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(11) **EP 1 021 302 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
15.01.2003 Bulletin 2003/03

(21) Application number: **98946612.3**

(22) Date of filing: **09.10.1998**

(51) Int Cl.7: **B41J 2/14**, B41J 2/16

(86) International application number:
PCT/GB98/03050

(87) International publication number:
WO 99/019147 (22.04.1999 Gazette 1999/16)

(54) **DROPLET DEPOSITION APPARATUS AND METHODS OF MANUFACTURE THEREOF**
TRÖPFCHENAUFZEICHNUNGSGERÄT UND HERSTELLUNGSVERFAHREN
APPAREIL UTILE POUR DEPOSER DES GOUTELETTES ET PROCEDES DE FABRICATION
ASSOCIES

(84) Designated Contracting States:
AT CH DE ES FR GB IT LI NL SE

(30) Priority: **10.10.1997 GB 9721555**

(43) Date of publication of application:
26.07.2000 Bulletin 2000/30

(60) Divisional application:
02010145.7 / 1 241 007

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EP 1 021 302 B1

Description

[0001] The present invention relates to droplet deposition apparatus, in particular an inkjet printhead, which comprise a channel communicating with a supply of droplet liquid and an opening for ejection of droplets therefrom, at least one channel side wall being displaceable in response to electrical signals, thereby to effect ejection of droplets from the channel.

[0002] Figure 1a is a cross-sectional view of the channels of the prior art inkjet printhead construction according to WO92/22429, belonging to the present applicant and incorporated herein by reference. Piezoelectric ceramic sheet 12 is poled in its thickness direction 17 and formed in one surface with channels 11 bounded on two sides lying parallel to the channel axis by channel walls 13. By means of electrodes 23 formed on either side of each wall 13, an electric field can be applied to the piezoelectric material of the walls, causing them to deflect in shear mode in a direction transverse to the channel axis. Pressure waves are thereby generated in the ink which result in the ejection of an ink droplet. These principles are known in the art, e.g. from EP-A-0 364 136, belonging to the present applicant and incorporated herein by reference.

[0003] Channels 11 are closed along one side lying parallel to the channel axis by the surface of a cover 14 having conductive tracks 16 at the same pitch interval as the ink channels formed thereon. Solder bonds 28 are formed between tracks 16 and the channel wall electrodes 23, thereby securing the cover to the base and creating an electrical connection between the electrodes and the track in a single step. To protect them from later being corroded by the ink, electrodes and tracks are then given a passivant coating.

[0004] As shown in figure 1 b, which is a sectional view taken along the longitudinal axis A of a single channel of the prior art printhead of figure 1a, a nozzle plate 20 having respective ink ejection nozzles 22 is mounted at the front of the sheet 12 whilst an ink manifold 26 is defined at the rear by a manifold structure 21. Tracks 16 are led to the rear of cover 14 for connection to a drive circuit, typically embodied in a microchip 27 which in turn is driven by signal received via input tracks 18.

[0005] In printheads of this ilk, the channel walls - and in particular the electrodes formed thereon - are often passivated so as to protect from subsequent corrosion by the ink. Reference is made in this regard to WO95/07820, incorporated herein by reference.

[0006] In the device discussed above, however, such conventional passivation prior to attachment of the cover would inhibit the formation of solder bonds between the electrodes and the tracks. On the other hand, passivation after the cover has been attached can only be applied from the end of the channel, resulting in low quality coating of the electrodes and tracks, especially at the midpoint of the channel remote from the channel ends.

[0007] A first aspect of the present invention consists in droplet deposition apparatus comprising droplet deposition apparatus comprising:

at least one longitudinal, open-topped droplet liquid channel defined by facing longitudinal side walls and a bottom, longitudinal surface extending between the side walls;
means for applying an electric field to piezoelectric material in at least one of said walls, thereby to effect displacement of the wall relative to said longitudinal channel so as to eject a droplet from the channel; and
a cover closing the open, longitudinal top side of the channel;

characterised in that said bottom longitudinal surface of the channel is formed with an opening for droplet ejection, and;

the cover incorporates two ports for supply of droplet liquid, the ports being spaced along the channel on either side of the opening.

[0008] Such a construction simplifies the manufacture of known printheads, particularly those of the top shooter kind discussed in WO91/17051 (belonging to the applicant and incorporated herein by reference). Figure 2 shows a sectional view along the channels of such a prior art printhead, with those features that correspond to figure 1 being denoted by corresponding reference numbers. Droplet ejection takes place from a nozzle 22 formed in the channel cover component 60 whilst droplet liquid is supplied to the channel via ports 33 formed in the channel base and which are typically connected in their turn to ink supply conduits (not shown) formed in a base component 35 that is separate from the piezoelectric channelled component 12.

[0009] In accordance with the invention, an opening communicating with a droplet ejection orifice is formed in the bottom surface of the channel, thereby allowing the cover component to incorporate ports for supply of ink into the channel. A further, separate base component is consequently no longer required.

[0010] A second aspect of the present invention provides a method of manufacture of droplet deposition apparatus comprising the steps of:

providing a body including piezoelectric material and having at least one longitudinal, open-topped channel, the channel being defined by facing longitudinal side walls and a bottom, longitudinal surface extending between the side walls;

characterised by forming an opening in the bottom longitudinal surface of the channel for ejection of droplet liquid;

providing means for applying an electric field to piezoelectric material in at least one of said walls,

thereby to effect displacement of the wall relative to said longitudinal channel so as to eject a droplet from the channel;

closing the open, longitudinal top side of the channel by means of a cover having two droplet fluid supply ports arranged so as to lie spaced along the channel on either side of the opening.

[0011] Further advantageous embodiments of the invention are set out in the description, drawings and dependent claims.

[0012] The invention will now be described by way of example by reference to the following diagrams, of which:

Figure 3 is a sectional view taken along the channel axis of a printhead according to a first embodiment of a first aspect of the present invention;

Figures 4a and 4b show detail of the rear part of the printhead of figure 3 before and after attachment of the cover respectively;

Figure 5 is a sectional view taken along the channel axis of a printhead according to a second embodiment of a first aspect of the present invention;

Figure 6 is a sectional view taken along the channel axis of a printhead incorporating both first and second aspects of the present invention;

Figure 7 is a sectional view taken along the channel axis of a printhead according to a second embodiment of a second aspect of the present invention;

Figure 8 is a detail perspective view of the end of the piezoelectric body of the printhead of figure 7.

Figures 9 and 10 are sectional and detail sectional views respectively of an alternative embodiment of the printhead shown in figure 7.

[0013] Figure 3 illustrates a printhead according to a first embodiment of the first aspect of the present invention, with those features that are common to figure 3 and the prior art printhead of figures 1 and 2 being designated by common reference numerals.

