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(54) **INK JET PRINT HEAD MODULES WITH COMMON INK SUPPLY**

TINTENDRUCKKOPFMODULE MIT GEMEINSAMER TINTENZUFUHR

MODULES DE TETE D'IMPRIMANTE A JET D'ENCRE AVEC ALIMENTATION EN ENCRE
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(73) Proprietor: **Marconi Data Systems Inc.**
Wood Dale, Illinois 60191-1073 (US)

(72) Inventor: **BODE, Henry, J.**
River Forest, IL 60305 (US)

(74) Representative: **McGowan, Nigel George**
Marconi Intellectual Property
Marrable House
The Vineyards
Gt. Baddow
Chelmsford Essex CM2 7QS (GB)

(56) References cited:
US-A- 4 340 896 US-A- 4 413 267
US-A- 5 485 187

- **PATENT ABSTRACTS OF JAPAN vol. 007, no. 149 (M-225), 30 June 1983 & JP 58 057969 A (CANON KK), 6 April 1983,**
- **PATENT ABSTRACTS OF JAPAN vol. 005, no. 010 (M-051), 22 January 1981 & JP 55 142668 A (OKI ELECTRIC IND CO LTD), 7 November 1980,**
- **PATENT ABSTRACTS OF JAPAN vol. 009, no. 179 (M-399), 24 July 1985 & JP 60 048360 A (CANON KK), 16 March 1985,**
- **PATENT ABSTRACTS OF JAPAN vol. 014, no. 083 (M-0936), 16 February 1990 & JP 01 297259 A (VICTOR CO OF JAPAN LTD), 30 November 1989,**
- **PATENT ABSTRACTS OF JAPAN vol. 009, no. 098 (M-375), 27 April 1985 & JP 59 222361 A (CANON KK), 14 December 1984,**

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Description

[0001] This invention relates generally to ink jet printers. More specifically, the invention relates to a system for providing liquid ink at proper static pressure to a series of drop-on-demand ink jet print orifices.

[0002] As is known, ink jet printing systems utilize printing heads in which ink droplets are emitted through one or more orifices and onto a target surface. In impulse type drop-on-demand printing, the emission of ink through the orifice is controlled by creating pressure pulses within an ink chamber in the printhead. Referring to prior art FIG. 1, a typical printhead 2 is provided with an array of orifices 3, which are individually controlled to emit ink droplets 4 that form the desired image on the target surface as the surface moves relative to the printing head. The orifices are fed ink from individual chambers 5 within each printhead, which communicate with corresponding input ports 6. Ink is supplied via capillary action to each input port 6 from a reservoir 7 through ink supply lines 9.

[0003] It is important that the proper static pressure, typically a small negative static pressure, is achieved at each ink jet orifice to avoid orifice drool. Static pressure within the printhead is largely a function of the static fluid pressure at the printhead input port, since capillary forces within a given printhead offset any appreciable variation in pressure head among the orifices in that printhead. Thus, the static pressure at the input port influences the pressure at the ink jet orifices which are in immediate proximity to the input port. The optimal static pressure is determined by the physical properties of the ink, such as viscosity and surface tension, wettability and the substrate material used to construct the orifices. Ordinarily, the optimal static pressure of the ink is negative one to three inches of water (248-744 Nm⁻²). As can be seen in FIG. 1, and as is known from hydraulic theory, the static pressure at the input port is a function of the difference in height (H) between the input port and the reservoir ink level. More particularly, the static pressure at each orifice is a function of the difference in height between each orifice and the reservoir ink level.

[0004] In commercial ink jet printing applications, it is advantageous to provide a printing apparatus having a large printing area to permit imaging of a large image on a target surface without multiple passes of the surface past the printing head. This may be accomplished by providing a number of printheads vertically stacked or "stitched" together. Vertically stacked printhead arrangements, however, present special problems associated with the control of static pressure, and their commercial advantages have heretofore been limited by increasing costs or complexity relating to ink storage and delivery. It is not feasible to supply all printheads in a stacked arrangement from a common reservoir because uniform static pressure cannot be achieved. As seen in FIG. 1, printheads disposed above the reservoir fluid level experience negative static pressure, while

those disposed below the reservoir experience positive static pressure. Moreover, while it is feasible to provide each printhead with a separate, level-controlled reservoir as illustrated in FIG. 2, the cost of such an arrangement is prohibitive. Additionally, the space limitations and tight spacing between printheads make it physically impractical to install reservoirs and level-control devices in this configuration.

