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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,255,019**
(86) 1997/05/22
(87) 1997/11/27

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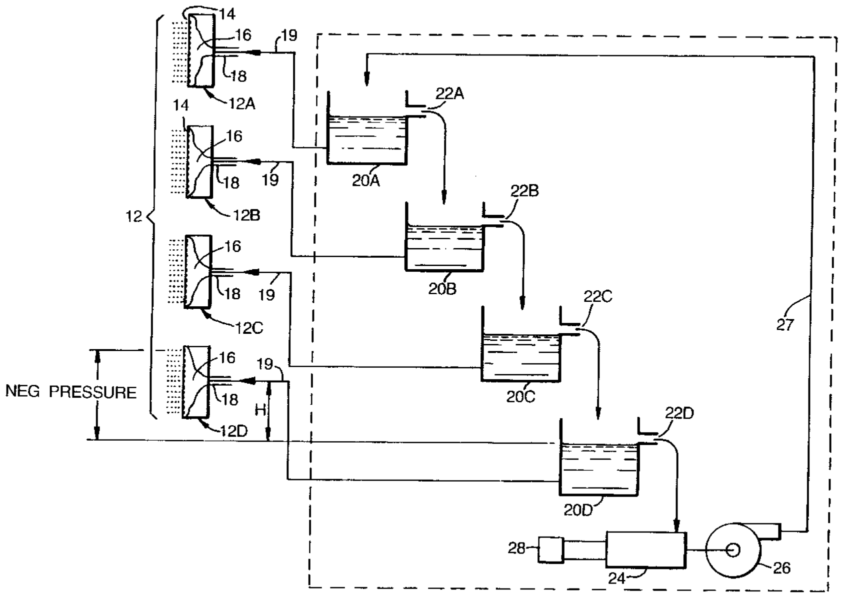
(51) Int.Cl.^{6} B41J 2/175
(30) 1996/05/22 (60/018,109) US
(30) 1997/05/12 (08/854,487) US

(54) **MODULES DE TETE D'IMPRIMANTE A JET D'ENCRE AVEC ALIMENTATION EN ENCRE COMMUNE**

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



(57) Un système permettant d'amener l'encre à une tête d'impression composite (12) comporte un premier compartiment (20A) en communication fluidique avec une première série d'orifices (14, 12A), et un second compartiment (20B) en communication fluidique avec une seconde série d'orifices (14, 12B). Le premier et le second compartiment (20A, 20B) sont configurés de façon à permettre une sortie d'encre qui maintienne le niveau d'encre dans lesdits compartiments à un niveau de remplissage désiré. Un réservoir (24) permet de fournir l'encre au premier et au second compartiment (20A, 20B).

(57) A system for supplying ink to a composite printing head (12) has a first compartment (20A) in fluid flow communication with a first set of orifices (14, 12A), and a second compartment (20B) in fluid flow communication with a second set of orifices (14, 12B). The first and second compartments (20A, 20B) are configured to allow the egress of ink to maintain the level of ink therein at a desired fill height. A reservoir (24) is also provided for supplying ink to the first and second compartments (20A, 20B).

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B41J 2/175

A1

(11) International Publication Number: WO 97/44194

(43) International Publication Date: 27 November 1997 (27.11.97)

(21) International Application Number: PCT/GB97/01405

(22) International Filing Date: 22 May 1997 (22.05.97)

(30) Priority Data:

