



(11) Publication number: **0 593 040 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **93116573.2**

(51) Int. Cl.⁵: **B41J 2/16**

(22) Date of filing: **13.10.93**

(30) Priority: **15.10.92 JP 277081/92**

(43) Date of publication of application:
20.04.94 Bulletin 94/16

(84) Designated Contracting States:
DE FR GB IT

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(54) **Liquid jet recording head and liquid jet recording apparatus.**

(57) A heater board(1) having a plurality of energy generating elements disposed thereon to discharge recording liquid droplets therefrom is adhesively secured to a base plate(5). A plurality of ink flow paths are formed on a solid layer(8) deposited on the heater board(1). In addition, a ceiling plate(2) having a common liquid chamber communicated with the ink flow paths is mounted on the solid layer(8), and the ceiling plate(2) is thrust against the solid layer by the resilient force of a comb-shaped retaining leaf spring(7).

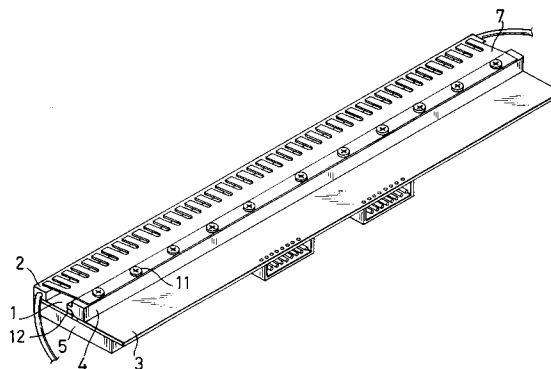


FIG. 1A

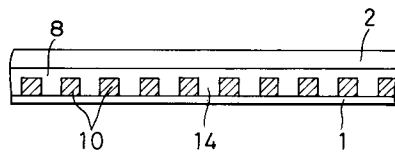


FIG. 1B

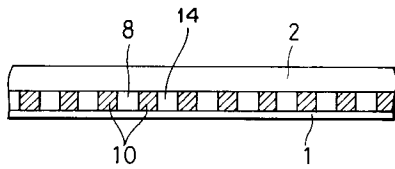


FIG. 1C

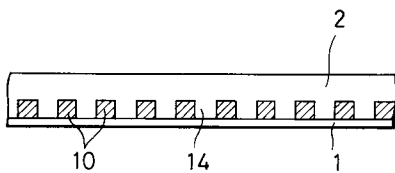


FIG. 1D

The present invention relates generally to a liquid jet recording head. More particularly, the present invention relates to a liquid jet recording head wherein a member is firmly connected to a heater board so as to form a plurality of ink flow paths for the liquid jet recording head.

Various kinds of ink jet recording heads each adapted to discharge recording liquid droplets from discharging orifices have been hitherto known. For example, one of the conventional ink jet recording heads is constructed such that deformation of a piezoelectric element is transformed into variation of pressure in a liquid flow path, causing recording liquid droplets to be discharged from discharging orifices toward a recording medium. Other one is constructed such that a pair of electrodes are disposed so as to forcibly deviate the direction of discharged recording liquid droplets away from the initial one. Another one is constructed such that recording liquid droplets are discharged from discharging orifices by utilizing thermal energy for the purpose of generating bubbles by quickly heating a heating element disposed in an ink flow path.

Among the foregoing conventional ink jet recording heads, the conventional ink jet recording head of the type adapted to discharge recording liquid droplets by utilizing the thermal energy has such advantages that the liquid discharging orifices each designed in the form of an orifice or the like can be disposed at a high density for discharging recording liquid droplets therefrom which makes it possible to effect recording with a high resolving power, that the whole ink jet recording head can easily be designed with small dimensions, and that the ink jet recording head can easily be designed with a long length and with a two-dimensional configuration by fully utilizing the advanced technology in the latest semiconductor industry especially in the fields of circuit integration and micro-working engineering of which reliability has been remarkably improved. Owing to these advantages, a number of liquid discharging orifices can practically be arranged in the form of multi-nozzle at a higher density, and moreover, they can be produced not only at a high efficiency but also at an inexpensive cost on a mass production line. For this reason, particular attention has been paid to the aforementioned type of ink jet recording head.

Fig. 4 is a schematic perspective view which shows by way of example a conventional ink jet recording head.

The ink jet recording head shown in Fig. 4 belongs to a so-called full line type ink jet recording head of which discharging orifices are arranged across a length corresponding to one side of, e.g., an A4-sized recording sheet.

In this figure, reference numeral 1 designates a heater board made of silicon or a similar material.

A plurality of electrothermal transducers (not shown) each serving as a discharge energy generating element and a plurality of electrode-like wiring conductors (not shown) for feeding electricity to the electrothermal transducers are arranged on the upper surface of the heater board 1. Reference numeral 2 designates a ceiling plate made of a glass or a metallic material. An ink introduction port through which a recording liquid such as an ink or the like (hereinafter referred to as an ink) is introduced and a cavity serving as a common liquid chamber for the introduced ink while making communication with respective ink flow paths are formed in the ceiling plate 2 by employing a cutting process or an etching process. Reference numeral 9 designates an ink feed tube connected to the ink introduction port.

Each ink flow path is formed on a solid layer 8 at the position corresponding to each discharge energy generating element disposed on the heater board 1 (see Fig. 5A). The ceiling plate 2 is adhesively secured to the solid layer 8, and the heater board 1 is adhesively secured to a base plate 5. While electrical connecting pads for the heater board 1 are correctly aligned with electrical connecting pads for a flexible printed circuit (flexible base plate) 3, a retaining member 4 for depressively retaining the flexible base board 3 on the base plate 5 is secured to the base plate 5 by tightening a plurality of screws, whereby the heater board 1 is mechanically connected to the flexible printed circuit 3. One end of a retaining leaf spring 6 is fixed to the upper surface of the retaining member 4, while the other end of the same is brought in close contact with the upper surface of the ceiling plate 2 so as to resiliently depress the latter from above. Thus, the ceiling plate 2 is mechanically thrust against the heater board 1.

