(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 934 053 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
05.01.2011 Bulletin 2011/01

(21) Application number: **05791390.7**

(22) Date of filing: **10.10.2005**

(51) Int Cl.:
B41J 2/165 *(2006.01)*

(86) International application number:
PCT/AU2005/001563

(87) International publication number:
WO 2007/041746 (19.04.2007 Gazette 2007/16)

(54) **PRINTHEAD MAINTENANCE STATION**

DRUCKKOPFWARTUNGSSTATION

STATION DE MAINTENANCE DE TETE D'IMPRESSION

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(43) Date of publication of application:
25.06.2008 Bulletin 2008/26

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EP 1 934 053 B1

Printed by Jouve, 75001 PARIS (FR)

Description

Field of the Invention

[0001] This invention relates to a maintenance assembly with a maintenance station for an inkjet printhead. It has been developed primarily for facilitating maintenance operations, such as sealing, cleaning or unblocking nozzles in an inkjet printhead.

Background of the Invention

[0002] Inkjet printers are commonplace in homes and offices. More recently, inkjet printers have been proposed for use in portable devices, such as digital cameras, mobile phones etc. Furthermore, with the advent of MEMS technology, whereby inexpensive photolithographic techniques from the semiconductor industry are used to manufacture microelectomechanical systems, the possibility of disposable inkjet printers is becoming a commercial reality. The present Applicant has developed many different types of MEMS inkjet printheads, some of which are described in the patents and patent applications listed in the above cross reference list.

[0003] Although the cost and power requirements of inkjet printheads is being reduced through the use of MEMS technology and improved inkjet nozzle designs, it is also necessary to reduce the cost and power requirements of other printer components, in order to incorporate inkjet printers into portable devices or to provide disposable inkjet printers.

[0004] A crucial aspect of inkjet printing is maintaining the printhead in an operational printing condition throughout its lifetime. A number of factors may cause an inkjet printhead to become non-operational and it is important for any inkjet printer to include a strategy for preventing printhead failure and/or restoring the printhead to an operational printing condition in the event of failure. Printhead failure may be caused by, for example, printhead face flooding, dried-up nozzles (due to evaporation of water from the nozzles - a phenomenon known in the art as decap), or particulates fouling nozzles.

[0005] In some cases, printhead failure may be remedied by simply firing nozzles periodically using a 'keep wet cycle'. This strategy does not require any external mechanical maintenance of the printhead and may be appropriate when a nozzle has not been fired for a relatively short period of time (*e.g.* less than 60 seconds). A 'keep wet cycle' can be used to address decap, and the consequent formation of viscous plugs in nozzles, during active printing.

[0006] However, a 'keep wet cycle' cannot be used when the printer is left idle over long periods of time, for example, when it is in between print jobs, switched off or in transit. Furthermore, a 'keep wet cycle' is not appropriate for clearing severely blocked nozzles and does not address the problem of printhead face flooding. Accordingly, inkjet printers typically include a printhead maintenance station, which is designed to prevent printhead failure and/or remediate printheads to an operational condition.

[0007] One measure that has been used for preventing printhead failure is sealing the printhead, thereby preventing evaporation of water and the drying up of nozzles. Commercial inkjet printers are typically supplied with a sealing tape across the printhead, which the user removes when the printer is installed for use. The sealing tape protects the primed printhead from particulates and prevents the nozzles from drying up during transit. Sealing tape also controls flooding of ink over the printhead face.

[0008] Aside from one-time use sealing tape on new printers, sealing has also been used as a strategy for maintaining printheads in an operational condition during printing. In some commercial printers, a gasket-type sealing ring and cap engages around a perimeter of the printhead when the printer is idle. With the printhead capped in this way, evaporation of water from the nozzles is minimized, and a relatively humid atmosphere can be maintained above the nozzles, thereby minimizing the extent to which nozzles dry up.

[0009] Furthermore, gasket-type sealing rings have been combined with suction cleaning in prior art maintenance stations. A vacuum may be connected to the sealing cap and used to suck ink from the nozzles. The sealing cap minimizes nozzle drying and entrance of particulates from the atmosphere, while the suction ensures any blocked nozzles are cleared prior to printing. Hence, this type of maintenance station employs both preventative and remedial measures.

[0010] Another remedial strategy used in prior art printhead maintenance stations is a rubber squeegee. The squeegee does not act as seal; rather, it is wiped across the printhead and removes any flooded ink. Squeegee cleaning may be used immediately prior to printing, after the vacuum flush described above.

[0011] The printhead maintenance strategies described above have several shortcomings, especially in the present age of inkjet printing. Modern inkjet printers are required to have smaller drop volumes, and hence smaller nozzle openings, for high resolution photographic printing. It is also desirable to use stationary pagewidth printheads for high-speed printing, as opposed to scanning printheads. It is also desirable to reduce the overall cost of inkjet printers and incorporate them into low-powered portable devices, such as digital cameras and mobile phones.

[0012] Current printhead maintenance strategies are unable to provide inkjet printers, which meet these demands. With smaller nozzle openings (of the order of 5-20 microns), nozzle blocking due to decap becomes a serious problem. At present, the only reliable way of dealing with blocked nozzles is to use a suction pad. However, suction devices are bulky, expensive and consume large amounts of power, making them unsuitable for many inkjet applications. Furthermore, suction pads are waste-

ful of ink and can consume up to 0.25 ml of ink with each remediation.

[0013] Additionally, none of the prior art maintenance stations are able to provide a printhead ready for printing after a single maintenance operation. Typically, it is necessary to employ separate preventative (*e.g.* sealing) and remedial (*e.g.* suction and squeegee-cleaning) measures in order to provide a fully operational printhead. However, operations such as squeegee-cleaning are not suitable for all types of printhead, because it exerts shear stress across the printhead and can damage sensitive nozzle structures.

[0014] US 4,571,601 describes a printhead maintenance assembly comprising a silicone roller, which engages with an ink ejection face of a printhead. Whilst the roller is engaged with the printhead, the roller is rotated so as to remove impurities from the ink ejection face.

[0015] US 2004/125167 A1 discloses an inkjet printer with a printhead assembly for maintaining a printhead in an operable condition. Said printhead assembly consists of a printhead having an ink ejection face with nozzles and a printhead maintenance station. The maintenance station comprises an elastically deformable pad having a contact surface configured for sealing engagement with some of the nozzles of the ink ejection face and an engagement mechanism for rolling said pad across the ejection face between a first position in which said contact surface is sealingly engaged with nozzles, and a second position in which said contact surface is disengaged, whereby said contact surface is progressively contacted with said nozzles during sealing engagement and peeled away from said nozzles during disengagement.

[0016] Therefore, it would be desirable to provide an inkjet printhead maintenance station, which combines both preventative and remedial measures. It would further be desirable to provide an inkjet printhead maintenance station, which can be fabricated at low cost and is therefore suitable for fabrication of a disposable printer. It would be further desirable to provide an inkjet printhead maintenance station, which does not significantly impact on the overall size of the printer and is therefore suitable for incorporation into handheld electronic devices. It would be further desirable to provide an inkjet printhead maintenance station, which does not impact on the overall power consumption of the printer and is therefore suitable for incorporation into battery-powered electronic devices. It would be further desirable to provide an inkjet printhead maintenance station, which does not waste large quantities of ink with each remedial operation. It would further be desirable to provide an inkjet printhead maintenance station, which cleans ink from a flooded printhead without exerting high shear stresses across the printhead.

Summary of the Invention

[0017] Accordingly, a first embodiment of the invention provides a printhead assembly as detailed in claim 1. The invention also provides an ink jet printer as detailed in claim 11. Advantageous embodiments are provided in the dependent claims.

[0018] For the avoidance of doubt, the term "progressively contacted" is used to mean a type of engagement, which is opposite to "peeling away". In other words, different portions of the contact surface progressively come into contact with the ink ejection face at different times during engagement. Likewise, different portions of the contact surface are progressively peeled away from the ink ejection face at different times during disengagement. The specification and drawings below describe in detail this type of engagement and disengagement, and various ways of achieving such engagement and disengagement.

[0019] The printhead maintenance station advantageously combines both preventative and remedial measures for maintaining an inkjet printhead in an operable condition. In terms of preventative measures, the contact surface seals the ink ejection face, thereby minimizing evaporation of water from the nozzles and minimizing the effects of ink drying up inside the nozzles. Sealing engagement of the contact surface with the ink ejection face also protects the printhead from particulates in the atmosphere, which can damage or block nozzles. Typically, the pad is held in its first position when the printhead is left idle over relatively long periods. However, the pad may be moved into sealing engagement at any time when the printhead is not printing.

[0020] In terms of remedial measures, the contact surface cleans ink from the ink ejection face due to the unique interaction between the contact surface and the printhead. From a detailed analysis of advancing and receding contact angles, the present inventors have found that peeling disengagement of the contact surface from the ink ejection face has the effect of moving ink along the contact surface (or the ink ejection face) towards an edge portion. Once deposited at an edge portion, the ink may be readily removed. A detailed explanation of the principle of advancing and receding contact angles, and how these relate to the present invention is given below.

[0021] In addition to cleaning flooded ink from the ink ejection face, the peeling disengagement action of the contact surface from the printhead also has the effect of unblocking nozzles. Peeling disengagement generates a negative pressure above nozzles in the printhead and, hence, draws out viscous ink material or particulate contaminants blocking the nozzles. Accordingly, the peeling disengagement has the combined effects of clearing blocked nozzles and removing ink to an edge portion of the contact surface or printhead.

[0022] A further advantage of the printhead maintenance station is that it has a simple design, which is compact, can be manufactured at low cost and consumes very little power. The suction devices of the prior art require external pumps, which add significantly to the cost and power consumption of prior art printers. Moreover, the requirement of an external vacuum pump adds sig-

nificantly to the bulk of prior art printers. By obviating the need for a vacuum pump to effectively unblock printhead nozzles, the present invention allows inkjet printers to be installed into a wider range of devices and also opens up the potential for a commercially-viable disposable inkjet printer.

[0023] A further advantage of the printhead maintenance station is that nozzles can be unblocked without wasting large quantities of ink. Whereas prior art suction devices are wasteful of ink, adding to the overall cost of printer operation, the present invention withdraws only a minimum quantity of ink from nozzles during remediation. Moreover, by depositing the ink onto an edge portion of the pad (and/or the printhead), the means for removing this ink is greatly simplified.

[0024] A further advantage of the printhead maintenance station is that the cleaning action exerts minimal shear stress across the ink ejection face. Accordingly, sensitive nozzle structures are less likely to be damaged during maintenance when compared to, for example, wiping or squeegee cleaning of printheads.

[0025] Optionally, the pad is substantially coextensive with the printhead. A pad configured in this way ensures maintenance of the entire printhead, whilst simplifying the design of the maintenance station as far as possible. As described below a portion of the pad may extend beyond one end of the printhead, although this type of arrangement is still understood to be within the definition of the term 'substantially coextensive'.

[0026] The contact surface is substantially uniform, so that ink can flow freely across its surface. Optionally, the contact surface should have a minimal number of pits or indentations, to avoid trapping ink in micro-pockets and consequently reducing the efficacy of the cleaning action.

[0027] The pad is elastically deformable and, preferably, has minimal or no creep. Elastic deformability provides sealing engagement of the pad with the printhead. Moreover, it ensures the pad can be used repeatedly without loss of either sealing or cleaning performance. Suitable materials for forming the pad include thermosetting or thermoplastic elastomers. For example, the pad may be comprised of silicone, polyurethane, Neoprene®, Santoprene® or Kraton®. Optionally, the pad is comprised of a silicone rubber.

[0028] Optionally a peel zone between the contact surface and the ink ejection face advances and retreats transversely across the ink ejection face during engagement and disengagement. In this embodiment, ink retreats with the peel zone in a longitudinal line towards a longitudinal edge portion of the contact surface or printhead as the pad is peeled away. This has the advantage that the ink travels a minimum distance across the ink ejection face and maximizes the cleaning efficiency of the maintenance station.

[0029] The engagement mechanism moves the pad substantially perpendicularly with respect to the ink ejection face. This arrangement has the advantage of simplifying the motion of the pad and, moreover, the means for achieving this. For example, a simple solenoid or motor/cam arrangement, consuming very little power, may be used to provide reciprocal linear movement of the pad.

