(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 893 264 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
27.01.1999 Bulletin 1999/04

(51) Int Cl.[6]: **B41J 2/17**

(21) Application number: **98303578.3**

(22) Date of filing: **07.05.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.07.1997 US 897797**

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(54) An ink jet printhead including a non-ink priming and coating fluid

(57) An ink jet printhead for use in an ink jet printer, or mounted in an ink jet printer being shipped or being stored. The ink jet printhead (34) consists of a printhead structure having a body including walls having surfaces defining fluid flow channels (44) and fluid ejecting nozzles (62) at the ends of the channels. In order to achieve a successful first time ink wetting and priming of the printhead structure, the channels and the nozzles are filled with a non-ink priming and coating fluid prior to a first time filling thereof with printing ink. The non-ink priming and coating fluid has low surface tension and volatility characteristics for enabling the non-ink priming and coating fluid to spontaneously and quickly move through the channels of the printhead and into the nozzles thereof. The non-ink priming and coating fluid also has surface treating characteristics for wetting and coating the surfaces of the walls of the channels and nozzles in order to clean and lubricate such surfaces, thereby destroying any hydrophobic film on such surfaces, and enabling a successful first time wetting and priming of the channels and nozzles with printing ink.

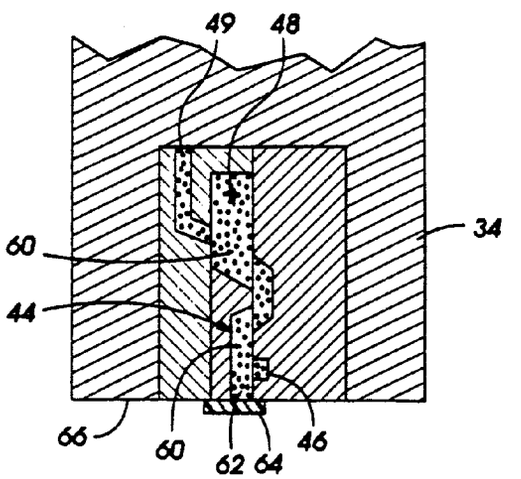

FIG. 2

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Description

The present invention relates generally to liquid ink printers or recording apparatus and more particularly relates to an ink jet printhead for use in such a recording apparatus. The printhead is charged or filled with a non-ink priming and coating fluid prior to a first time filling or charging of the printhead with printing ink.

Liquid ink printers such as inkjet printers are well known, and include the type frequently referred to as continuous stream or as drop-on-demand printers, and use piezoelectric, acoustic, phase change wax-based or thermal energy ink release techniques. Each such printer has at least one printhead that when filled or charged with ink, is then controllable to direct droplets of ink towards a recording sheet for printing. Within the printhead, the charged ink is contained in a plurality of channels that are individually connected to ink ejecting and directing nozzles. Power pulses cause the droplets of ink to be expelled or ejected as required from the nozzles.

In a thermal ink-jet printer, for example, the power pulses are usually produced by heatable resistors, each located in a respective one of the channels, and each individually capable of being powered to heat and vaporize ink in the channels. As voltage is applied across a selected resistor, a vapor bubble grows in the associated channel and initially bulges from the channel orifice or nozzle, followed by collapse of the bubble. The ink within the channel then retracts and separates from the bulging ink thereby forming a droplet moving in a direction away from the nozzle, and towards the recording medium or sheet. As such, a print dot or spot of ink having a desired size and shape for quality printing is deposited on the recording medium. The channel is then refilled by capillary action, which, in turn, draws ink from a supply container of liquid ink. Operation of a thermal ink-jet printer is described in, for example, U.S. Patent No. 4,849,774.