[0014] As in the prior art device, a piezoelectric ceramic body 12 poled in the thickness direction is formed with channels 11 separated by channel walls 13. As known from EP-A-0 364 136 referred to above, electrodes 23 are formed along each wall 13 in the ink-containing channel 11 as well as extending along a rearward groove 100 to the rear face 130 of the body. In addition, there is provided a cover 14, a surface 15 of which closes the open side of each of the channels 11, a nozzle plate 20 with nozzles 22 for droplet ejection and a manifold for supply of ink into the channel in the form of a transverse cut in the body 12. Surface 15 of cover 14 has tracks 16 formed thereon (suitable processes are well known) which in turn are connected to microchip 27 (which is illustrated figuratively in figure 3 and not to scale) which in turn receives input signals from input tracks 18.

[0015] Detail of the rear part of the printhead prior to attachment of the cover is shown in figure 4a: a passivation layer 140 (not shown in figure 3 but indicated by dashed hatching in figure 4a) is applied over the entirety of the electrodes 23 (indicated by solid hatching in both figures 3 and 4a) in the channel and part way along the rearward groove 100. In contrast to the prior art construction, passivation is carried out before attachment of the cover and advantageously according to the method described in WO95/07820, belonging to the present applicant and incorporated herein by reference.

[0016] A mechanical bond between body and surface 15 of cover 14 is achieved by means of adhesive layer 160, applied to the end surfaces of the walls 13 in the region of the channels 11 prior to assembly of cover and body and preferably in accordance with the method discussed in WO95/04658, belonging to the present applicant and incorporated herein by reference. Figure 4b illustrates the assembled printhead, with the adhesive bond being indicated at 220. Such a bond may indeed be tougher and have a longer fatigue life than the corresponding solder bond of the prior art construction described above.

[0017] Electrical connection between the conductive tracks 16 on the cover and that part of the electrode 23 in the rearward groove 100 is achieved by a protrusion 170 of a malleable, deformable, conductive material such as solder affixed to the end 180 of track 16. On assembly of the cover to the body, as illustrated in figure 4b, protrusion 170 comes into contact with electrode 23 and is deformed, thereby providing an effective electrical contact 200 between electrode 23 and track 16.

[0018] A bead 190 of a sealing paste or high viscosity glue is also applied so as to form on assembly an ink seal 210 between the end of the ink channel 11 and the electrical contact 200. Such a seal protects the electrical contact from later corrosion by ink. Preferably, the seal is positioned so as to straddle the free end 150 of the passivation layer 140, thereby preventing the seepage of ink under the passivation layer from where it might otherwise attack the electrode material 23.

[0019] Figure 5 illustrates a second embodiment of the first aspect of the present invention. A ceramic piezoelectric body 290 is, as in the previous embodiment, poled in the thickness direction and formed with channels 11 separated by channel walls 13 which in turn have an electrode 23 formed on each side. Ink ejection, however, takes place from a centrally located nozzle 320 formed either directly in the cover 350 or, as shown, in a nozzle plate 330 communicating with the channel via an aperture 340 formed in the cover. Body 290 is additionally formed with two manifolds 310 for supply of from both ends of the channel, as indicated by arrows 300. A further structure (not shown) will supply the manifolds with ink from a reservoir.

[0020] Such a "double-ended" printhead configuration is disclosed in WO91/17051, belonging to the present applicant and incorporated herein by reference,

and has advantages in terms of a lower operating voltage over the "single-ended" configuration described above. Furthermore, the configuration of base 290 is suited to manufacture by moulding - a technique that is potentially more attractive from the point of view of manufacturability than conventional sawing techniques described in the aforementioned EP-A-0 364 136.

[0021] The connection of the channel electrode 23 to conductive tracks 370 formed on that surface of cover 350 facing body 290 is as already described with regard to figures 3, 4a and 4b, however, and is located in groove 360 formed at one side of the body 290. Similarly, in the region of the channel itself (the channel walls of which are passivated prior to assembly) and at that end 380 of the body not occupied by an electrical connection, cover 350 is attached to the piezoelectric ceramic body by a conventional adhesive bond (not shown).

[0022] In order to minimise the distance travelled by the ink from the channel proper 11 to the outlet of the nozzle 320 - thereby reducing pressure losses and consequent reductions in droplet ejection velocity - the nozzle 320 may be formed in the cover 350 itself. Advantageously the nozzle is formed by laser ablation as described, for example, in WO93/15911 incorporated herein by reference, and to this end the cover may be made of an easily ablatable material, suitably a polymer such as polyimide, polycarbonate, polyester or polyetheretherketone, typically of 50µm thickness.

[0023] The stiffness of a cover plate formed of such an easily ablatable material may be increased by application of a coating of stiffer material to the inner and outer surfaces of the ablatable cover plate. Particularly suitable for this purpose is silicon nitride: it can also be used as a passivant coating in the process of the aforementioned WO95/07820, is deposited as a smooth coating suitable for the subsequent application of a non-wetting coating, and will not short out electrodes of adjacent channels due to its non-conducting properties. Two layers of such a material placed either side of the polyimide cover and each having a thickness of around 5% of that of the cover (2.5µm in the case of a 50µm thick cover) will typically increase bending stiffness by a factor of 5-10 (based on standard compound beam theory and assuming a value of Young's Modulus for the stiffening material approximately 100 times greater than that of the polymer and good adhesion between the stiff and polymer materials). Such a thin layer has no significant effect on the ease with which the cover plate can be ablated to form a nozzle, particularly if the material of the layer itself is to some degree ablatable.

[0024] Expressed in broad terms, the cover plate for an inkjet printer comprises a layer of a first, easily ablatable, material having further layers bonded on opposite sides thereof, the further layers each being of a material having a stiffness at least an order of magnitude greater than that of the first material and being of a thickness at least an order of magnitude less than that of the first layer.

[0025] Referring now to figure 6, there is shown a printhead incorporating both first and second aspects of the present invention. Piezoelectric ceramic body 400 is formed with channels 11, channel-separating walls 13 and electrodes 23 which are supplied with actuating signals via conductive tracks 410 connected to drive circuitry (not shown). Unlike previous embodiments, however, droplet ejection takes place from a nozzle 420 communicating with an opening 430 formed in the body 400 at the closed, bottom surface 440 of the channel 11 - this is in contrast to figure 5 where the nozzle 320 is located in a cover 350 closing the open, top side of the channel 11.

[0026] Moulding is again the preferred method of manufacture of the channelled body 400, and the arrangement of figures 4a and 4b is again employed for electrical connection between the electrodes 23 and conductive tracks 410. Communication hole 430 may also be formed during the moulding process or may be formed subsequently, e.g. by means of a laser. Cover 450 no longer incorporates a nozzle but is instead formed with ink inlet ports 460. Such an arrangement has a lower component count than embodiments discussed earlier and has consequential manufacturing advantages. Alternatively, ink supply ports could be formed in the channelled component, e.g. at the channel ends.

