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Adachi et al.

[11] **3,757,165**

[45] **Sept. 4, 1973**

[54] **DEVICE FOR REMOVING ELECTRIC POTENTIAL FROM AN ELECTRICALLY CONDUCTING MATERIAL LAYER OF A RECORDING SHEET**

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[52] **U.S. Cl.** ..... **317/2 R**, 317/262 A

[51] **Int. Cl.** **H05f 3/04**

[58] **Field of Search** ..... 317/262 A, 2 R, 2 A, 317/2 F; 250/49.5 ZC, 6 C, 6 TC

[56] **References Cited**

UNITED STATES PATENTS

3,716,754	2/1973	Weber et al.	317/2 F
3,332,396	7/1967	Gundlach	250/49.5 ZC
2,314,940	3/1943	Hewitt	317/2 R

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[57] **ABSTRACT**

A device adapted for use with electrophotographic image forming apparatus of the type in which the spacing between the voltage impressing station and the developing station for the recording sheet is smaller than the length of the recording sheet. The device is effective to reduce the voltage being impressed on an electrically conducting layer of the recording sheet substantially to the level of the ground potential or reference voltage immediately before the developing station by first impressing on the electrically conducting material layer of the recording sheet a bias voltage of opposite charge to a bias voltage impressed on the layer in the voltage impressing station on the upstream side of the developing station and then alternatingly impressing bias voltages of alternately varying polarities and successively decreasing absolute values on the electrically conducting material layer of the recording sheet, so as to improve the conditions under which the recording sheet is developed.

