

Nov. 10, 1959

R. E. HAYFORD ET AL

2,911,944

XEROGRAPHIC DEVELOPMENT APPARATUS

Filed Sept. 16, 1954

4 Sheets-Sheet 1

FIG. 1

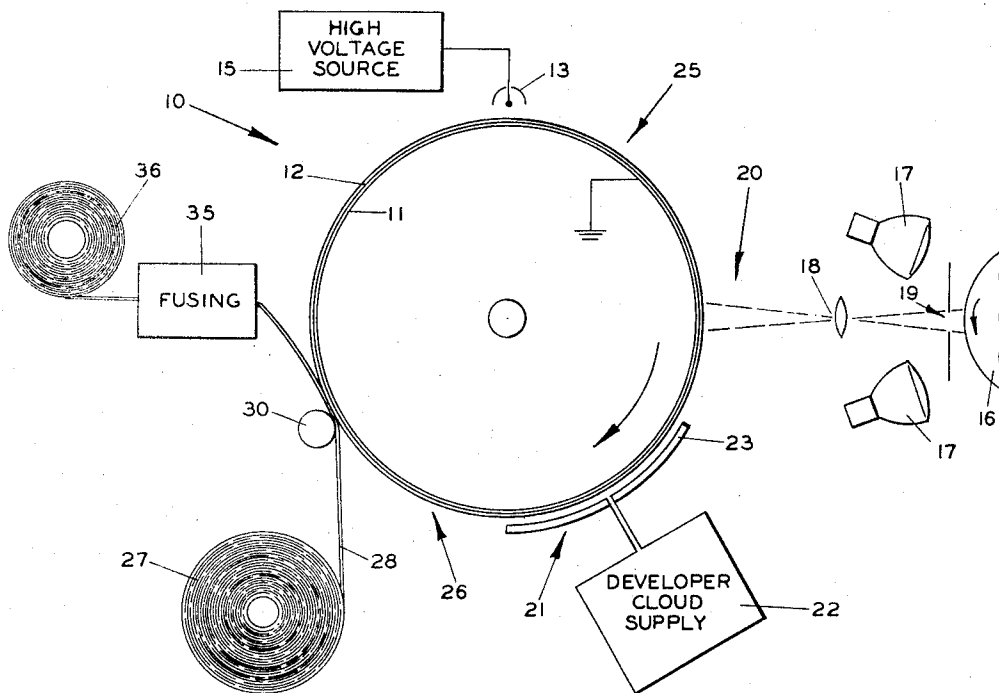
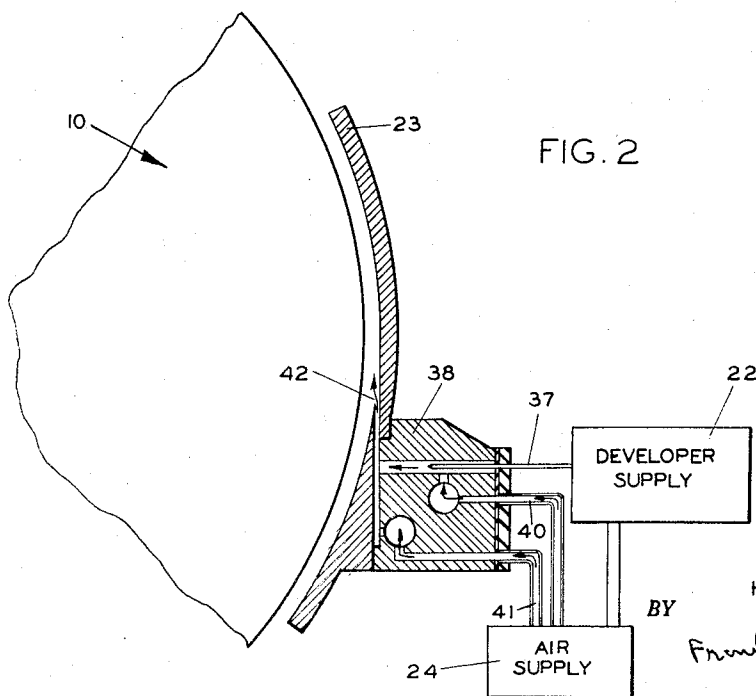