With the conventional ink jet recording head constructed in the above-described manner, since a single retaining leaf spring 6 having a long length is employed therefor, when the upper surface of the ceiling plate 2 is rugged, warped or deformed, the retaining leaf spring 6 can not satisfactorily thrust the ceiling plate 2 against the heater board 1 in correct conformity with the ruggedness, the warpage or the deformation of the ceiling plate 2, resulting in the thrusting force uniformly distributed in the longitudinal direction failing to be applied to the ceiling plate 2. In an extreme case, there arises an occasion that no thrusting force can not be applied to the ceiling plate 2. Thus, in spite of the fact that the solid layer 8 should tightly be secured to the heater board 1 as shown in Fig. 5A, there arises a malfunction that a gap appears between the solid layer 8 and the heater board 1 as shown in Fig. 5B as time elapses.

With the ink jet recording head constructed in that way, when recording liquid droplets are discharged therefrom, pressure waves induced by the discharge of the recording liquid droplets propagate to adjacent ink flow paths, causing a malfunction of crosstalk to occur. Consequently, there arise problems that the density of each printed item on the recording medium locally varies from place to place, the discharging speed of the recording liquid is reduced, in an extreme case, no discharge is achieved with the recording liquid, and moreover, a quality of recorded item is degraded.

The present invention has been made in consideration of the aforementioned background.

An object of the present invention is to provide a liquid jet recording head which assures that a quality of recorded item can be improved without any occurrence of crosstalk while a certain intensity of thrusting force is uniformly applied to a solid layer.

Another object of the present invention is to provide a liquid jet recording apparatus having a liquid jet recording head of the foregoing type mounted thereon.

In the first aspect of the present invention, a liquid jet recording head comprises;

a substrate,

a first base plate, mounted on the substrate, having a plurality of discharging energy generating elements disposed on the first base plate for discharging recording liquid droplets,

a second base plate, mounted on the first base plate, having a plurality of liquid flow paths at the positions corresponding to the discharging energy generating elements, and

a comb-shaped retaining leaf spring, secured on the substrate, for thrusting the second base plate against the first base plate.

Here, a liquid jet recording head may further comprise an elastic member interposed between the second base plate and the retaining leaf spring.

In the second aspect of the present invention, there is provided a liquid jet recording apparatus for performing a recording operation by discharging recording liquid droplets toward a recording medium having a liquid jet recording head, the recording head comprising;

a substrate,

a first base plate, mounted on the substrate, having a plurality of discharging energy generating elements disposed on the first base plate for discharging recording liquid droplets,

a second base plate, mounted on the first base plate, having a plurality of liquid flow paths at the positions corresponding to the discharging energy generating elements, and

a comb-shaped retaining leaf spring, secured on the substrate, for thrusting the second base

plate against the first base plate.

A liquid jet recording apparatus may further comprise an elastic member interposed between the second base plate and the retaining leaf spring.

Here, the ink jet recording apparatus may produce bubbles in the recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of the bubbles.

The second base plate may include a ceiling plate, and a plurality of liquid flow paths each including a discharging orifice and a common liquid chamber communicated with the plurality of liquid flow paths are formed integral with the ceiling plate.

The second base plate may be composed of a solid layer having a plurality of liquid flow paths each including a discharging orifice formed thereon and a ceiling plate having a common liquid chamber formed therein which communicates with the liquid flow paths.

The comb-shaped retaining leaf spring may be divided into plural segments in the longitudinal direction thereof.

In the third aspect of the present invention, an ink jet recording head comprises;

a base plate,

a heater board, disposed on the base plate, having a plurality of discharging energy generating elements for discharging recording liquid droplets disposed on the heater board in the longitudinal direction,

a solid layer placed on the heater board, the solid layer being formed a plurality of liquid passages at the positions corresponding to the discharging energy generating elements, respectively,

a ceiling plate, mounted on the solid layer and the heater board, having a common liquid chamber formed on the ceiling plate while making communication with the plurality of liquid passages, and

a longitudinal extending comb-shaped retaining leaf spring for thrusting the ceiling plate against the heater board.

Here, an ink jet recording head may further comprise

a flexible printed circuit on the base plate so as to allow electricity and signals to be fed to the discharging energy generating elements via the flexible printed circuit.

An ink jet recording head may further comprise a retaining member for firmly securing the flexible printed circuit to the base plate, and wherein the retaining leaf spring is fixedly secured to the retaining member by tightening a plurality of screws.

In the fourth aspect of the present invention, an ink jet recording head, comprises;

a base plate on which disposed are a plurality of discharging elements for discharging recording

liquid droplets,

a liquid flow paths forming member having partitions for forming flow paths corresponding to the plurality of discharging elements, and

a comb-shaped leaf spring for bringing the partitions of the liquid flow paths forming member into contact with the base plate to form flow paths.

Here, the comb-shaped leaf spring may depress the liquid flow paths forming member at a range covering the flow paths.

The range covering the flow paths may exist near to discharging orifices.

The comb-shaped leaf spring may depress the liquid flow paths forming member against the base plate.

An ink jet recording head may further comprise an elastic member interposed between the liquid flow paths forming member and the comb-shaped leaf spring.

In the fifth aspect of the present invention, there is provided a liquid jet recording apparatus for performing a recording operation by discharging recording liquid droplets toward a recording medium, comprising;

a liquid jet recording head comprising;

a base plate on which disposed are a plurality of discharging elements for discharging recording liquid droplets,

a liquid flow paths forming member having partitions for forming flow paths corresponding to the plurality of discharging elements, and

a comb-shaped leaf spring for bringing the partitions of the liquid flow paths forming member into contact with the base plate to form flow paths, and

a mounting portion on which the liquid jet recording head is mounted.

Here, the comb-shaped leaf spring may depress the liquid flow paths forming member at a range covering the flow paths.

The range covering the flow paths may exist near to discharging orifices.

The comb-shaped leaf spring may depress the liquid flow paths forming member against the base plate.

A liquid jet recording apparatus may further comprise an elastic member interposed between the liquid flow paths forming member and the comb-shaped leaf spring.

The liquid jet recording head may produce bubbles in the recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of the bubbles.

The liquid jet recording head may produce bubbles in the recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of

the bubbles.

The ink jet recording apparatus may produce bubbles in the recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of the bubbles.

According to the present invention, even though the ceiling plate has slight ruggedness or warpage, uniform thrusting force can be applied to the upper surface of the ceiling plate by the comb-shaped retaining leaf spring in correct conformity with the ruggedness or warpage of the ceiling plate. Thus, there does not arise a malfunction that certain gap appears between the partition wall defining the liquid flow paths and the heater board. As a result, when recording liquid droplets are discharged from discharging orifices of the liquid jet recording head, any pressure wave does not propagate to adjacent liquid flow paths, and thus avoids an occurrence of crosstalk.

