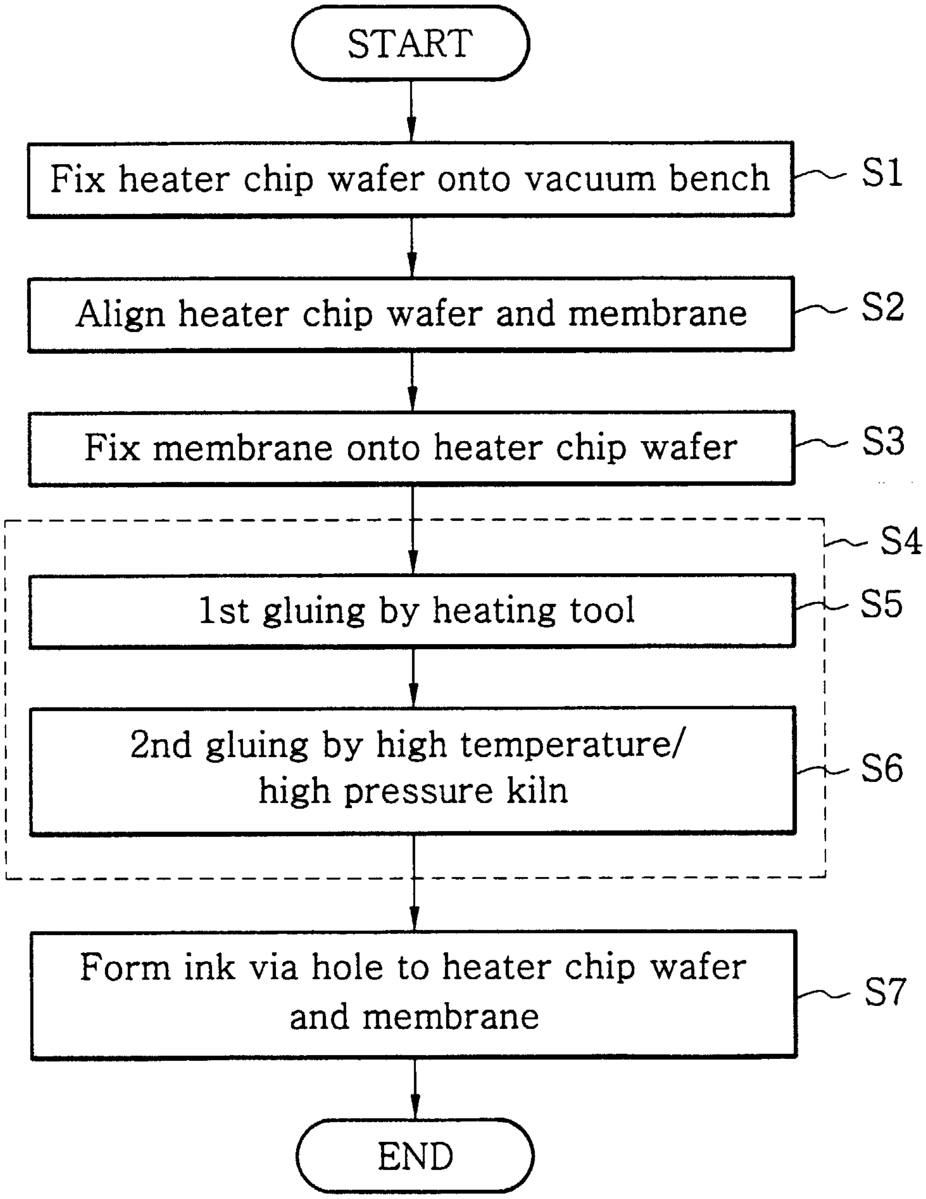
START
Fix heater chip wafer onto vacuum bench
S1
Align heater chip wafer and membrane
S2
Fix membrane onto heater chip wafer
S3
S4
1st gluing by heating tool
S5
2nd gluing by high temperature/ high pressure kiln
S6
Form ink via hole to heater chip wafer and membrane
S7
END

