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Kashio

[11] **3,776,461**

[45] **Dec. 4, 1973**

[54] **NOZZLE DEVICE FOR INK JET PRINTING EQUIPMENTS**

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[52] **U.S. Cl.** **239/125,** 239/15, 239/103

[51] **Int. Cl.** **B05b 9/00**

[58] **Field of Search** 239/3, 15, 101, 102, 239/103, 125, 124, 126

[56] **References Cited**

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Attorney—Allison C. Collard

[57] **ABSTRACT**

A nozzle device for ink jet printing equipments having a tube whose open end constitutes an ink nozzle exit wherein there is provided a protective member in which there is formed an extremely narrow slit extending horizontally inward from its end face, said slitted member being fitted around the periphery of the tube with the nozzle portion thereof exposed so as to allow the ink excessively flowing out of the exit end of the nozzle to be sucked into the slit by the capillary suction afforded thereby.

4 Claims, 9 Drawing Figures

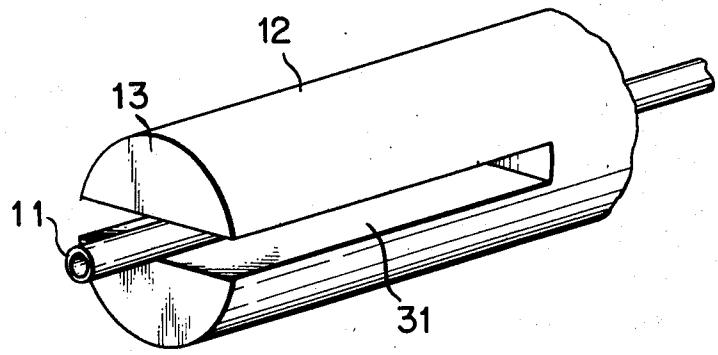


FIG. 1A
PRIOR ART

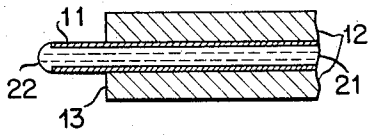


FIG. 1B
PRIOR ART

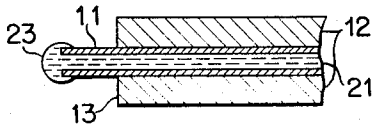


FIG. 1C
PRIOR ART

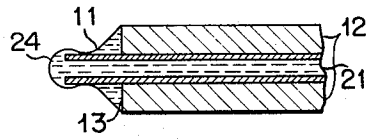


FIG. 1D
PRIOR ART

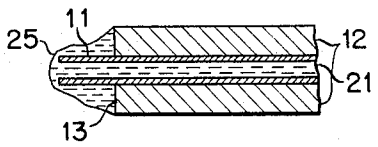


FIG. 2

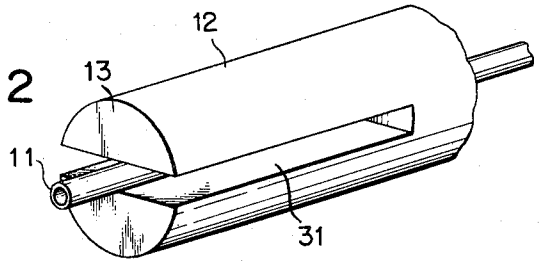


FIG. 3

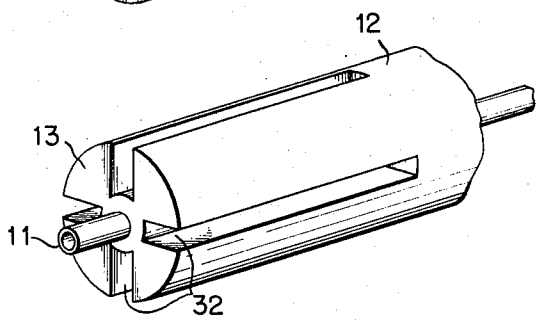
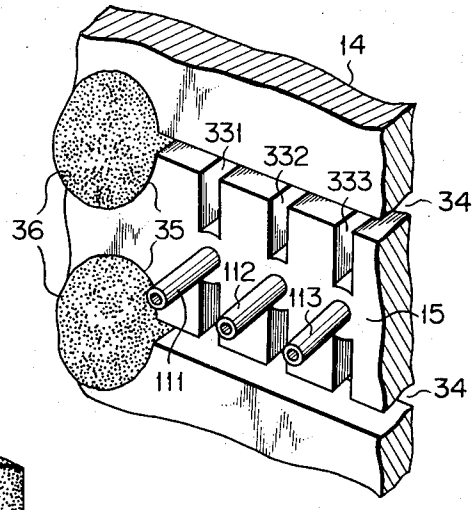


