Sept. 21, 1971 S. LATONE 3,606,863

DEVELOPMENT ELECTRODE

Filed Feb. 12, 1969 4 Sheets-Sheet 1

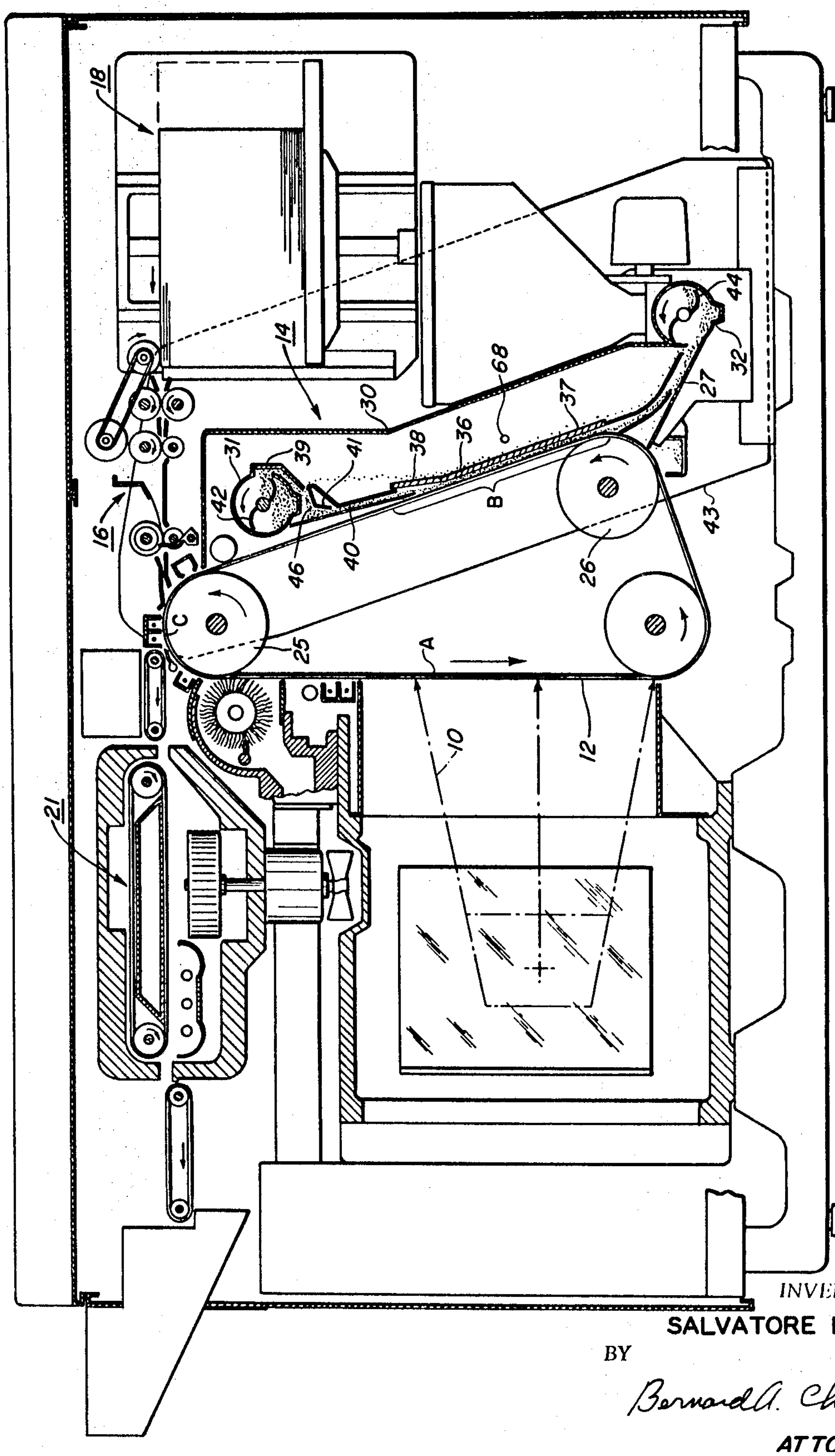

FIG. 1