[0027] The printhead of figure 7 also employs a cover component 500 having ink inlet ports 520, 522 and 524 located at either end and in the middle of a channel 11 formed in a piezoelectric body 530. Channel walls are separated by a gap 540 into two sections 550, 560 supplied by ports 520, 522 and 522, 524 respectively, with each section being independently actuatable by means of respective electrodes 570, 580 driven by drive circuits (not shown) via conductive tracks 650, 660. For each section there is provided a respective nozzle 610, 620 formed in a nozzle plate 615 and communicating with a section of the channel 11 via communication holes 630, 640 formed in the bottom surface of the channel at points located midway between the respective inlet ports for that section.

[0028] Such a configuration is described in co-pending UK patent application no. 9710530.8, belonging to the applicant and incorporated herein by reference, and results in a printhead having two parallel rows of independently actuatable printing elements that is compact and which has a reduced actuating voltage per unit droplet ejection velocity due to the "double-ended" ink supply to each channel section.

[0029] Unlike earlier embodiments, the conductive tracks 650, 660 that electrically connect the channel electrodes to the drive chips are formed on the piezoelectric body itself, advantageously in the same step in which the electrodes 570, 580 are deposited on the channel walls. Such an arrangement is known from EP-A-0 397 441, belonging to the applicant and incorporated herein by reference, and consequently will not

be described in further detail here. Connection between track 650,660 and drive chip 590,600 may be achieved by any conventional method, including wire bonding or gold ball connection.

[0030] Piezoelectric body 530 may be moulded: in addition to having clear manufacturing advantages, such a process permits the end of the channel 11 to be formed as illustrated in figure 8, namely with a smooth, continuous transition 700 from the top surface 720 of the body to both the channel wall 730 and the bottom, longitudinal surface 710 of the channel. This in turn avoids discontinuities in the subsequently-deposited electrode material and the associated heating effects which might have a deleterious effect on the operational life of the printhead as a whole.

[0031] Alternatively, channels may be formed in the piezoelectric component by sawing using a disc cutter - as described e.g. in EP-A-0 309 148 - and illustrated in the sectional and detail sectional views of figures 9 and 10. It follows that the depth of the channel 11 will run out more gradually at each end, as shown at 800, and that the piezoelectric channel wall defined between adjacent sawn channels 11 will run continuously between the two active sections 550,560. However, a break 810 in the electrodes on the channel walls at a location between the two sections ensures that each the wall in active section can be actuated independently by signals supplied via electrical input 820. Such a break may be achieved e.g. by masking during deposition of the metal plating or by removal of the plating by a laser.

[0032] Connection between the electrodes on the channel walls and the electrical input 820, whilst not shown in detail, may be achieved by any of the known techniques including wire bond between tracks formed in shallow "run-out" grooves formed in the area 900 rearward of the channel 11 (described in the aforementioned EP-A-0 364 136) or conductive adhesive (e.g. anisotropic conductive adhesive) between conductive tracks formed in area 900 on the surface of the piezoelectric sheet itself and (described in EP-A-0 397 441).

[0033] As in the embodiment of figure 7, each channel 11 is closed along its two active sections 550,560 by appropriate lengths 820,830 of a cover component 500 which is also formed with ports 520,522,540 that allow ink to be supplied to each channel active section and, optionally, allow ink to be circulated through each channel section for cleaning purposes, as is generally known. Ports may be positioned so as to define the edge of an active section, as in the case of port 522, in which case manufacture is simplified. In the example shown, the width of cover port 552 and the cover closing lengths 820, 803 are of the same order of magnitude, typically 2mm.

[0034] Ink ejection from each active section is again via openings that communicate the channel with the opposite surface of the piezoelectric component (sheet 860) to that in which the channel is formed. In the present embodiment, these openings take the form of

slots 840,850 which extend some distance - typically 200µm - in the longitudinal direction of the channel so as to allow some leeway in the placing of the respective nozzles 870,880 in nozzle plate 890. Offsetting of nozzles is generally necessary whenever simultaneous droplet ejection from adjacent channels is not possible e.g. in "shared wall" printheads of the kind illustrated, is generally known e.g. from EP-A-0 376, and will not therefore be discussed in any greater detail.

[0035] Printheads according to the present invention may also be made in a modular format as described in the aforementioned WO91/17051, each module being formed in opposite end surfaces thereof with respective channel parts so that, upon butting together of modules, further channels are formed between respective pairs of butted modules. In such arrangements, the respective channel parts may include at least part of a slot formed in the channel base and of sufficient length that, even if a pair of butted modules and their respective slot parts are not perfectly aligned, there remains an overlap between the two slot halves sufficient to accommodate a nozzle.

[0036] As in the previous embodiment, nozzles 870,880 are formed in a nozzle plate 890 which, as illustrated, may extend over the substantially the entire length of piezoelectric sheet 860 so as to provide a suitably large area for engagement e.g. of a capping and/or wiping mechanism.

[0037] The piezoelectric channel walls, for example, can be polarised in opposite directions normal to the plane of the channel axes as known, for example, from EP-A-0 277 703 incorporated herein by reference. Alternatively, polarisation of the channel walls can be parallel to the plane of the channel axes with electrodes formed in the channel walls themselves as known, for example, from EP-A-0 528 647.

[0038] Nor is every channel in a printhead required to be capable of droplet ejection: active channels capable of droplet ejection may be alternated in the printhead with inactive - so-called dummy channels - as described, for example, in the aforementioned EP-A-0 277 703.

Claims

1. Droplet deposition apparatus comprising:

at least one longitudinal, open-topped droplet liquid channel (11) defined by facing longitudinal side walls (13) and a bottom, longitudinal surface (440) extending between the side walls;

means for applying an electric field to piezoelectric material in at least one of said walls (13), thereby to effect displacement of the wall relative to said longitudinal channel (11) so as to eject a droplet from the channel; and a cover (450) closing the open, longitudinal top

side of the channel;

characterised in that said bottom longitudinal surface (440) of the channel is formed with an opening (430) for droplet ejection, and;

the cover (450) incorporates two ports (460) for supply of droplet liquid, the ports being spaced along the channel on either side of the opening.

