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[11] **3,884,185**

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[54] **COATED WIRE DEVELOPER BRUSH**

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[52] **U.S. Cl.** **118/637;** 117/17.5

[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** ..... 118/637; 117/17.5, 111 C

[56] **References Cited**

UNITED STATES PATENTS

3,613,638	10/1971	Solarek	118/637
3,614,221	10/1971	Solarek	355/3
3,664,857	5/1972	Miller	117/17.5
3,691,993	9/1972	Krause et al.	118/637

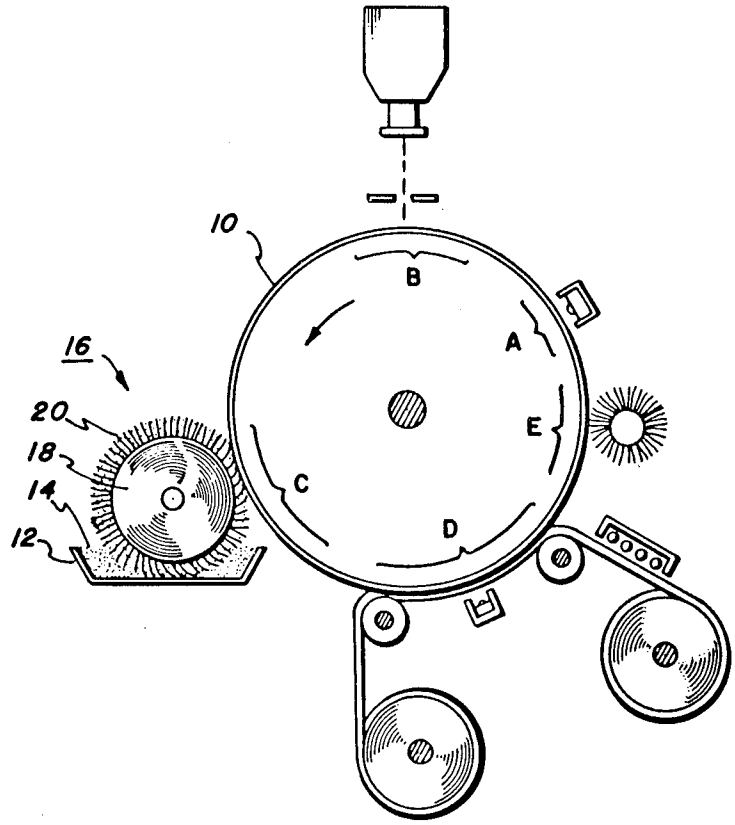
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[57] **ABSTRACT**

A developer brush comprises a support member which has a plurality of bristles extending outwardly therefrom. Each bristle is a conductive metal thread coated with an insulating material. Each thread is connected to a source of electrical potential so they may also function as a development electrode. The metal thread and insulating coating are electrically insensitive to humidity changes so that consistent development results are obtained irrespective of humidity conditions.