FIG. 4



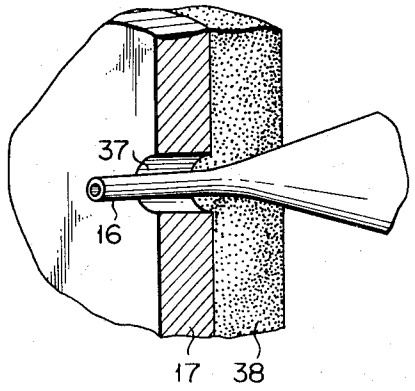


FIG. 5

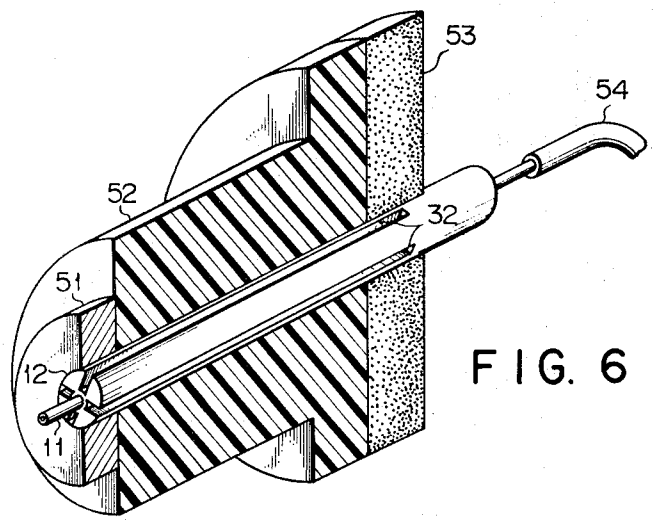


FIG. 6

NOZZLE DEVICE FOR INK JET PRINTING EQUIPMENTS

This invention relates to a nozzle device for ink jet printing equipments. An ink jet printing equipment known to date comprises a nozzle device consisting of a narrow tube into which there is supplied ink at a pressure and suction means which draws ink out of the nozzle by means of an electrical field, magnetic field or supersonic waves and jets the ink in very fine particles on to a medium of recording. The prior art ink nozzle device consists, as shown in FIGS. 1A to 1D, of an extremely narrow tube **11**, 0.15 mm in outer diameter whose open forward end constitutes a nozzle outlet through which to jet ink, and a protective member **10** surrounding said narrow fragile tube. Into this tube is supplied ink **21** at a hydrostatic pressure. As illustrated in FIG. 1A, there is presented the meniscus **22** of ink at the forward end of the tube **11** corresponding to an equilibrium between the hydrostatic pressure prevailing inside the nozzle and the surface pressure of the ink **21.** When the ink is subjected to a suction acting in the forward direction of the nozzle where there is formed such meniscus, then the meniscus is deformed and finally broken to pieces, so that the ink is ejected in very fine particles.

However, external vibrations imparted to the nozzle or unduly high hydrostatic pressure applied to the ink sometimes prevents it from forming the desired meniscus indicated by the curve **22** of FIG. 1A. In such case, ink runs over even the peripheral surface of the tube **11** and is collected thereon as illustrated by the curve **23** of FIG. 1B. In extreme cases, the ink is deposited, as shown by the curves **24** and **25** of FIGS. 1C and 1D, on not only the peripheral surface of the tube **11** but also the forward end face **13** of the protective member **12.** Under such conditions, the ink does not form the desired meniscus, failing to be ejected properly in uniform particles. Particularly in the cases of FIGS. 1C and 1D, the ink can not be jetted at all. With the conventional ink jet printing equipment, therefore, it was necessary to take out the nozzle for washing each time the ink fails to jet freely.

