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XEROGRAPHIC APPARATUS

Filed May 1, 1958 | 2 Sheets-Sheet 1

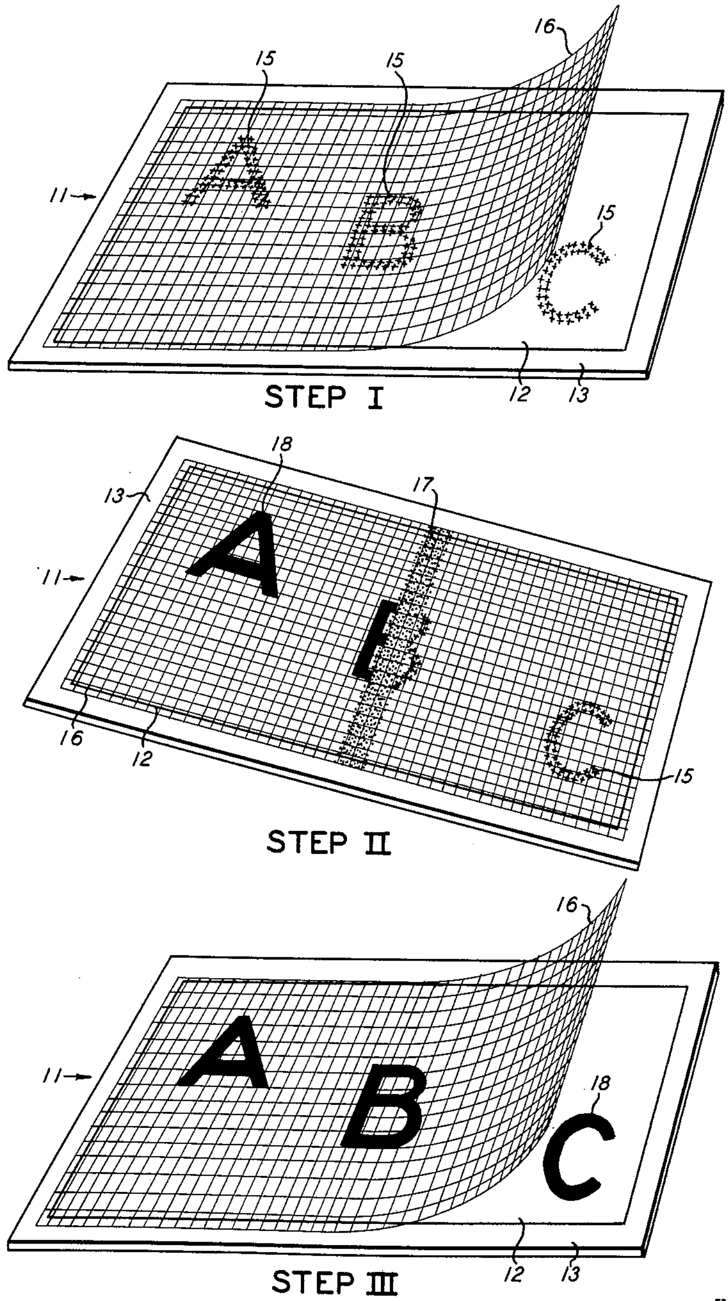

FIG. 1

INVENTOR.
Robert W. Gundlach

BY Stanley Z. Cole

ATTORNEY

Dec. 5, 1961

R. W. GUNDLACH

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2 Sheets-Sheet 2

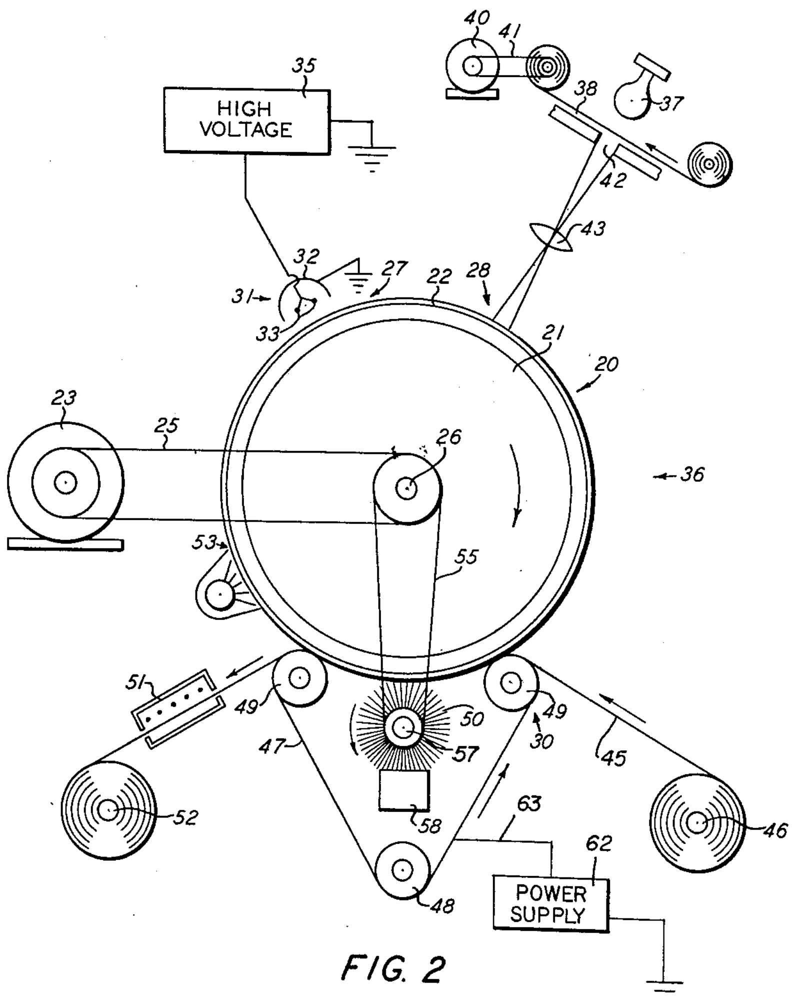

FIG. 2

INVENTOR.
Robert W. Gundlach

BY Stanley Z. Cole

ATTORNEY

3,011,473

XEROGRAPHIC APPARATUS

Robert W. Gundlach, Spencerport, N.Y., assignor to Xerox Corporation, a corporation of New York

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This invention relates in general to xerography and in particular to development of elastrostatic latent images.

In the art of xerography, as is disclosed in Walkup U.S. Patent 2,784,109, in order to attain high quality development a development electrode is employed. The development electrode typically is positioned facing the surface to be developed and directs the lines of force due to the charges on the image surface outward to the electrode in patterns which accurately reflect the charge patterns. Without a development electrode these lines of force tend to go inward into the surface, and the lines of electric force are not as accurate a representation of the image as is possible with a development electrode. Since development in xerography is in accordance with lines of force there follows, when a development electrode is employed, particle deposition on the image surface in a manner which is true to the charge pattern.

With known electrodes it is necessary to space the electrode accurately from the surface to be developed in order to insure reproducible quality and this spacing requirement has necessitated a high level of machining accuracy in such elements as the development electrode surface and spacers to maintain the development electrode at particular distances from the surface to be developed, and the like. Also when development electrodes are employed in automatic and continuous machines, since particles also deposit on the surface of the development electrode it is necessary to clean the electrode to maintain a uniform effect from development to development and this has necessitated intricate mechanism for cleaning during continuous operation of the apparatus.