2. Apparatus according to 1, wherein the supply ports (460) are spaced on either side of the opening (430) by an equal amount.
3. Apparatus according to claim 1 or 2, wherein the bottom longitudinal surface of the channel is formed with at least two openings, the openings being spaced along the channel.
4. Apparatus according to claim 3, wherein the cover incorporates droplet supply ports spaced along the channel so as to lie either side of each opening.
5. Apparatus according to any preceding claim, wherein the piezoelectric material deforms in shear mode when subject to the electric field.
6. Apparatus according to any preceding claim, wherein an electrode (23) is formed on a channel-facing surface of the channel wall (13).
7. Apparatus according to claim 6, wherein an electrode is also formed on the channel wall on a surface opposed to the channel-facing surface of the channel wall.
8. Apparatus according to any preceding claim, wherein said channel wall is displaceable in response to electrical signals in a direction transverse to the axes of the channels.
9. Apparatus according to any preceding claim, wherein said bottom, longitudinal surface (440) is defined by a base, said base and said longitudinal side walls (13) being integral.
10. Apparatus according to any preceding claim and including a plurality of longitudinal channels arranged parallel to one another.
11. Method of manufacture of droplet deposition apparatus comprising the steps of:

providing a body including piezoelectric material and having at least one longitudinal, open-topped channel (11), the channel being defined by facing longitudinal side walls (13) and a bottom, longitudinal surface (440) extending between the side walls;

characterised by forming an opening (430) in the bottom longitudinal surface of the channel for ejection of droplet liquid;

providing means (23) for applying an electric field to piezoelectric material in at least one of said walls, thereby to effect displacement of the wall relative to said longitudinal channel so as to eject a droplet from the channel;

closing the open, longitudinal top side of the channel by means of a cover having two droplet fluid supply ports arranged so as to lie spaced along the channel on either side of the opening.

12. Method according to claim 11 comprising the step of forming said bottom, longitudinal surface (440) and said longitudinal side walls (13) so as to be integral with one another.
13. Method according to claim 12 comprising the steps of providing a body (530) of piezoelectric material and removing material from said body, thereby to form said channel in said body.
14. Method according to claim 11 comprising the steps of
 - providing a body (530) in the form of a sheet having first and second opposite surface;
 - removing material from the first surface of said body, thereby to form the channel (11);
 - forming an opening (430) in the bottom longitudinal surface (440) of the channel, the opening communicating with said second surface of the sheet.
15. Method according to claim 14 comprising the step of polarising the piezoelectric material of the sheet in a direction perpendicular to said first and second surfaces.

Patentansprüche

1. Apparat zur Ablagerung von Tröpfchen, welcher aufweist:

wenigstens einen langgestreckten oben offenen Tröpfchenflüssigkeitskanal (11), welcher durch einander zugewandte langgestreckte Seitenwände (13) und eine langgestreckte Bodenfläche (440), welche sich zwischen den Seitenwänden erstreckt, definiert bzw. gebildet ist; eine Einrichtung zum Anlegen eines elektrischen Feldes an piezoelektrisches Material in wenigstens einer der Seitenwände (13), wodurch eine Verlagerung der Wand in Bezug auf den besagten langgestreckten Kanal (11) so bewirkt wird, dass ein Tröpfchen aus dem Ka-

nal ausgestoßen wird; und
eine Abdeckung bzw. einen Deckel (450), welcher die offene langgestreckte Oberseite des Kanals verschließt;

dadurch gekennzeichnet, dass die langgestreckte Bodenfläche (440) des Kanals mit einer Öffnung (430) für den Ausstoß von Tröpfchen ausgebildet ist und;

die Abdeckung bzw. der Deckel (450) zwei Öffnungen (460) für die Zufuhr von Tröpfchenflüssigkeit enthält, wobei die Öffnungen entlang dem Kanal auf beiden Seiten der Öffnung beabstandet sind.

2. Apparat gemäß Anspruch 1, wobei die Zuführöffnungen (460) auf beiden Seiten der Öffnung (430) um einen gleichen Betrag beabstandet sind.

3. Apparat gemäß Anspruch 1 oder 2, wobei die langgestreckte Bodenfläche des Kanals wenigstens mit zwei Öffnungen ausgebildet, deren Öffnungen entlang dem Kanal beabstandet sind.

4. Apparat gemäß Anspruch 3, wobei die Abdeckung bzw. der Deckel Tröpfchenversorgungsöffnungen einschließt bzw. aufweist, welche entlang dem Kanal so beabstandet sind, dass sie zu beiden Seiten von jeder Öffnung liegen.

5. Apparat gemäß irgendeinem vorgehenden Anspruch, wobei das piezoelektrische Material in einem Schermodus deformiert wird, wenn es dem elektrischen Feld ausgesetzt wird.

6. Apparat gemäß irgendeinem vorhergehenden Anspruch, wobei eine Elektrode (23) auf einer dem Kanal zugewandten Fläche der Kanalwand (13) ausgebildet ist.

7. Apparat gemäß Anspruch 6, wobei die Elektrode auch auf der Kanalwand auf einer Oberfläche entgegengesetzt zu der dem Kanal zugewandten Oberfläche der Kanalwand ausgebildet ist.

8. Apparat gemäß irgendeinem vorhergehenden Anspruch, wobei die besagte Kanalwand in Abhängigkeit von elektrischen Signalen in einer Richtung quer zu den Achsen der Kanäle verlagerbar ist.

9. Apparat gemäß irgendeinem vorhergehenden Anspruch, wobei die besagte langgestreckte Bodenfläche (440) durch eine Basis bzw. einen Boden definiert bzw. gebildet ist, wobei die Basis bzw. der Boden und die besagten langgestreckten Seitenwände (13) integral bzw. einzügig ausgebildet sind.

10. Apparat gemäß irgendeinem vorhergehenden An-

spruch und welcher eine Mehrzahl von langgestreckten Kanälen aufweist, welche parallel zueinander angeordnet sind.

5 11. Verfahren der Herstellung eines Tröpfchenablagerungsapparats, welches die folgenden Schritte aufweist:

Schaffen eines Körpers, welcher piezoelektrisches Material einschließt und wenigstens einen langgestreckten oben offenen Kanal (11) aufweist, wobei der Kanal durch einander zugewandte langgestreckte Seitenwände (13) und eine langgestreckte Bodenfläche (440), welche sich zwischen den Seitenwänden erstreckt, gebildet ist;

gekennzeichnet durch Bilden einer Öffnung (430) in der langgestreckten Bodenfläche des Kanals für den Ausstoß einer Tröpfchenflüssigkeit;

Vorsehen einer Einrichtung (23) zum Anlegen eines elektrischen Feldes an piezoelektrisches Material in wenigstens einer der besagten Wände, wodurch die Verlagerung der Wand in Bezug auf den besagten langgestreckten Kanal so bewirkt wird, dass ein Tröpfchen aus dem Kanal ausgestoßen wird;

Schließen der langgestreckten offenen Oberseite des Kanals mittels einer Abdeckung bzw. eines Deckels, welche bzw. welcher zwei Versorgungsöffnungen für Tröpfchenflüssigkeit aufweist, welche so angeordnet sind, dass sie entlang dem Kanal auf beiden Seiten der Öffnung beabstandet liegen.

