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APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGE

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Fig. 1.

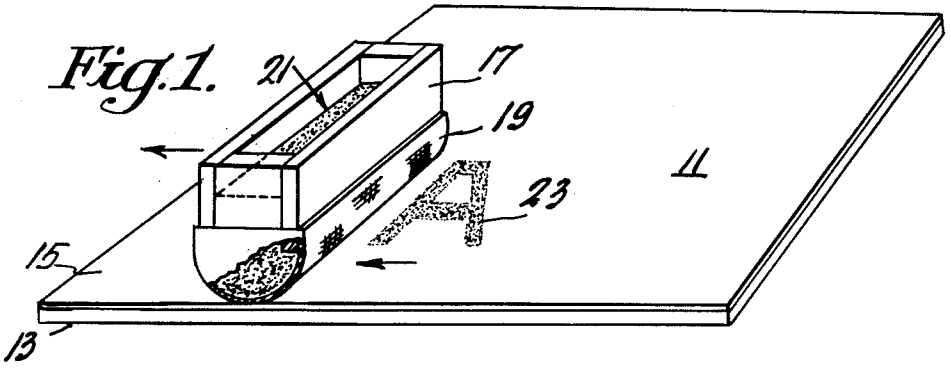
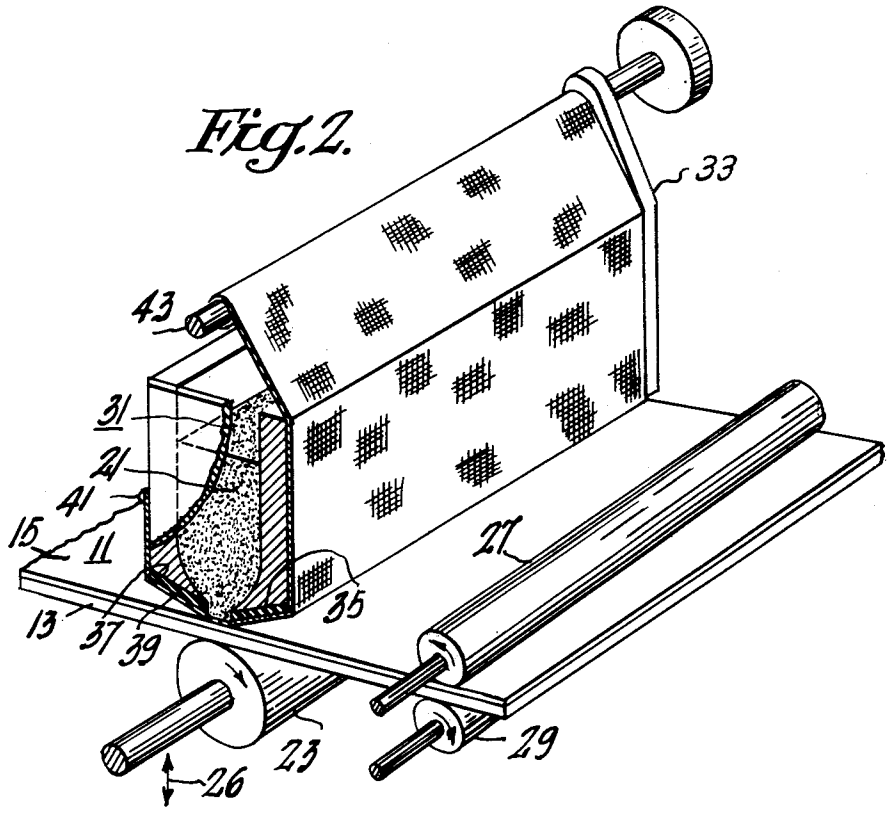


Fig. 2.



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APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGE

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This invention relates to electrostatic printing and more particularly to improved methods and apparatus for developing electrostatic images.

