United States Patent [19]

Kojima

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[45] **May 27, 1975**

[54] **INJECTION NOZZLE FOR AN INK JET PRINTER**

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[52] **U.S. Cl.** **346/140**; 239/601

[51] **Int. Cl.** **G01d 15/18**

[58] **Field of Search** 346/140, 75; 239/601, 15, 239/3

[56] **References Cited**

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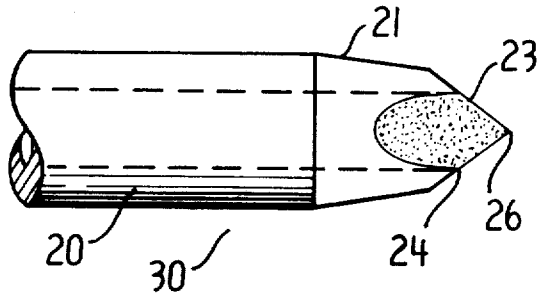
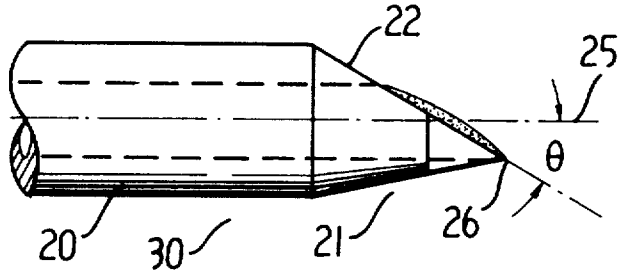
Attorney, Agent, or Firm—Oblon, Fisher, Spivak, McClelland & Maier

[57] **ABSTRACT**

An injection nozzle for an ink jet printer comprises a fine pipe for feeding ink therethrough onto a separately positioned paper under the control of an electric field, the one end of the pipe being faced toward the paper and being obliquely cut away through the axis thereof and having a sharp lead point to concentrate the electric field further cut from the sides of the cutting plane of the oblique cut.

4 Claims, 6 Drawing Figures





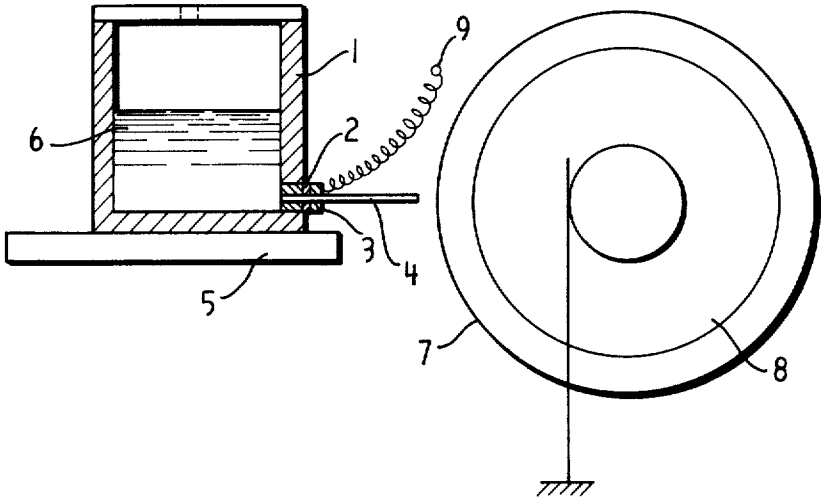


FIG. 1
(PRIOR ART)

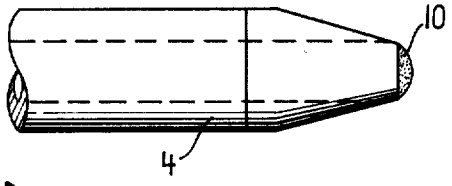


FIG. 2A
(PRIOR ART)

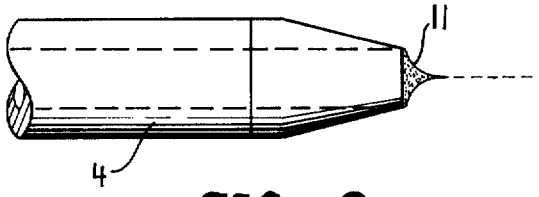


FIG. 2B
(PRIOR ART)

