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Krause et al.

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[54] **METHOD FOR TRANSFERRING DEVELOPED IMAGE**

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Related U.S. Application Data

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[52] **U.S. Cl.** **117/17.5,** 96/1.4

[51] **Int. Cl.** **G03g 13/16,** G03g 15/16

[58] **Field of Search** ..... 117/17.5; 96/1 R, 1 S, 96/1 D, 1.4; 118/637; 355/3, 17

[56] **References Cited**

UNITED STATES PATENTS

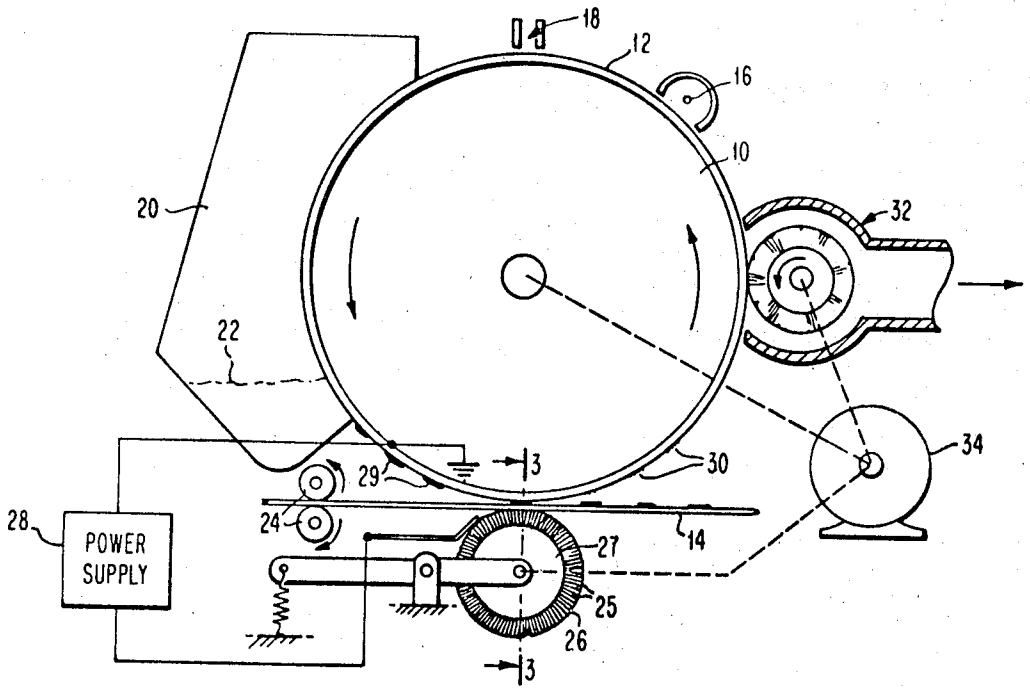
2,901,374	8/1959	Gundlach	118/637
2,959,153	11/1960	Hider	118/637
3,152,012	10/1964	Schaffert	118/637
3,328,193	6/1967	Oliphant et al.	118/637
3,368,894	2/1968	Matkan et al.	118/637
3,551,146	12/1970	Gundlach	96/1.4
3,589,895	6/1971	Ville	118/637
3,599,603	8/1971	Ralston et al.	118/637
3,627,523	12/1971	Shelffo	96/1.4

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[57] **ABSTRACT**

A method and apparatus for transferring a developed electrostatic image from an image-bearing member to a medium such as copy paper in response to the evenly distributed field produced by a D.C. biased metallized fiber brush roller which contacts the copy paper to produce the transfer.

