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Hinz

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[54] DEVICE FOR DIRECT ELECTROSTATIC RECORDING USING A SPRAY ELECTRODE

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[58] Field of Search 346/74 ES, 74 S, 74 SB, 346/74 TP; 178/6.6 A

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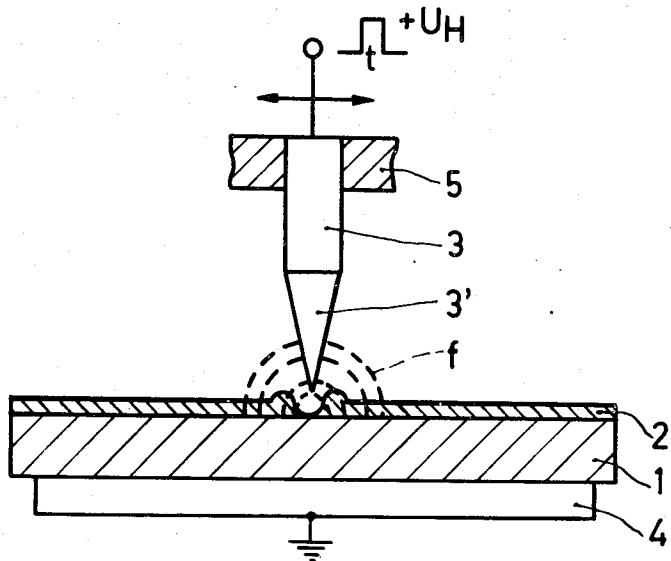
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[57] ABSTRACT

A device for direct electrostatic recording in which conductive toner material is removed from a record carrier by way of an electric voltage applied to spray electrodes. The spray electrode has a tip which almost touches the toner material, and the voltage applied to the electrode is chosen such that the force of adhesion of the toner material is overcome only directly underneath the tip. The charged toner material is attracted by the electrode and is subsequently deposited adjacent the location on the record carrier from which the toner material has been removed.

2 Claims, 4 Drawing Figures



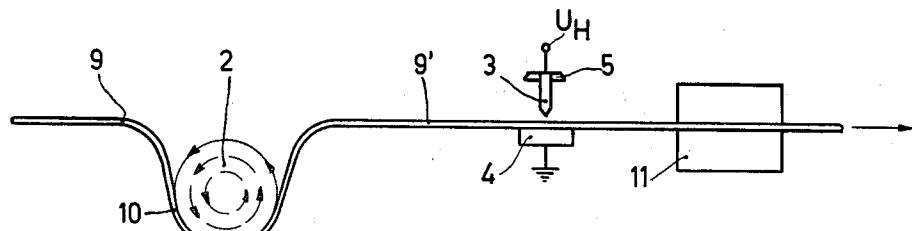
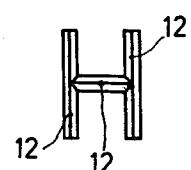
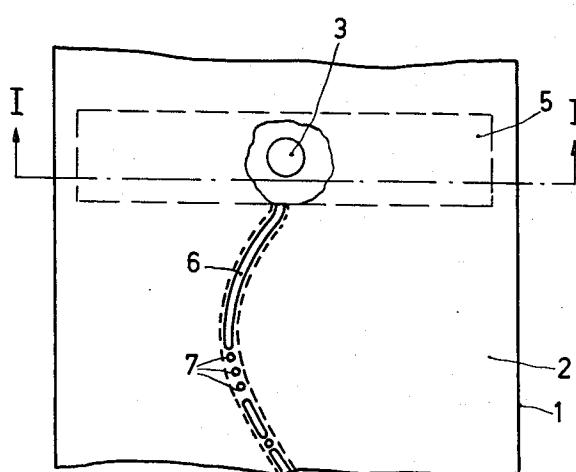
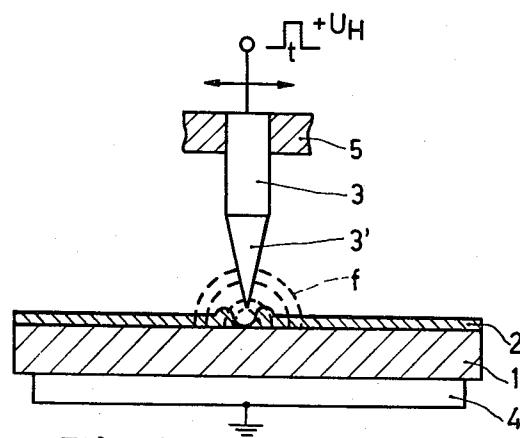


