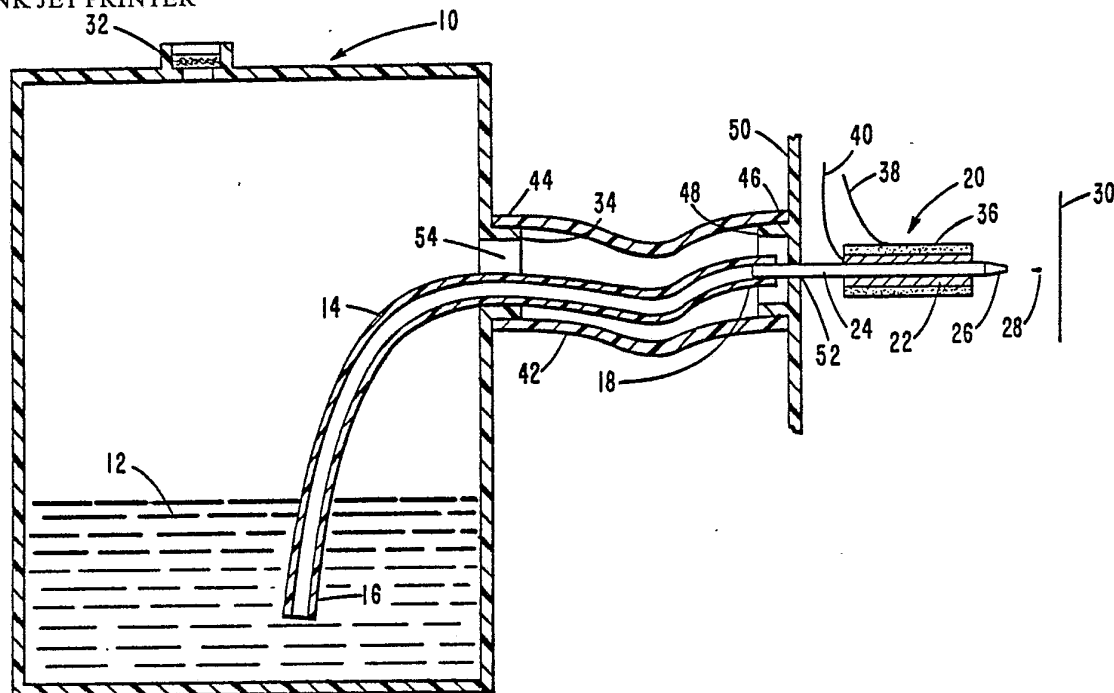




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification³ : B41J 3/04</p>	<p>A1</p>	<p>(11) International Publication Number: WO 83/04389 (43) International Publication Date: 22 December 1983 (22.12.83)</p>
<p>(21) International Application Number: PCT/US83/00867 (22) International Filing Date: 31 May 1983 (31.05.83) (31) Priority Application Number: 385,956 (32) Priority Date: 7 June 1982 (07.06.82) (33) Priority Country: US (71) Applicant: NCR CORPORATION [US/US]; World Headquarters, Dayton, OH 45479 (US). (72) Inventors: THOMAS, Jacob, Earl ; 101 Park Lane, Ithaca, NY 14850 (US). McKNIGHT, James, Kim ; 5211 Voorheis Road, Trumansburg, NY 14886 (US). (74) Agents: HAWK, Wilbert, Jr. et al.; Patent Division, NCR Corporation, World Headquarters, Dayton, OH 45479 (US).</p>		<p>(81) Designated States: DE (European patent), FR (European patent), GB (European patent), JP. Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: INK JET PRINTER



(57) Abstract

An ink jet printer in which an ink-carrying conduit (14) connected between an ink reservoir (10) and a print head (20) is placed within an enclosure (42) for a portion of its length and which enclosure (42) is an extension of the reservoir (10) in large tubular form to contain the conduit (14) in an ink vapor atmosphere. An advantage of this arrangement is that the ink vapor atmosphere in the enclosure (42) prevents or at least limits the flow of one or more ingredients of printing ink through the wall of conduit (14) and thereby maintains the composition of the printing ink in a substantially constant condition.

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INK JET PRINTERTechnical Field

The present invention relates to ink jet printers, and, more particularly, to ink jet printers which utilize the so-called drop-on-demand method of operation.

Background Art

Non-impact printers have recently become very popular due to their quiet operation resulting from the absence of mechanical printing elements impacting on record media during printing. Among such printers, ink jet printers are particularly important as they permit high speed recording on plain untreated paper.

