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Davis et al.

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[54] **ELECTROPHOTOGRAPHIC COPY SYSTEMS**

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[52] **U.S. Cl.**..... **355/10,** 117/37 LE, 118/637, 355/15

[51] **Int. Cl.**..... **G03g 15/10**

[58] **Field of Search**..... 355/10, 15, 16; 117/37 LE; 118/637

[56] **References Cited**

UNITED STATES PATENTS

3,155,546	11/1964	Dirks	118/637
3,284,224	11/1966	Lehmann	117/37 LE
3,663,219	5/1972	Takahashi	355/10

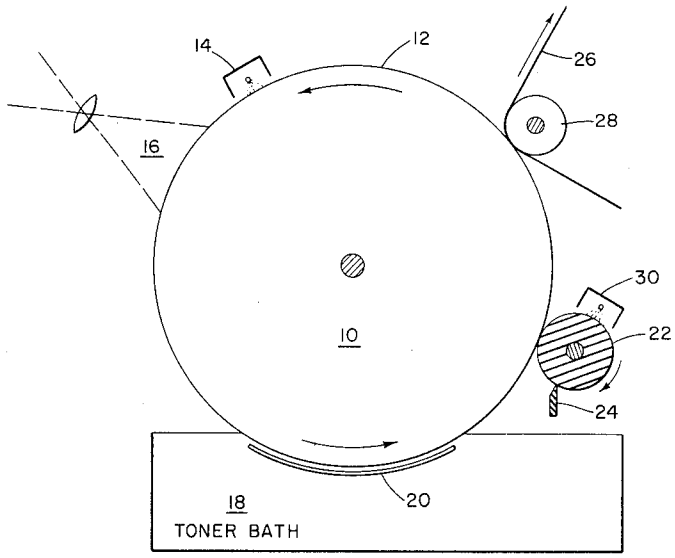
Primary Examiner—Richard L. Moses

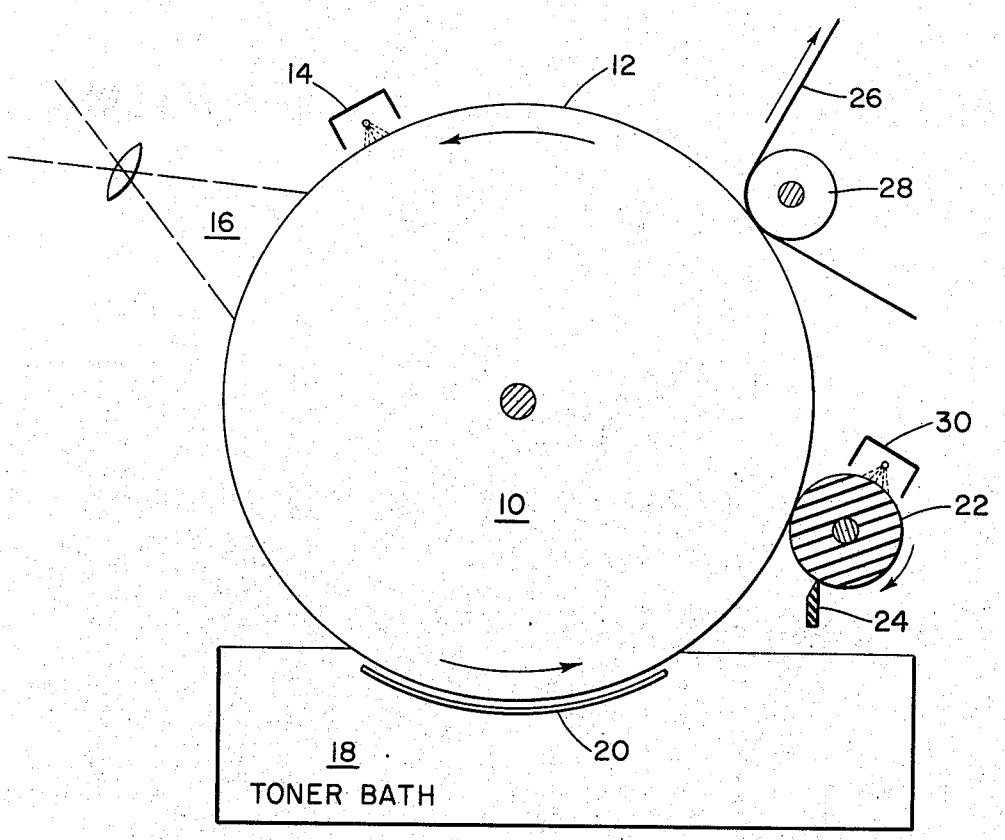
Attorney, Agent, or Firm—Kenway, Jenney and Hildreth

[57] **ABSTRACT**

In electrophotographic copy systems in which the electrostatic image is developed from a liquid developer containing charged toner particles, and subsequently squeegeed to remove excess developer, improved definition and less background results if a charge of polarity the same as the image is applied to the squeegee.