In order for the droplets of ink ejected as above to have the desired size and shape, both the channels and nozzles must be fully wetted or coated with ink and primed, prior to droplet ejection. In other words, the surfaces of the walls of both the channels and nozzles must be prepared for encouraging and enabling desired ink flow therethrough. Such wetting or coating and priming of the channels and nozzles is usually carried out as a first time ink prime or priming of a printhead structure after manufacturing of such structure. It is also usual to rewet and reprime such channels and nozzles as ongoing maintenance activities, following prolonged idle periods of the ink jet printer. Post-idle period priming activities are well known, and are usually carried out mechanically, for example, with a capping and vacuum suction maintenance apparatus within the printer.

A successful first time ink wetting and priming of a printhead structure is usually the more difficult to achieve. It has been found that this is due in significant part to a type of hydrophobic filming that tends to grow on, or form on the surfaces of the walls of the channels and nozzles, particularly on the surface of brand new and unused printhead structures. In part, the difficulty is also due to a relatively low wetting ability of preferred quality printing inks which each tend to have a desired but relatively high surface tension of such inks. Such relatively high surface tension and resulting low wetting ability, are required in such inks in order for the inks to have acceptably controllable image forming qualities.

The difficulty of a first time wetting and priming of a printhead structure is further exacerbated or aggravated in cases, where after manufacture of the printhead structure, it is stored or shipped over an extended period of time, usually in a dry state or not charged with ink. Such a printhead structure usually can be stored or shipped as such by itself, or assembled onto an ink jet printer. Furthermore, the difficulty of a first time wetting and priming of printhead structures is even worse if the printhead structure is that of a full width array (FWA) printhead having 4000+ (four thousand and more) channels and nozzles that must be fully and successfully wetted and primed with ink for the first time, after such extended storage or shipping.

In accordance with the present invention, there is provided an ink jet printhead for use in an ink jet printer, or mounted in an ink jet printer being shipped or being stored. The ink jet printhead comprises a printhead structure having a body including walls having surfaces defining fluid flow channels, and fluid ejecting nozzles at the ends of the channels. In order to achieve a successful first time ink wetting and priming of the printhead structure, the channels and the nozzles are filled with a non-ink priming and coating fluid prior to a first time filling thereof with printing ink. The non-ink priming and coating fluid has low surface tension and volatility characteristics for enabling the non-ink priming and coating fluid to spontaneously and quickly move through the channels of the printhead and into the nozzles thereof. The non-ink priming and coating fluid also has surface treating characteristics for wetting and coating the surfaces of the walls of the channels and nozzles in order to clean and lubricate such surfaces, thereby destroying any hydrophobic film on such surfaces, and enabling a subsequent successful first time wetting and priming of the channels and nozzles with printing ink.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a partial perspective view of an ink jet printer having a plurality of printheads including the non-ink priming and coating fluid prior to a first time wetting and priming of the printheads with printing ink in accordance with the present invention;

FIG. 2 is an enlarged, fragmentary, elevational sectional view of a channel and nozzle of a printhead

of the present invention; and

FIG. 3 is a simplified perspective view showing a printhead linear array of nozzles including the non-ink priming and coating fluid in accordance with the present invention.

Referring now to FIG. 1, the essential components of a printing apparatus or printer, generally designated 10, are illustrated. As shown, the outside covers or case and associated supporting components of the printing apparatus 10 are omitted for clarity. The essential components of the printing apparatus 10 include a motor 11 connected to a suitable power supply (not shown) and arranged with an output shaft 14 parallel to an axis 15 of a cylindrical drum 16 which is supported for rotation on bearings (not shown). A pulley 17 permits direct engagement of the output shaft 14, to a drive belt 18 for enabling the drum 16 to be continuously rotationally driven by the motor 11 in the direction of an arrow AA at a predetermined rotational speed.

A recording medium such as a sheet of paper or a transparency (not shown since the printer 10 as shown is as in storage or in shipping transit), will in operation be placed over an outer surface 20 of the drum 16, with its leading edge attached to the surface 20. Typically, the sheet is attached to the drum either through the application of a vacuum, through holes in the drum 16 (not shown), or through other means of holding the sheet to the drum, for example, electrostatic means. In operation, as the drum 16 with a sheet attached thereto rotates, it will move the sheet with it past a printhead carriage 22.

