United States Patent

Klavsons et al.

[15] **3,638,613**

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[54] TONER DEVELOPER SYSTEM

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

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

[58] **Field of Search** 118/621, 637; 117/17.5; 355/3

[56] **References Cited**

UNITED STATES PATENTS

3,152,012	10/1964	Schaffert	117/17.5 X
3,283,703	11/1966	Childress et al	118/637 X
3,572,922	3/1971	Olden	355/3

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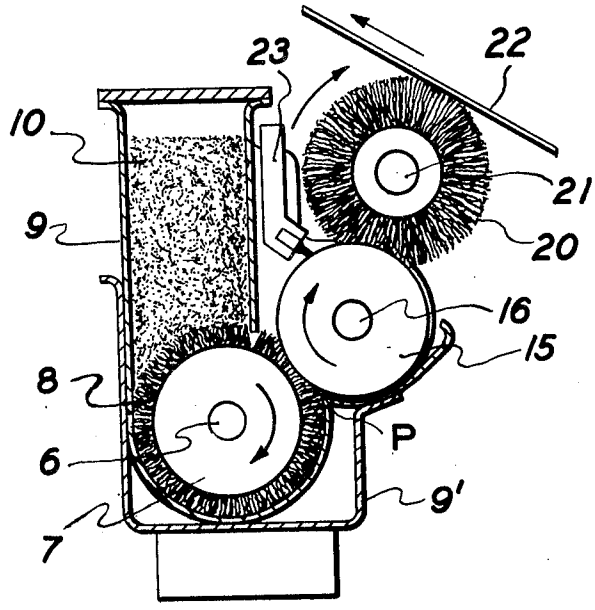
[57] **ABSTRACT**

A developer apparatus wherein a transfer or donor roller triboelectrically attracts to its surface toner contained in a sump or reservoir. The toner in the sump is prevented from agglomerating by an agitator device. A fur brush picks up toner from the transfer or donor roller and deposits it upon a charged surface whereby the image thereon is rendered visible.