FIG. 2



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FIG. 4

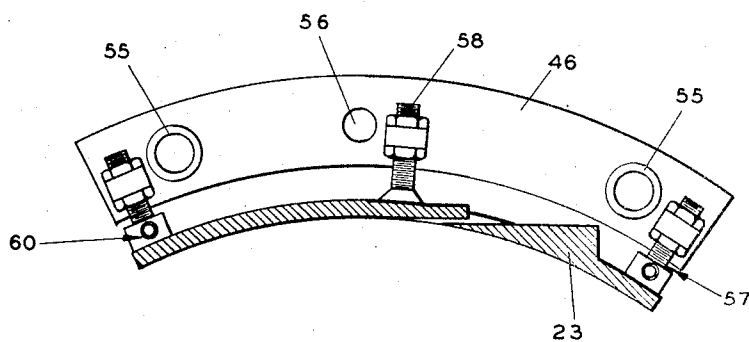
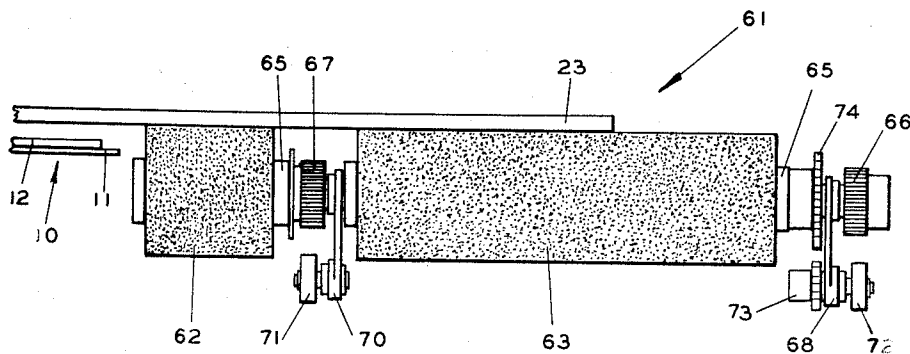


FIG. 5



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4 Sheets-Sheet 4

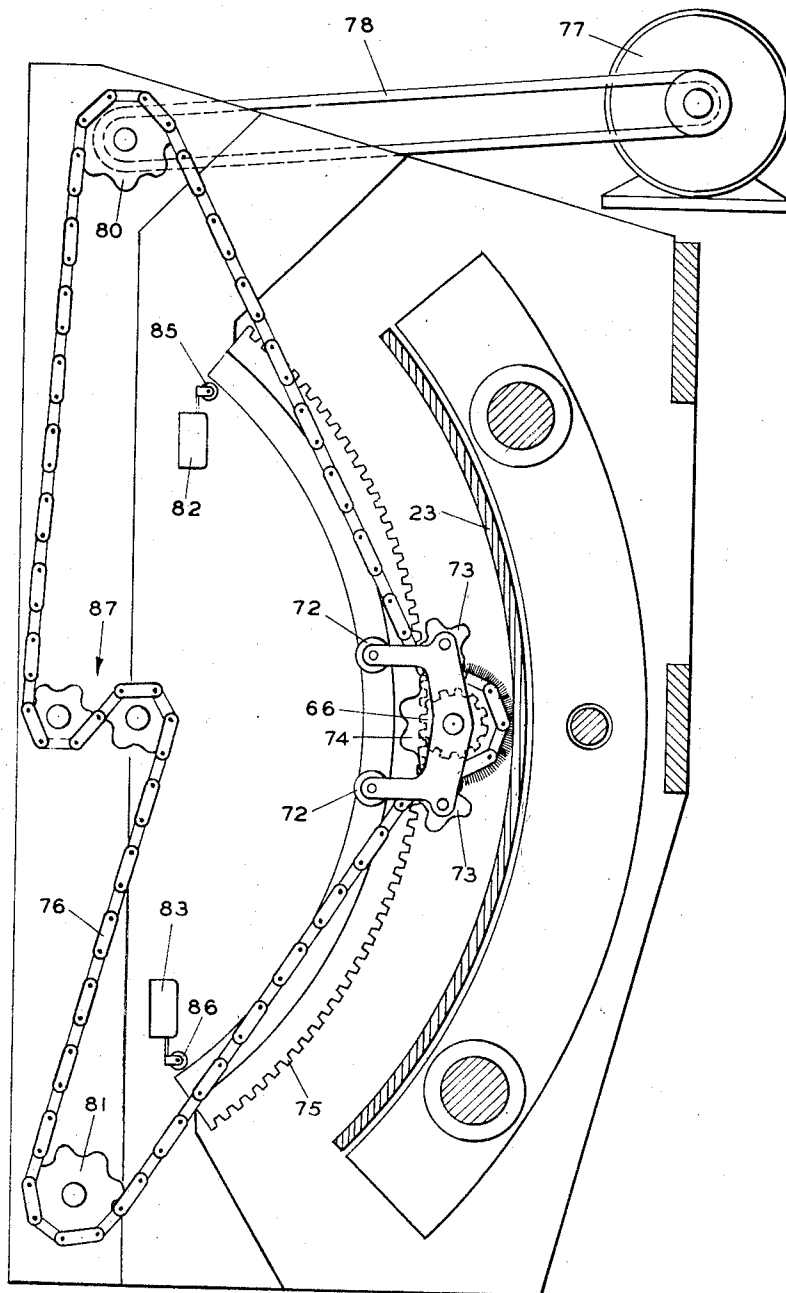


FIG. 6

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XEROGRAPHIC DEVELOPMENT APPARATUS

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Application September 16, 1954, Serial No. 456,538

6 Claims. (Cl. 118—637)

This invention relates to xerography and more particularly to an electrode used in the development process.

