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(54) **System for controlling ink temperature using a heated umbilical**

Gerät zur Kontrolle der Tintentemperatur mittels einer erwärmten Verbindung

Appareil pour contrôler la température d'encre muni d'un cable ombilical chauffé

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(56) References cited:

US-A- 4 337 469 **US-A- 4 814 786**
US-A- 5 451 989 **US-A- 5 784 279**
US-A- 5 821 963

- **PATENT ABSTRACTS OF JAPAN vol. 1997, no. 02, 28 February 1997 (1997-02-28) & JP 08 258284 A (BROTHER IND LTD), 8 October 1996 (1996-10-08)**
- **PATENT ABSTRACTS OF JAPAN vol. 007, no. 031 (M-192), 8 February 1983 (1983-02-08) & JP 57 185156 A (RICOH KK), 15 November 1982 (1982-11-15)**
- **PATENT ABSTRACTS OF JAPAN vol. 006, no. 172 (M-154), 7 September 1982 (1982-09-07) & JP 57 083457 A (RICOH CO LTD), 25 May 1982 (1982-05-25)**
- **PATENT ABSTRACTS OF JAPAN vol. 017, no. 368 (M-1443), 12 July 1993 (1993-07-12) & JP 05 057903 A (BROTHER IND LTD), 9 March 1993 (1993-03-09)**

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Description

Technical Field

[0001] The present invention relates to continuous ink jet printers and more particularly to reducing heater watt density in an ink jet printer without degrading the ink.

Background Art

[0002] In continuous ink jet printing, ink is supplied under pressure to a manifold that distributes the ink to a plurality of orifices, typically arranged in linear array(s). The ink is expelled from the orifices in jets which break up due to surface tension in the ink into droplet streams. Ink jet printing is accomplished with these droplet streams by selectively charging and deflecting some droplets from their normal trajectories. The deflected or undeflected droplets are caught and re-circulated and the others are allowed to impinge on a printing surface.

[0003] During the start up cycle of ink jet printers it is advantageous to clean the charge plate face by means of means of water which condenses on the charge plate face. This process requires the ink to be heated rapidly above the temperature of the charge plate face.

[0004] In one ink jet printing product line of Scitex Digital Printing, Inc., of Dayton, Ohio, there is an ink heater that is energized for about 90 seconds during startup. This heater is a "cartridge" style, with approximately 13mm² (5 square inches) of area emitting 500 watts. Unfortunately, at this watt-density (38W/mm²(100 watts per square inch)) the surface temperature of the heater can get high enough to cause the ink dye to come out of solution and form massive globs on the heating element. These globs can break off and clog filters or orifices. Furthermore this agglomerated ink will reduce the efficiency of the heater.

[0005] In other products the ink is heated to a minimum temperature of 54°C (85°F) during operation of the printer. This is done to reduce the limit the range of the temperature dependent fluid properties.

[0006] In this way the stimulation operating point can be stabilized over a wide range of ambient temperatures.

[0007] US 4337469-A discloses a heating pipe for a printer that allows the viscosity and surface tension of the ink to be maintained constant. A control system controls the power supply to the heating pipe.

[0008] US 5 821 963-A discloses a means for heating ink in a printer comprising a heater surrounding a supplying tube.

[0009] A need has therefore been recognized for a system which can incorporate a lower watt-density heater without degrading the ink used in the system.

[0010] It is the object of the present invention to provide a means to heat the ink while keeping the surface of the heater cool enough to prevent degradation of the ink.

[0011] The invention provides an improved means for heating ink in an ink jet printer according to claim 1. Thermal insulation can enclose the fluid tubing and the heater, and a protective covering can enclose the thermal insulation. An elastomeric layer can be situated between the fluid tubing and the heater, while maintaining close thermal contact between the fluid tubing and the heater.

[0012] Other objects and advantages of the invention will be apparent from the following description and the appended claims.

Brief Description of the Drawing

[0013]

Fig. 1 illustrates an ink jet printer system including a heated umbilical in accordance with the present invention;

Fig. 2 is a circuit diagram of the heated umbilical arrangement; and

Fig. 3 is a cutaway view of the umbilical constructed in accordance with the present invention.

Detailed Description of the Invention

[0014] The present invention describes a means of reducing heater watt density, by incorporating a heated umbilical, a temperature sensor, associated solid state controls for energizing the heater, and associated software.

