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[54] **TRANSFER OF COLOR IMAGES**

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Dec. 24, 1971 Australia 7516/71

[52] **U.S. Cl.** ..... **117/37 LE,** 96/1 SD, 96/1 LY, 96/1.2, 96/1.4, 117/17.5, 355/4, 355/10, 355/17

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

[58] **Field of Search** ..... 117/17.5, 37 LE; 96/1 R, 96/1 LY, 1.2, 1.4; 118/637; 355/4, 10, 17

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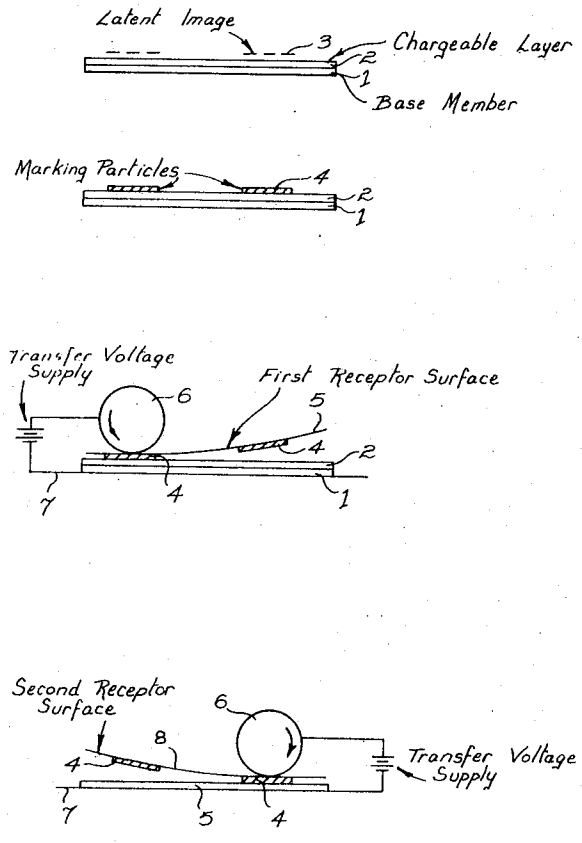
[57] **ABSTRACT**

An electrostatic method for the reproduction of printed matter in which an electrostatic latent image is developed by the attraction of electroscopic marking particles thereto and is then transferred to a first receptor surface by the simultaneous application of contact and a directional electrostatic field of a polarity to urge the marking particles to receptor surface, the image being then transferred from the first receptor surface to a second receptor surface by the simultaneous application of contact and a directional electrostatic field of opposite polarity to urge the marking particles to the second receptor surface.