In the art of xerography images are formed on xerographic plates. The plates are composed of photoconductive insulating material overlying a conductive backing member. Plates are sensitized by placing a uniform electrostatic charge on the photoconductive insulating layer while the plate is kept in darkness, and a latent image is formed on the surface of the insulating layer by exposing this layer, while sensitive, to a light pattern. Areas of this layer struck by light become conductive and dissipate the electrostatic charges on the surface by allowing them to flow to the conductive backing member. Areas of the sensitive photoconductive insulator not exposed to light continue to act as insulators and retain the electrostatic charge on the surface.

The latent image which is formed on the surface of the photoconductive insulator is composed of electrostatic charges in image formation. This electrostatic image pattern may be developed by bringing particles which are charged opposite in sign to the electric charge of the pattern itself into contact with the surface carrying the charge pattern or the pattern may be otherwise utilized. A developed image on the surface of a plate may be transferred to sheets or webs through the use of electrostatics or other methods known to the art and may be there permanently affixed or, it may be allowed to remain on the plate for viewing and the like.

Xerography, as described above, may be adapted for automatic type operation. For example, the xerographic plate may be made to automatically progress through the different stages of operation necessary to produce the developed image which may then be automatically transferred or otherwise utilized. This form of automatic operation may also be adapted for continuous automatic operation by repeating the xerographic image producing cycle automatically.

A problem which has been encountered in automatic continuously operating machines involves an electrode used during the development stage. This electrode, which will be referred to in this application as the "development electrode," is positioned parallel to the photoconductive insulating layer during development.

Basic to the use of the development electrode is the desire to reproduce copies of the original image of high quality and without distortion. Electrostatic lines of force exist between the electrostatic charges on the photoconductive insulating layer and areas of different charge potential. When large areas carrying electrostatic charges exist the lines of force which are present due to charges in the central area of the large area tend to run inward through the photoconductive insulating layer to the conductive backing member which is the nearest surface carrying a different potential. Lines of force running from electrostatic charges near the external boundaries of this large area will tend to extend outward and around the outside border of the large area at which point their paths will extend inward through the photoconduc-

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tive insulating layer to the conductive backing member. Development of such an electrostatic latent image creates deposition which relates to the paths taken by the electrostatic lines of force or development of the electrostatic fields. Therefore, development of a large area as has just been described will reproduce copies with hollow centers and emphasized edges. To prevent such development a surface is positioned at a slight distance from the photoconductive insulating layer during development. This surface, the development electrode, is composed of a conductive material and is usually either biased slightly or maintained at about the same potential as the plate backing member. Such an equipotential surface will cause an increase in the lines of force extending outwardly from the plate member creating electrostatic fields which when developed will produce distortion free and fringe free high quality copy.

It is an object of this invention to improve the art of xerography by providing new means, methods and apparatus which relate to the development electrode.

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, at a distance which is within the field of influence of the electrostatic charges on the layer surface, tends to build up on its surface a coating of developer material. While this coating remains thin the image which is developed is generally not affected. However, a coating of developer material on the development electrode interposes a new surface between the sensitive layer and the development electrode and if the particles carry electrostatic charge, this coating may effectively change the bias potential on the electrode which substantially decreases beneficial aspects of the development electrode during development of the electrostatic image and this coating also adds new uncontrollable problems. The lack of control which follows heavy deposition is to some extent also attributed to the fact that the coating which forms is generally uneven and follows unknown and different patterns. A heavy coating may drop agglomerates of developer powder to the plate surface resulting in a nonuniform distorted development of the electric image pattern. Also, such a coating may cause irregular and uncontrolled flow patterns of the developer material being presented to the plate surface which will cause streaking of the developed image.

It is, therefore, an object of this invention to provide means, methods and apparatus to control the amount of material allowed to remain deposited on the development electrode.

In continuously operating automatic machines development is constantly taking place in that a new portion of a latent image is continuously being presented to the development zone for development purposes. Therefore, it becomes necessary to present to the development zone a development electrode with a minimum coating of developer particles to facilitate high quality true reproductions in a continuously operating automatic machine.

It is, therefore, another object of this invention to provide means and methods to control and limit the amount of material allowed to deposit and remain on effective areas of the development electrode used in a machine adapted for continuous operation.

It is another object of this invention to provide apparatus to control and limit the amount of material allowed to deposit on effective areas of the development electrode used in a machine adapted for continuous operation.

Briefly, this invention embodies a development electrode of slightly more than twice the width of the xero-

graphic plate which constantly moves back and forth across the width of the xerographic plate. The path of travel of the development electrode extends just slightly more than half of the electrode outward from one edge of the photoconductive insulating layer and then from the other edge. Brushes extending outward from the sensitive layer constantly move up and down along the length of the development electrode not directly above the sensitive layer or areas extending outward from the edge of this layer thereby brushing clean areas of the development electrode.

It is another object of this invention to provide apparatus to clean all areas of a development electrode used in a machine adapted for continuous operation during each successive cycle of movement of the development electrode.

It is yet another object of this invention to provide means and methods to clean all areas of a development electrode used in a machine adapted for continuous operation during each successive cycle of movement of the development electrode.

