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SEGMENTED DEVELOPMENT ELECTRODE

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FIG.1

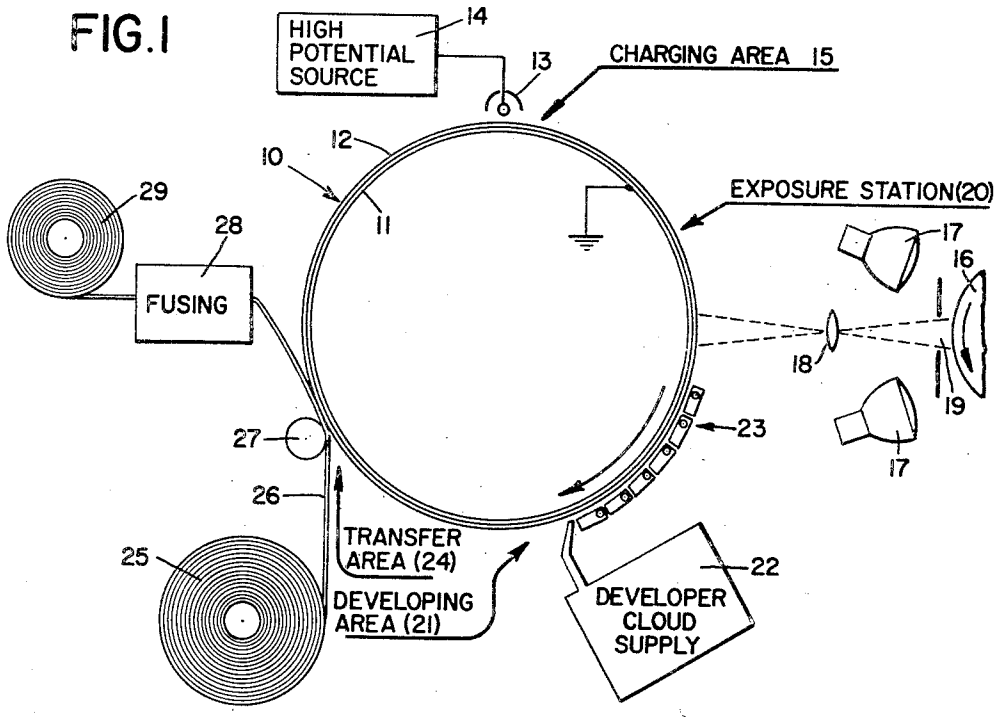
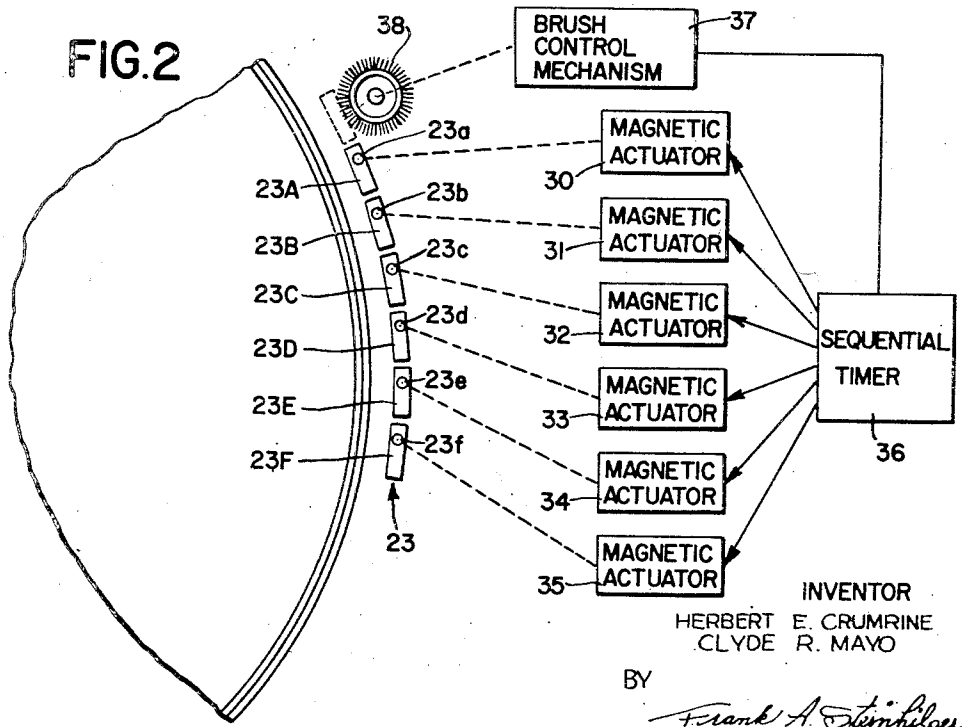