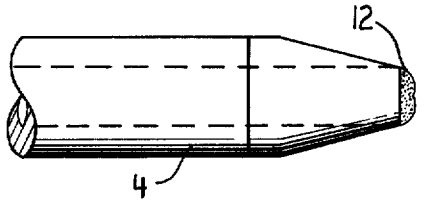


FIG. 2C
(PRIOR ART)

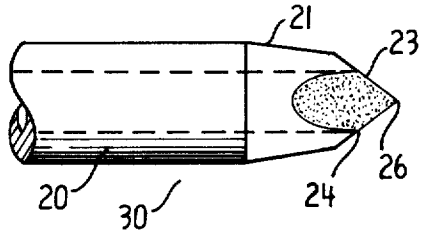


FIG. 3

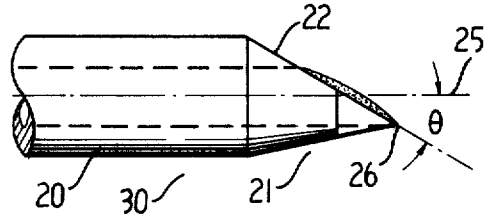


FIG. 4

INJECTION NOZZLE FOR AN INK JET PRINTER

BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates generally to an ink jet printer and, more particularly, to an improved ink injection nozzle for an ink jet printer.

2. Description of the Prior Art:

Ink jet printers are usually designated to have various features such as simple construction, quiet operation, and capability of printing on ordinary lower cost paper which offers many applications including facsimile apparatus.

FIG. 1 shows a schematic diagram of a conventional ink jet facsimile apparatus wherein an ink injection nozzle 4 is inserted in a metal holder 3 secured at the bottom of an ink vessel 1 through an insulated packing ring 2. The metal holder 3 is connected to a conductor 9 which is supplied with a high voltage D.C. bias and video signal. The ink vessel 1 is mounted on a base plate 5 which is movable along a line parallel to the longitudinal axis of a cylindrical drum 8, positioned along one side thereof, by a driving motor, not shown, at a predetermined mainscanning rate, the cylindrical metal drum 8 being connected to a ground potential and rotated by a driving motor, also not shown, at a predetermined sub-scanning rate. Ordinary lower cost paper 7 is wound on the surface of the drum 8.

In this conventional, or prior art, apparatus, ink of a relatively high oil concentration is preferably used. The D.C. bias and video signal for example, are about 2K. V and 0.7K. V., respectively, and the gap between the pointed end of the ink injection nozzle 4 and the drum 8 is generally between 1 mm and 4 mm.

The nozzle 4 has an appropriate outer diameter of 0.4 mm, and an approximate inner diameter of 0.2 mm and is tapered at one end, but the pointed end thereof is cut to be perpendicular to the axis of the nozzle 4. Therefore, the frequency response of the ink droplet is limited within 2 KHz because of the variations of the ink meniscus formed, as will be described hereinafter.

The ink meniscus at the end of the conventional ink injection nozzle 4 is varied as shown in FIG. 2. When the D.C. bias and the video signal are not supplied to the conductor 9, or only the D.C. bias is supplied thereto, the ink flows from the vessel 1 to the nozzle 4 through the holder 3 and a meniscus 10 thereof at the pointed end of nozzle 4, as shown in FIG. 2*a*, is formed by the surface tension effect.

But, when the voltage supplied to the conductor 9 is higher than the predetermined level, the ink is attracted by the electric field between the pointed end of nozzle 4 and the drum 8 so that ink droplets 11, as shown in FIG. 2*b*, are shot toward the paper 7 wound on the surface of the drum 8.

After shooting such ink droplets, an ink meniscus 12, as shown in FIG. 2*c*, is formed. This process of ink meniscus formation is repeated and printing of various patterns on the paper 7 is made in accordance with the video signal.

The significant variation of the ink meniscus, as shown in FIG. 2, however, does not only result in limited frequency response thereof, but also brings about an edge effect phenomenon on the printed patterns on account of the ink being initially injected in the form of lumps at each initial shooting time.