12. Verfahren nach Anspruch 11, welches den Schritt der Bildung der besagten langgestreckten Bodenfläche (440) und der besagten langgestreckten Seitenwände (13) so aufweist, dass diese integral bzw. einstückig miteinander sind.

13. Verfahren gemäß Anspruch 12, welches die Schritte des Schaffens eines Körpers (530) aus piezoelektrischem Material und der Entfernung von Material von dem besagten Körper aufweist, wodurch der besagte Kanal in dem besagten Körper geformt bzw. gebildet wird.

14. Verfahren gemäß Anspruch 11, welches die Schritte aufweist:

Vorsehen eines Körpers (530) in der Form einer Platte mit ersten und zweiten gegenüberliegenden Flächen bzw. Oberflächen;

Entfernen von Material von der ersten Oberfläche des besagten Körpers und dadurch Formen bzw. Ausbilden des Kanals (11);

Formen bzw. Bilden einer Öffnung (430) in der

langgestreckten Bodenfläche (440) des Kanals, wobei die Öffnung mit der zweiten Oberfläche der Platte kommuniziert bzw. in Verbindung steht.

15. Verfahren nach Anspruch 14, welches den Schritt der Polarisierung des piezoelektrischen Materials der Platte in einer Richtung senkrecht zu der ersten und der zweiten Oberfläche aufweist.

Revendications

1. Dispositif de dépôt de gouttelettes comprenant :

au moins un canal longitudinal à sommet ouvert de circulation de liquide pour gouttelettes (11) défini par des parois latérales longitudinales de parement (13) et une surface longitudinale inférieure (440) s'étendant entre les parois latérales ;

un moyen destiné à appliquer un champ électrique au matériau piézoélectrique dans au moins une desdites parois (13), pour ainsi effectuer le déplacement de la paroi par rapport audit canal longitudinal (11) afin d'éjecter une gouttelette du canal ; et

un couvercle (450) fermant le côté longitudinal supérieur ouvert du canal ;

caractérisé en ce que ladite surface longitudinale inférieure (440) du canal comprend une ouverture (430) servant à l'éjection des gouttelettes, et ;

le couvercle (450) incorpore deux orifices (460) servant à l'alimentation du liquide pour gouttelettes, les orifices étant espacés le long du canal de chaque côté de l'ouverture.

2. Dispositif selon la revendication 1, dans lequel les orifices d'alimentation (460) sont espacés de chaque côté de l'ouverture (430) d'une distance égale.

3. Dispositif selon la revendication 1 ou 2, dans lequel la surface longitudinale inférieure du canal comprend au moins deux ouvertures, les ouvertures étant espacées le long du canal.

4. Dispositif selon la revendication 3, dans lequel le couvercle incorpore des orifices d'alimentation en gouttelettes espacés le long du canal de façon à se trouver de chaque côté de chaque ouverture.

5. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le matériau piézoélectrique se déforme selon un mode de cisaillement lorsqu'il est soumis au champ électrique.

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel une électrode (23) est formée sur une surface de parement de canal de la paroi de canal (13).

7. Dispositif selon la revendication 6, dans lequel une électrode est également formée sur la paroi de canal sur une surface opposée à la surface de parement de canal de la paroi de canal.

8. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ladite paroi de canal est déplaçable selon une direction transversale aux axes des canaux en réponse à des signaux électriques.

9. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ladite surface longitudinale inférieure (440) est définie par une base, ladite base et lesdites parois latérales longitudinales (13) étant d'un seul tenant.

10. Dispositif selon l'une quelconque des revendications précédentes et comprenant une pluralité de canaux longitudinaux disposés parallèlement les uns aux autres.

11. Procédé de fabrication d'un dispositif de dépôt de gouttelettes comprenant les étapes consistant à :

prévoir un corps comprenant un matériau piézoélectrique et comportant au moins un canal longitudinal à sommet ouvert (11), le canal étant défini par des parois latérales longitudinales de parement (13) et une surface longitudinale inférieure (440) s'étendant entre les parois latérales ;

caractérisé par l'étape consistant à façonner une ouverture (430) dans la surface longitudinale inférieure du canal pour l'éjection du liquide pour gouttelettes ;

l'étape consistant à prévoir un moyen (23) destiné à appliquer un champ électrique au matériau piézoélectrique dans au moins une desdites parois, pour ainsi effectuer le déplacement de la paroi par rapport audit canal longitudinal afin d'éjecter une gouttelette du canal ;

l'étape consistant à fermer le côté longitudinal supérieur ouvert du canal au moyen d'un couvercle comportant deux orifices d'alimentation en fluide pour gouttelettes disposés de façon à se trouver à une certaine distance le long du canal de chaque côté de l'ouverture.

12. Procédé selon la revendication 11, comprenant l'étape consistant à façonner ladite surface longitudinale inférieure (440) et lesdites parois latérales longitudinales (13) de sorte qu'elles sont d'un seul tenant l'une avec l'autre.

13. Procédé selon la revendication 12, comprenant les étapes consistant à prévoir un corps (530) réalisé à partir d'un matériau piézoélectrique et à retirer de la matière dudit corps, pour ainsi façonner ledit canal dans ledit corps.

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14. Procédé selon la revendication 11, comprenant les étapes consistant à

prévoir un corps (530) sous la forme d'une 10
feuille présentant une première surface et une
deuxième surface opposées ;
retirer de la matière de la première surface du-
dit corps, pour ainsi façonner le canal (11) ;
façonner une ouverture (430) dans la surface 15
longitudinale inférieure (440) du canal, l'ou-
verture communiquant avec ladite deuxième sur-
face de la feuille.

15. Procédé selon la revendication 14, comprenant 20
l'étape consistant à polariser le matériau piézoélec-
trique de la feuille selon une direction perpendicu-
laire auxdites première et deuxième surfaces.