7 Claims, 5 Drawing Figures



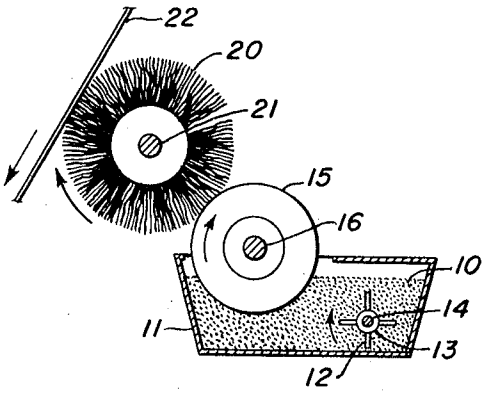


FIG. 1

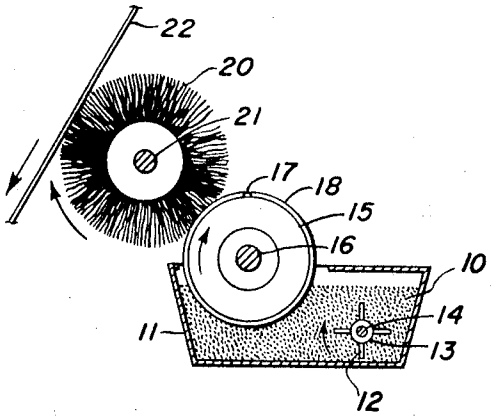


FIG. 3

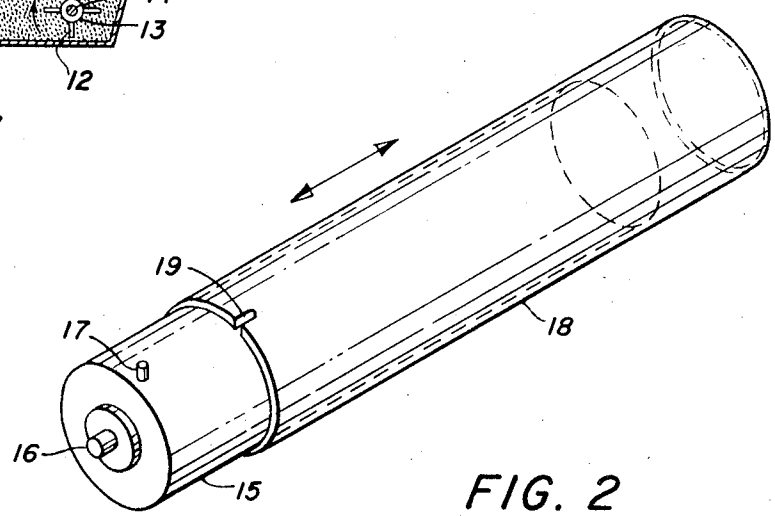


FIG. 2

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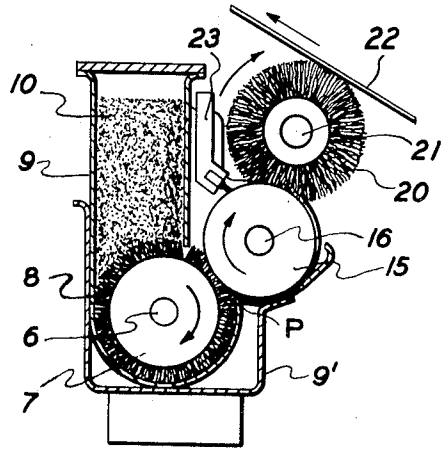

FIG. 4

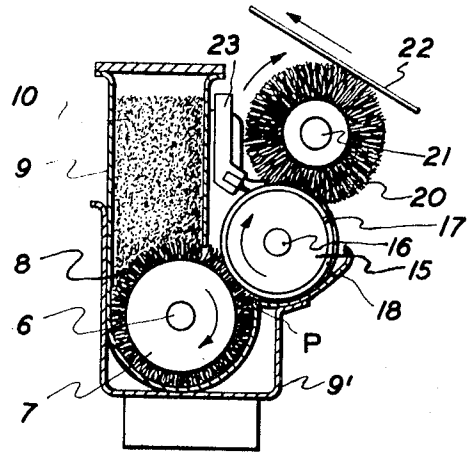

FIG. 5

TONER DEVELOPER SYSTEM

This invention relates to electrography. More particularly, this invention relates to an apparatus for developing the electrostatic latent image on charged surfaces by depositing electroscopic developer particles or toner thereon.

Conventionally in the electrographic process a uniform electrostatic charge is placed upon a photoconductive or dielectric surface by a charging mechanism. Subsequently, parts of the surface are discharged as by exposure to light. In other electrographic processes an electrostatic pattern or image is formed directly on the insulating surface corresponding to the original pattern or image to be reproduced. In order to form a visible rendering of this electrostatic image it is necessary to develop the image with electroscopic powders or toner. Assuming that the charged surface has a positive charge, a toner is selected such that it will be charged to a polarity opposite to that of the electrostatic image. When the oppositely charged toner is deposited on the image surface having a positive electrostatic charge, the charge on the image exerts a force of attraction on the toner and retains the toner in the charged areas. By this means the image is made visible.

In the development process the objective sought is a reproduction of the original which has sharp, contrast and which is free of background smudging. The development of the electrostatic latent image can be achieved by employing various techniques. One technique is to cascade developer material on the surface carrying to the electrostatic image and to transfer this developed image to a recording sheet or web while in contact with the image-carrying surface and thereafter fixing the image by application of heat to the recording means. For an example of cascade development see U.S. Pat. to Carlson, No. 2,990,278. Another technique conforms in many respects to that just described except that a powder cloud of developer particles is dispersed over the surface carrying the latent image, discussed further in U.S. Pat. No. 3,239,465. A third technique is to deposit developer or toner on to the image-bearing surface by means of a magnetic brush set forth in U.S. Pat. No. 2,791,949. The magnetic brush is composed of a mass of very small iron particles which form "fibers" under the influence of a magnetic field. When the desired developer or toner is mixed with the magnetic powder it is charged triboelectrically and upon being picked up by a magnet a brush is formed with charged toner particles adhering in a random manner to the iron fibers. Still another technique of image development is to deposit toner thereon by means of a fibrous member of fur brush impregnated with toner, set forth in U.S. Pat. No. 3,251,706. This invention is concerned with improvements in a fibrous member developing system.

All of the above approaches to the development of the electrostatic image have application in practical devices. However, each of these methods have advantages and disadvantages which make one more acceptable over the others in a desired machine. For example, the technique of cascade developing may be undesirable because it depends on gravity flow and causes abrasion on the dielectric surface and because it is expensive to construct as well as being bulky. Similar objections can be ascribed to the method of powder cloud development. There, the powder cloud is usually created by dispersing the toner particles under air pressure through a nozzle on to the image surface. The mechanism necessary to create the powder cloud is generally expensive and bulky. The magnetic brush developing method furnishes fully developed large solid dark areas in images however, continuous tone images are reproduced with excessive contrast. Here again, bulk and economics are factors to be reconciled. Fur brush development processes taught by the prior art have the disadvantage that the amount of toner applied to the brush could not be easily controlled. Where unequal amounts of toner is deposited on the fur brush, developed images may have light and dark areas as well as undesirable background smudges.