[0005] Prior art distribution systems are not readily adaptable to stacked printhead arrangements because of the complexity and costs associated with manufacturing and maintenance. There is thus desired an ink jet fluid distribution system which may be easily and inexpensively constructed and which provides proper and dependable control of the static pressure of ink delivered to each printhead in a stacked arrangement.

[0006] US-A-4,340,896 discloses an apparatus for delivering ink to an array of impulse ink jet heads some of which may be at different vertical locations. A flow of ink is established along a supply conduit located vertically below the ink jet heads. Ink feed conduits connect at junctions to the supply conduit to provide the ink jet heads with ink. A plurality of flow impeding devices are employed between the junctions so as to enable the formation of columns of ink in the feed conduits of sufficient height to supply the ink to the impulse ink feed jets. Appropriate spacing of the ink jet heads above the top of the ink columns then provides required small negative ink pressures.

[0007] According to the invention there is provided a system for supplying liquid to a composite printing head having at least two vertically disposed sets of orifices, comprising: a liquid compartment for each of said sets of orifices for communicating liquid thereto, each said compartment being configured to maintain the level of liquid therein at a desired fill height and to permit excess liquid to spill from said compartment over an edge thereof, said compartments being positioned relative to each other to cause liquid to spill from a compartment to the next lower compartment; and a reservoir for receiving liquid spillage from the lowest one of the compartments and supplying liquid to the uppermost one of the compartments.

[0008] In a preferred embodiment of the invention, several printheads each has a set of orifices for printing or marking a substrate. Each printhead is supplied from one of the compartments of a multi-compartment reservoir via a separate feed line. The compartmentalized ink reservoirs utilize a weir system which maintains a predetermined optimum static pressure within each compartment. The feed pressure to each printhead is controlled by the relative height of the fluid column at each compartment with respect to the height of an inlet port which is immediately proximate to the set of orifices. The height of the fluid may be controlled by the height of the weir associated with that compartment or the fluid level in such weir.

[0009] The present invention provides significant ad-

vantages over other ink jet fluid distribution systems. Because the weir system automatically maintains a desired level of ink in the individual compartments, there is no need for individual level detectors for each compartment, thereby reducing parts and costs.

[0010] The present invention will now be described by way of example with reference to the accompanying drawings in which:-

FIG. 1 is an illustration of prior art printheads and ink distribution system as described above;

FIG. 2 illustrates the problems associated with independent level controls for a stacked printhead arrangement;

FIG. 3 is an illustration of a preferred embodiment of the invention; and

FIG. 4 is an illustration of a vacuum chamber feature of the present invention.

[0011] Referring to FIG. 3, the fluid system embodying the present invention comprises a composite printing head 12 including a plurality of ink embodying jet printheads 12A-12D. Composite printing head 12 can be stationary and arranged to print an image on a target surface (not shown) which moves relative thereto. Alternatively, the printing head 12 can be movable relative to the target surface, or both the printing head 12 and the target surface can be movable relative to each other.

[0012] Although schematically illustrated as four spaced apart printheads 12A-12D, the composite printing head 12 preferably has three or four distinct internal printheads or manifolds that are integrally attached to provide an even distribution of ink as it is ejected out of the printheads. It will be appreciated that any number of printheads can be used to create the desired width of the area to be printed.

[0013] Preferably, each printhead 12A-12D has a set of ejection nozzles or orifices 14 which are supplied fluid by a common chamber or manifold 16 within each printhead 12A-D. The set of orifices may number twelve as illustrated, or more or less in number, it being within the skill of one knowledgeable in the art to choose the number of orifices and the pattern of those orifices. The manifolds 16 are supplied fluid through associated inlet ports 18 and feed lines 19 attached to the printheads 12A-D. Although it is desirable to have a separate printhead for each set of orifices, a single printhead could have two or more sets of orifices with associated inlet ports. Also, while the sets of orifices are depicted to comprise a single row, there may be multiple rows of orifices in a set, or other configurations, as those skilled in the art would understand.

[0014] To supply ink to the printheads 12A-12D through the feed lines 19, each printhead 12A-12D is provided with associated compartments 20A-20D which maintain a constant fluid level of ink therein using weirs 22A-22D. Each weir 22 includes an opening, drain or other egress for permitting the flow of ink from one com-

partment to the next lower compartment, or in the case of the lowermost compartment 20D, back to a reservoir 24. A pump 26 provides a low-volume flow of ink from reservoir 24 to the uppermost compartment 20A via return line 27. A level detection device 28 is also provided to ensure an adequate ink reserve is fed to reservoir 24 from a main storage container (not shown). To ensure that an adequate amount of ink is supplied to the compartments, means are provided to control the flow of fluid in the return line 27. For example, a valve or other control device can be utilized, or the pump can be configured to pump ink at a desired constant flow rate through the supply line.