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Fig. 1A PRIOR ART

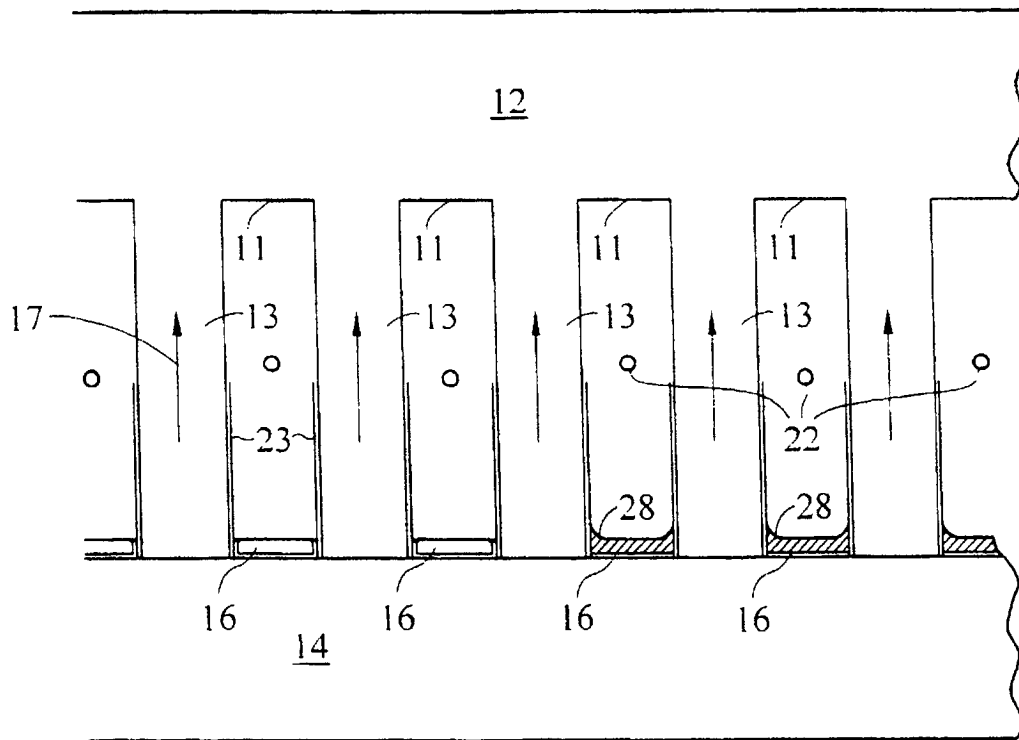


Fig. 1B PRIOR ART

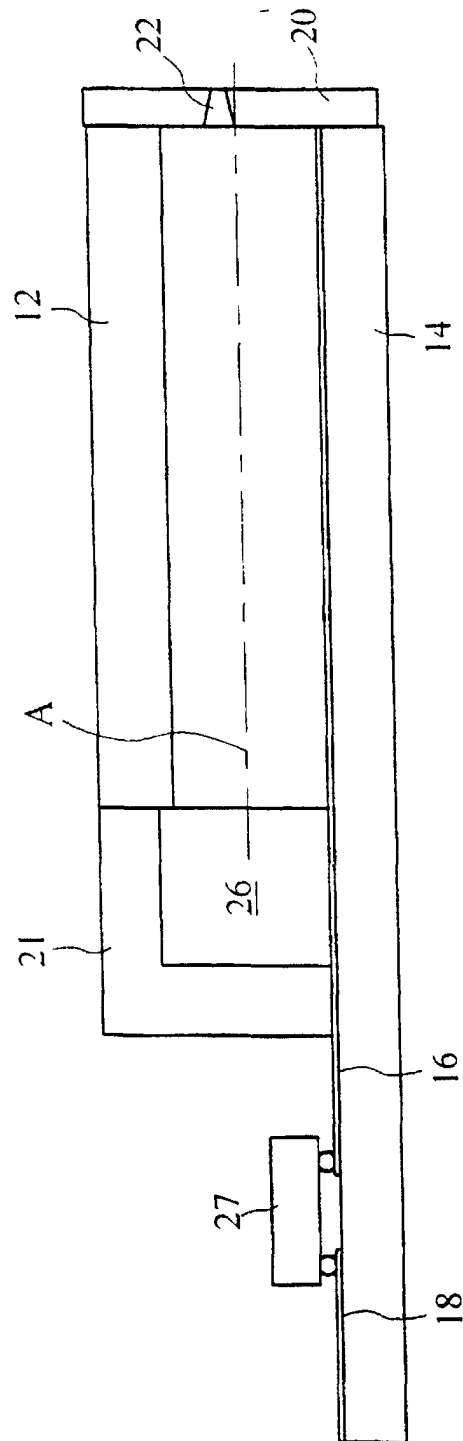


Fig. 2

PRIOR ART

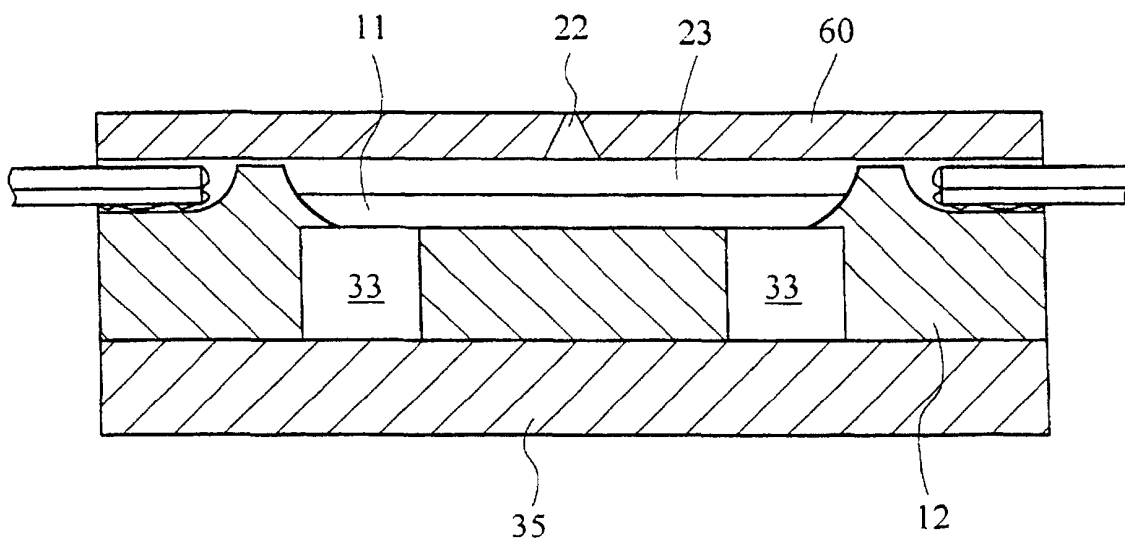


