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Chang

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[54] **SURFACE FOR IMPRESSION DEVELOPMENT IN ELECTROPHOTOGRAPHY**

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[52] **U.S. Cl.** .... **117/17.5,** 117/111 R, 118/261, 118/637

[51] **Int. Cl.** **G03g 13/08**

[58] **Field of Search** .... 117/17.5, 111 R; 118/637, 261; 355/3, 15

[56] **References Cited**

UNITED STATES PATENTS

3,405,682	10/1968	King et al.	117/17.5
3,472,695	10/1969	Kaufer et al.	117/17.5
3,566,786	3/1971	Kaufer et al.	117/17.5
3,296,965	1/1967	Reif et al.	117/17.5
3,152,012	10/1964	Schaffert	117/17.5
2,892,709	6/1959	Mayer	117/17.5
3,284,224	11/1966	Lehmann	117/17.5

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Assistant Examiner—M. Sofocleous
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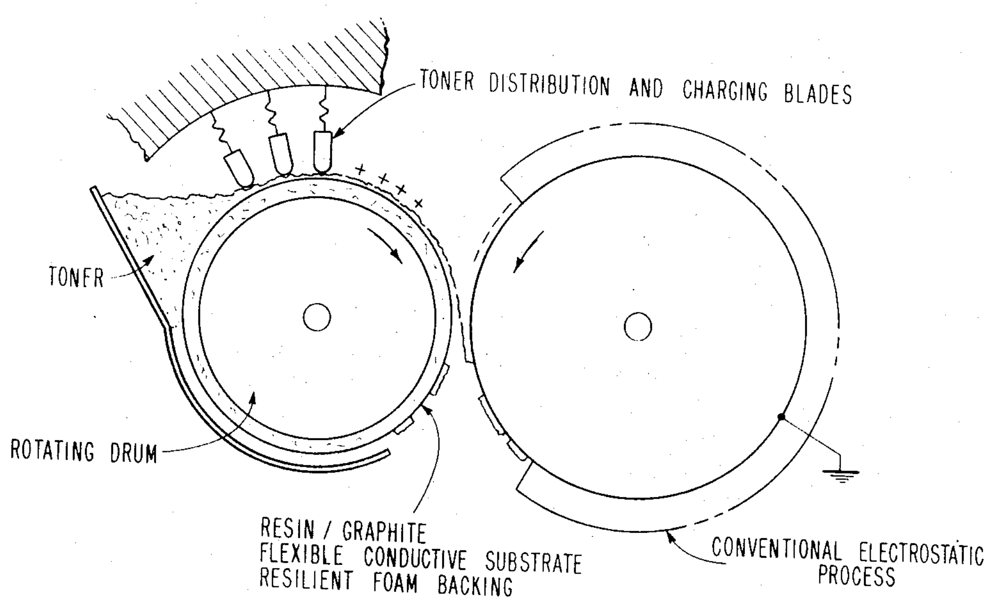
[57] **ABSTRACT**

In an impression development process for electrophotography, toner particles and an electrostatic image are brought into contact; the toner particles are transported by means of a developer surface which is resilient, electrically conductive, rough, and triboelectrically remote from the toner; mutually interrelated moving means are used to move said developer surface and said latent electrostatic image into contact at zero relative peripheral speed.

3 Claims, 2 Drawing Figures



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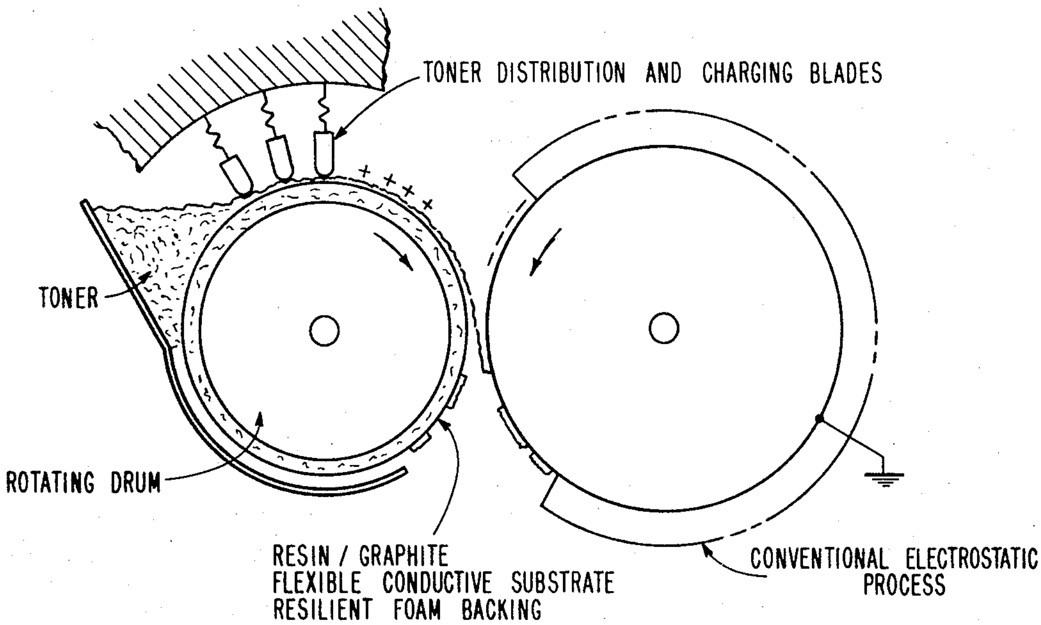

