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(54) **Droplet deposition apparatus and methods of manufacture thereof**

Tröpfchenaufzeichnungsgerät und Herstellungsverfahren dafür

Appareil utile pour deposer des goutelettes et procédés de fabrication associés

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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 1 a is a cross-sectional view of the channels of the prior art inkjet printhead construction according to W092/22429. 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-O 364 136.

[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 1b, 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 W095/07820.

[0006] Reference is also made to US 4,611,219 which discloses a base plate having piezoelectric or other liquid-jetting-pressure-generation elements disposed thereon, a spacer plate defining liquid chambers and an orifice plate with to - in an example - two orifices for each liquid chamber.

[0007] This invention provides 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 supplying droplet liquid to the channel;
an array of longitudinal, open-topped droplet liquid channels defined by facing longitudinal side walls and a bottom, longitudinal surface extending between the side walls; said channels arranged side by side in an array direction, at least one of said channels including:

means for supplying droplet liquid to the channel;
means for applying an electric field to piezoelectric material in at least one of said side walls, thereby to effect displacement of the side 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;
characterized in that the bottom longitudinal surface of said at least one channel is formed with two openings for droplet ejection, the openings being spaced along the length of the channel.

[0008] Such a construction brings to the arrangement of WO98/52763 - the advantage of reduced component count.

[0009] Corresponding method claims are also comprised in the present invention, and other aspects are as set out in other independent claims.

[0010] Further advantageous embodiments of the invention are set out in the description, drawings and dependent claims.

[0011] The disclosure of all claims is deemed incorporated here as consistory clauses, unless already set out above.

[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;
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 further printhead:
Figure 6 is a sectional view taken along the channel axis of still a further printhead;
Figure 7 is a sectional view taken along the channel axis of a printhead according to an embodiment 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 with those features that are common to figure 3 and the prior art print-

head 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 know) 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 W095/07820, 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 W095/04658. 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] In figure 5, 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 W091/17051, 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 W093/15911, 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 W095/07820, 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] Figure 7 illustrates an embodiment of the present invention.

[0028] 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 actuable 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.

[0029] Such a configuration results in a printhead having two parallel rows of independently actuable 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.

[0030] 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. Connection between track 650,660 and drive chip 590,600 may be achieved by any conventional method, including wire bonding or gold ball connection.

[0031] 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 defeterious effect on the operational life of the printhead as a whole.

[0032] 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.

[0033] 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).

[0034] 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.

[0035] 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.

[0036] Printheads according to the present invention may also be made in a modular format as described in the aforementioned W091/17051, 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.

[0037] 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.

[0038] 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. 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.

[0039] 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:

an array of longitudinal, open-topped droplet liquid channels (11) defined by facing longitudinal side walls (730) and a bottom, longitudinal surface (710) extending between the side walls; said channels arranged side by side in an array direction, at least one of said channels including:

means (520, 522, 524) for supplying droplet liquid to the channel;

means (660, 570, 580, 650) for applying an electric field to piezoelectric material (530) in at least one of said side walls (730) thereby to effect displacement of the side wall relative to said longitudinal channel so as to eject a droplet from the channel; and

a cover (500) closing the open, longitudinal top side (720) of the channel;

characterized in that the bottom longitudinal surface (710) of said at least one channel is formed with two openings (610, 620) for droplet ejection, the openings being spaced along the length of the channel.

2. Apparatus according to claim 1, wherein the means for supplying droplet liquid comprises supply ports in the cover spaced along the channel so as to lie either side of each opening.

3. Apparatus according to claim 1 or claim 2, wherein the piezoelectric material deforms in shear mode when subject to the electric field.

4. Apparatus according to any of claims 1 to 3, wherein an electrode is formed on a channel-facing surface of the channel wall.

5. Apparatus according to claim 4, wherein an electrode is also formed on the channel wall on a surface opposed to the channel-facing surface of the channel wall.

6. Apparatus according to any of claims 1 to 5, wherein said channel wall is displaceable in response to electrical signals in a direction transverse to the axes of the channels.

7. Apparatus according to any of claims 1 to 6, wherein said bottom, longitudinal surface is defined by a base, said base and said longitudinal side walls being integral.

8. Apparatus according to any preceding claim, further comprising a nozzle plate having nozzles in communication with said openings for droplet ejection.

9. Method of manufacture of droplet deposition apparatus comprising the steps of:

providing a body (530) including piezoelectric material and having an array of longitudinal, open-topped droplet liquid channels (11), the channel being defined by facing longitudinal side walls (730) and a bottom, longitudinal sur-

face (710) extending between the side walls; said channels arranged side by side in an array direction; and for at least one of said channels :

forming through piezoelectric material (530) in the bottom longitudinal surface of the channel two openings (610, 620) for ejection of droplet liquid, the openings being spaced along the channel;
providing means (660, 570, 580, 650) for applying an electric field to piezoelectric material in at least one of said side walls, thereby to effect displacement of the side wall relative to said longitudinal channel so as to eject a droplet from the channel; and
closing the open, longitudinal top side of the channel by means of a cover (500).

10. Method according to claim 9 comprising the step of closing the open longitudinal top side of the channel by means of a cover incorporating droplet supply ports spaced along the channel so as to lie either side of each opening.

11. Method according to claim 9 or claim 10 comprising the step of forming said bottom, longitudinal surface and said longitudinal side walls so as to be integral with one another.