The printhead carriage 22 is supported for example by a lead screw 24 that is mounted so that its axis is parallel to the axis 15 of the drum 16. Additionally, it is supported by fixed bearings (not shown) which enable it (the carriage 22) to be capable of slidably translating axially. A carriage rail 23 provides further support for the carriage 22 as it moves in the direction of arrow 25, that is perpendicular to the moving direction of the sheet. A second motor 26, such as a stepper motor or other positioning mechanism, which is controlled by a controller 28, drives the lead screw 24 with a second belt 29. As shown, the belt 29 is connected to a clutch 30, and to another clutch 31 that is attached to the lead screw 24 for movement thereof.

In accordance with the present invention, the printer 10, for example, includes printhead partial width arrays 32 that are each filled or charged with the non-ink priming and coating fluid 60 of the present invention, prior to a first time wetting and priming thereof with printing ink. The printhead partial width arrays 32 comprise a first partial width array printbar 32A, a second partial width array printbar 32B, a third partial width array printbar 32C, and a fourth partial width array printbar 32D. Each printbar 32A-32D as shown includes at least a printhead 34, or as preferred here, two printheads, a first printhead die 34 and a second printhead die 36 that are butted together to form such printbar.

Referring to FIGS. 1, 2, and 3, as is well known, each of the printheads 34 and 36 includes several hundred or more channels and nozzles which in operation can be fired sequentially. In operation the partial width arrays 32, when charged or filled with ink, can be moved in the direction of arrow 25 for printing on the sheet. When filled with ink as such, the first, second and third partial width array printbars 32A-32C, respectively, will each contain ink of one of the colors cyan, magenta or yellow, for color printing. The fourth partial width array printbar 32D will contain black ink when necessary, especially when needed for printing graphics. However, before they are filled the first time with ink as such, each of the partial width array printbars 32A-32C is preferably filled with the non-ink priming and coating fluid of the present invention, while in storage, during shipping, or prior to filling with ink.

In addition to the partial width arrays 32, the printer 10 also includes a full-width array or pagewidth printbar 40 that is also filled or charged with the non-ink priming and coating fluid 60 of the present invention, prior to a first time wetting and priming thereof with printing ink. The pagewidth printbar 40 is supported by an appropriate support structure (not shown) above the drum 16 for printing on the recording medium when filled or charged with printing ink. The pagewidth printbar 40 has a length sufficient to print across the entire width (or length) of the recording medium during a single pass of the recording medium beneath the printbar. The printbar 40 as shown, includes a plurality of printhead units 42 that are affixed to a supporting substrate (not shown) in an abutted fashion. Alternatively, individual printhead units 42 may be spaced from one another by a distance approximately equal to the length of a single printhead subunit and bonded to opposing surfaces of the supporting substrate.

In each case, a front or forward facing edge of each printhead unit 34, 36 and 42, contains liquid droplet ejecting orifices or nozzles 62 which can in operation, eject ink droplets along a trajectory 45 (FIG. 1), which is substantially perpendicular to the surface of a recording medium. As shown in FIG. 2, each printhead contains heating elements 46, and printed wiring boards (not shown). The printed wiring boards contain circuitry required to interface and cause the individual heating elements 46 in the printhead units to eject liquid (e.g. ink) droplets from the nozzles 62. While not shown, the printed wiring boards are connected to individual contacts contained on the printhead units via a commonly known wire bonding technique. The data required to drive the individual heating elements 46 is supplied from an external system by a standard printer interface, modified and/or buffered by a printer micro processor (not shown) within the printer.

As shown in FIG. 2, for example, such a printhead for example, includes a tube 49 through which a fluid, such as ink or the non-ink priming and coating fluid 60

of the present invention, is introduced into manifold 48. Such fluid is then conducted from the manifold 48 into a plurality of channels shown as 44. Each of the channels 44 of the printhead includes a heating element 46. When a signal is sent by a control means to a corresponding heating element 46, the energy of the signal causes heat to be generated in the channel 44. The heat causes vaporization of fluid or liquid such as ink in the channel 44, and the liquid in the channel 44 is pushed outwards through the corresponding nozzle 62 in the form of a droplet. Once a quantity of liquid is ejected from the channel 44, the channel 44 is replenished from the manifold 48.