In machines adapted for continuous operation wherein the xerographic plate is in the shape of a cylindrical drum, a development electrode of the same shape as the portion of the drum it is positioned over would be required. This form or shape of a development electrode is required to provide equal spacing of the electrode from the photoconductive insulating layer. Cleaning means, as for example, brushes which sweep the deposited developer from the development electrode must follow the circumference of the development electrode in order to properly clean and condition the electrode for development purposes.

It is an additional object of this invention to provide apparatus for cleaning an internally cylindrically shaped development electrode.

It is yet a further object of this invention to provide means and methods for cleaning a shaped development electrode.

Other objects and advantages of this invention will be apparent in view of the following description considered in the light of the attached drawings wherein,

Figure 1 illustrates one embodiment of an automatic electrophotographic device adapted for continuous operation;

Figure 2 is a side view of one embodiment of the development section of the apparatus shown in Figure 1;

Figure 3 is a front view of one embodiment of the development electrode and its driving mechanism;

Figure 4 is a side view of one embodiment of the means provided to position and guide the development electrode through its cycles;

Figure 5 is a top view of one embodiment of the development electrode cleaning means; and

Figure 6 illustrates one embodiment of the driving mechanism for the cleaning means.

Referring more specifically to the drawings, in Figure 1 an embodiment of a continuously operating xerographic apparatus is shown. The xerographic plate is in this instance formed in the shape of a rotating drum generally designated 10 and is composed of conductive backing member 11 and photoconductive insulating layer 12. Conductive backing member 11 is, as indicated, held at a ground potential. A uniform electrostatic charge is placed on layer 12 by corona discharge electrode 13 which is supplied from high voltage source 15 at the area generally designated 25. An image 16 on a surface moving at a proper linear speed is illuminated by lamps 17 and is projected from between slit 19 through lens 18 at exposure station generally designated 20 whereat the electrostatic latent image is formed on sensitive layer 12. At position 21 development of the electrostatic latent image takes place. Developer cloud supply 22 supplies a cloud of developer particles in air to the area between layer 12 and development electrode 23 where development of the

electrostatic latent image on layer 12 takes place. At the area generally designated 26 transfer of the developed image from layer 12 takes place. Roll 27 supplies a continuously fed web 28 under roller 30 and into contact with layer 12 whereat adhesive form of transfer occurs by using a web 28 having an adhesive coating on one surface thereof and applying proper pressure with roller 30. It is to be understood, of course, that other types of transfer may be used, such as corona transfer, and this invention is intended to include the other forms of transfer within its scope. The web, optionally, is next fed, carrying the transferred image, through fusing apparatus 35 wherein the copy is made permanent and is then fed onto roll 36. The movement of web 28 is synchronized with the turning of drum 10, which in this embodiment is rotated in a clockwise direction. The drum 10 and the web 28 may be driven by a motor (not shown) or by other conventional means.

Although not shown in Figure 1, a cleaning device may optionally be positioned along the path of rotation of xerographic plate next following the transfer area to clean the plate surface prior to charging or sensitizing. The cleaning mechanism may be a rotating brush or the like operating to remove any particles remaining on the plate surface after transfer.

In Figure 2 a more detailed drawing of development stage 21 is shown. As in Figure 1 the drum is generally designated as 10, the development electrode as 23, and the developer cloud supply as 22. As appears more clearly in this figure, developer cloud supply 22 feeds developer through turbulence tubes 37 to manifold block 38 wherein additional air supplied by air supply 24 is mixed with the mixture of powder and air fed through tubes 37, the additional air carried by tubes 40 and 41 being mixed as indicated in the drawing. Although not clearly shown in this figure, tubes 37 extend across the width of photoconductive insulator 12 (see Figure 3). The developer cloud is emitted from manifold block 38 through development slot 42.

In Figure 3 a detailed front view of development electrode 23 as it relates to its supports, controls, and the drum 10 is shown. Manifold block 38 is permanently mounted over photoconductive insulator 12 so that developer fed through tubes 37 and mixed with air fed through tubes 40 and 41 will issue forth from development slot 42 (not shown in this figure) directly over the electrostatic latent image on the surface of layer 12. A slot 43 is provided in development electrode 23 to allow lateral movement of electrode 23 while manifold block 38 remains stationary and above sensitive layer 12. Shafts 45 ride through guide members 46 and 49 and act to support development electrode 23 at its proper distance and position during the course of movement of electrode 23 through its cycles. Shafts 45 are permanently affixed to the framework of an automatic machine such as is shown in Figure 1. Screw 47 is supported by support bar 53 and the framework of the equipment (not shown) and is driven by motor 50 through belt 48. A sleeve 52 is permanently affixed to guide member 46 and a hole is provided in guide member 46 to allow movement of screw 47 through sleeve 52 and guide member 46 while motor 50 is operating. A pin 51 extends from sleeve 52 into grooves provided in screw 47 and causes lateral movement of development electrode 23 back and forth above drum 10. The rotation of screw 47 with pin 51 fitted within its grooves causes movement of guide member 46 and so movement of development electrode 23 which is attached to guide member 46 until pin 51 reaches one end of screw 47. At an end pin 51 following grooves cut in screw 47 follows a new path reversing the direction of movement of sleeve 52 thereby causing the direction of movement of development electrode 23 to reverse. This new direction is followed until the other end of screw 47 is reached at which point the direction of travel is again reversed. In operation then, while screw 47 rotates

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in one direction and does not otherwise move, development electrode 23 is constantly driven back and forth due to the action of pin 51 in the grooves of rotating screw 47 over drum 10 while guided and positioned by shafts 45. It is to be understood, of course, that mechanical systems other than the one shown will accomplish the same results and are, therefore, intended to be included within the scope of this invention.

