

[54] MEANS FOR PRECLUDING TRAILING OF TONER IMAGES IN ELECTROPHOTOGRAPHY OF THE WET TYPE

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[63] Continuation of Ser. No. 194,340, Nov. 1, 1971, abandoned.

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[52] U.S. Cl. 118/637; 117/37 LE; 118/429; 118/DIG. 23

[51] Int. Cl.² G03G 13/00

[58] Field of Search..... 117/37 LE, 93.4 A; 118/637, 424, 429, DIG. 23

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[57] **ABSTRACT**

A means for precluding trailing of toner images during development in electrophotographic apparatus of the wet type operating at a developing rate of more than 150 mm./sec., which means comprises a pair of rollers disposed along the path of travel of a copy sheet released from the developing liquid tank, one roller made of metal with its peripheral surface arranged to come into contact with the image bearing surface of the copy sheet, the other disposed opposite the metallic roller with its peripheral surface contacting the back surface of the copy sheet. The peripheral surface of the latter roller is of a material having a surface resistance of less than 1×10^7 ohm-cm., and both rollers are maintained at the same potential or grounded, which condition is effective to preclude blurring of a toner image on the copy sheet.

7 Claims, 3 Drawing Figures

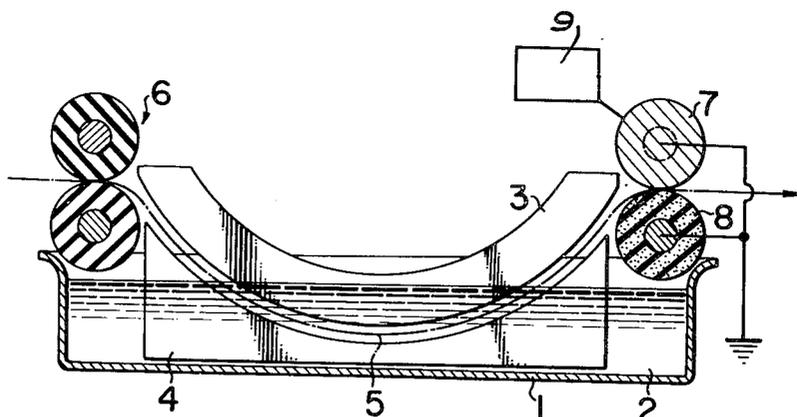


FIG. 1

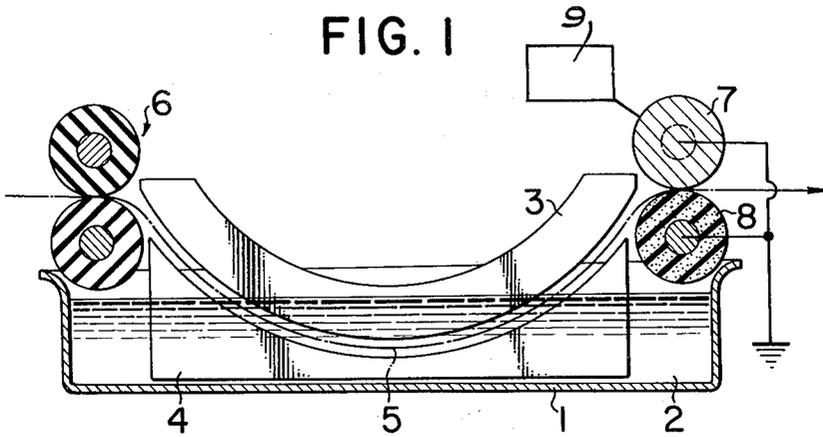


FIG. 2

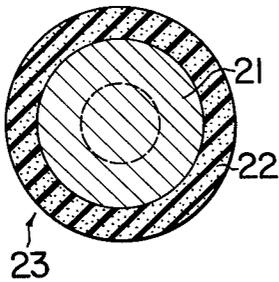
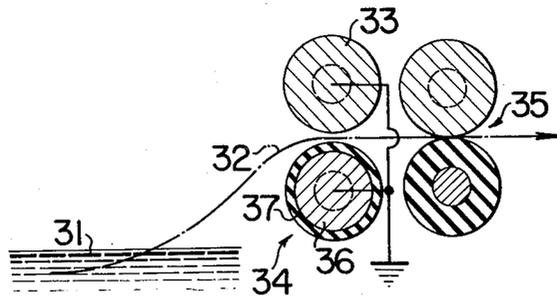


FIG. 3



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MEANS FOR PRECLUDING TRAILING OF TONER IMAGES IN ELECTROPHOTOGRAPHY OF THE WET TYPE

This is a continuation Ser. No. 194,340 filed Nov. 1, 1971, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a means for precluding trailing of toner images in electrophotography of the wet type.

