

[54] **XEROGRAPHIC DUPLEX TECHNIQUE**

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[56] **References Cited**

UNITED STATES PATENTS

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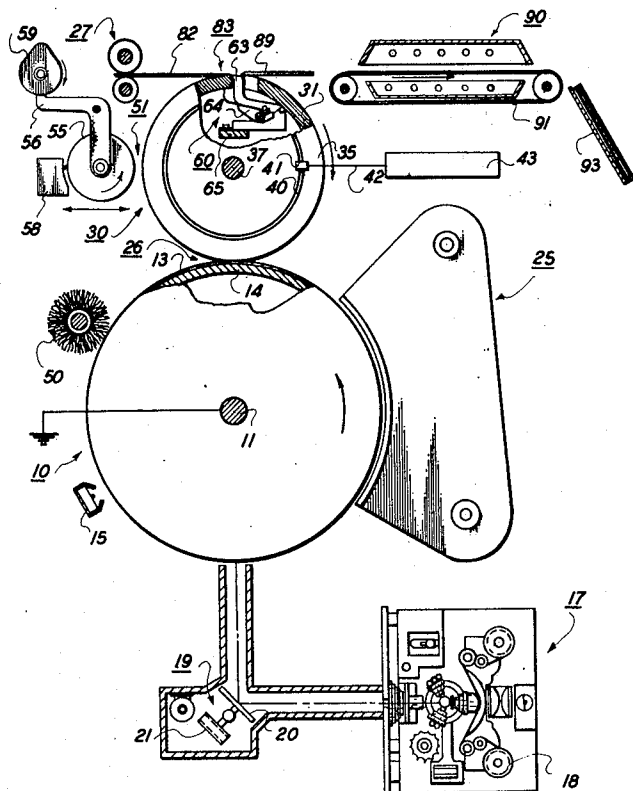
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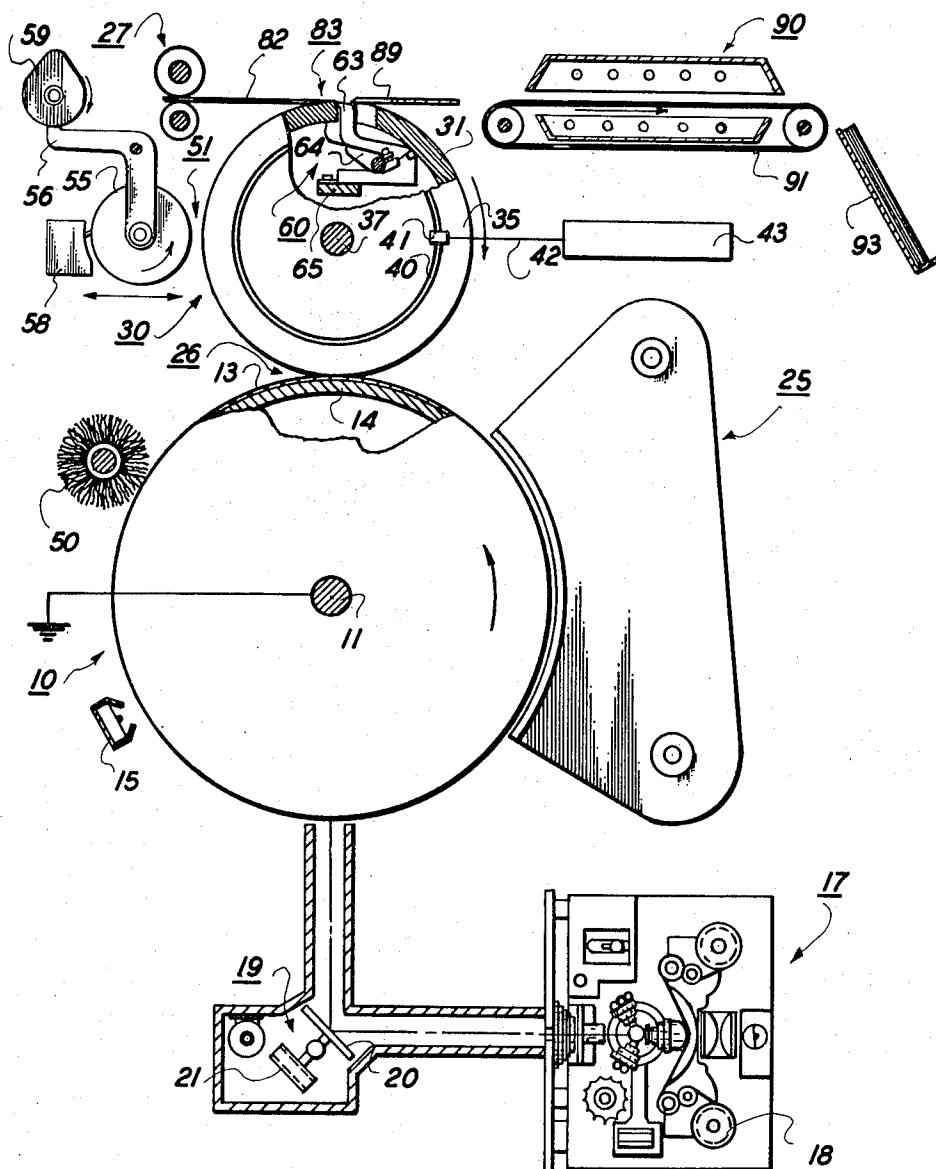
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[57] **ABSTRACT**