In the art of electrophotography, latent electrostatic images are frequently produced by the following techniques: an electrostatic charge is uniformly distributed over a photoconductive surface of an electrophotographic element, the photoconductive surface is then exposed to a light image to produce thereon a latent electrostatic image, this image is then developed with a finely-divided powder or toner which adheres to the charges on the photoconductive surface to produce a visible image thereon. This method is more fully described in a publication entitled "Electrofax" Direct Electrophotographic Printing on Paper by C. J. Young and H. G. Greig, RCA Review, December 1954, vol. XV, No. 4.

As set forth in said publication, magnetic brush development has provided a preferred method for the processing of electrophotographic paper prints and for continuous mechanical development. Since the advent of magnetic brush development, high speed printing machines have been devised. Such a printing machine is described in a publication entitled A Thin-Window Cathode-Ray Tube for High-Speed Printing with "Electrofax," by R. G. Olden, RCA Review, September 1957, vol. XVIII, No. 3. At high printing speeds such as, for example, 10,000 or more characters per second, even magnetic brush type of apparatus becomes quite complex and expensive.

Accordingly, it is a general object of this invention to provide improved methods and apparatus for developing electrostatic images.

It is a further object of this invention to provide improved methods and apparatus for developing electrostatic images at high speeds.

It is yet another object of this invention to provide improved developer apparatus of extremely simple design.

It is a still further object of this invention to provide improved apparatus for developing electrostatic alphanumeric characters at speeds in excess of 10,000 to 20,000 characters per second.

These and other objects and advantages are accomplished in accordance with this invention which provides simplified apparatus for applying developer powder to electrostatic images. Such apparatus includes a container for a supply of developer powder, at least a portion of the container comprising a porous, preferably flexible, nonabrasive material such as, for example, cotton cloth. As the flexible material is contacted across an electrostatic image, developer particles are electrostatically attracted through the pores in the material and adhere to the electrostatic image. If desired, means can be provided to adjust the contact pressure between the flexible material and the surface on which the electrostatic image resides. Means may also be provided for stretching the flexible material to enlarge the pores therein to enhance development at very high speeds.

Other objects and advantages are included in the following detailed description and are illustrated in the drawings wherein:

FIGURE 1 is a perspective view of an improved apparatus for developing electrostatic images in accordance with this invention;

FIGURE 2 is a perspective view, partly in cross section, of a mechanized version of the developer apparatus of FIG. 1.

Similar reference characters are applied to similar elements throughout the drawings.

A method of developing electrostatic images, in accordance with this invention, is illustrated in FIG. 1. The electrostatic image may be produced on a recording element 11 having a paper backing 13 and a photoconductive coating 15 thereon as described in the aforementioned Young and Greig publication. In the alternative, the electrostatic image may also be produced on other photoconductive recording elements such as those described in U.S. Patent 2,297,691 to C. F. Carlson. Once the electrostatic image is produced on the recording element 11, it is developed using the device illustrated in FIG. 1 which comprises, for example, an elongated box-like container 17, the bottom of which preferably is made of a porous fabric material 19 which may be fastened in any suitable manner to the box-like container 17 to provide thereon a more or less rounded flexible bottom. Alternatively, the porous material might comprise a very smooth, non-abrasive apertured material, such as an apertured nylon sheet. The interior of the container is at least partially filled with any well known electroscopic developer material. Such material may, for example, comprise finely-divided carbon black or finely-divided resin particles which contain carbon black. To develop the electrostatic image on the recording element 11 into a visible image, the flexible material in the bottom of the box-like container 17 is contacted to the surface of the photoconductive coating 15 on the element 11. As the container 17 is moved across the electrostatic image, developer material is electrostatically drawn through the pores in the flexible material 19 and attracted to the electrostatic image to produce a visible image as is shown at 23.

The foregoing method of developing electrostatic images is unexpectedly fast in that the flexible material 19 can be moved across the recording element 11 as rapidly as is possible to do so by manual means, and yet no trouble is encountered in producing a full, dense visible image. Under some circumstances one might expect that developer particles might clog the pores in the flexible material 19. This however, does not result. It has been observed that, in passing the flexible material 19 over the photoconductive surface, developer particles in the box-like container 17 are caused to be violently agitated. It is believed that this result probably is obtained as the flexible material 19 passes from an uncharged area to a charged area on the recording element 11, thereby causing the developer particles to encounter an abrupt change in attractive force, resulting in the aforementioned violent agitation which prevents clogging of the pores in the flexible material 19.