As shown in FIG. 3, a full width or pagewidth array printhead, such as 40 (FIG. 1) includes a linear array of channels 44 (only portions thereof adjoining nozzles 62 are shown) and the corresponding nozzles 62. (In both FIGS. 2 and 3, the size of the channels 44 and nozzles 62, relative to the rest of the apparatus, have been significantly exaggerated.) In accordance with the present invention, when the channels 44 and nozzles 62 are filled with the non-ink priming and coating fluid 60 of the present invention, all external openings into the channels, such as the external side of the nozzles 62, preferably will be sealed, for example, with a removable sealing device 64.

The non-ink priming and coating fluid 60 of the present invention is preferably a fluid having low surface tension and volatility characteristics for enabling the non-ink priming and coating fluid to spontaneously and quickly move through the channels of the printhead and into the nozzles thereof, as well as surface treating characteristics for wetting and coating the surfaces of the walls of the channels and nozzles. Wetting and coating the surfaces of the walls of the channels and nozzles as such advantageously cleans and lubricates such surfaces, thereby destroying any hydrophobic film on such surfaces and enabling a successful first time wetting and priming of the channels and nozzles with printing ink.

The non-ink priming and coating fluid 60 can equally be a mixture of fluids comprising a transport or carrier component that has a relatively low surface tension for providing the low surface tension and volatility characteristics of the fluid or mixture. As a mixture, the non-ink priming and coating fluid will include at least one surface wetting or coating component that leaves a hydrophilic coating on the surfaces of the walls of the channels and nozzles. Such a hydrophilic coating can be a temporary wetting of the surfaces for preventing such surfaces from rapidly drying out, or it can be a dried out hydrophilic (high energy surface) coating resulting from a cleaning and lubrication of such surfaces that is still effective (even after removal of the fluid and drying out of the channels and nozzles), for facilitating a successful first time wetting and priming of the channels and nozzles with printing ink. Such a dried out hydrophilic coating is believed to effectively destroy any otherwise hydrophobic film on the surfaces, thus enabling the successful first time wetting and priming of the printhead with printing ink even after the surfaces have dried.

In a first contemplated embodiment, the transport or carrier component providing the low surface tension and volatility characteristics, for example, is propanol (that is, 1-propanol (propyl alcohol); or 2-propanol (isopropyl alcohol)). The surface coating component providing the low volatility, surface treating or wetting and coating characteristic is water, for example, which is added at ratio of about 50% by volume. Propanol as such is usually used for example as a solvent for paints and coatings. Because propanol (1-propanol or propyl alcohol; and 2-propanol or isopropyl alcohol), is highly volatile, its use alone would ordinarily tend to cause the surfaces of the walls of the channels and nozzles to unfortunately dry out rapidly. Therefore, the addition of 50% water (by volume) as a low volatility wetting component, prevents the surfaces of the walls of the channels and nozzles from drying out rapidly, and thus allows the channels and nozzles to be successfully primed a first time with printing ink, virtually spontaneously. Reductions to 50% or less of the ratio of the volatile carrier or transport component advantageously enables long term storage and shipping of printheads preprimed with the fluid 60 of the present invention, by making such storage and shipping stable and safe. The transport or carrier component and the low volatility surface coating component can each be colorless. Because most printing inks are aqueous based, it is also preferable that the low surface tension and relatively volatile transport or carrier component be soluble in water.

In a second contemplated embodiment, the transport or carrier component providing the low surface tension and volatility characteristics providing transport component, for example, is also propanol (that is, 1-propanol (propyl alcohol); or 2-propanol (isopropyl alcohol)). In this embodiment, component providing the relatively low volatility, surface treating or wetting and coating characteristic is glycerol (glycyl alcohol), which is also added at ratio of about 50% by volume. Glycerol is normally used for example as a penetrant. Glycerol is a colorless, syrupy liquid that is soluble in water.

