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Punnett

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[54] **METHOD OF ELECTROSTATICALLY COPYING INFORMATION ON BOTH SIDES OF AN ORIGINAL ONTO BOTH SIDES OF A SUPPORT MATERIAL**

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Related U.S. Application Data

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[52] **U.S. Cl.**..... **96/1 R,** 96/1.3, 117/17.5, 117/68, 118/637, 355/3, 355/17

[51] **Int. Cl.**..... **G03g 13/08,** C03g 15/08

[58] **Field of Search**..... 117/17.5, 68; 96/1 R, 1 S, 1 D, 1 A, 1.3; 118/637; 355/3, 17

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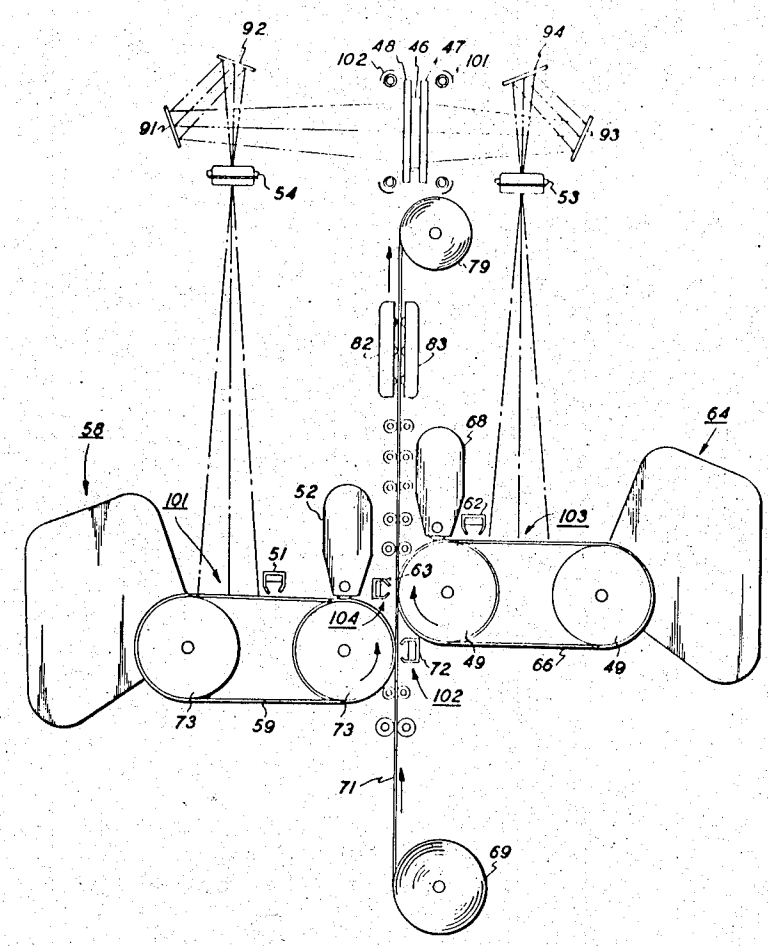
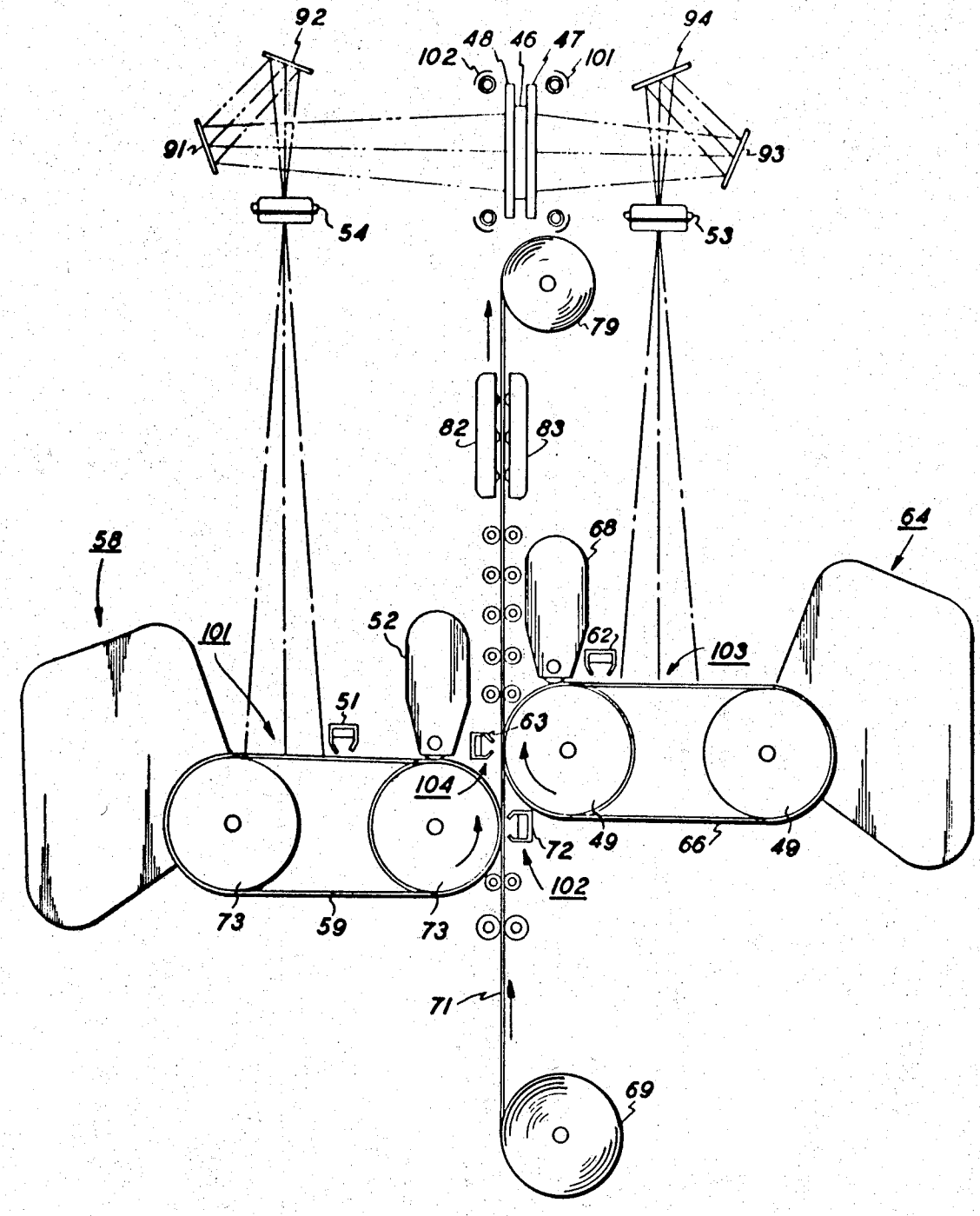
[57] **ABSTRACT**

