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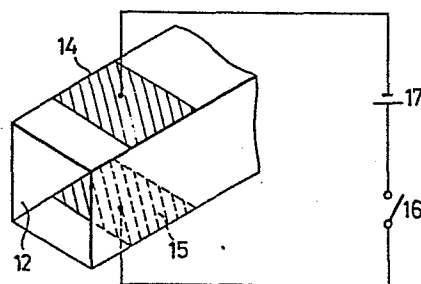
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54 Ink jet forming unit.

57 An ink jet forming unit comprising a nozzle 12 which is filled with a water-based ink 18, two electrodes 14, 15, contacting the ink and at least one of which is near the opening through which the ink is jetted, and an interruptible power circuit 16, 17 connected to these electrodes whereby the electrodes electrolyze the water to form a gas bubble 21 which separates an ink droplet 23 from the ink and propels it through the opening under the force of the expanding bubble.

FIG. 2



INK JET FORMING UNIT

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to ink jet forming units in an ink jet printer.

Description of the Prior Art

5 An ink jet printer is advantageous in that it can record data on ordinary sheets, it needs no developing nor fixing, and it generates little noise. Recording systems employed for the printer are roughly classified into (1) a first or continuous type in which ink drops are continuously
10 jetted and are selectively applied to a recording sheet, and (2) a second or pulsed group in which an ink drop is jetted only when printing is effected.

In the continuous group, it is necessary to control the trajectories of ink droplets for instance by a
15 method in which an ink droplet is deflected by charging. Therefore, not only is the control mechanism intricate, but it is also necessary to provide a space for installation of an ink circulation system, so that it is difficult to miniaturize the printer.

20 The recording systems in the pulsed group can be further classified according to principle of operation of forming the ink jet with an ink jet forming unit. In an ink jet forming unit for a so-called "magneto-fluid-graphic" system, a magnetic ink is allowed to rise on a controlling

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recording stylus and it is then attracted by an electric field so that it is jetted. Therefore, in the case where data are recorded in color with the ink jet forming unit, the number of recording colors is limited because the
5 magnetic material has its own color other than the color of the ink and the color of the ink may change as the magnetic material is oxidized. On the other hand, in an ink jet forming unit which performs recording according to a so-called "bubble jet" system, the ink is boiled to form
10 bubbles. Accordingly, the ink must be thermally stable. However, such inks are difficult to prepare.

SUMMARY OF THE INVENTION

Accordingly, an object of this invention is to provide an ink jet forming unit which can record data in
15 desired colors and stably jets ink drops.

The foregoing object of the invention has been achieved with an ink jet forming unit which, according to the invention, comprises: gas producing means for electrolyzing water of a water-based ink to produce a gas;
20 and a nozzle in which an ink drop is formed by the gas and is jetted by the pressure which is provided as the gas expands.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an external view showing a print head
25 using ink jet forming units according to this invention; Fig. 2 is a perspective view showing the essential components of the ink jet forming unit in one of the nozzles

of Fig. 1;

Fig. 3 is an explanatory diagram describing the principle of operation for forming an ink jet with the ink jet forming unit of Figs. 1 and 2;

5 Fig. 4 is a perspective view showing the essential component of one modification of the ink jet forming unit of the invention;

Fig. 5 is an explanatory diagram describing the principle of operation for forming an ink jet with the ink
10 jet forming unit of Fig. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will be described with reference to its embodiments.

Fig. 1 shows the external appearance of a print head.
15 The print head 10 has an aperture plate whose length is substantially equal to the width of a recording sheet (not shown). A number of ink jet forming units are arranged on the aperture plate (the nozzle plate). More specifically, the ink jet forming units are arranged at
20 equal intervals and in a line in the longitudinal direction of the ink jetting surface 1. In the case of a printer which records data on a recording sheet of size "A4" paper with a recording density of 8 lines/mm, a nozzle 12 is associated with each ink jet forming unit
25 and has an opening, each side of which is about 60 μ m. In this case, 1,728 nozzles 12 are arranged at equal intervals of 60 μ m.