60/018,109	22 May 1996 (22.05.96)	US
08/854,487	12 May 1997 (12.05.97)	US

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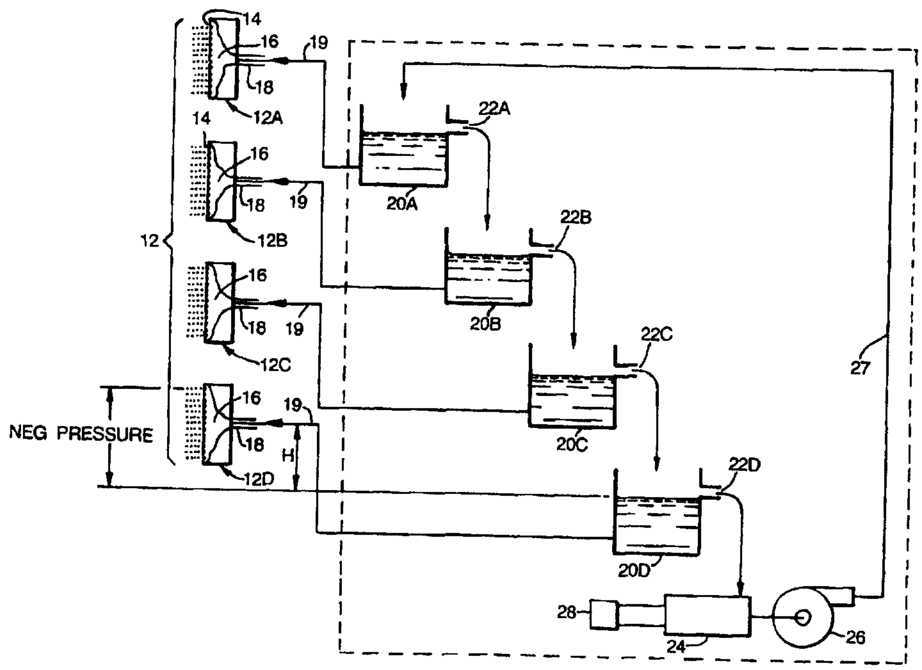
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: INK JET PRINT HEAD MODULES WITH COMMON INK SUPPLY



(57) Abstract

A system for supplying ink to a composite printing head (12) has a first compartment (20A) in fluid flow communication with a first set of orifices (14, 12A), and a second compartment (20B) in fluid flow communication with a second set of orifices (14, 12B). The first and second compartments (20A, 20B) are configured to allow the egress of ink to maintain the level of ink therein at a desired fill height. A reservoir (24) is also provided for supplying ink to the first and second compartments (20A, 20B).

INK JET PRINT HEAD MODULES WITH COMMON INK SUPPLY

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.

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.

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, wetability 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. 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.

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.

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.

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.

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.

The present invention provides significant advantages 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.

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.

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.

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.

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.

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 compartment 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.

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.

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-20B 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.

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.

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.

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.

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.

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

AMENDED SHEET

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.