[0015] As will be understood, the ink level in each compartment 20 may be maintained constant and therefore the static pressure at the inlet of each printhead, which is determined by the height (H) of the feed line above the ink level in its associated compartment, is the same for each printhead. The printhead 12, and preferably the entire set of orifices for each printhead 12, are disposed above the ink level in the associated compartment 20 to provide a negative pressure in feed lines 19, which combines with the capillary forces therein to yield the proper pressure at the inlet port 18 which is in immediate proximity to the orifices 14.

[0016] To lower gas vapor pressure and reduce dissolved air in the ink, a degassing device is provided, such as a membrane over the reservoir or a partial vacuum above the ink in each container. Alternatively, all of the containers 20A-20D can be placed in a single vacuum chamber 30 as shown in FIG. 4. As illustrated, the containers 20 are stacked within the chamber 30 and have a single port 32 for creating a low negative pressure to reduce dissolved air in the ink. As shown, the containers 20 can also be stacked so that the flow out of adjacent containers is in opposite directions, thereby allowing the containers to approach vertical alignment to conserve space. A control means 34 is provided to ensure that an adequate amount of liquid is supplied to the containers 20A-20D from the reservoir 24.

[0017] Also, an adjustment mechanism can be provided to adjust the heights of the printheads 12A-12D, and therefore the sets of orifices 14, relative to the level of the ink in the compartments 20A-D. This type of adjustment mechanism is known in the art and could be configured for adjustment of the printing head 12 as a unit. The adjustment mechanism could also be configured to independently adjust the height of the printheads 12A-12B, provided they are not integrally joined together.

[0018] Similarly, a moving mechanism can be provided to adjust the heights of the compartments 20A-20D, and thus the height of the ink in each compartment, relative to the heights of the printheads 12A-12D and their associated sets of orifices 14. If the compartments 20 are joined together as a staggered unit, the moving mechanism can be configured to adjust the height of the entire assembly. Alternatively, the moving mechanism

can be configured to independently adjust the height of the compartments 20. This individual adjustment can be provided by a moving mechanism such as the device disclosed in U.S. patent application Ser. No. 08/728,866, filed October 10, 1996.

[0019] It will be appreciated that more than one return line can be used to individually feed each container rather than supplying the top container 20A. Also, various other devices can be utilized to control the drainage of ink from each container, such as valves, siphons, or the like.

[0020] While the invention is depicted in schematic form, it is within the skill of those in the art to enclose the wiers in individual cartridges or as part of a single elongated container, thereby obtaining a compact ink system for an ink jet printer. It is within the scope of the present invention to monitor the flow of ink supplied by the pump and the flow to each printhead so that each weir is maintained full to assure proper static pressure at the multiplicity of printheads.

[0021] Thus, an ink jet fluid distribution system is provided which may be easily and inexpensively constructed and which provides proper and dependable control of the static pressure of ink delivered to each printhead in a stacked arrangement.