[0030] With the pad being moved perpendicularly with respect to the ink ejection face, the unique engagement action of the contact surface is usually determined by the profile of the contact surface itself. Optionally, the pad is configured so that the contact surface is sloped with respect to the ink ejection face. Accordingly, during perpendicular engagement of the pad with the ink ejection face, a first end of the contact surface is contacted before a second end of the contact surface. Sloping of the contact surface may be in the form of a linear gradient (*i.e.* the contact surface is flat). For example, the contact surface may be angled at 5-30°, 8-20° or 10-15° with respect to the ink ejection face. Alternatively, sloping of the contact surface may be in the form of a curved or rounded gradient. In either case, progressive contact of the surface with the ink ejection face is ensured during engagement. Likewise, a peeling motion is ensured during disengagement.

[0031] As mentioned above, engagement of the pad may be provided so as to engage the contact surface progressively transversely across the printhead.

[0032] The maintenance station is typically configured so that peeling disengagement of the contact surface from the ink ejection face draws ink from the printhead towards an edge portion of the contact surface, the ink ejection face, or both. This cleaning action may be used to clear blocked nozzles and remove ink flooded on the surface of the ink ejection face.

[0033] The speed of engagement and disengagement, together with the contact time, may be varied in order to optimize the cleaning action. Optimal cleaning will also depend on other factors, such as the size of printhead, the elasticity of the pad, the shape of the pad, the motion of the engagement mechanism etc. The skilled person will readily be able to optimize cleaning of the printhead for any given system by varying one or more of these parameters.

[0034] The pad may be moved according to a predetermined algorithm, depending on the expected severity of nozzle blockage. For example, different maintenance actions may be suitable for different printer conditions (*e.g.* first use, paper jam, recovery, user intervention etc.). Some situations may require five reciprocal movements of the pad, whereas other situations may require only one engage/disengage sequence. Suitable algorithms may be programmed into a control system controlling operation of the printhead maintenance station.

[0035] Optionally, the maintenance station further comprises an ink removal system for removing ink deposited on an edge portion of the contact surface or ink ejection face. The ink removal system advantageously avoids build up of ink on the pad or on the printhead, and channels any surplus ink away from the printhead.

[0036] The ink removal system may comprise any substrate or mechanism that can effectively remove ink from

the edge portion(s). For example, the pad may be moved and contacted with an absorbent material after it has disengaged from the printhead.

[0037] Optionally, the ink removal system comprises a wicking element positioned adjacent an edge of the printhead. Ink which has been deposited towards the edge of the printhead and the pad is absorbed into the wicking element, which may simply be an absorbent material, and removed by wicking through the material. This arrangement has the advantage of simplicity and obviates the need for additional moving parts or a vacuum system in the maintenance station.

[0038] Optionally, the ink removal system comprises a wicking channel.

[0039] The invention has been developed primarily for use with a pagewidth inkjet printhead. Optionally, the printhead comprises a plurality of nozzles, with each nozzle having a diameter of less than 20 microns or less than 15 microns.

[0040] However, the invention is equally applicable to any type of printhead where sealing and/or remedial measures are required to maintain the printhead in an operable condition. For example, the invention may be used in connection with standard scanning inkjet printheads in order to simplify conventional maintenance stations.

Brief Description of the Drawings

[0041] Specific forms of the present invention will be now be described in detail, with reference to the following drawings, in which:-

Figure 1 shows an equilibrium contact angle for a wetting droplet of liquid on a surface;
Figure 2 shows an equilibrium contact angle for a non-wetting droplet of liquid on a surface;
Figure 3 shows advancing and receding contact angles for a droplet of liquid moving along a surface;
Figure 4A is a side view of a contact surface before engagement with an ink ejection face of a printhead;
Figure 4B is a side view of a contact surface partially engaged with the ink ejection face during engagement;
Figure 4C shows in detail a peel zone between the contact surface and a printhead nozzle during engagement;
Figure 4D shows in detail the peel zone in Figure 4C after it has advanced past the nozzle;
Figure 5A is a side view of the contact surface sealingly engaged with the ink ejection face;
Figure 5B is a side view of a contact surface partially engaged with the ink ejection face during disengagement;
Figure 5C shows in detail a peel zone between the contact surface and a printhead nozzle during disengagement;
Figure 5D shows in detail the peel zone in Figure 4C as it retreats from the nozzle;
Figure 5E shows in detail the peel zone in Figure 4D after it has retreated from the nozzle;
Figure 6 is a side view of the contact surface immediately after it has disengaged from the ink ejection face;
Figure 7 is a longitudinal side section view through a printhead maintenance station according to the invention;
Figure 8 is a side view of the printhead maintenance station shown in Figure 7;
Figure 9 is a transverse side section view of the printhead maintenance station shown in Figure 7;
Figure 10 is an end view of the printhead maintenance station shown in Figure 7;
Figure 11 is an exploded perspective view of the printhead maintenance station shown in Figure 7;
Figure 12 is a perspective view of a pad moving perpendicularly with respect to an ink ejection face of a printhead;
Figure 13 is a perspective view of a pad;
Figure 14 is a perspective view of a pad;
Figure 15A-C are schematic side views of a cylindrical pad at various stages of engagement with an ink ejection face of a printhead;
Figure 16A-C are schematic side views of a contact surface being brought into engagement with an ink ejection face of a printhead by rotational movement;
Figure 17 is a schematic side view of a roller being rolled across an ink ejection face of a printhead;
Figure 18 is a schematic side view of a printhead assembly comprising a wicking element;
Figure 19 is a schematic side view of a printhead assembly comprising a wicking channel;
Figure 20 is a plan view of the printhead and film shown in Figure 19;
Figure 21 is a schematic side view of the printhead assembly shown in Figure 19 with the pad fully engaged;
Figure 22 is a schematic side view of the printhead assembly shown in Figure 21 at the point of disengagement; and
Figures 23A-D are transverse side section views of a printhead maintenance station, having a rotating pad cleaning action, in various stages of a printhead maintenance cycle.

Detailed Description of Specific Embodiments

Contact Angle Hysteresis

[0042] In general terms, and as mentioned above, the present invention relies on an understanding of contact angles - specifically, a hysteresis between advancing and receding contact angles.

[0043] The shape of a droplet of liquid on a solid surface is determined by its contact angle(s). Depending on factors such as the surface tension in the liquid and the

interactive forces between the solid and the liquid, the shape of the droplet will change. Figure 1 shows a droplet of liquid 1 having a contact angle of 20° on a solid surface 2. With acute contact angles, the liquid is said to be "mostly wetting" the surface 2. Figure 2 shows a droplet of another liquid 3 having a contact angle of 110° on the solid surface 2. With obtuse contact angles, the liquid is said to be "mostly non-wetting".

[0044] The contact angles shown in Figures 1 and 2 are static or equilibrium contact angles. Since the droplet is symmetrical, the contact angle measured on either side of the droplet would be the same. However, the situation changes if the droplet of liquid is moving. Figure 3 shows a droplet of liquid 4 moving down the surface 2, which is now sloped. As shown in Figure 3, the shape of the droplet changes when it is moving. The result is that the contact angle on its leading (advancing) edge is greater than the contact on its tailing (receding) edge. In other words, the droplet is more wetting when receding and less wetting when advancing. The contact angle designated as θ_A in Figure 3 is called the Advancing Contact Angle, and the contact angle designated as θ_R in Figure 3 is called the Receding Contact Angle.

[0045] For a typical droplet of ink moving across a silicone surface, the advancing contact angle is about 90°, whereas the receding contact angle is about 15°. Without wishing to be bound by theory, it is understood by the present inventors that this contact angle hysteresis is responsible for the cleaning action provided by the present invention.

[0046] In Figures 4A and 4B, a flexible pad 6 having a contact surface 7 is progressively brought into contact with a printhead 5 having an ink ejection face 8. Figure 4C shows an exploded view of a peel zone 9 in Figure 4B, when the contact surface 7 is partially in contact with the ink ejection face 8. Figure 4C shows in detail the behaviour of ink 11 as the surface 7 is contacted with a nozzle opening 10 on the printhead. Ink 11 in the nozzle opening 10 makes contact with the contact surface 7 as it advances across the printhead 5. However, since the advancing contact angle θ_A of the ink 11 on the contact surface 7 is relatively non-wetting (about 90°), the ink has little or no tendency to wet onto the contact surface 7. Hence, as shown in Figure 4D, the ink 11 remains on the ink ejection face 8 or in the nozzle 10, and the peel zone 9 advancing across the ink ejection face is relatively dry.

[0047] In Figures 5A and 5B, the reverse process is shown as the flexible pad 6 is peeled away from the ink ejection face 8. Initially, as shown in Figure 5A, the contact surface 7 is sealingly engaged with the ink ejection face 8. In Figure 5B, the contact surface 7 is peeled away from the ink ejection face 8, and the peel zone 9 retreats across the face. Figure 5C shows a magnified view of the peel zone 9 as the contact surface 7 is peeled away from the nozzle opening 10 on the printhead 5. Ink 11 in the nozzle opening 10 makes contact with the contact surface 7 as it recedes across the ink ejection face 8. However, since the receding contact angle θ_R of the ink 11 on the surface 7 is relatively wetting (about 15°), the ink in the nozzle opening 10 now tends to wet onto the contact surface 7. Hence, as shown in Figures 5D and 5E, the peel zone 9 retreating across the ink ejection face 8 is wet, carrying with it a droplet of ink 12 drawn from the nozzle opening 10 or from the ink ejection face 8. This has the effect of clearing blocked nozzles in the printhead 5 and cleaning ink flooded on the ink ejection face 8.

[0048] Figure 6 shows the flexible pad 6 as the last part of the contact surface 7 is peeled away from the ink ejection face 8. The contact surface 7 has collected a bead of ink 12 at the final point of contact with the printhead 5.

[0049] As will be readily appreciated from the foregoing discussion, the present invention may be implemented in many different forms, provided that the contact surface 7 is contacted with the ink ejection face 8 so as to produce a contact angle hysteresis. Various forms of the invention are described in detail below.

Printhead Maintenance Station Having Linear Pad Movement

[0050] Referring to Figures 7 to 11, a printhead maintenance station 20 comprises an elastically deformable pad 6 having a contact surface 7. The pad 6 is mounted on a support 23, having a recess 24 for receiving the pad. The support 23 is mounted on a support arm 25 having lugs 26 protruding from each end. The pad 21, support 23 and support arm 25 are bonded together to form a pad sub-assembly.

[0051] A housing 30 comprises a body 31 and a cap 32, which is snap-fitted to the body with a plurality of snap-locks 33. The two-part construction of the housing 30 enables it to be assembled by receiving the pad sub-assembly in the body 31 and then snap-fitting the cap 32 onto the body. The lugs 26 protruding from each end of the support arm 25 are received in complementary slots 34 in the housing 30. Accordingly, the support arm 25 is slidably movable within the slots 34, allowing the pad 6 to move slidably relative to the housing 30.

[0052] The extent of movement of the pad 6 is defined by the slots 34. In a first position shown in Figure 7, the lugs 26 abut an upper end 37 of each slot 34 and the pad 6 protrudes, at least partially, from the housing 30. In a second position (not shown), the lugs 26 abut a lower end 38 of each slot 34, defined by the cap 32, and the pad 6 is withdrawn inside the housing 30.

[0053] As shown in Figure 11, a pair of springs 35 are fixed to the cap 32 and urge against a lower surface 36 of the support arm 25. The springs 35 bias the pad 6 towards the first position shown in Figure 7.

[0054] The pad 6 is movable between the first and second positions by means of an engagement mechanism 40, which is shown in Figure 7. The engagement mechanism 40 comprises a motor 41, which rotates a pair of cams 42, engaged with respective lugs 26 at each end

of the support arm 25. Rotation of the motor 41 and the cam 42 causes linear sliding movement of the support arm 25 and, hence, the pad 6. Accordingly, the pad 6 may be moved reciprocally between the first and second positions upon actuation of the motor 41.

[0055] In the first position, the contact surface 7 is sealingly engaged with the ink ejection face 8, as shown in detail in Figure 5A. In the second position, the contact surface 7, is disengaged from the ink ejection 8, as shown in Figure 4A. In between these two positions, the contact surface 7 may be either progressively contacting or peeling away from the ink ejection face 8.

[0056] Figure 12 shows the perpendicular movement of the pad 6 with respect to the ink ejection face 8. As discussed above, this movement together with the profile of the contact surface 7 allows the printhead 5 to be maintained in an operable condition by sealing, cleaning and/or nozzle-clearing actions.

Alternative Pad Configurations

[0057] In the embodiment shown in Figures 4-12, the pad 6 is moved linearly and substantially perpendicularly with respect to the ink ejection face 8. The pad 6 is shown in Figures 4A and 12 having a sloped contact surface 7 in the form of a straight-line gradient. This sloped contact surface 7 allows it to be progressively contacted with and peeled away from the ink ejection face 8 during engagement and disengagement respectively.