Method and apparatus are herein disclosed for creating a duplex copy. First and second dry toner images are formulated on an image retaining member. The first image is electrically transferred to a storage member. A sheet of final support material is placed over the first image supported on the storage member and the second image electrically transferred to the opposite side of the support sheet. Sufficient pressure is applied to the sheet while it is in contact with the storage member to bond the images to the sheet whereby the image remains upon the sheet as it is removed from the storage member.

14 Claims, 1 Drawing Figure





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XEROGRAPHIC DUPLEX TECHNIQUE

This invention relates in general to xerography, and in particular, to a means for efficiently transferring xerographic images to both sides of a final support sheet.

In conventional automatic xerography, a photosensitive plate, which consists of a photoconductive coating placed over a conductive backing, is uniformly charged and the charged plate then exposed to a light image of an original. Under the influence of the light image, the charge on the plate is selectively dissipated to record the original input scene information in the form of a latent electrostatic image. The latent image is developed, or made visible, by applying oppositely charged toner particles to the plate surface whereby the toner particles are attracted into the imaged areas. The developed images are generally transferred from the photoconductor to a final support sheet, such as paper or the like, and affixed thereto to form a permanent record of the original.

Means have long been sought in automatic xerography of providing apparatus having a duplexing capability. However, most duplexing devices have heretofore been characterized by their complexity, as exemplified by Rubin in U.S. Pat. No. 3,318,212, or involved the use of more than one photoreceptor, as taught in U.S. Pat. No. 3,536,398 to Bhagat.

It is a general object of this invention to improve xerographic duplexing apparatus.

It is a further object of this invention to provide a relatively simple and efficient means for creating duplex copy.

These and other objects of the present invention are attained by sequentially formulating two distinct images upon photoconductive plate and electrically transferring the first image to a biasable storage member. A sheet of final support material is placed in contact with the storage member, directly over the first image, and the second image electrically transferred to the opposite side of the sheet. Sufficient pressure is applied to the sheet, while it is in contact with the storage member, to cause the two images to become bonded to the sheet so that the images remain affixed thereto upon removal of the sheet from the storage member. The pressure bonding of the first image to the sheet also constitutes the transfer of that image to the sheet. The transfer of the second image to the sheet is accomplished electrostatically with the bonding acting to fix the second image to the sheet.

For a better understanding as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawing illustrating a schematic view, in partial section, of an automatic xerographic reproducing device embodying the teachings of the present invention.

Referring now specifically to the FIGURE, the apparatus of the present invention is shown embodied in the drum type automatic xerographic reproducing machine. The central element of the machine is a drum 10 which is mounted for rotation in the machine frame upon a shaft 11. The drum is driven in the direction indicated by means of a motor (not shown). The drum basically comprises an outer surface 13, consisting of a photoconductive insulating material such as vitreous

selenium or the like, that is placed upon a grounded conductive substrate 14. Initially, a uniform electrostatic charge is placed on the photoconductive surface by means of a conventional corona charging device 15 similar to that disclosed by Vyverberg in U.S. Pat. No. 2,836,725.