Fig. 1

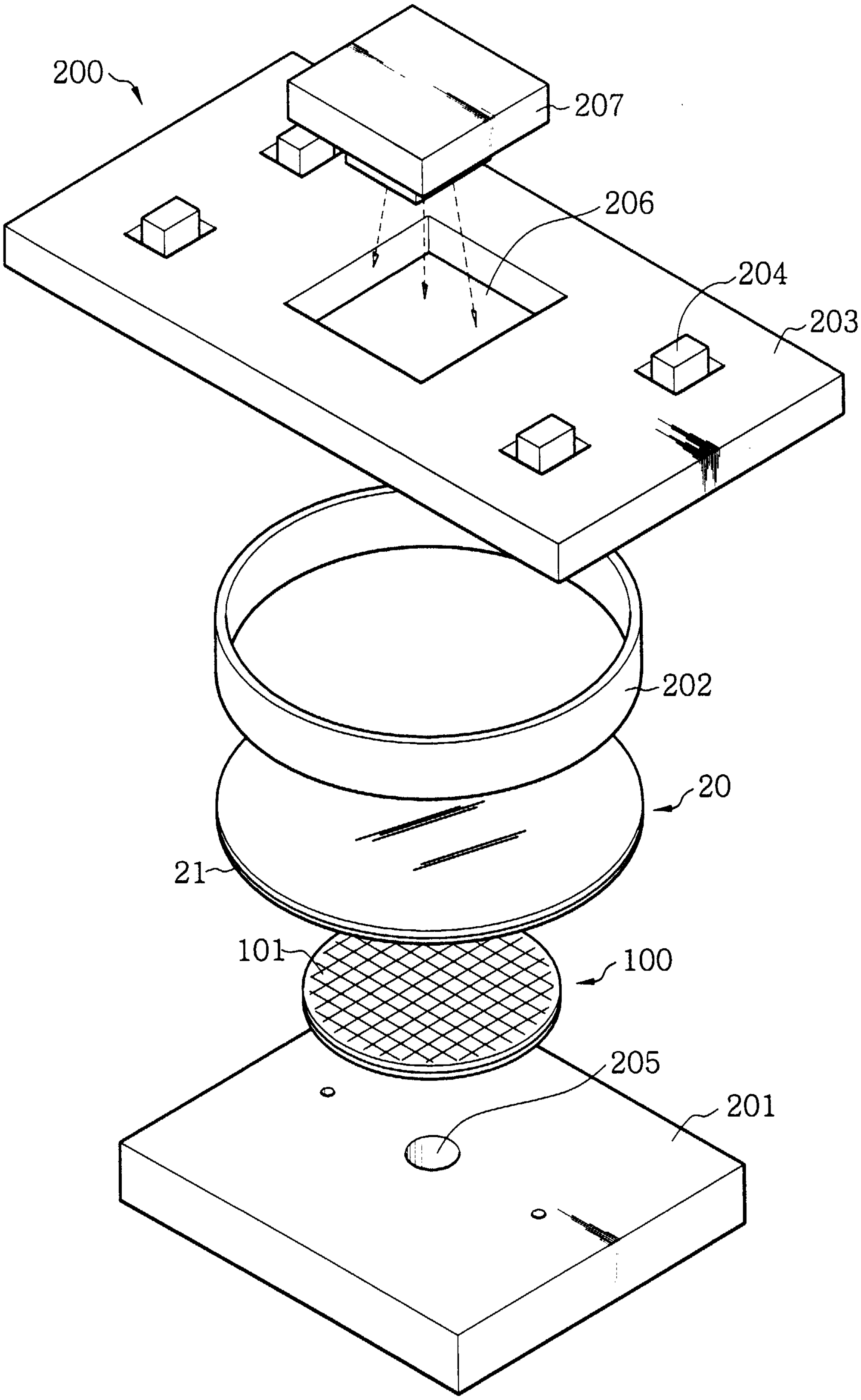

Fig. 2