[0015] In accordance with the present invention, reducing the heater watt density is achieved by replacing the small cartridge style heaters with ink heaters having much higher surface area. One convenient means to do this is to apply heat to the entire length of fluid tubing by means of an extended heater element. One particularly convenient means to do this is to heat the printhead ink supply tubing of the printhead umbilical. Consider the use of a 12m (40 foot) umbilical which is commonly used to allow the print head to be placed remotely on a bindery line, roll-to-roll printer, or other printing equipment. With a 12m (40 foot) long umbilical the effective surface area of the heater is 7m² (282 in²). This is an increase in surface area of a factor of 56 relative to the typical cartridge style heaters. In this way, the power density levels are kept low enough to avoid degrading the ink.

[0016] Referring now to the drawings, Fig. 1 shows an ink jet printer system incorporating the heated umbilical of the present invention, and Fig. 2 illustrates a circuit diagram 30. The circuit 30 comprises a temperature sensor or thermistor 32 at print head 34, a heated umbilical 36 comprised of heater unit 48 and umbilical 50, two solid state relays 38, and two thermostats 40. A fluid system 35 supplies ink to the printhead 34 via at least one umbilical 50. A signal from thermistors 32 is transmitted between the printhead 34 and the fluid system 35, as indicated by representative signal line 37 in Fig. 1.

[0017] In an ink jet printer it is desirable to prevent ink from draining out of the umbilical when the printhead is removed. For this reason, the fluid fittings which couple to the printhead normally incorporate check valves. If the umbilical was to heat the ink, and flow of ink from the umbilical was blocked by the check valves, the umbilical could become a potential hazard. Due to the thermal expansion of the fluid in the sealed umbilical, pressures could rise to a few Mpa (a few thousand psi) in a 12m (40 foot) umbilical by heating the ink by 120°C. For this reason the heated umbilical must include several safeguards.

[0018] One of these safeguards is a metal braid 46 around the plastic core 42 of the umbilical. With a TFE tubing having a wall thickness of 0.76mm (0.030 inch) reinforced by stainless steel braid, the tubing is rated for use up 232°C (450°F) and 20.7Mpa (3000 PSI). The rated burst strength is 89.6Mpa (13,000 PSI). The umbilical tubing is therefore capable of withstanding not only normal operating conditions with ink flowing, but also abnormal operation, where there may be no ink flow yet heat is still being applied.

[0019] A second safeguard is the use of thermostats 40 which open, preventing current flow to the heater element 48, when the umbilical gets too hot (120°C). The thermostats 40 for each umbilical 50 are arranged so that one thermostat is on each leg of the input power. Similarly, the two solid state relays 38 are also arranged so as to have one on each leg of the input power. The thermostats 40 will open up the circuit in the event of an unsafe operating condition.

[0020] Third, the heated umbilical is provided with pressure relief valve with a relief pressure of 0.5Mpa (75 psi). This prevents the pressure in the umbilical from rising higher than 0.5Mpa (75 psi). The fluid vented through the pressure relief valve goes to a waste ink container.

[0021] In Fig. 3, umbilical 50 is illustrated in detail. An inner core 42 of the umbilical 50 comprises plastic tubing 44 surrounded by a metal braid 46 to provide strength. The tubing 44 is preferably capable of withstanding not only normal operating conditions with ink flowing, but also abnormal operation, where there may be no ink flow, yet heat is still being applied. Under abnormal conditions, steam can be created, with its inherently high temperatures and pressures. The braided tubing structure of the heated umbilical of the present invention is constructed to be capable of withstanding the high pressures and temperatures that may occur.

[0022] Continuing with Fig. 3, those skilled in the art will recognize that heating element 48 can be placed around the tubing 44 in any of a variety of suitable configurations. For example, heat tape can be wrapped directly around the tubing 44.

Alternatively, an intermediate layer of flexible elastomer can be placed around the tubing 44, and then the heating element 48 can be wrapped around the intermediate layer. Yet another configuration proposes a heating

wire, protected by a flexible braid, wrapped around the tubing.

[0023] In a preferred embodiment of the present invention, thermostats 40 of Fig. 2 are placed as close as possible to the tubing 44, with the heating element 48 wrapped around the tubing and the thermostat, as best illustrated in Fig. 3.

Surrounding the heating element 48 is an insulation layer 52, in the form of a flexible tape, fiberglass felt, or other appropriate material. Preferably, there is enough insulation 52 so that the exterior surfaces are not hot to the touch. Surrounding the insulation 52 is a layer of protective covering 54, such as a flexible conduit or sleeve. The conduit can be smooth or convoluted, of the appropriate size and material. A protective sleeve is the preferred method, since the bend radius is minimized.

