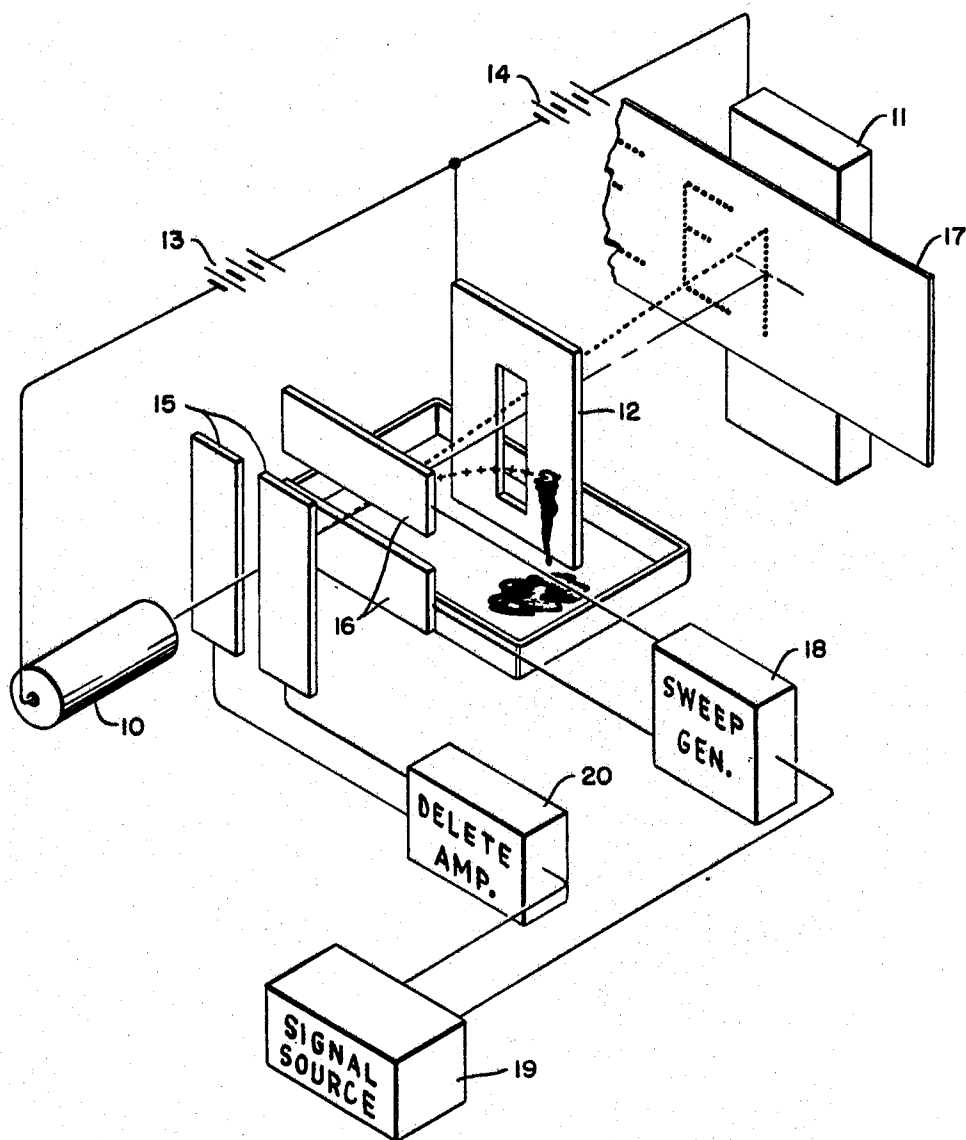


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C. R. WINSTON
FLUID TRANSFER DEVICE
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FLUID TRANSFER DEVICE

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ABSTRACT OF THE DISCLOSURE

In an electrostatic printer, an ink jet generator provides a supply of synchronous ink droplets each carrying a uniform charge, with the droplets being attracted through a slot in a mask electrode to a platen by electrostatic attraction. A pair of vertical deflection electrodes and a pair of horizontal electrodes are placed between the generator and the mask with a sweep generator supplying sawtooth signals to the vertical deflection electrodes to cause the droplets passing through the aperture in the mask to trace vertical line segments on paper moving across the platen. Delete pulses are applied to the horizontal electrodes in accordance with input signals to impart a predetermined horizontal deflection to selected ones of the droplets, causing them to impinge upon the mask, thereby preventing them from reaching the platen.

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 maintenance 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 frequency or subjecting the stream of ink to high frequency oscillations to provide the synchronous formation 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 plates 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 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

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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, an electrostatic printer is provided using a synchronous ink jet generator to supply droplets of uniform size and carrying a uniform charge through a slot in a mask to a platen, with the droplets being attracted to the platens by electrostatic attraction. A pair of vertical deflection electrodes are supplied with a sweep signal preferably in the form of a sawtooth waveform, so that the droplets form vertical traces at the platen on a recording medium moving across the front of the platen at right angles to the vertical traces. A pair of delete electrodes provides horizontal deflection to the droplets where control of delete pulses of a single predetermined magnitude applied to the delete electrodes. The operation of an amplifier supplying signals to the delete electrodes is synchronized with the operation of the sweep generator to delete predetermined ones of the droplets from the vertical traces causing the selected droplets to impinge upon the mask, so that the droplets do not reach the recording medium. Thus, selected droplets are deleted from each vertical trace to form the desired indicia to be recorded.

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

Referring now to the drawing there is shown an electrostatic printer using an ink jet generator 10 to supply synchronous droplets of uniform size and carrying a uniform charge. The charge may be imparted to the ink in the ink jet generator in the manner disclosed in the patent to C. R. Winston, Patent No. 3,060,429, granted Oct. 23, 1962. The uniform size and spacing of the droplets may be obtained by vibrating the nozzle in the generator at high frequency or by imparting periodic disturbances to the ink stream issuing from the nozzle by any other suitable technique.