Fig. 2 shows the essential parts of the ink jet forming unit. The nozzle 12 is an elongated, insulated and hollow part. The nozzle 12 has upper and lower electrodes 14 and 15 at positions on the inner walls which are slightly backward of the external opening and are positioned such that the electrodes 14 and 15 confront each other. A series circuit consisting of a switch 16 and a DC voltage source is connected between the upper and lower electrodes 14 and 15. When the switch 16 is turned on, the water-based ink (not shown) in the nozzle 12 is subjected to electrolysis, so that the ink comes out in a jet. The upper and lower electrodes 14 and 15 are of a metal such as nickel, silver, nickel-plated iron, or gold- or silver-plated iron. The electrodes are formed in the nozzle by vacuum deposition or other conventional methods.

Fig. 3 shows the principle of forming an ink jet with the ink jet forming unit. Fig. 3(A) shows the standby state of the ink jet forming unit in which the nozzle 12 is filled with ink 18. The ink is supplied from an ink tank (not shown) by capillary action. The ink 18 is prepared by dissolving pigment and electrically conductive material in water. The conductivity of the ink is adjusted to be between 10^{-1} and $10^{-2} \Omega^{-1} \cdot \text{cm}^{-1}$.

Fig. 3(B) shows the initial state of the ink jet forming unit, in which a recording voltage is applied between the electrodes 14 and 15. When a printing pulse of several volts to several tens of volts is applied

between the electrodes 14 and 15, hydrogen is produced from the upper electrodes 14 which is used as a cathode, while oxygen is produced from the lower electrode 15 which is used as an anode. These gases form bubbles 21 and 22. The
5 bubbles 21 and 22 grow abruptly into one bubble as shown in Fig. 3(C). As a result, the ink column is separated into two parts near the opening; that is, an ink part 18A is formed and separated from the remaining ink 18 by the bubbles 21, 22. The ink 18A is moved outwardly as bubbles
10 21 and 22 grow and coalesce, and is finally jetted as an ink droplet 23 as shown in Fig. 3(D).

The above-described operation is accomplished in one microsecond to several hundreds of micro-seconds in which the printing pulse is applied. The ink droplet 23
15 strikes a recording sheet which is spaced slightly away from the ink jet forming unit, thus printing one dot. In practice, a number of ink jet forming units of the print head 10 are selectively driven according to a picture signal, to record data for one line in a single action.
20 When the recording of one line is achieved, the recording sheet or the print head is moved a distance of one line in the secondary scanning direction, so that the next printing operation can be started. At this time, the ink 18 in the nozzle 12 is restored by
25 capillary action as shown in Fig. 3(A).

With these ink jet forming units, printing can be

achieved at a frequency of about 1 kHz if the printing pulse voltage and the size of the ink droplet are set to suitable values. This recording speed is sufficiently high for desired operation. It is unnecessary for the ink to contain
5 magnetic material, and the ink can be used at room temperature. As a result, the ink can be used for a long period of time without any changes in the ink.

Fig. 4 shows one modification of the nozzle of the ink jet forming unit according to the invention. The nozzle 25
10 is made up of the lower electrode 16 and insulated inner walls. A metal plate, or a metal bar, which is made of nickel or the like is arranged in the ink passageway which is linked to the ink tank. The metal plate in the passageway is the other electrode.

15 Fig. 5, arranged similarly to Fig. 3, shows the principle of operation for forming an ink jet with the ink jet forming unit in Fig. 4. In Fig. 5, those components which have been described with reference to Fig. 3 are therefore designated by the same reference numerals, and
20 their detailed descriptions are omitted. In this modification, the lower electrode 15 is remote from the other electrode, and only the bubble 22 produced from the lower electrode 15 is directly utilized for jetting an ink drop. Accordingly, in order to obtain the same
25 recording speed as that of the above-described embodiment under the same conditions as those of that embodiment, it is necessary to slightly increase the printing pulse

voltage. However, the modification is advantageous in that since only the lower electrode 15 is arranged on the inner wall of the nozzle, the ink jet forming unit can be readily manufactured and accordingly the manufacturing cost
5 can be reduced.

In the above-described embodiment, the ink jet forming units are arranged over the entire width of a recording sheet, so that one line of data is recorded in one action. However, when recording should be achieved at
10 an especially high speed, a method may be employed in which one to several tens of ink jet forming units are arranged in a print head, and recording is carried out simultaneously with the parallel ink jet forming units while the print head is moving relative to the recording
15 paper in the main scanning direction. It goes without saying that it is not always required that the nozzle is square or rectangular in section.