Fig. 3

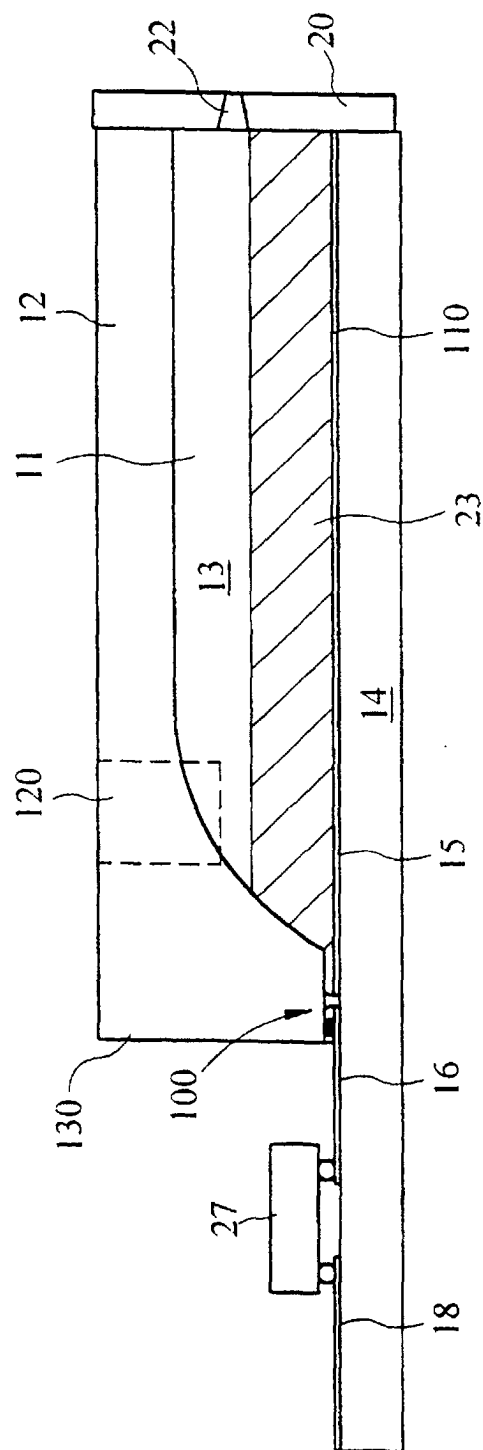


Fig. 4A

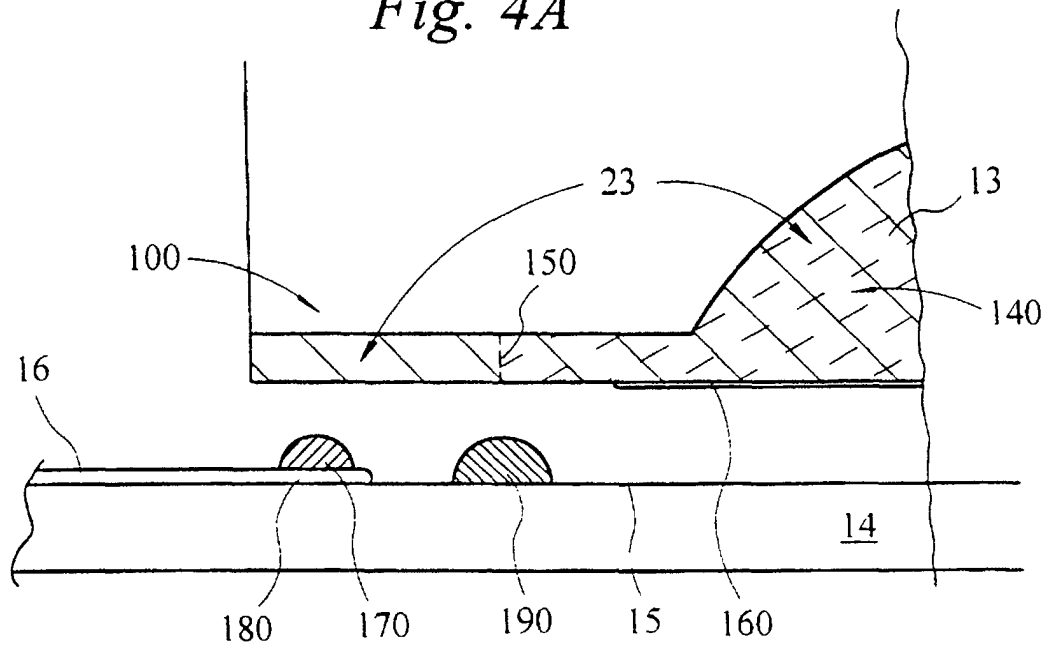


Fig. 4B

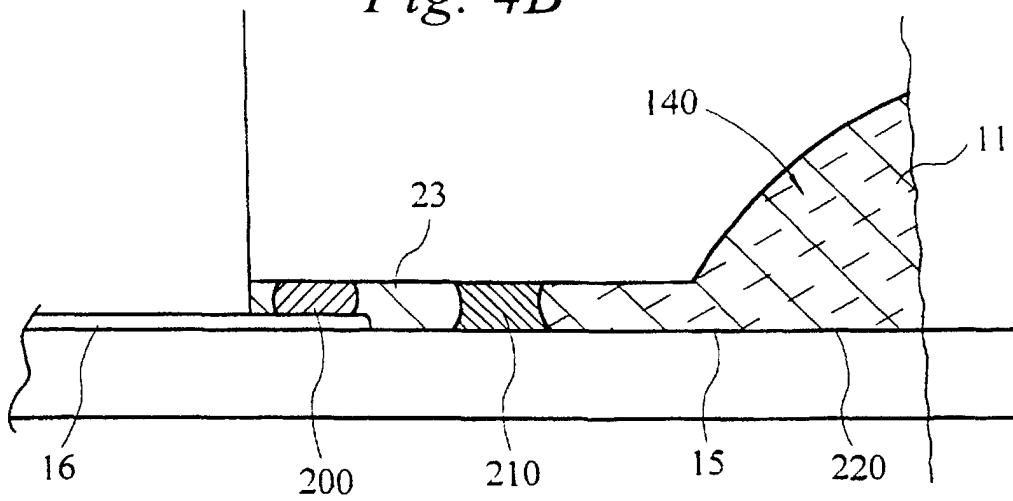


Fig. 5

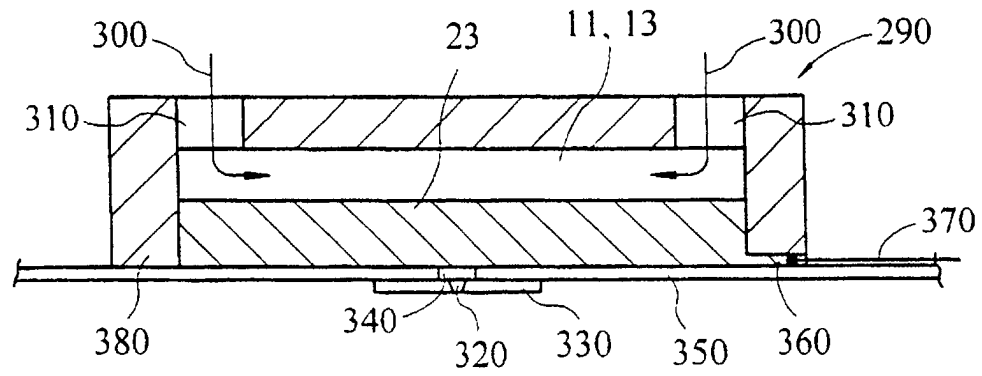


