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METHOD AND APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGES WITH ELECTROSCOPIC POWDER

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Fig. 1

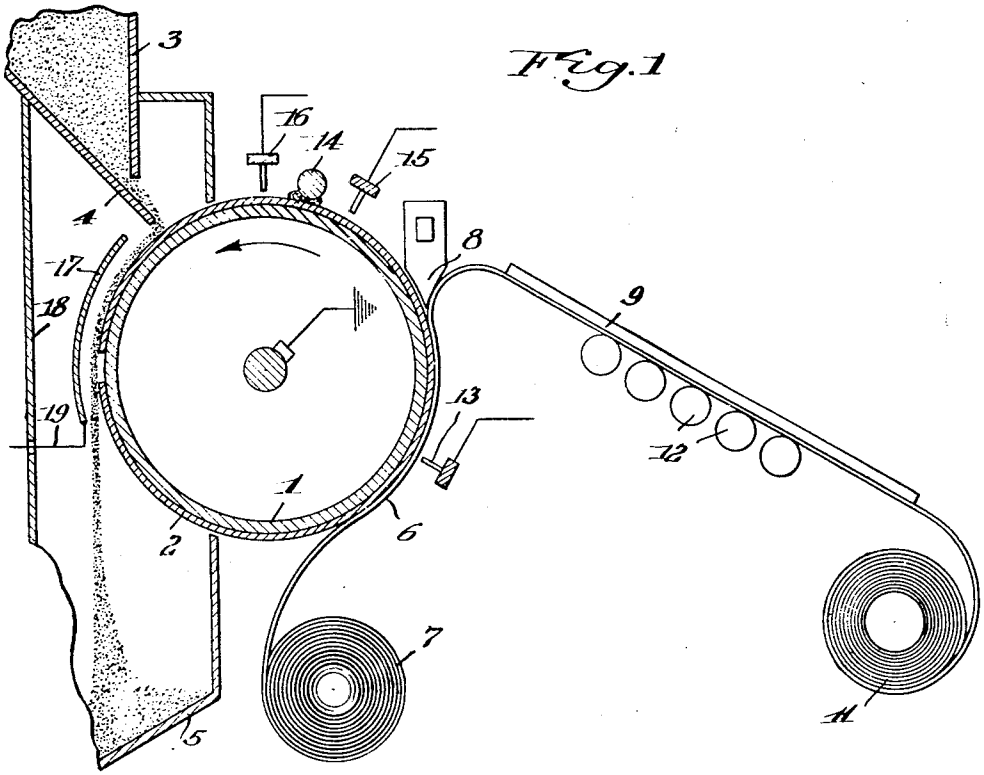
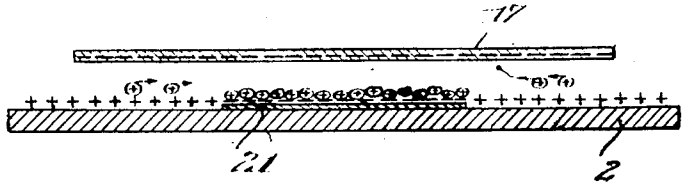


Fig. 2



INVENTORS
Lewis E. Walkup
Donald L. Hauser
BY
Harold E. Stonebraker
Their Attorney

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METHOD AND APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGES WITH ELECTROSCOPIC POWDER

Lewis E. Walkup and Donald L. Fauser, Columbus, Ohio, assignors, by mesne assignments, to Battelle Development Corporation, Columbus, Ohio, a corporation of Delaware

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7 Claims. (Cl. 101—426)

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This invention relates to a method and apparatus for developing electrostatic images with electroscopic powder, with reference particularly to the general type of apparatus in which an insulating image layer on a conductive plate is electrostatically charged and the image then developed by dusting thereon an electroscopic powder which is subsequently transferred and affixed to a suitable transfer sheet or support, and it has for its purpose to afford a procedure by which the background areas or non-image portions of the plate carrying the image layer are maintained substantially free from electroscopic powder, which adheres only to the image area, thus resulting in a copy or reproduction in which the background areas as well as the image areas correspond closely to the original subject, so as to produce a faithful copy with background areas free from undesirable shadows or darkened portions.