SUMMARY OF THE INVENTION

Accordingly, it is one object of the present invention to provide a new and improved unique injection nozzle for an ink jet printer.

It is another object of this invention to provide an improved injection nozzle for an ink jet printer which is capable of making the frequency response of the ink droplets more quick.

It is yet another object of this invention to provide an improved injection nozzle for an ink jet printer which will produce printed patterns of better quality.

In summary, according to the present invention, the foregoing objects and others are achieved by a novel injection nozzle for an ink jet printer which comprises a fine pipe for feeding ink therethrough on a separately positioned paper under the function of an electric field, the pipe being obliquely cut away to the axis thereof to form a leading edge facing the paper, and both sides of this edge being further cut away to form a sharply pointed end for concentrating the electric field.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description of the present invention when considered in connection with the accompanying drawings, in which:

FIG. 1 illustrates a schematic diagram of a conventional ink jet printer, previously described;

FIG. 2 shows the ink meniscus being formed in the operation of the conventional injection nozzle, as previously described;

FIG. 3 shows a top view of a preferred embodiment of an ink injection nozzle formed according to the present invention; and

FIG. 4 shows a side view of the embodiment illustrated in FIG. 3 and the ink meniscus being formed therein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 3 and 4, an ink injection nozzle generally designated by reference numeral 30 for an ink jet printer is formed from a fine metal pipe 20 having the usual axial channel for feeding ink therethrough onto a separately positioned paper under the function or control of an electric field, in the usual manner, as previously discussed.

The pipe 20 is tapered near one end and is then further obliquely cut away along one plane toward and through the longitudinal axis 25 thereof to form a leading edge 21. The cutting angle θ which is formed between the oblique plane 22 and the longitudinal axis 25 is in a range of degrees from 30 to 60. Both of the lateral edges 23 and 24 of the leading edge 21 formed on either side thereof by the oblique plane 22 are further cut away to form a sharply pointed end 26. The pointed end 26, however, may have a radius of curvature of an ink droplet produced by the attraction of the electric field.

When the injection nozzle 30 is adapted for conventional facsimile apparatus, as shown in FIG. 1, under the same conditions described above, the frequency response of ink droplets results in 4 KHz or more and printed patterns of better quality are thus obtained. It

may be due to the fact that the wide variations in ink meniscus because of the surface tension effect are not easily produced, whether shooting ink droplets or not, that the edge effect phenomenon of printed patterns is significantly reduced.

According to the present invention, the nozzle should be formed from a metal pipe preferably having an outer diameter in the range of between 0.4 mm and 0.7 mm and an inner diameter in the range of between 0.2 mm and 0.4 mm. The gap between the pointed end of the ink injection nozzle and the drum preferably should be generally between **1** mm and **4** mm.

Tests with a nozzle formed from a metal pipe having an outer diameter of 0.4 mm and an inner diameter of 0.2 mm provided highly satisfactory results.

In the case of another embodiment using the same injection nozzle, except utilizing a metal pipe having an outer diameter 0.55 mm, and an inner diameter of 0.3 mm, substantially the same result was achieved.

Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An injection nozzle for an ink jet printer, comprising a fine pipe having a longitudinal channel for feeding ink therethrough onto a separately positioned paper under the control of an electric field, one end of said pipe being tapered and cut away along an oblique plane toward and through the axis thereof to form a leading edge facing said paper, and both sides of said leading edge being further cut away to form a sharply pointed end for concentrating said electric field.

2. An injection nozzle according to claim **1**, wherein said pipe is made of metal and said ink has an oily character.

3. An injection nozzle according to claim **1**, wherein the outer diameter of said pipe is on the order of between 0.4 mm and 0.7 mm, the inner diameter is on the order of between 0.2 mm and 0.4 mm, and the gap between said pointed end and said paper is approximately between 1.0 and 4.0 mm.

4. An injection nozzle according to claim **1**, wherein the cutting angle of said pipe to the axis thereof when obliquely cut is in the range of from 30° to 60°.

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