6 Claims, 6 Drawing Figures



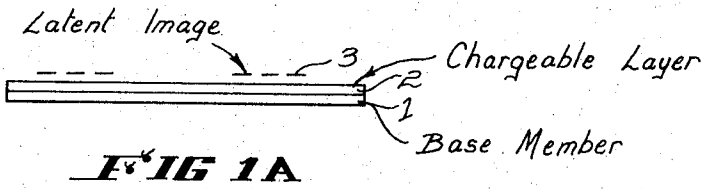


FIG 1A

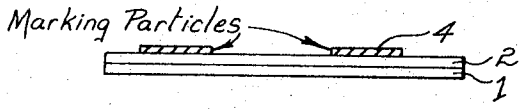


FIG 1B

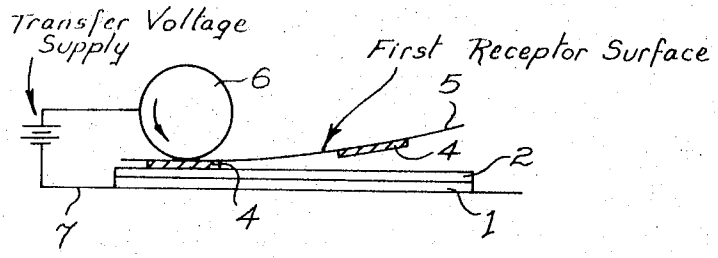


FIG 1C

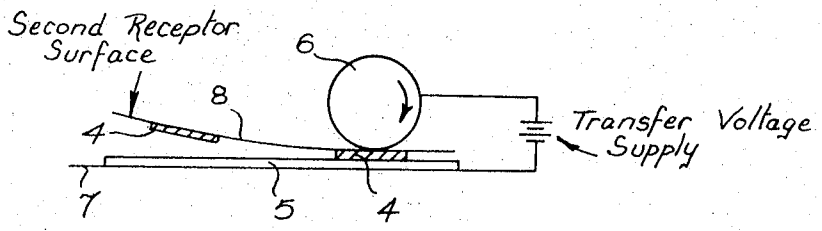


FIG 1D

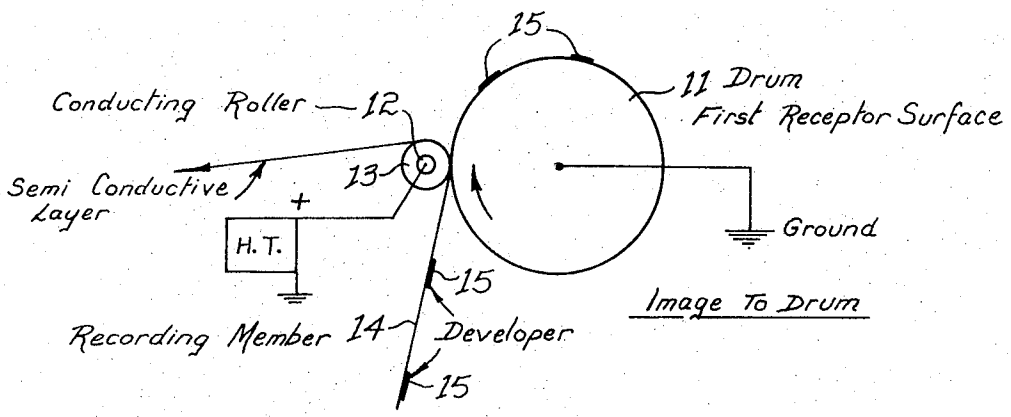

15
11 Drum
First Receptor Surface
Conducting Roller
12
Semi Conductive
Layer
13
+
H.T.
Ground
15
Image To Drum
Recording Member
14
Developer
15

FIG 2A

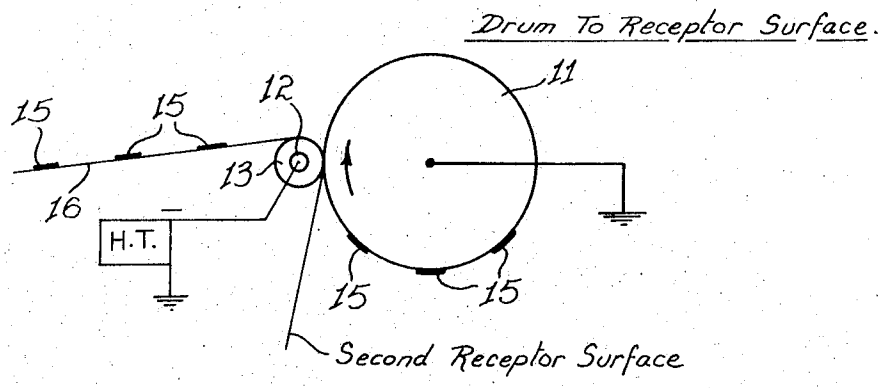

Drum To Receptor Surface.
11
12
15
15
13
16
−
H.T.
15
15
Second Receptor Surface

FIG 2B

TRANSFER OF COLOR IMAGES

This invention refers to electrostatic reproduction and in particular refers to a method and means whereby right reading transfer copies may be produced on a desired receiving sheet from a right reading electrophotographic or electrostatic master sheet or member.