It is accordingly the object of this invention to provide an ink nozzle device wherein, in case ink unduly runs over the peripheral surface of the nozzle, such excess deposition can be naturally removed by the capillary suction afforded by the very narrow slit formed in the neighboring member, thereby enabling the ink always to present the desired meniscus and be ejected in uniform particles under a stable condition.

According to the present invention this object is attained by providing an ink sucking slit extending in the neighborhood of the peripheral surface of the opposite side of the nozzle to its exit end.

Therefore, the ink nozzle device according to the invention provides an ink jet printing equipment which performs printing under very stable conditions against, for example, external vibrations and eliminates the necessity of carrying out a time-consuming operation of frequently taking out the nozzle for washing in order to remove ink attached to the periphery thereof.

The present invention can be more fully understood from the following detailed description when taken in conjunction with reference to the appended drawings, in which:

FIGS. 1A to 1D are sectional views of the nozzle device, showing the various forms of ink occurring during operation; FIGS. 2 to 4 are perspective views of the nozzle devices according to the embodiments of the invention;

FIG. 5 is a perspective view, partly in section, of a nozzle device according to another embodiment of the invention; and

FIG. 6 represents the case where an ink nozzle device according to the embodiment of FIG. 3 is put to practical application.

FIG. 2 represents a first embodiment of this invention. A tube **11** whose open forward end constitutes the exit end of an ink nozzle cosists, for example, of an extremely narrow glass tube about 0.1 to 0.12 mm in inner diameter and 0.135 to 0.155 mm in outer diameter. This glass tube **11** is surrounded for protection by a protective member **12** consisting of a round metal rod so as to have its open forward end project to the outside about 0.5 mm. The protective member **12** has an elongated ink sucking slit **31** about 0.15 mm wide extending horizontally inward from its end face **13** in a manner to divide the protective member **12** into two parts. Said slit **31** protects the tube **11** by holding it therein. Accordingly, the ink excessively flowing out of the open forward end of the tube and deposited on the peripheral surface of the tube **11** up to the forward end face **13** of the protective member **12** is immediately drawn or sucked into the metal walled slit **31** by the capillary suction afforded thereby. It is further preferred to coat a water-repellent material on the peripheral surface of the exposed portion of the tube **11** so as to prevent ink from continuously settling thereon. This holds true with the following embodiments.

FIG. 3 illustrates a nozzle device according to another embodiment of the invention. As in FIG. 2, the tube **11** is formed of an extremely narrow glass tube, which is inserted into a protective member consisting of a round metal rod so as to have its forward end project to the outside about 0.5 mm. This protective member **12** has four elongated ink sucking slits **32** about 0.15 mm wide formed in the peripheral surface so as to extend horizontally lengthwise from the forward end face **13** of said member **12,** with the bottom of each slit **32** disposed near the peripheral surface of at least that part of the tube which faces the forward end surface of said protective member **12.** The embodiment of FIG. 3 is characterized in that the protective member **12** has a greater mechanical strength than that of FIG. 2.

FIG. 4 indicates a nozzle device according to still another embodiment of the invention. This embodiment has a plurality of juxtaposed tubes **111** to **113,** which are each formed of a glass tube as in FIG. 2 and inserted into a protective member **14** consisting of a metal plate so as to have the forward end project to the outside about 0.5 mm from said metal plate. An ink nozzle device provided with such plural tubes is used with a recorder which records a plurality of letters at the same time. Said metal plate **14** includes ink drawing or sucking slits **331** to **333** whose bottom is disposed near the periphery of said tubes **111** to **113,** a guide groove **34** communicating with all these slits **331** to **333,** and an ink holding cavity **35** in which there is contained a spongy material **36.** The ink excessively running out of the open forward end of the tubes **111** to **113** is sucked into the corresponding slits **331** to **333** and then conducted through the guide groove **34** to the

ink holding cavity **35** where the ink is absorbed into the spongy material.