A method for duplex printing or reproducing the information from both sides of an original document upon a support material by simultaneously forming an electrostatic latent image conforming to each side of the original document on respective photoconductive plates, developing the plates and transferring the developed images from the plates onto opposite sides of the support material.

2 Claims, 1 Drawing Figure

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METHOD OF ELECTROSTATICALLY COPYING INFORMATION ON BOTH SIDES OF AN ORIGINAL ONTO BOTH SIDES OF A SUPPORT MATERIAL

This is a division, of application Ser. No. 751,783, filed Aug. 12, 1968.

This invention relates to electrostatic printing and in particular to method and apparatus for printing on both sides of a support material.

Ordinary printed documents are frequently used as originals in a reproduction process. Many times, however, the information to be reproduced exists on both sides of the original document and in order to completely reproduce such documents with the presently known copiers, two individual copy steps are necessary. The document is first exposed on one side and a copy is made of it, then the operator of the copier must reverse the document and expose the oposite side to make a copy of it. This two-step procedure is very time consuming and the copier requires the constant attention of the operator so that the document is manipulated properly. In addition, the number of sheets or rolls or paper used is doubled for each two-sided document reproduced since information can be conveniently placed only on one side of the copy sheet at a time.

Various feeding attachments for copiers have been developed to reverse the two-sided document after copying the first side in order to make the copier more completely automatic and eliminate the need of the manual operation, but these attachments are usually bulky, expensive to manufacture and subject to maladjustment thereby creating the hazard of possible destruction of the original document as it is guided by the mechanism. Such attachments, although they can be made to operate rapidly, do not overcome the disadvantage of successive exposures of each side of the original document which wastes time, or the disadvantage of using two sheets for a complete copy of the two-sided original document which wastes materials.

Although most copiers have the capability of reproducing information on the two sides of a single copy sheet if each side of the copy sheet is exposed, developed and fixed individually, it is not an easy result to accomplish. The copy sheet must be redirected into the feed tray of the machine after the first side of the original document has been copied onto it and made permanent. Then, after the copy sheet is reversed and fed back into the machine, the second side of the original document is exposed, developed and fixed to it. Even under ordinary conditions the re-entry of the copy sheet to the copier is difficult especially when many original documents are copied in succession since the correct original document as well as the proper side of the original document must be exposed upon any specific sheet in order that the two sides of the copy sheet match the two sides of the original document.

Accordingly, it is an object of this invention to improve the method and apparatus for copying both sides of an original document which overcomes the deficiencies of the prior art devices as described above.

A second object of the invention is to form images on both sides of a support material in a continuous process.

A third object of the invention is to form images on two surfaces capable of retaining an electrostatic charge and transfer the images to opposite sides of a support material.

Another object of the invention is to transfer in substantial alignment onto opposite sides of a support material the developed images on two xerographic plates.

This invention uses two photoconductive plates upon which electrostatic latent images can be produced. The latent images are produced on the plates simultaneously, developed with toner particles or powder and then transferred to a final support material. In one embodiment of the invention two photosensitive belts are used in copying both sides of a two-sided original document. Both belts travel at idential surface speed while an optical pattern conforming to one side of the original document is produced to expose the first belt and an optical pattern conforming to the second side of the original document is produced to expose the second belt. After the images are developed with toner particles, they are transferred from the belts to opposite sides of the support material.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be used in conjunction with the accompanying drawing, which shows a schematic arrangement of a xerographic reproduction machine showing the path of a transfer web and the positions of two xerographic belts relative to each other and to the transfer web.

The present invention uses two photoconductive insulating plates capable of retaining an electrostatic latent image. These plates can assume any convenient shape such as a flat plate, drum, endless belt or any other functional configuration. The electrostatic latent image can be produced on the surface in any suitable manner such as through the process of xerography, electrography, etc. For the purpose of this description, however, the invention is described within the environment of xerographically-formed images.

The drawing illustrates the elements of the invention in detail, which includes two photoconductive insulating plates in the form of belts to accomplish reproduction of a two-sided original. The original can be a sheet, continuous web or other form of material bearing information on both sides. It may also comprise two sheets or webs printed in simplex, that is, printed only on one side and positioned back-to-back to form two sided printed material. Simultaneously, optical patterns conforming to each side of the original are produced to expose respectively a plate and thereafter, both plates are developed and the developed images transferred onto opposite sides of support material such as sheet material or web. An original bearing information to be reproduced on both sides; e.g., sheet **46,** is placed between two platens, right platen **47** and left platen **48,** where it is held in a flatened, unbuckled position while illumination thereof by any suitable means is taking place. If the original takes the form of a sheet it can be placed and held between the platens either manually or by an automatic document feeding mechanism until exposure is completed. If, in the alternative, the original takes the form of a continuous web, it can be fed between the two platens in a continuous manner and held relative to the plates by any suitable means. The illumination lamps **101, 102** may be arranged to scan each side of the original **46,** such as the illumination apparatus disclosed in U. S. Pat. No. 3,062,095 or be adapted to effect "flash" exposure of the original. It is intended,

that the scanning operation be such that the information on each side of the original be scanned, projected and imaged onto the respective photoconductor belts **59,66** in synchronism with the movement of the surface of the belts. The two sides of the document **46** are illuminated simultaneously during exposure to keep the time for duplex exposure at a minimum and to assure that both images eventually transferred to record material or web **71** are placed on opposite sides thereof in substantial alignment.