Developer devices in accordance with this invention are admirably suited to mechanized operations, for example, as illustrated in FIG. 2. As shown in this figure, the recording element 11 is drawn over a conductive backing member, such as a roller 23 by, for example, a pair of driven pressure rollers 27 and 29.

A developer trough 31 is mounted above the recording element 11 and is supported by a bracket 33. The trough 31 preferably has a rectangular opening in the bottom, the sides of the opening being defined by two elongated flanges 35 and 37 of flexible material such as rubber. A sheet 39 of porous flexible material such as, for example, cotton cloth is fastened at one end 41 to the side of the trough 31 and covers the opening between the flexible flanges 35 and 37. The other end of the sheet 39 is fastened to a roller 43 by means of which the sheet 39 can be stretched to enlarge the pores therein.

For developing electrostatic images residing on the surface of the recording element **11**, the trough **31** is at least partially filled with developer powder. As the drive rollers **27** and **29** rotate, the recording element is drawn past the trough **31** with the element's electrostatic image-bearing surface in contact with the porous sheet **39**. As electrostatic images pass under the trough **31**, they are continuously developed with developer powder from the trough **31**. Apparatus such as this is capable of developing alpha-numeric characters on 8½-inch wide electrophotographic paper at rates as high as 100,000 characters per second.

If desired, contact pressure between the recording element **11** and the porous sheet **39** can be regulated by mounting the backing number **23** so that it is adjustable in a vertical plane as schematically illustrated at **26**.

It has been found that, although the type of porous material employed is not critical, loosely woven cotton is to be preferred. Cotton cloth, for reasons which are not understood, works equally well with either triboelectrically positive or negative developer powders whereas a material such as, for example, nylon produces best results with only triboelectrically positive developer powders.

What is claimed is:

1. Apparatus for developing electrostatic images comprising a container for a supply of finely-divided electroscopic developer particles, a portion of said container defining an opening covered with a material adapted to contact an electrostatic image bearing surface, the pores in said material being of the size to permit developer particles to be electrostatically drawn therethrough; and means for moving one of said trough and said image bearing surface with respect to the other with said material in contact with said image bearing surface.

2. The apparatus of claim 1 wherein said porous material is flexible.

3. The apparatus of claim 2 wherein said flexible material is cloth.

4. The apparatus of claim 3 wherein said cloth is cotton.

5. Apparatus for developing electrostatic images comprising a trough for containing a quantity of finely-divided electroscopic developer particles, said trough having a substantially rectangular opening in the bottom thereof and a porous flexible material over said opening

adapted to contact an electrostatic image bearing surface, the pores in said flexible material being of a size to permit developer particles to be electrostatically drawn therethrough, and means for moving one of said trough and said image bearing surface with respect to the other with said flexible material in contact with said image bearing surface.

6. The apparatus of claim 5 including means for stretching said flexible material to enlarge the pores therein.

7. The apparatus of claim 5 including means for adjusting the contact pressure between said flexible material and said electrostatic image bearing surface.

8. Apparatus for developing electrostatic images comprising: a trough for containing a quantity of finely-divided electroscopic developer particles, said trough having a substantially rectangular opening in the bottom thereof; a pair of elongated flexible flanges on opposite sides of said opening; a porous flexible material supported on said flanges and covering said opening, said flexible material being adapted to contact an electrostatic image bearing surface, the pores in said flexible material being of a size to permit developer particles to be electrostatically drawn therethrough; and, means for moving one of said trough and said image bearing surface with respect to the other with said flexible material in contact with said image bearing surface.

9. The apparatus of claim 8 including means for stretching said flexible material to enlarge the pores therein.

10. The apparatus of claim 8 including means for adjusting the contact pressure between said flexible material and said electrostatic image bearing surface.

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