[0024] The temperature control is accomplished by reading the temperature of the ink in the printhead 34. This is compared to the desired temperature by a suitable temperature control system, which energizes the solid state relays 38 for the umbilical as required.

[0025] When the system is initially turned on, after preliminary self-diagnostic tests, the ink begins to flow and the heat is turned on. Once the desired temperature is reached, the print head startup process can begin. The entire "warm-up" and "startup" process takes less than 30 minutes from a "cold" condition. Once the system is warmed up, the startup process takes approximately 8 to 12 minutes.

[0026] During startup, the heater is energized to produce "condensation cleaning" of the charge plate. To achieve good condensation, the ink must be heated quickly, so that the catcher and charge plate are still "cold" in relation to the fluid. The fluid temperature has to rise by approximately 7 degrees C in 75 seconds for the process to work well. With 800 ml/min of ink flow, this dictates the wattage requirements for the umbilical.

[0027] The input power varies from 180 volts to 253 volts. The ambient can be cool, for example as low as 15 degrees C. Given these two factors, a heater resistance for a preferred embodiment gives enough wattage for the "low-volts, low-temp" condition, which is more than enough for other conditions. In the preferred embodiment, therefore, the resistance is 27 ohms. Thus, the instantaneous heater power varies from 1200 to 2370 watts. The temperature control simply changes the duty cycle of the supplied power appropriately to maintain the desired temperature.

[0028] This description has only referred to a single umbilical connecting the fluid system and printhead. It must be recognized however that the number of umbilical is not limited to one. For example, a supply line to the printhead could be heated, while one or more additional umbilical might contain the ink return lines to the fluid system and the electrical connections.

Industrial Applicability and Advantages

[0029] The present invention is useful in the field of ink jet printing, and has the advantage of reducing heater watt density. The reduction in heater watt density, as proposed by the present invention, has the additional advantage of having power levels that are low enough to avoid degrading the ink.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that modifications and variations can be effected within the scope of the invention.

Claims

1. A means for heating ink in an ink jet printer, the ink jet printer having a printhead (34) and a fluid system (35) for supplying ink to the printhead (34) via at least one umbilical (50) including a flexible fluid tube (44) through which the ink flows to the printhead (34); and **characterised by**
 - a reinforcing layer (46) surrounding an inner core (42) of the tube (44); and
 - an extended heater element (48) surrounding the reinforcing layer and in close thermal contact with the tube (44) for supplying heat to a length of the tube (44).
2. A means for heating ink as claimed in claim 1, wherein the reinforcing layer is a metal braid (46).
3. A means for heating ink as claimed in claim 1 or 2 and further comprising thermal insulation means (52) for enclosing the tube (44) and the heater element (48).
4. A means for heating ink as claimed in claim 1, 2 or 3 and further comprising an elastomeric layer between the tube (44) and the heater element (48).
5. A means for heating ink as claimed in any one preceding claim and further comprising at least one thermostat (40) for stopping current flow to the heater element (48).
6. A means for heating ink as claimed in any one preceding claim and further comprising a pressure relief valve for relieving excessive pressure in the fluid tubing.
7. A means for heating ink as claimed in claim 6 wherein a relief pressure is approximately 0.5 MPa (75 psi).
8. A means for heating ink as claimed in any one preceding claim and further comprising temperature controller means (37) for controlling power supplied

to the means for heating ink.

9. A means for heating ink as claimed in claim 8 wherein the temperature controller means is associated with the fluid system (35).
10. A means for heating ink as claimed in any one preceding claim and further comprising a fluid fitting for coupling to a printhead, the fluid fittings incorporating check valves.

