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DEVELOPING ELECTROSTATIC IMAGES WITH A LIQUID DEVELOPER

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FIG. 1

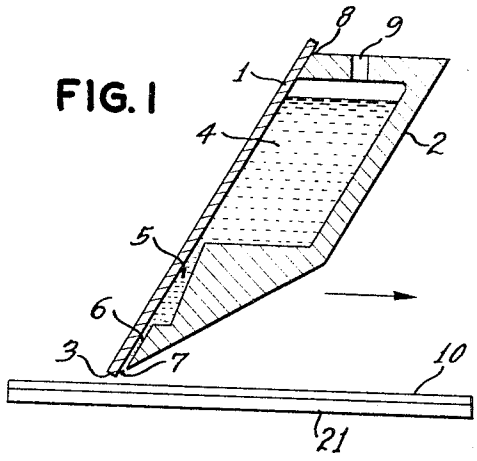
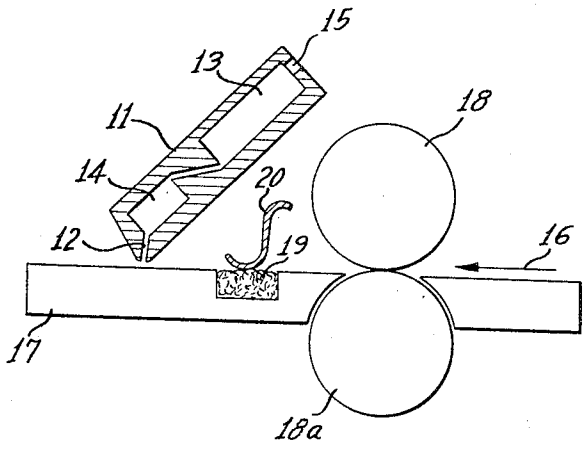


FIG. 2



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DEVELOPING ELECTROSTATIC IMAGES WITH A LIQUID DEVELOPER

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5 Claims

The present invention relates to a process for developing electrostatic fields by means of a relative motion between the surface of a material carrying the electrostatic field and a wetting developer which is contained within a linear gap and is in contact with the aforementioned surface.

The present invention further relates to a device for carrying out this process.

In wetting development, use is made of the changes in the adhesive stress of the developing liquid on the surface to be developed, the changes in adhesive stress being due to the imagewise differentiated condition of the surface which carries an electrostatic field.

Wetting developers are liquids, the composition of which is such that they wet the material to be developed only in the areas carrying an electrostatic field. Apart from the selection of the developing liquids, it is desirable in this process to apply the developing liquid to the material carrying the electrostatic field in such a way that a rapid wetting and development of the image areas is effected without applying too large an amount of excess developer which could remain attached by purely mechanical adhesion and in an undesired manner even to those areas which should not be contacted with the developer.

Furthermore, the developing method should provide the possibility of producing reversal images by applying an additional potential during the developing process. For this reason as well, an excess of developing liquid must be avoided so that the developer can not come into contact with the back of the material, which would result in a short circuit and thus prevent the build-up of a sufficiently high voltage for reversal development. Further, the back of the photocopying material must be contacted electrically in approximately the same areas to which developing liquid is supplied on the front. With this developing process, known methods, such as wiping over or passing through a container of liquid, do not produce uniformly and faultlessly developed images. Other known processes and devices for coating and photocopying purposes do not produce satisfactory results either because of the different objects they are intended to achieve, and particularly because it is not possible to make use of the differences in the mechanical properties of the surface of the material carrying the latent image, for example roughness, during the developing process. Only the differences in the field intensity should be used for achieving the imagewise wetting of the material.

Further, the developing device should be designed in such a way that, although the amount of developer required for covering the entire area is available, the developing liquid, which has a low viscosity, can not flow out of or down from the device.

In the process of the present invention, a wetting developer is applied to a material carrying an electrostatic field from a thin, linear slot which may be in contact with the surface of the material with at least one of its boundary surfaces, and a relative motion is effected between the surface and the slot.

The present invention further includes a device for

carrying out the above process, which device includes two substantially opposite boundary surfaces forming a duct in which the wetting developer is contained, the cross-section of the duct being one-dimensionally extended and the duct having at least one open end during the developing process, whereas the other end may be connected to a reservoir, if desired.

One advantage of the device of the present invention is that the design thereof is very simple and that there are no complicated moving parts. This results in an easy and simple mode of operation with an extremely low susceptibility to trouble. Further economical advantages result from the low maintenance costs thereof and its quick readiness for use. Through the process of the present invention, images of electric fields are obtained which exhibit very good covering power and sharp boundaries.

An electrostatic field is understood in the present invention to be a space which is considered from the point of view of its electrical properties and which surrounds an electrically effective body. The space may be filled with gas or with solid bodies, it may, however, also be a vacuum. An electric field is considered to extend over a certain region of space when the prevailing physical conditions guarantee that a "small electrical test charge e" would be exposed to a force K if it were brought to any point of that region of space.

Such an electrostatic field may, for example, be produced by providing an organic or inorganic photoconductive coating, known in electrophotography, with an electrostatic charge, differentiating the coating by imagewise exposure if desired.

Imagewise modified electrostatic fields may also be produced by imagewise exposure of a suitable coating which is simultaneously provided with a direct current voltage. The basic principles of this method are described in the book "Photoelectrets and the Electrophotographic Process" by V. M. Fridkin and I. S. Zheludev (1961), Library of Congress Catalog Card Number: 61–10020, and A. Kaliman, B. Rosenberg: "Persistent Internal Polarization" Phys. Rev. 1955, pages 1596–1610.

