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[54] ELECTROPHOTOGRAPHIC RECEIVER SHEET PICKUP METHOD AND APPARATUS 8 Claims, 5 Drawing Figs.

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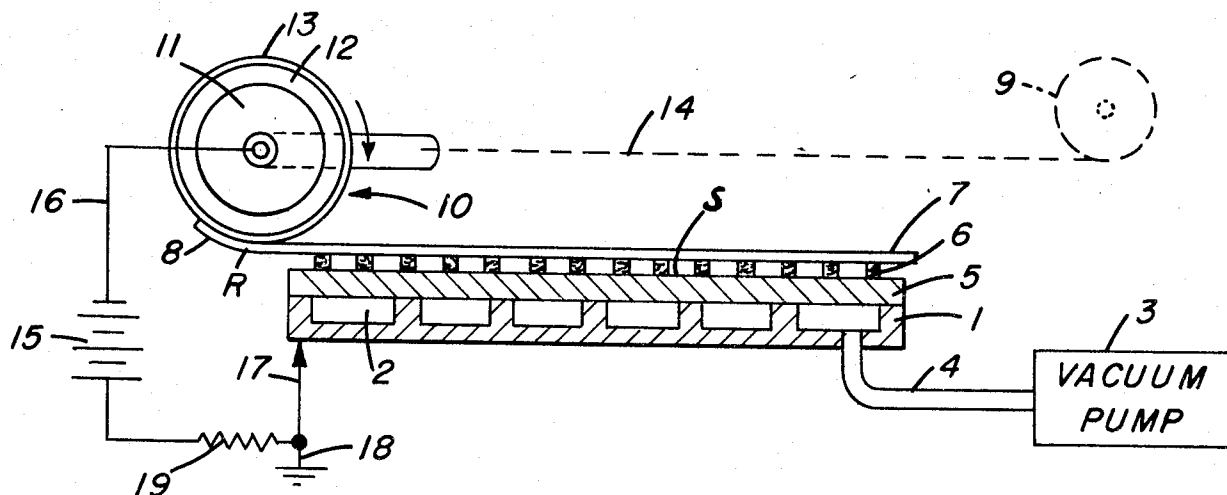
[50] Field of Search. 355/3, 73