12. Method according to claim 11 comprising the steps of providing a body of piezoelectric material and removing material from said body, thereby to form said channel in said body.

13. Method according to claim 9 comprising the steps of:

providing a body 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;
forming said two openings in the bottom longitudinal surface of the channel, the openings communicating with said second surface of the sheet.

14. Method according to claim 13 comprising the step of polarising the piezoelectric material of the sheet in a direction perpendicular to said first and second surfaces.

Revendications

1. Dispositif de dépôt de gouttelettes comprenant :

une rangée de canaux longitudinaux à sommet ouvert de circulation de liquide pour gouttelettes (11) défini par des parois latérales longitudinales se faisant face (730) et une surface longitudinale inférieure (710) s'étendant entre les parois latérales ; lesdits canaux étant disposés côte à côte dans une direction de rangée, l'un au moins des canaux comprenant :

des moyens (520, 522, 524) servant à l'alimentation du liquide pour gouttelettes dans le canal ;
des moyens (660, 570, 580, 650) destinés à appliquer un champ électrique au matériau piézoélectrique (530) dans au moins l'une desdites parois latérales (730), pour ainsi effectuer le déplacement de la paroi latérale par rapport audit canal longitudinal afin d'éjecter une gouttelette du canal ; et
un couvercle (500) fermant le côté longitudinal supérieur ouvert (720) du canal ;
caractérisé en ce que la surface longitudinale inférieure du canal (710) dudit ou de chaque canal comprend deux ouvertures (610, 620), pour l'éjection des gouttelettes, les ouvertures étant espacées le long du canal.

2. Dispositif selon la revendication 1, dans lequel les moyens d'alimentation en liquide pour gouttelettes comprennent des orifices d'alimentation dans le couvercle, espacés le long du canal de façon à se trouver de chaque côté de chaque ouverture.

3. Dispositif selon la revendication 1 ou 1a revendication 2, dans lequel le matériau piézoélectrique se déforme selon un mode de cisaillement lorsqu'il est soumis au champ électrique.

4. Dispositif selon l'une quelconque des revendications 1 à 3, dans lequel une électrode est formée sur une surface faisant face au canal de la paroi de canal.

5. Dispositif selon la revendication 4, dans lequel une électrode est également formée sur la paroi de canal sur une surface opposée à la surface faisant face au canal de la paroi de canal.

6. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite paroi de canal peut se déplacer en réponse à des signaux électriques, dans une direction transversale par rapport aux axes des canaux.

7. Dispositif selon l'une quelconque des revendications 1 à 6, dans lequel ladite surface longitudinale inférieure est définie par une base, ladite base et lesdites parois latérales longitudinales étant d'un seul tenant.

8. Dispositif selon l'une quelconque des revendications précédentes, comprenant en plus une plaque de bu-

se comprenant des buses en communication avec lesdites ouvertures pour l'éjection des gouttelettes.

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

prévoir un corps (530) comprenant un matériau piézoélectrique et comprenant une rangée de canaux longitudinaux à sommet ouvert (11) de circulation de liquide pour gouttelettes, le canal étant défini par des parois latérales longitudinales se faisant face (730) et une surface longitudinale inférieure (710) s'étendant entre les parois latérales ; lesdits canaux étant disposés côte à côte dans une direction de rangée, et pour au moins desdits canaux :

façonner au moyen d'un matériau piézoélectrique, (530) dans la surface longitudinale inférieure du canal, deux ouvertures (610, 620) pour l'éjection de liquide pour gouttelettes, les ouvertures étant espacées le long du canal ;
prévoir des moyens (660, 570, 580, 650) destinés à appliquer un champ électrique au matériau piézoélectrique dans au moins l'une desdites parois latérales, pour ainsi effectuer le déplacement de la paroi latérale par rapport audit canal longitudinal afin d'éjecter une gouttelette du canal ; et
fermer le côté longitudinal supérieur ouvert du canal au moyen d'un couvercle (500).

10. Procédé selon la revendication 9 comprenant l'étape consistant à fermer le côté longitudinal supérieur ouvert du canal au moyen d'un couvercle comprenant des orifices d'alimentation de gouttelettes espacés le long du canal de façon à se trouver de chaque côté de chaque ouverture.

11. Procédé selon la revendication 9 ou la revendication 10, comprenant l'étape consistant à façonner ladite surface longitudinale inférieure et lesdites parois latérales longitudinales de sorte qu'elles sont solidaires entre elles.

12. Procédé selon la revendication 11, comprenant les étapes consistant à prévoir un corps réalisé à partir d'un matériau piézoélectrique et à retirer de la matière dudit corps, pour ainsi façonner ledit canal dans ledit corps.

13. Procédé selon la revendication 9, comprenant les étapes consistant à :

prévoir un corps sous la forme d'une feuille présentant une première surface et une deuxième surface opposées ;
retirer de la matière de la première surface dudit corps, pour ainsi façonner le canal ;
façonner lesdites deux ouvertures dans la surface longitudinale inférieure du canal, les ouvertures communiquant avec ladite deuxième surface de la feuille.

14. Procédé selon la revendication 13, comprenant l'étape consistant à polariser le matériau piézoélectrique de la feuille dans une direction perpendiculaire auxdites première et deuxième surfaces.