Other objects, features and advantages of the present invention will become apparent from reading of the following description which has been made in conjunction with the accompanying drawings.

Fig. 1A is a perspective view of an ink jet recording head constructed according to an embodiment of the present invention;

Figs. 1B to 1D are fragmentary enlarged front views each of which shows an ink jet recording head according to the present invention modified based on a difference of production process as viewed in the ink discharging direction wherein hatched portions represent hollow spaces, respectively;

Fig. 2 is a sectional view of an ink jet recording head constructed according to the present invention;

Fig. 3 is a plan view of a retaining leaf spring for the ink jet recording head of the present invention;

Fig. 4 is a perspective view of a conventional ink jet recording head; and

Figs. 5A and 5B are fragmentary enlarged front views each showing that a solid layer of the conventional ink jet recording head is connected to a heater board wherein hatched portions represent hollow spaces, respectively.

The present invention will now be described in detail hereinafter with reference to the accompanying drawings which illustrate preferred embodiments thereof.

Fig. 1A is a perspective view of an ink jet recording head constructed according to an embodiment of the present invention, and Fig. 1B is a fragmentary enlarged front view of the ink jet recording head shown in Fig. 1A as viewed in the discharging direction.

In Fig. 1A and 1B, reference numeral 1 designates a heater board (first base plate) made of a silicon substrate. A plurality of electrothermal transducers (discharging heaters) and a plurality of electrode-like wiring conductors made of aluminum or a similar metallic material for feeding electricity to the electrothermal transducers are formed on the heater board 1 by employing a film forming process. Reference numeral 2 designates a ceiling plate in which a cavity 2A serving as a common liquid chamber is formed for the purpose of feeding an ink to a plurality of ink (liquid) flow paths therefrom. A solid layer 8 (molded of, e.g., an epoxy resin or the like) serving as a liquid flow paths forming member is laminated on the upper surface of the heater board 1 to form the liquid flow paths at the positions corresponding to the discharging heaters, respectively. The ceiling plate 2 is adhesively secured to the solid layer 8. To assure that the heater board 1 is firmly held on a base plate (substrate) 5, the heater board 1 and the base plate 5 are adhesively secured to each other while they are correctly aligned with each other.

Here, a process of forming ink flow paths each having an ink discharging orifice formed at the foremost end thereof will be described below.

In the case of an ink jet recording head of the type shown in Fig. 1B, after the discharging heaters and the electrode-like wiring conductors as mentioned above are formed on the heater board 1 serving as a first base plate, a pattern of positive type dry film is adhesively secured to the heater board 1, and subsequently, a part of the dry film corresponding to the ink flow paths each including a discharging orifice 10 is hardened by irradiating an active energy. After an unhardened part of the dry film is removed from the heater board 1, a solid layer 8 is formed on the heater board 1 by pouring an epoxy resin or the like thereon, and the ceiling plate 2 is then adhesively secured to the solid layer 8. After the solid layer 8 is hardened, a part of the solid layer 8 corresponding to the ink flow paths each including a discharging orifice 10 is dissolved in a strong alkaline solution, whereby desired ink flow paths and discharging orifices 10 are formed in the solid layer 8. In this case, the solid layer 8 has a partition 14 between adjacent ink flow paths.

Next, in the case of an ink jet recording head of the type shown in Fig. 1C, in contrast with the preceding case, a solid layer 8 of negative type dry film is adhesively secured to a heater board 1, and thereafter, a part of the solid layer 8 other than ink flow paths each including a discharging orifice 10 is hardened by irradiating active energy. Subsequently, an unhardened part is removed from the heater board 1 by dissolving it in a developing solution, whereby portions corresponding to ink

flow paths are formed on the heater board 1. In addition, a ceiling plate 2 is adhesively secured to the solid layer 8 so that finally desired ink flow paths each including a discharging orifice 10 are formed on the heater board 1. In this case, a liquid flow paths forming member is constructed by the solid layer 8 and the ceiling plate 2, and the solid layer 8 also has a partition 14 between adjacent ink flow paths.

In connection with the relationship among the heater board 1, the solid layer 8 and the ceiling plate 2, the ceiling plate 2 excluding the heater board 1 serving as a first base plate but including the solid layer 8 is hereinafter referred to as a second base plate.

Next, in the case of an ink jet recording head of the type shown in Fig. 1D, a ceiling plate 2 serving as a second base plate is made of glass, resin or the like, and ink flow paths each including a discharging orifice 10 and a common liquid chamber communicated with the ink flow paths are formed in the ceiling plate 2 by etching, cutting, molding, laser beam machining or the like. The thus formed ceiling plate 2 is adhesively secured to a heater board 1 having discharging heaters and electrode-like wiring conductors formed thereon in the same manner as the preceding cases by employing a film forming process. In this case of Fig. 1D, the ceiling plate 2 itself serves as a liquid flow paths forming member and has a partition 14 between adjacent ink flow paths.

To assure that electricity and signals are taken into the ink jet recording head from the outside for the purpose of discharging recording liquid droplets therefrom, while electrical connecting pads for a flexible printed circuit (flexible base plate) 3 are exactly aligned with electrical connecting pads for the heater board 1, the heater board 1 is firmly held on the base plate 5 by a retaining member 4 with an elastic member 12 interposed therebetween, and the flexible printed circuit 3 is firmly held on the base plate 5 directly by the retaining member 4 by tightening a plurality of screws 11.

In Figs. 1 and 3, reference numeral 7 designates a retaining leaf spring. As is best seen in Fig. 3, a plurality of slit-shaped cutouts are formed on the retaining leaf spring 7 in the longitudinal direction so as to allow it to exhibit a comb-shaped contour. A width A and a depth C of each cutout and a distance B between adjacent cutouts may be varied depending on a material of the leaf spring 7. It is preferable that the width A of each cutout is dimensioned to be small as far as possible from the viewpoint of production technique so as to keep effective areas of the leaf spring 7 by which the resilient force are applied. On the other hand, a dimension representing the distance B between adjacent cutouts is preferably small in order for the

spring 7 to follow the ruggedness or the deformation of the ceiling plate 2. It is practically preferable that the distance B is set to about 1 to 3 mm considering the warpage or the like of the ceiling plate 2 at the time of its production. In addition, a dimension representing the depth C of each cutout can arbitrarily be selected depending on the thickness of the retaining leaf spring 7, the elasticity of the same and a size of the ink jet recording head. It is, however, required that the dimension of the depth C should be selected such that each tooth is not affected by the operational state of adjacent teeth of the comb-shaped leaf spring 7.