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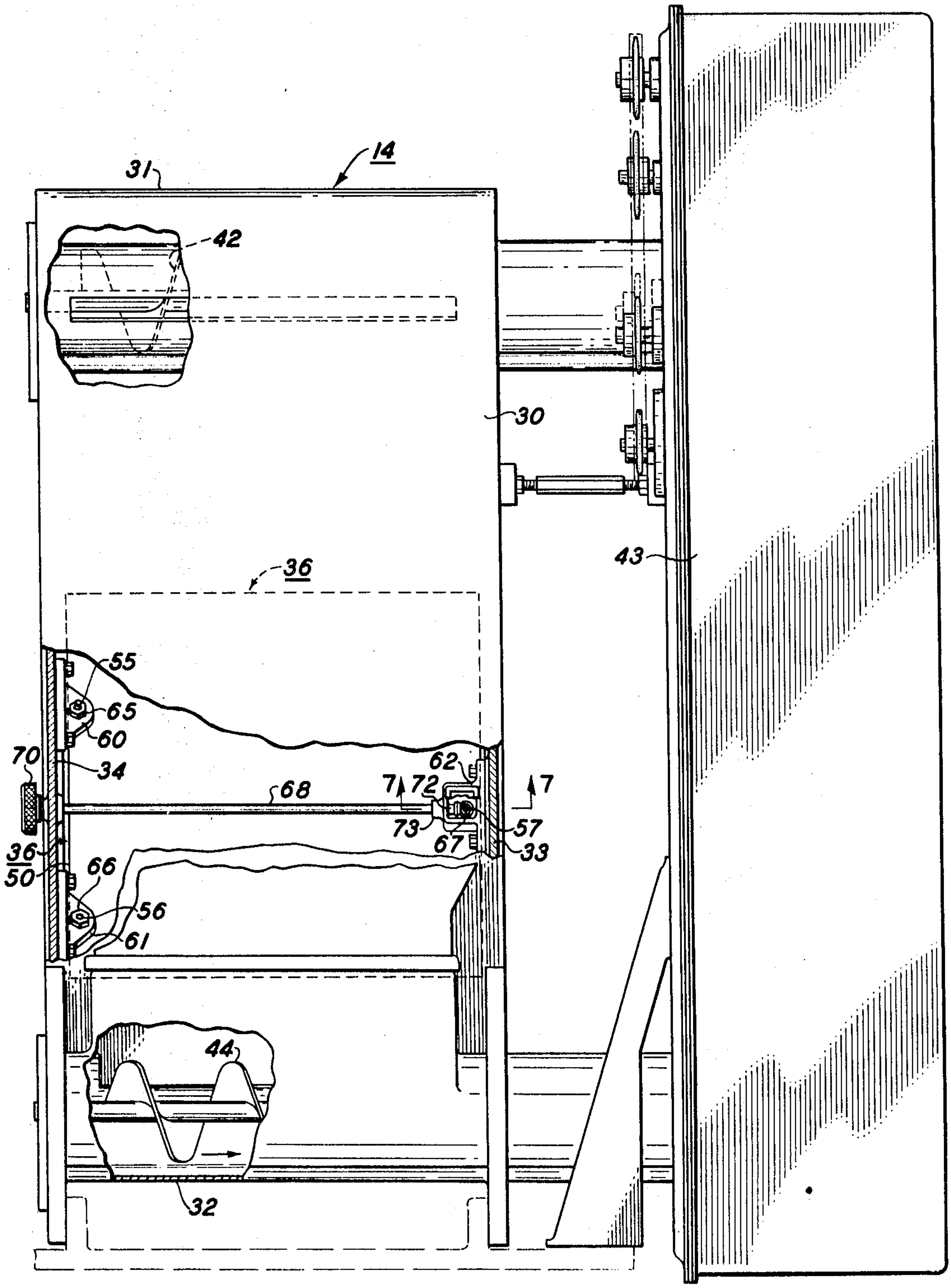
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FIG. 2