As is apparent from the above description, in the invention, the bubbles are formed by electrolysis.
20 Therefore, it is unnecessary to preheat the ink jet forming units, and it is possible to quickly start the recording operation. The ink jet forming unit of the invention is simple in construction, low in manufacturing cost and high in reliability when compared with the conventional one
25 in which an ink drop is jetted by a pressure wave which is provided by an electro-mechanical conversion element.

CLAIMS

1. An ink jet forming unit for use with an ink (18) containing water, comprising:
 - a nozzle (12) containing said ink with an opening in the end thereof; and
 - 5 gas producing means, disposed at least partially within said nozzle for electrolyzing said water in said ink to produce a bubble (21) of gas which forms an ink drop (18A) and jets said ink drop through said opening by the pressure generated by said bubble.
- 10 2. An ink jet forming unit, as claimed in Claim 1, wherein said gas producing means comprises two electrodes (14, 15) contacting said ink.
3. An ink jet forming unit, as claimed in Claim 2, wherein said gas producing means further comprises a circuit
15 attached across said electrodes comprising a controlled power source (16, 17).
4. An ink jet forming unit, as claimed in Claim 2, wherein only one of said electrodes is arranged near said opening.
- 20 5. An ink jet forming unit, as claimed in Claim 2, wherein both said electrodes are arranged near said opening.
6. An ink jet forming unit, as claimed in Claim 1, comprising a plurality of said nozzles arranged parallel to one another and a plurality of gas producing means, each
25 associated with a separate nozzle.