[0058] However, the contact surface may adopt other profiles and still achieve a similar effect when moved perpendicularly with respect to the ink ejection face 8. Figures 13 and 14 show two alternative configurations for the pad 6 in which the contact surface 7 has a curved profile in cross-section.

[0059] As shown in Figures 15A-C, the pad may alternatively be in the form of a cylinder 50, extending along the length of the printhead 5. The cylinder may be moved perpendicularly with respect to the ink ejection face 8 so that it is in either an engaged or a disengaged position. Figures 15A-C show progressive contacting of a curved contact surface 51 of the cylinder 50 so that it is brought into sealing engagement with the ink ejection face 8. The reverse process of peeling the contact surface 51 away from the ink ejection face 8 cleans the face or clears blocked nozzles on the printhead 5, as described above. The cylinder 50 is offset from the printhead 5 so that any ink drawn from the printhead moves towards an edge portion of the printhead during disengagement, and not towards the centre.

[0060] Any of these alternative pads may readily be incorporated into the printhead maintenance station 20 described above by simple replacement of the pad 6 in Figure 11.

Printhead Maintenance Station Having Rotational Pad Movement

[0061] In all the embodiments described thus far, the contact surface 7 has been sloped. With a sloped contact surface 7, linear motion of the pad 6 produces the peeling action required by the invention. However, as an alternative not falling under the subject-matter of the claims, the pad 6 may be moved rotationally in order to achieve the progressive engagement and peeling disengagement from the ink ejection face 8.

[0062] In Figures 16A-C, there is shown a pad 60 mounted on an arm 61, which is attached to a pivot 62 at one end. The arm 61 is rotated by means of a motor 63 connected to the pivot 62. The pad 60 has a flat contact surface 64, which is progressively contacted with the ink ejection face 8 by virtue of the rotational movement of the arm 61. In the reverse process (not shown), the pad 60 is peeled away from the ink ejection face 8 also by virtue of the rotational movement of the arm 61. The pad 60 may be cuboid-shaped in this alternative, since the requisite engagement and disengagement action is generated by the rotational movement of the pad.

[0063] As shown in Figures 16A-C, the pad is progressively contacted (and, by the reverse process, peeled away) along the longitudinal direction of the printhead 5. The printhead 5 has longitudinal rows of nozzles (not shown), with each row ejecting the same colored ink. By engaging/disengaging the pad 60 along the longitudinal direction of the printhead 5, color mixing between adjacent rows of nozzles is minimized as ink is drawn longitudinally along the ink ejection face 8 towards a transverse edge portion of the face and the pad 60.

Printhead Maintenance Station Having Rolling Pad Movement

[0064] As an alternative not falling under the subject-matter of the claims as shown in Figure 17, the pad may alternatively be in the form a roller 70, which extends along the length of the printhead 5. In this alternative embodiment, the roller 70 is rolled transversely across the ink ejection face 8 so that a leading peel zone 71 between the roller and the face is dry, and a tailing peel zone 72 between the roller and the face is wet. As explained above, this difference is due to an advancing contact angle at the leading peel zone 71 being greater than a receding contact angle at the tailing peel zone 72. Accordingly, the rolling action has the effect of cleaning the ink ejection face 8 due to this contact angle hysteresis. Unlike the embodiments described above, in this alternative, advancing and receding contact angles are experienced simultaneously by different surfaces of the roller 70.

[0065] The roller 70 is rolled across the ink ejection face using a rolling mechanism 73. The rolling mechanism 73 comprises a pivot arm 74 to which the roller 70 is rotatably mounted at one end. The pivot arm 74 is

pivoted about a pivot 75, and an opposite end of the arm is moved by means of a solenoid 76. Actuation of the solenoid 76 causes the pivot arm 74 to pivot and the roller 70 is consequently rolled transversely across the ink ejection face 8.

Absorbent Wicking Element Adjacent Printhead For Removing Ink

[0066] In all the embodiments and alternative not falling under the subject-matter of the claims as and alternative described above, the cleaning action of the pad 6 generally deposits ink towards a predetermined region of the contact surface 7, which is typically an edge portion. Some ink may also be deposited on an edge portion of the ink ejection face 8 - either a transverse edge portion or a longitudinal edge portion depending on the configuration or movement of the pad 6.

[0067] Figure 18 shows an embodiment where deposited ink 81 is removed by means of a wicking element 80 positioned adjacent a longitudinal edge 83 of the printhead 5. The wicking element 80 wicks ink away from a longitudinal edge portion 82 of the contact surface 7 and/or the ink ejection face 8. From Figure 18, it can be seen that the edge portion 82 of the contact surface 7 extends past an edge of the printhead 5, allowing the edge portion 82 to contact with the wicking element 80 adjacent the printhead. Hence, ink deposited at the edge portion 82, as the contact surface 7 peels away from the ink ejection face 8, is transferred onto the wicking element 80. The edge portion 82 is the final point of contact between the contact surface 7 and the ink ejection face 8 during disengagement.

[0068] The pad 6 and wicking element 80 are configured to move ink away from an opposite longitudinal edge portion 84 of the printhead 5, which comprises wirebond encapsulant 85. The encapsulant 85 protects wirebonds (not shown) connecting the printhead 5 to other printer components (not shown).

[0069] The crowded environment around the printhead 5 means that the wirebonded edge portion 84 is relatively inaccessible. It is an advantage of the present invention that the pad 6 can access and move ink away from this severely crowded edge portion 84.

[0070] The wicking element 80 is formed from an absorbent material, such as paper or foam, and is positioned in a cavity defined between a print media guide 86 and a support 87 on which the printhead 5 and print media guide are mounted. The print media guide 86 has a guide surface 88 for guiding print media past the printhead 5 when the pad 6 is fully disengaged from the ink ejection face 8.

[0071] An ink collector 89 receives ink that has wicked through the wicking element 80, ensuring that ink is always removed away from the printhead 5.

Wicking Channel Adjacent Printhead For Removing Ink

[0072] With repeated maintenance operations, the wicking element 80 may become.damaged after repeated engagement of the pad 6. In particular, if the wicking element 80 is comprised of paper and saturated with absorbed ink, it may disintegrate when contacted with the contact surface 7. Whilst more robust wicking materials may be used, a problem remains in that wicking rates through the material are relatively slow.

[0073] In an example, and referring to Figures 19 and 20, a film 120 is positioned adjacent the longitudinal edge 83 of the printhead 5. The film 120 has a proximal longitudinal edge 121 and a distal longitudinal edge 122 relative to the printhead 5. The film 120 cooperates with the support 87 to define a wicking channel 124. The distal longitudinal edge 122 may be attached to the support 87 via a plurality of anchor points 123. The anchor points 123 may be, for example, spots of adhesive spaced apart along the distal edge 122. Alternatively, the distal edge 122 of the film 120 may be fixed to the paper guide 86, and the film held in position by being sandwiched between the support 87 and the paper guide.

[0074] The film 120 is typically a biaxially oriented polyester film (*e.g.* Mylar® film). Due to the stiffness and resilience of the film 120, attachment to the support 87 along the distal longitudinal edge 122 provides a tapered wicking channel 124. A channel inlet 125 is provided adjacent the longitudinal edge 83 of the printhead 5, while a channel outlet 126 is provided distal from the printhead 5.

[0075] Due to the tapering of the wicking channel 124, ink received in the channel inlet 125 wicks rapidly along the channel towards the channel outlet 126 by capillary action, thereby removing ink away from the printhead 5. Furthermore, since the anchor points 123 are spaced apart along the distal longitudinal edge 122 of the film 120, ink can flow in between the anchor points and exit the channel outlet 126.

[0076] A secondary wicking element 127 is positioned between the media guide 86 and the support 87 at the channel outlet 126. The secondary wicking element 87 is positioned to receive ink from the channel outlet 126 and wicks ink into the ink collector 89. The secondary wicking element 127 is comprised of an absorbent material, such as paper or foam. Since the secondary wicking element 127 is not physically contacted by the pad 6 during printhead maintenance operations, it has a comparatively long lifetime compared to the wicking element 80 described above.

[0077] Referring to Figure 20, a plurality of vents in the form of slots 128 are defined in the film 120 towards its proximal longitudinal edge 121. The slots 128 are positioned for receiving any ink, which does not enter the channel inlet 125. For example, any ink deposited on the outer surface of the film 120 (*i.e.* the upper surface of the film 120 as shown in Figure 19) during printhead maintenance, is wicked into the channel 124 via the slots 128.

The elongate slots 128, extending longitudinally along the film 120, have been shown to be particularly effective in wicking ink into the channel 124. However, any shape of vent may equally be used for the same purpose.

[0078] Referring to Figures 21 and 22, there is shown a printhead maintenance operation including cooperation of the contact surface 7 and the film 120. In Figure 21, the pad 6 is fully engaged with the printhead 5. The edge portion 82 of the contact surface 7 abuts against the film 120, urging the film against the support 87. The edge portion 82 contacts the film 120 so that the vents 128 are sealed by the contact surface 7. In this way, any ink on the edge portion 82 of the contact surface 7 is squeezed into the vents 128 and into the channel 124, during engagement of the pad 6.

[0079] In Figure 22, the contact surface 7 has peeled away from the ink ejection face 8 so that ink 81 has moved towards the edge portions 82 and 83. Due to the resilience of the film 120 (and due, in part, to stiction forces between the film 120 and the contact surface 7), the tapered channel 124 is defined as the pad 6 is disengaged from the printhead 5. Accordingly, as shown in Figure 22, the ink 81 removed from the ink ejection face 8 is positioned in the channel inlet 125 at the point of disengagement.

[0080] Once the ink 81 has entered the channel inlet 125, it is rapidly wicked towards the channel outlet 126 due to the tapering of the channel 124 and the capillary action provided thereby. The ink 81 is subsequently received by the secondary wicking element 127 and deposited into the ink collector 89. Hence, efficient and rapid removal of ink 81 away from the contact surface 7 and/or printhead 5 is achieved.

Engagement Mechanism with Rotating Pad-Cleaning Action

[0081] As described above, a wicking element 80 or film 120 may be positioned adjacent an edge portion 83 of the printhead 5, so that ink 81 is removed from the contact surface 7, ready for the next cleaning sequence.

[0082] In an example, the maintenance station may be configured so that ink is removed from contact surface 7 after the pad 6 is disengaged from the printhead face 8. In this example, the engagement mechanism is configured to move the contact surface 7 into engagement with a remote cleaning means after it has disengaged from the printhead face 8. For example, rotation of the pad 6 after disengagement may be used to bring the contact surface 7 into cleaning engagement with a squeegee or blotter. Rotation may, for example, rock the pad through an arc and past a squeegee. Alternatively, rotation may be fully through 180° using a similar mechanism to those used in rotating 'self-inking' stamps. Self-inking stamps have been known for decades in the stamping art (see, for example, US Patent Nos. 239,779; 405,704; 669,137; 827,347; 1,121,940; 2,079,080; 2,312,727; 2,919,645; 3,364,856; 3,402,663; 3,631,799; 3,952,653; 3,988,987; 4,432,281 and 4,852,489), and the skilled person will readily appreciate how such stamping mechanisms may be used to rotate the pad 6 through 180° onto a blotter after it has disengaged from the printhead face 8.

[0083] Figures 23A-D show a cleaning sequence for a printhead assembly 90, in which the pad 6 is cleaned after disengagement from the printhead face 8 by rocking past a rubber squeegee.

[0084] Referring to Figure 23A, there is shown in cross-section a printhead cartridge 91 comprising the printhead 5 mounted on support 92. Encapsulated wirebonds 85 extend from one longitudinal edge of the printhead 5, while the paper guide 88 is fixed to the support 87 on an opposite side of the printhead. Still referring to Figure 23A, there is also shown a printhead maintenance station 100 comprising the pad 6 having the contact surface 7 for engagement with the ink ejection face 8 of the printhead 5. The pad is mounted on a cradle 101, which can be moved vertically towards the printhead 5 and which can also be rotated or rocked towards a rubber squeegee 102 fixed to a wall 103 of the maintenance station 100.

[0085] Referring now to Figure 23B, the sloped contact surface 7 is brought into sealing engagement with the printhead face 8 by moving the pad 6 vertically upwards using an engagement mechanism (not shown) similar to that shown in Figures 7-11.

[0086] In Figure 23C, the printhead face 8 is cleaned by moving the pad 6 vertically downwards, thereby peeling the contact surface 7 away from the printhead face. A droplet of ink 104 is deposited along an edge portion of the contact surface 7 after it has disengaged from the printhead.