3 Claims, 6 Drawing Figures

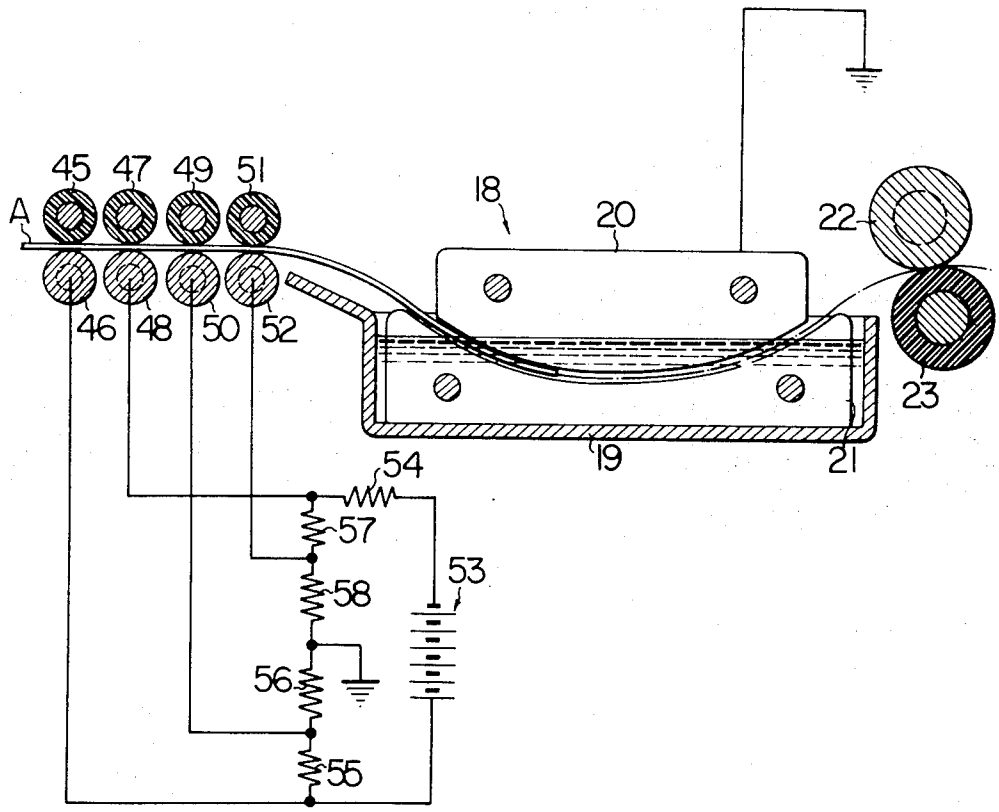


FIG. 1 PRIOR ART

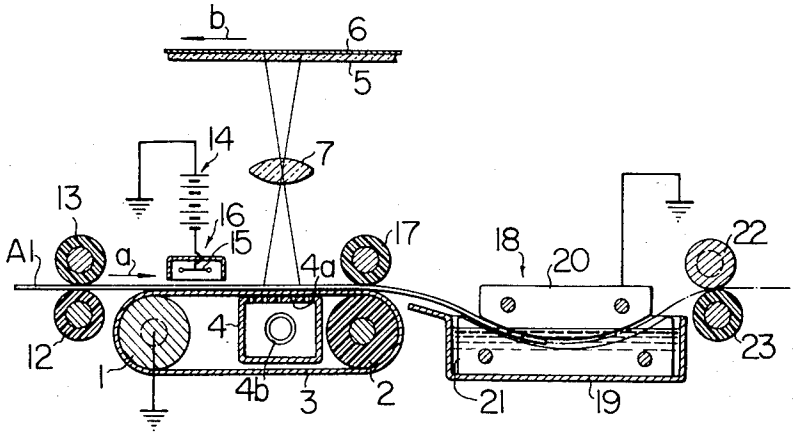


FIG. 2 PRIOR ART

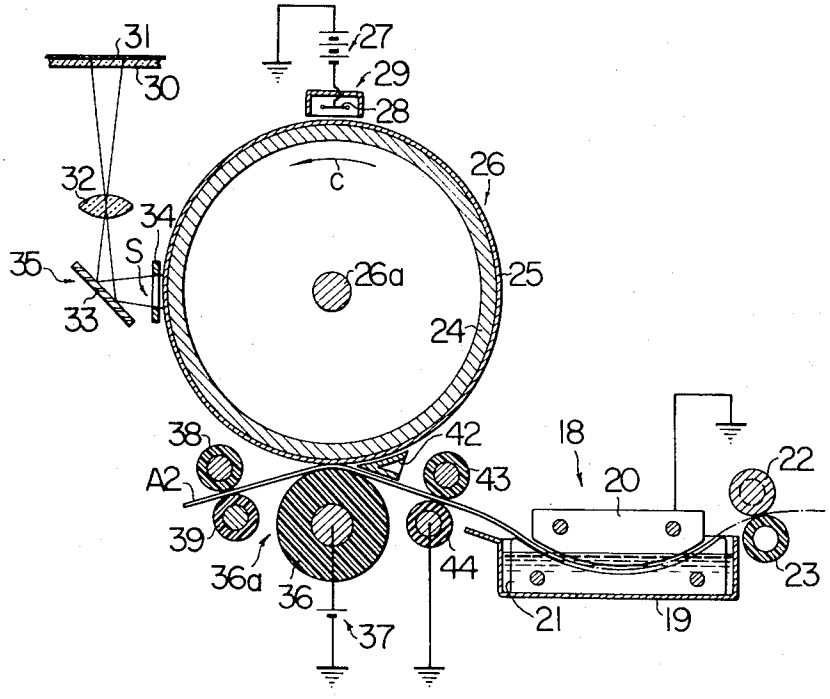


FIG. 3

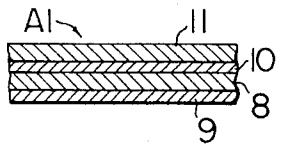


FIG. 4

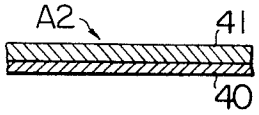


FIG. 5

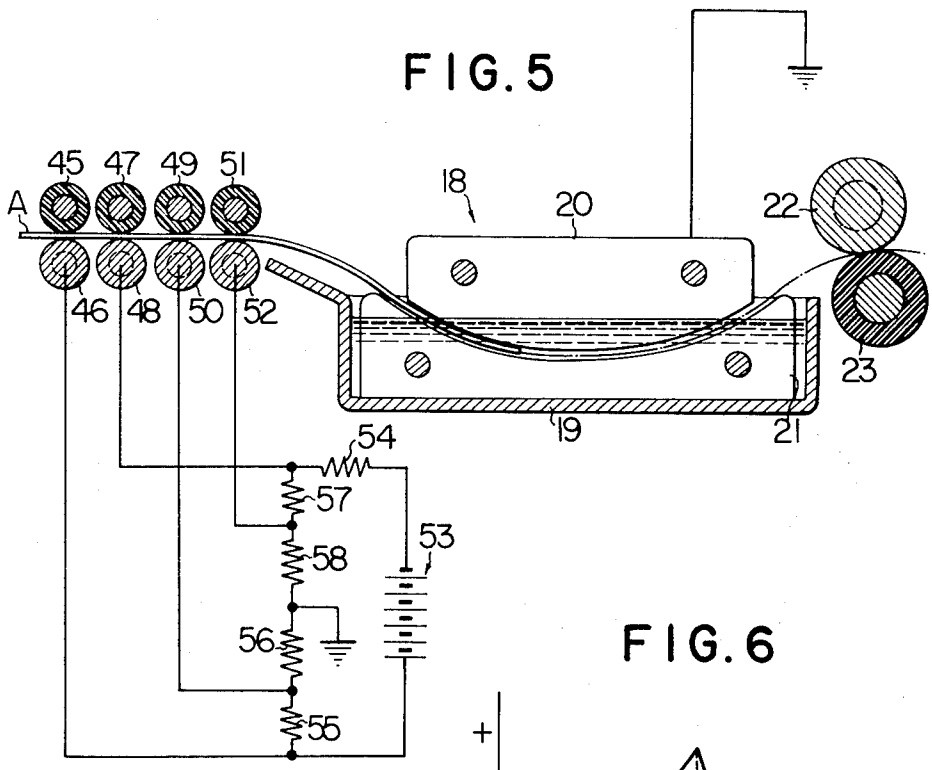
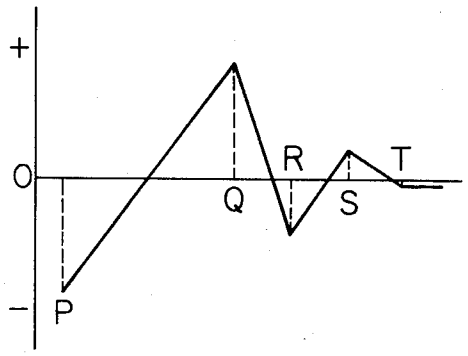


FIG. 6



DEVICE FOR REMOVING ELECTRIC POTENTIAL FROM AN ELECTRICALLY CONDUCTING MATERIAL LAYER OF A RECORDING SHEET

BACKGROUND OF THE INVENTION

This invention relates to a device for removing electric potential from an electrically conducting material layer of a recording sheet which device is adapted for use with apparatus for converting an electrostatis latent image into a visible image by a toner or other developing agent or electrophotographic image forming apparatus.

Nowadays, there are many types of electrophotographic image forming apparatus which include electrophotographic duplicating apparatus and other apparatus wherein a recording sheet having a photoconductive material layer on its electrically conducting material layer is electrically charged, exposed to an optical image of an original and developed to provide a duplicate of the original, apparatus for providing a duplicate of an original by developing an electrostatic latent image produced by other means than electric charging and exposure to an optical image of the original, apparatus for providing a duplicate of an original by developing an electrostatic latent image produced by charging and exposure to an optical image of the original and transferred to a recording sheet having a dielectric material layer on its electrically conducting material layer, and apparatus used in some type of facsimile system for developing an electrostatic latent image produced from electric signals and recorded on a recording sheet having an electrically conducting material layer. In such apparatus, it has become customary to minimize the spacing between the voltage impressing station in which a bias voltage is impressed on the recording sheet for charging the same or transferring the image and the developing station in which the electrostatic latent image is converted into a visible image, in order to increase the operation speed of apparatus and to obtain an overall compact size.