It is recommendable that the slit-shaped cutouts of the retaining leaf spring 7 are formed by employing an etching process, a press-forming process or the like. A material employable for the retaining leaf spring 7 is typically exemplified by a phosphor bronze and a stainless steel. In the case that the stainless steel is employed as a material for the retaining leaf spring 7, the dimensions of A, B and C are determined such that A is set to 0.25mm, B is set to 2.5mm and C is set to 8.5mm.

The ceiling plate 2, the solid layer 8 and the heater board 1 are firmly placed one above another by fastening one end part of the retaining leaf spring 7 to the retaining member 4 by tightening a plurality of screws 11, and moreover, applying the resilient force of the retaining leaf spring 7 to the upper surface of the ceiling plate 2.

Since a plurality of slit-shaped cutout portions are formed on the retaining leaf spring 7 in the longitudinal direction, the retaining leaf spring 7 has excellent conformity to any ruggedness, warpage and deformation of the ceiling plate 2, whereby the resilient force of the retaining leaf spring 7 can uniformly be applied to the substantially whole range of the ceiling plate 2.

It is preferable that the resilient force of the retaining leaf spring 7 is applied to the range covering the ink flow paths defined between the heater board 1 and the solid layer 8 as shown for example in Fig. 2, it is more preferable that it is applied to the range covering the ink flow paths nearer to the discharging orifice 10, and it is most preferable that it is applied to the range where the discharging orifices 10 are formed. This is because the configuration of the discharging orifice 10 and the ink flow path mostly affect quality of recorded item, so that it is possible to record with high quality for a long term by inhibiting the deterioration of the configuration of them with age.

Fig. 2 is a schematic sectional view of the ink jet recording head constructed according to an embodiment of the present invention.

In the embodiment shown in Fig. 2, in addition to the structure shown in Fig. 1A, an elastic member 13 molded of a silicone rubber or the like is

interposed between the retaining leaf spring 7 and the ceiling plate 2 so that the resilient force of the retaining leaf spring 7 is applied to the ceiling plate 2 via the elastic member 13. With this construction, the elastic member 13 serves to alleviate the adverse influence derived from ruggedness, warpage or the like of the ceiling plate 2 so that the resilient force of the retaining leaf spring 7 can more uniformly be applied to the ceiling plate 2. Moreover, in the embodiments shown in Figs. 1A to 1D and Fig. 2, it is preferable for the retaining leaf spring 7 to contact the ceiling plate 2 or the elastic member 13 by lines rather than by areas. This is because it is possible to inhibit the affection to the resilient force which is caused by the deformation of the leaf spring 7 itself.

The present invention achieves distinct effect when applied to a recording head or a recording apparatus which has means for generating thermal energy such as electrothermal transducers or laser light, and which causes changes in ink by the thermal energy so as to eject ink. This is because such a system can achieve a high density and high resolution recording.

A typical structure and operational principle thereof is disclosed in U.S. patent Nos. 4,723,129 and 4,740,796, and it is preferable to use this basic principle to implement such a system. Although this system can be applied either to on-demand type or continuous type ink jet recording systems, it is particularly suitable for the on-demand type apparatus. This is because the on-demand type apparatus has electrothermal transducers, each disposed on a sheet or liquid passage that retains liquid (ink), and operates as follows: first, one or more drive signals are applied to the electrothermal transducers to cause thermal energy corresponding to recording information; second, the thermal energy induces sudden temperature rise that exceeds the nucleate boiling so as to cause the film boiling on heating portions of the recording head; and third, bubbles are grown in the liquid (ink) corresponding to the drive signals. By using the growth and collapse of the bubbles, the ink is expelled from at least one of the ink ejection orifices of the head to form one or more ink drops. The drive signal in the form of a pulse is preferable because the growth and collapse of the bubbles can be achieved instantaneously and suitably by this form of drive signal. As a drive signal in the form of a pulse, those described in U.S. patent Nos. 4,463,359 and 4,345,262 are preferable. In addition, it is preferable that the rate of temperature rise of the heating portions described in U.S. patent No. 4,313,124 be adopted to achieve better recording.

U.S. patent Nos. 4,558,333 and 4,459,600 disclose the following structure of a recording head,

which is incorporated to the present invention: this structure includes heating portions disposed on bent portions in addition to a combination of the ejection orifices, liquid passages and the electrothermal transducers disclosed in the above patents. Moreover, the present invention can be applied to structures disclosed in Japanese Patent Application Laying-open Nos. 123670/1984 and 138461/1984 in order to achieve similar effects. The former discloses a structure in which a slit common to all the electrothermal transducers is used as ejection orifices of the electrothermal transducers, and the latter discloses a structure in which openings for absorbing pressure waves caused by thermal energy are formed corresponding to the ejection orifices. Thus, irrespective of the type of the recording head, the present invention can achieve recording positively and effectively.

The present invention can be effective to a so-called full-line type recording head whose length equals the maximum length across a recording medium as previously discussed. Such a full-line type recording head may consist of not only one integrally arranged recording head but also a plurality of recording heads combined together.

In addition, the present invention can be applied to various serial type recording heads: a recording head fixed to the main assembly of a recording apparatus; a conveniently replaceable chip type recording head which, when loaded on the main assembly of a recording apparatus, is electrically connected to the main assembly, and is supplied with ink therefrom; and a cartridge type recording head integrally including an ink reservoir.

It is further preferable to add a recovery system, or a preliminary auxiliary system for a recording head as a constituent of the recording apparatus because they serve to make the effect of the present invention more reliable. As examples of the recovery system, are a capping means and a cleaning means for the recording head, and a pressure or suction means for the recording head. As examples of the preliminary auxiliary system, are a preliminary heating means utilizing electrothermal transducers or a combination of other heater elements and the electrothermal transducers, and a means for carrying out preliminary ejection of ink independently of the ejection for recording. These systems are effective for reliable recording.