FIG.2



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SEGMENTED DEVELOPMENT ELECTRODE

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9 Claims. (Cl. 118—51)

The present invention relates to xerographic techniques, and more particularly to a segmented development electrode for incorporation in apparatus adapted to develop a powder image on the insulating image layer of a xerographic plate.

In the production of xerographic copies, the photoconductive insulating image layer of the xerographic plate is first charged electrostatically, the charged surface then being exposed under light to the subject to be copied, thereby forming an electrostatic image. Thereafter the image layer having the electrostatic image thereon is subjected to a cloud of electroscopic or developer powder to produce a powder image, which is then transferred and affixed to paper or other transfer medium.

In the making of powder images on insulating layers that have been charged electrostatically, it has been found that undesirable effects arise in the background areas due to the adherence of portions of the electroscopic powder to the non-image areas of the plate on which the image layer is supported. The powder that adheres to the non-image areas is carried on to the transfer sheet along with the powder on the image areas. Such powder as remains on the non-image areas is subsequently charged and causes a build-up of powder and a continual increasing of undesirable effects in the background areas in printing operation.

The present invention has particular reference to techniques involving the use of developing materials consisting of a combination of finely divided pigmented electroscopic powder with a coarser carrier material. The carrier material is triboelectrically charged with a polarity opposite to that of the electroscopic powder upon frictional engagement therewith and acts to retain the electroscopic powder which is attracted to and surrounds the particles of carrier material. If the charge on the non-image areas of the plate has a greater attractive force for the electroscopic powder particles than has the charge on the carrier material, 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.

It has hitherto been suggested 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 opposing the charge on the image areas and the same as that on the electroscopic powder. Thus, the charge on the non-image areas will repel the electroscopic powder and prevent its adherence to the non-image areas. For this purpose a charged development electrode has been incorporated in continuous printing machines or in other mechanisms 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.

In line copy work employing a cascade type of development, the development electrode serves to clear up the white background in the copy. When xerography is used for continuous tone reproductions, the development electrode then serves the significant purpose of improving the tone relationship between the copy and the original. In either case, the development electrode makes possible the reproduction of solid black areas.

For example, in the Patent No. 2,573,881 issued to Walkup et al., a development electrode is disclosed operating in conjunction with a rotary mechanism. Similarly, in the co-pending application of Hayford and Crumrine, S. N. 456,538, filed September 16, 1954 entitled "Xerographic Development Electrode," there is disclosed a development electrode incorporated in a continuous and automatic xerographic device.

During development of the electrostatic latent image on the photoconductive insulating surface, fine powder particles are brought into the field of influence of the charges on the surface and are deposited on charged areas. The development electrode, which is spaced at a slight distance from this sensitive layer, tends to build-up on its surface a coating of developer material. As long as this powder accumulation remains light, the image which is developed is ordinarily not affected adversely. However, a relatively heavy coating of developer material on the development electrode interposes a new surface between the sensitive layer and the development electrode. If the coating particles carry an electrostatic charge, this may effectively alter the bias potential on the electrode and substantially diminish the beneficial aspects of the development electrode during development of the electrostatic image.