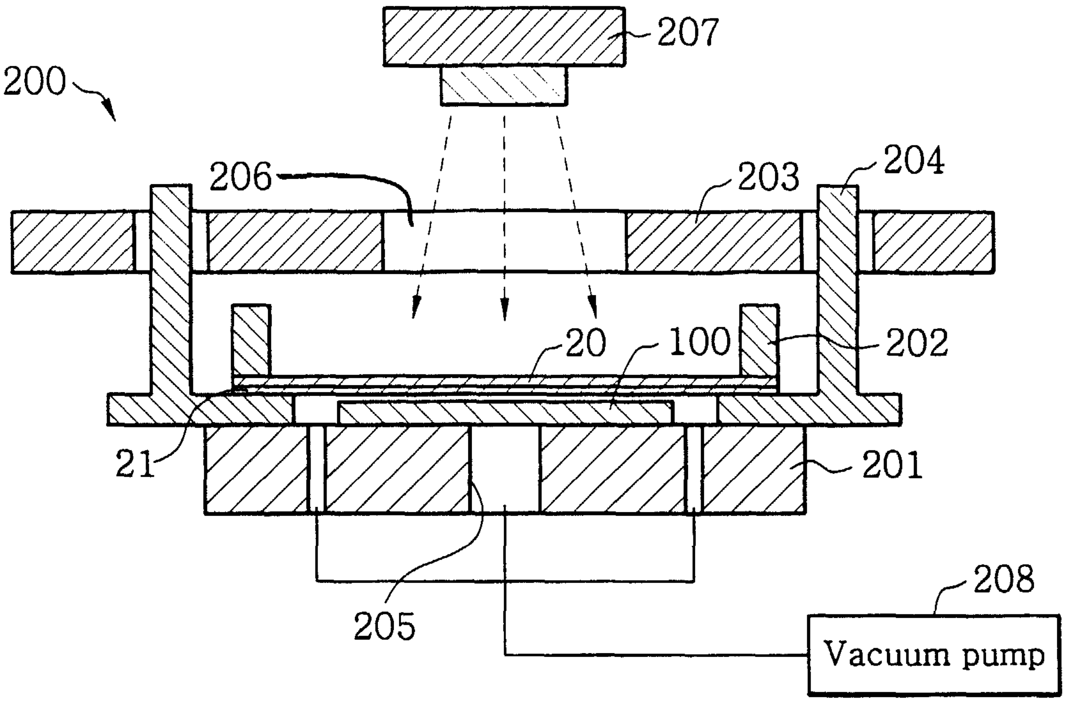

Fig. 3

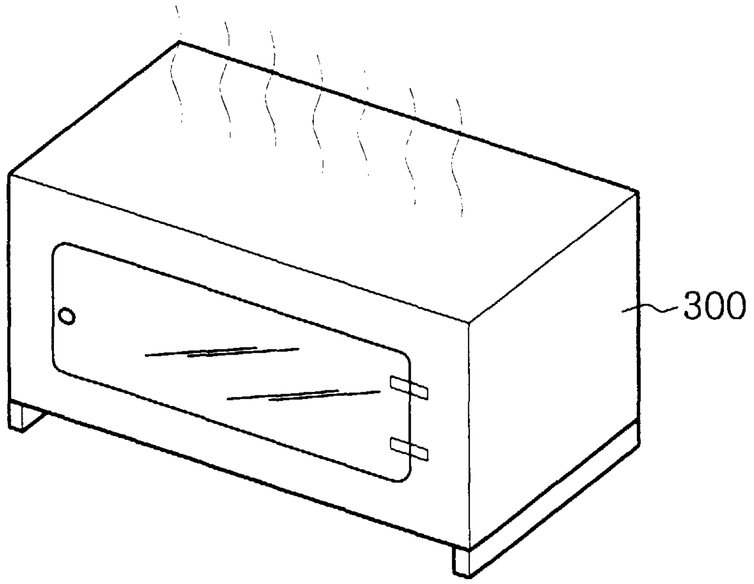