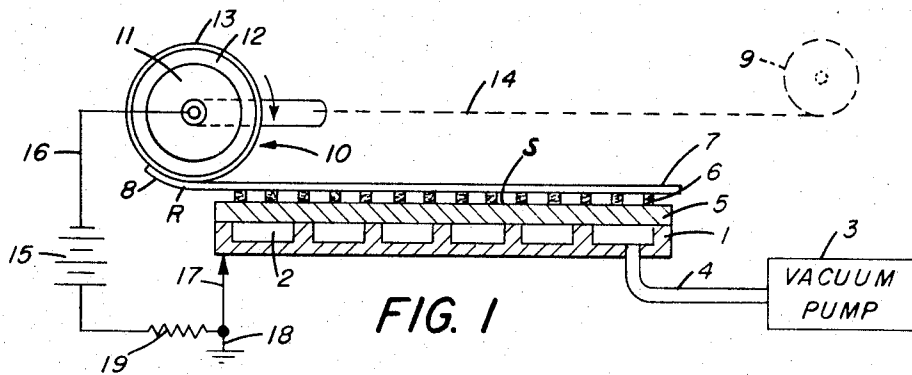
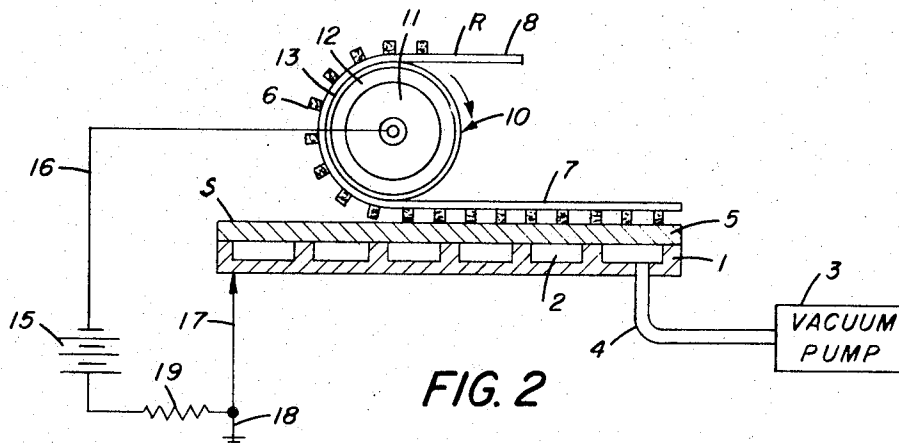
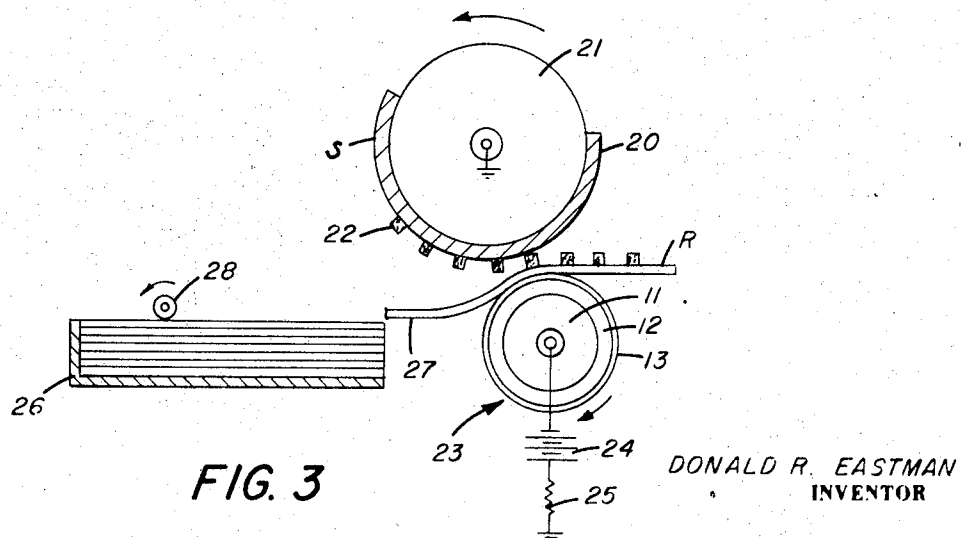
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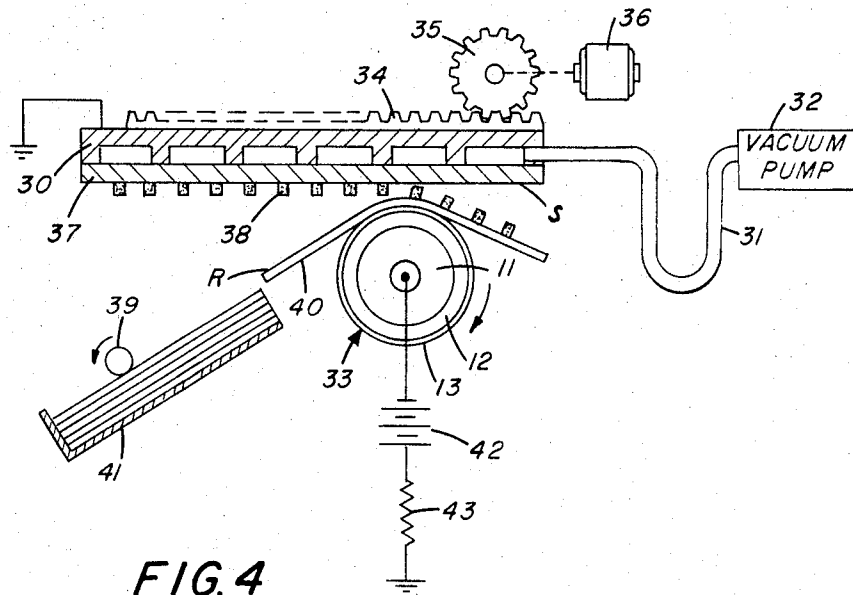
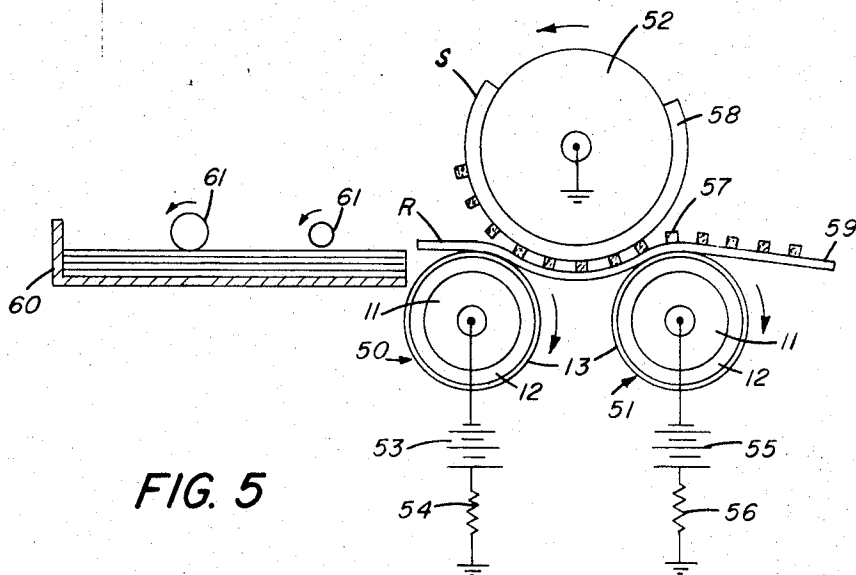
ABSTRACT: An electrophotographic copier, in which a powder image is transferred from a layer of photoconductive material to a receiver sheet in contact therewith, includes at least one electrically biased roller having an electrically conductive core and an electrically insulating layer formed on and surrounding the core. As the roller and the receiver sheet are moved relative to one another, the roller picks up the receiver sheet for subsequent transport through the copier and, at the same time, effects transfer of the powder image to the receiver sheet. In another embodiment, two biased rollers are used, one to effect transfer of the powder image to the receiver sheet and the other to pick up or strip the receiver sheet from the photoconductive material for guiding it into a designated path of further movement through the copier.