The present invention provides an improved and comparatively inexpensive fibrous member developer system. The fibrous member of the invention picks up toner from a transfer donor roller with which it is in contact. The transfer donor roller may be supported over a sump or reservoir containing developer or toner and attracts the toner by triboelectric action to achieve a uniform deposit of toner upon its surface. An agitator means is situated within the reservoir containing the toner and performs the function of preventing toner caking or agglomeration. In another embodiment of the invention a metering member or roller deposits toner on to the transfer donor roller and also ameliorates the problems of cavitation, minor caking and distribution of toner. The invention further contemplates the use of a disposable donor sleeve which may be inserted over the donor rollers.

It is an object of the present invention to provide apparatus for the deposition of developer or toner on to a surface bearing an electrostatic latent image wherein a fibrous member picks up toner from a donor roller and then applies the toner to the image-bearing surface.

It is another object of the invention to provide a toner sump or container having an agitator therein to prevent lumping or agglomeration of the toner.

It is another object of the invention to provide a toner sump or housing partially shaped to the arc segment configuration of the metering roller and the donor roller to prevent caking of the toner as well as accumulation of toner below the donor roller.

It is a further object of the invention to provide a disposable sleeve which is insertable over the donor roller cylinder for preserving the life thereof.

The nature of the present invention having been set forth, there will now be presented a more detailed description in illustration but not limitation, of the invention in the following specification and drawings in which:

FIG. **1** is a diagrammatic side view of the fibrous toner system;

FIG. **2** is an isometric view of the transfer donor roller with a sleeve partially inserted thereon;

FIG. **3** is the same view as FIG. **1** with a sleeve shown inserted over the transfer donor roller;

FIG. **4** is a diagrammatic side view of the brush toner system embodying the metering roller without the insertable donor roller sleeve; and

FIG. **5** is the same view as FIG. **4** with the sleeve inserted over the donor roller.

The same reference numerals represent the same elements in all of the figures.

The present invention is particularly intended and adapted for the development of an electrostatic latent image, such as particularly a latent image of relatively fine detail composed of relative charged and uncharged areas on an insulating surface. The development method taught by the present invention may be employed to apply toner directly to a photoconductive surface or to electroscopic paper both bearing an electrostatic latent image.

Illustrated in FIG. **1** there is shown a fibrous member toning system having a housing or sump **11** containing electroscopic developer particles or toner **10**. The developer particles **10** may be mixed with grossly larger beads 200 microns in diameter to prevent the toner which ranges from 5 to 20 microns in diameter on the average from lumping while in the container. The housing **11** may take any suitable configuration but is shown as a rectangular box having four sidewalls and bottom wall with the top wall having an opening to admit transfer donor roller **15**. Also situated within the housing **11** is an agitator means **13** which preferably comprises a shaft **14** that may be supported by opposite sidewalls of housing **11**. On the shaft of the agitator means are baffles **12** which rotate in the direction shown and which serve the purposes of creating a turbulence in the toner for preventing caking or agglomeration of toner material **10** and presenting a continuous supply of toner to donor roller **15**. Although agitator means **13** is shown totally immersed in the toner material **10** it is not necessary for proper operation that it be so immersed. How-

ever, the immersed agitator in the toner is a preferred embodiment since it creates a greater turbulence in the toner particles. Transfer donor roller 15 is a cylinder which may be made of a metal such as copper, steel or aluminum or of a dielectric such as a plastic. Donor roller 15 rotates on shaft 16 at a predetermined rate and is mounted to a suitable support means so that a portion of its surface is in contact with the toner material contained in the sump. Through triboelectric effects transfer donor roller 15 picks up a metered amount of toner from the sump. The toner picked up by the transfer donor roller 15 uniformly adheres to the transfer donor roller as it rotates about its axis. In contacting relation to the transfer donor roller cylinder is a fibrous member or a fur brush in the form of a cylinder 20 whose length may be more or less coextensive with donor roller 15. Alternately, the fibrous member may comprise a half cylinder. The material covering the fibrous cylinder may comprise synthetic fibers, natural fibers or mixtures of various fibers as set forth in U.S. Pat. No. 3,251,706. The preferred embodiment is a natural fiber of New Zealand rabbit fur. The fibrous member rotates about shaft 21 and is similarly mounted on suitable support means. Paper 22 which in this preferred embodiment may be electroscopic paper bearing an electrostatic latent image thereon is moved across the fibrous member in the direction shown by the arrow and the latent image is rendered visible by depositing toner thereon. The toner is electrostatically attracted to the charged surface since it is selected to have a polarity opposite thereto.

