

Description

This invention is concerned with a printing apparatus comprising the features of first part of claim 1 known from JP—A—5745066.

Several workers (e.g., Amberntsson, et al., U.S. Patent No. 3,953,862, Hon, et al., U.S. Patent No. 4,025,928, and Kasugajama, et al., U.S. Patent No. 4,306,245) have disclosed ink jetting devices for printing, and the overall versatility of ink jetting for both printing and plotting is well known. Unfortunately previous ink jet printers and their key element, the ink jet head, have been both expensive and complex. Because of the expense and complexity of these prior ink jet heads, prior workers have had to ensure that the heads could be used continuously over a period of several years and tens of thousands of sheets of writing, that the ink supply could be refilled, and that various parts of the assembly which required maintenance were accessible for cleaning and repair. Naturally, each of these requirements in the prior art served to further increase both complexity and expense. Finally, and for many users most unfortunately, the users were often faced with the unwanted, awkward and potentially messy task of refilling an ink reservoir or, at best, replacing an ink cartridge. In either case, the user was required to disconnect and reconnect some form of fluid coupling or fluid plug, thereby exposing both hands and clothing to the liquid ink.

The present invention provides a printing apparatus of the kind comprising the features of the claim 1.

An apparatus as set forth in the last preceding paragraph may be further characterized by housing means coupled to the support means and substantially surrounding the ink reservoir for providing mechanical protection for the collapsible ink reservoir, and an air vent through the housing means to prevent a partial vacuum from forming around the ink reservoir.

In apparatus as set forth in either one of the last two immediately preceding paragraphs, it is preferred that the collapsible ink reservoir is resilient to provide a negative back pressure on the ink.

An apparatus as set forth in any one of the last three immediately preceding paragraphs, may be further characterized by alignment means on the support means for aligning the printing apparatus with the ink jet printer.

In apparatus as set forth in any one of the last four immediately preceding paragraphs, it is preferred that the jetting means is a thermal resistor.

In apparatus as set forth in the last preceding paragraph, it is preferred that the thermal resistor is a film resistor deposited on the substrate.

In apparatus as set forth in the last preceding paragraph, it is preferred that the film resistor is a thin film resistor.

In apparatus as set forth in either one of the last two immediately preceding paragraphs, it is preferred that the electrical connection means comprises film conductor runs deposited on the sub-

strate and connected to the film resistor, and film conductor pads deposited on the substrate and terminating the film runs for external electrical connection.

In apparatus as set forth in the last preceding paragraph, it is preferred that the film conductor runs and pads are thin film conductors.

The present invention further provides a method of filling an ink reservoir having a fill hole in a printing apparatus as described hereabove with liquid ink, characterized by the steps of drawing a partial vacuum on the fill hole to create a partial vacuum in the ink reservoir, allowing liquid ink to be sucked through the fill hole into the ink reservoir under the influence of the partial vacuum, and permanently sealing the fill hole, so that ink cannot later escape from the ink reservoir through the fill hole.

The present invention solves the problems of prior art ink jet heads by providing a head which is simple and sufficiently inexpensive as to be disposable. The head is totally self-contained with a single unit including a sealed ink reservoir, ink jetting mechanism (i.e., thermal thin film resistors), electrical connections (i.e., thin film conductive runs and pads), fluid interconnection, and jetting orifices. Once the ink in the sealed reservoir is used up, typically requiring about 500 full pages of text printing, the entire head is thrown away and replaced with a new head. It is therefore only necessary for the user to break and make a mechanical and an electrical connection, usually having a harmlessly low voltage, and it is never necessary for the user to handle a fluid (i.e., ink) coupling.

There now follows a detailed description which is to be read with reference to the accompanying drawings of a disposable ink jet head according to the invention; it is to be clearly understood that this head has been selected for description to illustrate the invention by way of example and not by way of limitation.

In the accompanying drawings:

Figure 1 shows an exploded view of a disposable ink jet head according to the preferred embodiment of the present invention; and

Figure 2 shows a second view of the disposable ink jet head as shown in Figure 1.

