Oct. 11, 1966 E. ASCOLI 3,278,940

ELECTROSTATIC EMITTER FOR WRITING WITH INK JET

Filed Sept. 23, 1963

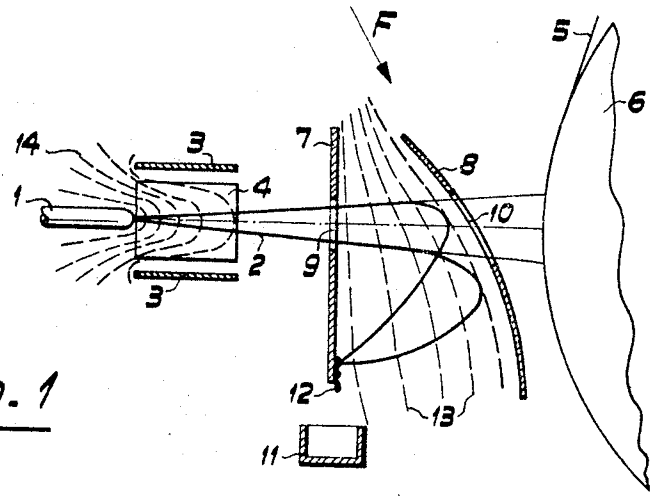

Fig. 1

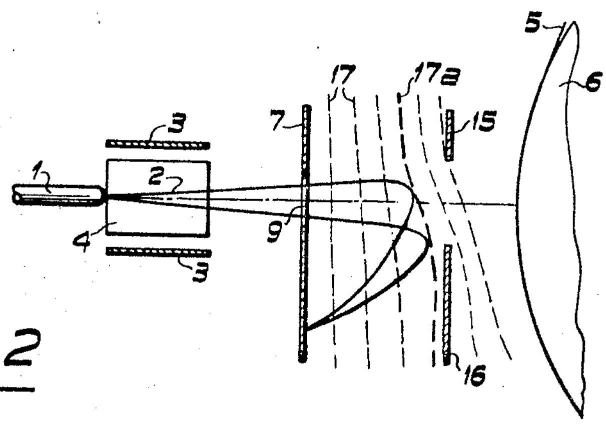

Fig. 2

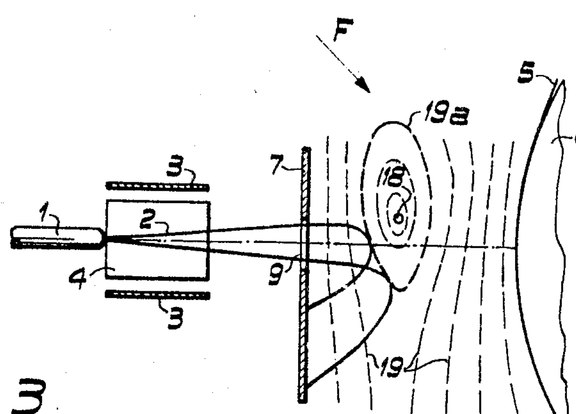

Fig. 3

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United States Patent Office 3,278,940 Patented Oct. 11, 1966

3,278,940

ELECTROSTATIC EMITTER FOR WRITING WITH INK JET

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Filed Sept. 23, 1963, Ser. No. 310,691
Claims priority, application Switzerland, Oct. 8, 1962, 11,808/62
7 Claims. (Cl. 346—75)

This invention relates to an improvement in electrostatic emitters for performing writing with a jet of ink.

There is a known process for writing with an ink jet, wherein the jet spurts from a nozzle which is either fixed or animated with a predetermined movement, the jet itself being deviated electrostatically or electromagnetically to trace the desired sign. An emitter for this process consists principally of a base of insulating material which supports a metal capillary tube fed with ink, and four deflector plates disposed symmetrically in opposing pairs around the axis of the tube and in front thereof. The difference between the potential of the tube and the mean potential of the plates creates an axial electric field which removes particles of ink, carrying electric charges, at the end of the tube, and accelerates the latter, forming a jet which strikes the writing surface. This jet then passes between the deflector plates and the potential difference between two opposing plates creates a transverse electric field which deflects the path of the jet. Thus, by applying suitable voltages between the deflector plates, it is possible to control the direction of the jet to have it trace the desired sign.

When the writing is not continuous but includes intervals of space between the different consecutive signs to be traced, it appears that the emission of ink particles is not satisfactory at the moment of starting the emission, and the jet shows a substantial dispersion for a few milliseconds each time it is restarted. This dispersion would be manifested by a light mark on the writing surface if no means is provided to prevent it.

