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FLUID TRANSFER DEVICE

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8 Claims

ABSTRACT OF THE DISCLOSURE

In an electrostatic printer, uncharged ink is supplied under pressure from a nozzle vibrated by a piezoelectric crystal to provide a supply of uniformly shaped ink droplets directed through a charging ring which causes a predetermined charge to be placed on selected droplets in accordance with input signals applied to the ring. The droplets then pass through a pair of vertical deflection electrodes having a D-C field applied thereacross, so that the charged droplets are deflected into a different path from the path followed by the uncharged droplets, with the charged droplets passing through an aperture in a mask while the uncharged droplets strike the mask causing them to be intercepted. The charged droplets then are accelerated by an accelerating electrode and pass between a pair of horizontal deflection electrodes supplied with sawtooth signals, causing the charged droplets to trace horizontal line segments on paper moving vertically in the path of the droplets.

BACKGROUND OF THE INVENTION

With the increasing use of high speed computers and high speed transmission facilities, there has arisen a need for high speed printers capable of recording data as rapidly as it can be produced or transmitted. Although mechanical printers have been designed which are capable of operating at most of the required speeds, such printers inherently require considerable maintainance and are noisy in operation. In order to overcome the disadvantages of mechanical printers electrostatic printers have been developed in which charged particles of ink are variably deflected in accordance with input signals to trace characters on paper placed in front of a platen providing the electrostatic attraction. It has been found that better control of the placement of the ink droplets formed in such a printer can be achieved by vibrating the nozzle at high frequencies or subjecting the stream of ink to high frequency oscillations to provide the synchronous formation of droplets of uniform size.

Two methods of printing with such electrostatic printers have been utilized in the past. In one of these methods, each character is traced in two dimensions through the use of horizontal and vertical deflection electrodes placed in the path which the droplets traverse from the nozzle to the recording medium. This type of printer requires a relatively complex character decoder for decoding permutation-coded input signals into the horizontal and vertical analog signals necessary to form characters.

A second method which has been employed, uses a trace or deflection of the ink droplets in one direction only, while moving the paper in a second direction to provide the required two-dimensional characters. In printers of this type, each of the droplets issuing from the ink jet generator have been variably charged in accordance with the signal to be recorded; with the droplets to be deleted being provided with a maximum or minimum charge of a predetermined value. All of the droplets then pass through a fixed electric field and are variably deflected in accordance with the charge carried by each

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droplet. Those droplets which carry the maximum or minimum deleting charge generally are deflected onto a mask so that they do not reach the recording medium. A problem exists in this type of recording, however, in view of the fact that the charges carried by each of the droplets vary considerably; so that interaction of the widely different potentials between adjacent droplets results in improper deflection of the droplets in such a system.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of this invention, a fluid transfer device is provided using a synchronous ink jet generator for supplying a stream of uncharged droplets of fluid moving in a first path across a space toward a target in the form of paper placed in front of a platen. The droplets pass through a charging ring having a predetermined potential applied to it at selected periods of time in accordance with an input signal, so that selected droplets are charged to a predetermined value with other droplets passing through the ring remaining in an uncharged condition. The droplets then pass through a fixed D-C field established across the path of the droplets, causing the selected charged droplets to be deflected into a different path from that followed by the uncharged droplets, with the uncharged droplets being intercepted. The charged droplets then are accelerated and pass through a cyclically varying field which is established orthogonally to the fixed field, causing the charged droplets to be deflected along line segments of a predetermined length across the paper carried by the platen. Since the paper moves at right angles to the line segments, the horizontal traces of droplets (with predetermined droplets being deleted from the traces) cause the desired indicia to be recorded on the paper.

BRIEF DESCRIPTION OF THE DRAWING

The single figure of the drawing shows a diagrammatic view of a preferred embodiment of the fluid transfer device made according to the invention and used as an electrostatic printer.

DETAILED DESCRIPTION

In the description of the preferred embodiment of this invention the terms "charged" and "uncharged" will be used to define the different states of the droplets of fluid being acted on. These terms are intended to cover electrostatic charges imparted to the fluid in an electrostatic printer or similar fluid transfer device, and also are intended to cover magnetic fluid in the polarized and unpolarized states, with "charged" and "polarized" being considered synonymous and "uncharged" and "unpolarized" being considered synonymous. The principles of this invention may be applied equally as well to the use of magnetic fluids as to the use of fluids which can retain an electrostatic charge.

Referring now to the drawing, there is shown an electrostatic printer using an ink jet generator 10 consisting of a nozzle 11 surrounded by a cylindrical piezoelectric crystal 12 supplied with a source of high frequency A-C signals from a signal generator 13, so that the crystal 12 vibrates the nozzle 11 causing the formation of a succession of uniformly sized droplets. The nozzle 11 is supplied with ink under pressure from a suitable source (not shown) with the ink issuing from the nozzle in an uncharged state. The ink used, however, is chosen to exhibit the characteristic of being capable of carrying an electrostatic charge; and the ink droplets are passed through a charging ring 15 which is supplied with pulses of a predetermined negative potential from a signal source 16. The pulses supplied to the charging ring 15 cause a droplet being formed or passing through the charging ring 15, at the time of the application of a pulse, to be charged with a predetermined electro-

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static charge which is proportional to the value of the pulse applied to the charging ring 15. The charging pulses applied to the ring 15 from the source 16 are in the form of a train of binary pulses, each of the pulses having the same predetermined magnitude; so that droplets which are charged by the charging ring each carry the same predetermined electrostatic charge; and droplets passing through the ring 15 whenever no charging pulse is applied to the ring pass therethrough in an uncharged state.