Patentansprüche

1. Vorrichtung zum Erwärmen von Tinte in einem Tintenstrahldrucker, der einen Druckkopf (34) und ein Flüssigkeitssystem (35) zum Liefern von Tinte zum Druckkopf (34) über mindestens ein Zuführelement (50) aufweist, das eine biegbare Flüssigkeitsleitung (44) umfasst, durch die die Tinte zum Druckkopf (34) gelangt;
gekennzeichnet durch eine Verstärkerfolie (46), die einen inneren Kern (42) der Leitung (44) umgibt; und ein langgestrecktes Heizelement (48), das die Verstärkerfolie umgibt und in engem Wärmekontakt mit der Leitung (44) steht, um eine Länge der Leitung (44) mit Wärme zu versorgen.
2. Vorrichtung zum Erwärmen von Tinte gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Verstärkerfolie aus einem Metallgeflecht (46) besteht.
3. Vorrichtung zum Erwärmen von Tinte gemäß Anspruch 1 oder 2, **gekennzeichnet durch** eine Wärmeisoliereinrichtung (52), die die Leitung (44) und das Heizelement (48) umgibt.
4. Vorrichtung zum Erwärmen von Tinte gemäß Anspruch 1, 2 oder 3, **gekennzeichnet durch** eine elastomere Schicht zwischen der Leitung (44) und dem Heizelement (48).
5. Vorrichtung zum Erwärmen von Tinte gemäß einem der vorhergehenden Ansprüche, **gekennzeichnet durch** mindestens einen Thermostat (40), der die Stromversorgung des Heizelements (48) unterbricht.
6. Vorrichtung zum Erwärmen von Tinte nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** ein Entlüftungsventil, das den Überdruck in der Flüssigkeitsleitung abbaut.
7. Vorrichtung zum Erwärmen von Tinte gemäß Anspruch 6, **dadurch gekennzeichnet, dass** der Entlüftungsdruck etwa 0,5 MPa (75 psi) beträgt.

8. Vorrichtung zum Erwärmen von Tinte nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** eine Temperatursteu­erung (37), die den zur Vorrichtung zum Erwärmen der Tinten gelieferten Strom steuert.
9. Vorrichtung zum Erwärmen von Tinte gemäß Anspruch 8, **dadurch gekennzeichnet, dass** die Temperatursteu­erung dem Flüssigkeitssystem (35) zugeordnet ist.
10. Vorrichtung zum Erwärmen von Tinte nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** ein an den Druckkopf anschließbares Verbindungsstück mit Rückschlagventil.

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Revendications

1. Moyen destiné à chauffer de l'encre dans une imprimante à jet d'encre, l'imprimante à jet d'encre comportant une tête d'impression (34) et un système à fluide (35) destiné à fournir de l'encre à la tête d'impression (34) par l'intermédiaire d'au moins un cordon ombilical (50) comprenant un tube à fluide souple (44) au travers duquel l'encre circule vers la tête d'impression (34) et **caractérisé par**
une couche de renfort (46) entourant une âme intérieure (42) du tube (44), et
un élément de chauffage étendu (48) entourant la couche de renfort et en contact thermique étroit avec le tube (44) en vue de fournir de la chaleur à une longueur du tube (44).
2. Moyen destiné à chauffer de l'encre selon la revendication 1, dans lequel la couche de renfort est une tresse métallique (46).
3. Moyen destiné à chauffer de l'encre selon la revendication 1 ou 2 et comprenant en outre un moyen d'isolation thermique (52) destiné à enfermer le tube (44) et l'élément de chauffage (48).
4. Moyen destiné à chauffer de l'encre selon la revendication 1, 2 ou 3 et comprenant en outre une couche élastomère entre le tube (44) de l'élément de chauffage (48).
5. Moyen destiné à chauffer de l'encre selon l'une quelconque des revendications précédentes et comprenant en outre au moins un thermostat (40) destiné à arrêter la circulation du courant vers l'élément de chauffage (48).
6. Moyen destiné à chauffer de l'encre selon l'une quelconque des revendications précédentes et comprenant en outre une soupape de décharge de pression destinée à décharger une pression excé-

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sive dans le tube à fluide.

7. Moyen destiné à chauffer de l'encre selon la revendication 6 dans lequel la pression de décharge est approximativement 0,5 MPa (75 livres par pouce carré).
8. Moyen destiné à chauffer de l'encre selon l'une quelconque des revendications précédentes et comprenant en outre un moyen de régulation de température (37) destiné à commander la puissance fournie au moyen destiné à chauffer de l'encre.
9. Moyen destiné à chauffer de l'encre selon la revendication 8 dans lequel le moyen de régulation de température est associé au système à fluide (35).
10. Moyen destiné à chauffer de l'encre selon l'une quelconque des revendications précédentes et comprenant en outre un montage pour fluide en vue du raccordement à une tête d'impression, les montages pour fluide incorporant des clapets de non-retour.