Development electrodes also place limitations on the particular developing system which can be employed. Thus, and for example, in developing flat plates using cascade development it has been found possible to use development electrodes but at the same time it has been found necessary to space the development electrode at a greater distance than is desired in order to accommodate the cascading particles between the electrode and the surface to be developed. In automatic machines using cascade development and going at a rather rapid pace it has been found that the development electrode in order to accommodate the cascading and rapidly moving particles must be spaced so far from the surface that it adds little to the image quality and typically either other developing techniques must be employed or the electrode is omitted thus detrimentally affecting image quality.

Also in the art of xerography there are various systems for employing webs or the like on which image development takes place directly. Thus, and for example, there is now known a xerographic paper sensitive member and this member when in web form may be tautly positioned about a support base and a development electrode may be maintained at a proper spacing from the surface to be developed. If, however, there are buckles or ripples in the sensitive member, image distortions result during development. Further, attempts to use cut sheets instead of continuous webs have increased the difficulties in using a development electrode during image development. Typically there is no convenient way of assuring that accurate space between the sheet and the electrode surface is maintained during development. Similarly systems, as for example, as is disclosed in Carlson U.S. Patent 2,297,691, FIG. 9, employ single sheets if desired for image development. Real difficulties, however, exist if attempts

are made to develop such sheets positioned on real images and spaced from a development electrode during image development.

Now in accordance with the present invention, the problems of the prior techniques employing a development electrode during development are overcome. In accordance with this invention quality image development is maintained with greatly simplified apparatus. Further, in accordance with this invention high quality images are produced and great flexibility exists as to the particular particle developing system one can employ. Still further in accordance with the present invention there is disclosed new apparatus and method manipulations for quality image development of either sheets or webs carrying either a real image or the effects of a real image which improve on the art of xerography.