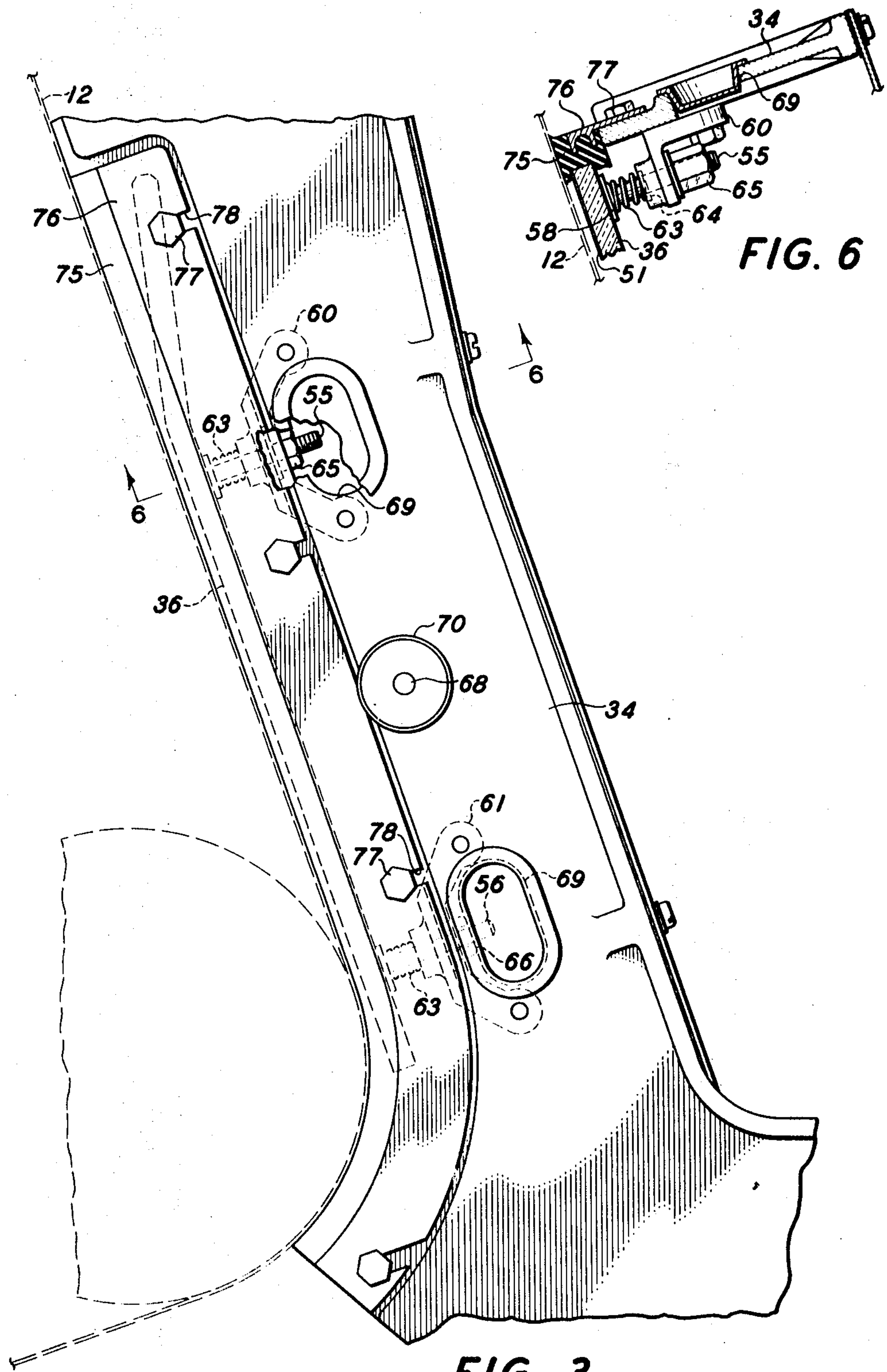
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FIG. 6

FIG. 3

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DEVELOPMENT ELECTRODE

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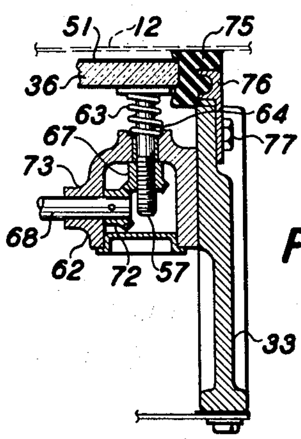