10 Claims, 3 Drawing Figures



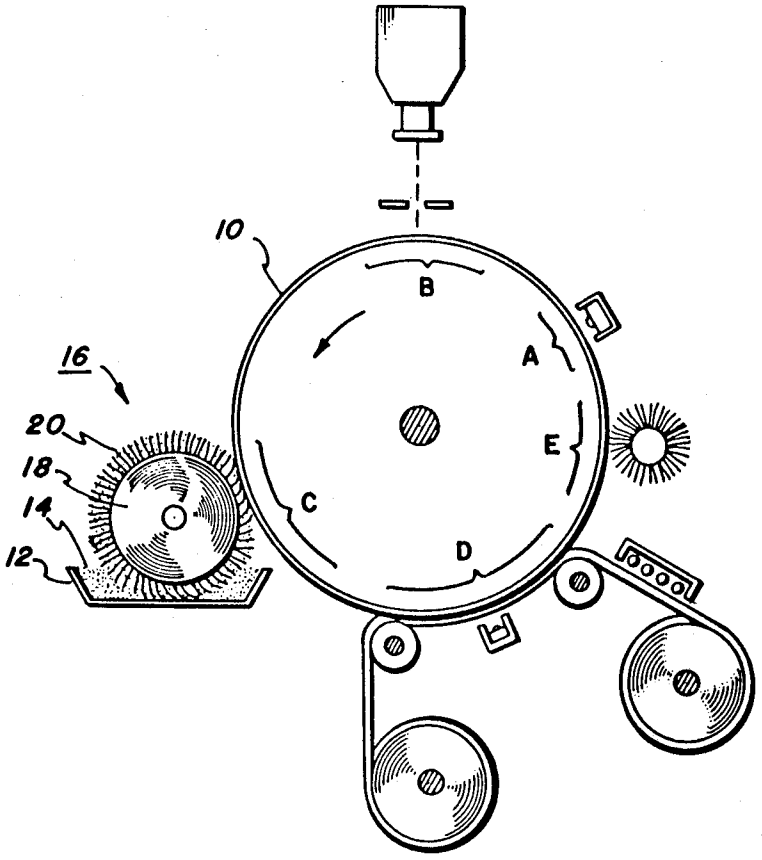


FIG. 1

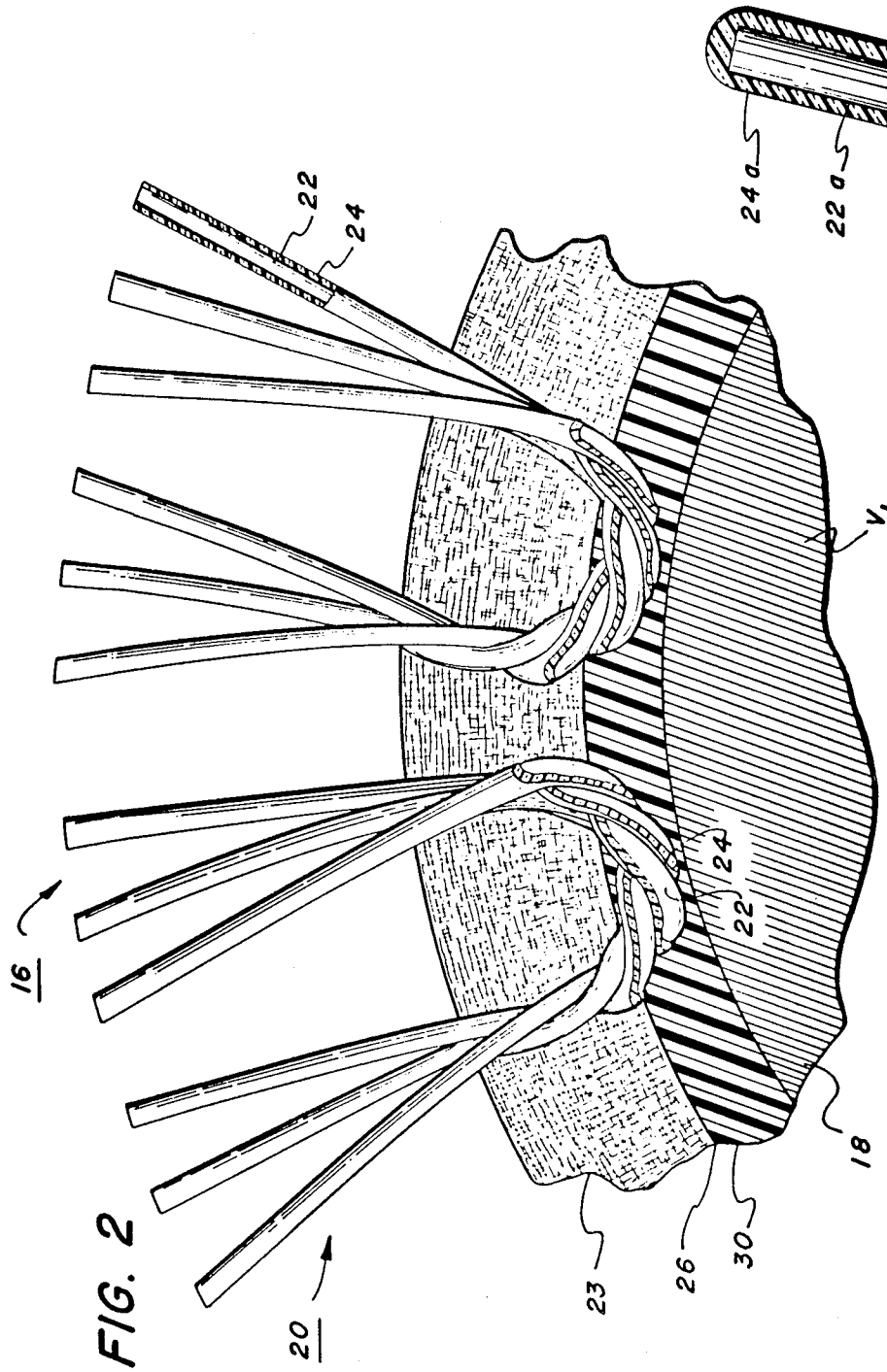


FIG. 2

FIG. 3

COATED WIRE DEVELOPER BRUSH

It has been common to utilize a developer brush for conveying developer or toner particles to an electrostatic latent image for developing the same. One type of brush that has been utilized has been a fur brush which is commonly made of animal fur. Fur brush development has not been altogether satisfactory because of its general unreliability in developing electrostatic images with consistency of quality. The reason for this lack of reliability has been found to have a relationship with relative humidity conditions. When low humidity is present, the brush tends to accumulate static charge which results in a stronger attractive force by the brush for toner particles resulting in less toner than required being attracted to the latent image from the brush with the end product being a light density image. When the relative humidity is high, the opposite takes effect resulting in too much toner being released from the brush such that the ultimate image has a high background density. It is believed that the last mentioned situation is caused by a weakening in the triboelectricfication between the brush and toner particles permitting toner which is retained on the brush to be easily attracted from it to the background or non-image areas by the relatively stronger field in those areas or by random mechanical adhesion.

In order to enhance solid area development and suppress background development, the backing roller for the fur brush bristles must be conductive to provide an electrode in order to set up a field between the electrode and the latent image. However, the backing roller is quite far from the photoconductive surface and therefore is not too efficient.

One proposal to correct the above-mentioned deficiencies is found in U.S. Pat. No. 3,664,857. That patent teaches that the brush may comprise bristles or filaments which are prepared from a variety of natural and synthetic fur materials. The metallized fur brush suggested there is electrically connected to a conductive backing so that the brush may act as a closely spaced development electrode. A problem with that brush, however, is that when the conductive metallized fibers contact the photoconductive surface, there is a significant possibility that portions of the latent image will become discharged upon such contact.