Fig. 4

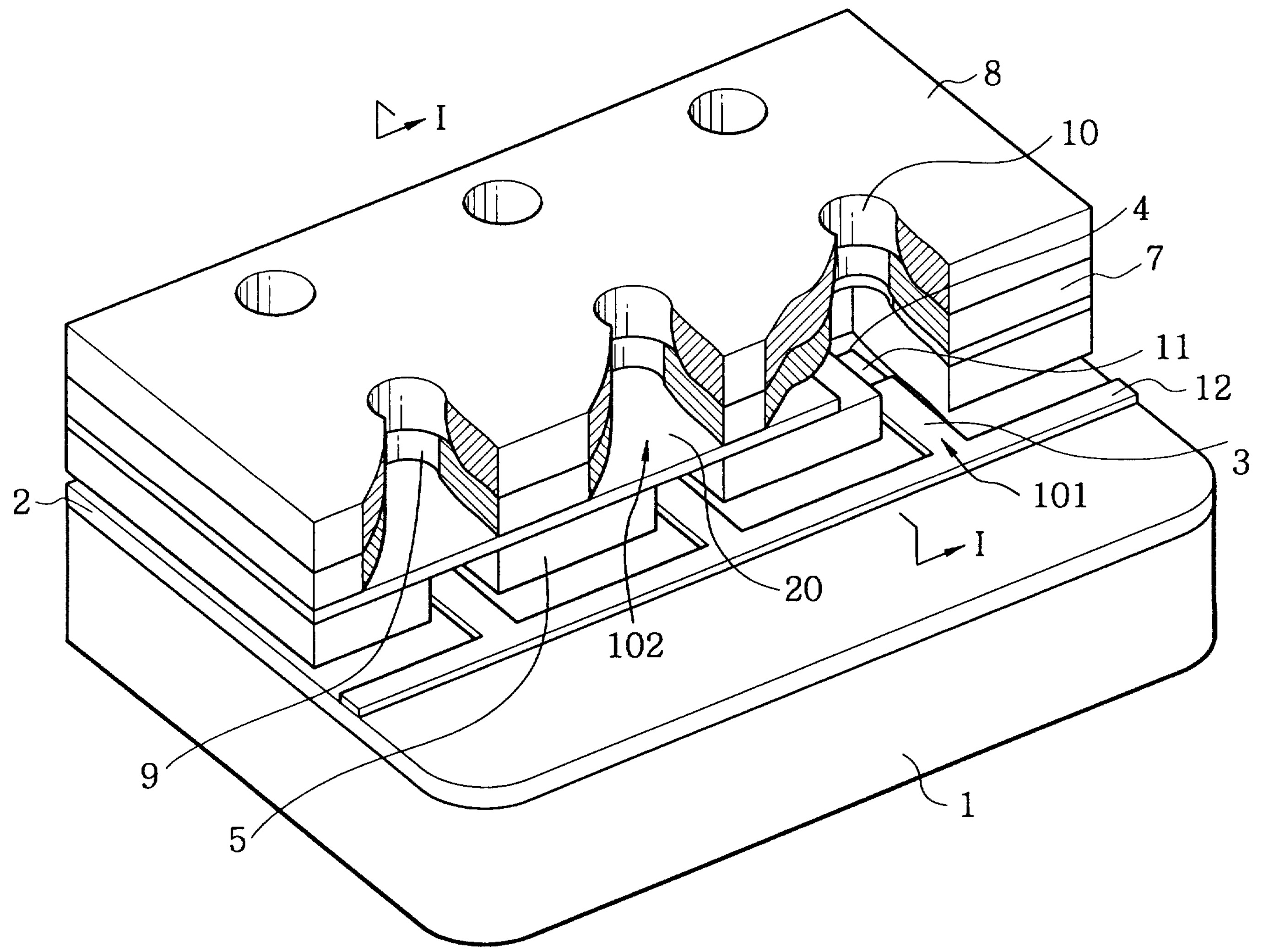

Fig. 5

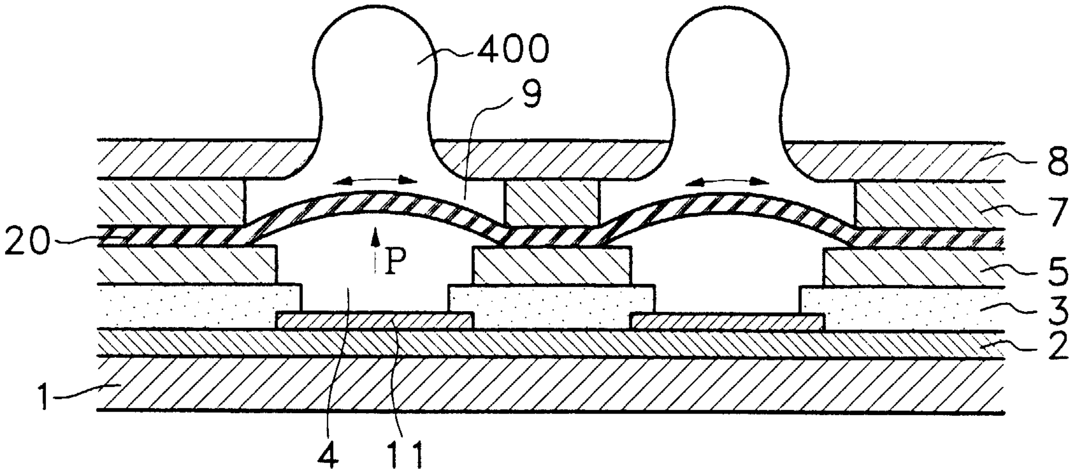