The process and the device according to the present invention will be further illustrated by reference to the accompanying schematic drawings in which:

FIGURES 1 and 2 show two embodiments respectively, of the device of the present invention in side elevation.

FIG. 1 is the simplest embodiment of the device. A strip of thin material, for example sheet metal or another elastic or plastic material, preferably having the width of the sheets or webs to be developed and a height of approximately 10–100 mm. preferably 30–50 mm. is connected to a shaped part 2, for instance a body fabricated from a plastic material or metal, in such a manner that the strip of material 1 is extended over the end of the tapered part 2. This extension 3 may be 1.0–8.0 mm. long, preferably 2.0–5.0 mm. Part 2 has a recess 4 which serves as a reservoir for the developing liquid. A narrow tapered recess 5 which is preferably provided with grooves is cut vertically into the front of part 2 which is in contact with the flexible material 1. The recess 5 is intended to serve as a resistance to the free flow of the developing liquid. At point 8 the flexible material 1 is secured to part 2.

If the device of the invention is moved, in the direction indicated by the arrow, across the surface 10 carrying the electrostatic field, the flexible material 1 is slightly lifted off the tapered part 2, and developing liquid can flow through the now formed duct 6 to the lower part 7 of the device. The material 1 and the liquid are thereby in direct surface contact with the area to be developed.

FIG. 1 shows the device ready for use. When it is not being used, the flexible material 1 closes the duct 6, so that the developing liquid can not flow out. The entire device

can then be tipped back so that all the developing liquid collects in the recess **4**. When doing this, the filling opening **9** is closed. It is however, not always necessary that part **1** closes the duct **6** when the device is not being used. This is not required when the diameter of the duct **6** is so small that the surface tension of the liquid is sufficient to prevent it from flowing out.

FIGURE 2 shows a further embodiment of the device of the present invention which produces preferred results. A container extending generally over the entire width of the area to be developed and consisting of solid material, preferably metal, is provided with a narrow linear duct **12** at its lower end and is directly connected to a larger reservoir **13**. A smaller intermediate container **14** may be provided between the duct **12** and the storage container **13**; the storage container is provided with a filling opening **15**. The opening of the duct **12** is designed to be so narrow that the surface tension of the developing liquid is sufficient to prevent the liquid from running out when the device is not being used. Only the contact between the material to be developed and the liquid which is retained at the discharge opening of the duct **12** by surface tension effects a continuous flow. Contact between the container **11** and the material to be developed is accompanied by a relative motion, i.e. either the material, or the container **11**, or both are moved. As shown in FIG. 2, the material to be developed can be fed to the device by means of a suitable auxiliary device. The material **16** to be developed is moved over a feed table **17** in the direction indicated by the arrow, is seized by one or two feed rolls **18** and **18***a*, and is passed in contact with the aforementioned duct opening via a moistening device **19** having a cooperating pressure spring **20**, if desired. The developed image is delivered at the other end of table **17**.

If a reversal development is to be effected with the process and the device of the present invention, care should be exercised that a higher tension can be applied during the wetting process between the developing liquid and the material carrying the electric field, possibly in the area in which the wetting process takes place at any particular moment. Such processes can be carried out with good results with the device of the present invention.

For this purpose, one pole of a voltage source is connected to the flexible material **1** shown in FIG. 1, and the other pole to the metal supporting plate **21**. With the device according to FIG. 2 the two pole ends are connected to the container **11** and the table **17**. Potentials of up to 800 volts may be applied. Short circuit or interruption of the current will not occur either before, during, or after the developing process. With this method, it is an advantage that the contact between the wetting developer and the material to be developed remains at all times under direct or immediate current contact.

The process and the device of the present invention make it possible to develop electrophotographic material very quickly. Even with developing speeds of approximately 20 cm. per second, excellent results are obtained. It is, however, also possible to increase or decrease this speed and then also very good image quality is obtained. It is possible to develop both cut sheets, for example DIN A5–DIN A1, or continuous material from a roll. With the latter, feed rolls or similar devices which transport the material to be developed when it emerges from the developing zone are not required if the winding and unwinding devices are controlled. With this method of working any number of prints can be developed with absolute consistency.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. A process for developing an electrostatic image on the surface of a sheet of material comprising providing a liquid wetting developer dispenser carrying a supply of liquid wetting developer and including a thin elongated discharge duct defined between a pair of spaced boundary surfaces at least one of which is rigid and wherein liquid wetting developer is preventing by surface tension from running out through said duct except when said duct is adjacent an electrostatic field, passing a sheet of material in contact with said one rigid boundary surface and causing liquid developer to flow only onto those portions of the surface of the sheet having electrostatic charges thereon in a thin elongated area extending widthwise of the associated sheet, and moving said dispenser relative to the surface of said sheet so as to very quickly develop the entire electrostatic image on said sheet.

2. A process as defined in claim **1** wherein said sheet remains stationary and said dispenser is moved.

3. A process as defined in claim **1** wherein said dispenser remains stationary and said sheet is moved.

4. A process as defined in claim **1** wherein both said dispenser and said sheet are moved.

5. A process as defined in claim **1** wherein each of the boundary surfaces of said thin elongated discharge duct are rigid.

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