It is accordingly an object of this invention to devise new methods of particle image development in the art of xerography.

It is a further object of this invention to devise new and improved apparatus for use in image development in the art of xerography.

Additional objectives of the present invention will be more readily apparent in view of the following disclosure and description, especially when read in conjunction with the accompanying drawings.

In the drawings:

FIGURE 1 illustrates, through flow steps, an embodiment of the manipulations of the instant invention; and,

FIGURE 2 is a diagrammatic illustration of an embodiment of apparatus according to this invention.

For a better understanding of this invention, reference is now had to FIGURE 1, Steps 1, 2 and 3. In this figure there is illustrated a xerographic plate generally designated **11** comprising a photoconductive insulating layer **12** overlying a conductive backing member **13**. Photoconductive insulating layer **12** may comprise any of the known materials useful for image formation in xerography such as, for example, vitreous selenium, selenium tellurium mixtures, anthracene, photoconductive materials disbursed in binder films such as zinc oxide in a resin binder and the like and backing member **13** may comprise a conductive layer such as aluminum, brass and the like, or may comprise other support materials now common in xerography such as paper or insulating materials or the like. Plate **11** prior to Step 1 illustrated in FIGURE 1 is carried through the normal image formation steps in xerography as is disclosed, for example, in Carlson 2,297,691 or an image pattern is deposited on the surface through other techniques as, for example, selective charge deposition or the like. Image pattern **15** is in this embodiment illustrated as letters "A," "B" and "C" made up of positive electrostatic charges. It is to be realized, of course, that pattern **15** may comprise negative electrostatic charges and may comprise any form or shape of image desired and that the choice of polarity and image pattern in this figure are for illustrative purposes only.

In Step 1, FIGURE 1 there is being positioned across the surface of plate **11** a foraminous structure **16** which may comprise a conductive metal screen or other conductive material having a regular and frequent pattern of openings therein. Foraminous structures **16** is as illustrated placed in physical contact with the image bearing surface, in this embodiment photoconductive insulating layer **12**, by laying it across the surface.

In practice if a conductive material were placed in electrical contact with all areas of the surface of an image bearing member the image pattern on the surface would discharge through the conductive medium. However, what is considered normal physical contact results in actual physical contact only at a few points across the surfaces. Thus, there exists between foraminous structure

16 and the surface of photoconductive insulating layer 12 minute gaps, generally of air, which separate foraminous structure 16 from plate 11. This air gap layer is not one which is easily displaced or removed and thus its presence can be expected without taking any positive action. The few points of contact between structure 16 and image surface 12 may become discharged. However, contact is generally in terms of point contact rather than broad area contact and these areas of point contact which are discharged do not distort the quality of the developed image produced in accordance with this invention.

In Step 2 of FIGURE 1 there is illustrated image development. In Step 1 screen 16 is being placed across plate 11 and when Step 1 is completed screen 16 is across the surface of photoconductive insulating layer 12. In Step 2 screen 16 remains in position against the image bearing surface of photoconductive insulating layer 12 of plate 11 and there is cascaded across the assembly of screen 16 against plate 11 cascade developer 17. As illustrated in this figure cascade developer 17 is approximately midway in the development process. There thus continues to exist of charge pattern 15 letter "C" whereas letter "A" is now a fully developed image 18 and letter "B" is partially developed.

Referring now to Step 3, screen or foraminous structure 16 is being removed from the surface photoconductive insulating layer 12 overlying conductive backing member 13 of plate 11. Removal of screen 16 from the surface of photoconductive insulating layer 12 leaves behind on the surface of photoconductive insulating layer 12 developed image 18. The step illustrated in Step 3 is optional in carrying out the instant invention. What is of interest is the formation of a quality image pattern in accordance with new and simplified techniques which also result, as will become apparent in FIGURE 2, in new and simplified apparatus. Image development takes place in accordance with Step 2 of FIGURE 1 and if desired developed image 18 can be transferred, for example, from the composite assembly of screen 16 and plate 11 illustrated in Step 2 to paper or the like or it may be examined in place on plate 11 or the like if desired. Preferably, however, foraminous structure 16 is removed from plate 11 before the developed image is utilized as through transfer from or fusing on the surface of plate 11.