Patentansprüche

1. Apparat zur Abscheidung von Tröpfchen, welcher folgendes umfasst:

ein Feld von lang gesteckten, oben offenen Tröpfchenflüssigkeitskanälen (11), welche durch einander zugewandte, lang gestreckte Seitenwände (730), und eine lang gestreckte Bodenfläche (710), welche sich zwischen den Seitenwänden erstreckt, gebildet sind; wobei die Kanäle in einer Feldrichtung nebeneinander angeordnet sind, und mindestens einer der Kanäle folgendes beinhaltet:

Mittel (520, 522, 524), um dem Kanal Tröpfchenflüssigkeit zumiführen;
Mittel (660, 570, 580, 650), um ein elektrisches Feld an piezoelektrisches Material (530) in wenigstens einer der Seitenwände (730)anzulegen, wodurch eine Verlagerung der Seitenwand in Bezug auf den lang gestreckten Kanal so bewirkt wird, dass ein Tröpfchen aus dem Kanal ausgestoßen wird; und
eine Abdeckung (500), welche die offene, lang gestreckte Oberseite (720) des Kanals verschließt;
dadurch gekennzeichnet, dass die lang gestreckte Bodenfläche (710) des mindestens einen Kanals mit zwei Öffnungen (610, 620) für den Ausstoß von Tröpfchen ausgebildet ist, wobei die Öffnungen entlang der Länge des Kanals beabstandet sind.

2. Apparat gemäß Anspruch 1, wobei das Mittel, um Tröpfchenflüssigkeit zuzuführen, Zuführungsöffnungen in der Abdeckung umfasst, welche entlang des Kanals so beabstandet sind, dass sie zu beiden Seiten jeder Öffnung liegen.

3. Apparat gemäß Anspruch 1 oder Anspruch 2, wobei das piezoelektrische Material in einem Schermodus deformiert wird, wenn es dem elektrischen Feld aus-

gesetzt wird.

4. Apparat gemäß irgendeinem der Ansprüche 1 bis 3, wobei eine Elektrode auf einer dem Kanal zugewandten Fläche der Kanalwand ausgebildet ist.

5. Apparat gemäß Anspruch 4, wobei eine Elektrode ebenfalls auf der Kanalwand ausgebildet ist, und zwar auf einer Fläche entgegengesetzt zu der dem Kanal zugewandten Fläche der Kanalwand.

6. Apparat gemäß irgendeinem der Ansprüche 1 bis 5, wobei die Karlalwand in Abhängigkeit von elektrischen Signalen in einer Richtung quer zu den Achsen der Kanäle verlagerbar ist.

7. Apparat gemäß irgendeinem der Ansprüche 1 bis 6, wobei die lang gestreckte Bodenfläche durch eine Basis bzw. einen Boden gebildet ist, wobei die Basis bzw. der Boden und die lang gestreckten Seitenwände integral ausgebildet sind,

8. Apparat gemäß irgendeinem vorhergehenden Anspruch, welcher weiter eine Düsenplatte umfasst, welche Düsen aufweist, welche mit den Öffnungen zum Tröpfchenausstoß in Verbindung stehen.

9. Verfahren zur Herstellung eines Tröpfchenabscheidungsapparates, welches die folgenden Schritte umfasst:

Schaffen eines Körpers (530), welcher piezoelektrisches Material einschließt und ein Feld von lang gestreckten, oben offenen Tröpfchenflüssigkeitskanälen (11) aufweist, wobei der Kanal durch einander zugewandte, lang gestreckte Seitenwände (730), und eine lang gestreckte Bodenfläche (710), welche sich zwischen den Seitenwänden erstreckt, gebildet ist; wobei die Kanäle in einer Feldrichtung nebeneinander angeordnet sind; und mindestens einer der Kanäle folgendes gilt:

Ausbildung von zwei Öffnungen (610, 620) für den Ausstoß von Tröpfchen, durch piezoelektrisches Material (530) in der lang gestreckten Bodenfläche des Kanals, wobei die Öffnungen entlang der Länge des Kanals beabstandet sind;
Bereitstellung von Mitteln (660, 570, 580, 650) zum Anlegen eines elektrischen Feldes an piezoelektrisches Material in wenigstens einem der Seitenwände, wodurch die Verlagerung der Seitenwand in Bezug auf den lang gestreckten Kanal so bewirkt wird, dass ein Tröpfchen aus dem Kanal ausgestoßen werden kann; und
Schließen der lang gestreckten offenen Oberseite des Kanals mit einer Abdeckung (500).

10. Verfahren gemäß Anspruch 9, welches den Schritt des Schließens der offenen, lang gestreckten Oberseite des Kanals mittels einer Abdeckung umfasst, welche Tröpfchenzuführungsöffnungen integriert, welche entlang des Kanals so beabstandet sind, dass sle zu beiden Seiten jeder Öffnung liegen.

11. Verfahren gemäß Anspruch 9 oder Anspruch 10, welches den Schritt der Ausbildung der lang gestreckten Bodenfläche und der lang gestreckten Seitenwände so aufweist, dass diese integral sind.

