United States Patent

[11] 3,580,670

[72] Inventor **Gopal C. Bhagat**
Rochester, N.Y.

[21] Appl. No. **751,986**
[22] Filed **Aug. 12, 1968**
[45] Patented **May 25, 1971**
[73] Assignee **Xerox Corporation**
Rochester, N.Y.

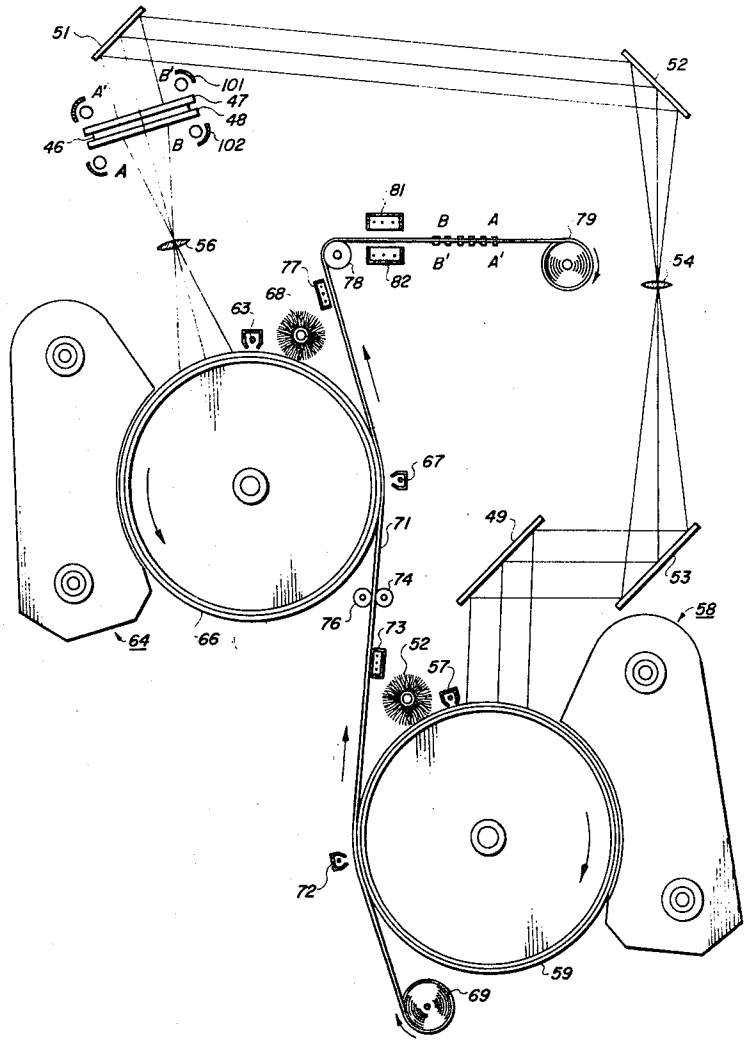
[54] **APPARATUS FOR DUPLEXING**
12 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **355/3,**
355/23, 355/26
[51] **Int. Cl.** **G03b 27/32**
[50] **Field of Search** 355/23, 24,
26, 27, 28, 3; 95/12.2, 18

[56] **References Cited**
UNITED STATES PATENTS
2,578,320 12/1951 Schubert 355/23

Primary Examiner—John M. Horan
Attorneys—Paul M. Enlow, Norman E. Schrader, James J. Ralabate, Ronald Zibelli, Clarence A. Green and Bernard A. Chiama

ABSTRACT: A apparatus for duplex printing by forming on the surface of a first plate an electrostatic latent image conforming to the information to be placed on the first side of a support material, then forming on the surface of a second plate an electrostatic latent image conforming to the information to be placed on the opposite side of the support material, developing the latent images, and transferring the developed image on each plate to its respective side of support material.