Figure 1 shows an exploded view of the disposable ink jet head. A glass or ceramic substrate 10 carries a plurality of thin-film thermal jetting resistors 20 and thin-film metal electrical connecting runs 30 and pads 40. A jet feed hole 50 is provided through the substrate 10 to permit the flow of ink from a reservoir side 60 to a jetting side 70 of the substrate 10.

An orifice plate 80 is attached to the substrate 10 by, for example, an epoxy adhesive or solder. The orifice plate 80 is composed of glass, ceramic, or a metal such as nickel and contains a plurality of small (.025—.076 cms) drop expulsion holes 90, one associated with each jetting resistor 20, to provide both a jetting chamber and orifice needed for proper ink jetting toward a print medium (paper) in the direction 6. The orifice plate 80 is

also provided with grooves 95 on the side facing the substrate 10 which mate with the substrate 10 to permit the flow of ink from the jet feed hole 50 to the drop expulsion holes 90 by capillary action.

The orifice plate 80 also provides mechanical protection to prevent abrasion or impact damage to the jetting resistors 20 during shipment and use.

The substrate 10 is mounted and sealed by an adhesive in the recess 100 on the front side 160a of a plastic molded backing plate 110. The backing plate 110 serves several purposes: (1) it mechanically supports the substrate 10; (2) it is provided with molded-in-place alignment pins 120 used to align the entire head in the printer; and (3) it is provided with a molded-in-place groove 130 and feed hole 140, which when mated with the reservoir side 60 of the substrate 10 provide a capillary feed line for the ink to the jet feed hole 50.

An elastic hollow ink reservoir 150 is adhesively mounted and sealed to the rear side 160b of the backing plate 110. The ink reservoir 150 is made either as a single piece of resilient flexible silicone rubber (not shown), or from a relatively inflexible plastic half-shell 170 glued to a flexible, resilient plastic half-shell 180, in the general shape of a sewing thimble. In either case, the ink reservoir 150 serves not only to contain the ink which in use can only exit via the feed hole 140, but also to provide back pressure on the ink so that the ink will only exit the drop expulsion holes 90 when the jetting resistors 20 are energized.

A plastic molded outer housing 190 is then adhesively mounted on the rear side 160 of the backing plate 110 to provide firm mechanical protection for the ink reservoir 150. As ink is expelled from the drop expulsion holes 90, the ink reservoir 150 (or the half-shell 180 in the case of the two-piece construction) slowly collapses. It is therefore necessary to provide an air-pressure equalization vent 200, which is a hole through the outer housing 190, as shown in Figure 2 to prevent the creation of a partial vacuum within the outer housing 190.

The ink reservoir 150 is filled via a fill hole 210, which is a hole through the back plate 110 to the ink reservoir 150, as shown in Figure 1. The ink reservoir 150 is filled by first drawing a partial vacuum on the fill hole 210 to remove the majority of the air within the ink reservoir 150, then allowing liquid ink to be sucked into the ink reservoir 150 under the influence of the partial vacuum. The fill hole 210 is then plugged and sealed to prevent ink from later escaping from the ink reservoir 150 except from the drop expulsion holes 90 when the jetting resistors 20 are energized. The ink pathway through the entire ink jet head is thus hydraulically sealed except for the small drop expulsion holes 90.

In use, the head is aligned in the printer by the alignment pins 120 and held in place by a clamp (not shown) to either the backing plate 110 or the outer housing 190. The printer contains electrical contacts (not shown) which are arranged to mate with the pads 40 to provide the necessary electri-

cal signals to energize the jetting resistors 20. Thus, it is no longer necessary for the user to break or make any liquid connections as the ink is used up since the head is now a single, hydraulically sealed unit with a self-contained ink supply. When the ink is finally expended, the entire head is discarded and replaced with a new head.