A reduction in spacing between the voltage impressing station and developing station may, however, have deleterious effect. If the spacing is smaller than the length of recording sheets, the electrically conducting material layer of each recording sheet move along its path would, so to speak, electrically connect the two stations while moving along its path of travel, with a result that developing would not be effected satisfactorily. The duplicates produced may be soiled by the adhesion of the developing agent to their background or the image may not be effected at all depending on the charge carried by the electrically conducting material layer.

One example of such impediment in developing will be described with reference to FIG. 1 and FIG. 2. In FIG. 1, a plurality of endless conveyor belts 3 made of electrically conducting rubber are trained over a pair of belt rollers 1 and 2, belt roller 1 being made of metal or electrically conducting rubber and grounded to serve as an opposite electrode plate in developing. A suction box 4 formed in its upper surface with suction openings 4a is disposed between the upper run and lower run of endless belt 3 for drawing by suction a recording sheet A1 conveyed by the upper run of conveyor belt 3 to permit the sheet to move in a plane condition. Suction box 4 is connected to a suitable suction pump (not shown) through a line 4b.

A transparent original support table 5 is disposed parallel to the upper run of conveyor belt 3 in a position which is above suction box 4.. An original 6 is placed on original support table 5 and moved in the direction of an arrow *b* in synchronism with the movement of the recording sheet A1 fed to the upper run of conveyor belt 3 in the direction of an arrow *a*, so as to have its picture projected onto the recording sheet through a projection lens 7 disposed between table 5 and belt 3 in an exposing operation.

Recording sheet A1 includes an insulating material layer 8, electrically conducting material layers 9 and 10 one disposed on the upper surface of layer 8 and the other on the underside thereof as shown in FIG. 3, and another electrically conducting material layer 11 disposed on electrically conducting material layer 10. Recording sheet A1 is fed to endless conveyor belt 3 by a pair of conveyor rollers 12 and 13 in the direction of arrow *a*.

Disposed leftwardly upwardly of the upper run of conveyor belt 3 in FIG. 1 is a voltage impressing station 16 which is a charger including a wire electrode 15 on which a high voltage (negative charge as shown) is impressed by a power source 14. Recording sheet A1 is electrically charged uniformly on its entire surface. The electrically conducting material layer 9 of recording sheet A1 is grounded through roller 1. However, due to the fact that the electrically conducting belt 3 is not a perfect conductor and other reasons, electrically conducting material layer 9 is placed, during a charging operation, in a position in which it has an electric potential of a higher absolute value (negative charge as shown) than the ground potential or reference potential.

After being electrically charged, recording sheet A1 has an electrostatic latent image of the original formed thereby by having an optical image of the original projected onto it through projection lens 7. Recording sheet A1 having an electrostatic latent image formed thereon is fed through a hold-down roller 17 to a developing station 18.

Developing station 18 includes a developing liquid tank 19 containing a quantity of developing liquid therein, a plurality of guide fins 20 and 21 disposed in two vertically spaced two rows in tank 19, and a pair of discharge and squeeze rollers 22 and 23 disposed rightwardly upwardly of tank 19 in FIG. 1 and maintained in pressing engagement with each other. Recording sheet A1 receives a supply of a toner from the developing liquid which carries an opposite charge (positive charge as shown) to the electrostatic latent image so as to render the latent image visible while moving through its path of movement between fins 20 and 21. Then, the recording sheet is discharged from the developing station while being squeezed by rollers 22 and 23.

The spacing between voltage impressing station 14 and developing station 18 is smaller than the length of recording sheet A1. Thus, recording sheet A1 to whose electrically conducting material layer 9 an electrical potential (negative charge as shown) of a higher absolute value than the reference potential is imparted in voltage impressing station 14 is subjected to the influences of the electric field while stretching over both voltage impressing station 14 and developing station

18. As a result, more toner than is necessary may be supplied to the electrostatic latent image and the background may be soiled, and the toner may adhere to the electrically conducting material layer itself and soil the underside of the duplicate.

In FIG. 2, a photosensitive drum 26 comprising a photoconductive material layer 25 provided on a drum body 24 made of metal or other electrically conducting material is supported by a shaft 26a for rotation in the direction of an arrow *c*, and electrically charged uniformly on its entire surface by a charger 29 including a wire electrode 28 on which a bias voltage (negative charge as shown) is impressed by a power source 27.