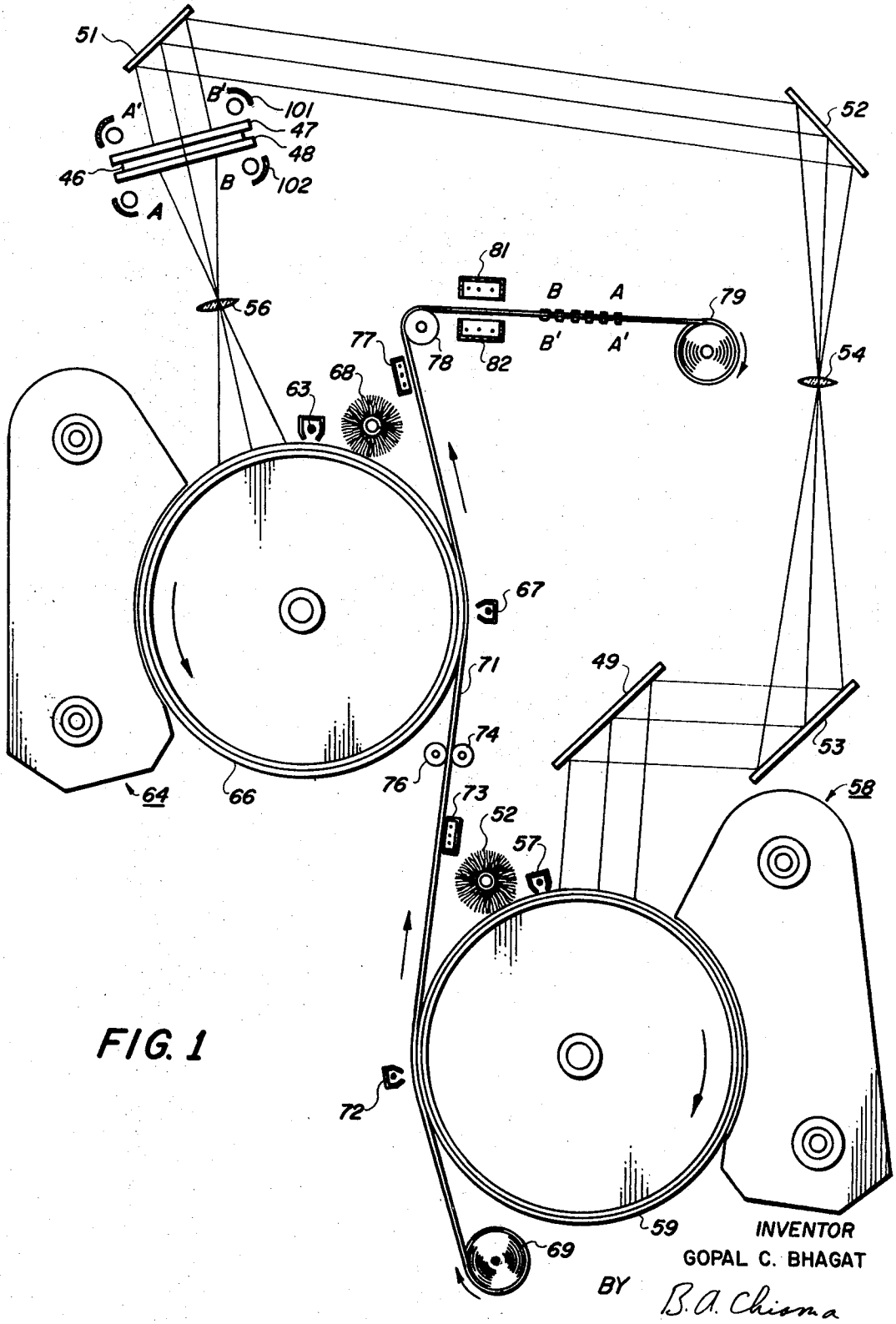


FIG. 1

INVENTOR
GOPAL C. BHAGAT
BY B. A. Chioma
ATTORNEY

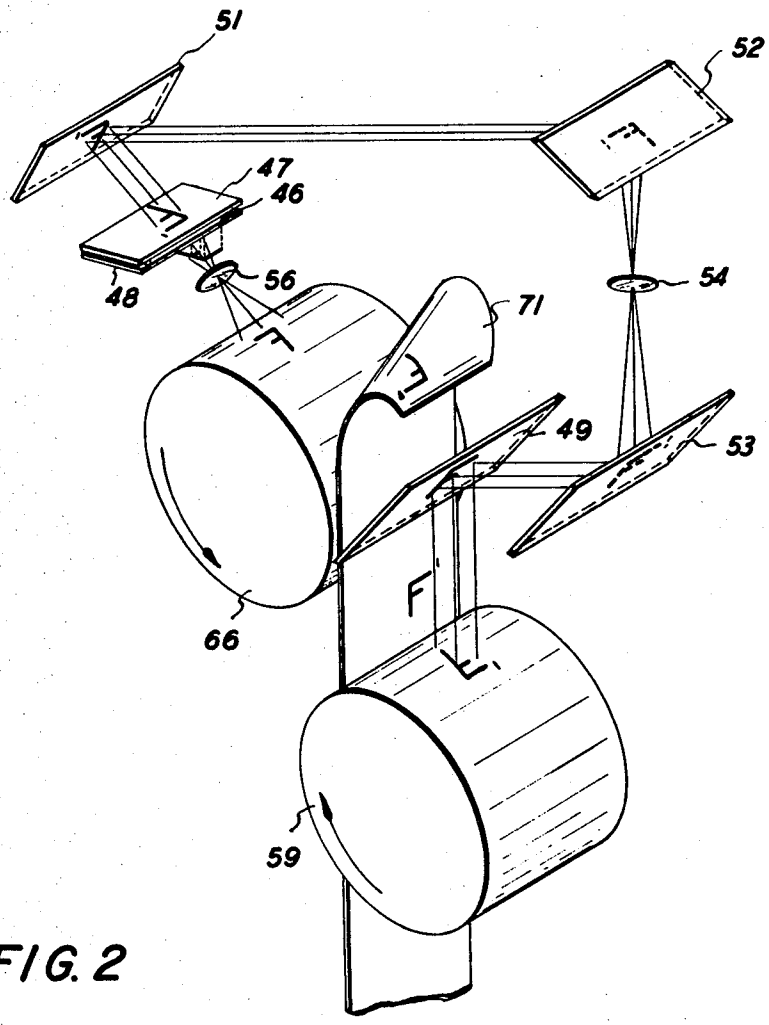


FIG. 2

APPARATUS FOR DUPLEXING

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

It is frequently desirable to use ordinary printed sheets as originals in a reproduction process. Many times, however, the information to be reproduced exists on both sides of the original sheet and in order to completely reproduce such originals with the presently known copiers, two individual copy steps are necessary. The original is first exposed on one side and a copy is made of it, then the operator of the copier must reverse the original and expose the opposite 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 original is manipulated properly. In addition, the number of sheets or rolls of paper used is doubled for each two-sided master 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 original 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 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 which wastes time, or the disadvantage of using two sheets for a complete copy of the two-sided original which wastes materials.

Although most copiers have the capability of reproducing information on the both sides of a 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 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 is exposed, developed and fixed to it. Even under ordinary conditions the reentry of the copy sheet to the copier is difficult especially when many originals are copied since the correct original as well as the proper side of the original must be exposed upon any specific copy sheet in order that the two sides of the copy sheet match the two sides of the original.

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

Another object of the invention is to reproduce both sides of an original document on a support material.

Another object of the invention is to provide an apparatus which forms images on both sides of a support material in a continuous process.

Another object of this invention is to reproduce both sides of an original document in substantial alignment on opposite sides of a support material.