[0087] In Figure 23D, the engagement mechanism (not shown) moves the cradle 101 further downwards so that its bottom surface 105 abuts with a cam surface 106 on the maintenance station. Abutment of the cradle 101 with the cam surface 106 causes the cradle to rock towards the rubber squeegee 102. The squeegee 102 removes the ink droplet 104 from the contact surface 7 as it rocks past the squeegee. This cleans the pad ready for re-use in the next maintenance cycle. Any suitable cleaning means, such as a foam pad, may of course be used to clean the pad 6 instead of the rubber squeegee 102 shown in Figures 19A-D.

[0088] Finally, the cradle 101 is moved back into the position shown in Figure 23A, which completes the maintenance cycle. A biasing mechanism (not shown) rocks the cradle 101 back into its vertical position shown in Figure 23A as the cradle is moved upwards and away from the cam surface 106.

[0089] It will, of course, be appreciated that the present invention has been described purely by way of example and that modifications of detail may be made within the scope of the invention, which is defined by the accompanying claims.

Claims

1. A printhead assembly for maintaining a printhead in an operable condition, said printhead maintenance assembly comprising:

   a printhead (5) comprising an ink ejection face (8) having nozzles (10) for ejection of ink (11); and
   a printhead maintenance station (20) comprising:

   an elastically deformable pad (6) having a substantially uniform contact surface (7) configured for sealing engagement with all the nozzles (10) contained in the ink ejection face (8) of the printhead (5); and
   an engagement mechanism for moving said pad substantially perpendicularly with respect to said ink ejection face between a first position in which said contact surface (7) is sealingly engaged with all the nozzles (10), and a second position in which said contact surface is disengaged from all the nozzles,
   wherein said maintenance station is configured such that said contact surface (7) is progressively contacted with said nozzles during sealing engagement and peeled away from said nozzles (10) during disengagement, such that a contact angle hysteresis is produced which is responsible for a cleaning action, said cleaning action having the effect of clearing blocked nozzles in the printhead and cleaning ink flooded on the ink ejection face.

2. The printhead assembly of claim 1, wherein said pad (6) is substantially coextensive with said printhead.

3. The printhead assembly of claim 1, wherein said pad (6) is comprised of silicone.

4. The printhead assembly of claim 1, wherein a peel zone between said contact surface (7) and said ink ejection face (8) advances and retreats transversely across said face during engagement and disengagement.

5. The printhead assembly of claim 1, wherein said contact surface (7) is sloped with respect to said ink ejection face (8) such that, during engagement, a first part of said surface is contacted with said face prior to a second part of said surface.

6. The printhead assembly of claim 1, wherein said peeling disengagement draws ink from said printhead towards an edge portion of said contact surface (7) and/or said face (8).

7. The printhead assembly of claim 1, further comprising an ink removal system for removing ink from an edge portion of said contact surface and/or said face.

8. The printhead assembly of claim 7, wherein said ink removal system comprises a wicking element or wicking channel positioned adjacent an edge of said printhead.

9. An inkjet printer comprising the printhead assembly according to any one of the preceding claims.

Patentansprüche

1. Eine Druckkopfanordnung zur Instandhaltung eines Druckkopfes in einem operablen Zustand, wobei die Druckkopfinstandhaltungsanordnung folgendes umfasst:

   einen Druckkopf (5), der eine Tintenausstoßfläche (8) mit Düsen (10) zum Ausstoßen von Tinte (11) umfasst; und
   eine Druckkopfinstandhaltungsstation (20), die folgendes umfasst:

   einen elastisch verformbaren Block (6) mit einer im Wesentlichen einheitlichen Kontaktoberfläche (7), die für einen dichten Eingriff mit sämtlichen Düsen (10) konfiguriert ist, die in der Tintenausstoßfläche (8) des Druckkopfes (5) beinhaltet sind; und
   einen Eingriffmechanismus zur Bewegung des Blocks im Wesentlichen senkrecht in Bezug auf die Tintenausstoßfläche zwischen einer ersten Position, in der die Kontaktoberfläche (7) in dichtem Eingriff mit sämtlichen Düsen (10) ist, und einer zweiten Position, in der die Kontaktoberfläche von sämtlichen Düsen gelöst ist,
   wobei die Instandhaltungsstation derart konfiguriert ist, dass die Kontaktoberfläche (7) mit den Düsen während des dichten Eingriffs progressiv in Kontakt gebracht wird und von den Düsen (10) während des Lösens derart abgezogen wird, dass eine Kontaktwinkelhysterese erzeugt wird, die für einen Reinigungsvorgang verantwortlich ist, wobei der Reinigungsvorgang den Effekt der Freimachung von blokkierten Düsen in dem Druckkopf und der Säuberung von auf der Tintenausstoßfläche im Überschuss vorhandener Tinte aufweist.

2. Die Druckkopfanordnung nach Anspruch 1, wobei der Block (6) mit dem Druckkopf im Wesentlichen

flächengleich ist.

3. Die Druckkopfanordnung nach Anspruch 1, wobei der Block (6) Silicon umfasst.

4. Die Druckkopfanordnung nach Anspruch 1, wobei eine Abziehzone zwischen der Kontaktoberfläche (7) und der Tintenausstoßfläche (8) sich während des Eingriffs und des Lösens quer über die Fläche ausbreitet und zurückzieht.

5. Die Druckkopfanordnung nach Anspruch 1, wobei die Kontaktoberfläche (7) in Bezug auf die Tintenausstoßfläche (8) abgeschrägt ist, so dass während des Eingriffs ein erster Teil der Oberfläche mit der Fläche vor einem zweiten Teil der Oberfläche kontaktiert wird.

6. Die Druckkopfanordnung nach Anspruch 1, wobei das abziehende Lösen Tinte von dem Druckkopf in Richtung auf einen Randabschnitt der Kontaktoberfläche (7) und/oder der Fläche (8) zieht.

7. Die Druckkopfanordnung nach Anspruch 1, die ferner ein Tintenentfernungssystem zum Entfernen von Tinte von einem Randabschnitt der Kontaktoberfläche und/oder der Fläche umfasst.

8. Die Druckkopfanordnung nach Anspruch 7, wobei das Tintenentfernungssystem ein Dochtelement oder einen Kanal mit Dochteffekt umfasst, das/der zu einem Rand des Druckkopfes benachbart positioniert ist.

9. Ein Tintenstrahldrucker, der die Druckkopfanordnung nach einem der vorstehenden Ansprüche umfasst.

Revendications

1. - Ensemble tête d'impression pour maintenir une tête d'impression en état de fonctionnement, ledit ensemble de maintenance de tête d'impression comprenant :

   - une tête d'impression (5) comprenant une face d'éjection d'encre (8) ayant des buses (10) pour l'éjection d'encre (11) ;
   et
   - une station de maintenance de tête d'impression (20) comprenant :

     - un joint déformable élastiquement (6) ayant une surface de contact sensiblement uniforme (7) configurer pour un engagement étanche avec toutes les buses (10) contenues dans la face d'éjection d'encre (8) de la tête d'impression (5) ; et
     - un mécanisme d'engagement pour déplacer ledit joint sensiblement perpendiculairement par rapport à ladite face d'éjection d'encre entre une première position dans laquelle ladite surface de contact (7) est en engagement étanche avec toutes les buses (10), et une seconde position dans laquelle ladite surface de contact est désengagée de toutes les buses,
     ladite station de maintenance étant configurée de telle sorte que ladite surface de contact (7) est progressivement mise en contact avec lesdites buses lors de la mise en engagement étanche et arrachée desdites buses (10) lors du désengagement, de telle sorte qu'une hystérésis d'angle de contact est produite, laquelle est responsable d'une action de nettoyage, ladite action de nettoyage ayant pour effet de nettoyer les buses bloquées dans la tête d'impression et de nettoyer l'encre qui s'est écoulée sur la face d'éjection d'encre.

2. - Ensemble tête d'impression selon la revendication 1, dans lequel ledit joint (6) est sensiblement coextensif avec ladite tête d'impression.

3. - Ensemble tête d'impression selon la revendication 1, dans lequel ledit joint (6) est composé de silicone.

4. - Ensemble tête d'impression selon la revendication 1, dans lequel une zone d'arrachage entre ladite surface de contact (7) et ladite face d'éjection d'encre (8) avance et recule transversalement à ladite face lors de la mise en engagement et du désengagement.

5. - Ensemble tête d'impression selon la revendication 1, dans lequel ladite surface de contact (7) est inclinée par rapport à ladite face d'éjection d'encre (8) de telle sorte que, lors de la mise en engagement, une première partie de ladite surface est mise en contact avec ladite face avant une seconde partie de ladite surface.

6. - Ensemble tête d'impression selon la revendication 1, dans lequel ledit désengagement par arrachage aspire de l'encre à partir de ladite tête d'impression vers une partie de bord de ladite surface de contact (7) et/ou de ladite face (8).

7. - Ensemble tête d'impression selon la revendication 1, comprenant en outre un système de retrait d'encre pour retirer l'encre d'une partie de bord de ladite surface de contact et/ou de ladite face.

8. - Ensemble tête d'impression selon la revendication

7, dans lequel ledit système de retrait d'encre comprend un élément à effet mèche ou un canal à effet mèche positionné adjacent à un bord de ladite tête d'impression.

9. - Imprimante à jet d'encre comprenant l'ensemble tête d'impression tel que défini à l'une quelconque des revendications précédentes.