Transfer methods are known in which an electrostatic latent image is produced on the surface of a photoconductive or dielectric recording member and is rendered visible by the application of electroscopic marking particles, which marking particles may be dry or suspended in an insulating liquid known as a carrier liquid, such carrier liquid generally being defined as having a volume resistivity in excess of 10^9 ohm cm and dielectric constant less than 3. The developed image deposit is subsequently transferred to a receiving member by contacting the image bearing surface with the surface of the receiving member, usually with the simultaneous application of a directional electric field. The combination of contact and the application of such directional electric field causes the transfer of a substantial portion of the image deposit to the receiving member surface.

It is also known to transfer more than one developed image deposit to a receiving member, and is also known to develop electrostatic latent images using electroscopic marking particles or toners of different colors. This combination allows the production of multicolor images on the surface of a desired receiving member, such as a paper web or metal surface or the like.

One disadvantage or presently known transfer methods is the necessity to produce the image on the recording member to read in the opposite sense to that of the transferred image. Consequently if it is required that the final transferred image should be right way reading it is necessary that the image as developed on the recording member which may be for instance an electrophotograhic master sheet should be wrong way reading. While this is not a disadvantage in an office copying machine which may be designed optically to produce right way reading or wrong way reading images as desired, it can introduce serious deficiencies when electrostatic transfer principles are used for the production of pre-press proofs for offset lithography. Such proofs are normally produced by using the positive separation transparencies from which the printing plates are to be made as originals, the electrostatic latent image being produced by contacting the charged surface of an electrophotographic recording member with the transparency in a vacuum frame, and exposing for a foredetermined time. However, as offset printing plates areright way reading the separation transparencies are normally made to produce right way reading images when they are used for the imaging of a photosensitive member by contact exposure with the emulsion side of the transparency in contact with the photosensitive surface of the member being imaged. Consequently when such transparencies are used for the production of electrostatic latent images on electrophotographic recording members with the transparency emulsion in contact with the recording member surface the image produced thereon is right way reading, and if such image is developed and transferred to the surface of a receiving member the image produced on the receiving member is wrong way reading.

In the past it has been usual to reverse the positioning of the transparency during contact exposure when right way reading transfer copies are required, however this results in a substantial loss of dot size when screened transparencies are employed as is usual for offset lithography, and may result in the complete loss of highlight dots in extreme cases. The thus produced proof is therefore not an accurate forecast of what may be produced when the same transparencies are used to produce offset printing plates in which the highlight dots are retained in a predictable manner.

A further disadvantage of the aforementioned prior art processes as applied to the production of pre-press proofs is the limitation of material types suitable as receiving members using reasonable low potentials for image transfer. This is due to the relatively insulating nature of the electrophotographic or dielectric recording member and the added necessity to provide operator protection by coating the voltage applicator means such as for instance a roller with a resilient layer of insulating material. This combination limits the volume resistivity of the receiving member if it is desired to use relatively low transfer potentials, and consequently it has been found that when the transfer potential is limited to 1,500 volts or less, the receiving member is usually limited in thickness to 0.010 inches or less in the case of a paper web, and more insulating members such as plastic films and the like cannot normally be used as receiving members at transfer potentials of this order.

We have now found that the effect of these prior art limitations may be reduced to a considerable extent by the methods and means of this invention now to be described in that highlight dot retention of a similar order to that of offset platemaking can be obtained using the same transparencies, whilst the finally produced transfer image is right way reading. In addition the transfer mechanics of the present invention allow a wider choice of materials to be used for the receiving member without introducing operator hazards.

According to this present invention the developed image deposit on an electrophotographic or electrostatic master sheet is transferred electrostatically to the surface of an intermediate member, and is subsequently further transferred to the image receiving member. The working surface of the intermediate member is conductive, which facilitates both the first and the second transfer steps, as in the first step the transfer voltages may be stabilised without regard for the electrical properties of the image receiving member, whereas in the second step the relatively insulating photoconductive master sheet is not used, which allows the image receiving member to be of higher resistivity than would apply in the prior art process using comparable transfer potentials. Thus in this invention an electorstatic latent image is produced on the surface of a photoconductive or dielectic master, which master may be useed once only or be of the reusable type as desired, and the image is developed therein using a dry or liquid dispersed toner of the desired color. The developed image is transferred to an intermediate member which is either metallic or has a metallised surface, using electrostatic transfer methods, and the image is subsequently transferred to the surface of the receiving member, which may be a paper web or metal surface or synthetic film or the like. It will be realized that when the image developed on the master sheet is right way reading, the image as finally transferred to the re-

ceiving member surface will also be right way reading.