Claims

1. A printing apparatus for jetting ink in an ink jet printer comprising

a collapsible ink reservoir (150);

jetting means (20) for imparting momentum to the ink, and electrical connection means (30) for energizing the jetting means;

orifice means (80) connected to the jetting means for providing an orifice (90) through which the ink is jetted under the influence of the momentum imparted by the jetting means;

support means (110) mechanically supporting the ink reservoir and the jetting means (20) and comprising means (120) to align the apparatus with the printer;

fill means (210) coupled to the ink reservoir for substantially filling the collapsible ink reservoir with ink; and

plug means coupled to the fill means for hydraulically sealing the fill means so that the only exit for the ink from the ink reservoir is through the orifice means, characterized in that a flat substrate (10) carrying the jetting means (20) and the electrical connection means (30) on its one side (70) is mechanically and hydraulically coupled with its other side (60) to a front face (160a) of the support means (110);

in that the ink reservoir (150) is mechanically and hydraulically coupled to a back face (160b) of the support means (110); and

in that a sealed hydraulic connection (130, 140) is provided in the support means (110) between the jetting means (20) and the ink reservoir (150).

2. A printing apparatus according to claim 1, further characterized by:

housing means (190) coupled to the support means and substantially surrounding the ink reservoir for providing mechanical protection for the collapsible ink reservoir; and

an air vent (200) through the housing means to prevent a partial vacuum from forming around the ink reservoir.

3. A printing apparatus according to either one of claims 1 and 2, characterized in that the collapsible ink reservoir is resilient to provide a negative back pressure on the ink.

4. A printing apparatus according to any one of the preceding claims characterized in that the jetting means (20) is a thermal resistor.

5. A printing apparatus according to claim 4, characterized in that the thermal resistor is a film resistor deposited on the substrate.

6. A printing apparatus according to claim 5, characterized in that the thermal resistor is a thin film resistor.

7. A printing apparatus according to either one

also provided with grooves 95 on the side facing the substrate 10 which mate with the substrate 10 to permit the flow of ink from the jet feed hole 50 to the drop expulsion holes 90 by capillary action. The orifice plate 80 also provides mechanical protection to prevent abrasion or impact damage to the jetting resistors 20 during shipment and use.

The substrate 10 is mounted and sealed by an adhesive in the recess 100 on the front side 160a of a plastic molded backing plate 110. The backing plate 110 serves several purposes: (1) it mechanically supports the substrate 10; (2) it is provided with molded-in-place alignment pins 120 used to align the entire head in the printer; and (3) it is provided with a molded-in-place groove 130 and feed hole 140, which when mated with the reservoir side 60 of the substrate 10 provide a capillary feed line for the ink to the jet feed hole 50.

An elastic hollow ink reservoir 150 is adhesively mounted and sealed to the rear side 160b of the backing plate 110. The ink reservoir 150 is made either as a single piece of resilient flexible silicone rubber (not shown), or from a relatively inflexible plastic half-shell 170 glued to a flexible, resilient plastic half-shell 180, in the general shape of a sewing thimble. In either case, the ink reservoir 150 serves not only to contain the ink which in use can only exit via the feed hole 140, but also to provide back pressure on the ink so that the ink will only exit the drop expulsion holes 90 when the jetting resistors 20 are energized.

A plastic molded outer housing 190 is then adhesively mounted on the rear side 160 of the backing plate 110 to provide firm mechanical protection for the ink reservoir 150. As ink is expelled from the drop expulsion holes 90, the ink reservoir 150 (or the half-shell 180 in the case of the two-piece construction) slowly collapses. It is therefore necessary to provide an air-pressure equalization vent 200, which is a hole through the outer housing 190, as shown in Figure 2 to prevent the creation of a partial vacuum within the outer housing 190.