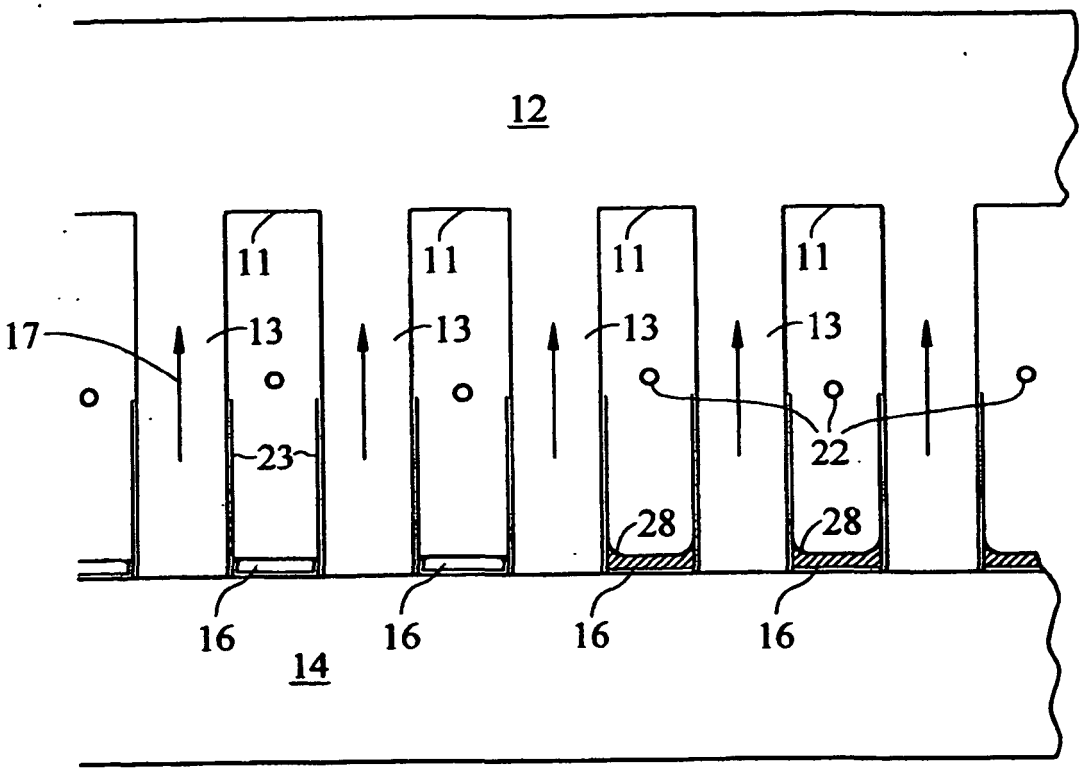
12. Verfahren gemäß Anspruch 11, welches die Schritte des Bereitstellens eines Körpers aus piezoelektrischem Material und der Entfernung von Material aus diesem Körper umfassen, um **dadurch** den Kanal in dem Körper auszubilden.

13. Verfahren gemäß Anspruch 9, welches die folgenden Schritte umfasst:

Bereitstellen eines Körpers in der Form eines Blattes bzw. einer dünnen Schicht mit ersten und zweiten gegentiberliegenden Flächen;
Entfemen von Material von der ersten Oberfläche des Körpers und **dadurch** Ausbilden des Kanals;
Ausbilden der zwei Öffnungen in der lang gestreckten Bodenfläche des Kanals, wobei die Öffnungen mit der zweiten Fläche des Blattes bzw. der dünnen Schicht in Verbindung stehen.

14. Verfahren gemäß Anspruch 13, welches den Schritt der Polarisierung des piezoelektrischen Materials des Blattes bzw. der dünnen Schicht in einer Richtung senkrecht zu der ersten und zweiten Flache aufweist.