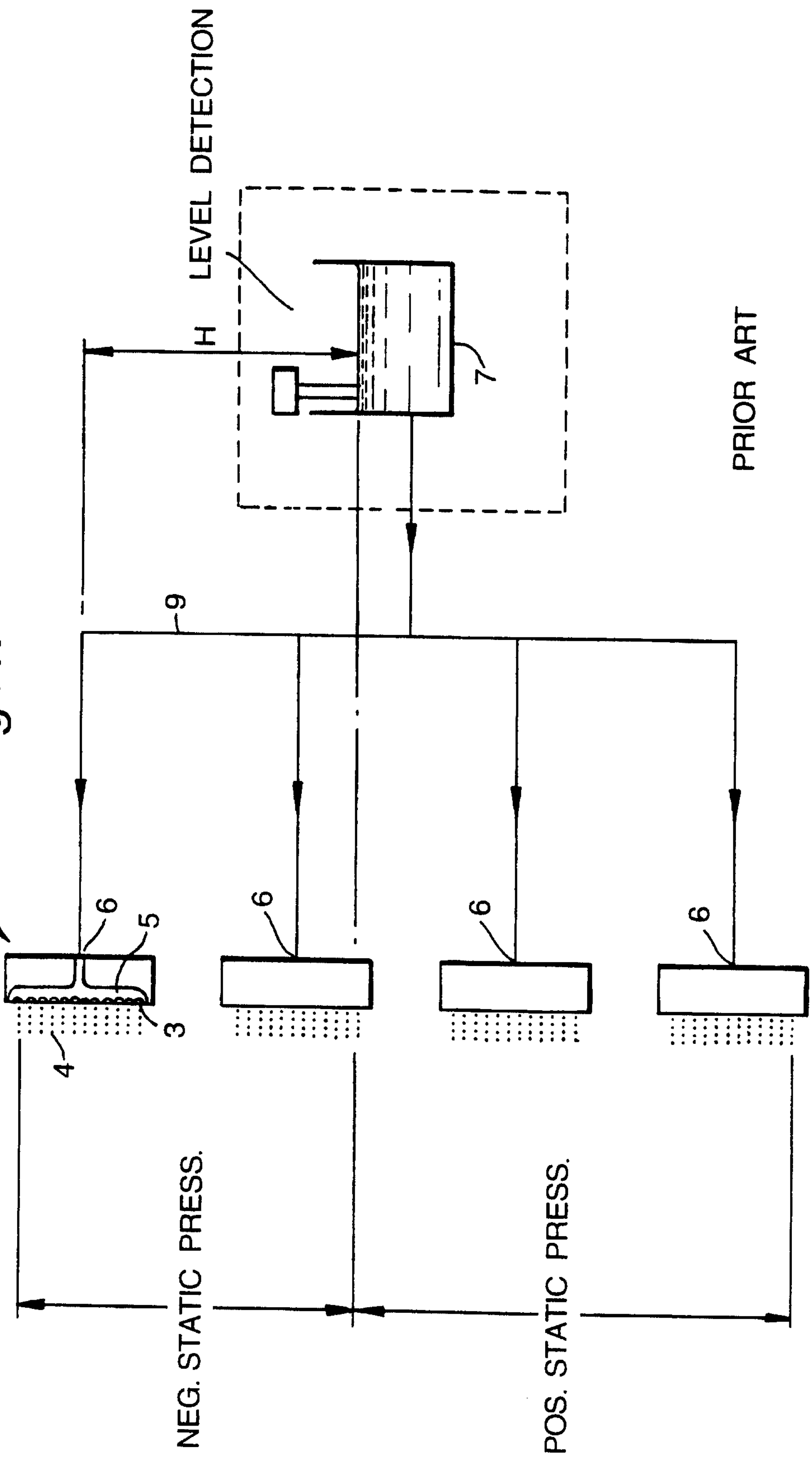
11. A system as claimed in any one of the preceding claims further comprising a device for creating a partial vacuum above the liquid in each compartment to lower the gas vapour pressure in the compartment.

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.

Fig. 1.