Claims

1. A system for supplying liquid to a composite printing head having at least two vertically disposed sets of orifices (14), comprising: a liquid compartment (20A-D) for each of said sets of orifices (14) for communicating liquid thereto, each said compartment being configured to maintain the level of liquid therein at a desired fill height and to permit excess liquid to spill from said compartment over an edge thereof, said compartments (20A-D) being positioned relative to each other to cause liquid to spill from a compartment to the next lower compartment; and a reservoir (24) for receiving liquid spillage from the lowest one of the compartments and supplying liquid to the uppermost one of the compartments.
2. A system as claimed in claim 1, wherein the desired fill height of each compartment (20A-D) is at a lower elevation than an inlet port (18) to its respective set of orifices (14) to define a static height difference creating a negative pressure acting on the liquid in the inlet port (18).
3. A system as claimed in claim 1 or 2, wherein the desired fill height of each compartment (20A-D) is lower than a lowermost orifice of its respective set of orifices (14) thereby maintaining a desired negative pressure to each orifice in the set of orifices.
4. A system as claimed in claim 2 or 3, wherein the static height difference defined in respect of each compartment (20A-D) is substantially the same so that the negative pressure acting on the liquid in the inlet port (18) to each set of orifices (14) is approximately the same.
5. A system as claimed in any one of the preceding claims further comprising a single supply line (27) for supplying liquid from the reservoir (24) to the uppermost compartment (20A).
6. A system as claimed in any one of the preceding claims, wherein each compartment (20A-D) is configured with an outlet opening (22A-D) adapted to allow liquid to drain therefrom to maintain said desired fill height and to direct the liquid into the next lower compartment, or, in the case of the lowest compartment, into the reservoir (24).
7. A system as claimed in any one of the preceding claims, wherein the flow of liquid out of a compartment is directed in an opposite direction to the flow of liquid out of the next lower compartment, thereby allowing a generally vertical stacking arrangement of the compartments (20A-D) and reservoir (24).
8. A system as claimed in any one of the preceding claims further comprising control means configured to ensure that an adequate amount of liquid is supplied to the compartments (20A - 20D) from the reservoir (24).
9. A system as claimed in any one of the preceding claims further comprising a pump (26) for delivering the liquid from the reservoir (24) to the uppermost compartment (20A).
10. A system as claimed in any one of the preceding claims wherein each compartment (20A-D) is configured to hold substantially the same volume of liquid.
11. A system as claimed in any one of the preceding claims further comprising a device for creating a partial vacuum above the liquid in each compartment to lower the gas vapour pressure in the compartment.
12. A system as claimed in any one of the preceding claims further comprising an adjustment mechanism for adjusting the height of the compartments (20A-D) to further control the elevation of liquid therein.
13. A system as claimed in any one of the preceding claims wherein each said set of orifices (14) is formed in a respective component printhead of the composite printing head.

14. A system as claimed in any one of the preceding claims wherein each said compartment (20A-D) includes a weir (22A-D) to maintain the level of liquid therein at said desired fill height and to permit said excess liquid to spill from said compartment over an edge thereof.

Patentansprüche

1. System zur Lieferung von Flüssigkeit an einen zusammengesetzten Druckkopf mit zumindest zwei vertikal angeordneten Sätzen von Öffnungen (14) mit: einem Flüssigkeitsfach (20 A-D) für jeden der Sätze an Öffnungen (14) zur Übertragung von Flüssigkeit an diese, wobei jedes der Fächer derart ausgebildet ist, um das Flüssigkeitsniveau darin auf einer gewünschten Füllhöhe beizubehalten und zu ermöglichen, daß überschüssige Flüssigkeit von dem Fach über einen Rand desselben überlaufen kann, wobei die Fächer (20 A-D) relativ zueinander so positioniert sind, um zu bewirken, daß Flüssigkeit von einem Fach zu dem nächstniedrigeren Fach überlaufen kann; und einem Reservoir (24) zur Aufnahme von Flüssigkeitsüberlauf von dem untersten der Fächer und zur Lieferung von Flüssigkeit an das oberste der Fächer.
2. System nach Anspruch 1, wobei sich die gewünschte Füllhöhe jedes Faches (20 A-D) bei einer geringeren Höhe als ein Einlaßkanal (18) zu seinem jeweiligen Satz von Öffnungen (14) befindet, um eine statische Höhendifferenz zu definieren, die einen negativen Druck erzeugt, der auf die Flüssigkeit in dem Einlaßkanal (18) wirkt.
3. System nach einem der Ansprüche 1 oder 2, wobei die gewünschte Füllhöhe jedes Faches (20 A-D) niedriger als eine unterste Öffnung ihres jeweiligen Satzes von Öffnungen (14) ist, wodurch ein gewünschter negativer Druck an jeder Öffnung in dem Satz von Öffnungen beibehalten wird.
4. System nach einem der Ansprüche 2 oder 3, wobei die statische Höhendifferenz, die bezüglich jedes Faches (20 A-D) definiert ist, im wesentlichen gleich ist, so daß der negative Druck, der auf die Flüssigkeit wirkt, in dem Einlaßkanal (18) zu jedem Satz von Öffnungen (14) annähernd gleich ist.
5. System nach einem der vorhergehenden Ansprüche, ferner mit einer einzelnen Versorgungsleitung (27) zur Lieferung von Flüssigkeit von einem Reservoir (24) an das oberste Fach (20A).
6. System nach einem der vorhergehenden Ansprüche, wobei jedes Fach (20 A-D) mit einer Auslaßöffnung (22 A-D) ausgebildet ist, die derart

ausgebildet ist, um zu ermöglichen, daß Flüssigkeit davon ablaufen kann, um die gewünschte Füllhöhe beizubehalten und die Flüssigkeit in das nächstniedrigere Fach oder in dem Fall des untersten Faches in das Reservoir (24) zu leiten.