The number and type of recording heads to be mounted on a recording apparatus can be also changed. For example, only one recording head corresponding to a single color ink, or a plurality of recording heads corresponding to a plurality of inks different in color or concentration can be used. In other words, the present invention can be effectively applied to an apparatus having at least one of the monochromatic, multi-color and full-color

modes. Here, the monochromatic mode performs recording by using only one major color such as black. The multi-color mode carries out recording by using different color inks, and the full-color mode performs recording by color mixing.

Furthermore, although the above-described embodiments use liquid ink, inks that are liquid when the recording signal is applied can be used: for example, inks can be employed that solidify at a temperature lower than the room temperature and are softened or liquefied in the room temperature. This is because in the ink jet system, the ink is generally temperature adjusted in a range of 30°C - 70°C so that the viscosity of the ink is maintained at such a value that the ink can be ejected reliably.

In addition, the present invention can be applied to such apparatus where the ink is liquefied just before the ejection by the thermal energy as follows so that the ink is expelled from the orifices in the liquid state, and then begins to solidify on hitting the recording medium, thereby preventing the ink evaporation: the ink is transformed from solid to liquid state by positively utilizing the thermal energy which would otherwise cause the temperature rise; or the ink, which is dry when left in air, is liquefied in response to the thermal energy of the recording signal. The present invention is most effective when it uses the film boiling phenomenon to expel the ink.

Furthermore, the ink jet recording apparatus of the present invention can be employed not only as an image output terminal of an information processing device such as a computer, but also as an output device of a copying machine including a reader, and as an output device of a facsimile apparatus having a transmission and receiving function.

In addition, the ink jet recording apparatus of the present invention is very effective for textile printing in which an image is printed onto a fabric or the like.

Embodiments of ink jet textile printing will be described below.

An ink jet printing step is carried out using the ink jet recording apparatus proposed in the present invention. Then, the recording medium is dried in a manner including natural drying. The dried medium is subjected to a step in which the dye on the recording medium is diffused into its fiber, and fixed there upon reaction. This step provides a full color development and the fastness of the fixed dye.

This diffusion-fixing step may be performed by a known method, for example, steaming. Prior to the printing step, the recording medium may be treated with an alkali.

Subsequently, a posttreatment step is performed in which the unreacted dye and the substances used for the pretreatment are removed. Finally, a correction-finishing step for defect correction and ironing is performed to complete recording.

The fabric for ink jet printing has to fulfill the following requirements:

- (1) Ability to develop a full color density of the ink.
- (2) High degree of ink exhaustion.
- (3) Rapid ink drying on the fabric.
- (4) Minimal irregular bleeding of the ink on the fabric.
- (5) Superior transportability within a device.

To fulfill these requirements, it is permissible to pretreat the fabric, if desired. For example, Japanese Patent Application Laying-Open No. 53492/1987 discloses fabrics having an ink receiving layer, and Japanese Patent Application Publication No. 46589/1991 proposes fabrics containing reduction-preventing agents or alkaline substances. Examples of such pretreatment include the incorporation of substances, selected from alkaline substances, water-soluble polymers, synthetic polymers, water-soluble metal salts, urea and thiourea, into fabrics.

Examples of the alkaline substances include alkali metal hydroxides such as sodium hydroxide or potassium hydroxide, amines such as mono-, di- or triethanolamine, and alkali metal carbonates or bicarbonates such as sodium carbonate, potassium carbonate or sodium bicarbonate. They also include organic acid metal salts such as calcium acetate or barium acetate, ammonia, and ammonia compounds. There can also be used sodium trichloroacetate which becomes alkaline upon steaming and under dry heat. Preferred alkaline substances are sodium carbonate and sodium bicarbonate which are used in dyeing with reactive dyes.

Examples of the water-soluble polymers include starches from corn and wheat, celluloses such as carboxymethyl cellulose, methyl cellulose or hydroxyethyl cellulose, polysaccharides such as sodium alginate, gum arabic, locust bean gum, tragacanth gum, guar gum, or tamarind seeds, proteins such as gelatin or casein, and naturally occurring polymers such as tannin-derived substances or lignin-derived substances.

Examples of the synthetic polymers include polyvinyl alcohol compounds, polyethylene oxide compounds, water-soluble polymers derived from acrylic acid, and water-soluble polymers derived from maleic anhydride. Preferred are the polysaccharidal polymers and cellulose derived polymers.

Examples of the water-soluble metal salts include halides of alkali metals or alkaline earth metals which form typical ionic crystals and which

have pH of 4-10. Representative examples of such compounds are alkali metal halides such as NaCl, Na_2SO_4 , KCl or CH_3COONa , and alkaline earth metal halides such as CaCl_2 or MgCl_2 . Preferred are the Na, K and Ca salts.

The method of incorporating the above-described substances into the fabric in the pretreatment is not restricted. However, there can be cited dipping, padding, coating or spraying which is in customary use.

The printing ink to be imparted to the fabric for ink jet printing merely adheres to the fabric when it is applied onto the fabric. Hence, it is preferred to perform a subsequent step for reacting the dye with the fiber and fixing it there. Such a reaction-fixing step may be carried out by a known method, such as steaming, HT steaming, thermofixing, or unless the alkali-treated fabric is used, alkali pad steaming, alkali blotch steaming, alkali shocking, or alkali cold fixing.

The removal of the unreacted dye and the substances used in the pretreatment can be performed by washing in accordance with a known method, after the reaction-fixing step is carried out. The washing procedure is preferably combined with a known fixing treatment.

The recorded material that has undergone the above-mentioned posttreatment step is cut into a desired size. The cut pieces are subjected to a step for obtaining a final processed product, such as sewing, bonding or welding. Thus are obtained clothes such as one-piece dresses, outer garments, ties, or swimming suits, quilt covers, sofa covers, handkerchiefs, and curtains. Many methods of processing the fabric by sewing, etc. into clothes and other daily necessities are described, for example, in known books, including the monthly magazine "Soen", published by Bunka Shuppan-Kyoku, a publishing company in Japan.

While the present invention has been described above with respect to preferred embodiments thereof, it should of course be understood that the present invention should not be limited only to these embodiments but various change or modification may be made without departure from the scope of the invention as defined by the appended claims.

A heater board (1) having a plurality of energy generating elements disposed thereon to discharge recording liquid droplets therefrom is adhesively secured to a base plate (5). A plurality of ink flow paths are formed on a solid layer (8) deposited on the heater board (1). In addition, a ceiling plate (2) having a common liquid chamber communicated with the ink flow paths is mounted on the solid layer (8), and the ceiling plate (2) is thrust against the solid layer by the resilient force of a comb-shaped retaining leaf spring (7).