The ink reservoir 150 is filled via a fill hole 210, which is a hole through the back plate 110 to the ink reservoir 150, as shown in Figure 1. The ink reservoir 150 is filled by first drawing a partial vacuum on the fill hole 210 to remove the majority of the air within the ink reservoir 150, then allowing liquid ink to be sucked into the ink reservoir 150 under the influence of the partial vacuum. The fill hole 210 is then plugged and sealed to prevent ink from later escaping from the ink reservoir 150 except from the drop expulsion holes 90 when the jetting resistors 20 are energized. The ink pathway through the entire ink jet head is thus hydraulically sealed except for the small drop expulsion holes 90.

In use, the head is aligned in the printer by the alignment pins 120 and held in place by a clamp (not shown) to either the backing plate 110 or the outer housing 190. The printer contains electrical contacts (not shown) which are arranged to mate with the pads 40 to provide the necessary electri-

cal signals to energize the jetting resistors 20. Thus, it is no longer necessary for the user to break or make any liquid connections as the ink is used up since the head is now a single, hydraulically sealed unit with a self-contained ink supply. When the ink is finally expended, the entire head is discarded and replaced with a new head.

Claims

1. A printing apparatus for jetting ink in an ink jet printer comprising
a collapsible ink reservoir (150);
jetting means (20) for imparting momentum to the ink, and electrical connection means (30) for energizing the jetting means;

orifice means (80) connected to the jetting means for providing an orifice (90) through which the ink is jetted under the influence of the momentum imparted by the jetting means;

support means (110) mechanically supporting the ink reservoir and the jetting means (20) and comprising means (120) to align the apparatus with the printer;

fill means (210) coupled to the ink reservoir for substantially filling the collapsible ink reservoir with ink; and

plug means coupled to the fill means for hydraulically sealing the fill means so that the only exit for the ink from the ink reservoir is through the orifice means, characterized in that a flat substrate (10) carrying the jetting means (20) and the electrical connection means (30) on its one side (70) is mechanically and hydraulically coupled with its other side (60) to a front face (160a) of the support means (110);

in that the ink reservoir (150) is mechanically and hydraulically coupled to a back face (160b) of the support means (110); and

in that a sealed hydraulic connection (130, 140) is provided in the support means (110) between the jetting means (20) and the ink reservoir (150).

2. A printing apparatus according to claim 1, further characterized by:

housing means (190) coupled to the support means and substantially surrounding the ink reservoir for providing mechanical protection for the collapsible ink reservoir; and

an air vent (200) through the housing means to prevent a partial vacuum from forming around the ink reservoir.

3. A printing apparatus according to either one of claims 1 and 2, characterized in that the collapsible ink reservoir is resilient to provide a negative back pressure on the ink.

4. A printing apparatus according to any one of the preceding claims characterized in that the jetting means (20) is a thermal resistor.

5. A printing apparatus according to claim 4, characterized in that the thermal resistor is a film resistor deposited on the substrate.

6. A printing apparatus according to claim 5, characterized in that the thermal resistor is a thin film resistor.

7. A printing apparatus according to either one



of claims 5 and 6, characterized in that the electrical connection means (30) comprises:

film conductor runs deposited on the substrate and connected to the film resistor; and film conductor pads (40) deposited on the substrate and terminating the film runs for external electrical connection.

8. A printing apparatus according to claim 7, characterized in that the film conductor runs (30) and pads (40) are thin film conductors.

9. A method of filling an ink reservoir having a fill hole (210) in a printing apparatus according to any one of the preceding claims 1 to 8 with liquid ink, characterized by the steps of:

drawing a partial vacuum on the fill hole to create a partial vacuum in the ink reservoir (150);

allowing liquid ink to be sucked through the fill hole into the ink reservoir under the influence of the partial vacuum; and

permanently sealing the fill hole, so that ink cannot later escape from the ink reservoir through the fill hole.