As proposed in Belgian Patent No. 577,784, for example, a recording apparatus projects a jet of ink from a tube by means of an electric field, continuously, and applies a blocking voltage on a stop electrode disposed between the tube and the writing surface, and having a hole traversed by the ink jet. In this construction, the stop electrode is designed to send the jet of ink against an accelerator electrode also having a hole for passage of the ink jet and the result is that this electrode is soiled by the ink, so that after a certain time of operation, its form is altered by the deposit of ink, altering the qualities of emission of the ink jet.

The purpose of the present invention is to avoid the dispersion of the ink jet in a device in which the ink jet is deflected by means of deflector plates or electrodes to permit tracing characters on a writing surface.

Accordingly, the subject of this invention is an electrostatic emitter for writing by an ink jet, comprising an ink nozzle, means for squirting a jet of ink from this nozzle, deflector plates disposed in proximity to the jet to deviate it before it reaches a writing surface. In this case the jet, having to pass at least in proximity to an electrode capable of being brought to a potential that can create an electrostatic field whereof an equipotential surface, substantially equal in value to the potential of the nozzle, is situated between the nozzle and the writing surface, in such a way as to control the ink jet and prevent it from reaching the writing surface. In that connection, the invention is characterized in that the said electrode is disposed in such a way as to create the said equipotential surface, between the deflector plates and the writing surface, obliquely to the axis of the nozzle, to reflect the ink jet in a given direction outside this axis.

In the accompanying drawings:

FIGS. 1 to 3 show, schematically and by way of example, three forms of execution of the subject of the invention.

In the embodiment shown in FIG. 1, the emitter constitutes a tube or nozzle **1** for feeding the ink which leaves the latter in the form of a deploying jet **2** passing between deflector plates **3** and **4** and ultimately ending on a sheet **5** disposed on the surface of a roller **6**.

Between the deflector plates **3** and **4** and roller **6** there are disposed a first electrode **7** and a second electrode **8**, each respectively having a hole **9**, **10** for passage of the ink jet which is to reach sheet **5**. The hole **10** in electrode **8** is aligned with hole **9** in electrode **7** and the nozzle of tube **1**. Below electrode **7** there is a channel **11** which is designed to collect the ink that may accumulate and make droplets **12** at the base of electrode **7** which in this embodiment serves as a target to receive the ink jet during start-up.

Means, not shown, permit applying to the electrode **7** a potential substantially equal to the mean potential of the deflector plates **3** and **4**. Means also applying as desired, to the electrode **8**, a potential substantially equal to that of electrode **7** or a potential substantially equal to that of tube **1** are provided.

When electrode **7** and electrode **8** are at the same potential, the electric field between these electrodes is zero and produces no deviation of the ink particles striking the paper **5**. On the contrary, when electrode **8** is brought to a potential substantially equal to that of tube **1**, the result is an electric field between electrodes **7** and **8**, of which field the equipotential surfaces are shown schematically by lines **13**. This electric field constitutes an electrostatic mirror which reflects the particles of ink from jet **2** against the bottom part of electrode **7**. Thus, as droplets of ink **12** form at the bottom edge of electrode **7**, they fall into channel **11**.

To prevent particles of ink from coming in contact with electrode **8**, it is advantageous for the potential difference between the latter and electrode **7** to be slightly greater than the potential difference between the latter and tube **1**. Thus, the equipotential surface whose value is equal to the potential of the nozzle, is situated between the electrodes **7** and **8** and obliquely intersects the axis of the nozzle.

In the device described, the combination for deviating the jet of ink to prevent it from reaching the paper **5** at the moment the priming of the jet is arranged in such a way that there is no disturbance of the electric field between the tube **1** and the deflector plates **3** and **4**. This field is represented schematically by its equipotential surfaces **14**. It is pointed out that the visibility in direction or arrow F is scarcely blocked by the presence of electrode **8**, which constitutes the stop electrode.

Each time the jet **2** is interrupted, it is controlled, when it is started up, by means not shown, by the application of the desired potential to electrode **8** to insure the deviation of the jet and its reflection toward electrode **7**. The priming of the jet can therefore take place without difficulty, because the focussing errors which occur at this instant have no effect on the cleanliness of the work. Moreover, these focussing errors can be compensated, at least in part, as a result of the convergence of the electrostatic mirror. After a very short time, on the order of a few milliseconds, electrode **8** is suddenly brought to the potential of electrode **7** and the jet, well under way, can pass through holes **9** and **10** to trace the desired sign on paper **5**. Note, too, that the voltages for deviation of the jet in order to form the sign to be traced can be

applied to plates 3 and 4 while the electrostatic mirror is still active.