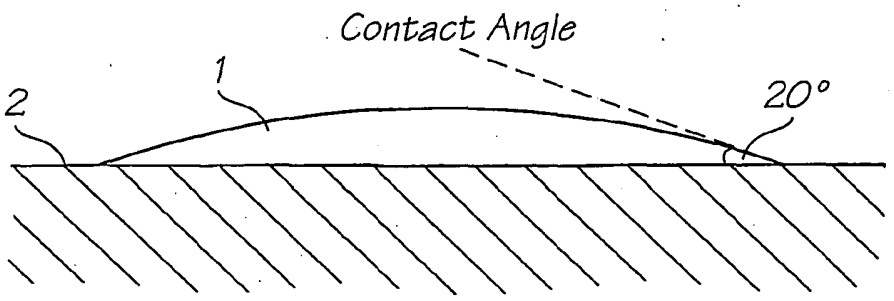


FIG. 1

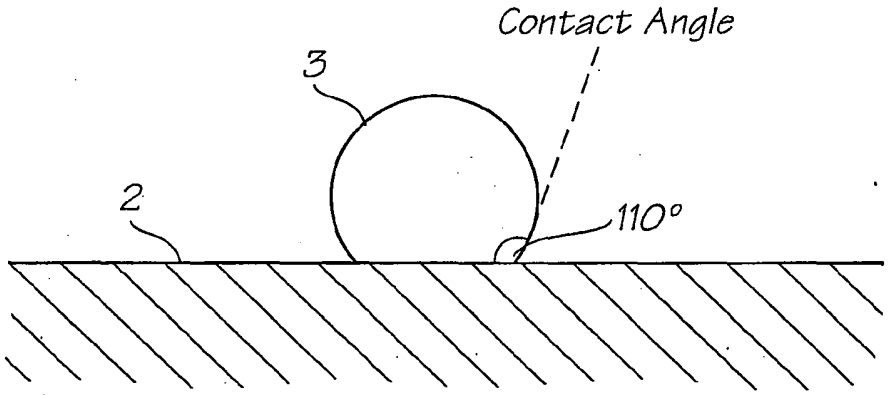


FIG. 2

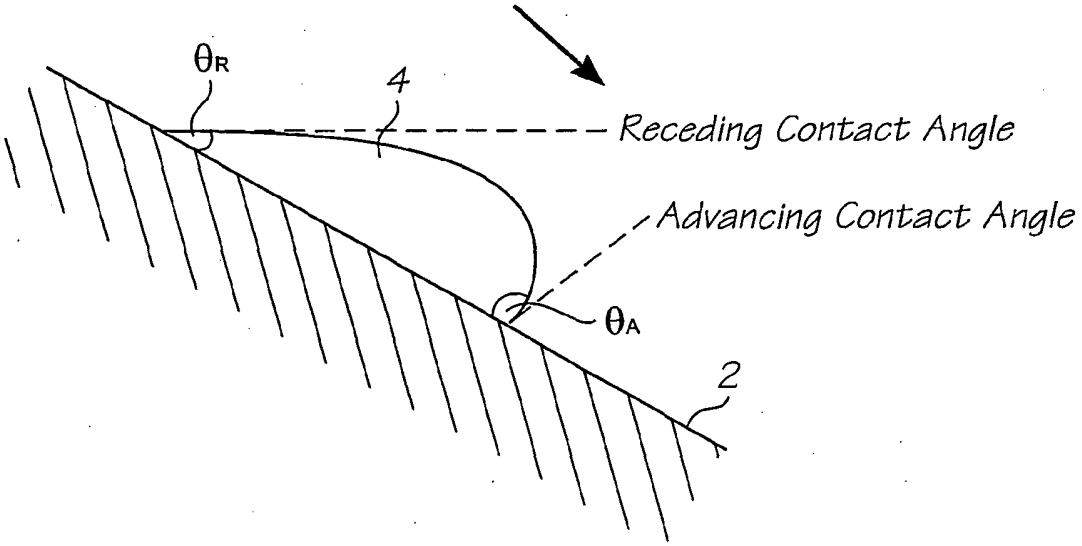


FIG. 3

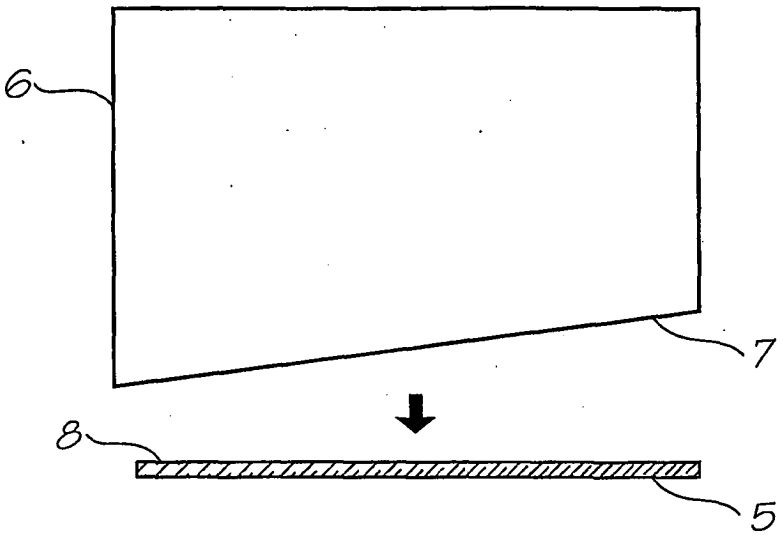


FIG. 4A

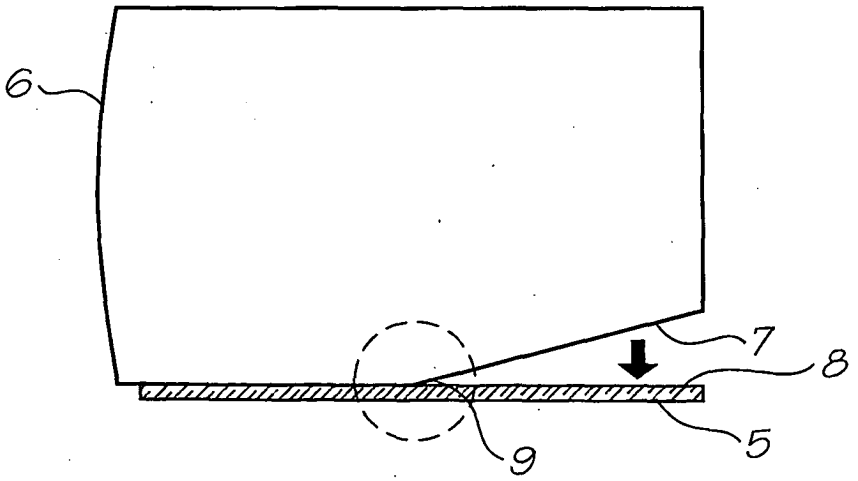


FIG. 4B

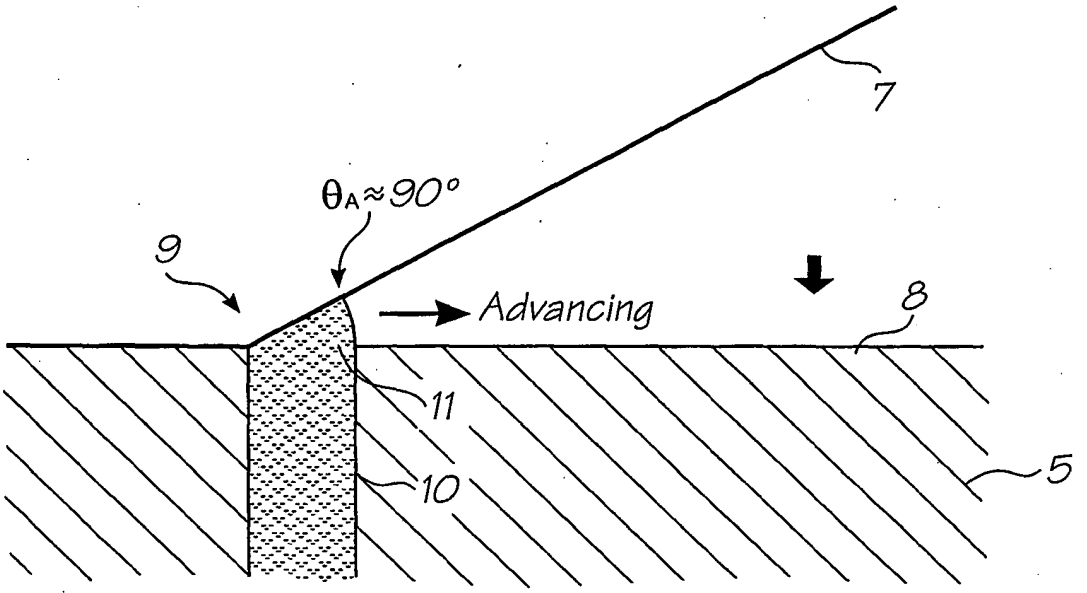


FIG. 4C

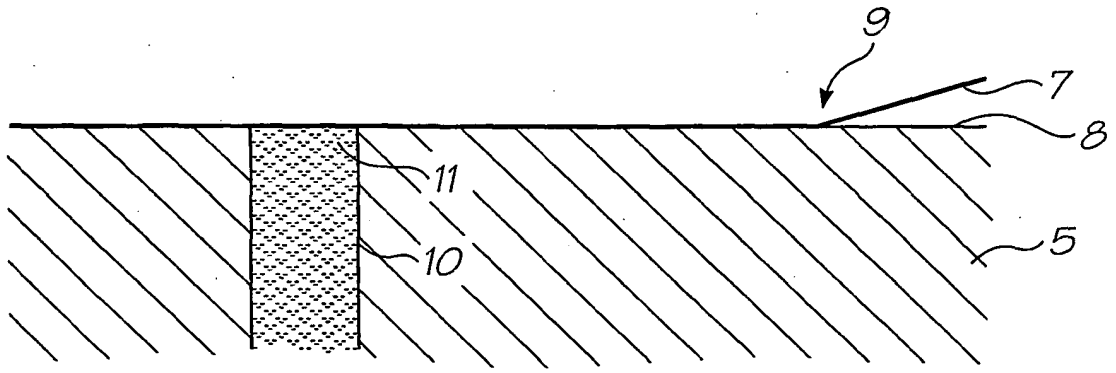


FIG. 4D

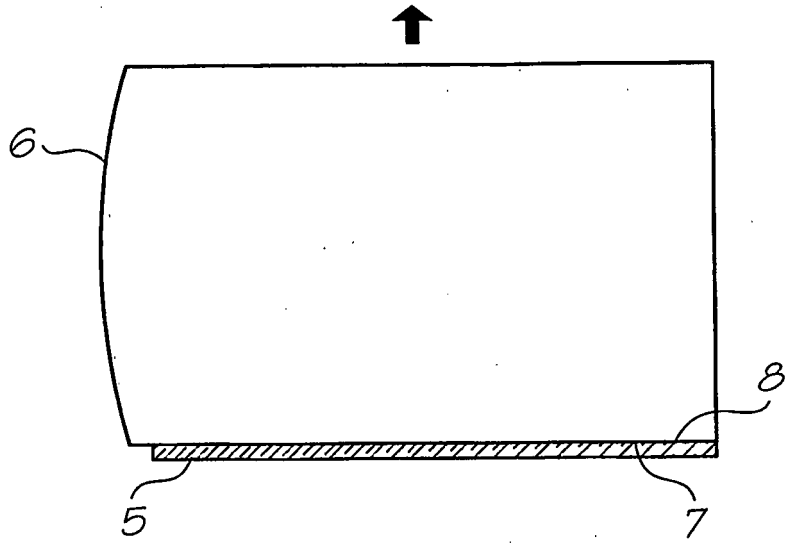


FIG. 5A

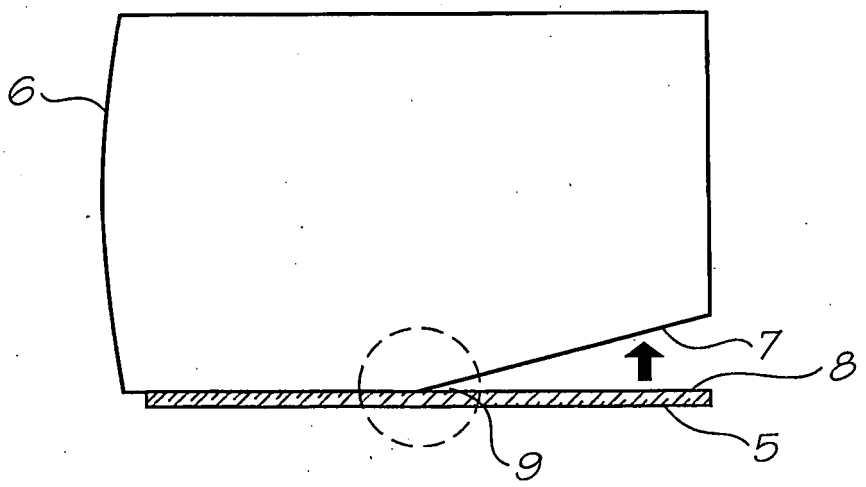


FIG. 5B

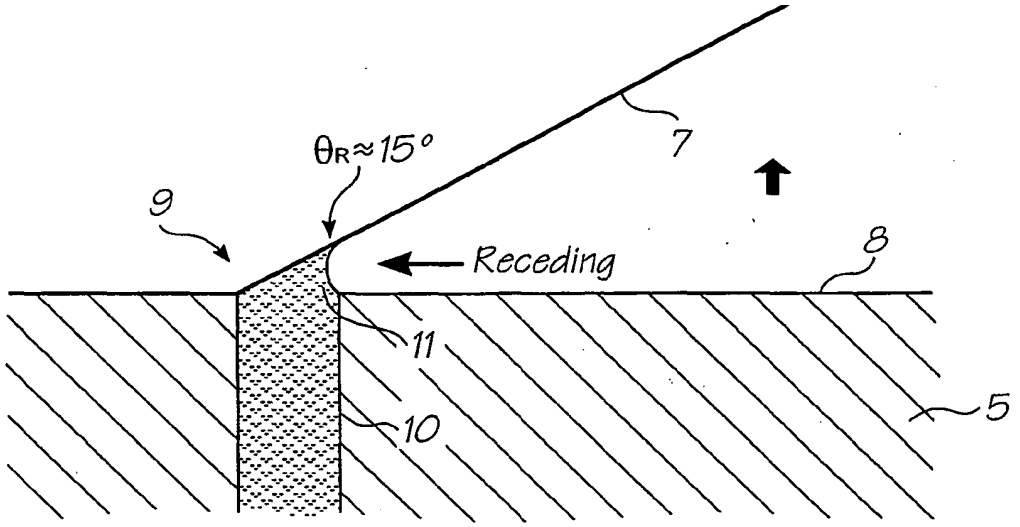


FIG. 5C

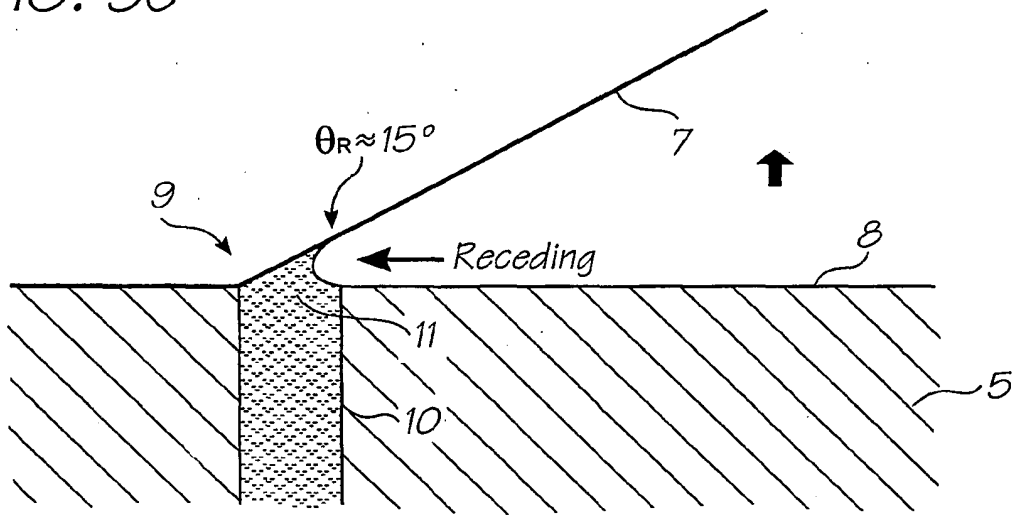