7 Claims, 1 Drawing Figure




14
12
26
28
16
10
30
22
24
18
TONER BATH
20

ELECTROPHOTOGRAPHIC COPY SYSTEMS

BACKGROUND OF THE INVENTION

This invention relates to electrophotographic copy systems utilizing liquid development and transfer of the toned image to the copy.

Systems featuring liquid development and liquid developing compositions are described in U.S. Pat. Nos. 3,003,404; 3,078,231 and 3,244,633.

In the electrophotographic processes for producing copies on plain, untreated paper, a latent electrostatic image is formed on the surface of a photoconductive insulating material. The image on the photoconductive insulating layer is developed by applying toner particles having a charge to be attracted to the charge of the latent image and the toner particles are then transferred to a copy sheet, forming thereon an image corresponding to the latent electrostatic image. When a liquid developer is employed, comprising charged essentially solid toner particles dispersed in a carrier liquid, the photoconductive insulating layer is wetted all over with the liquid developer composition and tends to retain sufficient toner in the background areas to discolor the printed copy. It is common practice to remove excess toner composition from the photoconductive insulating layer by means of a resilient squeegee roll, but this of itself does not remove all of the toner particles from the background areas. Accordingly, plain paper copying systems utilizing liquid developers had been characterized by high background color and also by a certain fuzziness of the developed image apparently caused by toner particles being attracted into the area surrounding the image.

DESCRIPTION OF THE INVENTION — SUMMARY

It has now been found that these particular drawbacks can be corrected by applying to the squeegee roller a charge the same as that of the latent image. This charge on the squeegee roller can be adjusted so as to eliminate background color and also image fuzziness without impairing the density of the image itself.

DRAWING

The invention is described in greater detail with specific reference to the drawing which is a schematic diagram representing an electrophotographic copy apparatus showing the general arrangement of the essential components.

PREFERRED EMBODIMENT

A drum **10** having a surface layer of a photoconductive insulating material **12** is arranged to rotate for continuous copying operation. A corona charging unit **14** causes a uniform electrostatic charge to be applied to the surface of the photoconductive insulating material **12.** The charged surface then passes an exposure station **16** where a light image of the original to be copied is projected onto the drum, usually in a scanning operation. This exposure causes the light struck areas of the photoconductive insulating surface **12** to become conductive and the charge therein to dissipate. Following the exposure at station **16** the drum carries a latent electrostatic image that is to say a relatively high charge in the unexposed areas that correspond to the dark parts of the original. The latent image is then carried into the toner bath **18** where it passes in close proximity to a floating metallic electrode **20** and comes into contact with liquid developer which is circulated between the floating electrode **20** and the drum surface **12.**

In the toner bath, toner particles suspended in the carrier liquid are attracted to the latent image on the drum surface. The latent image thus picks up toner particles attracted to it while the remaining areas of the drum surface become wet with the toner composition but also carry along a certain density of toner particles.

After emerging from the toner bath the drum passes past a squeegee roller **22** which removes excess liquid developer from the drum surface. The squeegee roller is a resilient elastomer and is driven at the same surface speed as the drum. A doctor blade **24** scrapes the surface of the squeegee roller prior to its contact with the drum to remove any accumulated toner material carried around by the squeegee roller. Thereafter the imaged portion of the drum now carrying toner particles in the image areas is passed into contact with the copy sheet **26** under the pressure of the transfer roller **28** and the final copy is transferred to the copy sheet.

The improvement represented by the present invention consists in the application of a charge to the squeegee roller **22** by means of a corona unit **30** positioned adjacent the squeegee roller surface. This squeegee charging corona unit is operated at a voltage of the same polarity as the drum charging corona **14** at a potential sufficient to remove toner from nonimaged areas of the photoconductive insulating surface. Although of the same polarity as the latent image, the charged squeegee roller does not obliterate or materially diminish the density of the toned image, but acts to remove toner from the background area and also from the area fringing the image. As a result, the toned image is made clean in the background areas and is substantially sharpened.