FIG. 7

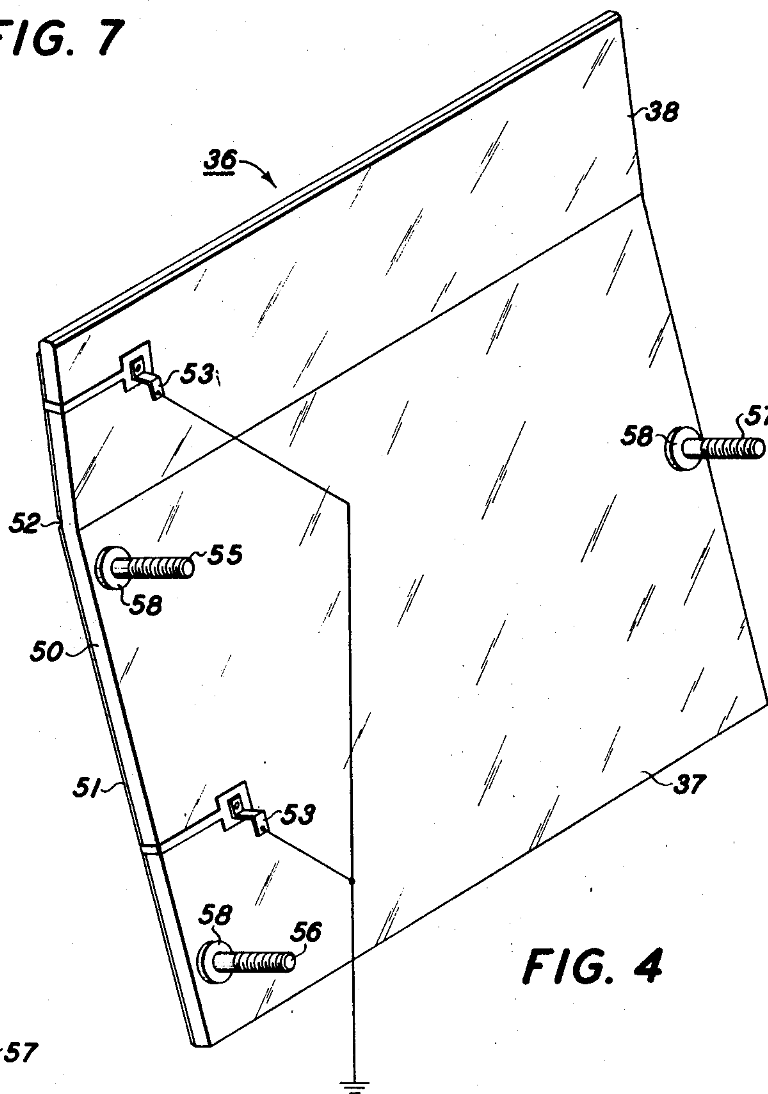

FIG. 4

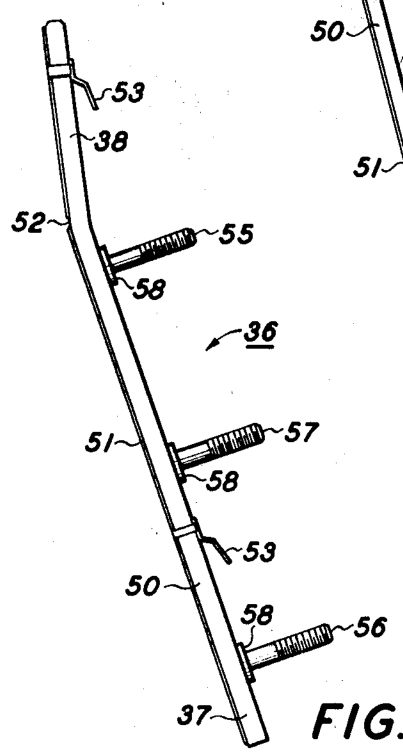

FIG. 5

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3,606,863
DEVELOPMENT ELECTRODE
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Filed Feb. 12, 1969, Ser. No. 798,669
Int. Cl. B05b 5/00
U.S. Cl. 118—637 3 Claims

ABSTRACT OF THE DISCLOSURE

A development electrode for use in cascade development of electrostatic latent images formed on flat photoreceptors such as flat runs of photoconductor belts or plates. The electrode is formed from a flat plate of glass coated with conductive material and mounted in position by means of a plurality of insulated adjustable devices.

This invention relates to improvements in development apparatus of the type wherein particulate material is cascaded over flexible photoconductive material when in a flat condition and is particularly adapted for use with automatic copiers/reproducers capable of high speed operation.

As is well known in recent years, the steadily increasing size of various government agencies and industries has required an enormous increase in the amount of paper work that must be accomplished, maintained, and made available for wide interplant or department circulation. In the present day commercial automatic copiers/reproduction machines, which are adapted to produce copies of between 5 and 60 8" x 11" sheets of copy per minute, the photoreceptor device is in the form of a drum which rotates in timed unison relative to a plurality of processing stations and the usual developing system is limited as to the amount of developing material that can be presented for use at a development zone for the machine.