After the droplets pass through the charging ring 15, all of the droplets are following the same predetermined path and pass between a pair of vertical deflection electrodes 18 having a fixed D-C potential applied thereacross from a battery 19. The droplets carrying the predetermined charge are deflected upwardly by the vertical deflection electrodes 18 into a second predetermined path, while the uncharged droplets are not affected by the field between the electrodes 18 and continue to follow the original path along which they were directed upon issuance from the nozzle 11. The charged droplets then pass through an aperture in an intercepting mask 19 and are accelerated through an aperture in an accelerating electrode 20 which has a positive D-C accelerating potential applied thereto from a battery 21. The uncharged droplets, however, strike the mask 19 just below the aperture therein and run off the mask 19 into a suitable collection or recovery receptacle 21. In the absence of any additional signals acting upon the charged droplets passing through the aperture in the accelerating electrode 20, the droplets continue to be accelerated toward the same point on a platen 25 which is at a higher positive potential than the accelerating electrode 20 caused by connecting an additional battery 22 between the electrode 20 and the platen 25. The platen 25 rotates in the direction shown by the arrow, carrying with it a suitable recording medium 26; so that straight line traces of the charged droplets, intermittently broken where uncharged droplets were deleted from the stream by striking the mask 19, are formed on the recording medium 26.

In order to record meaningful indicia on the recording medium 26, a sweep generator 28 (preferably a sawtooth generator) supplies a cyclically varying potential across a pair of horizontal deflection electrodes 29 to create a cyclically varying horizontal deflection field between the horizontal sweep electrodes 29. Thus, the charged droplets are caused to trace horizontal line segments on the moving recording medium 26 under the influence of the signals supplied to the sweep electrodes 29. The sweep generator 28 is operated in synchronism with the signal source 16, so that the deletion of droplets from the stream of droplets issuing from the nozzle is accomplished at such times in the horizontal sweep as to cause the appearance of blank spaces on the recording medium 26 during that portion of the horizontal traces in which no ink is desired to be applied to the recording medium 26. By controlling the pattern of the charging pulses applied to the charging ring 15 from the signal source 16, it is possible to form any desired two-dimensional indicia on the moving record medium 26.

Since all of the charged droplets carry a uniform charge, the interaction of electrostatic forces between adjacent droplets is uniform; so that it is possible to control accurately the quality of the indicia recorded. In addition, since the intercepted droplets carry no electrostatic charge, there is no charge build up on the intercepting mask 19 which can interfere with the proper placement of the charged droplets passing through the aperture in the mask 19.

What is claimed is:

1. A fluid transfer device including:

- a source of fluid droplets, said droplets moving along a substantially straight line;
- a mask intercepting said straight line;
- means for deflecting selected ones of the droplets out

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of said straight line causing the selected droplets to avoid interception by the mask; and means for accelerating the droplets that have been deflected out of straight line.

2. A fluid transfer device including:

- means for supplying a stream of droplets of fluid, said droplets moving in a first path across a space;
- means for imparting a predetermined charge to a selected droplet in the stream;
- means for establishing a fixed field across the first path to deflect the selected, charge droplet into a second path;
- means located in the first path for intercepting the droplets moving in that first path; and
- means for accelerating the droplets moving in the second path.

3. A device according to claim 2 further including means for establishing a cyclically varying field across the second path to cause the selected, charged droplet to be deflected along a line segment of a plane intersecting the second path.

4. A device according to claim 3 wherein the cyclically varying field is established orthogonally to the fixed field.

5. A fluid transfer device including:

- means for supplying a stream of droplets of fluid;
- means for imparting a predetermined charge to selected droplets of the stream;
- a source of signals for controlling the charge imparting means;
- intercepting means for intercepting the non-selected droplets from the stream of droplets;
- deflecting means for imparting a predetermined deflection to the selected droplets carrying the predetermined charge to cause the selected droplets to bypass the intercepting means; and
- second deflecting means for imparting a cyclically varying sweep deflection to the selected droplets.

6. A device according to claim 5 wherein the deflection imparted to the droplets by the second deflecting means is substantially orthogonal to the predetermined deflection.

7. A device according to claim 5 wherein the second deflecting means operates upon the selected droplets after they have bypassed the intercepting means.

8. Apparatus for transferring fluid including:

- means for supplying a stream of droplets of fluid directed along a first path toward a target;
- means for charging the droplets to a predetermined value;
- a source of signals for controlling the charging means so that only selected droplets are charged;
- a first pair of deflection electrodes having a D-C potential applied thereto for establishing a fixed field across the first path to cause the charge droplets to be deflected into a second path;
- an intercepting device located across the first path but out of the second path for intercepting the uncharged droplets; and
- a second pair of deflection electrodes having a cyclically varying potential applied thereacross and located to establish a cyclically varying field across the second path, said cyclically varying field being substantially orthogonal to said fixed field.

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