Fig. 1A PRIOR ART



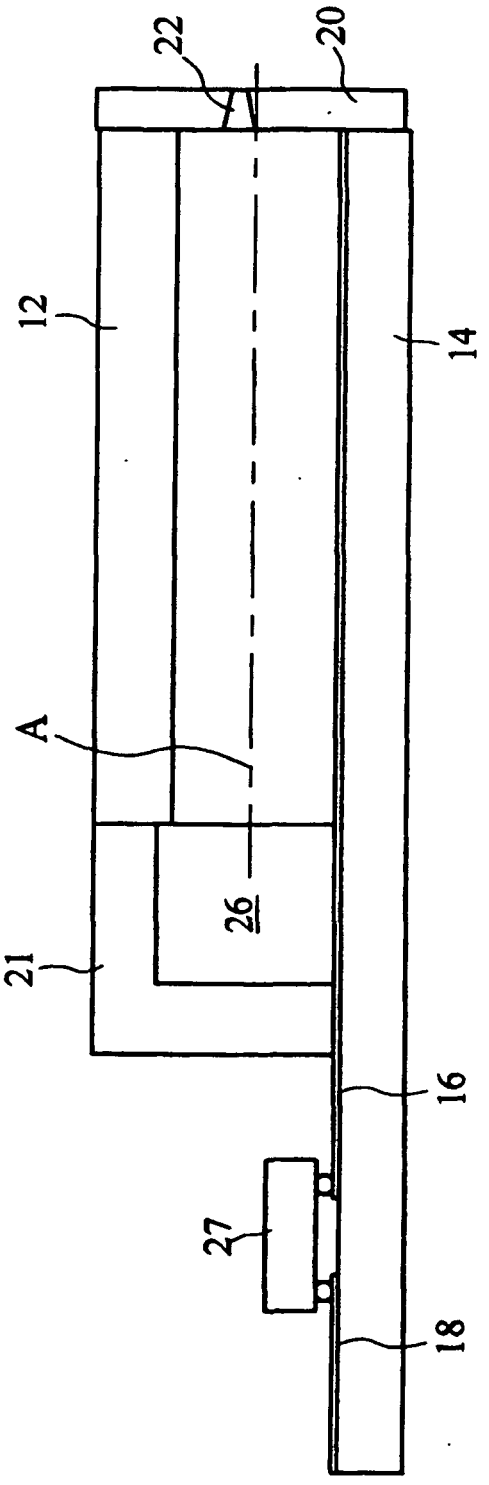


Fig. 1B PRIOR ART

Fig. 2

PRIOR ART

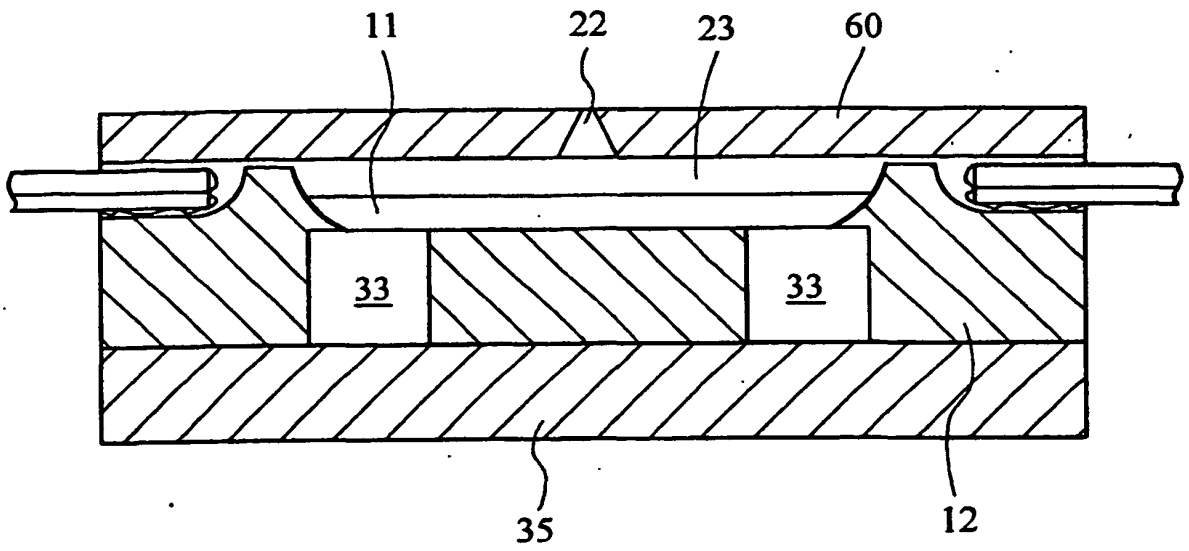


Fig. 3

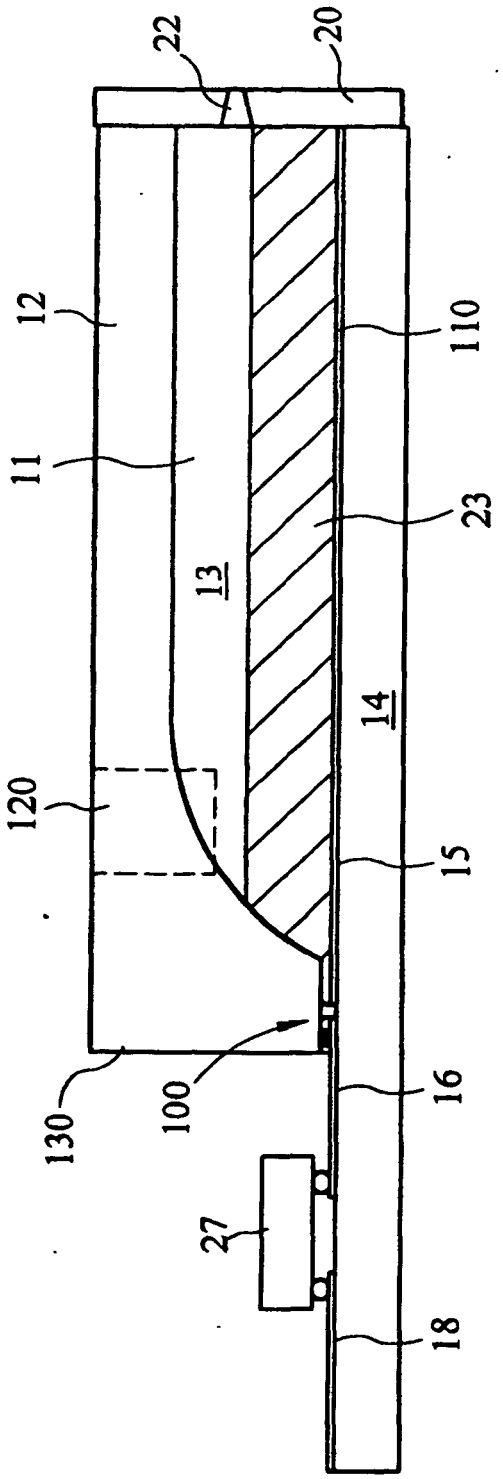
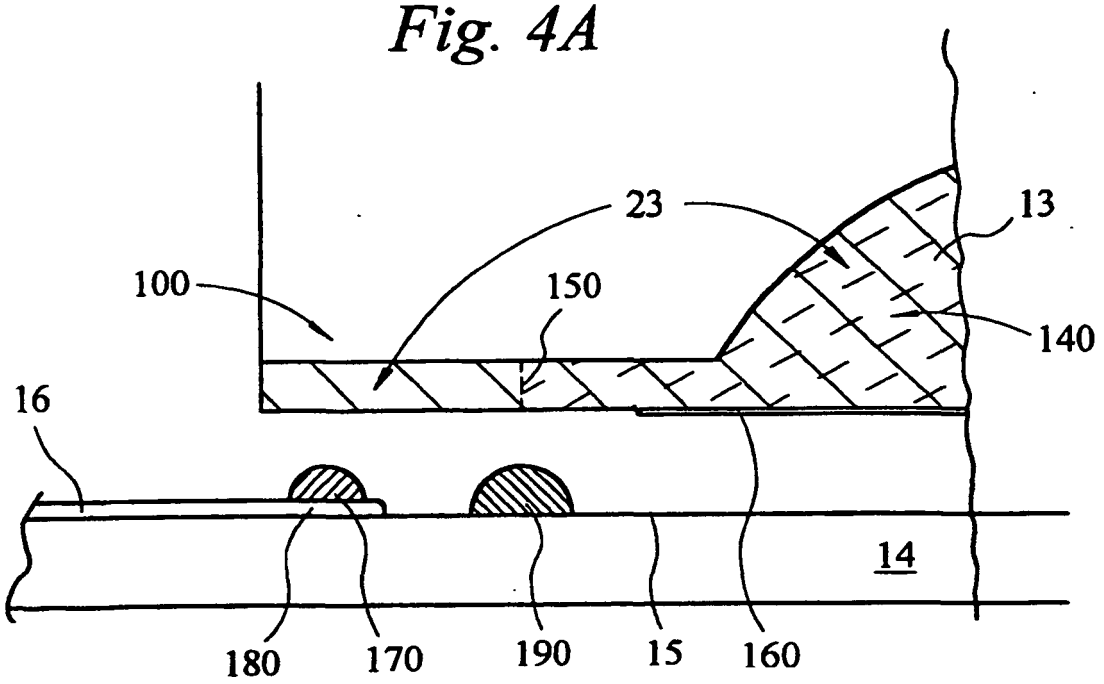