Various ink jet printing methods have been developed over the past years. In the so-called continuous ink jet method, such as disclosed in U.S. Patent No. 3,596,275, the ink is delivered under pressure to nozzles in a print head to produce a continuous jet of ink emitted through each nozzle. The ink jet is separated by vibration into a stream of droplets which are charged, and the flying droplets are either allowed to impact on a record medium or are electrostatically deflected for collection in a gutter for subsequent recirculation.

A second method, known as the electrostatic method, is disclosed, for example, in U.S. Patent No. 3,060,429. In this method the ink in the nozzles is under zero pressure or low positive pressure, and the droplets are generated by electrostatic pull and caused to fly between two pairs of deflecting electrodes arranged to control the direction of flight of the droplets and their deposition in desired positions on the record medium.

A third method, which is known as the drop-on-demand method, is described, for example, in U.S. Patent



-2-

No. 4,125,845. The droplets in this method are emitted under the control of an electronic character generator by means of volume displacement brought about in an ink chamber or channel by means of energization of a piezo-electric element. The volume displacement generates a pressure wave which propagates to the nozzles causing the ejection of ink droplets.

The drop-on-demand method has several advantages over the other above-mentioned methods. Ink jet printers using this method have a simpler structure requiring neither deflecting means for controlling the flight of the droplets nor the provision of an ink recovery system. Multiple print head printers using this method are simple and compact and are relatively easy to manufacture.

Ink jet printers are known in which the print head is connected to an ink reservoir by a flexible conduit carrying ink from the reservoir to the print head. A problem arising with ink jet printers of this type is that the solvents for the ink have the tendency to evaporate or slowly permeate through the wall of the ink carrying conduit. In particular, it has been found that in the case of printing inks which consist primarily of water and ethylene glycol, the water tends to penetrate through polyvinyl chloride tubing commonly used in practice. Such solvent loss is undesirable as it has the effect of changing the condition of the printing ink, particularly when the printer has been sitting idle for an extended period of time, and such change may adversely affect the operation of the printer.

Disclosure of Invention

It is an object of the present invention to provide an ink jet printer having means for preventing or at least limiting the flow of one or more ingredients of printing ink through the wall of an ink-carrying conduit, thereby maintaining the composition of the.



printing ink in a substantially constant condition in the printing system.

Thus, according to the invention, there is provided an ink jet printer including reservoir means for containing a supply of ink, printing means operably associated with said reservoir means for ejecting ink in droplet form, and flexible conduit means for carrying ink from said reservoir means to said printing means, characterized by enclosure means in fluid connection with said reservoir means for providing an ink vapor atmosphere for said conduit means between said reservoir means and said printing means, which atmosphere substantially corresponds with the ink vapor atmosphere in said reservoir means.

15 Brief Description of the Drawing

One embodiment of the present invention will now be described, by way of example, with reference to the single figure of the accompanying drawing which is a diagrammatic view, partly in section, of an ink jet printer according to the present invention.

Best Mode for Carrying Out the Invention

As seen in the single figure of the drawing, an ink reservoir 10 contains a supply of printing ink 12 which is sufficient for printing in excess of several million characters. A length of flexible tubing 14, having a fairly constant wall thickness, is immersed at one end 16 thereof in the ink 12 and is securely connected at the other end 18 to an ink jet print head 20 of the well-known tubular transducer type. The print head 20 includes a body portion 22 of cylindrical form having a glass tube 24 or passageway through the body portion and terminating in a nozzle 26 for ejecting a droplet 28 of printing ink to be applied to record media 30, which media may be in the form of paper or the like and supported in suitable manner around a drum or from



a platen (not shown). A filter-type vent 32 is provided in the top of the reservoir 10 and a flange-type outlet 34 is formed in one side thereof and through which passes the flexible tube 14.

5 The print head 20 includes a piezoelectric device or tubular type transducer 36 for causing ejection of the ink droplets 28, either in synchronous or asynchronous manner from the print head nozzle 26. The ink droplets 28, so produced from the nozzle 26, are of
10 essentially the same or constant in size and are normally ejected at a constant velocity. Leads 38 and 40 are appropriately connected to the print head 20 for actuating the transducer 36 so as to cause ejection of ink droplets 28 in well-known manner.