In the production of powder images on insulating image layers that have previously been electrostatically charged, it has been found that undesirable effects result in the background areas due to portions of the electroscopic powder adhering to the non-image areas of the plate on which the image layer is supported, the powder that adheres to the non-image areas being carried onto the transfer sheet along with the powder on the image areas, and such powder as remains on the non-image areas being subsequently charged and causing a build-up of powder and a continual increasing of undesirable effects in the background areas in printing operations or otherwise, where the image layer and supporting plate are repeatedly charged and dusted with electroscopic powder to produce multiple copies, and it is a particular purpose of the invention to afford a procedure and mechanism that will effectively prevent adherence of the electroscopic powder to the non-image areas of the plate so that the latter is free from electroscopic powder except over the image areas when the powder image is transferred.

The invention is particularly applicable to processes involving the use of developing materials consisting of a combination of finely divided pigmented electroscopic powder with a coarser carrier material, the carrier material being triboelectrically charged with a polarity opposite to that of the electroscopic powder upon frictional engagement therewith and acting to retain the electroscopic powder which is attracted to and surrounds the particles of carrier material, and if the charge on the non-image areas of the plate

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has a greater attractive force for the electroscopic powder particles than the charge on the carrier material has, the electroscopic powder particles are likely to be attracted to and held by the non-image areas on the plate even though such non-image areas are of a conductive character to drain off the major part of the electrostatic charge except over the insulating image areas, and it is a particular object of the invention to impose a further electrostatic charge on the non-image areas of the plate or to surround said areas with an electrostatic field such that the charge on the non-image areas will have a polarity opposite to the charge on the image areas and the same as the charge on the electroscopic powder, and will therefore repel such powder and prevent its adhering to the non-image areas.

A further purpose of the invention is to provide a practical, economical, and efficient construction in the form of an electrode or other electrostatic field-creating instrumentality that is adaptable to a continuous electro-printing machine or to other mechanism for applying electroscopic powder to a charged image layer, whereby the powder will be applied evenly and uniformly over the image areas of the plate and the non-image areas will be left substantially free of electroscopic powder.

To these and other ends, the invention consists in the construction and procedure that will appear clearly from the following description, when read in conjunction with the accompanying drawings, the novel features being pointed out in the claims following the specification.

In the drawings:

Fig. 1 is a diagrammatic sectional view illustrating one embodiment of the invention as incorporated in a continuous electro-printing apparatus, and

Fig. 2 is a diagrammatic view illustrating the action of an electrode in creating an electrostatic field adjacent to and on a plate when electroscopic powder is applied to the latter.

The invention is applicable to the method disclosed in copending application of Lewis E. Walkup and Edward N. Wise, Serial No. 24,674, filed May 1, 1948, and to the copending application of Roland M. Schaffert, Serial No. 55,816, filed October 21, 1948, which includes a rotating drum on which is mounted a conductive printing plate carrying an insulating image layer, combined with means for applying electroscopic powder by gravity to the image layer as the drum rotates, after which the powder image is transferred to a continuous strip of paper or other material that

is continuously fed along in contact with the drum at a point beyond the powder dusting area, the paper strip and drum being constantly charged by suitable charging instrumentalities which maintains an electrostatic charge constantly on the insulating image layer and also holds the paper strip in contact with the drum at the point where the image is transferred to the paper by electrostatic action.