3 Claims, 4 Drawing Figures



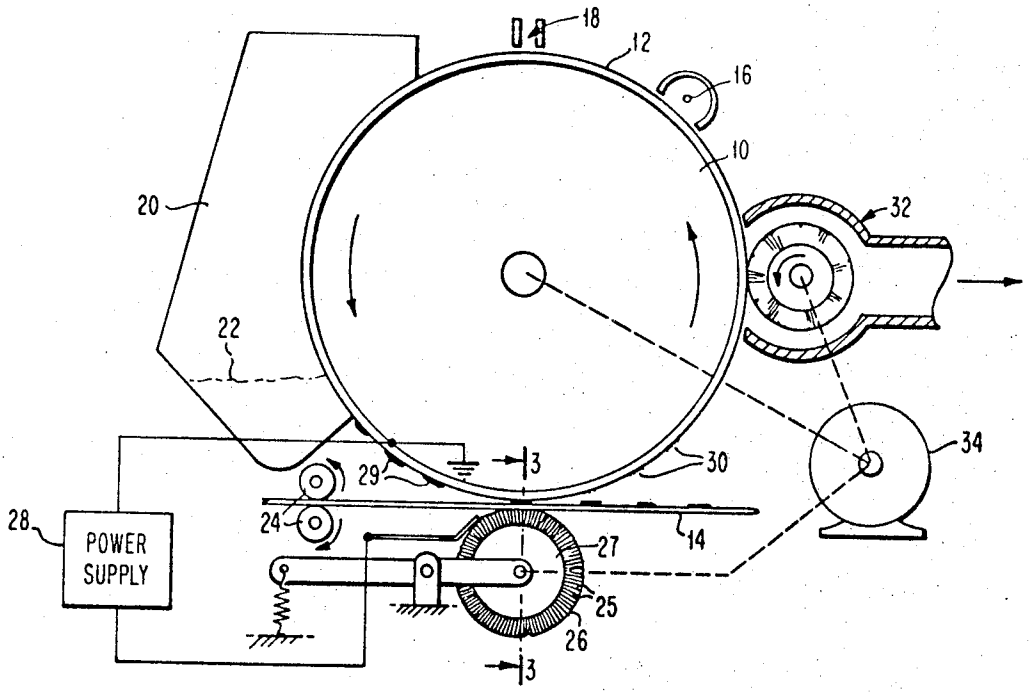


FIG. 1

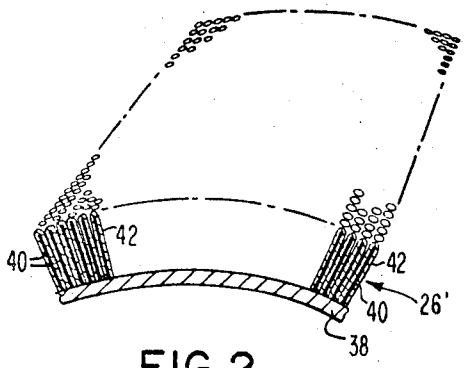


FIG. 2

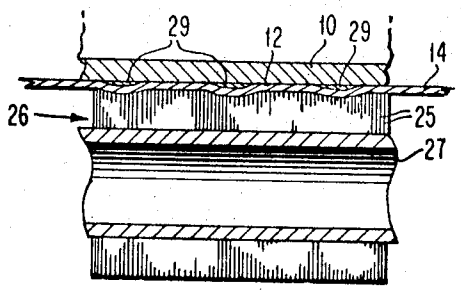


FIG. 3

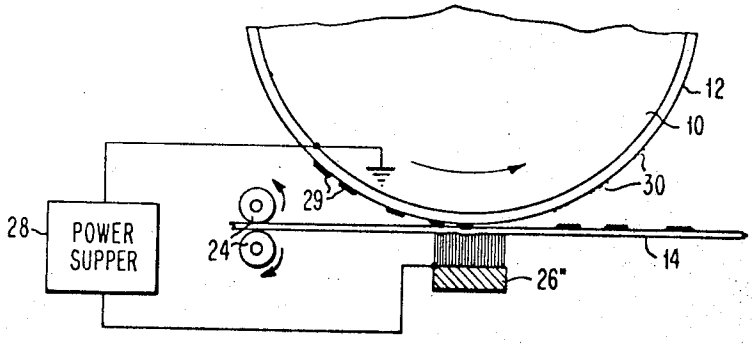


FIG. 4

METHOD FOR TRANSFERRING DEVELOPED IMAGE

This is a division of application Ser. No. 92,038 filed Nov. 23, 1970 now U.S. Pat. No. 3,691,993 issued Sept. 19, 1972.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrostatic image systems and more particularly to transfer of a developed image from an image-bearing member to a suitable transfer medium such as copy paper.

2. Description of the Prior Art

One prior art method and apparatus for transferring a developed image to a copy sheet comprises a system wherein a corona discharge device is utilized to produce a charge on the back of the copy sheet to attract the image toner from the image forming surface to the sheet. However, any vibration of the corona wire or dirt accumulation on the corona wire causes an uneven distribution of ionization and consequently causes uneven toner transfer which is observable on the copy. The efficiency of the corona discharge device and hence the quality of the resultant image varies widely with changes in temperature and relative humidity. In addition, when high density images are present, toner transfer by corona transfer techniques is rather inefficient. Another prior art method and apparatus for transferring a developed image utilizes a conductive roller member and a bias potential applied to the roller to produce the transfer of the developed image to the copy sheet. This method and apparatus produces satisfactory results under certain circumstances; however, the efficiency of transfer is low under certain conditions. In addition, sparking and other image distorting phenomena may occur as the copy sheet is separated from the image forming surface. It is therefore an object of this invention to produce apparatus and method for transfering a developed image comprising electrostatic charged developer particles from an image forming surface to a web of transfer material to produce a high transfer efficiency and also a consistent image under widely varying environmental conditions.