Fig. 6

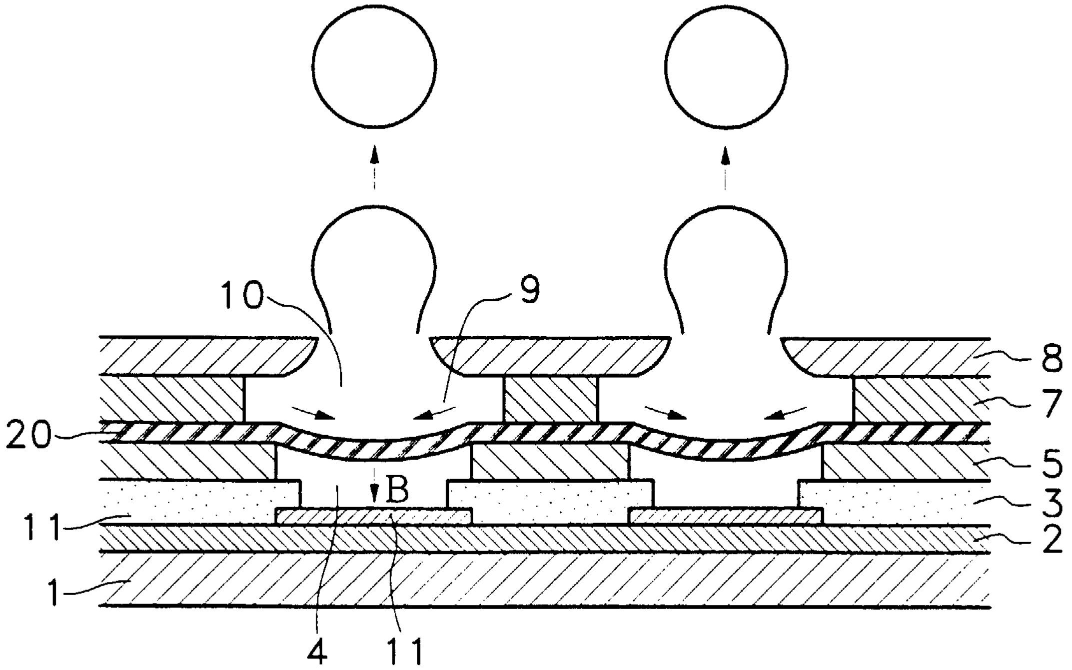

Fig. 7