FIG. 5D

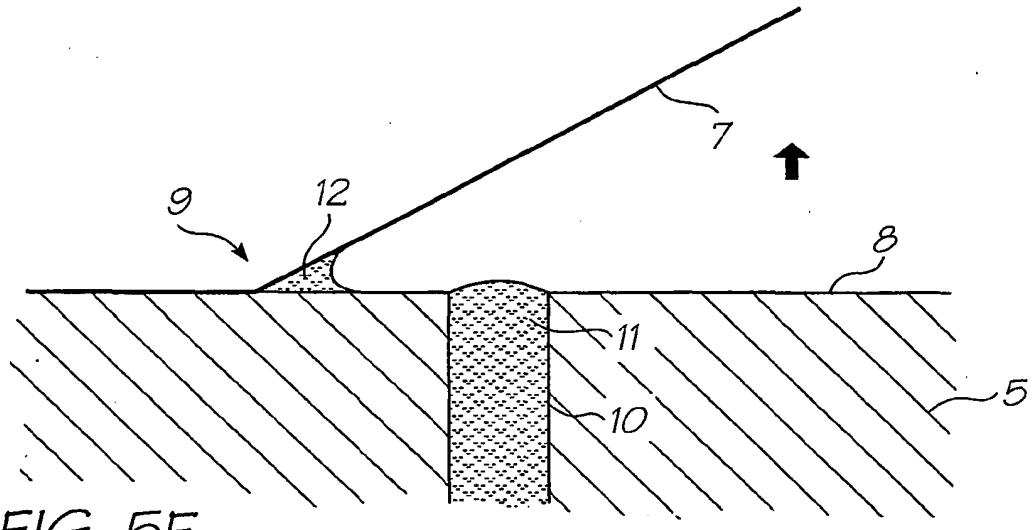


FIG. 5E

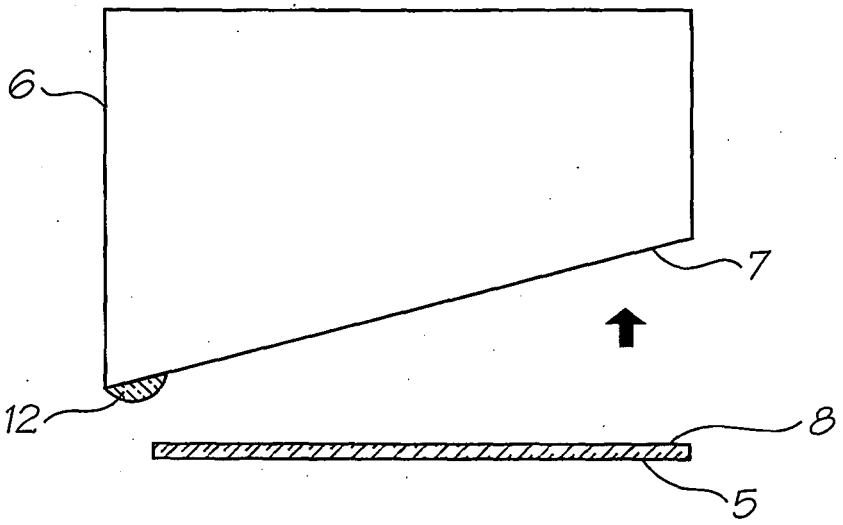


FIG. 6

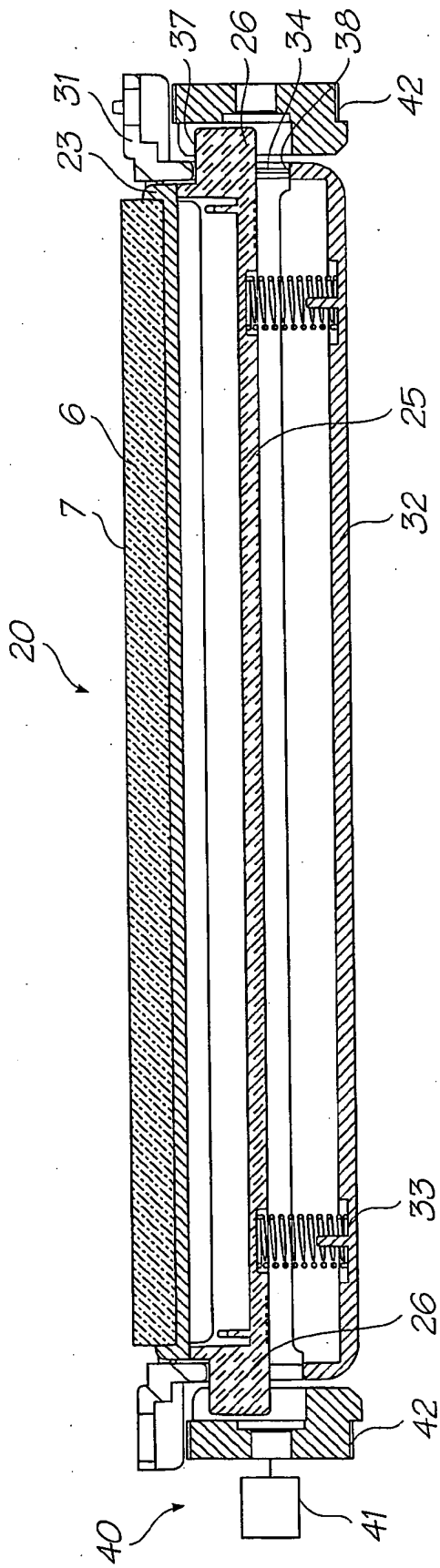


FIG. 7

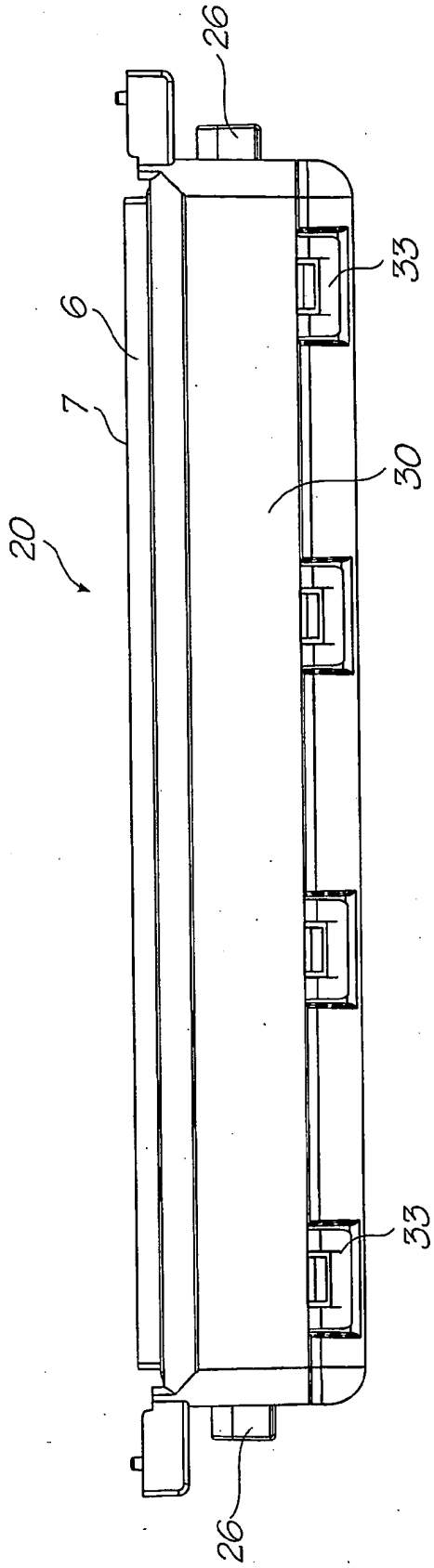


FIG. 8

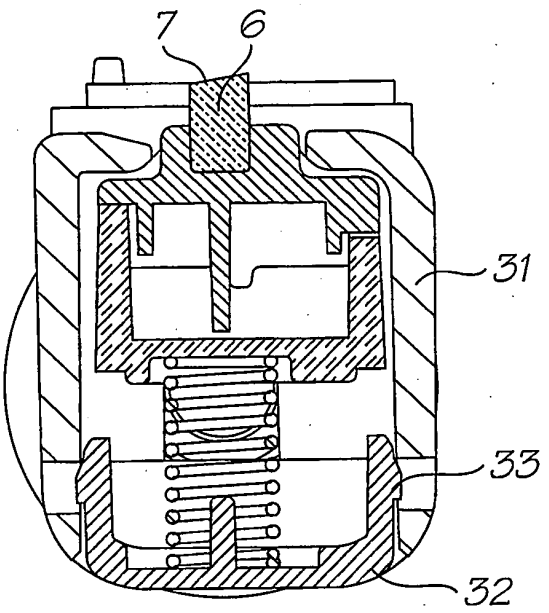


FIG. 9

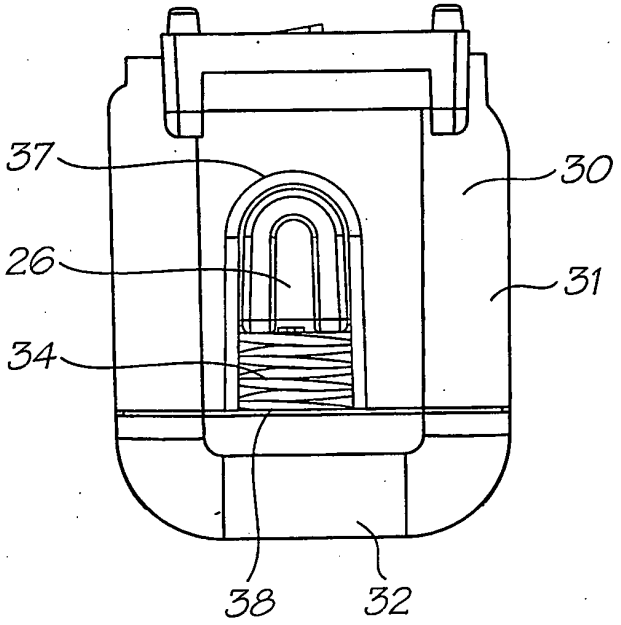


FIG. 10

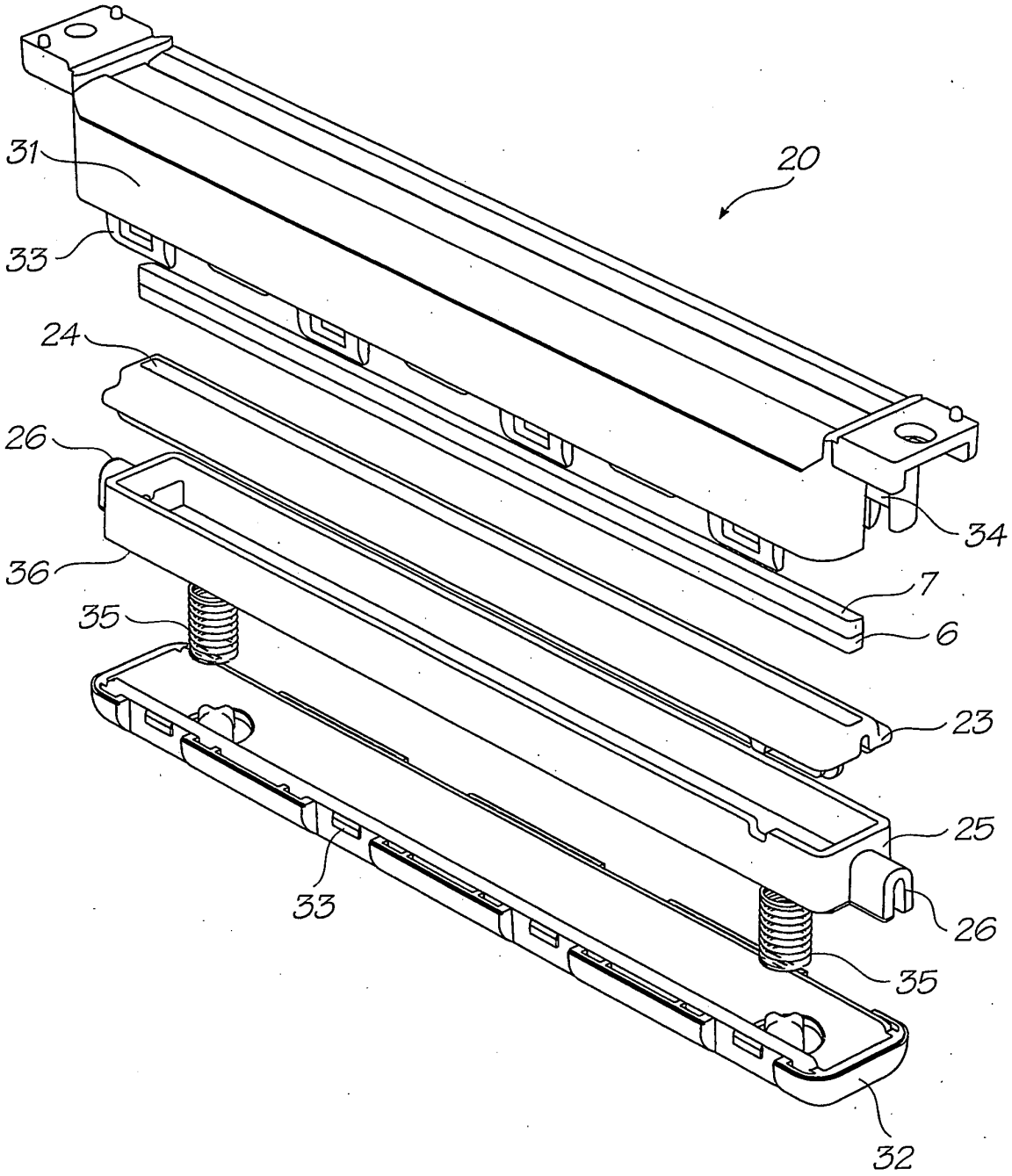


FIG. 11

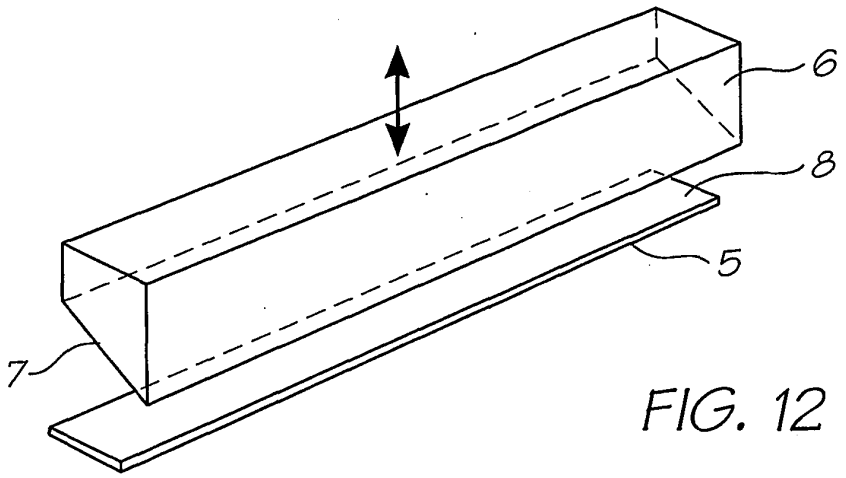


FIG. 12

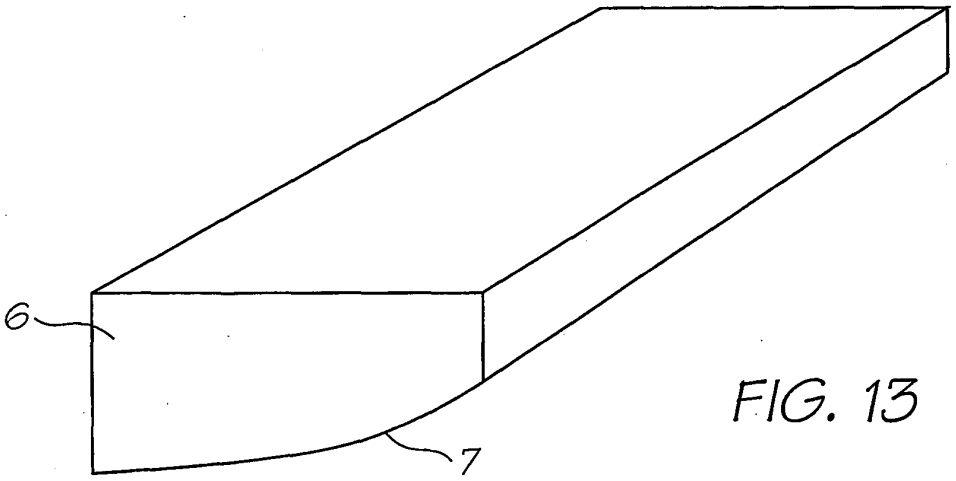


FIG. 13

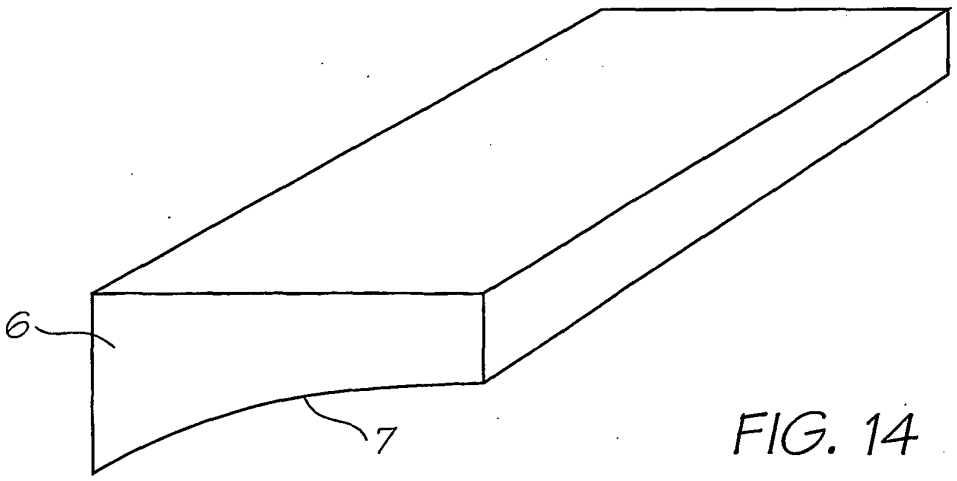


FIG. 14