Another solution to the above-mentioned problems is proposed by U.S. Pat. No. 3,614,221. That patent discloses a brush comprising long fibers of electrically non-conductive material and shorter fibers of electrically conductive material. The short conductive fibers do not contact the photoconductive surface but do serve as a development electrode. It is believed that one of the problems with this type brush is that the shorter fibers will act as an electrode only in those areas that the short fibers are located rather than across the whole brush. In other words, a brush constructed in accordance with the teachings of this patent does not act as an effective electrode across the entire development area. Furthermore, the short conductive fibers are too far away from the photoconductive surface to serve as a very efficient electrode. Also, the presence of metal fibers enters into triboelectric competition with the non-conductive material which requires toner with properties which will be compatible with this system. Thus, toner which works in a commerical system may not work in this system and therefore toner with

the necessary properties may not be readily available resulting in the necessity of developing a new toner for this particular sytem.

Accordingly, it is an object of this invention to provide a developer brush which obviates humidity sensitivity and which may act as a development electrode across the entire development area.

Another object of this invention is to provide a developer brush which will be compatible with toner particles normally used in other systems.

Other objects of this invention will become apparent from the following description with reference to the drawings wherein:

FIG. 1 is a schematic view of an electrostatic copier system;

FIG. 2 is an enlarged view of a portion of a developer brush disclosed in FIG. 1; and

FIG. 3 is a partial view of a modification of the brush of FIG. 1.