Referring to Fig. 1 which discloses such a mechanism, 1 designates the rotating drum while 2 is the conductive printing plate suitably mounted thereon and carrying the insulating image layer, which it is not necessary to show for purposes of the present invention, while 3 designates a discharge receptacle from which electroscopic powder gravitates over the inclined bottom 4 to fall onto the drum and travel downwardly by gravity, the surplus electroscopic powder which is not retained by the charged image layer on the drum falling into the receptacle 5. 6 designates the continuous paper strip that is fed from a roll 7 through a path adjacent to the drum as shown and from which it is deflected by the stripping fingers 8 after which the paper travels downwardly over an inclined chute or guide 9 onto a receiving roll 11. 12 designates heating elements that act to fuse the powder image onto the paper strip as it travels downwardly over the chute 9, while 13 designates corona discharge needles or other suitable devices for applying an electrostatic charge onto the paper strip 6 and onto the insulating image of the drum. 14 designates any suitable cleaning instrumentality for removing from the drum surplus electroscopic powder after each transfer operation, thus preparing the charged image layer to receive a fresh supply of electroscopic powder and additional charging units such as shown at 15 and 16 may be employed if desired to impose additional charges on the insulating layer of the drum, although these charging units and their location form no part of the present invention which will now be described in detail.

In order to prevent adherence of electroscopic powder to the non-image areas of the printing plate, there is provided an electrode 17 preferably curved as shown to conform to the curvature of the drum and located between the powder chamber wall 18 and the surface of the drum, being spaced at a distance of substantially 1.25" from the surface of the drum. The electrode 17 is in the form of a plate having a length preferably that of the drum 1 and extending around the drum from a point immediately beneath the inclined bottom 4 of the powder discharge receptacle to a point below that at which the powder falls away from the drum, so that the electrode substantially covers the entire area over which powder is in moving contact with the drum, and the electrode 17 may consist of a solid sheet, a screen, a series of wires, or a series of points suspended or located over the area described, or near the plate surface during development, the electrode 17 being connected by conductor 19 with any suitable source of potential supply to create the desired electrical field, and in actual practice, with the insulating image charged positively, satisfactory results have been had by applying to the electrode 17 a charge of from 1500 to 6000 volts having the same polarity as that of the insulating image, or positive.

Fig. 2 illustrates the action that is believed to take place and the effect produced by the electrode 17. Assuming that the insulating image area or layer 21, carried by the conductive supporting plate 22, is charged negatively, the electrode 17 is likewise charged negatively by applying a suitable potential, and such negative charge on electrode 17 induces a positive charge as indicated on the non-image areas of the plate 22, shown at either side of the image area 21. The electroscopic powder that produces the powder image by adherence to the image area 21 is charged positively by triboelectric action of the carrier material to which the electroscopic powder particles adhere until separated therefrom by the stronger attractive force of the charged insulating image layer 21. Since the non-image areas of the plate are electrostatically charged positively by the electrode 17 by induction, such positive charges repel the positively charged electroscopic powder particles, and thus any tendency of the electroscopic powder to adhere to the non-image or background areas of the plate is effectively overcome.

The electrode 17 having a charge of the same polarity as the insulating image layer exerts an attractive force on the electroscopic powder and to this extent may reduce the density of the powder image, but this is not of appreciable significance when proper voltages are applied to the electrode, and by suitably controlling the spacing between the electrode and the insulating image layer and the potential applied to the electrode, the electrostatic field between the electrode and the printing plate can be adjusted as desired and the relative action of the electroscopic powder on the insulating image layer and on the non-image areas of the plate can be regulated and controlled to give the proper and desired effect. By maintaining the polarity of the electrode charge the same as that of the charge on the insulating layer and opposite to the charge on the electroscopic powder, and properly controlling the spacing of the electrode from the image layer, also the potential applied to the electrode, undesirable or excessive adherence of electroscopic powder to the non-image or background areas of the plate can be definitely and effectively prevented, and any desired relation between the action of the electroscopic powder on the image areas and non-image or background areas can be maintained.

While the invention has been described with reference to the structure and procedure herein shown, the invention is not thus restricted and this application is intended to cover such modifications or departures as may come within the purposes of the improvements or the scope of the following claims.