Disposed leftwardly of photosensitive drum 26 in the figure is an exposure optical system 35 comprising a projection lens 32, a reflector 33 and a slit member 34 formed therein with a slit S for projecting the picture of an original 31 placed on an original support table 30. Photosensitive drum 26 electrically cahrged while rotating is exposed to an optical image of the original projected by optical system 35 to have an electrostatis latent image of the original formed thereon.

A transfer roller 36 made as of electrically conducting rubber is disposed below photosensitive drum 26 and maintained in pressing engagement therewith. A bias voltage (positive charge as shown) of an opposite charge to photoconductive material layer 25 to increase the result of image transfer is impressed on roller 36 by a power source 37, so that roller 36 is mounted in a voltage impressing station 36*a*.

A recording sheet A2 is fed between photosensitive drum 26 and transfer roller 36 by a pair of conveyor rollers 38 and 39. As shown in FIG. 4, recording sheet A2 comprises an insulating material layer 41 disposed on an electrically conducting material layer 40. While the insulating material layer 41 of sheet A2 is maintained in pressing contact with the periphery of photosensitive drum 26 by transfer roller 36, the electrostatic latent image on photoconductive material layer 25 is transferred to the insulating material layer 41 of sheet A2.

The recording sheet A2 to which the electrostatic latent image has been transferred is separated from the periphery of photosensitive drum 26 by a separator 42 and fed to developing station 18 by a pair of conveyor rollers 43 and 44. Developing station 18 is constructed in the same manner as described with reference to FIG. 1, so that detailed description thereof is omitted.

In case the spacing between voltage impressing station 36a and developing station 18 is smaller than the length of recording sheet A2, a bias voltage (positive charge as shown) is still being impressed on a portion of the electrically conducting material layer 40 when the sheet is introduced into the developing station after the electrostatic latent image (negative charge as shown) has been transferred thereto. Thus, while recording sheet A2 stretches over both voltage impressing station 36a and developing station 18, the toner (positive charge as shown) in the developing liquid will be prevented from adhering to recording sheet A2, and, in worst case, the latent image will not be developed at all.

One may think of removing the voltage impressed on electrically conducting material layers 9 and 40 by using electrically conducting rubber as a material for producing conveyor roller 44 and grounding such roller. However, since electrically conducting material layer 9 and 40 are not themselves perfect conductors, it will be very difficult to completely remove electric potential by this arrangement.

SUMMARY OF THE INVENTION

This invention has as its object the provision of a novel device for removing electric potential from an electrically conducting material layer of a recording sheet adapted for use with electrophotographic image forming apparatus of the type in which the spacing between the voltage impressing station and the developing station for a recording sheet is smaller than the length of the recording sheet and effective to eliminate deleterious influences of the voltage impressed on the electrically conducting material layer of the recording sheet in the voltage impressing station on the developing operation performed in the developing station, even if the recording sheet stretches over both the voltage impressing station and the developing station.

According to the invention, there is provided a device in which a bias voltage of an opposite charge to a voltage impressed on the electrically conducting material layer of the recording sheet in the voltage impressing station is first impressed on the electrically conducting layer on the upstream side of the developing station, and then bias voltages of successively varying charges and successively decreasing absolute values are alternately impressed on the electrically conducting material layer, whereby the electric potential of the electrically conducting material layer can be reduced substantially to the reference potential. This device permits electrostatic latent images on recording sheets to be developed satisfactorily to provide duplicates of high quality even if such recording sheets have a length greater than the spacing between the voltage impressing station and the developing station.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 and FIG. 2 are sectional views illustrating electrophotographic image forming apparatus in which the present invention can be incorporated;

FIG. 3 and FIG. 4 are sectional views illustrating recording sheets which can be used in carrying the invention into practice;

FIG. 5 is a sectional view of the device for removing electric potential from the electrically conducting material layer of the recording sheet comprising one embodiment of the invention; and

FIG. 6 is a graphic representation of the manner in which electric potential is removed by the device shown in FIG. 4.