This coating also introduces uncontrollable factors in the development process. Such lack of control is to some extent attributable to the fact that the powder coating forming on the developer electrode is generally uneven and assumes random patterns. A heavy coating may drop agglomerates of developer powder to the plate surface, giving rise to a non-uniform, distorted development of the electrostatic image pattern. Moreover, a heavy coating may result in the presentation of irregular and uncontrolled flow patterns of the developer material to the plate surface and will cause streaking of the developed image.

In the above-identified co-pending application it is proposed to limit the deposition of powder on the development electrode by the use of cleaning means adapted to brush the face of the electrode so as to remove the powder deposit therefrom. The electrophotographic camera system disclosed in said co-pending application involves a development electrode of slightly more than twice the width of the xerographic plate. The development electrode is caused constantly to move back and forth transversely across the xerographic plate. Brushes are provided to engage the surface of the electrode when removed from its operative position relative to the xerographic plate for cleaning the powder deposition from the surface. While such apparatus serves to limit the deposition of the powder on the face of the development electrode, the mechanism involved is relatively complex and costly. Furthermore, the fact that the development electrode must be twice the normal size greatly enlarges the ultimate dimensions of the camera. Such enlargement is highly undesirable, particularly where there are severe limitations as to space, as in aircraft installations.

Accordingly, it is the principal object of the present invention to provide improved means and methods to control and limit the amount of material allowed to remain deposited on the developement electrode.

More particularly, it is an object of the invention to provide a cleanable development electrode for a rotary

drum-xerographic plate, which electrode has a width not exceeding that of the plate.

It is another object of the invention to provide a development electrode for a continuously operating xerographic apparatus, which development electrode is constituted by an array of segments. Means are also provided for reversing the position of the segments relative to the associated xerographic plate to permit the cleaning thereof.

Briefly stated, the invention embodies a segmented electrode wherein each segment is pivotally mounted and coupled to a mechanism adapted to reverse the position thereof relative to the associated xerographic plate, the segments being preferably reversed sequentially to minimize disruption of the electrostatic field. Brushing means are adapted to travel over the reversed face of the segments and to clean off the powder deposition thereon.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawing, wherein like elements are identified by like reference numerals.

In the drawing:

Fig. 1 illustrates schematically a preferred embodiment of an electrophotographic apparatus adapted for continuous and automatic operation, and incorporating a segmented development electrode in accordance with the invention.

Fig. 2 is an enlarged side view of the segmented electrode in conjunction with the actuating mechanism therefor.

Referring now to the drawing, the continuously operating xerographic apparatus shown in Fig. 1 comprises a xerographic plate formed in the shape of a rotating drum, generally designated by numeral **10**, and composed of a conductive backing member **11** and a photoconductive insulating layer **12**. Conductive backing member **11** is held at a ground potential.

A uniform electrostatic charge is imposed on layer **12** by a corona discharge electrode **13**, which is connected to a high-voltage source **14**. The charge is impressed on layer **12** in the region thereof designated in the drawing by numeral **15**. An image **16** on a surface moving at a proper linear speed is illuminated by lamps **17** and is projected through slit **19** and lens **18** at an exposure station, generally designated by numeral **20**, whereby an electrostatic latent image is formed on sensitive layer **12**.

At an angular position relative to drum **11**, designated by numeral **21**, the development of the electrostatic latent image takes place. A suitable developer cloud supply **22** feeds a cloud of developer particles suspended in air to the space defined between layer **12** and a segmented development electrode **23**, which electrode will be described in greater detail in connection with Fig. 2. At the area generally designated by numeral **24**, transfer of the developed image from layer **12** occurs. A roller **25** supplies a continuously fed web **26** under roller **27** and into contact with layer **12**, whereby an adhesive form of transfer is effected, web **26** having an adhesive coating on one surface thereof and being subjected to pressure by roller **27**.