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ELECTROPHOTOGRAPHIC RECEIVER SHEET PICKUP METHOD AND APPARATUS

FIELD OF THE INVENTION

This invention relates to electrophotographic copying apparatus and more particularly to a device incorporated in such apparatus for simultaneously effecting transfer of a powder image on a photoconductive element to a receiver sheet and also stripping the latter from the photoconductive element so it can continue in a different direction of movement through said apparatus.

DESCRIPTION OF THE PRIOR ART

Xerographic apparatus in which a powder image on a photoconductive drum or plate is transferred to a receiving member in the form of a web or sheet is well known. In such apparatus the image transfer is usually accomplished by a pressure roller which may or may not be biased. If the roller is biased, for example, by applying a direct current potential in the range of several hundred volts, between the xerographic drum or plate and the pressure roller in contact with the receiving member on the drum, its primary purpose is to effect transfer of the powder image. Subsequent to the transfer of the powder image and at some point further along the path of movement relative to the drum, the receiving member is separated from the drum. When the receiving member is in the form of a continuous web, it is merely brought into tangential contact with the drum so that there is no necessity for any stripping action. In this case, the receiving member engages the drum generally along a line and there is no large area of the receiving member in contact with the drum.

When the receiving member is in the form of a receiver sheet, provisions must be made to strip or remove the sheet from the drum or plate. If a vacuum plate is used to hold the photoconductive material flat and in position during the transfer step, then it becomes very difficult to remove or strip the receiver sheet, because no part of the sheet is readily available for engagement by a stripping member without devising a mechanism expressly for this purpose. Usually, the receiver sheet must be moved along in the apparatus so that other operations can be performed with respect to the sheet which then will bear the powder image: for example, fusing the powder image to the receiver sheet.

SUMMARY OF THE INVENTION

One object of the invention is to provide a device for an electrophotographic copier in which transfer of a powder image carried by a layer of photoconductive material to a receiver sheet and removal or stripping of the receiver sheet from the photoconductive material can be accomplished simultaneously.

Another object of the invention is to provide a device for an electrophotographic copier in which the operations of transferring a powder image carried by a sheet of photoconductive material to a receiver sheet and of stripping the receiver sheet from the sheet of photoconductive material can occur simultaneously, or independently, with no timed relationship to other operations in a copying cycle of operation.

Still another object of the invention is to provide a device for an electrophotographic copier in which the operations of effecting transfer of a powder image carried by a sheet of photoconductive material to a receiver sheet and of stripping the receiver sheet from the sheet of photoconductive material can be combined into a single operation.

These and other objects and advantages will be readily apparent to those skilled in the art by detailed description which follows of several embodiments of the invention.

The objects of the invention are attained by utilizing at least one roller which comprises a metallic core, a layer of electrically conductive and generally pliable material on said core, and a layer of electrically insulating material surrounding and contacting said pliable layer. The roller engages a receiver sheet that is in engagement with the surface of a layer of

photoconductive material that carries a powder image. The layer of photoconductive material overlies and is in contact with an electrically conductive element, such as a metal plate or drum. When the photoconductive material is in the form of a sheet, it can be maintained in position on the plate or drum by means of a vacuum. A high DC voltage is applied between the plate or drum and the conductive element supporting the photoconductive material. An electrostatic field is established between the conductive element and the roller which is of such polarity that the powder image will transfer to the receiver sheet which, in turn, will adhere electrostatically to the roller, thereby being stripped from the photoconductive material as the roller moves thereover. As a result, transfer of the powder image can occur at the same time as stripping and separation of the receiver sheet from the photoconductive sheet, provided a single roller is used. The same result can be attained sequentially by using a pair of tandemly arranged rollers.

Throughout the specification and claims, reference is made to a powder image. This term is meant to include not only an image formed by dry developers, such as those used in a cascade development process, but also by those developers used in a liquid development process.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings in which like reference numerals and characters designate like parts and wherein:

FIG. 1 is a schematic representation of a preferred embodiment of the invention showing the relative positions of the principal elements as the receiver sheet is about to be stripped from the sheet of photoconductive material;

FIG. 2 is a further schematic representation of the device of FIG. 1 showing the relative positions of the elements after a portion of the receiver sheet has been stripped from the sheet of photoconductive material and with a portion of the powder image transferred thereto;

FIGS. 3 and 4 are schematic representations of two other embodiments of the invention; and

FIG. 5 is a schematic representation of still another embodiment of the invention and showing an arrangement of two rollers for effecting image transfer and stripping of the receiver sheet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, a vacuum plate 1 is provided with a configuration of interconnected grooves or blind holes 2, as is well known in the art, which are connected to a vacuum pump 3 by a line 4. A sheet 5 comprising only a layer of photoconductive material or a photoconductive material coated on a suitable support is charged, exposed and developed so that a powder image 6 is formed in a well-known manner. The sheet 5 is positioned on and supported by plate 1 with the facing surface S that is, the surface bearing powder image 6 being oriented outward. The sheet 5 is maintained in position on plate 1 by the vacuum applied to grooves 2.

A receiver sheet 7 is positioned over and in contact with the facing surface S of sheet 5 and powder image 6. The receiver sheet 7 can be any type of transfer paper normally used in xerographic copying devices. For a reason set forth hereinafter, the sheet 7 is preferably positioned with an edge 8 extending beyond the edge of plate 1 and of sheet 5, as shown in FIG. 1.