Fig. 6

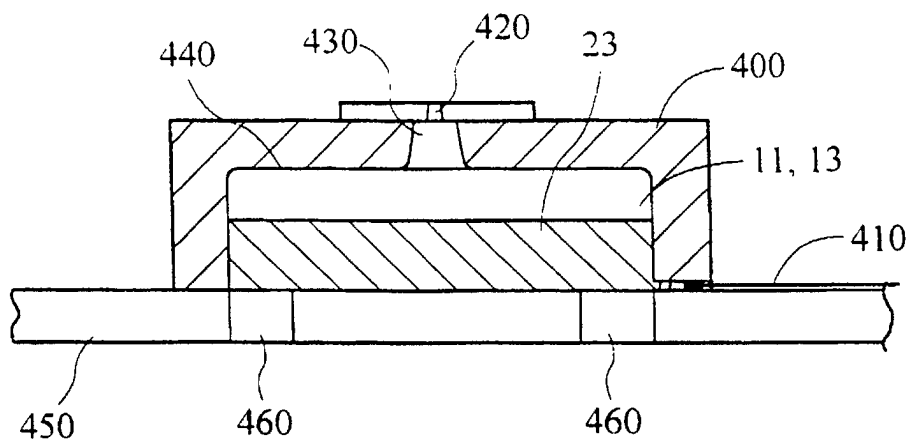


Fig. 7

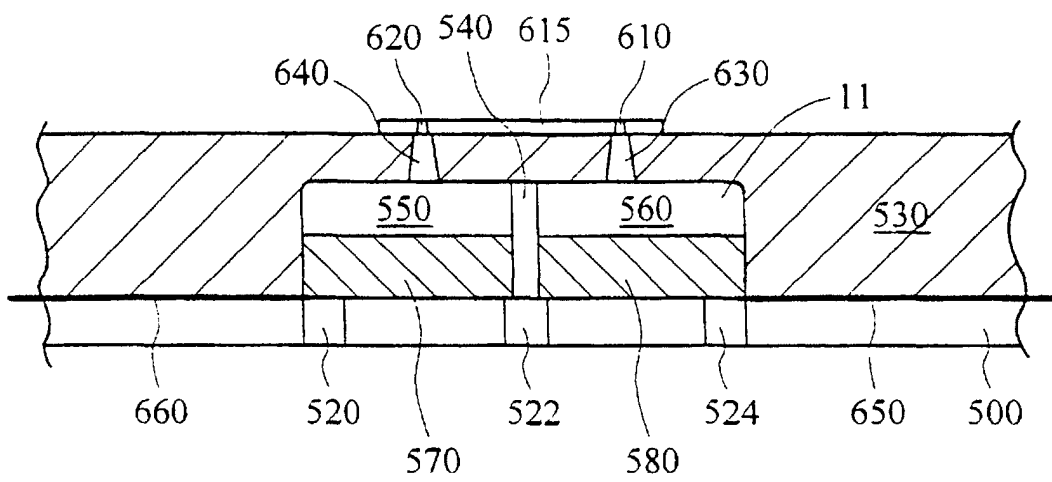


Fig. 8

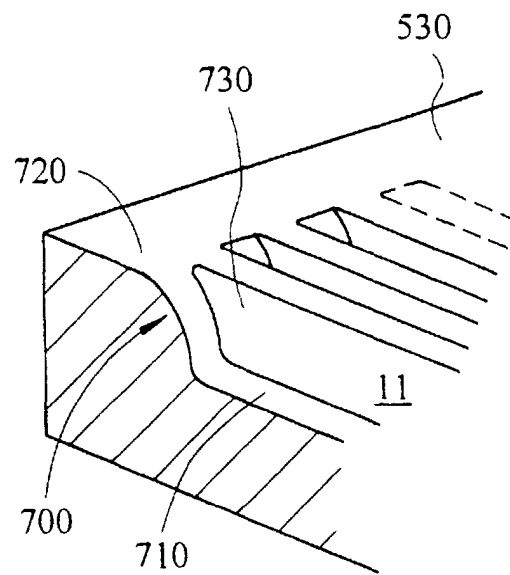


Fig. 9

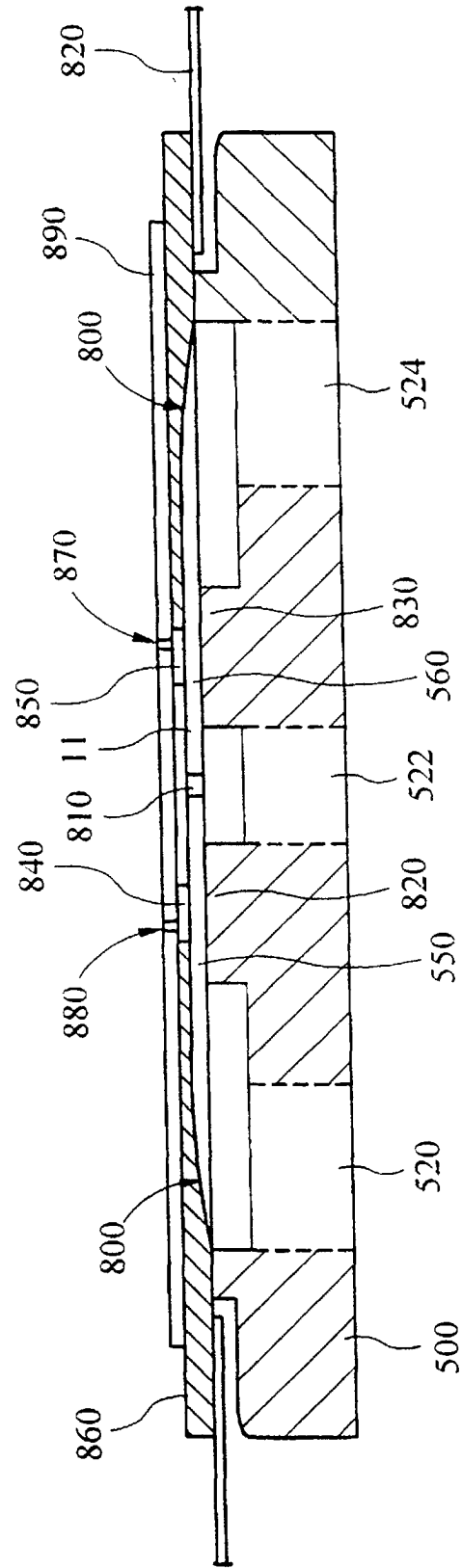


Fig. 10