In a third contemplated embodiment the wetting and non-ink priming and coating fluid 60 may include in addition to the low surface tension, volatility and surface treating characteristics above, other useful characteristics, or components providing such characteristics. For example, a fluid such as one normally used as a wafer cutting fluid and sold as KERFAID (tradename of Dynatex International, Santa Rosa California) has been found to be equally useful as a non-ink priming and coating fluid in accordance with the present invention. The components of KERFAID, for example, belong to chemical families of nonionic surfactants, polyethers, and wetting agents. KERFAID itself includes BTC (tradename of Millmaster Onyx, UK) which comprises a cationic surfactant of the alkyl quaternary ammonium chloride type in liquid form, and is usually used as a disinfectant. KER-

FAID also includes POLYOX (unestablished owner tradename); D1 water, and TRITON N-101(also an unestablished owner tradename).

POLYOX comprises a range of water soluble, high molecular weight polymers of ethylene oxides, normally used in lubricants, and TRITON N-101 comprises a nonylphenol ethoxylate nonionic surfactant, normally used in cleaning metals. It is believed that in a fluid composition comprising components such as those of KERFAID, the component equivalent to TRITON N-101 (nonylphenol ethoxylate nonionic surfactant) will behave as the transport or carrier component, and the component equivalent to POLYOX (the high molecular weight polymer of ethylene oxide) will behave as the low volatility surface wetting and coating fluid.

As further shown in FIGS. 2 and 3, the ink jet printhead of the present invention preferably includes means such as a seal device 64 for closing and sealing external openings into the channels or into the nozzles in order to prevent leakage of the non-ink priming and coating fluid 60 during storage or shipment thereof.

Further in accordance with the present invention, before the printhead is filled or charged with printing ink, the non-ink priming and coating fluid 60 is purged from the channels and nozzles by any suitable means including vacuum means. The channels and nozzles are then ready for a no-difficulty first ink wetting and priming of the channels and nozzles, thus enabling droplets or dots of ink ejected from the printhead to each have a desired size and shape, and to produce relatively high quality printing on a recording medium.

Referring again to FIG. 1, the printer or printing apparatus 10 preferably includes a maintenance system 50 located at one end of the drum 16 for preventing the nozzles in particular from drying out during idle periods following the printhead being filled with ink as above. The maintenance system 50 includes assemblies which provide wet wiping of the nozzles of the printheads 32 and 34 as well as vacuuming of the same printheads for maintenance thereof. Wet wipers and vacuuming of nozzles typically include a fluid applicator and vacuum means that are located within a stationary drum housing 52 and extend through a plurality of apertures 54A, 54B and 54C when necessary to provide maintenance functions. When the printhead carriage moves to the maintenance position, the wet wipers apply a fluid to the ink jet nozzles such that any dried ink, viscous plugs or other debris is loosened on the front face of the ink jet printbars. Once the debris has been sufficiently loosened, a plurality of vacuum nozzles each extending through a plurality of vacuum nozzle apertures 56A-56C vacuum away any of the cleaning fluid as well as any debris loosened thereby.

Once a printing operation has been completed and any cleaning of the printbars has been completed, if necessary, the carriage 22 is moved into position above another plurality of apertures 58A-58D. A plurality of capping members disposed within the housing 50, are moved into contact with the front faces of the printbars 32 and 34 through the apertures 58A -58D to thereby cap nozzles of the printheads in order to substantially prevent any ink which has been collected in the nozzles of the printheads from drying out.