In order tha the invention may be more readily understood reference will now be made to the drawings in which

FIG. 1 illustrates the operational steps of the process disclosed herein, and

FIG. 2 illustrates a preferred form of an equipment suitable for carrying out the disclosed process steps.

Referring now to FIG. 1 in detail, 1A shows a base member 1 having on one surface an electrostatically chargeable layer 2, on which has been produced an electrostatic latent image 3. FIG. 1B shows the electrostatic latent image as having been developed by the application of electroscopic marking particles 4 thereto. In FIG. 1C the developed recording member has been positioned on a conductive base member 7 and a first receptor member 5 placed in contact with the developed surface 2 of said recording member, said contact being assured by the application of conducting roller 6 simultaneously with the application of a transfer voltage whereby electroscopic marking particles 4 are transferred to the surface of said first receptor member 5. In FIG. 1D said first receptor member 5 has been placed imaged side up on said conducting base 7 and a second receptor member 8 contacted with the image bearing surface of first receptor member 5 under the influence of an electrostatic field to transfer said marking particles 4 from said first receptor member 5 to the surface of second receptor member 8.

In FIG. 2 a preferred means for carrying out the present invention is illustrated in which FIG. 2A illustrates the use of the apparatus to perform the first transfer operation, whereas FIG. 2B illustrates the use of the apparatus to perform the second transfer opeation. Referring to FIG. 2A, a conductive drum 11 is notably mounted in nominal contact with a conducting roller 12, which conductive roller has on its outer surface a relatively resilient semi-conducting layer 13. A recording member 14 having one side thereof a developed image consisting of electroscopic marking particles 15 is fed into the nip between said drum 11 and said roller 12 with the image deposit 15 facing drum 11. Drum 11 is grounded and positive high tension is applied to roller 12 simultaneously with the rotation of drum 11 in the direction shown whereby the image deposit 15 is transferred to the surface of drum 11.

In FIG. 2B the second transfer operation is illustrated, in which the application of negative high tension to roller 12 causes the transfer of the image deposit 15 from the surface of drum 11 to the surface of a second receptor member 16.

It will be realised that the polarities illustrated refer to the transfer of electroscopic marking particles which are attracted to a negative polarity and repelled by a positive applied polarity. In those instances where electroscopic marking particles of opposite polarities are employed the transfer polarities would be the reverse of those illustrated.

It will be realised tha several other mechanical devices may be produced which are suitable for use in accordance with the principles of this present invention. Several of such devices will now be described by way of example only, as it is possible to devise other mechanical devices which may be used to carry out the necessary functional steps of the invention. Consequently it should be understood that these various mechanical devices are described by way of example only, and are not intended to limit the scope of the invention to the mechanics described or illustrated.

EXAMPLE 1

A metallic drum was fabricated, the circumference of which was slightly in excess of the maximum length of images to be transferred. Thus when the maximum sheet size was 21 inches × 30 inches, the drum ws 7 inches diameter and 31 inches long. Pinions were provided on each end of the drum, the pitch circle diameter of these pinions being equal to the drum diameter. The drum was of aluminium with a grained outer surface. A resilient base member was prepared, with racks along each edge conforming in pitch to the pinions on the drum. Pin registration means were provided at one end of the resilient base. The racks were positioned to allow the polished surface of the drum to contact the surface of the resilient base. The resilient base was a sheet of polyurethane synthetic rubber, of ⅛ inch nominal thickness. The upper surface of the resilient base was positioned to contact the polished drum surface, while the lower surface of the resilient base was bonded to a metal plate. The polished surface of the drum was insulated from the metal plate bonded to the lower surface of the resilient base. Drive means were provided to move the drum in relation to the base, the rack and pinion maintaining the drum and base in register with each other. The drive means could be caused to rotate the drum while maintaining the axis of the drum in a fixed position whereby the resilient base was caused to move in a direction at right angles to the axis of the drum, or alternatively the resilient base could be maintained in a fixed position and the drum caused to move across the surface of the base by rotating with the pinions engaged in fixed racks. Means were also provided to apply a directional electric field between the drum and the resilient base, and either the drum or the resilient base could be grounded as desired.