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FIG. 1

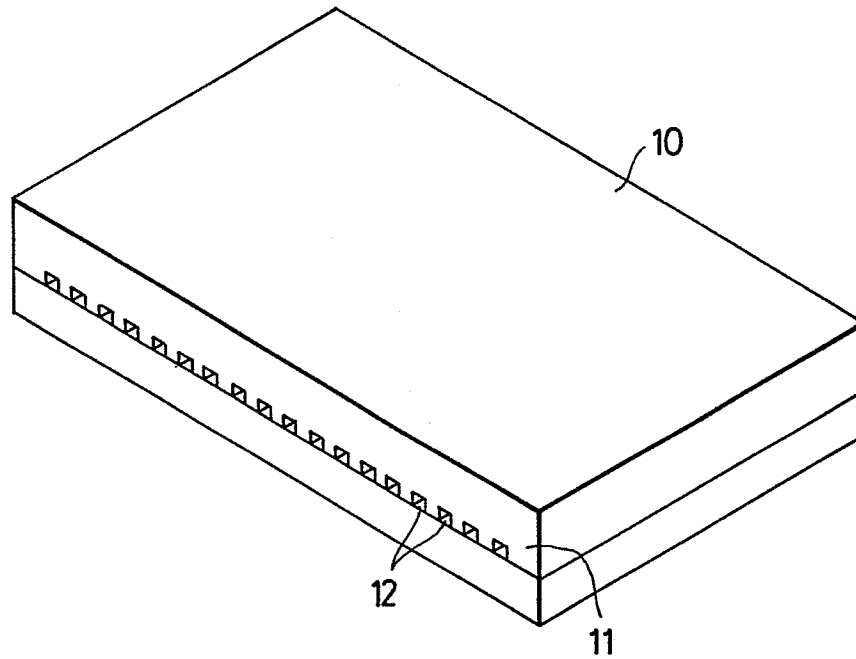


FIG. 2

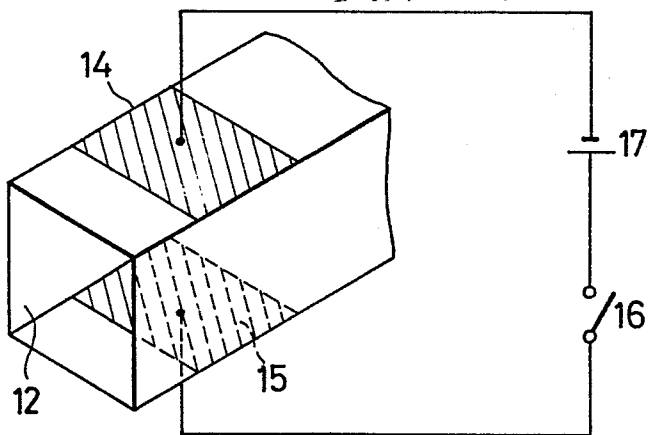


FIG. 4

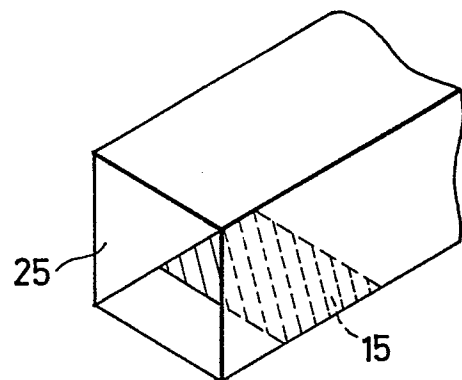
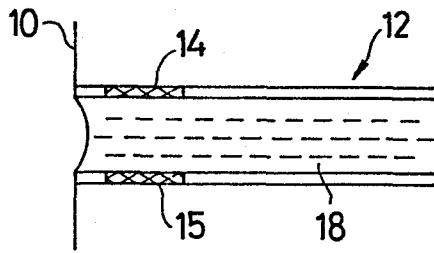
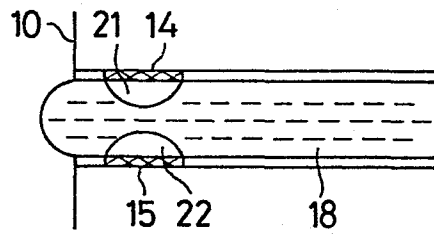


FIG. 3

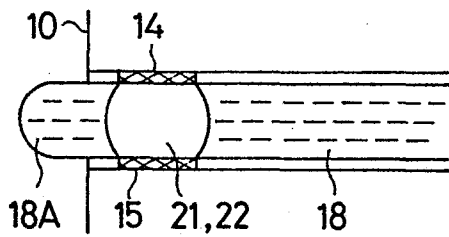
(A)



(B)



(C)



(D)

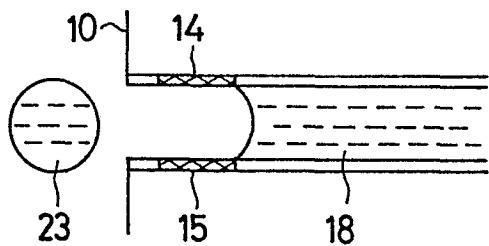
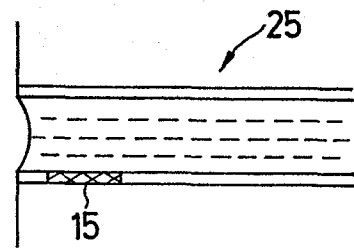
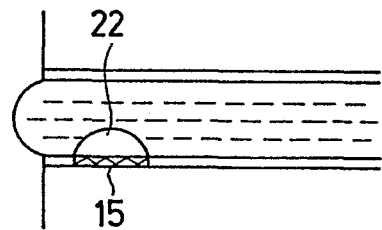


FIG. 5

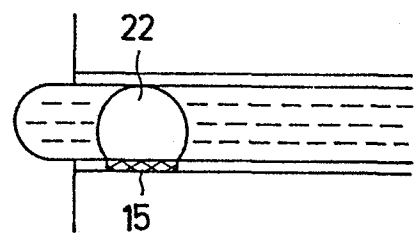
(A)



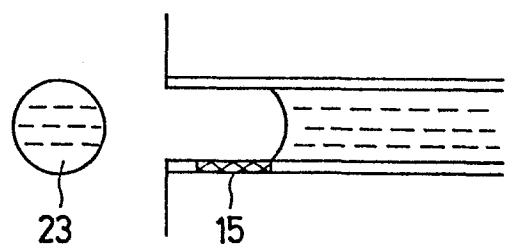
(B)



(C)



(D)





DOCUMENTS CONSIDERED TO BE RELEVANT			EP 83111510.0
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	DE - A1 - 3 228 887 (HEWLETT-PACKARD) * Fig. 1-4; page 8. lines 7-34, page 9, lines 1-16 * --	1-3,5	B 41 J 3/04
A	DE - A1 - 2 943 164 (CANON KK) * Fig. 1,8 with description * --	1,6	
A	EP - A1 - 0 014 918 (SMH-ADREX) * Fig. 4 with description * ----	1,6	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			B 41 J 3/00 G 01 D 15/00
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 18-05-1984	Examiner WITTMANN
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			