The uniformly charged drum surface is then moved past an exposure means, generally referenced 17, that is capable of exposing the charged surface to a flowing light image of the original input scene information to be reproduced thus forming a latent electrostatic image on the photoconductor. The optical system herein utilized is similar to that disclosed in U.S. Pat. No. 2,940,358 and is of the type wherein the original input scene information to be reproduced is stored in the form of minified data upon a film input 18. A movable mirror system 19 is positioned in the optical light path of the system and is arranged to redirect the flowing light image of the original onto the bottom portion of the moving drum surface. The mirror system basically comprises a plane mirror surface 20 and a roof mirror 21 which, in operation, are alternately interposed into the light path of the optical system so that each successive image presented to the drum surface is optically reversed. In practice, the optical means exposes the photoconductive drum to a first input wherein a right reading latent electrostatic image is formulated thereon.

Following the formation of the first right reading latent image, the image is moved past a conventional xerographic developing device 25 wherein the latent image is brought into contact with oppositely charged toner particles. The charged particles are attracted into the imaged areas creating a visible xerographic toner image. The term "toner image", as herein used, is employed in a broad sense to define an image created as the photoconductor moves through a single exposure and development step, and the image so created may include many separate and distinct pieces of input information.

After development, the now visible first right reading image is transported on the xerographic drum to a transfer station 26 where the image is temporarily transferred to, and stored in image configuration, upon the surface of an intermediate bias transfer roll 30. The transfer roll is arranged to extend transversely across the photoconductive drum surface and to move in synchronous relation therewith as shown in the drawing. In practice, the roll, which is initially placed at a relatively high bias potential, is arranged to coat electrically with the grounded photoconductive drum to establish a directional force field therebetween being of sufficient strength to attract the charged toner particles moving through this transfer region from the photoconductor towards the transfer member.

The biased transfer roll 30 comprises a conductive metal cylinder 31 that is closed at both ends by means of dielectric end caps 35 which also serve to electrically isolate the cylinder from the main machine frame. A support shaft 37 is secured in the end caps, the shaft being in axial alignment with cylinder 31, and is mounted within the machine in parallel alignment with drum shaft 11. The spacing between the two shafts is arranged so that cylinder 31 moves through the transfer station 26 in relatively close proximity to the photocon-

ductive drum surface. A drive means (not shown) operatively connected to the machine's main drive system, is operatively connected to shaft 37 and causes the transfer roll to be continually moved through the transfer station in predetermined timed relation with the moving photoconductive drum.

A commutator ring 40 is mounted in one of the end caps, and the commutator electrically connected to conductive cylinder 31. A brush 41, connected to a biasing source 43 via line 42, is adapted to ride in contact with the commutator ring and provides a movable connection by which power is supplied to the roll in order to create a directional force field in the transfer region. The force field associated with the electrically isolated transfer roll is dependent upon the establishment of a voltage contrast between the roll and grounded photoconductive drum 10 with the strength of the force field being proportional to the initial charge placed on cylinder 31 and inversely proportional to the distance between the two coating bodies. Accordingly, it has been found that a toner image can be efficiently transferred between the two coating members by maintaining a gap of between 0.002 and 0.005 inches therebetween while applying a voltage of between 600 and 1,200 volts DC to cylinder 31.

Subsequent to the formation of the first right reading image upon the drum, a second area on the photoconductive surface is again uniformly charged by means of charging corotron 15. This second uniformly charged area is moved past the exposure station 17 causing the photoconductor to be exposed to a flowing light image composed of additional input scene information so that a wrong reading latent electrostatic image is formulated on the drum surface. To produce this wrong reading image, roof mirror 21 is interposed into the optical light path of the system thereby replacing mirror 20. The wrong reading latent electrostatic image is then transported on the moving drum surface to the developing station 25 and a second image made visible in a manner similar to that herein described in reference to the first right reading image.

The timed sequence of charging, exposing and developing of the two oppositely reading images is controlled in predetermined timed relation by means of the machine control logic circuitry. Of course, the particular selection of the timed sequence of operation may be dependent on many factors, such as the location of the various processing stations, the length of velocity of the image storage member relative to the size of the drum and the like. For convenience of illustration, the circumference of the transfer roll is herein deemed to be one-half that of the photoconductive drum. The two members are driven at the same peripheral speed whereby the first image, which has been transferred and stored upon the transfer roll, is transported around the circular path of travel described by the drum and arrives at the transfer station at approximately the same time as the second developed image carried on the photoreceptor. Accordingly, the leading edges of the two images, lying respectively on the storage drum and the photoconductive drum, confront each other at the transfer region at approximately the same moment in time.