This invention uses two photoconductive insulating plates upon which electrostatic latent images can be produced. The latent images are produced on the plates, developed with toner particles or powder and then transferred to a support material. In one embodiment of the invention two photosensitive drums of equal circumference are used to copy both sides of a two-sided original document. Both drums travel at identical surface speeds while one side of the original is illuminated to expose the first drum and then the other side of the original is illuminated to expose the second drum. The electrostatic latent image formed on the first drum is developed and transferred to one side of the support material. The latent image on the second drum is developed and transferred to the opposite side of the support material in substantial registration with the image transferred from the first drum. 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 drawings, wherein:

FIG. 1 is a schematic illustration of a xerographic reproduction machine showing the path of a transfer web, the positions of two xerographic drums relative to each other and to the transfer web;

FIG. 2 is a schematic illustration showing that right reading images are placed on the web by both xerographic drums;

The present invention uses two photoconductive plates capable of retaining an electrostatic latent image. These plates can assume any convenient shape such as a flat plate, drum, or of 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 purposes of this description, however, the invention is described within the environment of xerographically formed images produced from rotatable drums.

In FIG. 1 there is shown the general elements of the invention which includes two photoconductive plates in the form of drums to accomplish reproduction of two-sided original. The sides of the original are illuminated to expose its own xerographic drum sequentially and thereafter the drums are developed and the resultant powdered images transferred onto opposite sides of the support material or web.

The optical patterns to which the drums are exposed can be generated in any known manner such as by exposing an original document to a source of illumination, passing light through a transparency, etc. In FIG. 1, a sheet **46** having information on both sides is shown as an original document. However, the original could be in the form of a continuous web or other convenient mode. It may also comprise two sheets or webs printed in simplex, that is, printed on one side only and being positioned back-to-back to form two-sided or duplex printing material. The sheet **46** is placed between two transparent plates or platens, upper platen **47** and lower plates **48**, where it is held in a flattened, unbuckled position while exposure 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, on the other hand, the original takes the form of a continuous web, it can be fed between the two platens in a continuous manner. 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 and projected onto the respective drums sequentially and in synchronism with the movement of the surface of the respective drums.

For reproducing both sides of an original on a single copy sheet that is, for duplex copying, it is necessary to give some consideration to the optical system used to assure both sides of the copy are right-reading. Referring to FIGS. **1** and **2**, the lower side of original **46** has two reference points A and B while the upper side of the original has corresponding reference points A^1 and B^1. When both images are finally transferred to the web, A must be opposite A^1 and B opposite B^1 to result in a properly reproduced original. For simplicity, the scanning apparatus is not shown in FIG. 2.

The optical system between the lower side of the original and drum **66** includes merely a projection lens **56**. Therefore, the image placed on the drum will be wrong reading, as represented by the F' just above the drum in FIG. 2. Since the drum **66** is provided with an exposure slot as are copiers of this general configuration, the image on the drum will be upright. With the drum rotating counterclockwise, the top of the image F' will be transferred to web **71** before the lower end thereof and will be the leading edge of the image on the web. Also, after transfer, the wrong reading image on the drum will be right-reading when placed on the web as indicated by the symbol F'.

The optical system between the upper side of the original and drum **59** comprises mirrors **51**, **52**, **53** and **49**, and the

projection lens 54. The light rays from the upper side of the original are reversed by the mirror 51 and rendered right-reading by the mirror 52. The lens 54, in turn, reverses the image, while the mirror 53 makes the image right-reading. Finally, the mirror 49 reverses the image before it is projected through an exposure slit (not shown) and on drum 59. In each instance, the effect of the mirror or lens is represented by the F'. The image, as placed on drum 59, is reversed and upright due to the mirror-lens system and the exposure slit between the upper side of the original and drum 59.

Since A and A' were transferred to their respective sides of the web before B and B', and both images are right-reading on their respective sides of the web, the copy on the web is an accurate reproduction of the original. In FIG. 1, the respective images are correctly aligned to one another as indicated by the relative positions of A, A', B and B' on the web just prior to being wound on reel 79.