Fig. 4A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13
100
150
140
16
14
180
170
190
15
160

Fig. 4B

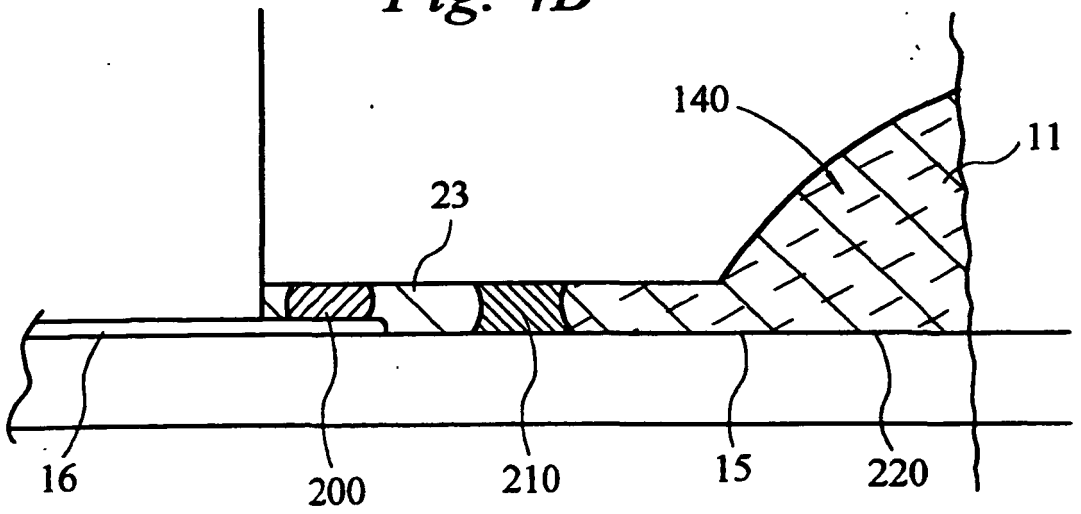
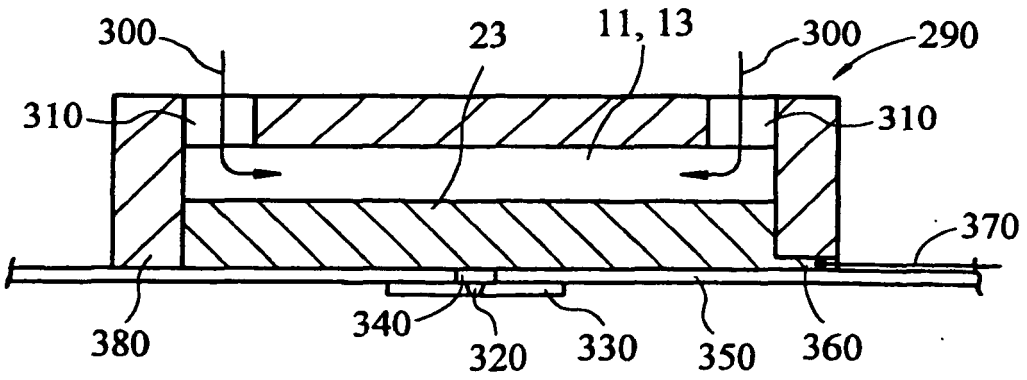