Patentansprüche

1. Tintenstrahldruckkopf in einem Tintenstrahldrucker mit einem kollabierbaren Tintenreservoir (150);

Spritzmitteln (20) zum Aufbringen eines Impulses auf die Tinte und einer elektrischen Verbindung (30) zum Betätigen der Spritzmittel;

mit den Spritzmitteln in Verbindung stehenden Öffnungsmitteln (80), welche eine Öffnung (90) vorsehen, durch die Tinte aufgrund des von den Spritzmitteln ausgeübten Impulses ausgespritzt wird;

Stützmitteln (110), welche mechanisch das Tintenreservoir und die Spritzmittel (20) unterstützen und Mittel (120) zum Ausrichten der Vorrichtung auf der Drucker umfassen;

Füllmitteln (210), die mit dem Tintenreservoir zum Füllen des kollabierbaren Tintenreservoirs mit Tinte gekoppelt sind, und mit den Füllmitteln gekoppelten Stopfenmitteln zum hydraulischen Abdichten der Füllmittel, so daß als einziger Ausgang für die Tinte aus dem Tintenreservoir die Öffnungsmittel verbleiben,

dadurch gekennzeichnet,

daß ein flaches, auf seiner einen Seite (70) die Spritzmittel (20) und die elektrische Verbindung (30) tragendes Substrat (10) mechanisch und hydraulisch mit seiner anderen Seite (60) mit einer Stirnfläche (160a) der Stützmittel (110) gekuppelt ist;

daß das Tintenreservoir (150) mechanisch und hydraulisch mit der Rückseite (160b) der Stützmittel (110) gekuppelt ist und

daß eine abgedichtete hydraulische Verbindung (130, 140) in den Stützmitteln (110) zwischen den Spritzmitteln (20) und dem Tintenreservoir (150) vorgesehen ist.

2. Tintenstrahldruckkopf nach Anspruch 1, gekennzeichnet durch

ein Gehäuse (190), das mit den Stützmitteln gekuppelt ist und im wesentlichen das Tintenreser-

voir umgibt, um einen mechanischen Schutz für das kollabierbare Tintenreservoir vorzusehen, sowie

eine Entlüftung (200) durch das Gehäuse, um die Ausbildung eines teilweisen Vakuums um das Tintenreservoir zu vermeiden.

3. Tintenstrahldruckkopf nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das kollabierbare Tintenreservoir nachgiebig ist, um einen negativen Reaktionsdruck auf die Tinte auszuüben.

4. Tintenstrahldruckkopf nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß die Spritzmittel (20) von einem Heizwiderstand gebildet sind.

5. Tintenstrahldruckkopf nach Anspruch 4, dadurch gekennzeichnet, daß der Heizwiderstand ein auf dem Substrat abgeschiedener Filmwiderstand ist.

6. Tintenstrahldruckkopf nach Anspruch 5, dadurch gekennzeichnet, daß der Filmwiderstand ein Dünnschicht-Widerstand ist.

7. Tintenstrahldruckkopf nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß die elektrische Verbindung (30) auf dem Substrat abgeschiedene Filmleiterbahnen, welche mit dem Filmwiderstand verbunden sind, und auf dem Substrat abgeschiedene Filmleiterplatten (40) aufweist, welche die Filmleiterbahnen zum äußeren elektrischen Anschluß abschließen.

8. Tintenstrahldruckkopf nach Anspruch 7, dadurch gekennzeichnet, daß die Filmleiterbahnen (30) und -platten (40) in Dünnschicht-Technik ausgeführt sind.

9. Verfahren zum Füllen eines Tintenreservoirs mit einem Fülloch (210) in einem Tintenstrahldruckkopf nach einem der vorangehenden Ansprüche 1 bis 8 mit flüssiger Tinte, gekennzeichnet durch die folgenden Schritte:

Abziehen eines teilweisen Vakuums am Fülloch zum Schaffen eines teilweisen Vakuums im Tintenreservoir (150);

Einsaugen von flüssiger Tinte durch das Fülloch in das Tintenreservoir unter dem Einfluß des Teilvakuums und

permanentes Abdichten des Fülloches, so daß die Tinte später nicht aus dem Tintenreservoir durch das Fülloch entweichen kann.