Referring to FIG. 1, prior to the lower side of the original being imaged onto xerographic drum 66, the drum is charged uniformly by corona charging device 63, and after exposure the drum is developed by any suitable developing device schematically indicated by 64. The drum thereafter locates the developed image at a position where it makes contact with the left side of web 71 where corona device 67 aides in the transfer of the image to the web. After the image has been transferred from the drum 66, cleaning device 68 removes any residual marking particles remaining on the surface of the drum thereby preparing the drum for reuse. Further description of xerographic processing and of details of the devices 63, 64, 67 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 Pat. No. 3,162,109 to Mayo et al.

In a similar manner, xerographic drum 59 prior to exposure is uniformly charged by any suitable device such as corona charging device 57, and thereafter exposed to a light pattern or image conforming to the information on the upper side of sheet 46. Next, the latent electrostatic image on drum 59 is developed by any suitable developing mechanism 58 which deposits toner particles upon the latent image to render the same visible and transferable. After image development, the drum locates the image adjacent the right side of web 71 where a corona transfer device 72 assists in transferring the toner particle image from the surface of drum 59 to the web. Thereafter, the drum passes cleaning device 52 which removes any residual toner particles remaining on the surface of the drum after transfer preparing it for reuse.

The web 71 can be any suitable support material to which the image can be fused or otherwise made permanent. 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. As shown in FIG. 1, the web is a continuous strip of paper fed from a supply roll 69. Web 71 may also consist of any suitable transfer material which serves as an intermediate to which the developed image is transferred prior to being placed on its final support material.

The web is initially fed from the roll 69, in synchronism with the speed of the surface of the drums, and after transfer and fusing have taken place for the images on both sides, the web is rewound on a takeup roll 79. The web first passes adjacent drum 59 where the image on the surface of the drum is transferred to the right side of the web. After this image is transferred onto the web, the web is moved under a fuser 73 which acts to partially fuse or fix the transferred image upon the web. The image is only partially fused at this point preferably, in order that the web be sufficiently cool so as not to adversely affect the transfer process to its other side. Although it is advantageous that some fusing take place on the image first transferred at this point, such fusing is optional.

In the alternative, the image transferred onto the right side of the web from drum 59 may be completely fused by an element such as the fuser 73. 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 fuser 73 and corona transfer device 67 would have to be lengthened in order that sufficient time is given for the surrounding air to cool the web before transfer. The toner images can be made permanent by any suitable method that lends itself to the system such as by vapor fusing, roll compression, etc., heat fusing not being critical to the operation of the invention.

After passing under the fuser 73, the web can be further guided by guide rollers 74 and 76 into contact with drum 66. The circumferences of drums 59 and 66 are equal lengths and their peripheries travel at equal speeds. Since the point at which drum 66 transfers its image to the left side of the web is physically removed from the point at which drum 59 transfers its image to the right side of the web, some timing arrangement must be made to assure that the images are transferred to the web in alignment with each other. This registration is achieved by exposing the drums in a sequential manner.

Assuming that transfer from drum 59 to the web takes place at transfer device 72 and that transfer from drum 66 to the web takes place at transfer device 67, the time a particular point on the web takes to travel between devices 72 and 67 is equal to the delay necessary between the time drum 59 begins to be optically exposed and drum 66 begins to be optically exposed. When this exposure sequence is observed, registration between the transferred images is accomplished as long as the time between exposing the drum to the optical pattern to be reproduced and transfer to the web is equivalent on both drums. However, if the time between drum exposure and transfer to the web were unequal for the two drums, the disparity would have to be taken into account in the exposure sequence.

After transfer of the image to the left side of the web is accomplished, the image is partially fused by passing it under fuser 77. The web is then brought around support roller 78 and between fuser devices 81 and 82 which permanently fuse the powdered images on both sides of the web. Thereafter, the web is rewound on roll 79 for storage. Fuser 77 is optional and can be deleted, especially if the path of travel between corona device 67 and fuser 81 is relatively short, since there is nothing along the length of the path of the web to disturb the unfused image placed on the left side of the web. The direction of rotation of drum 66 is counterclockwise while the direction of rotation of drum 59 is clockwise throughout the various steps of the reproduction process in order to achieve proper transfer from the drums to the web.