7. System nach einem der vorhergehenden Ansprüche, wobei die Strömung von Flüssigkeit aus einem Fach in einer entgegengesetzten Richtung zu der Strömung von Flüssigkeit aus dem nächstniedrigeren Fach gerichtet ist, wodurch eine allgemein vertikale Stapelanordnung der Fächer (20 A-D) und des Reservoirs (24) ermöglicht wird.
8. System nach einem der vorhergehenden Ansprüche, ferner mit einem Steuermittel, daß derart ausgebildet ist, um sicherzustellen, daß eine angemessene Menge an Flüssigkeit von dem Reservoir (24) an die Fächer (20A - 20D) geliefert wird.
9. System nach einem der vorhergehenden Ansprüche, ferner mit einer Pumpe (26) zur Lieferung der Flüssigkeit von dem Reservoir (24) an das oberste Fach (20A).
10. System nach einem der vorhergehenden Ansprüche, wobei jedes Fach (20 A-D) derart ausgebildet ist, um im wesentlichen das gleiche Volumen an Flüssigkeit zu halten.
11. System nach einem der vorhergehenden Ansprüche, ferner mit einer Vorrichtung zur Erzeugung eines Teilvakuums über der Flüssigkeit in jedem Fach, um den Gasdampfdruck in dem Fach zu verringern.
12. System nach einem der vorhergehenden Ansprüche, ferner mit einem Einstellmechanismus zur Einstellung der Höhe der Fächer (20 A-D), um die Höhe der Flüssigkeit darin weiter steuern zu können.
13. System nach einem der vorhergehenden Ansprüche, wobei jeder der Sätze von Öffnungen (14) in einem jeweiligen Komponentendruckkopf des zusammengesetzten Druckkopfes ausgebildet ist.
14. System nach einem der vorhergehenden Ansprüche, wobei jedes der Fächer (20 A-D) ein Überlaufwehr (22 A-D) umfaßt, um das Niveau der Flüssigkeit darin bei der gewünschten Füllhöhe beizubehalten und zu ermöglichen, daß die überschüssige Flüssigkeit von dem Fach über einen Rand desselben überlaufen kann.

Revendications

1. Système destiné à délivrer du liquide à une tête

d'impression composite ayant au moins deux ensembles d'orifices disposés verticalement (14), comportant : un compartiment de liquide (20A à D) pour chacun desdits ensembles d'orifices (14) afin d'y communiquer du liquide, chaque dit compartiment étant configuré afin de maintenir le niveau de liquide à une hauteur de remplissage souhaitée et afin de permettre à du liquide en excès de déborder dudit compartiment au-dessus d'un bord de celui-ci, lesdits compartiments (20A à D) étant positionnés l'un par rapport à l'autre afin d'amener du liquide à déborder depuis un compartiment vers le compartiment inférieur suivant; et un réservoir (24) destiné à recevoir le débordement de liquide depuis le plus bas des compartiments et à délivrer le liquide au plus haut des compartiments.

2. Système selon la revendication 1, dans lequel la hauteur de remplissage souhaitée de chaque compartiment (20A à D) est à une hauteur plus basse qu'un orifice d'entrée (18) vers son ensemble respectif d'orifices (14) afin de définir une différence de hauteur statique qui crée une dépression qui agit sur le liquide dans l'orifice d'entrée (18).

3. Système selon la revendication 1 ou 2, dans lequel la hauteur de remplissage souhaitée de chaque compartiment (20A à 20D) est inférieure à un orifice le plus bas de son ensemble respectif d'orifices (14) en maintenant ainsi une dépression souhaitée sur chaque orifice dans l'ensemble d'orifices.

4. Système selon la revendication 2 ou 3, dans lequel la différence de hauteur statique définie par rapport à chaque compartiment (20A à D) est sensiblement la même de telle sorte que la dépression agissant sur le liquide dans l'orifice d'entrée (18) pour chaque ensemble d'orifices (14) est approximativement la même.

5. Système selon l'une quelconque des revendications précédentes, comportant en outre une unique ligne d'alimentation (27) destinée à délivrer du liquide depuis le réservoir (24) jusqu'au compartiment le plus haut (20A).

6. Système selon l'une quelconque des revendications précédentes, dans lequel chaque compartiment (20A à D) est configuré avec une ouverture de sortie (22A à D) prévue pour permettre à du liquide de s'évacuer afin de maintenir ladite hauteur de remplissage souhaitée et afin de diriger le liquide dans le compartiment plus bas suivant, ou dans le cas du compartiment le plus bas, dans le réservoir (24).