In use, as electrophotographic master is prepared by charging and exposing a photoconductive recording member and developing the so formed electrostatic latent image in a dry or liquid dispersed toner of the required color. Generally we have found it desirable to use liquid dispersed toners when producing color prints, but the method and apparatus is equally applicable to dry transfer if desired. The master sheet containing the development image is positioned on the resilient base and registered on the register pins provided, and at this stage the drum is positioned at the end of the track and clear of the register pins. Normally when the recording member contains photoconductive zinc oxide as the photosensitive material, such photoconductor will have been charged negatively prior to exposure, and the toner forming the image deposit will be positively charged. In these instances a directional field is applied to effect transfer by the application of a negative polarity to the drum and a positive polarity to the resilient base, with either the drum or the base grounded in addition if desired. The transfer potential applied will normally be within the range 200 – 2,000 volts, but may be more or less in some instances depending on toner characteristics which are beyond the scope of the present invention. To effect transfer of the image deposit from the master to the drum the drum is caused to roll across the base by energising the drive means previously described simultaneously with the ap-

plication of the previously described directional electrical field.

The master sheet is then removed from the base and the image receiving sheet is positioned in register on the base. The directional field is reversed simultaneously with re-energising of the drive means to transfer the image deposit from the drum surface of the image receiving sheet. The process is repeated using different masters having image deposits of different colors thereon to produce a colored print on the image receiving member. Alternatively in some instances it is also possible to transfer all colored toner deposits to the drum and effect simultaneous retransfer of the several toner deposits to the image receiving member at the one time. such alternative requires the use of toners with a balanced electrophoretic behaviour outside the scope of the present invention.

EXAMPLE 2

In this example two drums were used in addition to the resilient base member, the image bearing dielectric master being fixed in register to the upper drum and transfer being effected to the lower drum which was metallic, and in contact with the upper drum. The image receiving sheet was positioned in register on the resilient base, and utilising the electrical considerations already described in relation to Example 1 the image was transferred from the photoconductive master to the drum and subsequently from the drum to the image receiving sheet in one pass. This apparatus allowed the image receiving member to remain fixed in position to the base throughout the entire operation of multicolor transfer. However when liquid developed images were transferred wet it was found advantageous to at least partially dry the top surface of the image receiving member just prior to each subsequent transfer step after the first pair.

EXAMPLE 3

In this example two drums are also used, but without the resilient base. The two drums are mounted side by side in a substantially horizontal plane, and indexed to each other to maintain registration. In addition register pins are provided on one durm, the other having a smooth polished surface. The first drum in addition may advnatgeously have a resilient surface such as an outer layer of a semiconducting polyurethane synthetic rubber if desired. In operation the image bearing master sheet is position in register on the first drum, and the two drums are rotated in contact with each other simultaneously with the application of the previously described directional electrical field to cause transfer of the image deposit to the polished surface of the second drum. The master sheet is then removed and the image receiving sheet is positioned in register on the surface of the first drum. The directional field is reversed and the drums rotated to cause transfer of the image deposit from the surface of the second drum to the image receiving sheet. The process is repeated as often as is required to produce the desired multicolor print.

EXAMPLE 4

In this example drums are not used. A base member is provided which is curved in one direction only, that is the base member is a segment of a cylinder of relatively large radius such as 2 ft. to 50 ft. or more. This curved base member surface may be in the form of a stainless steel plate or aluminised polyester resin film or the like, adequately supported. A roller is provided to contact said curved base, such roller bing of relatively small diameter, such as for instance 1¼, and preferably coated with a resilient semi-conducting layer of the type previously described. Registration means are provided at one end of the curved base member. In use the image bearing master sheet is position in register on the curved base with its image bearing surface in contact with the base, and the directional electrical field is applied as the roller is moved to cause contact between the two surfaces. If desired the master sheet can be peeled out of contact with the curved base plate immediately after the passage of the roller. As before the master sheet is removed and the image receiving member is position in register and the directional electric field reversed simultaneously with a second passage of the roller to effect transfer of the image deposit to the image receiving member. The process may be repeated as often as is required to produce a multicolored reproduction on the image receiving sheet.