Claims

1. A liquid jet recording head characterized by comprising;
 - a substrate,
 - a first base plate, mounted on said substrate, having a plurality of discharging energy generating elements disposed on said first base plate for discharging recording liquid droplets,
 - a second base plate, mounted on said first base plate, having a plurality of liquid flow paths at the positions corresponding to said discharging energy generating elements, and
 - a comb-shaped retaining leaf spring, secured on said substrate, for thrusting said second base plate against said first base plate.
2. A liquid jet recording head as claimed in claim 1, further characterized by comprising an elastic member interposed between said second base plate and said retaining leaf spring.
3. A liquid jet recording apparatus for performing a recording operation by discharging recording liquid droplets toward a recording medium having a liquid jet recording head, said recording head characterized by comprising;
 - a substrate,
 - a first base plate, mounted on said substrate, having a plurality of discharging energy generating elements disposed on said first base plate for discharging recording liquid droplets,
 - a second base plate, mounted on said first base plate, having a plurality of liquid flow paths at the positions corresponding to said discharging energy generating elements, and
 - a comb-shaped retaining leaf spring, secured on said substrate, for thrusting said second base plate against said first base plate.
4. A liquid jet recording apparatus as claimed in claim 3, further characterized by comprising an elastic member interposed between said second base plate and said retaining leaf spring.
5. A liquid jet recording apparatus as claimed in claim 3, characterized in that said ink jet recording apparatus produces bubbles in said recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of said bubbles.
6. A liquid jet recording head as claimed in claim 1, characterized in that said second base plate includes a ceiling plate, and a plurality of liquid

flow paths each including a discharging orifice and a common liquid chamber communicated with said plurality of liquid flow paths are formed integral with said ceiling plate.

7. A liquid jet recording head as claimed in claim 1, characterized in that said second base plate is composed of a solid layer having a plurality of liquid flow paths each including a discharging orifice formed thereon and a ceiling plate having a common liquid chamber formed therein which communicates with said liquid flow paths.
8. A liquid jet recording head as claimed in claim 1, characterized in that said comb-shaped retaining leaf spring is divided into plural segments in the longitudinal direction thereof.
9. An ink jet recording head characterized by comprising;
 - a base plate,
 - a heater board, disposed on said base plate, having a plurality of discharging energy generating elements for discharging recording liquid droplets disposed on said heater board in the longitudinal direction,
 - a solid layer placed on said heater board, said solid layer being formed a plurality of liquid passages at the positions corresponding to said discharging energy generating elements, respectively,
 - a ceiling plate, mounted on said solid layer and said heater board, having a common liquid chamber formed on said ceiling plate while making communication with said plurality of liquid passages, and
 - a longitudinal extending comb-shaped retaining leaf spring for thrusting said ceiling plate against said heater board.
10. An ink jet recording head as claimed in claim 9, further characterized by comprising;
 - a flexible printed circuit on said base plate so as to allow electricity and signals to be fed to said discharging energy generating elements via said flexible printed circuit.
11. An ink jet recording head as claimed in claim 10, further characterized by comprising;
 - a retaining member for firmly securing said flexible printed circuit to said base plate, and characterized in that said retaining leaf spring is fixedly secured to said retaining member by tightening a plurality of screws.
12. An ink jet recording head, characterized by comprising;

- a base plate on which disposed are a plurality of discharging elements for discharging recording liquid droplets,
a liquid flow paths forming member having partitions for forming flow paths corresponding to said plurality of discharging elements, and
a comb-shaped leaf spring for bringing said partitions of said liquid flow paths forming member into contact with said base plate to form flow paths.
13. An ink jet recording head as claimed in claim 12, characterized in that said comb-shaped leaf spring depresses said liquid flow paths forming member at a range covering said flow paths.
14. An ink jet recording head as claimed in claim 13, characterized in that said range covering said flow paths exists near to discharging orifices.
15. An ink jet recording head as claimed in claim 12, characterized in that said comb-shaped leaf spring depresses said liquid flow paths forming member against said base plate.
16. An ink jet recording head as claimed in claim 12, further characterized by comprising an elastic member interposed between said liquid flow paths forming member and said comb-shaped leaf spring.
17. A liquid jet recording apparatus for performing a recording operation by discharging recording liquid droplets toward a recording medium, characterized by comprising;
a liquid jet recording head, characterized by comprising;
a base plate on which disposed are a plurality of discharging elements for discharging recording liquid droplets,
a liquid flow paths forming member having partitions for forming flow paths corresponding to said plurality of discharging elements, and
a comb-shaped leaf spring for bringing said partitions of said liquid flow paths forming member into contact with said base plate to form flow paths, and
a mounting portion on which said liquid jet recording head is mounted.
18. A liquid jet recording apparatus as claimed in claim 17, characterized in that said comb-shaped leaf spring depresses said liquid flow paths forming member at a range covering said flow paths.
19. A liquid jet recording apparatus as claimed in claim 17, characterized in that said range covering said flow paths exists near to discharging orifices.
20. A liquid jet recording apparatus as claimed in claim 17, characterized in that said comb-shaped leaf spring depresses said liquid flow paths forming member against said base plate.
21. A liquid jet recording apparatus as claimed in claim 17, further characterized by comprising an elastic member interposed between said liquid flow paths forming member and said comb-shaped leaf spring.
22. A liquid jet recording head as claimed in claim 1, characterized in that said liquid jet recording head produces bubbles in said recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of said bubbles.
23. A liquid jet recording head as claimed in claim 12, characterized in that said liquid jet recording head produces bubbles in said recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of said bubbles.
24. A liquid jet recording apparatus as claimed in claim 17, characterized in that said ink jet recording apparatus produces bubbles in said recording liquid by utilizing thermal energy, and recording liquid droplets are discharged therefrom in response to the production of said bubbles.