15 A large diameter flexible tube 42 is securely connected at one end 44 thereof to the flange-type outlet 34 and at the other end 46 to a flange portion 48 of a print head supporting wall member 50. The wall member 50 includes an aperture 52 therethrough for
20 appropriately sealing and supporting the glass tube 24.

 The tubing 14, which may be made of a polyvinyl chloride material, one of which is known by the name TYGON and manufactured by Norton Chemical Company, is of a small diameter or bore for carrying the printing
25 ink 12 from the reservoir 10 to the print head 20. The tube 42 is of much larger diameter and may be made of similar flexible plastic material. The dimensions of the outlet 34 and of the tube 42 provide a space 54 between the two tubes which is an extension of the ink vapor-
30 filled atmosphere in the reservoir 10.

 A common formulation or mixture for printing inks includes approximately 85 percent ethylene glycol and 15 percent water along with a coloring dye. Since it has been found that water slowly permeates through
35 the wall of the tubing 14 with a rate which depends on the humidity outside such tubing, the printing ink, which is made up of a significant percentage of water,



slowly changes composition. When the tube 42 is properly sized to provide the space 54, the entire length of the tube 14 is essentially within the ink vapor of the atmosphere of the reservoir 10. It is seen that any water which passes through the wall of the tube 14, by reason of being in substantially the same atmosphere as that of the reservoir 10, may permeate in either direction through the wall of the tube, that the same atmosphere substantially minimizes the flow of water through the wall of tube 14, or that such atmosphere may essentially end any flow of water and thereby maintain the same ink composition throughout the printing system. While there may be a slight amount of evaporation of water from the entire system, including the permeation of water through the walls of the reservoir 10 and the wall of the tube 42, the rate of change of the composition of the ink is negligibly small.



CLAIMS:

1. An ink jet printer including reservoir means (10) for containing a supply of ink (12), printing means (20) operably associated with said reservoir means (10) for ejecting ink in droplet form, and flexible
5 conduit means (14) for carrying ink from said reservoir means (10) to said printing means (20), characterized by enclosure means (42) in fluid connection with said reservoir means (10) for providing an ink vapor atmosphere for said conduit means (14) between said reservoir
10 means (10) and said printing means (20), which atmosphere substantially corresponds with the ink vapor atmosphere in said reservoir means (10).

2. An ink jet printer according to claim 1, characterized in that said enclosure means (42) is a flexible member surrounding a portion of said conduit means (14) and providing a space therearound.

3. An ink jet printer according to claim 1, characterized in that said conduit means (14) is a first tube having a predetermined diameter, and that said enclosure means (42) is a second tube having a
5 diameter which is larger than said predetermined diameter and surrounding a portion of said first tube so as to provide a space therearound.

4. An ink jet printer according to claim 1, characterized in that said printing means (20) includes one or more piezoelectric transducers (36) carried by a support member (50).

5. An ink jet printer according to claim 4, characterized in that one end (44) of said enclosure means (42) is connected to a flanged outlet (34) of said reservoir means (10), and the other end (46) of said
5 enclosure means (42) is connected to a flanged portion