Revendications

1. Un appareil d'impression pour produire un jet d'encre dans une imprimante à jet d'encre, comportant:

— un réservoir d'encre (150) pouvant s'écra-

ser, — des moyens de production d'un jet d'encre (20) pour appliquer une quantité de mouvement à l'encre, avec des moyens de liaison électrique (30) permettant d'alimenter les moyens de production du jet d'encre,

— des moyens formant orifice (80), reliés aux moyens de production du jet d'encre de manière à présenter un orifice (90) au travers duquel l'encre est expulsée sous forme de jet sous l'effet de la quantité de mouvement appliquée par les moyens de production du jet d'encre,



— des moyens support (110), supportant mécaniquement le réservoir d'encre et les moyens de production du jet d'encre (20) et comprenant des moyens (120) pour aligner l'appareil avec l'imprimante,

— des moyens de remplissage (210), reliés au réservoir d'encre pour remplir pratiquement complètement d'encre le réservoir d'encre pouvant s'écraser, et

— des moyens d'obturation, reliés aux moyens de remplissage, pour sceller hydrauliquement les moyens de remplissage de sorte que la seule issue pour l'encre du réservoir d'encre soit constituée par les moyens formant orifice, caractérisé:

— en ce qu'un substrat plat (10) supportant les moyens de production du jet d'encre (20) et les moyens de liaison électrique (30) sur l'une de ses faces (70) est mécaniquement et hydrauliquement relié sur son autre face (60) à la face frontale (160a) des moyens de support (110),

— en ce que le réservoir d'encre (150) est mécaniquement et hydrauliquement relié à la face arrière (160b) des moyens de support (110), et

— en ce que une liaison hydraulique scellée (130, 140) est formée dans les moyens de support (110) entre les moyens de production du jet d'encre (20) et le réservoir d'encre (150).

2. L'appareil d'impression de la revendication 1, caractérisé en outre par:

— des moyens formant carter (190), reliés aux moyens de support et entourant presque complètement le réservoir d'encre pour assurer une protection mécanique de ce réservoir d'encre pouvant s'écraser, et

— un évent (200) de mise à l'air libre, traversant les moyens formant carter de manière à empêcher qu'un vide partiel ne se forme autour du réservoir d'encre.

3. L'appareil d'impression de l'une des revendications 1 et 2, caractérisé en ce que le réservoir

d'encre pouvant s'écraser est souple, de manière à procurer une contrepression négative sur l'encre.

4. L'appareil d'impression de l'une des revendications précédentes, caractérisé en ce que les moyens de production du jet d'encre (20) sont une résistance thermique.

5. L'appareil d'impression de la revendication 4, caractérisé en ce que la résistance thermique est une résistance en film déposée sur le substrat.

6. L'appareil d'impression de la revendication 5, caractérisé en ce que la résistance thermique est une résistance en couche mince.

7. L'appareil d'impression de l'une des revendications 5 et 6, caractérisé en ce que les moyens de connexion électrique (30) comprennent:

— des pistes conductrices en film, déposées sur le substrat et reliées à la résistance en film, et

— des plages de contact (40) conductrices en film, déposées sur le substrat et formant l'extrémité des pistes en film afin de permettre leur connexion électrique avec l'extérieur.

8. L'appareil d'impression de la revendication 7, caractérisé en ce que les pistes conductrices en film (30) et les plages de contact sont des conducteurs en couche mince.

9. Un procédé pour remplir d'encre liquide un réservoir d'encre pourvu d'un orifice de remplissage (210) dans un appareil d'impression selon l'une quelconque des revendications 1 à 8, caractérisé par les étapes consistant à:

— former un vide partiel par l'orifice de remplissage de manière à créer un vide partiel d'encre dans le réservoir d'encre (150),

— permettre à l'encre liquide d'être aspirée dans le réservoir d'encre par l'orifice de remplissage sous l'influence de ce vide partiel, et

— sceller de façon définitive l'orifice de remplissage, de sorte que l'encre ne puisse s'échapper ultérieurement du réservoir d'encre par l'orifice de remplissage.