Referring to FIG. 1, there is illustrated a rotatable drum **10** having a photoconductive surface thereon. Spaced around the photoconductively coated drum **10** are a charging station A, an imaging station B, a development station C, an image transfer station and fusing station D, and a cleaning station E, all of which are well-known in the electrostatic copier art. The development station comprises a toner sump pan **12** having toner particles **14** therein and a brush **16** which comprises a conductive support roll **18** having a plurality of bristles **20** extending outwardly therefrom.

Referring to FIG. 2, there is illustrated an enlarged view of the development roll and the bristles **20.** These bristles comprise a conductive metal thread **22** secured to a fabric strip **23** which in turn is secured to the roll **18.** Each thread **22** is coated with an insulating material **24** which covers substantially the entire exposed thread **22.** The insulating material should be displaced in the triboelectric series from the composition for of the toner particles **14** so that a triboelectric charging process may be relied on to cause the toner particles to be attracted to the bristles **20** to be carried thereby to the photoconductively coated drum **10.** Such insulating materials may be those which are commonly used to coat carrier particles in a two-component developer system. Examples of such materials are a terpolymer composition as disclosed in U.S. Pat. No. 3,526,533 and a polyester composition as disclosed in U.S. Pat. No. 3,672,928. Many other suitable compositions are disclosed in column **8** of U.S. Pat. No. 3,533,835. The disclosure of those patents are hereby incorporated herein.

The brush is constructed as follows: A continuous thread is coated with a suitable coating **24** by drawing the same through a solution and then drying it. A plurality of coated threads are twisted together to form a strand and are then woven into a pair of spaced fabric strips **23.** The strands are cut in the middle whereby two separate tapes of bristles are formed. The strands at the rear face **26** of the fabric **23** are abraded to remove the insulation thereat. A conductive epoxy resin **30** is applied to the fabric strip **23** and the strip **23** is then wrapped in helical fashion onto the cylindrical support **18** and fixed thereto by the conductive resin.

The coating material and the conductive metal thread are each essentially electrically insensitive to humidity changes, with the result that the bristles are electrically insensitive to humidity changes. The diame-

ter of each metal thread may be between 0.15 mil and 5 mils, preferably between 0.15 mil and 2 mils and the coating may be between 0.04 mils to 0.1 mil thick, preferably between 0.04 and 0.08 mils thick. The total length that each bristle extends from the base of the brush is between 0.1 inch and 0.6 inch, preferably between 0.3 and 0.5 inch.

The spacing of the brush from the photoconductor drum **10**, the bristle length, and the rotational speed of the brush relative to the rotational speed of the drum **10** are selected so that the side of the bristles first engage the photoconductor, thereby causing the bristles to bend. The sides of the bent bristles ride on the photoconductor but their exposed metal tips tend to be spaced from the photoconductor drum.

Each thread **22** is electrically connected through the conductive resin **30** to the roll **18** which has a voltage potential V_1 applied thereto. The potential V_1 is kept at a potential slightly higher than background potential in order that the threads may act as a development electrode.

In operation, the photoconductor **10** rotates in a counterclockwise direction to the various stations and acquires an electrostatic latent image thereon. The developer brush **16** rotates in a clockwise direction and as the bristles pass through the toner sump, the coating **24** of each bristle rubs against the toner particles **14** to triboelectrically charge and attract the same to the bristles. As the developer brush continues to rotate, the toner particles **14** are presented to the latent image by the bristles as the bristles contact the photoconductor surface. The triboelectric attraction between the toner particles and the bristles is less than the attraction for the toner particles by the image potential and therefore the toner particles will be attracted from the bristles to the image to develop the same. Assuming that the image carries a potential of +800 volts and the background potential is +200 volts, the potential of V_1 on the bristles will be around +300 volts. Background sump is achieved under those conditions since the attractive field for the toner particles is toward the developer roll when the bristles wipe against the background areas on the photoconductive surface. Any incidental engagement of the tip of the metal thread **22** with the photoconductor as the bristles initially engage the photoconductor will result in a point discharge of the latent image but obviously will not affect the development of the image since such discharge points will be far and few between. There is a distinct possibility, in the embodiment of FIG. **1**, that the tips of the metal threads **22** might contact the photoconductively coated drum **10** as the bristles disengage from the drum **10**, but that occurs after development of the image and, therefore, does not adversely affect the image. Obviously, the brush could also be rotated in a counterclockwise direction.