Fig. 3

DEVICE FOR DIRECT ELECTROSTATIC RECORDING USING A SPRAY ELECTRODE

The invention relates to a device for direct electrostatic recording in which conductive toner material is removed from a record carrier by application of an electric voltage to a spray electrode.

In devices for direct, fast electrostatic recording incorporating moving or stationary spray electrodes, the electrodes receive successive electric voltage pulses of a few hundred volts and loosen the toner layer at the recording position from the record carrier substrate, thus forming a trace (analog record) or character (digital record in normal writing, matrix writing, seven-segment writing etc.) corresponding to the information. Because the colors of the record carrier substrate and the toner layer provided thereon have a suitable difference in contrast, the recorded information will be visible in a properly recognizable form, for example, in black (color of the record carrier) on white (color of the toner).

In some known direct electrostatic recording methods the record carrier is situated between a coloring member and an electrode array. When an electric field is applied between the color member and the electrode array, the conductive toner material is transported to the record carrier arranged therebetween. There are two possibilities of recording information using a supply of characters:

1. A supply of toner in the form of characters on the coloring member in combination with flat electrodes.
2. Electrodes shaped as characters in combination with a layer of toner supplied by the coloring member.

The invention has for its object to dispense with the supply of toner on the coloring member and to reduce the cost of synchronizing the two recording actions such as the choice of the characters and of the recording location.

According to the invention this object is achieved in that the spray electrode comprises a pointed or wedge-shaped part which is adapted to operate in very close proximity to the toner material, the voltages applied to the electrode being chosen such that the adhesion of the toner material to the record carrier is overcome only directly underneath the tip or the top of the wedge, the charged toner material attacked by the electrode being subsequently deposited adjacent the location on the record carrier from which the toner material has been removed.

One embodiment according to the invention will be described in detail hereinafter with reference to the drawings.

FIG. 1 is a diagrammatic sectional view of a spray electrode and a record carrier in a device according to the invention.

FIG. 2 is a diagrammatic plan view of the arrangement shown in FIG. 1.

FIG. 3 is a diagrammatic side elevation of the device according to the invention.

FIG. 4 shows a spray electrode shaped as a character.

FIG. 1 shows a record carrier consisting of a strip of, for example, normal paper 1 a well known electrical insulation, (record carrier substrate) which is uniformly covered by a thin loose layer of toner 2. The toner particles of an electrically conductive material have a diameter of a few microns and a suitable power of adhesion

and cohesion. The record carrier 1, 2 thus prepared is transported in the position shown between a counter-electrode plate 4 (at earth potential) and a recording spray electrode 3. The spray electrode 3 is moved by way of a holder 5 in accordance with the analog signal to be recorded. The tip 3' of the spray electrode 3 just fails to touch the toner layer (not shown). In an extreme case this tip may even touch the record carrier.