Figure 4 is a detailed side view showing the relation of development electrode 23 to guide member 46. As previously indicated, shafts 45 pass through guide member 46 and as is clear in this figure shafts 45 move through ball bearings formed for linear travel or ball bushings 55, and opening 56 is provided in guide member 46 to allow screw 47 to move back and forth through guide member 46. As previously indicated, shafts 45 are permanently affixed to the framework of the equipment and because of the permanent position of ball bushings 55 it may be said that guide member 46 is moved through a fixed area. Development electrode 23 is connected to guide member 46 by the three screw assemblies 57, 58 and 60 which allow for adjustment of the spacing of development electrode 23 as it relates to guide member 46. Adjusting spacing between the guide members 46 and development electrode 23 also adjusts spacing between layer 12 and development electrode 23 in that drum 10 is, as are shafts 45, permanently affixed to the framework. Assembly 58 is formed as a part of development electrode 23 and allows movement along the screw length of the assembly. Assemblies 57 and 60 also allow adjustment along the screw length, but in addition allow for the new angles which will be created by connecting the screws of these assemblies to development electrode 23 so that they may pivot slightly in either direction as adjustment takes place.

It is noted that a detailed view of guide member 49 would appear the same as guide member 46 in Figure 4 except that opening 56 would not be present. As indicated in Figure 3, screw 47 does not extend to or through guide member 49. It is further pointed out that other mechanism able to accomplish what is accomplished by the mechanism of this figure is intended to be encompassed by this invention.

In Figure 5 a top view of cleaning means generally designated 61 as it is positioned in relation to development electrode 23 and drum 10 composed of photoconductive insulating layer 12 and conductive backing member 11 is shown. As is clear in this figure, cleaning means 61 projects to conductive backing member 11 of drum 10 but is spaced apart therefrom. Cleaning means 61 in this embodiment is composed of brushes 62 and 63 extending outward from axle 65 and positioned to contact all areas of development electrodes 23 which move into position above them. Also extending outward from axle 65 are pinions 66 and 67 and extension arms 68 and 70. Extension arm 70 is fitted at its end with guide wheels 71 which act to position in place pinion 67 along the rack in which its teeth ride. The combination of pinion 67 and guide wheels 71 connected through extension arm 70 and axle 65 also acts to support cleaning means 61 in its proper plane during the cleaning cycles. Similar provisions are made for pinion 66 through extension arm 68 and guide wheel 72 and this group also supports and aid in positioning cleaning means 61. Extension arm 68 is also fitted with a freely rotating set of sprocket wheels 73 and these act to properly position a chain which rides over sprocket 74 and which drives cleaning means 61 along racks provided as will be discussed more fully below.

In Figure 6 is shown a detailed view of the mechanism for driving cleaning means 61 shown in Figure 5. This mechanism acts to drive cleaning means 61 (not shown) through pinion 66 which is positioned at the outer edge of cleaning means 61 as is shown in Figure 5. As was previously indicated in the discussion relating to Figure

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5, and as appears more clearly in Figure 6, pinion 66 moves along rack 75 and is held in place on rack 75 by guide wheels 72. Also, as has been previously indicated and as appears more clearly in this figure, freely rotating sprocket wheels 73 act to position and hold in place chain 76 which passes around sprocket wheels 73 and over sprocket 74 to drive pinion 66 along rack 75. A reversible motor 77 drives the assembly through belt 78 connected to sprocket wheel 80. Sprocket wheel 80 also acts to supply a path for drive chain 76 at a point beyond rack 75. This latter function of sprocket wheel 80 is the only function of sprocket wheel 81, a freely rotating wheel positioned at a point beyond the opposite end of rack 75. Switches or microswitches 82 and 83, near each end of rack 75 and within the path of movement of guide wheels 72, are connected to reversible motor 77 through a box including timers and relays to bring motor 77 to a stop before it is rotated in the opposite direction. When a microswitch 82 or 83 is operated by a guide wheel 72 striking switch element 85 or 86 the direction of motor 77 is reversed. When motor 77 is reversed belt 78 drives sprocket wheel 80 in the opposite direction causing chain 76 to reverse the path of movement of pinion 66 along rack 75. Since rack 75 is shaped to provide a path for pinion 66 which will cause brushes 62 and 63 to ride against the surface of development electrode 23 movement up and down of pinion 66 along rack 75 causes brushes 62 and 63 to sweep the inner circumference of development electrode 23.