DESCRIPTION OF A PREFERRED EMBODIMENT

An embodiment of the invention will be described with reference to FIG. 5 and FIG. 6. FIG. 5 shows the same developing station as shown in FIG. 1, and like reference characters designate similar parts in the two figures. It is to be understood that the developing station 18 may be of a known dry developing agent type in place of the wet developing agent type as shown. Also, the recording sheet A is shown as a recording sheet having an electrically conducting material layer, but the recording sheet used may be of any one of the types shown in FIG. 3 and 4.

In FIG. 5, the recording sheet A having an electrically conducting material layer on which a bias voltage has been impressed at a voltage impressing station (not

shown) is passed through a plurality of pairs of electric potential removing rollers, **45** and **46, 47** and **48, 49** and **50** and **51** and **52** before being introduced into developing station **18.** Rollers **46, 48, 50** and **52** pressing against rollers **45, 47, 49** and **51** respectively are brought into contact with the electrically conducting material layer of recording sheet and made of metal or electrically conducting rubber, and rollers **45, 47, 49** and **51** are made of a suitable insulating material.

Rollers **46, 48, 50** and **52** which are connected to a power source **53** constitute bias voltage impressing means according to the invention. A bias voltage (positive charge as shown, see a point Q in FIG. **6**) of opposite charge to a voltage (negative as shown, see a point P in FIG. **6**) impressed on the electrically conducting layer of recording sheet at the voltage impressing station is impressed on the first roller **46.** A bias voltage (see a point R in FIG. **6**) of opposite charge to and having a slightly smaller absolute value than the voltage impressed on first roller **46** is owing to the presence of a resistor **54** impressed on second roller **48.** A bias voltage (see a point S in FIG. **6**) of opposite charge to and having a slightly smaller absolute value than the vias voltage impressed on second roller **48** owing to the provision of resistors **55** and **56** is impressed on second third roller **50.** Finally, a bias voltage (see a point T in FIG. **6**) of opposite charge to the voltage impressed on roller **50** and having an absolute value which has dropped substantially to the level of the ground voltage or reference voltage owing to the provision of resistors **54, 57** and **58** is impressed on fourth roller **52.**

Thus, bias voltages of different charges and having successively decreasing absolute values are alternately impressed on the electrically conducting layer of recording sheet A by rollers **46, 48, 49** and **50** so as to the electric potential of the electrically conducting material layer of recording sheet A may have a desired charge of a desired value. This eliminates the influences of the voltage impressed at the voltage impressing station on the developing operation performed at the developing station, even if recording sheet A has a length such that it stretches over both the voltage impressing station and developing station. The recording sheet can thus be developed satisfactorily without the background of the image or the underside of the sheet being soiled and with the toner image produced having an optimum density.

It is to be understood that rollers **46, 48, 50** and **52** may be replaced by electrodes of a suitable shape and configuration, and the number of rollers or electrodes is not limited to or the number of stages in which the absolute number of bias voltage is reduced successively is not limited to the specific number shown and described in the embodiment.

What is claimed is:

1. A device for removing electric potential from an electrically conducting material layer of a recording sheet adapted for use with electrophotographic image forming apparatus of the type in which the spacing between the voltage impressing station and the developing station for the recording sheet is smaller than the length of the recording sheet, comprising bias voltages impressing means for first impressing on said electrically conducting material layer of said recording sheet on the upstream side of said developing station a bias voltage of opposite charge to the bias voltage impressed on the electrically conducting material layer at said voltage impressing station, and then alternately impressing bias voltages of different charges and successively decreasing absolute values on the electrically conducting material layer of the recording sheet till the electric potential carried by the electrically conducting material layer is reduced substantially to the level of the reference or the ground potential immediately before the developing station.

2. A device as set forth in claim **1** wherein said bias voltage impressing means comprises a plurality of electrically conducting rollers connected to a power source.

3. A device as set forth in claim **1** wherein said bias voltages impressing means comprises a plurality of electrically conducting rollers combined with a plurality of resistors and connected to a power source.

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