The web is then fed, carrying the transferred image, through an image fusing apparatus **28**, wherein the copy is made permanent, and finally on to roller **29**. The movement of web **26** is synchronized with the turning of drum **10**, which in this embodiment is rotated in the clockwise direction, as indicated by the arrow. The drum **10** and the web **26** may be driven by a suitable motor (not shown) or by other conventional means. In addition, a cleaning device (not shown) may be positioned along the path of rotation of the xerographic plate subsequent to the transfer area to clean the plate surface prior to charging or sensitizing.

Referring now to Fig. 2, it will be seen that the segmented development electrode **23** is generally arcuate in form and conforms to the curvature of the drum. The width of this electrode substantially corresponds to that of the rotating drum. The segmented electrode **23** is constituted by a plurality of closely spaced, rectangular slats or segments **23A—23F**, the individual segments being small to bring about proper curvature and even spacing of the development electrode. Segments **23A—23F** are pivotally mounted at their upper ends on suitable shafts **23*a*—23*f***, whereby a half revolution of a shaft in the counter-clockwise direction turns over the related segment to present the reverse face thereof to the xerographic plate **12**. As indicated by the dashed line with respect to segment **23A**, the segment when reversed is shifted upwardly in position, thereby leaving a gap in the electrode which may thereafter be occupied by the adjacent segment when reversed. Thus, when all the segments are reversed the development electrode is effectively shifted upwardly along the drum to an extent equal to the size of one segment.

To prevent the shift of the development electrode upon reversal of the segments thereof, an extra segment may be provided at each end of the electrode. The extra electrode may be adapted to move only 90° to fill in the opening as the adjacent plates are reversed, thereby preventing the effective movement of the electrode.

The electrode segments are electrically interconnected and coupled to a suitable bias source to establish an electrostatic field in the area between the electrode and the xerographic plate. It will be evident that either face of the electrode segments is operative to establish the desired field.

The spacing of the segmented development electrode with respect to the xerographic plate is quite close and it is necessary to carry out cleaning of the electrode continuously during the operation of the mechanism. The electrode is cleaned by turning over the segments thereof sequentially to bring the dirty surface of the electrode upward and away from the plate and a clean surface to the plate. The dirty surfaces of the electrode segments are then swept clean by means such as a rotary brush **38** and turned back to face the plate.

In order to effect the sequential turning over of the segments, the shaft of each segment is coupled to a suitable actuating mechanism, such as electromagnetic actuators **30—35** coupled to shafts **23*a*—23*f***, respectively. Each actuator, which may include a conventional solenoid and armature, is designed so that when energized it acts instantly to reverse the position of the associated segment, and when de-energized it functions to restore the segment to its initial position. For the purpose of energizing or de-energizing the actuators in the desired manner, a sequential timer **36** is provided which supplies operating voltages successively to the actuators. In its simplest form the timer may consist of a motor-driven rotary multi-contact switch coupled to a power source and having a moving contact arranged to connect said source cyclically and sequentially to the actuators, such that each segment is actuated in turn until all are reversed and after a predetermined period all of the actuators are simultaneously released to cause said segments to revert to their original position. The cycle is then repeated. The rotary brush **24** is arranged to travel along the dirty outer surface. The operation of the brush is controlled by a suitable control mechanism **37** synchronized by timer **36** so that after all the segments are reversed, the brush sweeps down the electrode to remove the powder, while after the segments return to their original position, the brush sweeps up the electrode. Thus, both faces of the electrode are kept clean.

The mechanism for effecting the desired movement of the brush may be similar to that disclosed in the copending application, save for the fact that the brush travels on the outer surface of the electrode, rather than

on the surface facing the xerographic plate. The invention is by no means limited ot rotary brushes for cleaning purposes, and in lieu thereof moving felt pads or similar means may be successfully employed.

