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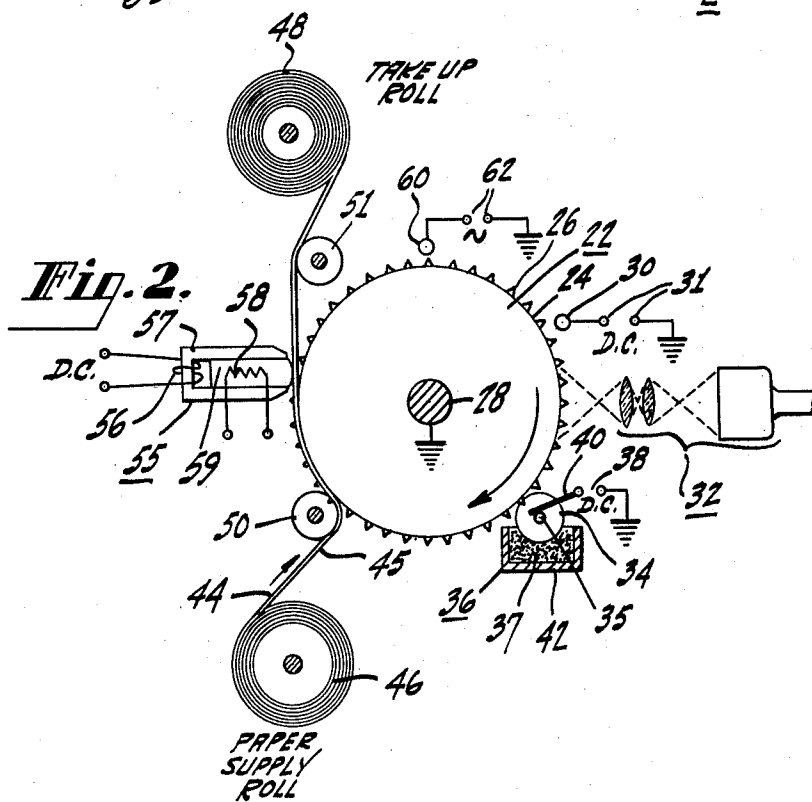
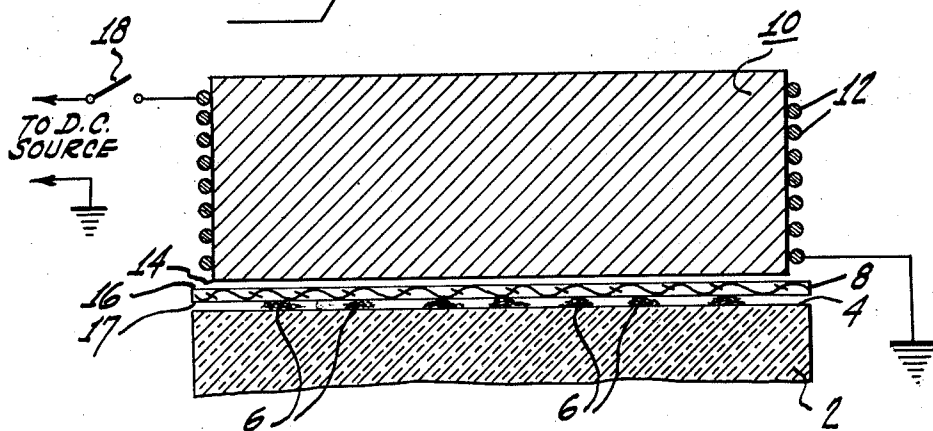
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ELECTROSTATIC PRINTING METHOD AND APPARATUS

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Fig. 1.



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3,106,479 ELECTROSTATIC PRINTING METHOD AND APPARATUS

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This invention relates to electrostatic printing and more particularly to an improved developer powder for use in electrostatic printing.

In electrostatic printing generally a latent electrostatic image is formed upon an insulating surface and developed into a visible image by the application to the surface of suitably charged colored particles. These colored particles are retained on the charge-retaining portions of the surface by electrostatic forces. The uncharged areas do not retain the particles but remain clear. The image so formed is then transferred from the insulating surface to a paper or other surface where it may be fused and permanently fixed.

A general explanation of electrostatic printing may be found in an article entitled, "Xerography, a New Principle of Photography and Graphic Reproduction," by Shaffert and Oughton, in the Journal of the Optical Society of America, December 1948, at page 991.

An important feature of the present invention is the provision of a developer powder having not only triboelectric but also ferromagnetic properties. Such a powder may be transferred from the insulating surface to a paper or other suitable surface by magnetic means instead of electrostatic means.