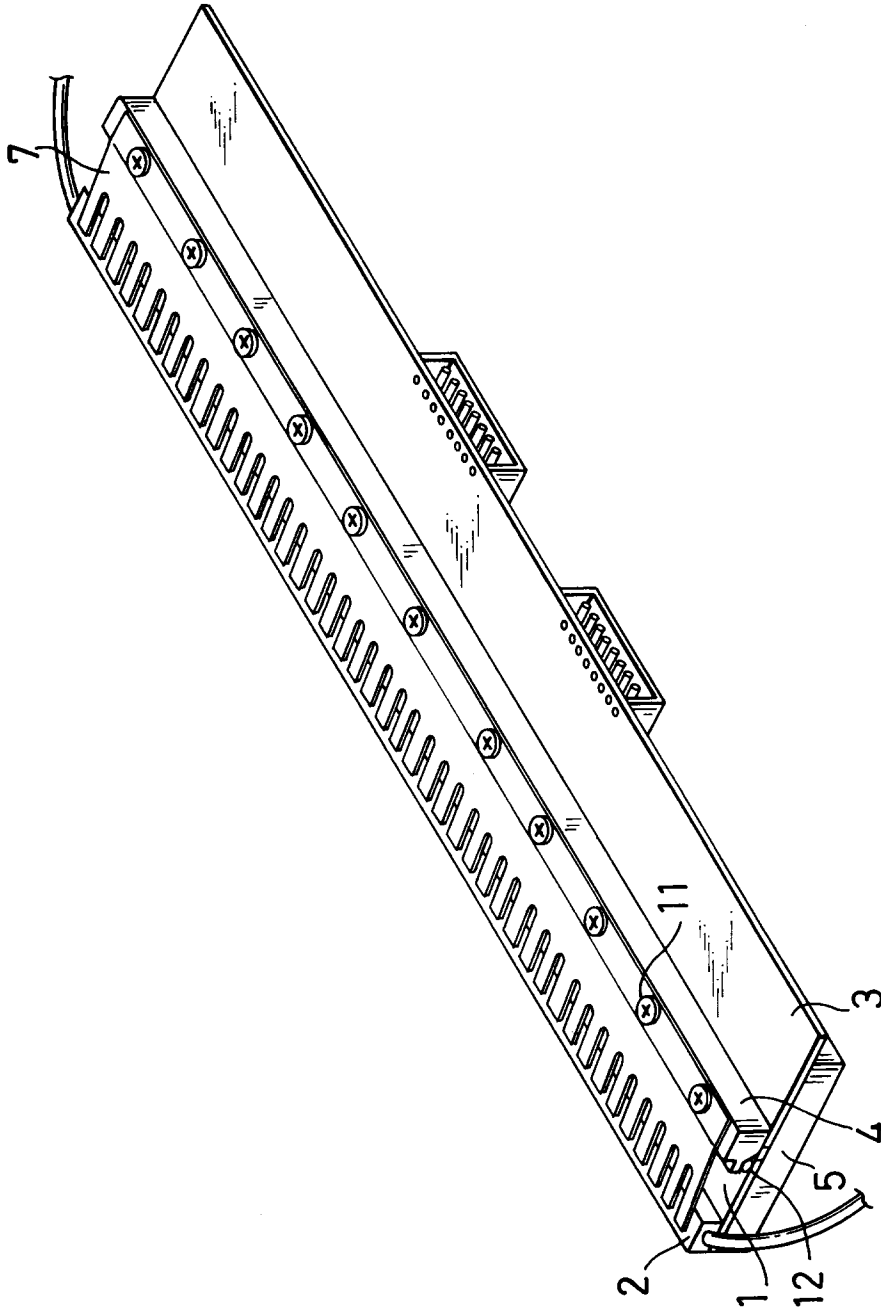


FIG. 1A

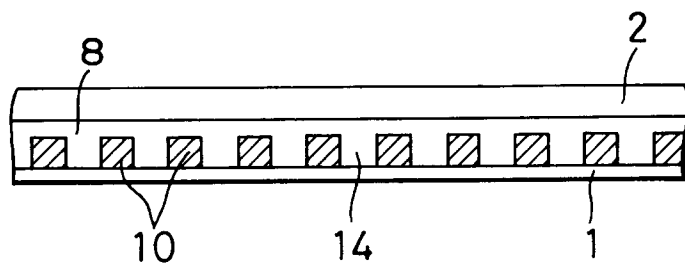


FIG.1B

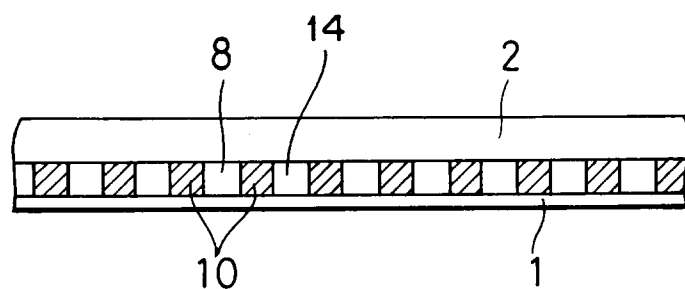


FIG.1C

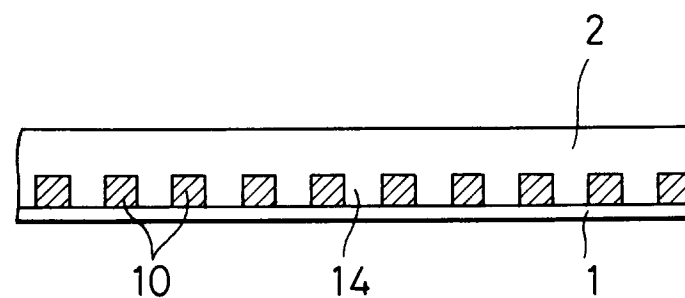


FIG.1D

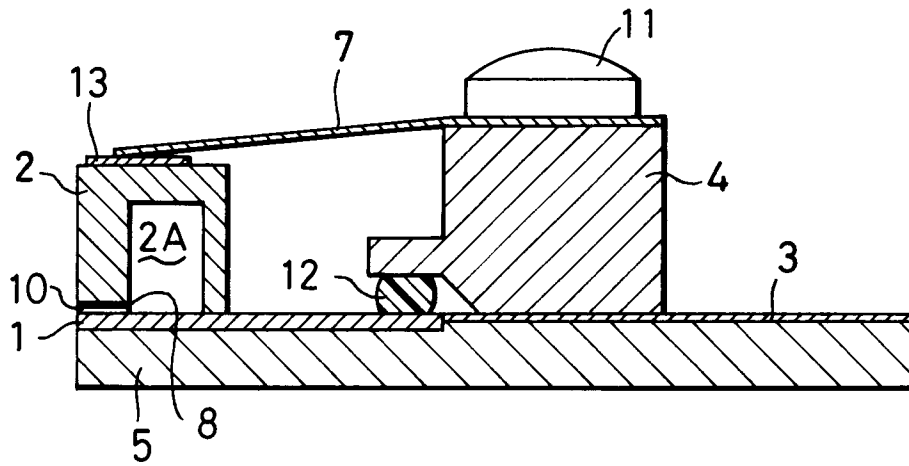