SUMMARY OF THE INVENTION

The apparatus comprises an image forming surface which may be an insulator or a photoconductive surface. An electrostatic image is produced on the surface by known techniques and the image is developed utilizing electrostatically charged developer particles which are commonly known as toner. A web of transfer material is provided adjacent to the image surface. A brush having conductive fibers is also mounted adjacent to the image surface and a constant potential difference is produced between the image surface and the brush member by means of a suitable power supply. Relative motion is produced between the brush and the image surface so that the tips of the brush fibers move the web of transfer material into intimate contact with the image surface. The potential difference is operative to attract the toner particles comprising the developed image to the web of transfer material and due to the constant force provided by the brush fibers, substantially all of the developer particles are transferred from the image surface to the web of transfer material. The image is then fixed to the web of transfer material by any suitable technique.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of an electrophotographic apparatus embodying the present invention;

FIG. **2** is an enlarged view showing in greater detail the metallized fiber embodiment of the transfer brush means for the apparatus shown in FIG. **1**;

FIG. **3** is a partial cross section view along the lines **3—3** of FIG. **1**;

FIG. **4** is a schematic view of an alternate embodiment of the apparatus embodying the invention wherein a flat transfer brush means is utilized.

DESCRIPTION OF PREFERRED EMBODIMENTS

One example of a particular apparatus in which the subject invention is adapted for use is the electrophotographic apparatus shown in FIG. **1.** In this apparatus, a rotatable drum **10** carries around its periphery an electrophotographic photoconductive member **12** on which is directed an image which it is desired to be reproduced on the paper sheet **14.** The surface of the photoconductor is uniformly charged to a predetermined polarity by corona discharge device **16.** A document having the image to be copied is placed so that a suitable exposure means is operable to direct the image to expose station **18** onto the surface of the photoconductor **12.** Relative motion is provided for the document at a speed synchronized with the surface speed of drum **10** in a manner known in the art. Where the photoconductive surface is illuminated by the image, the surface is discharged leaving a charged pattern in a form of the image to be copied.

Thereafter, the drum passes a development station **20** at which a toner-carrier mixture **22** is cascaded across or otherwise brought in contact with the electrostatic image on the surface of the photoconductor **12** as is known in the art. The toner, having a charge opposite from the polarity of the electrostatic image charge is attracted to the drum surface to render the image visible.

Continuing the counterclockwise rotation of the drum **10,** a copy paper **14** is fed into contact with the developed electrostatic image by the rollers **24.** A soft brush means **26** having resilient conductive fibers is disposed beneath the paper at the area of contact with the drum. Power supply **28** is coupled to produce a unidirectional potential between brush member **26** and the conductive backing of photoconductor **12.** The potential has a polarity opposite that of the toner, thereby attracting the toner to the copy paper. After this transfer operation, the paper **14** is separated from the drum and fed past a fusing station (not shown) which serves to fuse and permanently fix the toner to the paper. Since transfer of all the image toner **29** is not usually accomplished, residual toner **30** usually remains on the drum surface after a transfer operation. The drum continues to rotate past a cleaning apparatus **32** which cleans the surface of the photoconductor and removes any excess toner. This operation completes the cycling of the drum for reproducing the desired image.

The brush member **26** comprises a plurality of unitary fibers **25** which are permanently attached to the base member **27.** The fibers extend substantially outward from the base and the fibers are of substantially uniform length so that a potential applied to the brush will produce a substantially uniformly distributed field. The fibers may comprise any suitable material such as

metal fibers or non-metallic fibers which are provided with a conductive coating. The thickness of the individual fibers is small so that a substantially constant force can be exerted by the brush fibers on the transfer web so that intimate contact with the image surface can be produced without regard to the density of the developer particles in different portions of the developed image. The fibers are preferably of a thickness approximating the size of the individual toner particles so that the image transfer can be accomplished without distortion of the image. This size fiber also eliminates damage to the image forming surface and to the copy sheet which would result from the use of thicker and stiffer brush fibers. One suitable material is stainless steel fibers approximately 12 microns in diameter which are woven into a plush fabric which is then attached to a suitable support member. This type of brush produces excellent transfer, but is difficult to manufacture with all fibers upstanding so that a uniform field and a uniform force are produced by the brush.