The optical patterns to which plates **66** and **59** are exposed can be generated by any other devices. For instance, each of the optical patterns could be generated by illuminating a moving transparency which moves in synchronism with the belt surface or by a flash exposure as previously stated. If the plates **59,66** are in the form of xerographic drum, the imaging must be accomplished by scanning. In addition, the means of generating an optical pattern to be exposed onto one of the photoconductor belts may be different from the means for generating an optical pattern to be exposed onto the other belt.

As mentioned above, the document to be copied by the apparatus shown in the drawing is in the form of sheet **46** bearing information on both of its surfaces. The sheet is held between platens **47** and **48** while each side is scanned by devices **101** and **102.** Imaging light rays of information on the left side of the sheet is directed to a mirror **91** which, in turn, reflects them onto mirror **92.** This combination of the mirrors directs the light rays through lens **54** which focuses the resultant image on plate **59.** In a similar manner imaging light rays of the information on the right side of sheet **46** is directed to a mirror **93** which, in turn, reflects them onto mirror **94.** This combination of mirrors **93** and **94** directs the light rays through lens **53** which focuses the resultant image on plate **66.** The above-described lens-mirror system is intended only as an example of an optical system which can be used to expose plates **59** and **66** to the optical patterns generated by an illumination device and sheet **46,** and any suitable system that can place an optical image on the plates can be used in lieu of the one shown.

The plates **59** and **66** are electrostatic plates which are capable of retaining an electrostatic latent image in response to the optical light pattern which falls upon them. In order to assure that such a latent image is fully retained on each plate, each plate is exposed to its respective optical pattern in a darkened area. Prior to the right side of sheet **46** being illuminated to expose onto plate **66,** the photosensitive layer of the plate is charged uniformly by a corona charging device **62,** and after exposure, the plate is developed by a suitable developing device schematically indicated by **64.** The plate thereafter locates the developed image at a position where it makes contact with the right side of web or record material **71** where transfer device **63** aids in the transfer of the developed image to the web. After the image has been transferred from the plate **66,** cleaning device **68** removes any residual developer powder remaining on the surface of the plate thereby preparing the drum for reuse. Further description of xerographic processing and of details of the devices **62, 63, 64** and **68,** the power supplies and drives therefor are not necessary to understand the invention herein. Such details may be acquired from any one of a number of U. S. patents, such as U. S. Pat. No. 3,162,109 to Mayo et al.

In a similar manner, the electrostatic plate **59** prior to exposure is first uniformly charged by any suitable device, such as corona charging device **51,** and thereafter exposed to a light pattern or image conforming to the information on the left side of the sheet **46.** Next, the latent electrostatic image on the plate **59** is developed by a suitable developing mechanism **58** which deposits toner particles upon the latent image to render the same visible and transferable. After image development, the plate locates the developed image adjacent the left side of web **71** where a corona transfer device **72** assists in transferring the toner particle image from the surface of plate **59** to the web. Thereafter, the plate passes the cleaning device **52** which removes any residual toner particles remaining on the surface of the plate after transfer thereby preparing it for reuse.

Transfer devices **62** and **72** are shown as corona generating devices similar to those disclosed in Schaffert U.S. Pat. No. 2,576,047. They comprise either a unitary or a plurality of wires connected to a high voltage source. The wire is supported in a conductive shield that is arranged in closely spaced relation to the surface to be charged; i.e., web **71.** When the wire is energized, corona is generated along the surface of the wire and ions of the necessary polarity are caused to be deposited on the web surface. In addition to a corona device, transfer can be accomplished by any suitable method. For example, a roller, either heated or unheated, can be placed adjacent the web on the side of the web opposite the plate in order to accomplish transfer by compression or heat and compression.

The web **71** can be any support substrate material to which the image can be fused or otherwise made permanent. Web **71** may also comprise any suitable material which serves as an intermediate to which the developed image is transferred prior to being placed on its final support material. For instance, the web can be paper, plastic, metal, etc., and can take the form of individual sheets, a continuous strip, or any other convenient form. In the drawing the web **71** is a continuous strip of paper fed from a supply roll **69** at the same lineal speed as the speed of the belts.

The web is initially fed from the roll **69,** and, after the transfer and fusing steps have taken place for the images on both sides of the web, it is rewound on a take-up roll **79.** The web is first passed adjacent plate **59** where the image on the surface of the plate is transferred to the left side of the web. After this transfer step, the web can be moved under a fuser (not shown) which acts to partially fuse the transferred image upon the web.