EXAMPLE 5

In this example the first drum of Example 3 is replaced with the resilient roller of Example 4 and a pin register device is positioned above the nip between the two rollers. This apparatus functions in a manner similar to that of Example 3, and is substantially as is illustrated in FIG. **2.**

It will be realised that the metallised or metallic intermediate transfer member may also be in the form of a suitably indexed continuous belt, or a web contained on a feed roller and passed to a receiving roller. Such belt or web may be metallic or alternatively may be a polyester resin film or the like having coated on one side a layer of aluminium or other metal. The travel path of such belt or web may be arranged by the placing of suitable guide rollers to allow the various transfer functions to take place at set positions along said travel path.

It will also be realised that the intermediate transfer member is normally reusable, and usually will require cleaning between transfer sequences. Such cleaning may be carried out by contacting the intermediate transfer member surface with a wiper wetted with toner carrier liquid, or a rotating brush may also be employed if desired.

Further paper guide means and sheet separating means may also be provided in each of the embodiments to which such systems would be applicable, and the process may be automated to any desired extent without departing from the spirit of the invention.

I claim:

1. An electrostatic method for the reproduction of color printed matter comprising the following steps:

a. producing an electrostatic latent image on the dielectric surface of an electrostatically chargeable recording member;

b. contacting said electrostatic latent image with electroscopic marking particles of a color suspended in an insulating carrier liquid to develop said latent image;

c. transferring said developed image to an electrically conducting first receptor surface by the simultaneous application of contact and a directional elec-

trostatic field of a polarity to urge the marking particles to said first receptor surface;

d. transferring said developed image from said first receptor surface to a second receptor surface by the simultaneous application of contact and a directional electrostatic field of a polarity to urge developed image to said second receptor surface;

e. fixing said developed image to said second receptor surface; and,

repeating steps (a) to (e) at least once using electroscopic marking particles of a different color to produce a print on said second receptor surface containing at least two colors.

2. The method of claim **1** wherein said first receptor member is a roller, wherein said second receptor member is a sheet, and wherein said steps of transferrring comprise: passing said recording member bearing said developed image between the said first receptor roller and a pressure roller which urges the said recording member into contact with the first receptor roller; applying a field of one polarity between said rollers to transfer the said developed image to the said first receptor roller; and, then passing a sheet between the said rollers while applying a field of opposite polarity between the said rollers to transfer the developed image from the first receptor roller to said sheet.

3. The method of claim **1** further comprising at least partially drying the surface of the second receptor surface after the transfer thereto of electroscopic marking particles.

4. The method of claim **1** wherein the electrostatic field of step (C) is of one polarity, and wherein the electrostatic field of step (D) is of an opposite polarity to reject the developer and deposit it on the second receptor surface.

5. An electrostatic method for the reproduction of color printed matter comprising the following steps:

a. producing an electrostatic latent image on the dielectric surface of an electrostatically chargeable recording member;

b. contacting said electrostatic latent image with electroscopic marking particles of a color suspended in an insulating carrier liquid to develop said latent image;

c. transferring said developed image to an electrically conducting first receptor surface by the simultaneous application of contact and a directional electrostatic field of a polarity to urge the marking particles to said first receptor surface;

repeating steps (a) to (c) at least once using electroscopic particles of a different color to form a composite color particle developed image;

d. transferring said composite developed image from said first receptor surface to a second receptor surface by the simultaneous application of contact and a directional electrostatic field of a polarity to urge said composite developed image to said second receptor surface; and,

e. fixing said composite developed image to said second receptor surface.

6. The method of claim **5,** wherein said step of contacting includes at least partly drying said developed image prior to transfer to the said first receptor surface.

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