Since the bristles are insensitive to humidity conditions, a potential placed thereon and any triboelectric attraction between the bristles and the toner particles will be consistent irrespective of the humidity conditions resulting in consistent development.

Referring to FIG. **3**, an alternative embodiment is disclosed. In order to make certain that the exposed tip of metal threads **22***a* do not accidentally engage the photoconductor surface, the tips of the metal threads may also be completely surrounded with insulation material **24***a*. This may be effected by rotating the brush so that the tips of the bristles engage a roller coated with a solution of insulating material whereby the tips of the bristles become coated to cover the exposed tip of the metal thread.

While the developer brush has been shown in a system as disclosed in FIG. **1**, the developer also brush has utility in other systems for instance, a toner feed roll could be located between the developer brush **16** and a toner sump **10**. In that case, the toner feed roll picks up toner particles from the toner sump and thereafter the toner particles thereon are charged to the correct polarity by a corona emission device. The developer brush rotates with its bristles contacting the toner feed roll resulting in the toner particles being attracted thereto from the toner feed roll. Thereafter, the developer brush presents the toner particles to the photoconductor drum in the same manner as described with respect to the embodiment of FIG. **1**.

While the developer brush has been described as a roll, it may also take the form of a continuous web or belt with the bristles extending from the outer surface thereof.

What is claimed is:

1. A developer brush for applying toner particles to electrostatic latent images carried by a photoconductively coated member of an electrostatic processor, said brush comprising:

a support member, and a plurality of conductive flexible metal threads extending outwardly from said support member to form bristles; each of said threads having a coating of insulating material extending along its length to at least the outer tip thereof; said insulating material being triboelectrically displaced from said toner particles, whereby toner particles tend to be attracted to and held on said bristles by a triboelectric charging process; and means for connecting said threads to a source of electrical potential, thereby enabling said bristles to function as development electrodes.

2. The developer brush as recited in claim **1** wherein said support member is a cylindrical roll.

3. The developer brush as recited in claim **1** wherein the outer tips of said threads are covered by said insulating material.

4. The brush as recited in claim **1** wherein said means for connecting said threads to a source of electrical potential includes a conductive coating in electrical contact with said threads and the support member, and the source of electrical potential is applied to said support member.

5. A development system for an electrostatic processor having a photoconductive surface for carrying latent electrostatic images, said development system comprising:

a toner sump for storing a supply of toner particles, and a developer brush between said sump and said photoconductive surface; said brush comprising a support member having a plurality of flexible bristles extending outwardly therefrom, each of said bristles comprising a conductive flexible metal thread having an insulating material thereon covering substantially the entire length thereof at least to the outer tip thereof; said insulating material and said toner particles being selected so that the toner particles tend to be attracted to and held on said bristles by triboelectric charges imparted to said toner particles and said insulating material, said

brush being located relative to said photoconductive surface so that only the insulated portions of said fibers engage said photoconductive surface, and means for connecting said threads to a source of electrical potential whereby said bristles are biased to serve as development electrodes.

6. The brush as recited in claim **5** wherein said support member is a cylindrical roll.

7. The brush as recited in claim **5** wherein the outer tips of said threads are completely surrounded by said insulating material.

8. A developer brush for applying toner particles to an electrostatic latent image carried by a substrate; said brush comprising:

an electrically conductive support member;

a plurality of electrically conductive flexible threads secured to and extending outwardly from said support member to form bristles for said brush, substantially the entire length of each of said threads being coated with an electrically insulating material, said insulating material being triboelectrically displaced from said toner particles; and

means for applying an electrical potential to said threads via said support member, thereby enabling said threads to serve as development electrodes.

9. The developer brush of claim **8** wherein said coated threads are the only bristles on said brush.

10. The developer brush of claim **9** wherein said coated threads extend substantially equal distances from said support member so that said bristles have substantially identical lengths.

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