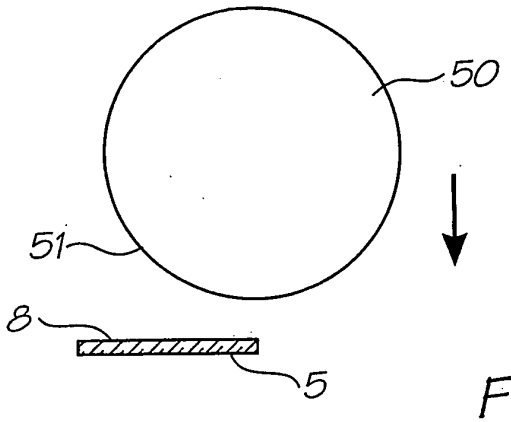


FIG. 15A

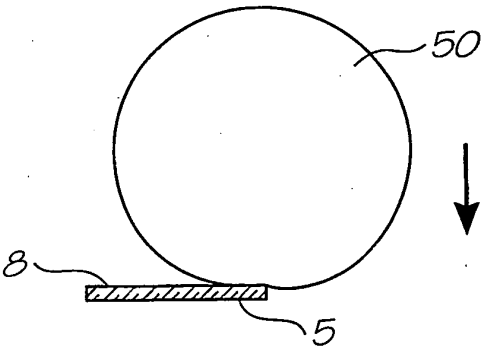


FIG. 15B

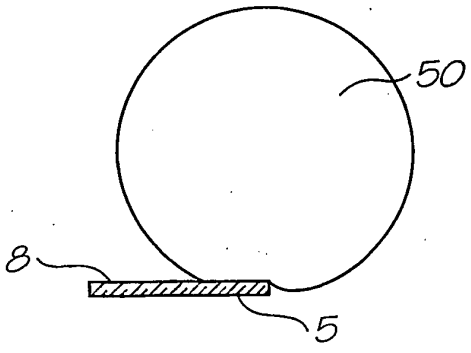


FIG. 15C

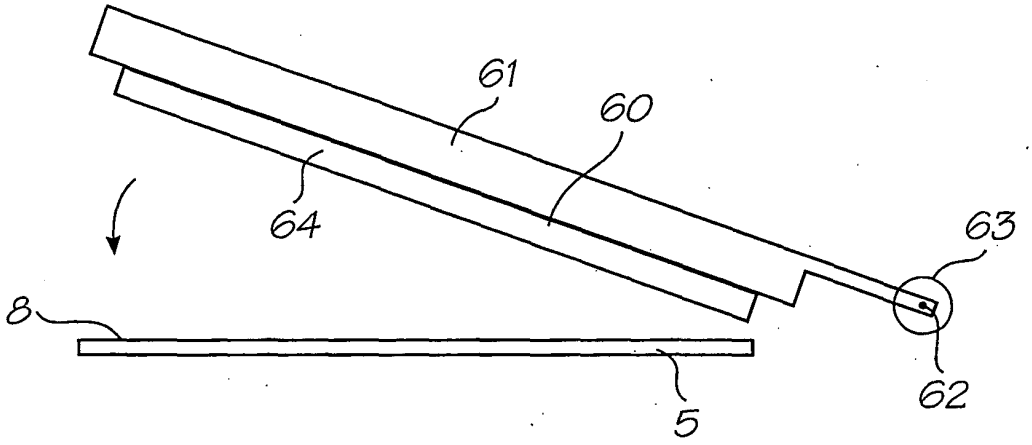


FIG. 16A

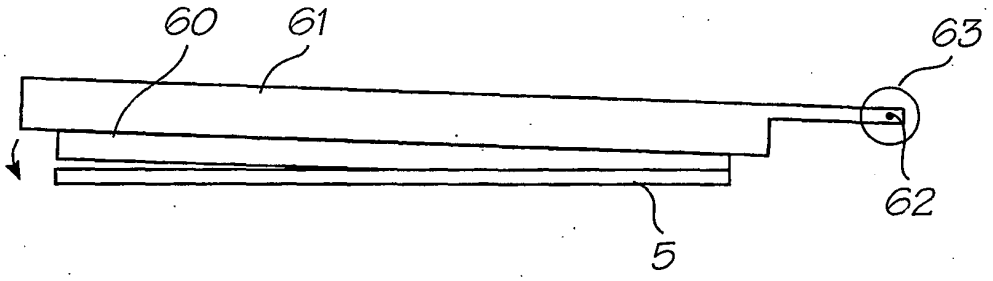


FIG. 16B

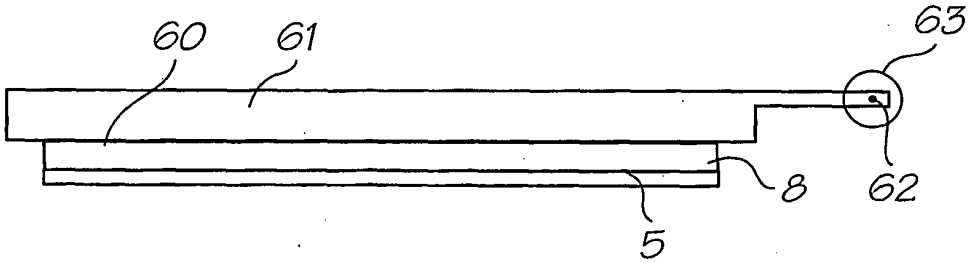


FIG. 16C

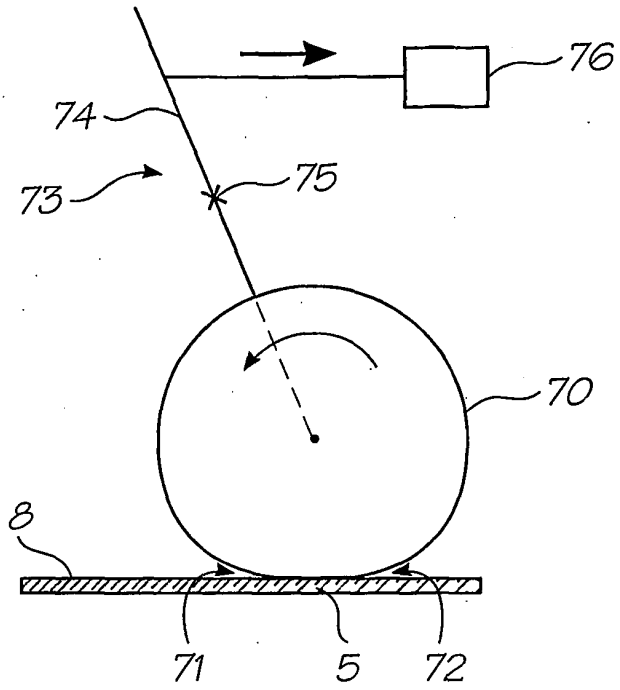


FIG. 17

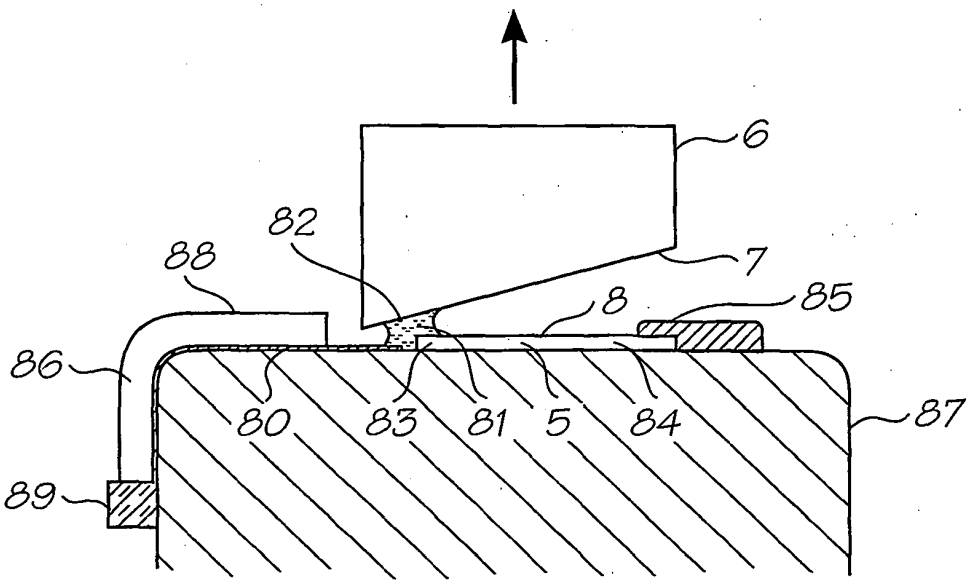
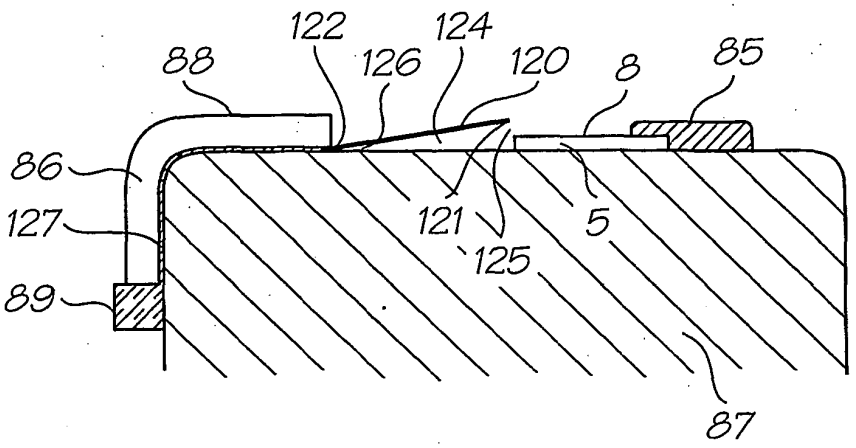


FIG. 18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121