We claim:

1. The method of developing an electrostatic image on a charged insulating image layer supported on a conductive plate, and which conductive plate extends across the background area of the image, which consists in applying developing powder to the charged image layer while maintaining an electrical field, produced by a potential having a polarity the same as that of the charge on the image layer and opposite to that of the charge on the developing powder, over the area of the plate to induce a charge in the background area opposite in polarity to the charge in the image area while the powder is applied, whereby powder having the same charge as the background area is repelled from the background area.

2. The method of developing an electrostatically charged image on an insulating image layer supported on a conductive plate which extends across a background area, which consists in applying developing powder to the charged image layer and inducing on the non-image areas of the plate an electrical charge having a polarity opposite to that of the charge on the image layer and the same as the charge on the developing powder to repel powder from the background area, said last-mentioned charge being produced by an electrical field applied to the plate while developing.

3. The method of developing an electrically charged image on an insulating image layer supported on a conductive plate which forms the background area of an electro-printing plate consisting of applying charged developing powder to the charged plate, the powder being applied between the plate and an electrode located adjacent to the plate, and applying to said electrode a potential, having a polarity the same as that of the charge on the image and opposite to that of the charge on the developing powder, to induce a charge of the same polarity as the polarity of the charge on the powder in the background area to repel the powder from the background area.

4. The method of developing an electroprinting plate having an electrostatic image on a charged insulating image supported by a conductive backing plate which forms the background area, which consists in applying charged developing powder to the surface of the plate on which the insulating image is charged oppositely to the developing powder, the powder adhering to the image electrically, electrically inducing a charge in the backing plate of the same polarity as the polarity of the charge of the powder to repel the powder from the background area and thereby maintain the background area free of powder.

5. An electroprinting apparatus comprising in combination, a plate consisting of an electrically conductive movable supporting backing plate carrying a nonconducting charged image layer, said backing plate extending across the background area of the image, means for charging said image layer, powder-applying means for presenting to the plate charged developing powder having a polarity opposite to the polarity of the charged image layer, background charge inducing electrode mounted in spaced relation from the image layer in the image-powder attraction zone to effect an electric field in said attraction zone to induce in the background area a charge of the same polarity as the polarity of the powder, whereby said powder is simultaneously repelled from the background area and attracted to the image area.

6. An electroprinting mechanism for transferring a charged powder image to a surface comprising an electroprinting plate consisting of an electrically conducting movable support which forms the background area of the printing plate having an image layer of electrically nonconducting material thereon, said image layer being charged electrically with a charge having a polarity opposite to that of the polarity of the charge of the powder to be transferred, powder-applying means located adjacent to the movable support acting to flow a stream of developer powder charged with a charge of polarity opposite to that of the charge on the insulating image layer over the plate, said powder adhering to the image layer electrostatically to form a powder image, an electrical field-producing electrode charged with the same polarity as the image area mounted in spaced relation to the plate surface with the stream of powder flowing between the electrode and the plate, said electrical field being such as to effect an induced charge of the same polarity as that of the powder in the background area to repel the powder from the background area, and, electrostatic means for transferring said charged powder image to a surface.

7. In an electric printing apparatus wherein moving support means are provided to move a conductive printing plate which forms the background area of the plate having an insulating image on its printing surface past a charging station, electrical means at said station for placing a charge of a first polarity on said insulating image, powder-applying means at a sequential station to deposit a powder carrying a charge of second polarity on said image surface, the combination with said powder-applying means of, an electrode spaced from and overlying a substantial part of the area over which said powder is deposited and means to charge said electrode to a potential of said first polarity to induce a charge of said second polarity in the background areas of said conductive printing plate during development thereof, said charge of second polarity in the background area acting to repel the like charged powder from the background area.

LEWIS E. WALKUP.
DONALD L. FAUSER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,221,776	Carlson	Nov. 19, 1940
2,297,691	Carlson	Oct. 6, 1942
2,357,809	Carlson	Sept. 12, 1944
2,359,476	Gravely	Oct. 3, 1944
2,483,462	Huebner	Oct. 4, 1949