As can be seen, there has been provided an ink jet printhead for use in an ink jet printer, or that is mounted in an ink jet printer being shipped or in storage. The ink jet printhead comprises a printhead body having walls defining fluid flow channels and fluid ejecting nozzles at the ends of the channels. In order to achieve a successful first time ink wetting and priming of the printhead the channels and the nozzles of the ink jet printhead are filled or charged with a non-ink priming and coating fluid prior to the first time filling thereof with printing ink. The non-ink priming and coating fluid has transport characteristics provided for example by a transport or carrier component for enabling the fluid to spontaneously and quickly move through the channels of the printhead into the nozzles thereof. It also has surface treating characteristics provided by a low volatility surface coating component mixed with the transport or carrier component for preventing the channels and the nozzles from rapidly drying out, by coating any hydrophobic film on surfaces of the channels and the nozzles, and thus enabling a successful first time ink wetting and priming of the channels and the nozzles with printing ink. Finally, the priming and coating fluid should be water soluble to ensure that it is easily replaced by the water based inks.

Claims

1. An ink jet printhead (34, 36, 42) for use in an ink jet printer, the ink jet printhead comprising:

   (a) a printhead body including walls having surfaces defining fluid flow channels (44), and fluid ejecting nozzles (62) connected to said channels; and

   (b) a non-ink priming and coating fluid contained within and filling said channels (44) and said nozzles (62) prior to a first time filling of said channels and said nozzles with printing ink, said non-ink priming and coating fluid having low surface tension and volatility characteristics for enabling the non-ink priming and coating fluid to spontaneously and quickly move through the channels of the printhead and into the nozzles thereof, and surface treating characteristics for wetting and coating the surfaces of the walls of the channels and nozzles in order to clean and lubricate such surfaces, thereby destroying any hydrophobic film on such surfaces, and enabling a successful first time wetting and priming of the channels and nozzles with printing ink.

2. An ink jet printhead (34, 36, 42), the ink jet printhead comprising:

(a) a printhead body including walls having surfaces defining fluid flow channels (44), and fluid ejecting nozzles (62) connected to said channels; and
(b) a non-ink priming and coating fluid contained within and filling said channels (44) and said nozzles (62) prior to a first time filling of said channels and said nozzles with printing ink, said non-ink priming and coating fluid including:

i) a transport component for spontaneously and quickly moving through said channels and into said nozzles; and
ii) a low volatility surface coating component mixed with said transport component for coating and wetting said surfaces of said channels and of said nozzles, thus when removed from said channels and said nozzles, enabling a successful first time filling and wetting and priming of said channels and said nozzles with printing ink.

3. An ink jet printhead according to Claim 2, wherein said transport component is soluble in water.

4. An ink jet printhead according to Claim 2 or 3, wherein said transport component is propanol.

5. An ink jet printhead according to Claims 2, 3 or 4, wherein said low volatility surface coating component is glycerol.

6. An ink jet printhead according to Claims 2, 3 or 4, wherein said low volatility surface coating component is water.

7. An ink jet printhead according to any of claims 2 to 6, wherein said low volatility surface coating and wetting component comprises 50% by volume of the non-ink priming and coating fluid.