An object of the invention is to provide an improved method for electrostatic printing.

Another object of the invention is to provide an improved developer powder for use in electrostatic printing and xerographic processes.

Another object of the invention is to provide, for use in electrostatic printing, an improved developer powder having both triboelectric and ferromagnetic properties.

These and other objects will be more readily apparent and the invention more easily understood by reference to the following detailed description, and to the drawings, of which:

FIGURE 1 is a partial sectional elevational view of an apparatus suitable for use in the practice of the invention.

FIGURE 2 is a partial sectional elevational view of a second device adapted to the practice of the invention in a continuous electrostatic printing process.

Previously, after an image had been developed on an insulating surface, the developer powder composing the image was transferred to a paper or other suitable surface by electrostatic forces usually provided by an electrical charge placed on the surface. By substituting a magnetic force for transferring the image, greater convenience may be added to the process since generally it is more convenient to exert a strong physical force by magnetic than by electrostatic means.

A suitable printing powder made in accordance with the invention comprises sulfur and micronized iron. The iron imparts magnetic properties to the powder and also combines with the sulfur when heated at a relatively low temperature to form a black iron sulphide that fuses to a surface forming a permanent image.

By micronized iron is meant iron in a finely divided state such that the individual particles are of the order of 10^{-4} cm. in size, although this particle size is not critical.

The process of manufacture comprises dissolving sulfur in toluol or other suitable volatile solvent and stirring in a quantity of micronized iron equal in amount to about 10 percent by weight of the sulfur originally dis-

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solved. This mixture is heated at about 200° F. to 250° F. until substantially all the solvent evaporates away. The remaining mass is ground dry in a ball mill using glass balls, to a particle size corresponding to about 50 percent through a 1200 mesh screen.

The powder thus formed is combined with a suitable carrier material and used in the ordinary way to develop a latent electrostatic image on a suitable insulating surface.

FIGURE 1 illustrates a method of electrostatic printing employing magnetic developer powder according to the invention. A body 2 having an insulating surface 4 bears a powder image 6 that has been developed upon the surface and consists of magnetic powder. A sheet of material 8, which may be of paper or other material, rests over and in contact with the powder image. A body of magnetic iron 10, surrounded by an electrical winding 12, is disposed over the sheet of material so that one surface 14 of the iron is close to or in contact with and covers substantially all of the upper surface 16 of the sheet. A switch 18 serves to connect the electrical winding to a direct current source. When the switch is closed, an electric current flows in winding 12, magnetizing the iron and creating a magnetic field perpendicular to the surfaces 14 and 16. The magnetic field attracts the powder upwards so that body 2 may be removed leaving the powder image upon the lower surface of the sheet of material. The powder image is then permanently fixed to the surface by heating momentarily at about 450° C.

The process as described is particularly adaptable to a continuous electrostatic printing operation using a rotating cylinder as illustrated in FIGURE 2.

In FIGURE 2, a cylinder 22, which may be of aluminum or any other non-ferrous, electrically conducting material, bearing a photoconducting surface 24, which may be of amorphous selenium or other suitable material, and annularly spaced sprocket teeth 26, rotates clockwise upon shaft 28. The shaft is suitably journaled in stationary supports (not shown) and is driven by a suitable source of motive power (also not shown). The lens system 32 serves to project a light image on the photoconducting surface 24.

The apparatus for obtaining the transferrable image on the surface 24 includes a corona discharge means 30 in the form of an electrode spanning the axial extent of the drum 32. It will be understood that the electrode 30 may be in the form of a plurality of spaced axially extending wires or a plurality of axially disposed needle points. The corona discharge means 30 is connected to a suitable source of high voltage direct current (not shown) which may be connected between terminals 31.

A magnetic developer powder, such as that described in the example above, is continuously applied to the surface 24 from an electrically charged roller 34, the surface of which moves through a quantity of the powder 37 which is maintained by any known replenishing means in a container 42. The roller 34 is supported by a shaft 35 shown schematically as being contacted by a brush 40 connected to one of the terminals 38 of a suitable direct current source (not shown).

The paper 44 to which it is desired permanently to transfer the powder image is held on paper supply roll 46 and may be apertured along its length with sprocket holes (not shown) in any known manner to receive the sprocket teeth 26. The pressure roller 50 and the tension roller 51 maintain the paper in contact with a portion of the surface 24 of the cylinder and with the magnetizing and heating head 55. Sprocket teeth 26 in cooperation with the aperture holes of the paper control the progression of the paper past the drum 22 toward take-up roll 48.