For optimum image development, the toner, transfer donor roller surface and the fibrous member should be selected from materials arranged in the triboelectric series also set forth in U.S. Pat. No. 3,251,706 in order that the toner will readily adhere to the transfer donor roller and in turn can be picked up by the fibrous member. Thus, the toner, transfer donor roller surface and the fibrous member are arranged in a triboelectric series with positive polarity (the fibrous member at the top and negative polarity (the toner) at the bottom or vice versa depending on the toner polarity desired. In this manner, any material placed in contact with another which is below it in the triboelectric series will become positively charged and the material below it in the series will become negatively charged. Thus, if a positively charged electrostatic image is to be developed the electroscopic powder must be charged negatively by contact with a brush material which is above it in the series. The negative electroscopic particles will then be deposited upon the positively charged image by electrical attraction.

Referring now to FIGS. 2 and 3 there is illustrated a donor roller cylinder 15 having inserted thereon a sleeve 18.

The usual method of preparing the aluminum transfer donor roller is to spray-coat it with an insulating plastic such as a methyl terpolymer composition of styrene and methacrylate. Other examples of suitable insulating plastics are set forth in U.S. Pat. Nos. 2,880,699, 2,895,847 and 2,901,374. With this process, many thin coats may have to be applied in order to achieve a uniform coating which may have a thickness of several mils. The aluminum roller stock may have to be sand-blasted or etched prior to spray-coating in order to provide a better bond with the coating material. Where the donor coating has been damaged as by normal handling or abuse, or its efficiency lessened by wear, the coating may have to be stripped with solvents and the time-consuming spraying operation repeated.

However, with the use of donor roller sleeves, replacement and maintenance is quick and simple. At the same time they provide a greater guarantee of surface uniformity. The donor roller when used with the sleeve no longer requires special surface preparation other than being turned to proper size for a sliding fit with the sleeve. Additionally, the triboelectric charges is easily controlled by changing the sleeve material.

Sleeve 18 may be cast or extruded to fit over donor roller 15. The sleeve may be made of a methyl terpolymer such as discussed above or a suitable substitute material and have typical thickness of 0.002, 0.004, 0.006 or 0.012 inch to help control toner charge in the fur brush development system. Reference numeral 17 is a driver pin upon which a notch 19 on sleeve 18 is inserted to prevent rotation of the sleeve.

In operation of the development system of FIGS. 1 and 3, donor roller 15 is rotated and picks up charged toner 10 from container or housing 11. The toner is stirred up by agitator 13 and is deposited uniformly on donor roller 15. Since toner 10 is remote from the donor in the triboelectric series the electroscopic particles are attracted to its surface. Fur brush 20 which is higher in the triboelectric series than donor roller 15 then collects toner from donor roller 15 and uniformly deposits toner on to the charged bearing surface 22. The latent image thereon is thereby developed as it moves past fibrous member 20. Fibrous member 20 also picks up toner from the uncharged areas of paper 22 and thereby furnishes a developed image free of spurious background. Both roller 15 and fibrous member 20 may be electrically biased to control the attraction and deposition of toner particles.

Illustrated in FIG. 4 there is shown a side view of a developer system which embodies a metering member of roller that obviates the need for an agitator of the type described in FIGS. 1–3 in order to prevent cavitation or caking of the toner. Reference numeral 9 is a sump or housing containing toner 10. Sump 9 has a generally J-shaped side view configuration and is permanently affixed to a support means by a bracket 9' which partially encases sump 9. The unique shape of container 9 prevents toner from reaching donor roller 15 except as controlled by metering roller 7 as will be described hereinafter. Positioned within the curved portion of the J-shaped housing is a cylindrical metering roller 7. Metering roller 7 also has a portion of its surface outside an opening in the lower part of the sump 9. Metering roller 7 may have a fibrous surface 8 which insures that excess toner is removed from the cylindrical transfer or donor roller 15. Alternately, metering roller may have the same surface as donor roller 15. Metering roller 7 prevents the toner 10 that is located directly above it from caking through rotation about shaft 6 and also carries a controlled amount of toner to doner roller 15.