When a high voltage U_H is applied to the electrode 3, a part of the conductive toner particles 2 is charged (negatively in this example because U_H is positive) via the paper substrate. At this pattern of field lines, which is determined by the pointed shape of the spray electrode 3 and the geometry and the dielectric properties of record carrier 1, 2 and counter-electrode plate 4 and which is denoted by broken lines, the field strength is only adequate to loosen toner particles 2 from the record carrier substrate 1 in a small region situated directly underneath the tip 3', which means that in this region the electric forces which act on the toner particles in the direction of the tip of the spray electrode 3 exceed the forces of adhesion directed towards the record carrier substrate 1. The released toner particles travel via the relevant "field line paths f" to the tip 3' of the spray electrode 3. They reach this tip within approximately 10 μ s, lose their charge and are subsequently positively charged again (in this example). The direction of their electric forces is then reversed. As a result, their kinetic energy is used up while traveling a small distance further along the flank of the tip. From this location they travel, via "field line paths" which are situated further outwards, to the record carrier 1, 2 where they are deposited on the still present, i.e. non-released, toner layer 2 while giving off their charge. After termination of this (static) process, the voltage could be switched off for a point recording, for example, 7 (see FIG. 2). For a line recording, for example 6, with a moving transport and spray electrode 3, the voltage remains switched on accordingly long. In this toner spray process, the controlled voltage application to the spray electrode 3 and the coordinated recording movements thus release toner material from small point-shaped and arbitrarily long line segments on the record carrier substrate, the said toner material being transported to the spray electrode 3 and back again to the edge regions of the points or lines. The partly exposed record carrier substrate displays the information through the color contrast between substrate and toner layer.

The record carrier substrate 1 can be provided with a toner layer for example:

1. during its manufacture, or
2. on the apparatus itself as in the device for analog recording shown in FIG. 3.

In accordance with FIG. 3, the record carrier 9, for example, normal paper is covered with toner 2 in a loop 10. This is successively effected during transport. Recording is effected on the record carrier 9' thus covered by means of a spray electrode device 3, 4, 5 as shown in FIG. 1. The toner layer is durably bonded to the paper substrate by means of a known fixation device 11.

Using a stationary row of spray electrodes, electrically controlled at option, the recording speed offered by the fast spraying action of approximately 20 to 40 μ s, limited by the mechanical movement in the devices shown in the FIGS. 1 and 2, could be fully utilized for

a point-like analog or character recording procedure.

Similar to the analog recording process illustrated, the method using spray electrodes can also be applied for writing digital characters. The spray electrodes for, for example, normal writing should then be shaped as a wedge 12 instead of being round and pointed. FIG. 4 shows this for the character H by way of example. This character can be provided on known type faces. The simplifications offered by the recording method and the device using spray electrodes for performing this method are suitable for application in compact apparatus, for example, hard-copy printers, printers for desk computers, etc..

Generally the said applications do not involve a need for simultaneous production of copies. However, such copies could be made from the relevant originals as desired in a photographic or electrophotographic process, for example, directly according to a transparency method utilizing a suitable transparent record carrier substrate.

For example, a combination of a device according to the invention and a known xerographic selenium drum copying apparatus can be realized for the production of copies: the transparent record carrier substrate prepared with toner acts as a (constant) intermediate record carrier (for example, in the form of an endless loop). This carrier can be printed at option with alpha-

numerical text by means of a spray electrode device. The text is then optically transferred (for example, according to the transparency method) to a selenium drum on which it is stored in the form of charge images.

5 The text can be printed on normal paper in a subsequent phase of a xerographic process. Erasing is effected, in as far as necessary, by covering the toner layer carrying the information again, for example, as in the device shown in FIG. 3.

10 What is claimed is:

1. A device for direct electrostatic recording of the type using conductive toner material uniformly deposited on an electrically insulating record carrier, the improvement comprising a pointed spray electrode means facing said toner material and in very close proximity thereto for attracting the toner material only directly underneath the tip of the spray electrode means and for subsequently depositing the attracted toner material 15 adjacent the location on the record carrier from which the toner material has been removed in response to an electrical voltage, and means for applying to said electrode an electrical voltage modulated by information to be recorded.

20 2. A device as claimed in claim 1, wherein the record carrier carrying the toner material is transparent.

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