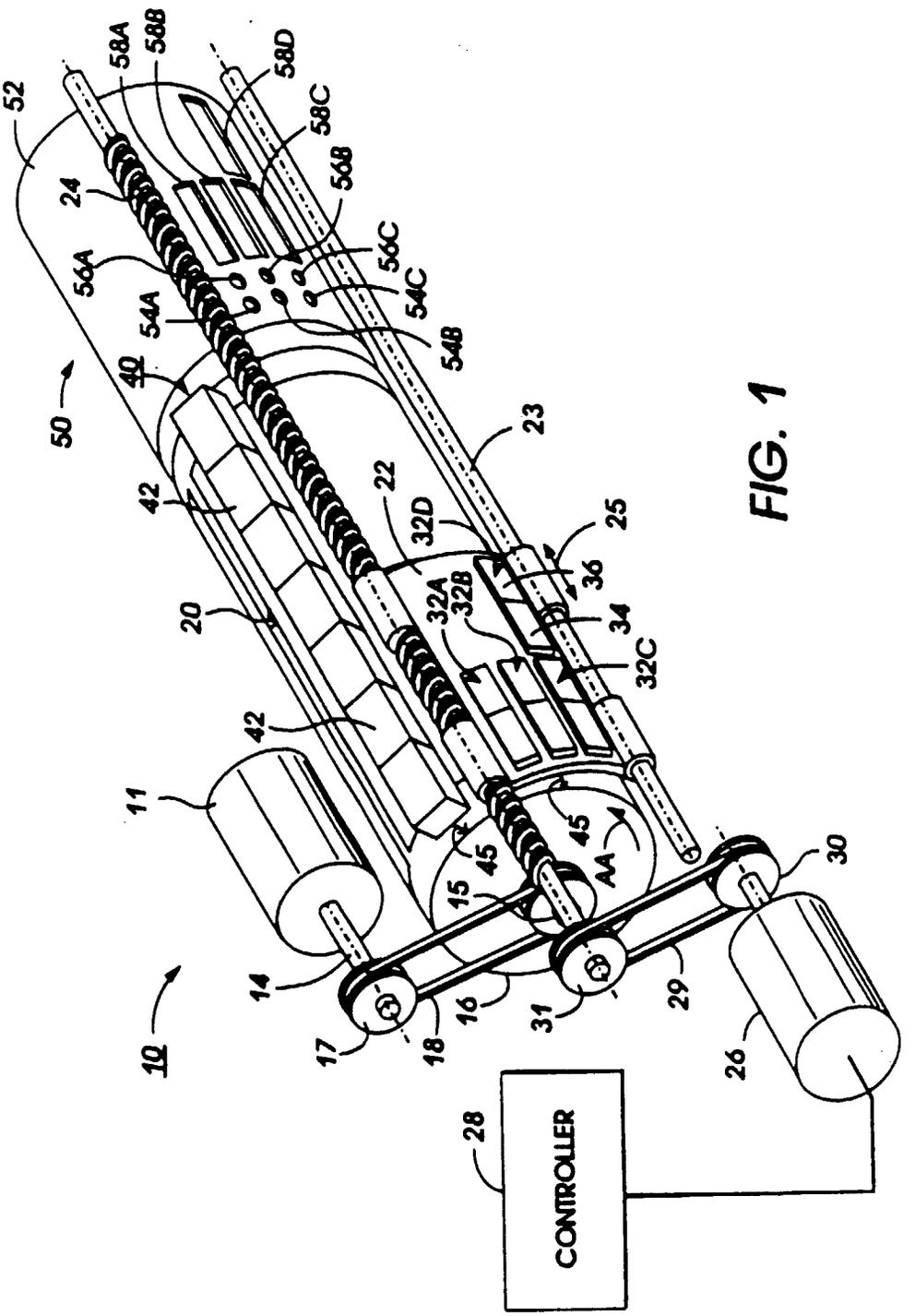
8. An ink jet printhead according to Claim 2, wherein said low surface tension transport component comprises nonylphenol ethoxylate, and said low volatility surface coating and wetting component comprises POLYOX, a high molecular weight polymer of ethylene oxide.

9. An ink jet printhead according to Claim 8, including an alkyl quaternary ammonium chloride surfactant.

10. An ink jet printer prior to being set up operationally, the ink jet printer comprising:

(a) a frame;
(b) means for supporting a print receiving substrate; and
(c) a full width array printhead (40) for producing ink prints on a supported substrate when filled with printing ink, said printhead, including:

i) a printhead body including walls having surfaces defining fluid flow channels (44) and fluid ejecting nozzles (62) at ends of said channels; and
ii) a non-ink priming and coating fluid having low surface tension and volatility characteristics for enabling the non-ink priming and coating fluid to spontaneously and quickly move through the channels of the printhead and into the nozzles thereof, and surface treating characteristics for wetting and coating the surfaces of the walls of the channels and nozzles in order to prevent the channels and nozzles from rapidly drying out, thereby coating and wetting any hydrophobic film on surfaces of the channels and nozzles, and thus when removed from the channels and nozzles, enabling a successful first time wetting and priming of the channels and nozzles with printing ink.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CONTROLLER