7. Système selon l'une quelconque des revendications précédentes, dans lequel l'écoulement de li-

quide hors d'un compartiment est dirigé dans une direction opposée à l'écoulement de liquide hors du compartiment inférieur suivant, permettant ainsi un agencement d'empilage globalement vertical des compartiments (20A à D) et du réservoir (24).

8. Système selon l'une quelconque des revendications précédentes, comportant en outre des moyens de commande configurés afin de s'assurer qu'une quantité correcte de liquide est délivrée aux compartiments (20A à D) depuis le réservoir (24).

9. Système selon l'une quelconque des revendications précédentes, comportant en outre une pompe (26) destinée à délivrer le liquide du réservoir (24) au compartiment le plus haut (20A).

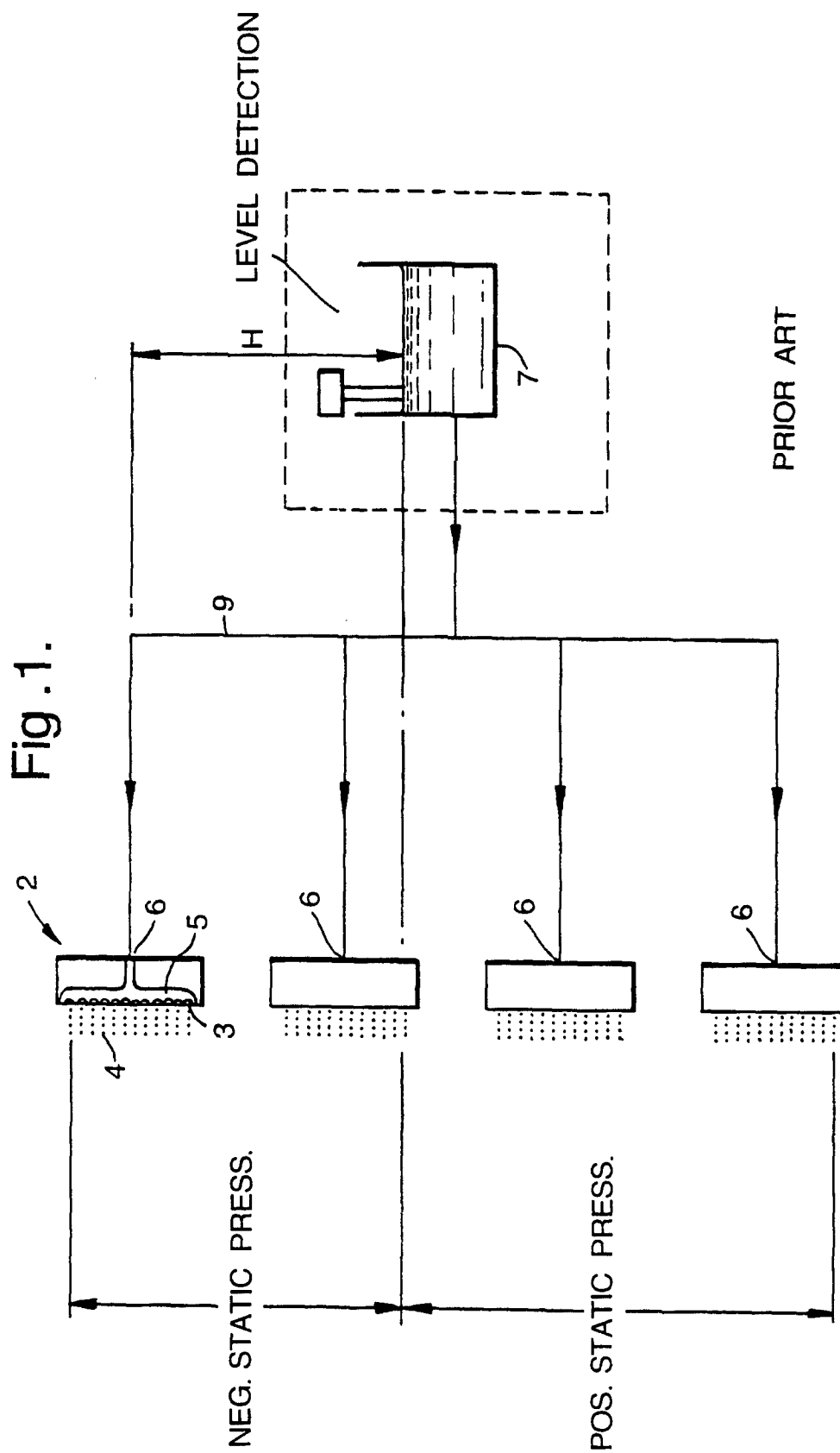
10. Système selon l'une quelconque des revendications précédentes, dans lequel chaque compartiment (20A à D) est configuré afin de maintenir sensiblement le même volume de liquide.