Another suitable type of brush (See FIG. **2**) which is easily manufactured and produces excellent operation is a brush comprising a nonconductive fiber to which a conductive coating is applied. Brushes of synthetic materials such as dynel and rayon can be manufactured with uniformly distributed upstanding fibers on a base material. The fibers are coated with a conductive material by any suitable means to provide the desired conductivity of the fibers. In the embodiment shown in FIG. **2** of the drawings, brush means **26'** comprises a base member **38** to which is fixed a plurality of uniform upstanding fibers. The fibers comprise an inner nonconductive part **40** which has an outer conductive coating **42.** This construction gives control over the conductivity of the fibers so that an effective technique for the prevention of arcing during separation of the image surface and the transfer material is produced.

One suitable technique for coating the surface of the fibers is the technique known in the art as electroless plating. One example of a brush construction utilizing this technique comprises a rayon plush fabric since this material contains a combination of physical, chemical and electrostatic properties which are suitable for this use. Other types of knit or construction such as sliver knit or flocking may be used for this purpose which results in plush fabrics with upstanding or substantially upstanding fibers. The particular fabric utilizes a double shuttle type of weave which is essential in keeping the fibers separated. The fibers are first washed and then sensitized by immersion in a suitable sensitizing solution such as stannous chloride. After sufficient rinsing, the fabric is then activated utilizing a suitable activating solution, for example, immersion in acidic palladium chloride solutions. After suitable rinsing, the material is placed in a proper plating bath such as a copper plating bath for a time which varies with the type of bath and the desired conductivity to be produced in the fibers. The material is then rinsed and dried. This operation produces a suitable conductive coating on the fibers so that a brush is produced by fixing the fabric to a suitable support member to produce the transfer brush. Other types of conductive coating may be produced on the fiber surface using electroless plating, for example, nickel, cobalt, iron, etc. In these cases a trace of phosphorus usually codeposits with the metallic layer. Precious metals such as gold, platinum and rhodium can be deposited by a double plating technique in which copper is first deposited on the synthetic fiber by the electroless plating method followed by an "immersion" plating technique in which all or part of copper film is converted to the desired precious metallic film. For this purpose an acidic salt solution of precious metal is employed in which the copper plated fabric is immersed, then rinsed and dried.

Relative motion may be produced between the image forming surface and the brush means **26** by any suitable means. In the embodiment shown, drum **10** is rotated about its axis from a suitable drive motor **34** by suitable belts or gears (shown dotted in the drawings). If desired, brush means **26** may also be rotated. Brush **26** may be rotated at a speed synchronized with the drum speed or driven at a faster rate to lessen the adverse effect in the event of any separation or bunching of the fibers in brush **26.** The flat brush **26''** shown in FIG. **4** is maintained stationary and reliable transfer of the image is produced.

Brush **26** should maintain at least a minimum area of contact to provide good transfer. A particular apparatus utilized a flat image forming surface and a 2 ⅛ inch diameter transfer brush. The brush was mohair with electroless plated copper fibers about one-eighth of an inch long. A range of potentials (700–1,200) and brush compressions were tried and the optimum configuration for this apparatus was found to be a potential of 1,100 volts with about 2mm compression in the brush fibers which produced a contact area approximately one inch wide. A 2 ⅛ inch diameter stainless steel fiber brush with ⅛ inch fibers was also utilized. The optimum transfer current which produced good transfer without arcing was found to be $0.2\mu A/in^2$. A series resistor was used with the stainless steel fiber brush to limit the current to this level.

The invention is also applicable to other types of image producing systems other than the embodiment shown in the drawings. For example, in a system with a dielectric image bearing surface, a higher transfer potential was found to be more suitable. Potentials in the range of 1,000 to 2,000 volts were found suitable for good transfer in apparatus of this type.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in the form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. The method of transferring a developed image comprising electrostatically charged developer particles from an image forming surface to a web of transfer material comprising the steps of:

forming a developed image on an image forming surface;

placing over the developed image a web of transfer material;

rotating a brush means comprising a plurality of conductive fibers;

producing a constant potential difference between said brush means and said image forming surface; and

producing relative motion between the brush means and the image forming surface so that the tips of the fibers move the web of transfer material into abutting contact with said image forming surface whereby said potential is operative to transfer the

developed image to said web of transfer material.

2. The method of transferring a developed image comprising electrostatically charged developer particles from an image forming surface to a web of transfer material comprising the steps of:

forming a developed image on an image forming surface;

placing over the developed image a web of transfer material;

rotating a brush means comprising a plurality of fibers, said fibers comprising non-conductive fibers having a conductive coating thereon;

producing a constant potential difference between said brush means and said image forming surface; and

producing relative motion between the brush means and the image forming surface so that the tips of the fibers move the web of transfer material into abutting contact with said image forming surface whereby said potential is operative to transfer the developed image to said web of transfer material.

3. The method according to claim 2 wherein said non-conductive fibers comprise synthetic material.

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