FIG. 1

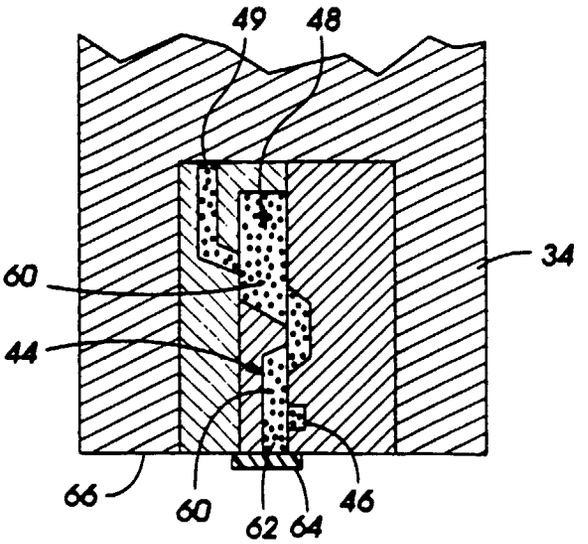

FIG. 2

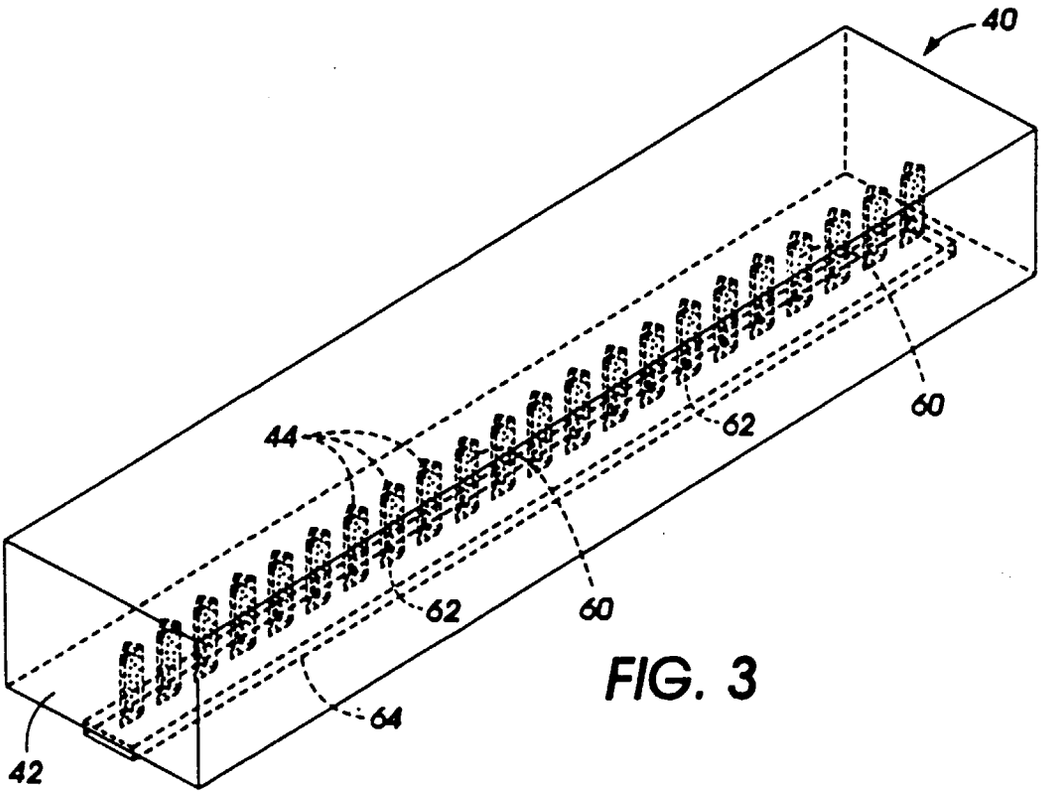

FIG. 3