140
11
23
16
200
210
15
220

Fig. 5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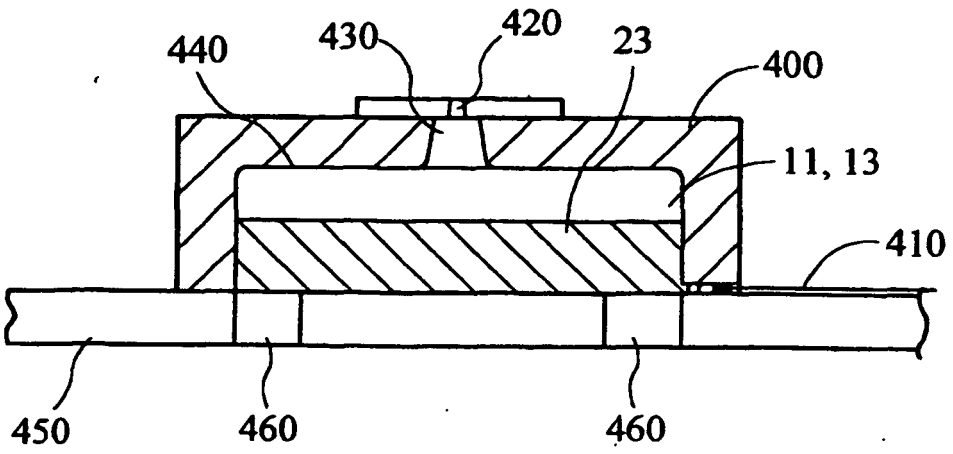
23
11, 13
300
290
310
310
370
380
340
320
330
350
360

Fig. 6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23
400
11, 13
410
450
460
460

Fig. 7

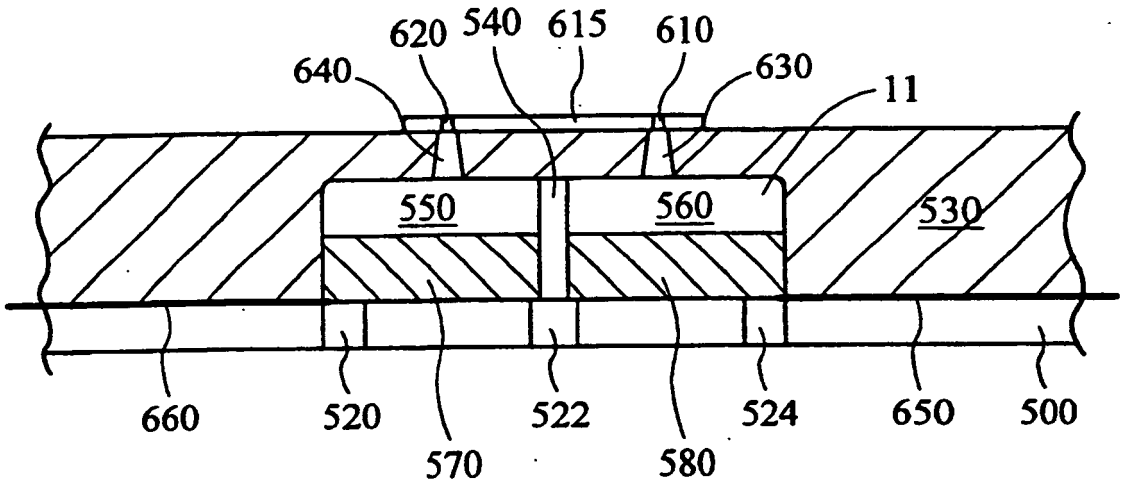
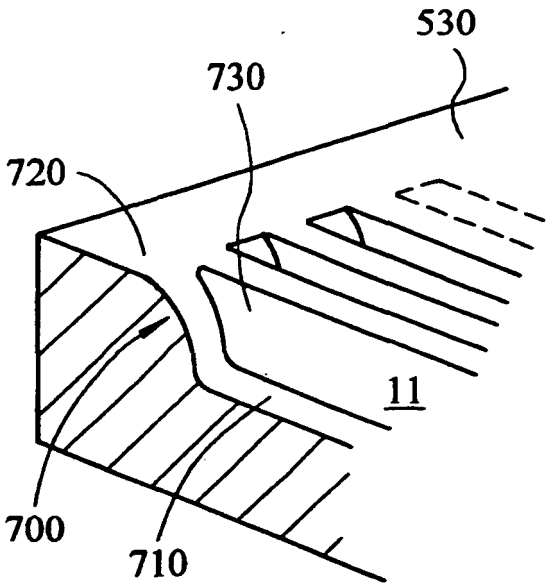