Prior to bringing the two toner images together within the transfer region, a sheet of final support

material, such as paper or the like, is secured to the transfer roll member in a manner wherein the sheet overlies the first image stored thereon. To this end, a sheet gripping mechanism is provided that is securely mounted within the transfer roll. Any suitable paper gripping means capable of securing a sheet to the roll surface may be used in the practice of the present invention provided that the gripper does not impede, in both electrical and a mechanical sense, the function of the transfer roll as it moves through the transfer zone. Basically, two sheet aligning and gripping assemblies 60 are supported in spaced parallel alignment within the roll and are arranged to act upon the two leading edge corners of a support sheet brought into operative communication therewith. Each assembly is made up of two main components, an aligning and gripping component 63, and a control component 64 that are supported upon a common base plate 65.

In operation, an individual sheet of support material 82, is forwarded from a supply bin or the like into a sheet receiving station 83 by means of feed roll assembly 27 prior to the arrival therein of the first image. At this time, the aligning and gripping component is elevated, via the control component, through openings provided in the cylinders to a position slightly above the roll surface and the sheet driven into aligning contact therewith. Once aligned, component 63 is caused to move downwardly thus locking the sheet against the surface on the roll. The gripping mechanism is retracted sufficiently within the roll to permit the roll to move freely through the transfer zone.

With the leading edge of the sheet secured to the roll, the roll continues to rotate in the direction indicated thereby positioning the trailing portion of the sheet over the first image. The first image, with the support sheet in contact therewith, is recirculated through the transfer zone in synchronization with the second image carried on the photoconductive drum. The introduction of a paper support or the like into the transfer region might be such as to warrant a reduction in the bias potential to prevent air breakdown from occurring in and about the transfer region. To this end, power supply 43 is preferably of the variable type capable of being controlled by means of the machine control system to reduce the transfer bias prior to introducing the sheet into the transfer zone. It has also been found that by coating the transfer member with a relatively thin coating of insulating material also minimizes air breakdown at most normal operating potentials. It is further preferred that this outer coating be formed of a material capable of providing a relatively smooth surface that exhibits good mechanical release properties in respect to the toner material that is brought in contact therewith. A polyurethane material, manufactured by the duPont Company under the tradename "Adiprene" having a resistivity of about 10^{13} to 10^{14} ohms cm. and showing extremely good release characteristics in respect to many commercially available toners may be used to coat the transfer roll.

As the second image passes through the directional force field within the transfer region, it is electrically transferred from the photoconductor to the outer surface of the final support sheet. After transfer, the sheet is transported to a pressure delivery station 51 located between transfer station 26 and sheet delivery station

83. Positioned in the pressure delivery station is a rotatably driven pressure roll 55 that is provided with a relatively hard working surface. The roll is rotatably supported within a rocker arm 56 and is arranged to move laterally in and out of pressure contact with the surface cylinder 31. The lateral movement of the pressure roll is controlled through the main machine system and is imparted to the pressure roll through means of a cam 59. In operation, the pressure roll is continually rotated in the direction indicated and is periodically cammed into pressure contact with the transfer roll to engage the support sheet therebetween after the second image transfer operation has been accomplished. The pressure exerted by roll 55 bonds the first image to the sheet and in the process effects the transfer of that image to the sheet. The pressure transfer of the first image is necessary because the first image is electrostatically tacked to roll 26 until this time. For this reason, it is preferable to remove the electrical bias on roll 26 during the pressure transfer. The second image is bonded to the opposite side of the sheet by the pressure exerted by roll 55. However, the pressure is necessary only for bonding because the second image is electrostatically transferred directly to the sheet. An oil dispensing unit 58, adapted to apply a silicone oil to the pressure roll, is also provided. The dispensing unit places a thin coating of oil over the roll surface which serves to prevent toner from being offset, or transferred, from the final support sheet to the roll.

It is herein contemplated that the present invention will be practiced in conjunction with either pressure sensitive toners, such as encapsulated toners as disclosed by Green in U.S. Pat. No. 2,953,470, or with more conventional heat sensitive toners as are generally known and used in the art. When a pressure sensitive toner is employed, the two images supported upon the sheet can be simply permanently affixed thereto as the sheet passes through the pressure applying station 51. Generally pressures in a range of between 200 and 600 PLI are sufficient to accomplish a permanent fix. In the case of heat sensitive toners, sufficient pressure is applied to partially bond the two images to the support sheet, that is, the toner images and the sheet coalesce to a point wherein the toner particles totally or almost totally remain on the sheet when it is removed from the transfer member. Pressures of about 40 to 300 PLI will normally achieve the desired result.