A roller 10 is used as a transfer and pickup member, see FIG. 1. Such a roller comprises a metallic core 11, a gelatin layer 12, and a thin layer of an insulating material 13. The metallic core 11 can be of most any metal; for example, steel, aluminum, copper, brass, etc. The gelatin layer 12, preferably, is electrically conductive and a similar material, such as conductive rubber, can also be used. It is best if the layer 12 is somewhat pliable and not hard so that roller 10 can be urged toward and contact the receiver sheet with at least some pres-

sure. The layer of insulating material can be relatively thin, that is, of the order of 0.001 inch. Some of the insulating materials that can be used are cellulose acetate, polyethylene, polyethylene terephthalate, etc. and can be in sheet form (adhered to the roller) or spraycoated on the gelatin or rubber layer. Roller 10 can be reciprocated relative to plate 1 by means of a suitable mechanism, for example, a motor-driven spring reel 9 that is connected by a cable 14 to roller 10.

A DC potential source 15 is connected between the plate 1 and roller 10 (core 11) via lines 16 and 17 with plate 1 being connected to ground by line 18. The powder image, as described hereinafter, will transfer to surface R of receiver sheet 7 with a potential of the necessary polarity in the range of 1,000 volts. However, pickup of the receiver sheet 7 by the roller 10 requires a voltage of approximately 10,000 volts. In order to prevent damage to roller 10 and the source 15, in the event the roller is momentarily shorted to ground, a current limiting resistor 19 can be placed in line 17.

Operation of the invention can best be understood with respect to FIGS. 1 and 2. After the exposed and developed photoconductive sheet 5 is positioned on and supported by plate 1 with the powder image facing outward, as seen in FIGS. 1 and 2, the vacuum is then applied to hold the sheet in position. Receiver sheet 7 is then positioned on sheet 5 with the edge 8 extending beyond the edge of plate 1. Roller 10 is positioned over edge 8 and so it will exert some pressure against the stacked elements, that is, plate 1 and sheets 5 and 7. The source 15 is then connected between core 11 and plate 1, when of the requisite polarity, establishes an electrostatic field which causes the powder image 6 to transfer from the facing surface S to the surface R of receiver sheet 7 as roller 10 is moved to the right by driven reel 9.

In addition, the electrostatic field causes receiver sheet 7 to be drawn to and picked up by roller 10. As roller 10 progresses to the right, the powder image 6 is progressively transferred from the photoconductive sheet 5 to receiver sheet 7 and, at the same time, the receiver sheet 7 is stripped or separated from the facing surface S of photoconductive sheet 5 which is held on plate 1 by virtue of the applied vacuum.

With reference to FIG. 3, another embodiment of the invention is disclosed wherein a layer of photoconductive material 20 is applied to all or only a part of the peripheral surface of a metallic drum 21 which is connected to ground. The photoconductive material 20 is imagewise exposed and developed so as to have a powder image 22 formed on the facing surface S thereof. A roller 23, of the same construction as described above, is maintained at a high DC potential with respect to ground by a source 24 through a limiting resistor 25. A supply of receiver sheets is retained in a supply hopper 26, each receiver sheet 27 being fed by means of a paper feed roller into the bite of drum 21 and roller 23. Sheet 27 is urged against the powder image 22 and facing surface S of photoconductive material 20 and the drum 21 by means of roller 23. The high DC potential which exists between roller 23 and drum 21 and is of the proper polarity establishes an electrostatic field such that the powder image 22 transfers to surface R of the receiver sheet 27 and the receiver sheet, in turn, is drawn to roller 23 so that it is progressively stripped and removed from the drum 21 with transfer of the powder image 22. Once removed from the electrostatic field, the receiver sheet can be readily directed into any desired path. The drum 21 and roller 23 can be motor driven and interconnected so that they will rotate in synchronism.