To prevent excessive loss of powder cloud when the segment is reversed, it is desirable that the reversal be carried out as quickly as possible. Accordingly, the actuators should be of the fast-acting type. It is to be understood that the invention is not limited to magnetic actuation and that the reversal of the segment may be carried out by various other mechanisms, such as those used to operate louvres. It is also possible to reverse the position of the several segments concurrently, rather than sequentially.

While there has been described what at present is considered to be a preferred embodiment of the invention, it is to be understood that many changes and modifications may be made therein without departing from the essential spirit of the invention. It is intended therefore in the appended claims to cover all such modifications as fall within the true scope of the invention.

What is claimed is:

1. In a xerographic apparatus, the combination comprising a xerographic plate, a development electrode in closely spaced relation to said plate, said electrode being constituted by a plurality of reversible segments, and means for reversibly positioning said segments relative to the plate, whereby either surface of the electrode may be presented in face-to-face relation to said plate.

2. In a xerographic apparatus, the combination comprising a cylindrical xerographic plate, a generally arcuate development electrode disposed in parallel spaced relation to said plate, said electrode being constituted by an array of rectangular segments whose width corresponds substantially to that of said plate, said segments being pivotally mounted whereby either surface thereof may be presented to said plate by reversal of said segments, and means for reversibly positioning said segments relative to the plate.

3. In a xerographic apparatus, the combination comprising a xerographic plate, a development electrode in closely spaced relation to said plate, said electrode being constituted by a plurality of reversible segments, means for reversibly positioning said segments relative to the plate, whereby either surface of the electrode may be presented in face-to-face relation to said plate, and cleaning means for removing deposited material from the surface of said electrode turned away from said plate.

4. In a xerographic apparatus, the combination comprising a cylindrical xerographic plate, a generally arcuate development electrode disposed in parallel spaced relation to said plate, said electrode being constituted by an array of rectangular segments whose width corresponds substantially to that of said plate, said segments being pivotally mounted whereby either surface thereof may be presented to said plate by reversal of said segments, means for reversibly positioning said segments relative to the plate, means to spray a gas suspension of powder into the space between said plate and said electrode, and cleaning means for removing deposited material from the surface of said electrode turned away from said plate.

5. In a xerographic apparatus, the combination comprising a cylindrical xerographic plate, a generally arcuate development electrode disposed in parallel spaced relation to said plate, said electrode being constituted by an array of rectangular segments whose width corresponds substantially to that of said plate, said segments being pivotally mounted whereby either surface thereof may be presented to said plate by reversal of said segments, means to spray a powder cloud in the space between said plate and said electrode, actuating means operable sequentially for reversibly positioning the segments relative to the plate successively, and means for removing deposited powder from the surface of said electrode turned away from said plate.

6. Xerographic apparatus comprising a xerographic plate, a segmented development electrode, disposed in spaced parallel relation to said plate and constituted by an array of conductive segments, each segment being pivotally mounted on a shaft, an actuator coupled to each shaft, means for sequentially energizing said actuators for reversibly positioning said segments relative to the plate successively, and means to feed a powder cloud in the space between said electrode and said plate.

7. Xerographic apparatus comprising a xerographic plate, a segmented development electrode disposed in spaced parallel relation to said plate and constituted by an array of conductive segments, each segment being pivotally mounted on a shaft, an actuator coupled to each shaft, means for sequentially energizing said actuators for reversibly positioning said segments relative to the plate successively, means to feed a powder cloud in the space between said electrode and said plate, and brush means arranged to travel across said electrode on the surface thereof turned away from said plate to remove powder deposit therefrom, said brush means being operative upon completion of said sequence.

8. Apparatus as set forth in claim 7, wherein said sequential energizing means is constituted by a timing device to effect cyclical and sequential reversal of said segments.

9. Apparatus as set forth in claim 8, wherein said brush means is operated by a control mechanism synchronized by said timer periodically to clean the turned away surface of said electrode.

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