LEVEL DETECTION
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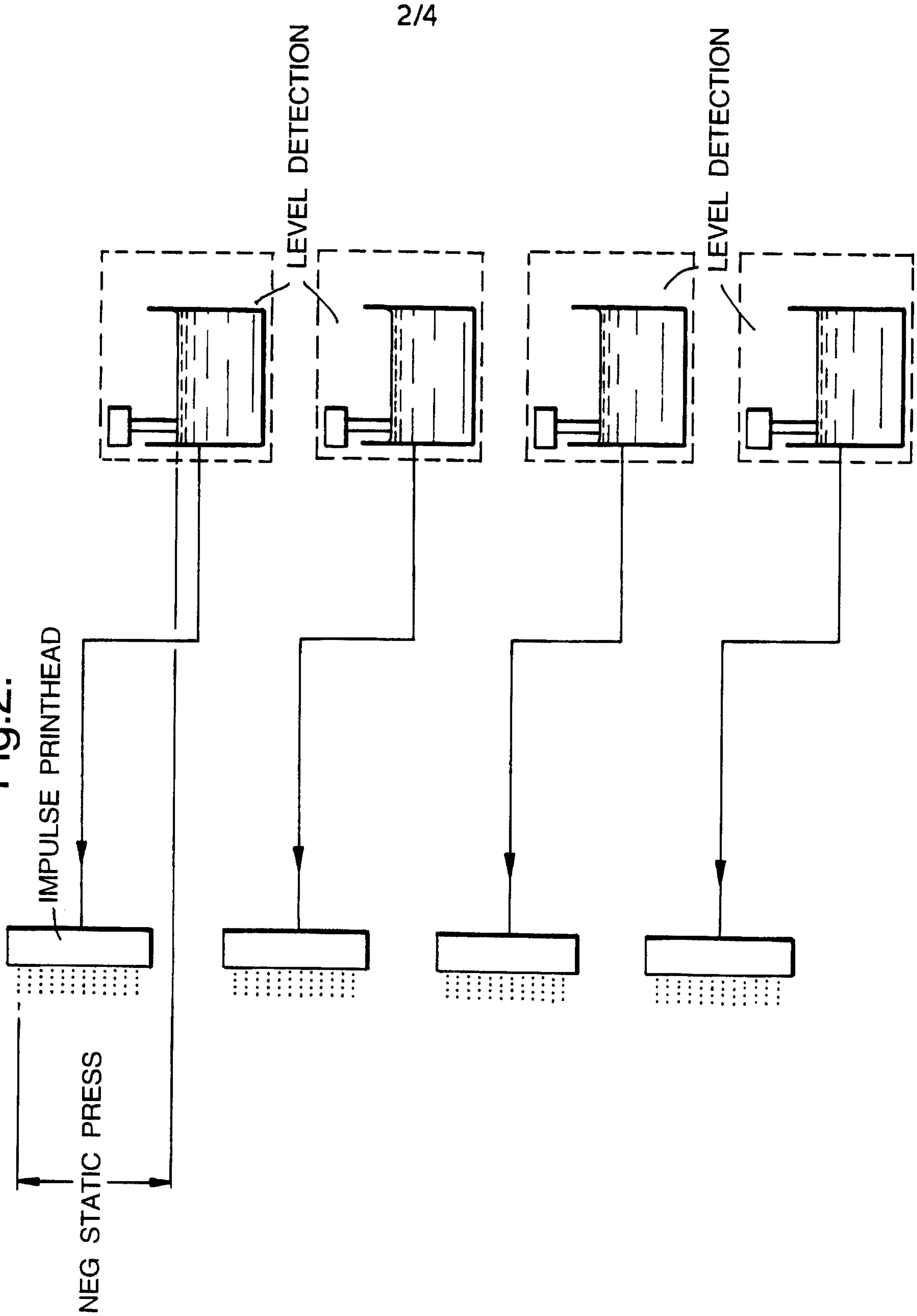
PRIOR ART