As a solution for overcoming the disadvantages for high speed copying, the latest machine concept for copiers utilizes flash exposure of a document and the arrangement of a moving photoconductor material in the form of an endless belt or a flexible web. However, there has been no effective way in which to present a development electrode for use with the photoconductor material in the form of a belt or as a flexible web in order to accomplish high speed development of the latent electrostatic images produced on the belt or web during the exposure step. One of the significant deficiencies in this regard has been the difficulty in providing a flat electrode of relatively large size which has an acceptable tolerance of flatness that will not adversely affect the developing process.

It is, therefore, the principal object of this invention to improve electrostatic developing apparatus that is capable of producing developed electrostatic images having line and solid areas at relatively high speeds.

Another object of this invention is to improve development latent electrostatic images on flat photoconductor material by utilizing a development electrode that is capable of being produced and maintained to acceptable tolerances relatively easily.

These and other objects of this invention are obtained by means of a development electrode made of glass plate having one side formed optically flat to within close tolerances and having this side coated with conductive metallic material which is maintained in insulated condition relative to surrounding structure. The electrode is formed into different electrode sections by scoring the coating so that different voltages may be applied to different sections. Mounting devices are fixed to the glass plate and are maintained electrically insulated relative to the metallic coating.

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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 conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic sectional view of a typical reproduction machine showing the various processing stations with the present invention associated therewith;

FIG. 2 is a rear view of the developer housing partly broken away, and vertical return housing as seen out of association with the selenium belt utilized in the machine and to which the present invention is applied;

FIG. 3 is an elevational view of a portion of the developer housing;

FIG. 4 is an isometric illustration of a development electrode;

FIG. 5 is an end view of the development electrode;

FIG. 6 is a fragmentary cross sectional view of one of the mounting posts for the electrode taken along line 6—6 in FIG. 3; and

FIG. 7 is a fragmentary cross sectional view of another mounting post for the electrode taken along line 7—7 in FIG. 2.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original to be copied is placed upon suitable transparent support platen arranged on the machine. While upon the platen, an illumination system flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays, indicated by line **10**, are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt **12** arranged on a belt support assembly **11.**

The belt assembly **11** may be slidably mounted relative to the frame of the machine and is adapted to drive the belt **12** in the direction of the arrow as shown in FIG. 1 at a constant rate. During this movement of the belt, the light imaging rays of an original is flashed upon the xerographic surface of the belt. The belt surface that intercepts the light rays comprises a layer of photoconductive material such as selenium on a conductive backing that is sensitized prior to exposure by means of a charging corona generator device indicated at **13.**

The flash exposure of the belt surface to the light image while at exposure station A discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14** and where the belt is maintained in a flat condition. The developer assembly **14** comprises horizontally and vertically conveying mechanisms which carry developing material to the upper part of the upper portion of the belt at the station B whereat the material is dispensed and directed to cascade down over the upwardly moving inclined selenium belt 12 in order to provide development of the electrostatic image.

As the developing material is cascaded over the xerographic plate, toner particles in the development material are deposited on the belt surface to form powder images. The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved at a speed approximately in synchronism with the moving belt in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism generally indicated at 16 adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral 18 to the developed image on the belt at the station C.

After the sheet is stripped from the belt 12, it is conveyed into a fuser assembly generally indicated by the reference numeral 21 wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Suitable drive means may be arranged to drive the selenium belt 12 in conjunction with timed flash exposure of an original to be copied, to effect conveying and cascade of toner material, to separate, and feed sheets of paper and to transport the same across the transfer station C and to convey the sheet of paper through the fuser assembly in timed sequence to produce copies of the original.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using an illumination system constructed in accordance with the invention. For further details concerning the specific construction of an electrostatic copier, reference is made to copending U.S. patent application Ser. No. 731,934, filed concurrently herewith in the name of Hewes et al.

In order to effect development of the electrostatic latent image on the selenium belt 12, the development system for the xerographic reproduction machine, shown in FIG. 2, includes a developer assembly 14 which coacts with the selenium belt 12 at the development zone B. At this development zone, the charged exposed surface of the belt 12 is developed to form a powdered toner image of the original that was previously illuminated.