Although slack is to some extent desirable in mechanism driven by a chain, in the mechanism shown in Figure 6 the amount of slack in chain 76 will vary due to the different position along a curved surface of pinion 66. Assembly 87 comprising two freely rotating sprocket wheels are mounted on a shaft centered between them. This assembly is free to rotate about this shaft and a torsion spring is provided to rotate the assembly to take up slack in drive chain 76 thereby insuring the proper amount of slack in chain 76 at all times during a cycle of movement of pinion 66.

To further clarify the action of pinion 67 shown in Figure 5, it is noted that it moves along a rack exactly like rack 75 which is connected as is rack 75 to the framework of the equipment. Guide wheels 71 shown in Figure 5 act to position and hold in place pinion 67 along its rack as guide wheels 72 act to position and hold in place pinion 66 along rack 75 shown in Figure 6. The combined action of the two separated racks operating on pinions 66 and 67 hold cleaning means 61 in a position which is perpendicular to the outer edge of drum 10 during its up and down rotating movement against development electrode 23.

Pinions 66, 67 and sprocket 74 are permanently affixed to axle 65. As cleaning means 61 is made to move due to the action of chain 76 on sprocket 74 cleaning means 61 is both rotated and moved either up or down along the racks provided for pinions 66 and 67 to ride in. The combined movement, that is the rotation of the brushes 62 and 63 and the displacement up and down, while brushes 62 and 63 are in position to contact areas of development electrode 23 cleans the surface of development electrode 23.

The cleaning mechanism which has been described and illustrated in connection with Figures 5 and 6 is duplicated on both sides of drum 10 with brush 63 at the outer extremity in both instances and the cycle of movement of development electrode 23 includes extending outward to the outer edge of brush 63 on each side. The mechanism shown and described is for illustrative purposes and mechanism generally able to guide and clean as does the mechanism of this embodiment is intended to be encompassed by this invention.

Although the apparatus has thus far been described in terms of a number of components it is to be understood

that these components acting together form an integrated mechanism. This point will appear more clearly as the overall operation is further examined.

In automatic machines adapted for continuous operation and especially such machines adapted for continuous tone reproduction, it is desirable to space the development electrode at a very slight distance as for example from .1 to .001 inch, from the photoconductive insulating layer. Development electrodes 23 of this embodiment of the invention is spaced to be adjusted by screw assemblies 57, 58 and 60 within this range. The development electrode itself should be composed of any dimensionally stable conductive material as for example steel, brass, aluminum and the like, and should be polished so as to present a smooth, even, equidistant surface to the photoconductive insulating layer which in this embodiment is layer 12.

Development electrode 23 is formed having a width slightly more than twice the width of drum 10. For example, if a drum 6 inches in width is being used, it would be desirable to use a development electrode with a width of approximately 14 inches. During development of the electrostatic latent image, some portion of the development electrode always appears above the photoconductive insulating layer being developed. The action of cleaning means 61 while an image is being developed is to clean those areas of development electrode 23 extending outwardly from either or both sides of drum 10. Cleaning of the outer extremities of development electrode 23 is assured in that cleaning means 61 will go through a number of cycles during the time an edge takes to extend outward from drum 10 to its furthest extended position and to return to above drum 10 again. To insure cleaning of all areas of development electrode 23 at least once during its cycle of movement it is desirable to allow more than half of development electrode 23 to extend outward on each side of drum 10 during a cycle of movement. In so doing cleaning of the center area as well as all other areas of development electrode 23 is assured since the central zone is extended into the cleaning area twice during the cycle of movement of electrode 23 and also because the area of the central zone which is extended the smallest distance on one side of drum 10 is extended the greatest distance on the other side. Further provisions may be made to insure cleaning of this central zone as for example providing that cleaning means 61 move through a cycle in less time than it takes for the development electrode to move that distance which makes up the central zone which is extended on both sides for cleaning purposes.

The time it takes for the movement of cleaning means 61 through its cycle is controlled by motor 77 and the distance cleaning means 61 must travel. In the embodiment shown a cycle of approximately 24 seconds in duration has been used to clean an electrode 23 of 13 inches along its inner circumference. The preferred cycle relates to the width and cycle time of development electrode 23 which in this embodiment is 14 inches and less than 2 minutes. In this embodiment cleaning of the central area at least once during each cycle of movement of development electrode 23 is assured.

The height of the development electrode should be such that loss of development cloud through the top and through the bottom is effectively prevented and the development slot 42 should be positioned as near to the center as is possible. As appears in Figure 3 development slot 42 does not extend across the entire width of development electrode 23 and this is a limitation of movement of electrode 23. While the equipment is in operation it is necessary to supply developer cloud through development slot 42 above all areas of the photoconductive insulating layer 12 and therefore a surface such as development electrode 23 cannot be interposed between slot

42 and layer 12. In operation then, when one end of development slot 42 reaches manifold block 38, the direction of movement of development electrode 23 is reversed. In order to keep the overall width of development electrode 23 to a minimum it is desirable to form development slot 42 with a maximum of coverage across the width of electrode 23. It is to be understood, of course, that an electrode may be formed of two members separated by a development slot and mounted on suitable supports, and this invention is intended to include such an electrode within its scope.