Another embodiment of the invention is shown in FIG. 4 wherein a vacuum plate 30 connected by a flexible member 31 to a vacuum pump 32 is reciprocated relative to a roller 33 by means of a rack 34 and a gear 35 that is driven by a motor 36. The plate 30 by virtue of the applied vacuum retains a sheet of photoconductive material 37 on the facing surface S of which a powder image 38 has been formed as described above. A paper feed roller 39 moves a receiver sheet 40 from a supply

hopper 41 into the bite of plate 30 and roller 33, the latter being pressed in a direction toward plate 30 and against the powder image 38 and the facing surface S thereby rotating roller 33. The high DC potential which is connected between roller 33 and plate 30 establishes an electrostatic field between roller 33 and plate 30 so that the powder image 38 transfers to surface R of receiver sheet 40 simultaneously with the separation of the latter from sheet 37 which is retained on plate 30 by the applied vacuum. A resistor 43 is used in conjunction with potential 42 as set forth above.

Another version of the invention is shown in FIG. 5 wherein the transfer of the powder image and pickup and separation of the receiver sheet are accomplished sequentially by means of a pair of driven rollers 50 and 51 in conjunction with a synchronously driven drum 52 both the rollers and the drum being of the type described hereinabove. A potential of about 1,000 volts is applied to roller 50 by means of a battery 53 which is connected on one side to ground through a limiting resistor 54. A voltage of about 10,000 volts is applied to roller 51 by means of a battery 55 which is connected on one side to ground through a limiting resistor 56. A powder image 57 is carried by the facing surface S of the photoconductive layer 58 on drum 52 which is connected to ground. As a receiver sheet 59 is fed from a paper supply hopper 60 by means of one or more feed rollers 61, it is first moved into contact with and between roller 50 and drum 52. The roller 50 presses the receiver sheet 59 against powder image 57 and photoconductive layer 58. The electrostatic field which exists between roller 50 and drum 52 due to potential supplied by battery 53 provides an electrostatic field of sufficient strength to effect transfer of powder image 57 to the surface R of receiver sheet 59. However, this field is not of sufficient strength to repel or force the receiver sheet out of contact with drum 52 so that sheet 59 continues to stay in contact with drum 52 as it continues to be moved toward roller 51. Its leading edge is then moved between roller 51 and drum 52. Since a higher DC potential is applied between roller 51 and drum 52 due to battery 55, a stronger electrostatic field exists which serves to separate sheet 59 from layer 58 with the powder image 57 then transferring to sheet 59. Receiver sheet 59 can now be transported through the remaining portion of the machine path for any further operations that must be performed to complete a cycle. It should be understood that in this particular embodiment of the invention, the transfer of the powder image 57 can be accomplished by means other than the biased roller 50, for example, a corona generating device or an electrically conducting roller can be used in place of roller 50. With the use of two rollers, an optimum operating setup can be obtained in that the rollers can be independently biased to obtain a field strength that will provide optimum results for transfer of the powder image as well as for stripping of the receiver sheet.

In any of the above-described embodiments of the invention, continuous, long-time operation may result in a buildup of potential of the wrong polarity on the surface of the roller effecting transfer of the powder image. This can be counteracted by directing corona emission of the proper polarity and potential to the surface of the roller with a suitable charging device.

Further, this invention can be utilized in either timed sequence with the other operations of the machine, i.e., the steps of charging, exposing and developing or can be utilized by continuous application of the DC potential to the rollers, thus making transfer of the powder image and pickup or stripping of the receiver sheet independent of any prior and/or subsequent time-sequence operations. The latter mode of operation simplifies the control circuits for a machine in which the invention is incorporated, but either is suitable for operation of the invention.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. In an electrophotographic copying apparatus comprising an electrically conductive member supporting a layer of photoconductive material, the facing surface of said layer bearing a powder image for transfer to a receiver sheet positionable in contact with said facing surface and image, the improvement comprising:

platen means comprising at least one element having an electrically conductive core and an electrically insulating material surrounding said core for urging said receiver sheet toward and into intimate contact with said facing surface and image;

a source of electrical potential connected between said platen means and said conductive member for establishing an electrostatic field therebetween; and

means for moving one of said platen means and said conductive member relative to the other during persistence of said field, whereby said powder image will be transferred to said receiver sheet and the latter will be removed by said platen means from said facing surface.