For this purpose, the developer assembly 14 is mounted adjacent to the moving belt 12 to establish the development zone B. Mounted within the developer assembly 14 is a screw conveyor arrangement utilized in conjunction with an internal bucket conveyor belt for continuously circulating developer material previously supplied to the upper end of the developer assembly and from where the developer material is cascaded over the now inclined upperly moving selenium belt 12 in order to accomplish development of the latent image thereon. As the developer material cascades over the flat run of the belt 12, between the belt supporting rollers 25, 26 upon which the belt 12 is mounted for movement, toner particles of the developing material adhere electrostatically to the previously formed electrostatic latent image areas on the belt, the remaining developer material falling off the lower portion of the belt assembly adjacent the roller 26 or the peripheral surface thereof to be deflected by baffle plate 27 into the bottom sump of the developer assembly 14. Toner particles consumed during the developing operation to form the visible powder toned image is replenished by a suitable toner dispenser mounted external to the developer assembly.

Specifically, the developing assembly 14 includes an elongated, vertically inclined, boxlike developer housing 30 having a top wall 31, a bottom wall 32, side walls 33 and 34, a front wall in the form of a development electrode, and a rear wall 35. As shown in FIG. 2, the side

walls 33 and 34 are shaped with a vertically inclined straight edge portion and a lower curved portion in conformity with the shape the selenium belt 12 assumes during the development function of the machine, as defined by the adjacent portions of the belt roller 26 to permit the developer housing to be positioned closely adjacent to the belt.

In order to be disposed for high quality reproduction, the developing assembly is capable of accomplishing line copy development and solid area development. This is made available by use of a development electrode 36 mounted upon the housing 30 as the front wall 35. The development electrode 36 is positioned so as to assume a spaced relationship relative to the adjacent run of the selenium belt, and is shaped as a thin rectangular plate and includes a main lower portion 37 and an upper extension plate 38 which serves as the entrance chute for developer material and which is mounted on but electrically insulated from the top edge of the main electrode portion 37.

During the developing function, development material comprising very small diameter carrier beads having smaller toner particles electrostatically adhering thereto, is introduced in the space between the development electrode 36 and the adjacent run of the selenium belt 12. As will be described more fully hereinafter, the development material is introduced into position for cascade development as a thin curtain formed between the belt 12 and the adjacent longitudinal edge of the electrode plate 36. This is accomplished by means of a baffle 39 secured in the upper region of the developer housing 30. The development material cascades downwardly from the baffle 39 and deposits from or collects in a funnel shaped space between a plate 40 and a guide plate 41 as observed in FIG. 1. The development material then falls freely between the electrode portion 37, 38 and the selenium belt during which time and distance the toner particles are pulled away from the carrier beads by action of the electrostatic charged image on the belt 12.

Denuded carrier particles and other toner particles which were not employed in developing the latent image and which have passed into the lower spacing between the electrode 36 and the belt 12 are deflected upon the pick-off baffle 27 which is at ground potential and carries the particles back into a conveyor system for the development material.

These particles are conveyed by the baffle plate 27 extending across the entire width of the housing 30 and being suitably mounted on the side plates 33, 34 thereof. The toner particles and denuded carrier particles are directed by the plate 27 into a developer material return system comprising a first conveyor screw arrangement 42 for conveying development material that has been cascaded over the surface of the belt 12, an internal bucket vertical conveying belt mounted for movement in a developer return housing 43 for conveying this material vertically to a position of deposit and, a second conveyor screw 44 for conveying the development material horizontally from the position of deposit for the conveyor belt to a position in communication with the upper reaches of the spacing between the development electrode 36, 37 and the belt 12 preparatory to continuous recascading of the material across the selenium belt 12.

Further details of the developer housing 30, the structure therein and the vertical developer return housing 43 with enclosed structure are not necessary to understand and utilize the present invention.

The conveyor screw 44 conveys developing material horizontally from the developer return housing 43 and into the developer housing 30 preparatory to movement of the developer material into cascading position. During operation of the developer assembly, the lower conveyor screw 44 and the upper conveyor screw 42 are driven in unison in the same directions and, are adapted to convey each in its own direction as indicated by the arrow, approximately the same quantity of development material in order to prevent the advancement of movement of development material of one of the screw conveyors over the other.

As the development material is poured out of the screw conveyor arrangement **42**, the material is directed by the baffle **39** into an elongated funnel shaped space or hopper **46** formed by the plate **41** and the inclined plate **40** mounted in the upper region of the developer housing **30**. This space or hopper **46** extends across the entire width of the housing **30** and directs the flow of developing material in a controlled amount into the development zone B by way of the restricted lower edges of the plates **40, 41** which, at this point, serves as a metering orifice.