The image may be partially fused at this point, but there must be assurance that the web is sufficiently cool so as not to adversely affect the transfer process to its other side. Although it may be advantageous that some fusing take place on the image first transferred before an image is tranferred to the opposite side in order to revent distortion or smearing of the image first transfered, such fusing is optional. The image transferred onto the left side of the web from plate **59** may also be completely fused by such an element along the path of the web between transfer devices **62** and **72.** However, because of the quantity of heat necessary to effect good fusing, the web would either have to be quickly cooled before the image on drum **66** were transferred to the opposite side of the web or the path of travel between the fuser and corona transfer device **62** would have to

be lengthened in order that sufficient time is given for the surrounding air to cool the web before transfer.

It is preferred that all fusing take place after both images have been transferred to the web **71** from their respective plates. Radiant heat fusing devices **82** and **83** make permanent the images placed on the left and right sides of the web as the web passes between them. Whether the fusing of the two developer powder images occurs concurrently or in a sequential manner as discussed beforehand, any suitable method that lends itself to the aparatus such as vapor fusing, roll compression, etc. can be used.

The two plates **59,66** are shown as flexible, endless photoconductor belts, the belt **66** traveling clockwise around its driving supporting rollers **49** and the belt **59** traveling counterclockwise around its driving supporting rollers **73.** Since the belts travel at the same speed, which is substantially the speed of the web, to assure transfer of the images to the web without smearing, and because the belts are exposed to their respective optical patterns simultaneously, it is necessary to make some accommodation for getting the two images transferred to the web opposite one another. As can be seen in the drawing,the distance that the plate **59** travels between its exposure station **101** and its transfer station **102** is shorter than the distance that plate **66** travels between its exposure station **103** and its tranfer station **104.** The difference in these two distances is equivalent to the distance the web travels between the transfer stations **102** and **104** and, therefore, the image existent on plate **66** is transferred, with the aid of transfer device **62** onto the right side of the web in substantial alignment with the image tranferred onto the left side of the web. Likewise, the period of time which elapses between the time the image on plate **59** commences transfer to the web and the time the image on plate **66** commences transfer to the web is a function of the time the web takes to travel between transfer device **72** and transver device **62.**

The invention herein is disclosed in detail within the environment of the xerographic process. It will be appreciated, however, that the xerographic reproduction process is not critical to the invention. Any suitable manner of forming a powder image on plates **59** and **66** which can be transferred to a record material can be utilized and methods other than xerography may be used to form the images on the plates such as by the utilization of character electrodes as disclosed by Shull in U.S. Pat. No. Re.25,830 xeroprinting masters as disclosed by Schaffert in U. S. Pat. No. 2,576,047, or any other suitable method. Rather than utilize a transfer step in the electrostatic processing of producing readable duplex copy of the document **46,** the printing process may involve the photoconductor zinc oxide paper in place of the photoreceptors **59, 66.** In this arrangement, each of the zinc oxide photo-receptor may be in the form of cut sheets or web.

It is intended that appropriate drive mechanisms and control circuits be a part of the gneeral disclosure herein, but such apparatus are not shown since the elements can be of any suitable design to accomplish the operational movement of the invention, as described above.

What is claimed is:

1. The method of printing the information on two sides of an original including the steps of

forming a first electrostatic latent image on a photoreceptor surface of the information on one side of the original,

forming a second electrostatic latent image on another photoreceptor surface of the information on the other side of the original simultaneously with the formation of said first latent image,

and developing the two latent images on their respective photoreceptor surfaces with finely divided electrostatic particles thereby forming on the surfaces respectively, visible images of the information on each side of the original.

2. The method of printing the information on two sides of an original respectively onto two sides of support material including the steps of

forming a first electrostatic latent image on a photoconductive surface of the information on one side of the original,

developing the first latent image and transferring the developed image onto one side of the support material,

forming a second electrostatic latent image on another photoconductive surface of the information on the other side of the original simultaneously with the formation on said first latent image,

and developing the second latent image and transferring the developed image onto the other side of the support material.

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