620
540
615
610
640
630
11
550
560
530
660
520
570
522
580
524
650
500

Fig. 8



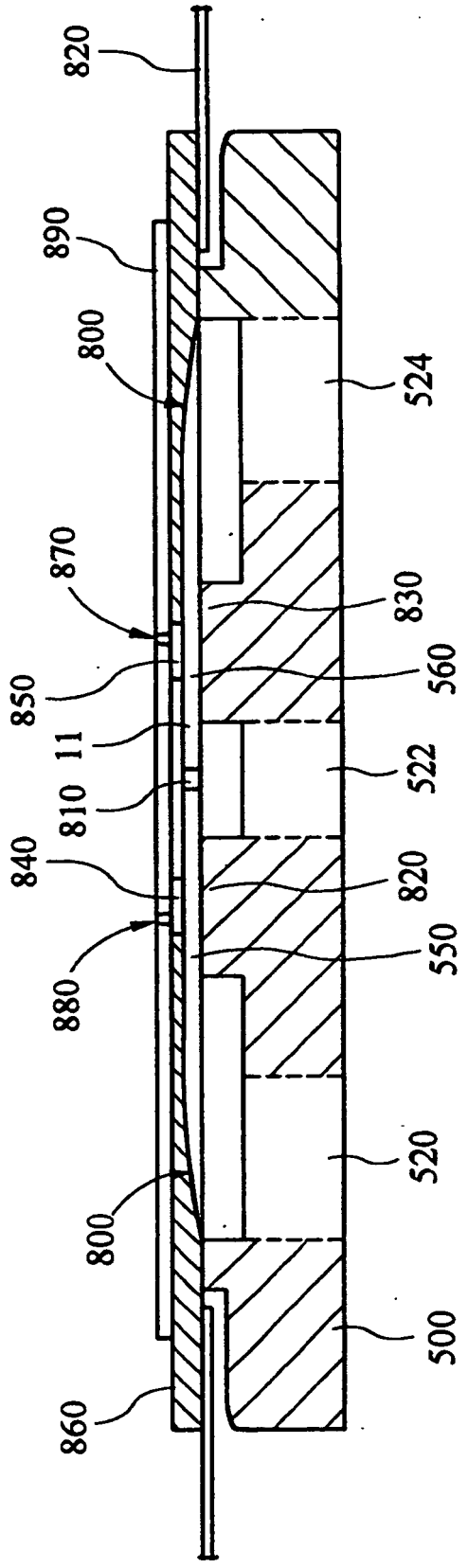

820
890
800
524
870
830
850
560
11
522
810
840
820
880
550
520
800
500
860

Fig. 9

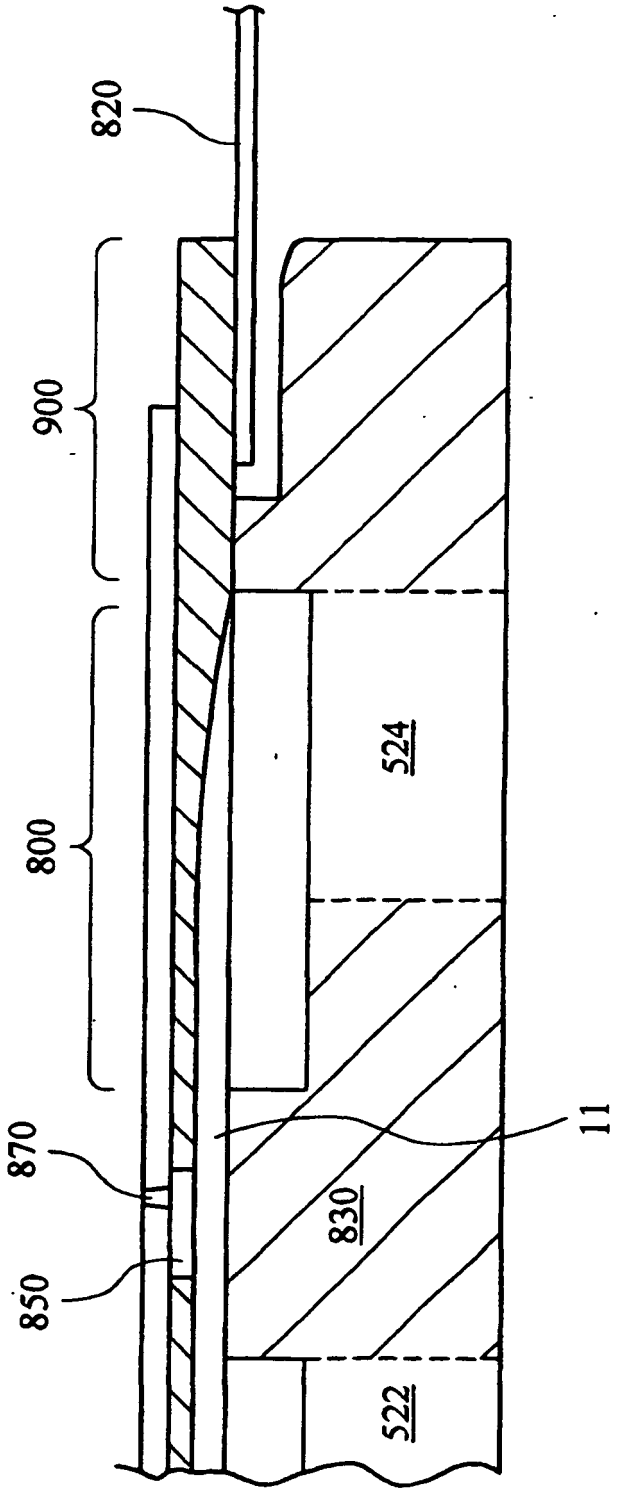


Fig. 10