The embodiment shown in FIG. 2 also includes tube 1, deflector plates 3 and 4, electrode 7 with hole 9 and roller 6 bearing the paper 5 which constitutes the writing surface. Electrode 8, according to FIG. 1, has been replaced, however, by two flat electrodes 15 and 16 which are brought to the same potential as that of electrode 7 during writing. At the moment of start-up of the jet, these electrodes are brought to a potential such that, the potential difference between electrode 7 and these electrodes 15 and 16 is greater than and opposite in sign to the potential difference between electrode 7 and tube 1. The potential difference between electrodes 15 and 7 is slightly greater than that between electrodes 16 and 7. The result of the difference in voltages applied to electrodes 15 and 16 is a dissymmetry of the electric field so that the equipotential surfaces of the field are incurved. These surfaces are designated 17 and are shown more boldly than the equipotential surface 17*a* whose potential corresponds to that of the tube 1. The curvature of the equipotential surfaces produces a deviation of the ink jet, so that the latter is reflected out of the axis of tube 1 and strikes the bottom part of electrode 7. Since the equipotential surfaces present a concavity toward tube 1, they act as a concave mirror and concentrate the particles of ink at a point that is practically stationary, even when the jet is deviated.

FIG. 3 shows another embodiment similar to that in FIG. 1 but in which the stop electrode 8 is simply replaced by a horizontal conductive wire 18 which can be brought to a potential creating an electrical field between this wire and electrode 7 which will be opposite in sign and greater than the electric field between tube 1 and electrode 7. In this form, the equipotential surfaces are designated as 19, while the surface whose potential is equal to that of tube 1 is marked 19*a*. Note that the equipotential surfaces comprised between electrode 7 and the equipotential surface 19*a* have a convexity toward tube 1, in such a way that there results a slight dispersion of the ink jet when the latter is reflected. This dispersion does not cause any inconvenience, however, because the bottom part of electrode 7, or any other part designed to receive the deviated jet can be made large enough to fulfill its role. In this last form of the invention, the potential to be applied to wire 18 is higher than in the preceding forms, but the visibility on the direction of arrow F is still greater than that obtained in the form of execution according to FIG. 1.

As a variation, it is possible to select a target other than the bottom part of electrode 7 to receive the ink jet during start-up. In this case, the form of electrode 8 in FIG. 1 could be selected to converge the ink jet directly into channel 11. We could even completely eliminate the target in the event the jet of ink can be deviated in a direction in which it can cause no damage.

I claim:

1. An electrostatic emitter for writing by ink jet 2, comprising an ink nozzle 1, means for squirting an ink jet 2 from this nozzle 1, deflector plates 3, 4 disposed in proximity to the jet 2 to deviate it before it reaches a writing surface 5, this jet 2 having to pass at least in proximity to electrode means 8, 15, 16, 18 which can be brought to a potential capable of creating an electrostatic field, whereof an equipotential surface 17*a*, 19*a* of value substantially equal to the potential of nozzle 1 is provided between the nozzle 1 and the writing surface 5 in such a way as to reflect the ink jet 2 and prevent it from reaching the writing surface 5, characterized in that the said electrode 8, 15, 16, 18 is disposed to create the said equipotential surface 17*a*, 19*a* between the deflector plates 3 and 4 and the writing surface 5, obliquely to the axis of the nozzle 1 to reflect the ink jet 2 in a given direction outside this axis.

2. An emitter according to claim 1, which comprises a target disposed in the path of the ink jet 2 which is reflected.

3. An emitter according to claim 2, wherein, an element 11 is disposed under the target and designed to collect the ink 12 which can flow therefrom.

4. An emitter according to claim 1, wherein said electrode means comprises a first and second electrode 7, 8 disposed between the deflector plates 3, 4 and the writing surface 5 with said first electrode disposed adjacent said deflector plates 3, 4 and each of said electrodes 7, 8 having an opening 9, 10 respectively for passage of the jet 2 when it is not reflected.

5. An emitter according to claim 4, wherein a prolongation of said first electrode constitutes a target disposed in the path of the ink jet 2 which is reflected.

6. An emitter according to claim 4, wherein, the second electrode 8 is disposed obliquely to the first 7.

7. An emitter according to claim 1, wherein said electrode means includes a first electrode 7, having an opening 9 for passage of the jet when it has left the deflector plates 3, 4 and two other electrodes 15, 16 disposed between said first electrode and the writing surface 5 and capable of being brought to different potentials relative to said first electrode to create the said equipotential surface 17*a*.

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