The development material leaving the hopper **46** continues its downward movement and flows between the plates **40, 41** and between the selenium belt and the electrode portion **38** in position to begin the cascade development function. The developer material falls in the form of a thin, wide sheet of falling particulate material to be influenced by the electrical charge on the belt **12** and the field charge between the belt and the electrode **46**.

As the developing mixture is cascaded over the xerographic belt **12**, toner particles are pulled away from the carrier beads and deposited on the belt to form powder images, while the partially denuded carrier beads and excess toner pass off the belt and into the developer housing **30** by way of the pick-off baffle **27** as previously described. As toner powder images are formed especially for solid area development additional toner particles must be supplied to the developing mixture in proportion to the amount of toner deposited on the selenium belt.

The development electrode **36**, as shown in FIG. 4, is formed as a plate **50** of ceramic material preferably glass which spans the entire front of the developer housing **30** and a thin coating **51** made from a suitable conductive metal. For good development of electrostatic latent images, by the cascade technique, it is necessary that the development electrode be uniformly spaced from the surface being developed. With the use of a flat photoconductive plate it is necessary that the electrode be uniformly spaced in two directions; that is, across its entire area or that area facing the plate. An uneven electrode surface, even to a degree involving ten-thousandths of an inch would affect the developing quality of the developing system being employed. For relatively large development zones, such as that illustrated in FIGS. 1 and 3, measuring approximately 10 inches in width and 9 inches in length, the use of a solid metallic development electrode would involve relatively large expense and care because of the difficulty encountered in manufacturing such large plates to a degree of acceptable smoothness. It has been found that a glass plate may be fabricated and maintained with an acceptabl smoothness on at least one side much more easily than for a metallic plate.

In order to complete the development electrode **36**, the coating **51** is applied to the side of the glass plate **50** facing the selenium belt **12** in the development zone B. The coating is preferably applied by the vacuum deposition technique in order to permit the formation of a precisely dimensioned thickness to the coating and insure that the smoothness of the electrode will be maintained. Any other process for applying a coating may be utilized, as long as the process will not adversely affect the smoothness of the supporting plate.

As previously stated, the development electrode **36** is also provided with an electrode extension **38** also of ceramic material or glass which assumes a plane at an angle to the plane of the main portion **37** of the electrode. This portion **38** is an extension of the material of portion **37** and is formed as a separate electrode by the scoring of the coating **51** along a line **52** which serves as an upper electrode limiting edge for the main portion **37** and the adjacent lower limiting edge for the electrode portion **38**. With this arrangement, the main portion **37** and the extension **37** are electrically separated, and different voltage for ideal development purposes with the machine illustrated in FIG. 1 may be impressed upon each portion. Suitable electrical terminals **53** are soldered or otherwise secured to strips of the coating material **51** formed around the edges of the glass plate **50** and across the back of the plate a short distance for permitting connection thereof to suitable sources of electrical power. In a typical machine of the type illustrated in FIG. 1, excellent development of latent images on the photoconductor belt **12** were acquired with 600 volts being impressed upon the extension **38** and with 200 volts impressed upon the main portion **37** of the development electrode.

From FIGS. 4 and 5, it is noted that the glass plate **50** is formed as a single member with the extension **38** being formed as a bent portion of the plate. This formation may be accomplished by a casting process and the surface facing the selenium belt, ground flat to an acceptable optical flatness. During the vacuum deposition process to produce the conductive coating **51**, the linear break or spacing **52** in the coating, and the conductive strips **54** to the terminals **53** may be produced by masking the affective areas during the deposition process.

On the back side of the electrode **36**, or that side opposite the photoconductor belt **12**, there is provided three threaded members **55, 56,** and **57**. Each of the members is integrally formed with an enlarged head **58** at one end and which is rigidly fixed to the back side of the ceramic plate **50**, say by cementing. As shown in FIG. 2, the threaded members are arranged so that the members **55, 56**, are adjacent one edge of the glass plate **50** and the member **57** is between the members **55, 56** but on the other edge of the glass plate. The members **55, 56** extend respectively through apertures formed in brackets **60, 61** secured to the side wall **34** of the developer housing **30** and, the member **57** extends through an aperture in a bracket **62** secured to the side plate **33** for the housing.