In at least one type of developing device known in the art, for use in electrophotographic apparatus of the wet type, a pair of so-called "squeeze rollers" is provided along the path of travel of a photosensitive sheet in a position immediately downstream of the developing liquid tank so as to positively develop an image on the photosensitive sheet and squeeze out excess developing liquid from the sheet.

Such a pair of squeeze rollers generally consists of a hard roller made of metal or other hard material and disposed so as to come into contact with the image bearing surface of the photosensitive sheet, and a resilient roller made of rubber or other resilient material and disposed opposite the hard roller so that its surface may come into contact with the back surface of the photosensitive sheet. As a natural consequence of this arrangement, the metallic roller is electrically conducting and the resilient roller is electrically insulating.

The conventional developing device of the type described causes no trouble when the rate of movement of a copy sheet to undergo developing, or the developing rate, is about 120 mm./sec. However, when the developing rate is increased to a level about 150 mm./sec., the toner adhered to the photosensitive sheet is liable to shift and slide in the direction of movement of the sheet, thereby trailing and blurring the toner image. Since an increase in the developing rate is an essential factor in increasing the efficiency of copying apparatus, the problem of trailing of toner images must be solved prior to increasing the developing rate.

SUMMARY OF THE INVENTION

In accordance with the present invention, it has been found that, if at least one roller made of a material having a surface resistance of less than 1×10^7 ohm-cm. is disposed opposite the metallic roller with the low resistance surface in contact with the back surface of the sheet while the metallic roller is in contact with the image bearing surface thereof, and both rollers are maintained at the same potential or grounded trailing of the toner image can be completely precluded even when the developing rate is more than 150 mm./sec. In fact, this roller combination in a developing device is effective to completely preclude trailing of toner images even if the developing rate is increased more than two-fold as compared with the current developing rate of conventional apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a developing device for electrophotographic apparatus incorporating one embodiment of the toner image trailing precluding means according to this invention;

FIG. 2 is a sectional view of a modification of the toner image trailing precluding roller used in the means according to this invention; and

FIG. 3 is a sectional view showing another form of the toner image trailing precluding means according to this invention.

DESCRIPTION OF PREFERRED EMBODIMENT

FIG. 1 shows a developing device for electrophotographic apparatus of the wet type incorporating therein the toner image trailing precluding means, according to this invention, which concurrently serves as a pair of squeeze rollers. In FIG. 1, a developing liquid 2 for electrophotography is contained in a developing liquid tank 1 in which one set of a number of guide fins having complementary surfaces are disposed so as to provide a photosensitive sheet passageway 5 therebetween.

Disposed in a position immediately upstream of the photosensitive sheet passageway is a pair of photosensitive sheet conveyor rollers 6 which pass therebetween a photosensitive sheet (not shown) that has been exposed to an optical image of an original to be duplicated after being electrically charged. The rollers 6 introduce the sheet between the two guide fins 3 and 4 and while the photosensitive sheet moves between the guide fins 3 and 4, it is immersed in developing liquid. The photosensitive sheet generally consists of a support layer of paper or other material and a photoconductive material layer formed on one surface of the support layer by applying zinc oxide or other photoconductive material with a suitable resin serving as a binder. Developing liquid 2 is generally an electrically insulating liquid mixed with a so-called toner which is prepared by treating a pigment like a carbon black in minute powder form with resin.

The photosensitive sheet moving along passageway 5 has an electrostatic latent image formed on its photoconductive material layer which is gradually developed and rendered visible by the developing liquid 2. When it is released from developing liquid tank 1, the photosensitive sheet is held between a metallic roller 7 and a toner image trailing precluding roller 8 pressing against each other. Metallic roller 7 is disposed such that its peripheral surface is brought into contact with the image bearing surface of the photosensitive sheet, and toner image trailing precluding roller 8 is disposed opposite metallic roller 7 with its peripheral surface in contact with the back surface of the photosensitive sheet and both rollers are driven in synchronism by drive means 9.