FIG. **5** shows a nozzle device according to a further embodiment of the invention. A tube **16** whose open forward end constitutes the exit end of an ink nozzle consists of a tapered glass tube whose forward end is as narrow as 0.1 to 0.12 mm in inner diameter and 0.135 to 0.155 mm in outer diameter and which grows progressively thicker toward the rear end. Said glass tube **16** is held in the central part of a through hole **37** about 0.5 mm in diameter bored in a metal plate **17** so as to have its forward end project to the outside about 0.5 mm from said metal plate **17.** To the backside of the metal plate **17** is tightly attached, for example, a spongy material **38** to allow the tube **16** to be inserted therethrough. The ink flowing out of the open forward end of the tube **16** is sucked into a groove defined by the outer peripheral wall of the tube **16** with the inner wall of the through hole **37** of the metal plate **17** and conducted to an ink absorber disposed behind the metal plate **17** and formed of a spongy material **38.**

FIG. **6** represents the case where an ink nozzle device according to the embodiment of FIG. **3** is put to practical application. An ink nozzle device consisting of a tube **11** having an open forward end acting as a nozzle exit end and a protective member provided with ink sucking slits **32** is inserted into a nozzle holder **52.** The ink sucking slits **32** extend lengthwise of the protective member **12** up to an ink absorbing member fitted to the rear end of the nozzle holder **52** and formed of, for example, a spongy material **53.** To the forward end of the nozzle holder **52** is attached a metal nozzle plate **51.** The ink nozzle device illustrated in FIG. **6** is used with an ink jet printing equipment which ejects ink using a electrostatic field. Said nozzle plate **51** is intended to elevate the action of an electrical field generated ahead of the tube **11.** To the rear end of the tube **11** is fitted an ink supply pipe **54.** The ink running out of the nozzle is immediately drawn or sucked into the slits **32** and conducted therethrough rearward of the nozzle holder **52** by the capillary suction afforded by said slits **32** up to the ink absorbing member **53** where the ink is preserved.

In the embodiments of the present invention described above, electrostatic pressure is impressed on the ink to let the ink be kept in the desired meniscus when it is jetted out of the nozzle front so that a high potential difference is created between the ink kept in such meniscus and an electrode disposed apart from the nozzle front end, thereby generating electrostatic attraction so that ink droplets of the ink having the desired meniscus are jetted to produce printing letters and the like on the recording medium.

While only several embodiments of the present invention have been shown and described it will be obvious to those persons of ordinary skill in the art that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention.

What is claimed is:

1. A nozzle device for ink jet printing equip-ment comprising:

a nozzle tube for jetting out ink droplets; and

a protective member disposed about the length of said nozzle tube and leaving an exposed discharge tip of said nozzle tube, said protective member having at least one capillary peripheral slit extending from the end near the discharge tip of said nozzle tube to a rearward portion near the other end of said protective member so that excessive ink collecting at the discharge tip of said nozzle tube will be drawn by capillary action through said at least one capillary peripheral slit away from the exposed discharge tip.

2. A nozzle device for ink jet printing equipment comprising:

at least one nozzle tube for jetting out ink droplets; and

a substantially planar member having at least one aperture through which said at least one nozzle tube is concentrically disposed so as to exit on one side thereof, said at least one nozzle tube positioned therein to leave a capillary cylindrical space that is interposed between said at least one aperture and said at least one nozzle tube so that excessive ink collecting at the discharge tip of said at least one nozzle tube will be drawn by the capillary action away from the discharge tip.

3. A nozzle device for ink jet printing equipment comprising:

a nozzle tube for jetting out ink droplets;

a cylindrically-shaped protective member concentrically disposed about the outside periphery of said nozzle tube and leaving an exposed discharge tip, said protective member having at least one capillary peripheral slit extending from the forward face near the discharge tip of said nozzle tube rearward to near the other end of said protective member;

a substantially cylindrically-shaped support member positioned about and exposing a portion of said protective member and having an aperture disposed concentrically therethrough, said aperture of approximately complimentary diameter to said protective member so as to receive the outside periphery thereof; and

a cylindrical nozzle plate of smaller diameter than said support member and extending therefrom, and concentrically positioned about the exposed portion of said protective member, said nozzle plate having a centrally disposed aperture substantially complimentary with the outer periphery of said protective member so that as ink is ejected through the discharge tip of said at least one nozzle tube any excess ink will contact and be drawn through said at least one capillary peripheral slit by the capillary action thereof.

4. The nozzle device as in claim **2** wherein disposed about said other end of said protective member is a sponge communicating with a portion of said at least one capillary peripheral slit to absorb the ink that is drawn therethrough.

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