Fig.2.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LEVEL DETECTION
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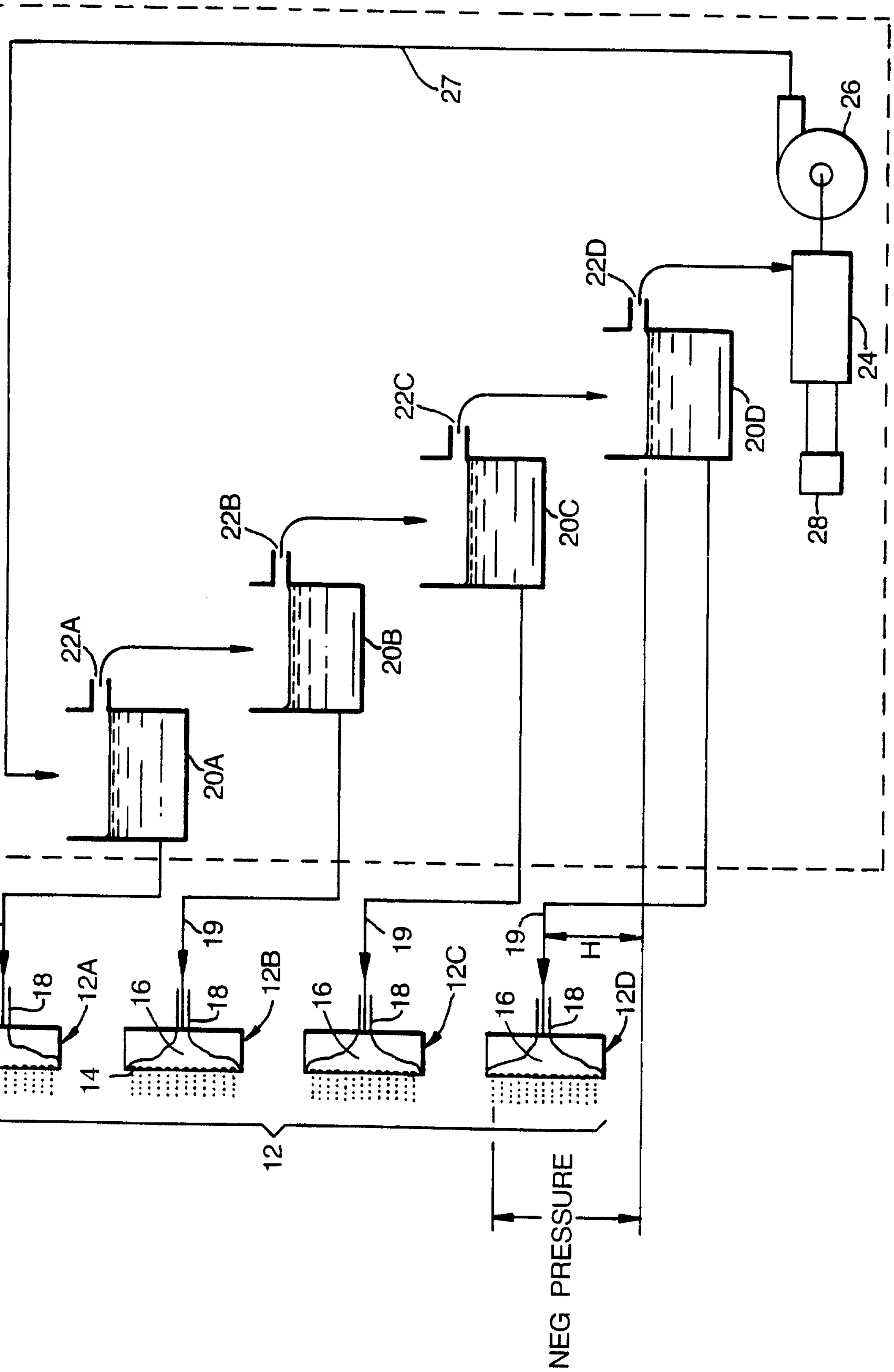
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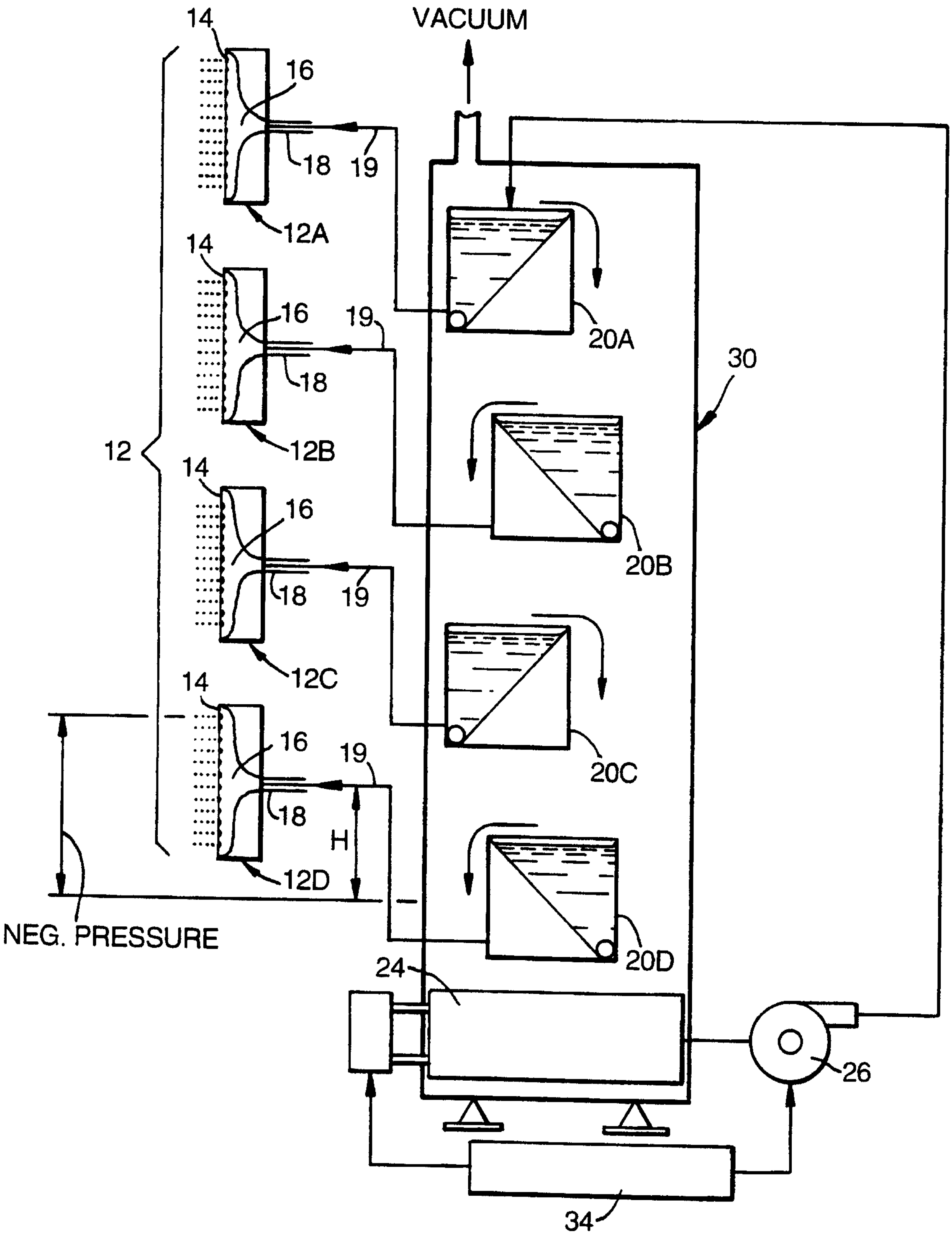
NEG PRESSURE