The droplets issuing from the ink jet generator are accelerated toward a conductive platen 11 through a slot in a conductive mask 12 by means of high voltage attraction created by placing the mask 12 and the platen 11 at high positive potentials relative to the potential applied to the ink in the ink jet generator. This is illustrated in the drawing by showing a first battery 13 connected between the ink jet generator 10 and the mask 12 and a second battery 14 connected in series with the battery 13 between the mask 12 and the platen 11.

A pair of delete electrodes 15 and a pair of vertical sweep electrodes 16 are placed between the ink jet generator 10 and the mask 12. In the absence of any signals applied to either of these sets of electrodes, the droplets issuing from the ink jet generator pass through an aperture or slot in the mask 12 and impinge upon a single point on a recording medium 17 placed in front of the platen 11. When the recording medium 17 is moved in the direction of the arrow, these droplets then trace a horizontal line along the length of the recording medium 17. The droplets issuing from the ink jet generator 10, however, are subjected to a cyclically varying vertical deflection field created between the sweep electrodes 16 by a sweep generator 18, which preferably supplies signals having a sawtooth or staircase waveform to the electrodes

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16. Thus, the droplets trace vertical line segments on the moving recording medium 17 under the influence of the signals supplied to the sweep electrodes 16.

In order to record meaningful indicia on the recording medium 17, a signal source 19 supplies signals to a delete amplifier 20 in synchronism with the operation of the sweep generator 18. These signals cause delete voltage pulses of a fixed amplitude and of varying durations to be applied to the delete electrodes, causing any droplets passing between the delete electrodes 15 at the time the pulses are applied to be deflected horizontally onto the mask 12, as indicated by the line of X's in the drawing. The interception of these droplets by the mask 12 then results in the appearance of blank spaces on the recording medium 17 during that part of the vertical traces when the delete signal is applied to the electrodes 15. The duration of the delete pulses applied to the electrodes 15 determines the number of ink droplets which are intercepted by the mask; and by controlling the size and duration of the delete pulses with respect to the vertical sweep applied to the sweep electrodes 16, it is possible to form any desired two-dimensional indicia on the moving recording medium 17. Since all of the droplets are of uniform charge, uniform interaction between droplets occurs, so that it is possible to control, accurately, the quality of the indicia recorded.

It will be apparent from the foregoing description that the vertical and horizontal electrodes could be interchanged in location and that the vertical sweep electrodes could be interchanged in position with the mask 12. In addition, although the invention has been illustrated as being used in an electrostatic printer, it also may be employed for measuring precise amounts of fluid to be delivered to a target; and the target could be located at the platen 11 or at the mask 12, with recovery of the measured droplets being made at one position and the other position being utilized to recover unwanted or waste droplets. It also should be apparent that the recording medium could be moved vertically, with horizontal traces being provided by the sweep electrodes in place of the vertical traces illustrated. If such a modification were made, the delete electrodes then would be the vertical electrodes and the sweep electrodes would be the horizontal electrodes, with suitable modifications being made to the mask.

Since other modifications of the fluid transfer device varied to fit particular operating conditions will be apparent to those skilled in the art, the invention is not considered limited to the embodiment chosen for purposes of disclosure, and encompasses all changes and modifications which do not depart from the true scope of the invention.

I claim:

1. A fluid transfer device including:
 - means for generating a stream of uniformly charged droplets of fluid flowing serially in a path having a nominal axis;
 - a first deflection electrode;
 - means for applying a cyclically varying sweep signal to the first deflection electrode to cause the droplets to be distributed along a line segment in a first plane containing the axis;
 - a second deflection electrode;
 - a mask having an aperture extending in the direction of the first plane, a face positioned toward the generating means, and positioned substantially in a second

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plane perpendicular to the nominal axis of the path of fluid droplets, wherein droplets normally pass through the aperture; and

means for selectively applying a signal to the second deflection electrode to deflect a selected droplet less than 90° and out of the line segment to a path wherein the droplet impinges upon the face of the mask.

2. A device according to claim 1 wherein the aperture in the mask comprises a slot, the slot being of such dimensions and being so located that only droplets distributed along the line segment pass therethrough.

3. A device according to claim 1 wherein the cyclically varying sweep signal has a sawtooth waveform.

4. A device according to claim 1 wherein the second deflection electrode is positioned at substantially a right angle with respect to the first deflection electrode.

5. A device for transferring ink to a record medium including:

means for generating a sequence of uniformly charged droplets of ink moving in a path across a space toward the record medium;

means for establishing a cyclically varying first field across the path travelled by the droplets to cause the droplets to be deflected along a line segment of a first plane substantially parallel with the record medium and intersecting the path;

a mask extending substantially in a second plane parallel with the first plane and positioned between the first field establishing means and the record medium, the mask having therein a substantially rectangular aperture aligned with the line segment and with the path extending through the aperture, whereby droplets deflected along the line segment pass through the aperture; and

means for establishing a second field substantially perpendicular to the first field and extending across the path at a predetermined time to deflect at least one droplet away from said line segment, and into an intersecting relationship with the mask.

6. A device according to claim 5 wherein the second field establishing means is at least in part located between the generating means and the mask.

7. A device according to claim 5 wherein the first field establishing means comprises:

a pair of deflection electrodes, one on either side of the path; and

a sweep amplifier connected to apply a voltage to each electrode which varies according to a sawtooth waveform and wherein the voltage applied to one electrode differs from a nominal voltage by an amount that is the same magnitude but of opposite sign with respect to the voltage applied to the other electrode.

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