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The magnetizing and heating head 55 is located at a point adjacent to the paper 44 and the drum 22 and extends axially across the entire length of the drum 22. It is energized by an electrical coil 56 and resistor 58 each of which is connected to any suitable source of electric current (not shown). The coil 56 is preferably connected to a direct current source and magnetizes the magnet 57, which may be of iron or other suitable material. The resistor 58 is embedded in, but electrically insulated from the heating head 59, which may be of brass or other suitable heat conducting material.

In operation, the corona discharge electrode 30 charges the surface 24 which then travels past the optical system 32, forming a latent electrostatic image upon the surface. The latent electrostatic image is developed into a powder image by the developer powder 37 carried into contact with the surface by the roller 34. The paper 44 is then carried over the roller 50 into contact with the powder image, and at a point where the paper is carried slightly (from .001" to .003") away from the surface 24 and into contact with the magnetizing and heating head, the head 55 performs two simultaneous functions. The magnet 57 creates a magnetic field which attracts the powder image from the cylinder surface 24 to the paper surface 45, and the heating element 59 heats the paper and the powder so that the powder fuses into the paper and becomes permanently fixed to the surface 45. The paper then continues on past the tension roller 51 to the take-up roll 48.

Erasure of the images impressed on the cylinder after transfer to the paper 44 is accomplished by a high voltage, high frequency electrode 60. This electrode is connected to a suitable source of high voltage alternating current (not shown) that may be connected between the terminals 62.

The invention is applicable generally to any electrostatic printing process wherein it is desired to transfer a powder image from one surface to another. It is not limited to the processes of electrostatic printing which involve forming the original latent electrostatic image upon a photoconducting surface, nor is it to be limited to transferring a powder image to a paper surface. Such a powder image may be transferred to a surface of any desired material such as, for instance, aluminum, iron, wood, or glass.

It should be understood that practice of the invention as described in the specific example given is not limited to the proportions of sulfur and iron described, but that generally the composition described gives satisfactory results through the range of proportions of 5 to 20 parts iron per 100 parts sulfur, by weight. There may also be included in the composition relatively small quantities of any of a large number of well known materials, such as wax, that will serve to control the fusing temperature of the powder produced. The amount of solvent used is not critical but is merely a matter of convenience and expense. It is only essential that the solvent be relatively volatile so that it may be evaporated away within a reasonable time at a temperature below about 300° F. The use of temperatures above 300° F. is not recommended since high heat causes the iron and sulfur to react together, producing iron sulfide and noxious odors.

The method of grinding employed is not critical in any way so long as a suitable particle size is provided.

The developer powder described in the specific example is believed to consist essentially of small iron particles, each being coated with a surface layer of sulfur and having an amorphous layer of iron sulphide between the particle and the surface layer.

It should be understood that the invention is not limited to the particular composition described but that other compositions may also be employed to provide a developer powder composed of finely divided particles of magnetic

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material having at least a surface coating of insulating material, such that the powder exhibits both magnetic and triboelectric properties and yields an image of a desired color when heated or otherwise treated.

There has thus been described an improved developer powder for electrostatic printing, which has ferromagnetic properties in addition to the usual properties desirable for electrostatic printing and permits the transferance of an image composed of the powder by magnetic in place of electrostatic means.

What is claimed is:

1. The method of electrostatic printing comprising developing, upon a first surface, a latent electrostatic image with a dry, electrically charged magnetic powder to produce on said first surface a visible powder image, bringing a second surface into contact with said visible powder image and while maintaining said contact transferring said visible powder image from said first surface to said second surface by applying a magnetic field having at least a substantial component in a direction perpendicular to the area of said second surface in contact with said visible powder image surface.

2. Apparatus for electrostatic printing comprising means for developing, upon a first surface, a latent electrostatic image with a dry, electrically charged magnetic powder, and magnetic means for transferring said developed image from said first surface to a second surface.

3. An electrostatic printing apparatus comprising a member circular in cross-section, means to support said member for rotation, a light sensitive surface on the periphery of said member, electric charging means positioned to apply a charge to said surface, means progressively located with respect to said first named means for impressing a light image upon said surface, means progressively located with respect to said light image impressing means for supplying a dry, fusible magnetic developer material to said surface, means for supporting a portion of a continuous sheet of paper whereby said sheet is held closely juxtaposed to said surface in a region progressively spaced from the developer material supply means, means for applying a magnetic field in a direction substantially perpendicular to said sheet of paper to transfer said dry, magnetic developer material from said light sensitive surface to the surface of said sheet, and heating means adjacent to said sheet to fuse said developer material to the surface of said sheet.

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