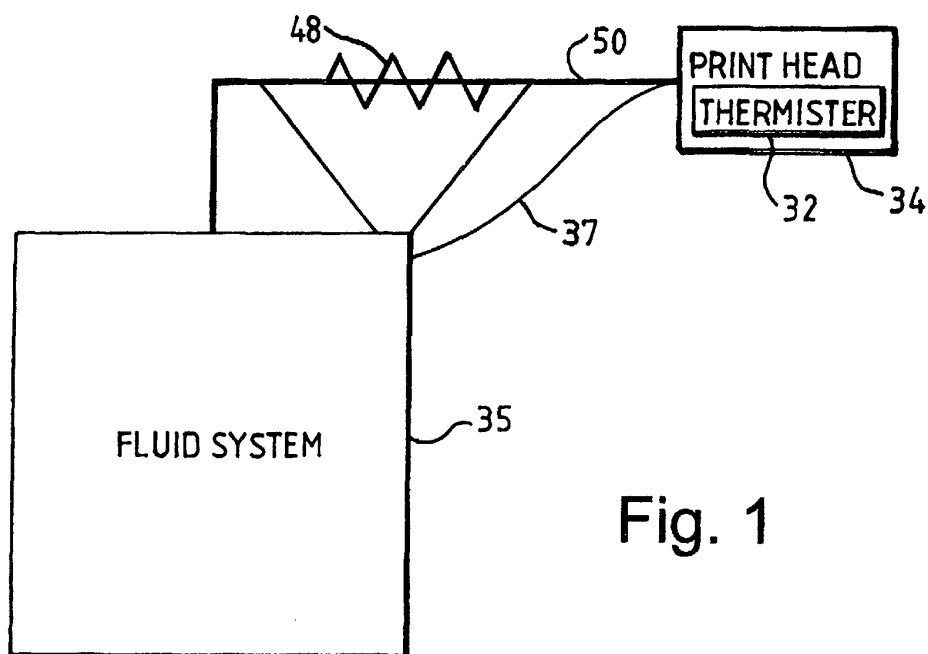


Fig. 1

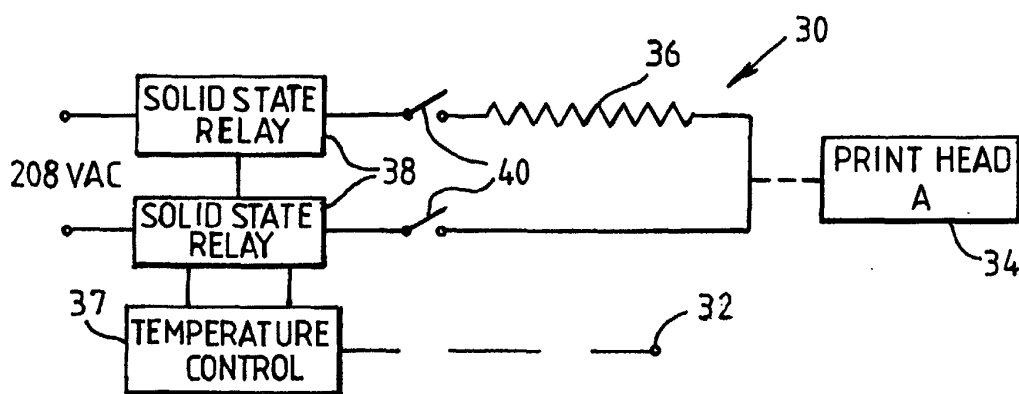


Fig. 2

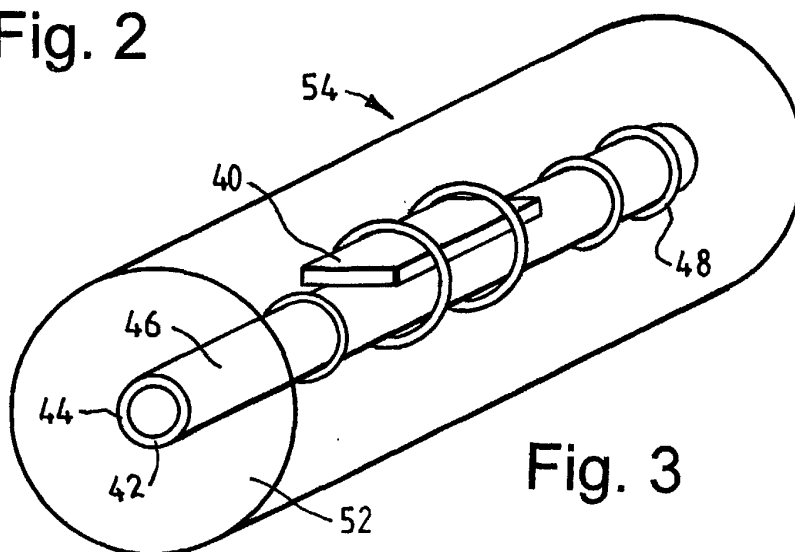


Fig. 3