FIG. 1

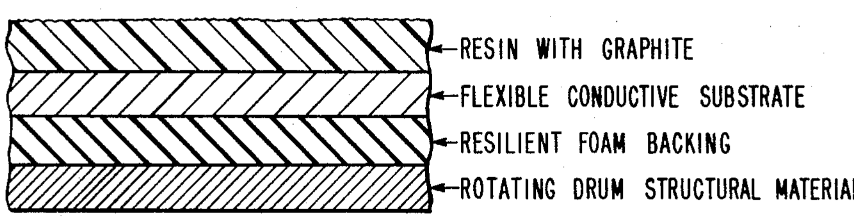

FIG. 2

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SURFACE FOR IMPRESSION DEVELOPMENT IN ELECTROPHOTOGRAPHY

FIELD OF THE INVENTION

The present invention is concerned with a development process for use in electrophotography. Electrostatic printing involves the production of electrostatic images on the surface of a dielectric member or the like, the application of charged minute electroscopic pigmented toner particles to the image-bearing surface, and the fixing of the developed image before or after transfer to a print medium, such as paper. Various techniques have been devised for applying the toner particles to the image-bearing surface. Among these is the technique sometimes called impression development. The present invention particularly relates to an improved impression development process.

In impression development, the surface of a carrier member, such as a sheet or roller, is coated or impregnated with a quantity of minute electroscopic pigmented toner powder particles; i.e., toner, to form an image-developing surface. The developing surface is then placed against the surface of the electrostatic image-bearing member. The placing of the developing surface on the image-bearing surface is performed so that virtually no relative peripheral speed exists during the contact between the developer and image-bearing surfaces. Thus, there is substantially no wiping, patting, or other motion during contact as is usally found in other techniques (e.g., brush or cascade development) for applying the toner to the image-bearing surface. For the purpose of the present invention, the term impression connotes contact without relative peripheral speed during contact.

PRIOR ART

Impression development is well known in the prior art. U. S. Pat. No. 3,152,012, issued Oct. 6, 1964 to Roland M. Shaffert, and the references cited therein, contain a very good summary of the prior art. In so far as we are aware, however, nothingl in the prior art suggests the particular features of novelty of the present process: namely, the use of a developer surface with the specified properties.

SUMMARY OF THE INVENTION

According to the process of the present invention, latent electrostatic images are developed by contacting them with toner particles transported by means of a resilient developer surface. The developer surface is textured; i.e., it is rough and uneven. It is electrically conductive and is triboelectrically remote from the toner. A more detailed understanding of the present invention may be obtained by referring to the drawings, which schematically depict a preferred embodiment of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows diagrammatically (not according to scale) a preferred embodiment of an apparatus suitable for use in the process of the present invention. FIG. 2 is a cross section through the developer surface and shows a preferred embodiment for such a surface.

Referring in more detail to FIG. 1, an apparatus is shown having the impression surface in a drum form. The system comprises an impression surface on a resilient backing with a toner reservoir adjacent to the drum surface. A series of toner distribution blades (made, for example, of polytetrafluoroethylene) are also provided. The blades rest directly on the impression drum and are held in contact by springs. They are electrically insulated from the remainder of the apparatus. Toner is drawn under the blades as the drum rotates. Contact among the drum surface, the blades and the toner results in a uniform layer of triboelectrically charged toner on the surface of the drum. By rotation of the drum, the charged toner is then brought into contact with the photoconductor, where toner is selectively transferred to the latent electrostatic image, which is also rotating on a drum. In the process of the present invention a single pass is sufficient to provide enough toner to give adequate image density. It is important that zero relative peripheral speed exist between the toner surface and the photoconductor, as is always the case in impression development.

Referring again to FIG. 2, a preferred embodiment of the developer surface is shown in greater detail. This comprises a binding resin in which finely divided graphite particles are dispersed in an amount from about 5 to about 60 percent by weight of the total weight of the graphite and resins. Underneath this resin-graphite surface is a layer of flexible conductor, and a resilient backing which may, for example, be foamed polymeric material or the like, for example, foamed rubber or polyurethane foam. Excellent results have been obtained with foam rubber having 100 pores per linear inch. When so desired, this resilient backing may be supported by a rigid metal drum substrate, as is shown in FIG. 2. It is important that the surface be resilient, to insure proper contact with the image-bearing surface.