As was mentioned above, the formation of the electrostatic latent image must be commenced on drum 59 before the commencement of the formation of the electrostatic latent image on drum 66 in order that registration of the images results on the support material. Referring to FIG. 1, it is seen that the image on the upper side of sheet 46 must be scanned first and drum 59 exposed to the optical pattern. Then, some time after the upper side of sheet 46 has begun to be scanned, the time depending on the time it takes a point on web 71 to travel between devices 72 and 67, the lower side of the sheet is scanned thereby exposing drum 66 to an optical pattern. Any suitable delay device (not shown) can be used to effect such a delay in scanning.

After an image formed on either of the drums has been transferred to the web, the drum can be stopped until it is reexposed or can continue to rotate. If either drum is stopped, it may be desirable to lift web 71 away from the circumference of the drum since web 71 may continue to be fed between the drums. However, such a device is optional. A lift device would be desirable because otherwise the web would continue to rub against and injure the photosensitive surface of the drum. Any suitable mechanism can be used to lift the web slightly away from the drum so that contact is no longer had. If used, the mechanism could be controlled electrically and programmed to lift the paper away from the surface of the drum just at the time that the drum stops, and allow the web to contact the

drum surface again as the drum reaches its transfer position in a subsequent cycle.

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

I claim:

1. An apparatus for printing on both sides of a movable transfer material including:

a first printing plate movable along a path and adapted to be positioned in contact with one side of the transfer material;

a first transfer device located adjacent the transfer material at the position where the first plate is adapted to be positioned in contact wit the transfer material;

a second printing plate movable along a path and adapted to be positioned in contact with the opposite side of the transfer material;

means for moving the first and second plates along their respective paths of movement at the same speed;

a second transfer device located adjacent the transfer material at the position where the second plate is adapted to be positioned in contact with the transfer material;

means for moving the transfer material between the first and second transfer devices in a predetermined period of time;

a first imaging means to place an image on the first plate located at a predetermined distance from the first transfer device, the distance being measured along the path of movement of the first plate between the first imaging means and the first transfer device;

means for activating the first imaging means;

a second imaging means to place an image on the second plate and located at a predetermined distance from the second transfer device, the distance being measured along the path of movement of the second plate between the second imaging means and the second transfer device, the predetermined distance between the first imaging means and first transfer device being equivalent to the predetermined distance between the second imaging means and second transfer device; and

means for activating the second imaging means a predetermined period of time after the first imaging means is activated, the predetermined period of time being equal to the predetermined period of time for moving the transfer material between the first and second transfer devices.

2. The apparatus in claim 1 wherein the first and second plates are adapted for retaining an electrostatic latent image and the first and second imaging means are means for forming an electrostatic latent image on the first and second plate, respectively and, further including, a first means for developing a latent image on the first plate located adjacent the path of movement of the first plate between the first imaging means and the first transfer device and a second means for developing a latent image on the second plate located adjacent the path of movement of the second plate between the second imaging means and the second transfer device.

3. The apparatus in claim 1 wherein the first and second imaging means comprise means for transferring a developed image onto the first and second plates, respectively.