2. The copying apparatus in accordance with claim 1 wherein said platen means comprises at least one roller having an electrically conductive core and a layer of insulating material encircling said core, said roller being movable relative to said receiver sheet for effecting simultaneous transfer of said powder image to said receiver sheet and continuous stripping of the latter from said facing surface.

3. The copying apparatus in accordance with claim 1 wherein said element comprises a metallic core, a thick layer of a generally pliable conducting material formed on and encircling said core and a thin layer of an electrically insulating material formed on and covering said pliable layer.

4. The copying apparatus in accordance with claim 1 wherein said platen means comprises at least a pair of tandemly arranged rollers, one of which effectively transfers said powder image to said receiver sheet and the other continuously strips said receiver sheet from said facing surface.

5. In an electrophotographic copying apparatus comprising an electrically conductive vacuum member for engaging one surface of a sheet of photoconductive material and retaining said sheet thereon with one edge of said sheet extending beyond the corresponding edge of said vacuum member, the other surface of said sheet bearing a powder image for transfer to a receiver sheet positioned in contact with said other surface, the improvement comprising:

a rotatable roller having an electrically conductive core and a layer of insulating material encircling said core, said roller engaging said one edge and being movable relative to and in contact with said receiver sheet;

a source of electrical potential connected between said vacuum member and said core for establishing an electrostatic field therebetween; and

means for moving one of said vacuum member and said roller relative to the other during persistence of said field, whereby said powder image will be transferred to said receiver sheet and the latter will be stripped progressively

from said sheet of photoconductive material.

6. In an electrophotographic copying apparatus comprising an electrically conductive vacuum member for engaging one surface of a sheet of photoconductive material and retaining said sheet thereon, the other surface of said sheet of photoconductive material bearing a powder image for transfer to a receiver sheet positioned in contact with said image bearing surface, the improvement comprising:

a pair of tandemly arranged rollers, each of which comprises an electrically conductive core and a layer of electrically insulating material surrounding said core for urging said receiver sheet toward and into intimate contact with said image bearing surface;

a source of potential connected between the core of each of said rollers and said vacuum member for establishing an electrostatic field therebetween; and

means for rotating said rollers in synchronism during persistence of said fields, whereby said receiver sheet is attracted to one of said rollers for movement thereby and, at the same time, said powder image transfers to said receiver sheet at said other roller.

7. The copying apparatus in accordance with claim 6 wherein each of said first and second rollers comprises a metallic core, a thick layer of gelatin encircling said core, and a thin layer of an electrically insulating material formed on and covering said layer of gelatin.

8. In an electrophotographic copying apparatus comprising an electrically conductive and rotatable drum having a layer of photoconductive material on at least a portion of its peripheral surface, the facing surface of said layer bearing a powder image for transfer to a receiver sheet, the improvement comprising:

a first roller having an electrically conductive core and an electrically insulating material surrounding said core and urged toward said drum for cooperating with said drum to move said receiver sheet therebetween and to hold it against said facing surface;

a second roller arranged in tandem relationship to said first roller and having an electrically conductive core and an electrically insulating material surrounding said core, said second roller being urged toward and cooperating with said drum for engaging said receiver sheet to strip it from said facing surface with said image for movement in a designated path;

a source of potential connected between the core of each of said rollers and said drum, at least during the time said receiver sheet is being moved by said rollers and drum, for establishing an electrostatic field of different strength between each of said rollers and said drum; and

means for rotating said rollers in synchronism during persistence of said fields, whereby said first roller effects transfer of said powder image to said receiver sheet and said second roller effects sequential stripping of said receiver sheet with said powder image from said facing surface.

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