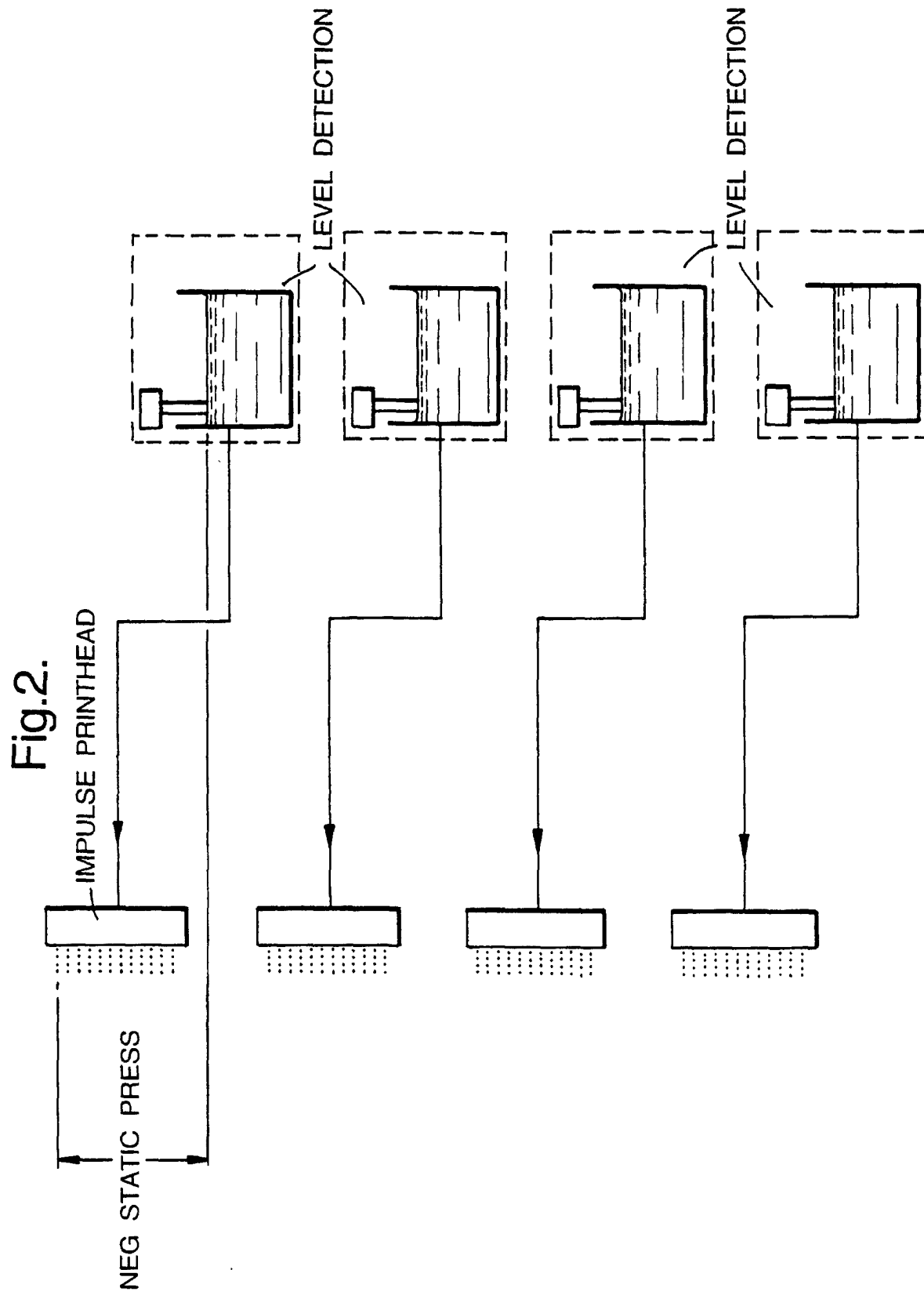
11. Système selon l'une quelconque des revendications précédentes, comportant en outre un dispositif destiné à créer un vide partiel au-dessus du liquide dans chaque compartiment afin d'abaisser la pression de vapeur de gaz dans le compartiment.

12. Système selon l'une quelconque des revendications précédentes, comportant en outre un mécanisme de réglage destiné à ajuster la hauteur des compartiments (20A à D) afin de commander encore la hauteur de liquide à l'intérieur.