4. The apparatus in claim 1 wherein the first and second plates are rotatable drums.

5. An apparatus for printing xerographically on both sides of a movable transfer material including:

a first charged xerographic plate movable along a path and adapted to be positioned in contact with one side of the transfer material;

a first transfer device located adjacent the transfer material at the position where the first plate is adapted to be positioned in contact with the transfer material;

a second charged xerographic plate movable along a path and adapted to be positioned in contact with the opposite side of the transfer material;

means for moving the first and second plates along their respective paths of movement at the same speed;

a second transfer device located adjacent the transfer material at the position where the second plate is adapted to be positioned in contact with the transfer material;

means for moving the transfer material between the first and second transfer devices in a predetermined period of time;

a first imaging means adapted for exposing the first xerographic plate to a light pattern at a first exposure station, the exposure station being located at a predetermined distance from the first transfer device, the distance being measured along the path of movement of the first plate between the first exposure station and first transfer device;

means for activating the first imaging means;

a second imaging means adapted for exposing the second xerographic plate to a light pattern at a second exposure station, the second exposure station being located at a predetermined distance from the second transfer device, the distance being measured along the path of movement of the second plate between the second exposure station and second transfer device, the predetermined distance between the first exposure station and first transfer device being equivalent to the predetermined distance between the second exposure station and second transfer device;

means for activating the second imaging means a predetermined period of time after the first imaging means is activated, the predetermined period of time being equal to the predetermined period of time for moving the transfer material between the first and second transfer devices;

a first means for developing an electrostatic latent image on the first plate located adjacent the path of movement of the first plate between the first exposure station and the first transfer device; and

a second means for developing electrostatic latent images on the second plate located adjacent the path of movement of the second plate between the second exposure station and the second transfer device.

6. The apparatus of claim 1 wherein the first and second plates are rotatable drums.

7. An electrostatic reproduction machine for printing on both sides of support material the information contained respectively on two sides of an original including:

a first photoconductive plate being movable in a closed path and having an exposure station at which one side of the original is adapted to be imaged:

a second photoconductive plate being movable in a closed path and having an exposure station at which the other side of the original is adapted to be imaged;

means for producing imaging light rays of both sides of the original sequentially and directing the rays upon said photoconductive plates respectively, at said exposure stations; and

means for moving said plates in their respective paths at approximately the same speed during processing of electrostatic images thereon.

8. The electrostatic reproducing machine of claim 7 wherein said photoconductive plates are in the form of drums.

9. The electrostatic machine of claim 8 wherein the diameter of the first photoconductive drum is approximately equal to the diameter of said second drum.

10. An electrostatic reproduction machine for printing on both sides of support material the information contained respectively on two sides of an original including:

a first electrostatic drum having an exposure station at which one side of the original is adapted to be imaged, said drum having a transfer station associated therewith and arranged to effect transfer of the developed electrostatic image of said one side of the original to one side of support material;

a second electrostatic drum having an exposure station at which the other side of the original is adapted to be imaged, said second drum having a transfer station as-

sociated therewith and arranged to effect transfer of the developed electrostatic image of said other side of the original to the other side of the support material;

means for producing imaging light rays of both sides of the original and directing the rays upon said drums respectively, at said exposure stations;

means for rotating said drums at speeds to effect approximately the same peripheral speed during processing of electrostatic images thereon and transfer therefrom; and

said first drum having a diameter approximately equal to that of said second drum whereby the period for electrostatic processing for one drum is the same for that of the other.

11. The machine of claim **10** wherein said means for producing imaging light rays is adapted to produce the rays for the first plate sequentially with the producing of the rays for the second plate.

12. An electrostatic reproduction machine for printing on both sides of support material the information contained respectively on two sides of an original including:

a first electrostatic drum having an exposure station at which one side of the original is adapted to be imaged, said drum having a transfer station associated therewith and arranged to effect transfer of the developed electrostatic image of said one side of the original to one side of support material;

a second electrostatic drum having an exposure station at which the other side of the original is adapted to be imaged, said second drum having a transfer station associated therewith and arranged to effect transfer of the developed electrostatic image of said other side of the original to the other side of the support material;

means for producing imaging light rays of both sides of the original sequentially and directing the rays upon said drums respectively, at said exposure station;

means for rotating said drums at speeds to effect approximately the same peripheral speed during processing of electrostatic images thereon and transfer therefrom; and

means for transferring the developed images sequentially upon the support material.