Cleaning means 61 shown in Figure 5 is composed of brushes 62 and 63 separated by pinion 67 and extension arm 70 mounted on a portion of axle 65. It is noted that whereas brushes 62 and 63 and pinions 67 and 66 are permanently affixed to axle 65, extension arms 68 and 70 are allowed to rotate freely. As has been previously indicated, pinions 66 and 67, pinion 66 at an extremity of cleaning means 61 and the other being separated from pinion 66 and near the other extremity, are affixed to axle 65 to drive cleaning means 61 along its path of movement while rotating and while held in its proper position in respect to drum 10 and development electrode 23. Means have not been devised to date to clean a development electrode spaced within the preferred distances from a conductive insulating layer 12 which extend and effectively clean within this narrow area. It has, therefore, become necessary to clean as shown in this embodiment in an area extending outward from drum 10. Complying with the desire to keep the electrode to a minimum width, brush 62 has been provided to clean development electrode 23 as close to drum 10 as is reasonably feasible. A preferred spacing between brush 62 and drum 10 of from $\frac{1}{16}$ to $\frac{1}{4}$ of an inch exists in this embodiment. A minimum of spacing has been found necessary in order to insure proper insulation between drum 10 and its components, the brush and development electrode 23.

A variety of materials have been found to work well as material for brushes 62 and 63, as for example, synthetic fiber material such as nylon, cellulose derivatives and the like and natural fibers such as cotton, wool, hair, furs and the like. Brushes composed of nylon fibers have been found to work particularly well with steel electrodes. The fibers should be dense enough to clean effectively, yet not too dense so as to clog with developer particles, and they should be fine enough to clean effectively and not too fine so that matting is avoided, yet thick enough to be durable and not too thick so that sufficient flexibility of the fibers is present and so that abrasion of the development electrode surface is avoided. Contact of the bristles with the surface of development electrode 23 should be a sweeping brushing form of contact, one which is effective in removing deposited particles and yet contact which does not act to brake the movement of the development electrode.

Although this invention has been described in terms of cleaning means 61 composed of brushes 62 and 63, it is not intended in any way to limit this invention to the particular embodiment shown, but it is intended to encompass within the scope of this invention all forms of cleaning means which can effectively accomplish the cleaning of all areas of development electrode 23 during its movement through a cycle. For example, cleaning means comprising bristles mounted and shaped like those of a broom extending across the entire extended area of a development electrode when fully extended, and connected to a rocker arm which is driven to cause the bristles to move back and forth across the height of the development electrode and which is adjusted to effectively clean the development electrode during the sweeping cycle will accomplish what cleaning means 61 accomplishes and is, therefore, intended to be included within the scope of this invention.

Experimentation has shown that cleaning of all areas

of development electrode 23 should take place at least once every four minutes when continuous development is carried on and preferably more often. Although a coating of developer particles is formed within these time intervals this coating has not been found to detrimentally affect the image developed on layer 12. Regulation of the cycle of movement of development electrode 23 is accomplished by controlling the speed of motor 48 which drives screw 47, the length of screw 47, the pitch of the grooves of screw 47, and the like. In the apparatus shown in the drawings a cycle of time of less than two minutes has been used. This further insures a clean development electrode 23 in that the cycle is repeated twice during the period in which one cycle should be completed.

The cleaning process and apparatus while in operation fills the surrounding area with developer particles removed from the surface of the development electrode. To protect other mechanism which may be a part of the xerographic apparatus shown in Figure 1 or other mechanism in the area and to protect an operator who might be near the equipment, it is desirable to enclose the cleaning apparatus. The enclosed area preferably is also subjected to a slight negative pressure due to the action of a vacuum creating system which acts to draw out of the enclosed area particles not deposited on the plate and particles which have been removed from the surface of the development electrode. It is also felt that this vacuum system aids in keeping the brushes of cleaning means 61 free of removed particles.

Although this invention is applicable to all fields of xerography, it is especially valuable in connection with continuous tone reproductions where its present need is greatest. A development electrode within the spacing requirements discussed in this invention may be used in most applications of the art of xerography. It is presently felt that critical narrow spaces as disclosed herein are required for continuous tone work. Since the cleaning mechanism of this invention is intended to effectively clean the closely spaced electrode, it naturally finds its real value in that application of xerography having the greatest need for such spacing.

The close spacing between development electrode 23 and layer 12 acts to bring developer cloud in a highly dense state close to the plate surface. Since the electrostatic field which causes developer particles to deposit on the plate surface is related to the spacing between the development electrode and the plate, intense fields are created using spacing as described in this invention. The combination of the dense cloud and the intense fields results in high quality distortion-free quickly developed reproductions.