13. Système selon l'une quelconque des revendications précédentes, dans lequel chaque dit ensemble d'orifices (14) est formé dans une tête d'impression de composant respective de la tête d'impression composite.

14. Système selon l'une quelconque des revendications précédentes, dans lequel chaque dit compartiment (20A à D) comprend un barrage (22A à D) destiné à maintenir le niveau de liquide à ladite hauteur de remplissage souhaitée et à permettre au dit liquide en excès de déborder dudit compartiment par-dessus un bord de celui-ci.





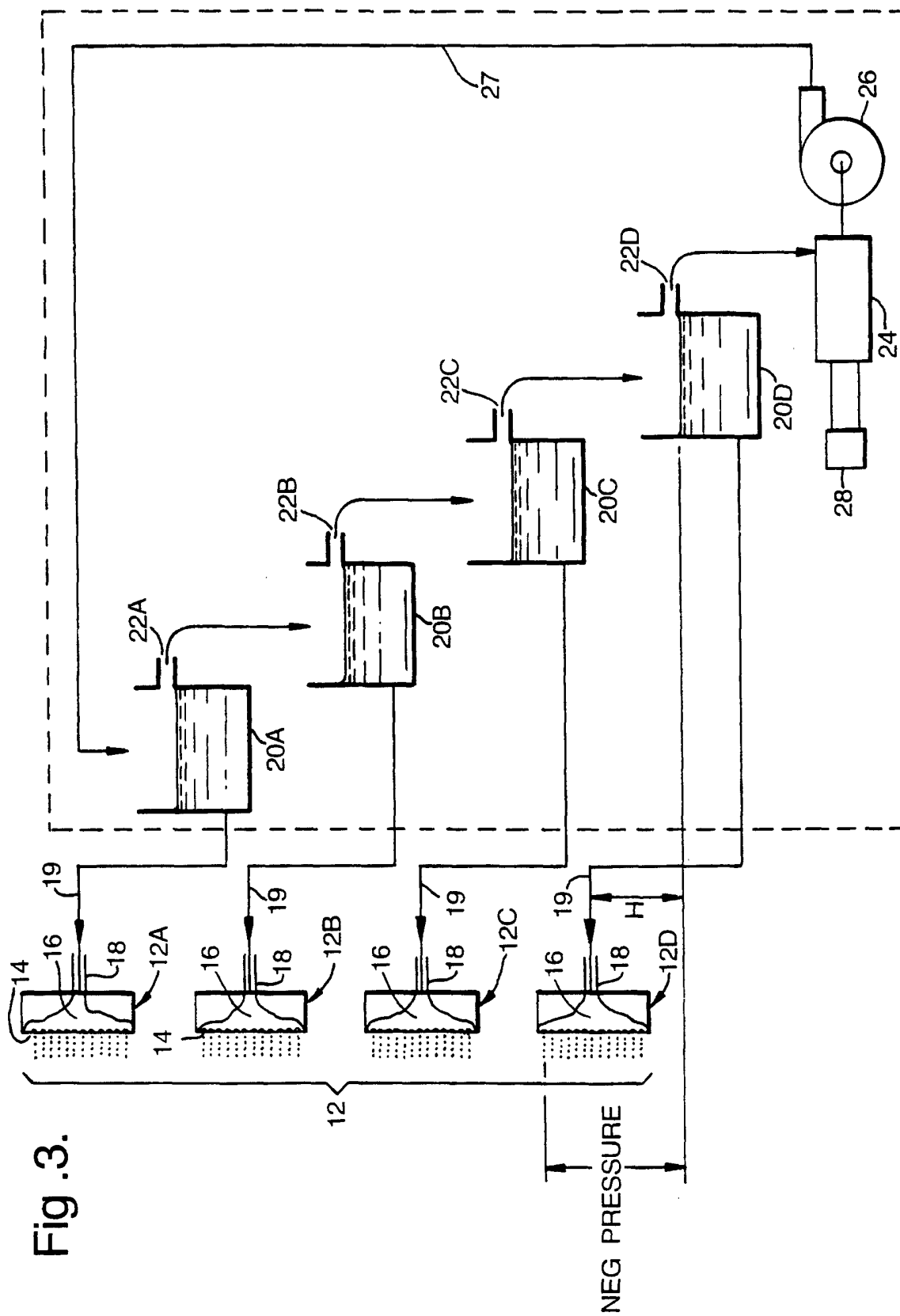


Fig.4.