The threaded members **55, 56** and **57** and the brackets **60, 61** and **62** serve as a mounting means for the development electrode **36** upon the developer housing **30** and also as devices for permitting close adjustment between the plane of the conductive coating **51** and the plane of the selenium belt **12**. As previously stated, for cascade development the spacing between a development electrode and the photoconductive surface being developed is critical, both in regard to dimensions and to parallelism. In order to accomplish adjustment, each member **55, 56** and **57** is provided with a coil spring **63** encircling the same and which are held in compression between the enlarged portion **59** and the adjacent side of the respective brackets **60, 61** and **62**, which sides are in the form of sockets **64** formed on the brackets for receiving one end of and holding each spring in position. Against the compression of the coil springs, each threaded member **55, 56** is provided with an adjusting nut **65, 66** respectively, which when turned on the members, engage the fixed brackets associated therewith. In the case of the member **57**, there is provided a threaded gear **67** which serves as an adjusting device for the adjacent edge of the electrode **36**. Adjustment then is affected by turning each of the adjusting nuts **65, 66** and the gear **67** against the forces provided by the coil springs **63** until the spacing between the coating **51** and the belt **12** is of uniform optimum distance. With the coatings on the main portion **37** and the extension plate **38** being impressed with electrical potential, an electrometer may be utilized to measure, at various points on the electrode **36**, the electric field between the electrode and the belt to insure dimension and uniformity of the spacing.

Turning adjustment movement for each of the nuts **65, 66** and the gear **67** is made possible through two large openings **69, 69** formed in the side plate **33** for the nuts **65, 66** respectively and by means of a shaft **68** and knob **70** attached thereto for the gear **67**. A suitable tool may be inserted through the openings **69, 69** and arranged to be engageable with the nuts **65**, **66** for adjusting same as aforesaid. In order to utilize the knob **70** and the shaft **68** as an adjusting drive for the gear **67**, the latter has its toothed surface in cooperative relationship with a bevel gear **72** secured at the adjacent end of the shaft **68** for rotating the gear **67**, during rotation of the shaft **68**. This end of the shaft is supported for rotation by a suitable bearing **73** supported on the bracket **62**. With this arrangement, an operator may accurately position the electrode **36** for optimum results, with all adjusting devices located in one plane, on the side facing the front of the machine and, in close proximity.

As shown in FIG. 6, the electrode **36**, when in position during a developing process has its side edges engaging and slightly depressing a pliable sealing strip material **75** secured by a support strip **76** and screws **77** to the adjacent edge of both side plates **33**, **34**. The screws **77** are received in slots **78** formed along an edge of the support strip **76** for permitting adjustment of the sealing strip **75** relative to the electrode **36**. The pliableness of the material **75** is such that readjustment of the spacing of the electrode **36** relative to the belt **12** will not impede the movement of the electrode nor distort the flatness of the coating **51** for small adjustments of the working plane of the electrode. The sealing strips serve to seal the interior of the housing **30** from the passage of developing material from the vicinity of the development zone B and to electrically insulate the electrode relative to the housing **30**.

While the invention has been described with reference to the structure of a copier reproduction machine disclosed herein, it is not confined to the details set forth and this application is intended to cover other uses and machines and modifications therefor as may come within the scope of the following claims.

What is claimed is:

1. A development electrode for use in an electrostatic reproduction machine of the cascade development type having a photoconductive plate positioned in flat condition during development with toner particles and including means for depositing toner particles upon the photoconductive plate while in the flat condition, the electrode including:

- a single ceramic plate having a flat portion positionable in generally parallel spaced relation relative to the photoconductive plate when in flat condition,
- a first conductive coating on said portion of the surface thereof facing the photoconductive plate,
- a second conductive coating on another portion of the ceramic plate and being electrically separated relative to the first coating, said other portion being flat and arranged so that said second coating is in a plane at an angle relative to said first coating, and means electrically connecting said first and second coatings to sources of electric power of different potential.

2. The development electrode of claim **1** including a plurality of mounting posts secured to the ceramic plate at the surface thereof remote from the surface bearing said first coating and means cooperable with said posts for adjustably moving the same relative to the photoconductive plate for permitting adjustment of the spacing between the first coating and the photoconductive plate.

3. The development electrode of claim **2** wherein said cooperable means are positioned so as to be accessible for adjusting said posts from the same side of said plate.

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U.S. Cl. X.R.

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