To accomplish removal of the sheet from the roll, the sheet is transported on the roll surface once again into station 83. Here the gripping component 63 is moved to a fully extended position causing the sheet to be elevated well above the roll surface. As the roll continues to move in the direction indicated, the elevated sheet is carried over stripping bar 89 which guides the sheet into a fuser assembly 90. The sheet is advanced through the fuser assembly by means of a suitable transport 91 wherein the heat sensitive images are permanently affixed to both sides of the support sheet. It should be clear that the fuser assembly is applicable only where heat sensitive toners are employed and, in the case of pressure sensitive toners, this operation can be by-passed or negated in some manner, as for example inactivating the heating means. The duplexed copy sheets are then taken from the fuser and stored in a collecting tray 93.

While the invention has been described with reference to the structure disclosed herein, it is not specifically confined to the details set forth, and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. The method of sequentially transferring a first charged powder image indirectly and a second charged powder image directly from the surface of an image retaining element onto both sides of a sheet of final support material including
 - bringing an electrically biased transfer member into electrical communication with said image retaining element to transfer said first image from the image retaining element to the surface of said transfer member,
 - securing a sheet of final support material to the biased transfer member with the backside of the sheet in contact with the first image retained thereon,
 - bringing the transfer member once again in electrical communication with said image retaining element to transfer said second image from the image retaining element to the top side of said final support sheet, and
 - applying pressure to the sheet secured to said transfer member to bond said images to both sides of said sheet whereby said first image is transferred from said transfer member to said sheet.
2. The method of claim 1 wherein sufficient pressure is applied to permanently fix said images to the support sheet.
3. The method of claim 1 further including the steps of
 - stripping the final support sheet from said transfer member, and
 - permanently fixing said first and second images bonded to the final support sheet.
4. The method of claim 1 further including the step of removing the electrical bias from said transfer member prior to applying pressure to said sheet.
5. The method of producing a duplex copy including
 - formulating a first charged toner image on the surface of a photoconductive plate,
 - bringing an electrically biased transfer member into electrical communication with said photoconductive plate to transfer said first formulated toner image from the plate to the transfer member,
 - securing a sheet of final support material to the transfer member with one side of the sheet contacting the transfer image supported thereon,
 - formulating a second charge toner image on said photoconductive plate,
 - bringing said electrical bias transfer member into electrical communication with said plate to transfer said second toner image to the opposite side of said final support sheet,
 - applying pressure to the sheet secured to said transfer member to bond said images to said opposite sides of said support sheet whereby said first image is transferred from said member to said sheet, and
 - removing said support sheet with the first and second images bonded thereto from said transfer member.

6. The method of claim 5 further including the step of removing an electrical bias from said transfer member prior to applying pressure to said sheet.

7. The method of claim 6 further including the step of permanently fixing the bonded images to said support sheet.

8. The method of claim 5 wherein sufficient pressure is applied to permanently fix the toner images to the support sheet.

9. Apparatus for producing a duplex copy including means to sequentially formulate a first and a second toner image on a moving photoconductive plate, an electrically biased transfer roll arranged to move in timed relation with said photoconductive plate through a region of electrical communication such that the first toner image is transferred from the plate to the roll surface and the image recirculated thereon through the region of electrical communication in synchronization with said second image on the photoconductive plate,

securing means operatively associated with said transfer roll for securing a final sheet of support material against the roll with one side thereof in contact with said first image, whereby said second image is transferred to the opposite side of said sheet upon recirculating said first image and final support through the region of electrical communication and

pressure applying means positioned adjacent to said transfer roll and being adapted to apply pressure to said sheet secured to said transfer roll to bond said images to opposite sides of said sheet whereby said first image is transferred from said roll to said sheet, and

means to remove said sheet with said first and second images bonded thereto from said roll.

10. The apparatus of claim 9 having further means to electrically remove the bias from said roll prior to applying pressure to said sheet.

11. The apparatus of claim 10 having further means to permanently fix the bonded toner images to said opposite sides of said support sheet.

12. The apparatus of claim 9 wherein said pressure applying means comprises a pressure roll member movably mounted adjacent to said transfer member, and

control means operatively associated with said pressure roll to move said pressure roll in and out of contact with said transfer roll to bond said first and second images to said support sheet.

13. The apparatus of claim 9 wherein said transfer roll comprises an uncoated steel drum.

14. The apparatus of claim 13 having further means to apply an offset preventing material to said steel drum.

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