Donor roller 15 is located adjacent the short arm of J-shaped housing 9. Donor roller 15 is mounted for rotation on shaft 16 and contacts both the metering roller 7 as well as a fibrous cylindrical member 20. At point P housing 9 is cuspated, i.e., contoured such that arc segments conforming to the surfaces of metering roller 7 and donor roller 15 meet at a point P. This contour of housing 9 at P prevents toner from accumulating and caking beneath donor roller 15. A wiper blade 23 contacting donor roller 15 is supported on housing 9 and is provided to control the amount of toner carried by donor roller 15. Alternately, wiper blade 23 may be dispensed with since metering roller 7 by its wiping action and rotational speed also controls the amount of toner carried by donor roller 15.

Fibrous member or fur brush 20 which may comprise a natural or synthetic fiber as noted above rotates on shaft 21 and is suitably supported to be in contacting relation with transfer roller 15 and electrostatic recording paper 22.

FIG. 5 depicts the developer apparatus of FIG. 4 and in addition shows donor sleeve 18 inserted upon donor roller 15. Sleeve 18 preserves the life of roller 15 and allows easy maintenance and replacement thereof as described above.

In operation of the developer system of FIGS. 4 and 5 metering roller 7, donor roller 15, and fibrous member 20 are rotated in the direction shown by the arrows. At the same time paper 22 is incrementally advanced. The rotation of metering roller 7 prevents cavitation and caking of toner 10 in sump 9 since a turbulence is created below the column of toner. The fibrous surface 8 of metering roller 7 carries toner from the sump to the roller 15 while rotating in a direction opposite to that of donor roller 15. Since the sump or container 9 is cuspated at P, toner is prevented from accumulating below donor roller 15. Wiper blade 23 controls toner thickness on

donor roller **15**. Fibrous member **20** in rotation picks up a controlled amount of toner from donor roller **15** and applies it to electrostatic recording sheet **22** in order to develop the latent image thereon. The toner is electrostatically attracted to the recording paper and is subsequently fused thereon by well-known fuser devices. It is contemplated that the elements of the embodiments of FIGS. **4** and **5** will be arranged in the triboelectric series as discussed above. It is also noted that the relative speed between metering roller and donor roller will control the amount of toner transferred to the donor roller independent of the amount of toner in the sump. Furthermore, the metering roller can be driven constantly or intermittently in increments controlled by the recording paper advance drive system. In addition, intermittently driving the donor roller in a similar fashion is preferable. The advantage of an incremental advance is that the increment image density can be simply controlled.

From the foregoing it is seen that the developer system described is capable of providing development of electrostatic latent images by means of a metering roller, a donor roller, donor roller sleeve, and fur brush.

We claim:

1. Apparatus for transferring electroscopic developer particles to a charged surface for the development of a latent electrostatic image thereon comprising:

a developer container having an opening in one wall, said opening located approximately midway of the length of said wall,

a metering member positioned below at least the major portion of said developer particles in said container,

means to move the surface of said metering member past the developer particles in said container and to the opening in said container,

a donor member adjacent said opening of said container, said donor member being in contact with a portion of said metering member surface, and

a fibrous member having a surface material selected to triboelectrically attract said developer particles from said donor member and to remove said developer particles from uncharged areas of said charged surface whereby the latent image thereon is rendered visible and free of background smudging.

2. The apparatus of claim **1** wherein said metering member is located at the bottom of said container and said container has a cuspated section adjacent said donor member whereby said developer particles are prevented from collecting below said metering member.

3. The apparatus of claim **2** wherein said metering member has a portion of its surface extending through said opening in said container.

4. The apparatus of claim **3** comprising a wiper blade contacting said donor member for controlling the amount of said developer particles thereon.

5. The apparatus of claim **4** and comprising a rigid disposable sleeve shaped to be inserted over said donor member and being composed of a material to triboelectrically attract said developer particles.

6. Apparatus for transferring electroscopic developer particles to a charged surface for the development of a latent image thereon comprising:

a container holding a quantity of developer particles,

a donor roller positioned to contact said developer particles, said donor roller having a surface material selected to triboelectrically attract said developer particles in a uniform manner,

an agitator located within said container to prevent agglomeration of said developer particles and to present new developer particles to the surface of said donor roller,

a rigid disposable sleeve for preventing wear by said developer particles of the surface of said donor roller, said sleeve shaped to be inserted over said donor roller and composed of a material selected to triboelectrically attract said developer particles, and

a fur brush in contact with said rigid disposable sleeve mounted upon said donor roller, said brush being selected to triboelectrically attract said developer particles from said rigid disposable sleeve mounted upon said donor roller for uniform application to said charged surface whereby the latent image on said charged surface is rendered visible and free of background smudging.

7. The apparatus of claim **6** comprising a driver pin on said donor roller and a notch in said rigid disposable sleeve said driver pin and notch cooperating to maintain said rigid disposable sleeve mounted on said donor roller.

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