Roller 8 differs from conventional insulating squeeze rollers in that it is made of a material having a surface resistance of less than 1×10^7 ohm-cm. Rollers 7 and 8 are grounded as shown in the figure. A bias voltage of suitable polarity and the same potential may be impressed on both rollers, however, in accordance with the polarity of the toner, in place of grounding them. The material used for precluding roller 8 may be natural rubber, synthetic rubber or synthetic resin suitably blended with powder metal or powder carbon black. In order that roller 8 may serve concurrently as a squeeze roller, the material may have considerable resilience.

By using roller 8 constructed as aforementioned, it is possible to completely preclude trailing of the toner image on the photosensitive sheet while the toner image is positively fixed and excess liquid is squeezed out of the photosensitive sheet. The results of experiments show that, when the surface resistance of roller 8 is below 1×10^7 ohm-cm., trailing of the toner image can be effectively prevented even if the developing rate

is as high as 340 mm./sec. It has been found that very good results can be achieved in precluding trailing of toner images when the surface resistance is in the particular range from 1×10^6 to 1×10^2 ohm-cm.

A modification in accordance with the present invention is shown in FIG. 2. Roller 8 may be replaced by a roller 23 which comprises a small roller 21 made of metal, rubber or the like and an outer peripheral marginal portion 22 made of the same material as roller 8 and fitted over small roller 21 as shown in FIG. 2. In case no resilience is required of roller 23, a hard material may be used to produce the outer peripheral marginal portion 22 of roller 23.

A further modification is shown in FIG. 3, wherein a metallic roller 33 and a toner image trailing precluding roller 34 arranged one above the other are provided along a photosensitive sheet passageway 32 in close proximity to a developing liquid 31, and a pair of conventional squeeze rollers 35 is disposed on the downstream side of rollers 33 and 34. Metallic roller 33 is disposed such that its outer peripheral surface is brought into contact with the image bearing surface of the photosensitive sheet, and roller 34 is disposed opposite roller 33 with its outer peripheral surface in contact with the back surface of the photosensitive sheet. Roller 34 comprises a metallic roller 36 and a small thickness layer 37 made of a hard material having a surface resistance of less than 1×10^7 ohm-cm. and fitted over the outer periphery of roller 36. Rollers 33 and 34 are spaced apart from each other a small distance and both grounded. Also, a bias voltage of suitable polarity and the same potential may be impressed on both rollers in accordance with the polarity of the toner in place of grounding them.

By arranging rollers 33 and 34 as shown, the object of this invention can be accomplished satisfactorily. Similar results can be obtained by arranging rollers 8 or 21 in place of roller 34 as shown in FIG. 3, or 21 or 34 in place of roller 8 as shown in FIG. 1.

What is claimed is:

1. In an electrophotographic apparatus of the wet type with a developing device having:
 - a. a developing tank containing developing liquid through which an exposed photosensitive sheet is passed;
 - b. a metallic roller disposed at the exit of the developing tank for contacting the image bearing surface of the passing photosensitive sheet; and
 - c. a squeegee roller disposed opposite the metallic roller for cooperatively contacting the passing photosensitive sheet at its back surface;
 wherein the improvement comprises:
 - d. means for rotating said rollers at a developing rate of greater than 150 mm./sec.;
 - e. means for producing on the peripheral surface of the squeegee roller contacting the back of the photosensitive sheet, a surface resistance of less than 1×10^7 ohm-cm; and
 - f. means for maintaining said squeegee roller at the same potential as said metallic roller to preclude the trailing of toner images.
2. Apparatus as in claim 1 wherein said squeegee roller is made entirely of a resilient material.
3. Apparatus as in claim 1 wherein said squeegee roller is made entirely of a hard material.
4. Apparatus as in claim 1 wherein the surface resistance of the squeegee roller is in the range from 1×10^6 ohm-cm to 1×10^2 ohm-cm.
5. Apparatus as in claim 1 wherein the squeegee roller is a metallic roller with a peripheral layer of resilient material.
6. Apparatus as in claim 1 further comprising a pair of squeeze rollers positioned downstream of said metallic and squeegee rollers.
7. Apparatus as in claim 1, wherein said developing liquid contains toner particles of a particular polarity and the polarity of the potential on said rollers is opposite to that on said toner particles.

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