Although the invention is generally applicable to electrophotography employing liquid developers in general it has been found especially useful in connection when the photoconductive insulating surface layer is an organic photoconductive insulating material, such as the polyvinyl carbozoles described in U.S. Pat. No. 3,037,861. This is typically charged initially to a negative surface voltage of about 900 volts. After imaging, the unexposed areas retain substantially all of their initial potential while the background areas drop to a potential of about 200 volts.

The liquid developer is one in which the toner particles carry a positive charge, such as is described in U.S. Pat. No. 3,244,633. One that has been found particularly suitable comprises an emulsion polymer of polyvinyl acetate in an aliphatic solvent, such as that sold under the trade designation Isopar, containing dissolved hydrogenated abiatic acid and dispersed carbon black, the dispersed polymer and carbon black being essentially positively charged.

In the toner bath the floating electrode acquires a charge of about −150 volts. It's presence serves to regulate the deposit of toner onto the surface **12** of the drum.

The squeegee roller **22** is typically formed of an elastomeric polyurethane, charged to a potential, controlled by a voltage applied to the corona unit, effective to clean the background areas and eliminate image

fuzziness. In actual practice the potential applied to the corona unit is increased to the point where the desired effect is attained. An excessive potential will be found to cause removal of toner from the images areas in an undesirable manner. The charged squeegee thus serves to remove excess liquid developer composition from the surface of the drum, which then drains back into the toner bath, while at the same time removing excess toner particles from the drum in those areas where it should not be. Following this squeegee roller the drum passes in contact with a copy sheet **26,** under the pressure of the transfer roller **28,** which is likewise an elastomeric solid such as polyurethane rubber.

It will be understood that the apparatus is constructed in accordance with conventional practices, the details of which have not been described as they are readily known. The only addition to conventional apparatus is the provision of a corona unit closely spaced from a squeegee roll and operating at a potential of the same polarity as the initial charge on the drum. Various auxiliary stations surrounding the drum have not been illustrated as they form no part of this invention, but may be present, such as a scrubbing station in the area following the image transfer and prior to the drum charging station.

Although this invention has been described with specific reference to the preferred embodiment it is contemplated that obvious modifications will occur to those skilled in the art familiar with the principles herein set forth, and that such may be made without departing from the scope of this invention.

Having thus disclosed our invention, we claim and desire to secure by Letters Patent.

1. In an electrophotographic copy apparatus which includes means for forming an electrostatic latent image on a photoconductive insulating surface, means for contacting said surface with a liquid developer containing toner particles suspended in a carrier liquid, a resilient, non-conductive squeegee roller for removing excess developer from said surface, and means for pressing said surface into contact with a copy sheet to transfer the developed image from said surface to said sheet, the improvement comprising a corona discharge device for applying to the surface of the squeegee roller an electrostatic charge of the same polarity as the charge of the electrostatic latent image, said charge being sufficient to cause said roller to remove toner particles from the substantially discharged background areas of the developed image on said photoconductive surface.

2. In an electrophotographic copy process in which an electrophotographic surface is charged and exposed to form an electrostatic image, is contacted with a liquid developer containing positively charged toner particles suspended in a carrier liquid, is contacted with a resilient, non-conductive squeegee roller to remove excess developer from said surface, and is then pressed against a copy sheet to transfer the image thereto, the improvement comprising providing a corona discharge adjacent said roller to apply to the surface of said squeegee roller an electrostatic charge of the same polarity as that of the latent image and of a magnitude sufficient to cause said roller to remove toner particles from the substantially discharged background areas of the developed latent image on said photoconductive surface.

3. Apparatus as set forth in claim **1** further comprising means for mechanically removing toner particles from the surface of said squeegee roller.

4. Apparatus as set forth in claim **1** wherein said removing means comprises a doctor blade.

5. In electrophotographic copy equipment having means for forming an electrostatic latent image on a photoconductive surface, developing apparatus comprising: means for contacting said surface with a liquid developer containing toner particles suspended in a carrier liquid, said developer being applied at a bias potential of the same polarity as the latent image; a resilient, non-conductive squeegee roller for removing excess developer from said surface; and a corona discharge device for applying to the surface of said roller an electrostatic charge of the same polarity as the latent image, said charge being sufficient to cause said roller to remove toner particles from the substantially discharged background areas of the developed image on said photoconductive surface.

6. Apparatus as set forth in claim **5** further comprising means for mechanically removing toner particles from the surface of said squeegee roller.

7. Apparatus as set forth in claim **4** wherein said removing means comprises a doctor blade.

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