FIG. 2

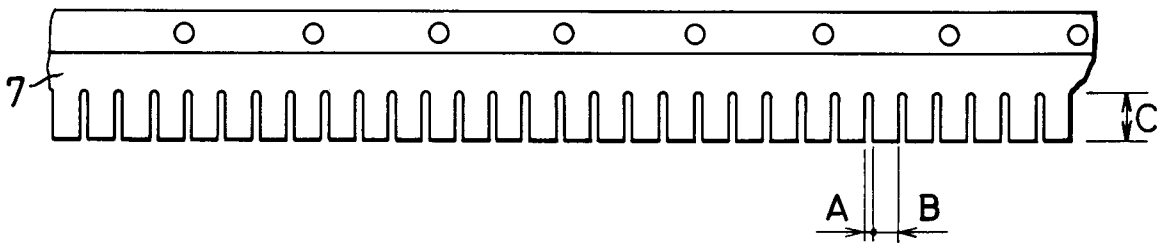


FIG. 3

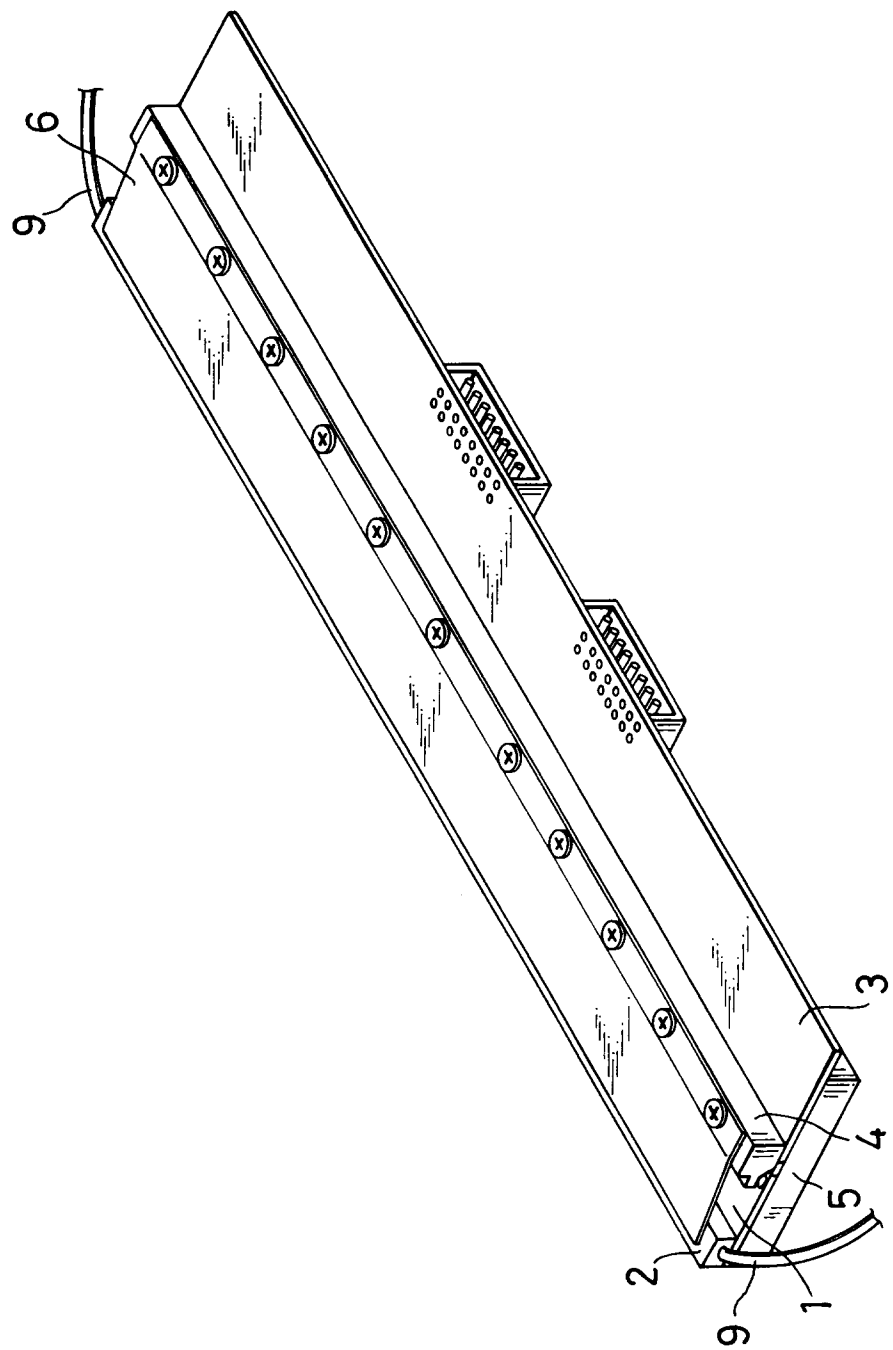


FIG. 4 (PRIOR ART)

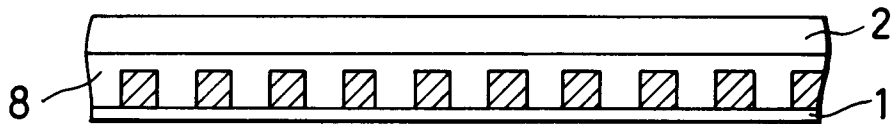


FIG.5A

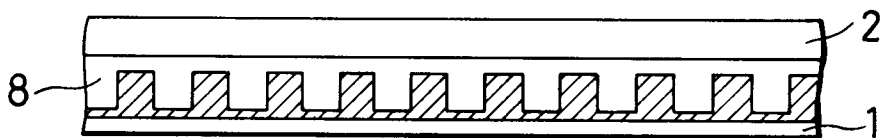


FIG.5B