While this invention has been described in terms of a specific embodiment, in terms of an embodiment including a rotating drum as the xerographic plate member, it is to be understood that it is intended to include within the scope of this invention xerographic plates having other forms such as flat xerographic plates and the like. It is also intended to include within the scope of this invention other forms of drive means for development electrode 23, other shapes of development electrodes, means other than as shown for driving cleaning means 61, cleaning means other than cleaning means 61, and the like, which are able to accomplish the ends achieved by the particular elements shown in connection with the embodiment that has been described.

It is intended to cover the invention described herein as broadly as the art will permit, within the spirit and scope of the appended claims.

What is claimed is:

1. In a xerographic apparatus of the type in which a xerographic plate of predetermined width moves in a path through a developing stage where an electrostatic latent image formed on the xerographic plate is developed by a developing material; a development electrode

system for said developing stage including a development electrode having a length equal to at least twice the width of said xerographic plate, mounting means connected to said development electrode to position said development electrode in closely spaced relationship to said xerographic plate, said mounting means permitting movement of said development electrode normal to the path of movement of said xerographic plate, electrode moving means connected to said development electrode for moving said development electrode to a first position in which at least a first half of said development electrode is in a non-operative relationship to said xerographic plate and a second position where a second half of said development electrode is in a non-operative relationship to said xerographic plate, and electrode cleaning means operatively connected to said development electrode for cleaning excess developing material from said first half of said development electrode when it is in said first position and for cleaning excess developing material from said second half of said development electrode when it is in said second position.

2. In a xerographic apparatus, the combination comprising a xerographic plate, a development electrode means at least equal to the width of said xerographic plate, mounting means connected to said development electrode means to position said electrode means in closely spaced operative relationship to said xerographic plate, said mounting means including means to permit movement of said electrode means relative to said plate, developing means operatively connected to said development electrode for supplying a developing material to said xerographic plate, driving means connected to said development electrode means for selectively positioning at least a portion of said development electrode means into or out of operative relationship with said xerographic plate, and cleaning means operably connected to said development electrode means for removing deposited developing material from the portion of said development electrode means not in operative relationship with said xerographic plate.

3. In a xerographic apparatus including a xerographic plate mounted for movement through a plurality of processing stations, a development electrode at least equal to the width of said xerographic plate, mounting means connected to said development electrode to position said development electrode in closely spaced operative relationship to said xerographic plate, the improvement including means forming part of said mounting means for permitting movement of said development electrode relative to said xerographic plate, driving means connected to said development electrode for moving said development electrode relative to said plate, whereby at least a portion of said development electrode is moved out of operative relation with said plate, means connected to said development electrode for supplying developing material to said xerographic plate, and cleaning means operatively connected to said development electrode for cleaning excess developing material from the portion of said development electrode that is moved out of operative relation with the plate.

4. In a xerographic apparatus having a xerographic plate mounted for movement through a developing stage where an electrostatic latent image formed on the xerographic plate is developed by a developing material, a development electrode having a width at least equal to that of the xerographic plate, mounting means connected to said development electrode to position said development electrode in closely spaced operative relationship to said xerographic plate, the improvement comprising means forming part of said mounting means for permitting movement of said development electrode relative to said plate, driving means connected to said development electrode for moving said development electrode relative to said xerographic plate, whereby at least a portion of said development electrode is moved out of

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operative relation with said plate, and brush cleaning means operatively connected to said development electrode for cleaning excess developing material from the portion of said development electrode that is moved out of operative relation with the plate.

5. In a xerographic apparatus of the type in which a cylindrical xerographic plate of predetermined width moves in a path through a developing stage where an electrostatic latent image formed on the xerographic plate is developed by a developing material, a substantially rigid electrically conductive development electrode in the form of an arcuate plate positioned concentrically with said xerographic plate, and mounting means connected to said development electrode to position said development electrode in closely spaced concentric relationship to said xerographic plate, the improvement including connections in said mounting means for permitting movement of said development electrode normal to the path of movement of said plate, said development electrode having a width at least twice the width of said xerographic plate, electrode moving means connected to said development electrode to oscillate said development electrode across the width of said xerographic plate, and electrode cleaning means positioned adjacent said xerographic plate to contact said development electrode when oscillated by said electrode moving means to clean deposited developing material from said development electrode.

6. In a xerographic apparatus of the type in which a cylindrical xerographic plate of predetermined width moves in a path through a developing stage where an electrostatic latent image formed on the xerographic plate is developed by a developing material, an electrically conductive development electrode cooperating with said xerographic plate, and mounting means connected

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to said development electrode to position said development electrode in closely spaced concentric relationship to said xerographic plate, the improvement including connections in said mounting means for permitting movement of said development electrode normal to the path of movement of said plate, said development electrode having a width at least equal to the width of said xerographic plate, electrode moving means connected to said development electrode to oscillate said development electrode across said xerographic plate, whereby at least a portion of said development electrode is moved out of operative relation with the plate, and brush means positioned adjacent said xerographic plate to contact the portion of the development electrode that is moved out of operative relation with the plate when oscillated by said electrode moving means, whereby to clean deposited developing material from said development electrode.

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