Fig.3.

Fig.4.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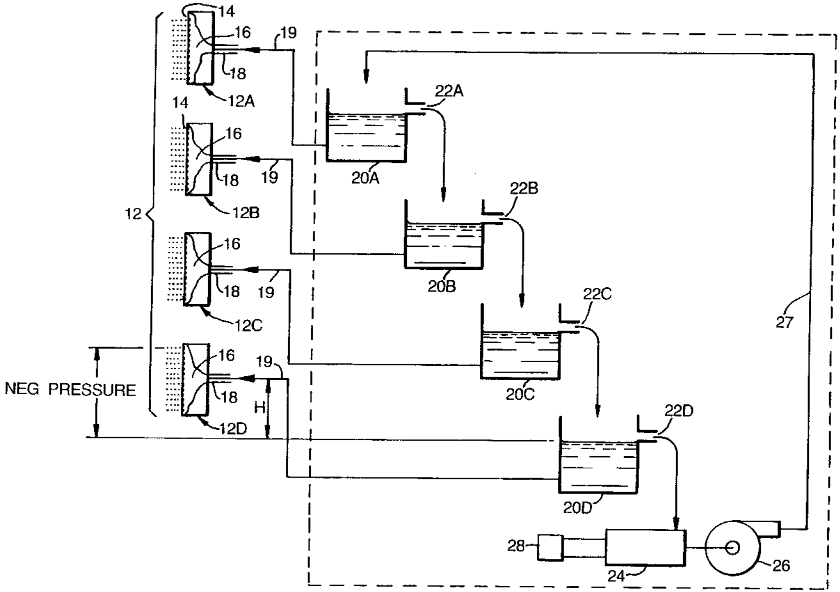

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