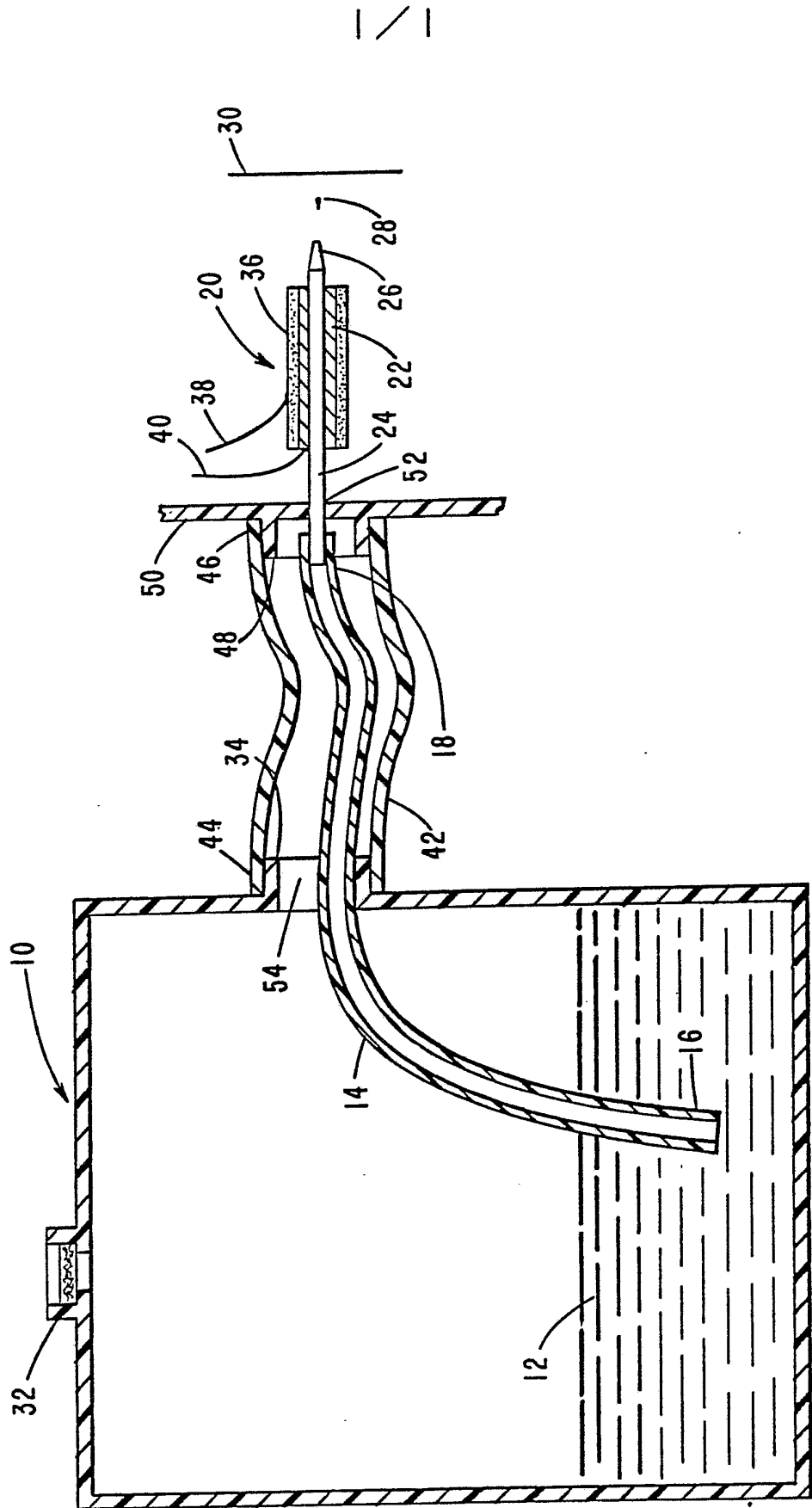


5. (concluded)
(48) of said support member (50).

6. An ink jet printer according to claim 1, characterized in that said conduit means (14) and said enclosure means (42) are made of polyvinyl chloride material.

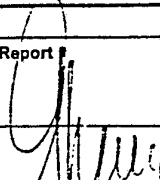
7. An ink jet printer according to claim 1, characterized in that said enclosure means (42) is formed as a tubular extension of said reservoir means (10) over said conduit means (14).





INTERNATIONAL SEARCH REPORT

International Application No PCT/US 83/00867

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³				
According to International Patent Classification (IPC) or to both National Classification and IPC				
IPC ³ : B 41 J 3/04				
II. FIELDS SEARCHED				
Minimum Documentation Searched ⁴				
Classification System	Classification Symbols			
IPC ³	B 41 J; B 43 K; G 01 D			
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵				
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴				
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸		
X	IBM-Technical Disclosure Bulletin, vol. 15, no. 7, December 1972 (New York, US) Stroms: "Compound hydraulic line", page 2152, see the entire document -----	1,2,3,5, 7		
A	US, A, 4329698 (SMITH) 11 May 1982 see column 3, line 45; column 3, lines 11-13; figures 2,3 -----	4		
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> <p>¹⁵ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width: 50%; border: none; vertical-align: top;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p> </td> </tr> </table>			<p>¹⁵ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p>
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IV. CERTIFICATION				
Date of the Actual Completion of the International Search ¹⁹	Date of Mailing of this International Search Report ²⁰			
30th September 1983	25 OCT. 1983			
International Searching Authority ¹	Signature of Authorized Officer ²⁰			
EUROPEAN PATENT OFFICE	 G.L.M. Kruidenberg			

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 83/00867 (SA 5420)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/10/83

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4329698	11/05/82	EP-A- 0054694	30/06/82
		JP-A- 57110459	09/07/82
		JP-A- 57188368	19/11/82

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