It should be mentioned that the drawing showing the developer surface in the form of a drum merely illustrates a preferred embodiment. The process of the present invention is applicable to developer surfaces having other configurations. For example, the surface may be in the form of a continous belt. On the other hand, it may also be planar.

In a preferred embodiment of the present invention, the surface is made of a binding resin in which graphite particles are dispersed. It is preferred that the graphite constitute from about 5 percent to 60 percent of the total weight of the graphite and resin, and that the graphite particles be very small, e.g., from submicron size to about 20 microns, with the major portion from about 2 to 12 microns in diameter. The optimum graphite content is about 20 to 30 percent.

In cases where reversal (discharged area development) development is desired, a particularly useful surface may be obtained, for example, using mica and carbon black dispersed in ethyl cellulose as the insulating resin.

It is essential that the developer surface be triboelectrically remote from the toner. This means that the toner and the surface are far apart from each other in the triboelectric series. The triboelectric series is well known to those skilled in the art and is discussed fully, for example, by V. E. Shashoua in the Journal of Polymer Science, 33, p. 65–85 (1958), where there is also described a simple test to enable one to place a material in the series.

It is necessary that the impression development surface be electrically conductive for it to be useful in the process of the present invention. In general, a quantitative idea of conductivity may be obtained as follows. The surface is charged with a corona, and residual charge is measured by a rotating disc electrometer. The residual charge (measured a split second later) should be quite low, preferably below about 50 volts, and most preferably zero or very close to zero.

It is essential that the surface be rough. In general, the mean surface variation should be from about 1 to about 15 microns, preferably about 7 to 8 microns. The average number of surface variations per linear inch is from about 100 to about 350, preferably about 250.

The following is a preferred procedure to make an impression development surface useful in the process of the present invention.

A copolymer of vinyl chloride (87 percent) and vinyl acetate (13 percent) is dissolved in a 1:1 by weight mixture of methyl ethyl ketone and 2-methoxyethyl acetate. A 15 percent solution concentration is used. The solution may be filtered, for example, through filter pad having 0.1 micron pore size. To 150 grams of the filtered solution is added 6.75 grams of graphite, for example, Asbury 007. The mixture is roll milled for one-half hour.

A sheet of aluminized polyethylene terephthalate is rinsed with tetrahydrofurane. The above mixture is coated on the rinsed sheet using a horizontal coater at a speed of 2.8 feet per minute to obtain a coat approximately 20 microns thick. The coating is cured overnight in an oven at 100°C.

Although an apparatus is shown in the drawing with blades used to distribute the toner, the present invention can be used with other methods of toning, such as magnetic brush, or cascade. In like manner, it is useful with both A.C. and D.C. corona. In cases where corona charging of the toner is used (rather than triboelectric charging using blades), the graphite content of the coating should be above about 20 percent.

The present process has several advantages. It requires very simple machinery, which occupies a small amount of space and can be produced at relatively low cost. It is particularly suitable to the development of large solid areas without edge effect. It has the advantage of requiring only one component replenishing and avoiding the need to maintain a toner-to-carrier ratio within a narrow range. Excellent quality has been obtained at the rate of 4 inches per second. Satisfactory results have been obtained at the rate of 32 inches per second. Higher speeds of development are feasible.

The process of the present invention is not to be limited to the use of particular materials. For use as the binding resin, many materials will suggest themselves too those skilled in the art. The resin should form an acceptable surface. Its mechanical strength should be sufficient so that it will be long wearing. It must also be triboelectrically remote from the particular toner being used. In general, the commercially available toners at present in use in electrophotography are based on polymers or copolymers of materials such as styrene and methacrylate esters. For use with such toners, particularly good results have been obtained with the developer surface the preparation of which is described above. Other useful resins include polytetrafluroethylene, ethyl cellulose and various phenoxy resins. Roughness may be obtained by adding any of a variety of particulate materials such as graphite, mica powder and asbestos powder. Conductivity is increased by the addition of carbon black. Various combinations of these additives are also suitable for use.

What is claimed is:

1. In an electrophotographic impression development process involving bringing toner particles and an electrostatic image into contact, said toner particles being transported on a developer surface, with mutually inter-related moving means being used to move said developer surface and said latent electrostatic image at zero relative peripheral speed, the improvement wherein the developer surface comprises a binding resin having dispersed therein finely divided graphite particles in an amount from about 5 to about 60 percent by weight of the total weight of the graphite and resin.

2. A process as claimed in claim **1** wherein the graphite particles are approximately 2–12 microns in diameter.

3. A process as claimed in claim **1** wherein the surface is made resilient by a backing of foamed polymeric material.

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