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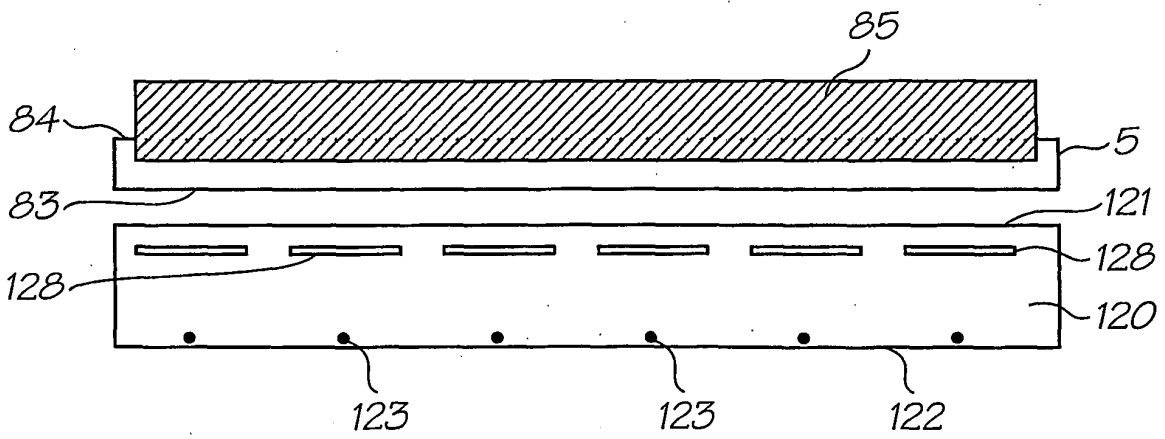
125
89
87

FIG. 19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123
122

FIG. 20

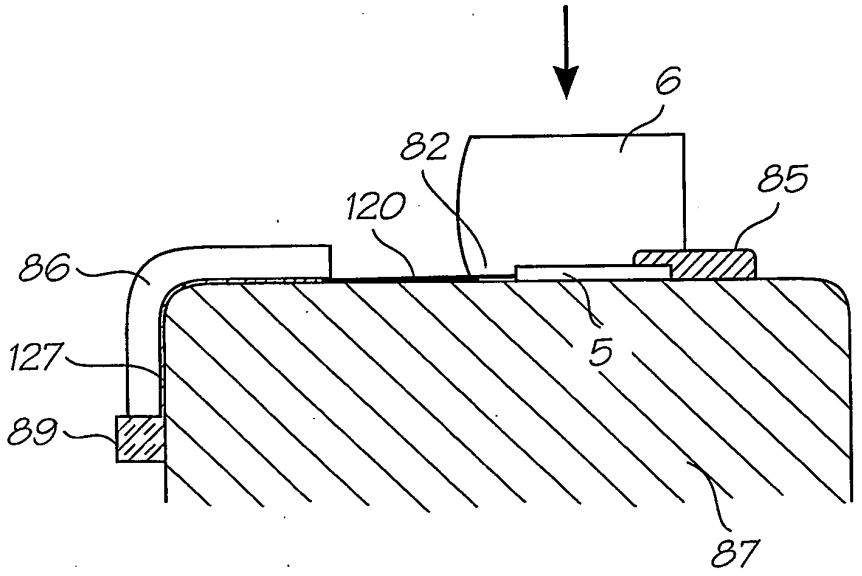

FIG. 21

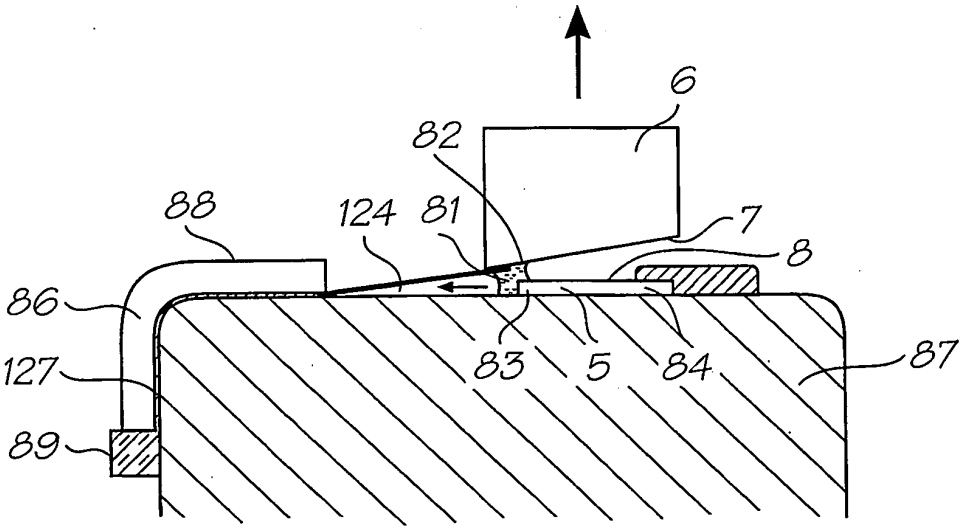

FIG. 22

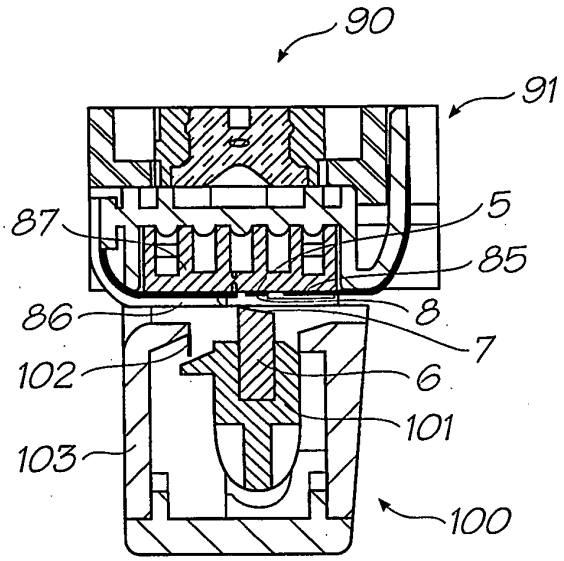

FIG. 23A

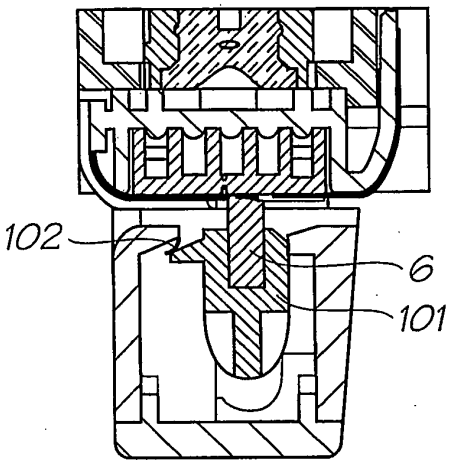

FIG. 23B

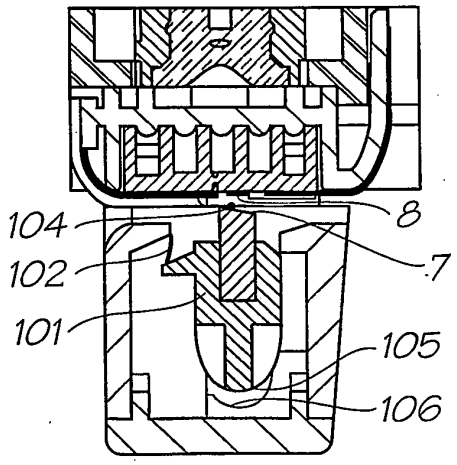

FIG. 23C

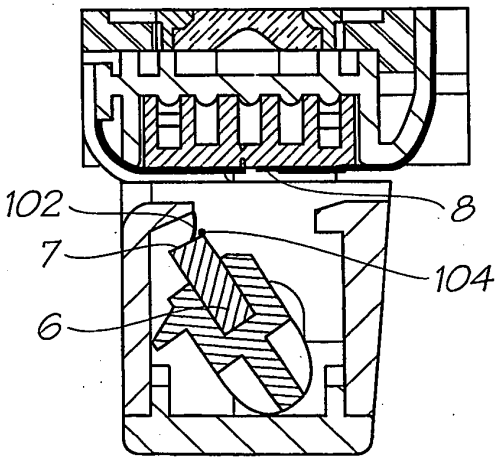

FIG. 23D

REFERENCES CITED IN THE DESCRIPTION

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