Although in describing the steps of FIGURE 1 a plate 11 has been employed it is to be realized that any form of image bearing surface may be used as, for example, an insulator, other than a photoconductive insulator, for example, carrying a charge pattern or a web of insulating material or highly resistant material on which a virtual charge pattern exists. Looking, for example, at FIGURE 9 of Carlson 2,297,691 it is seen that a sheet or web of material is placed on an image bearing surface and powder particles deposit on the web of material in accordance with the image on the image bearing surface. In accordance with the present invention the web on top of the image bearing surface in this Carlson patent may be substituted for plate 11 of FIGURE 1 and the foraminous structure 16 may be placed in physical contact with the web on which development is to take place. This will result in high quality image development employing a development electrode to develop real or virtual electrostatic latent images.

In FIGURE 2 is illustrated an embodiment of apparatus according to this invention. In this embodiment the plate comprises a drum 20 having an inner coating of conductive material 21 and an outer covering layer of photoconductive insulating selenium 22. As illustrated the conductive support layer 21 of drum 20 is maintained at ground potential. A motor 23 drives belt 25 connected to the drum axle 26 causing rotation of drum 20. The drum rotates in the direction indicated and positioned about the circumference of drum 20 is a charge station designated 27, an exposure station generally designated 28 and a development station generally designated 30.

At charge or sensitizing station 27 there is positioned a corona discharge electrode 31 comprising a shield 32 maintained as illustrated at ground potential partially surrounding corona discharge wires 33. Discharge wires 33 are connected as illustrated to high voltage source 35 which supplies upward of 5,000 volts to the discharge wires 33 and a sufficient potential to create corona discharge for plate sensitization as is well known in the art. The plate or drum 20 once it rotates by the sensitizing station 27 is sensitive to light and accordingly the entire device of FIGURE 2 is maintained in light-tight chamber 36. Drum 20 after being sensitized rotates to exposure station 28 whereat light 37 projects light through transparency 38 driven by motor 40 through belt 41 at a speed synchronized to the linear speed of drum 20. The light image is projected through slit 42 and then through lens 43 to the surface of photoconductive insulating layer 22 whereat charge is dissipated in accordance with the light pattern striking the charged and sensitive surface of photoconductive insulating layer 22. Drum 20 next rotates to development zone 30 whereat web 45 supplied from supply roll 46 moves against drum 20 while between development electrode 47 and the photoconductive insulating layer 22. Development electrode 47 comprises a foraminous structure such as a screen or the like and is positioned about positioning rollers 48 and 49. Rollers 49 as illustrated are positioned against drum 20 to maintain development electrode 47 in firm contact with the surface of drum 20 while conforming to the arc of the circumference of drum 20. In this embodiment rollers 49 also act to impart frictional drive to development electrode 47, but as is apparent other means of driving electrode 47 may be employed. Preferably, however, whatever the driving means, electrode 47 should move at the same speed as the surface being developed to avoid smearing of the deposited particles. Roller 48 is for purposes of guiding electrode 47 through its path of movement. Positioned within belt development electrode 47 is developing means which may, for example, comprise brush developing member 50 comprising a cylindrical member having fibrous extensions projecting therefrom loaded with developer powders and developer supply unit 58 to continuously maintain brush developing member 50 in a loaded condition. Brush developing member 50 is, as illustrated, positively driven in this embodiment by belt 55 connected between axle 57 of brush developing member 50 and axle 26 of drum 20. Gears or the like may be built in at either or both axles to bring about proper rotational speeds for quality development. Web 45 moves between development electrode 47 and drum 20 and the image on the surface of photoconductive insulator 22 results in image development on the surface of web 45. Following development web 45 moves through fuser 51, which permanently fixes the particle image on web 45, and then to take-up roll 52. Fuser 51 may comprise any of the known heat or vapor fusers commonly employed in the art.

In operation the plate is sensitized at sensitization station 27 and exposed at exposure station 28 to form on the surface of the plate an image pattern of electrostatic charge conforming to the image pattern of light projected to the drum 20. Drum 20 is then moved to development station 30 whereat particle deposition takes place in accordance with the image pattern of charge. In this embodiment image development, as distinct from the embodiment illustrated in FIGURE 1 in which the charge pattern on the image surface is directly developed through the deposition of particles thereon, takes place on the surface of web 45 which as illustrated is positioned against the image bearing surface 22. The web once developed is permanently fixed by moving it through fuser 51 and then as illustrated, it is fed to take-up spool 52 whereat it is rolled and stored for later utilization. Alternatively it may be cut into proper sheet lengths, as desired, and stacked or immediately fed to areas of utilization. Following separation of web **45** from drum **20**, drum **20** moves into erasure station **53** whereat a light or other activating source exposes the surface of the photoconductive insulating layer **22** thus releasing charge and preparing drum **20** for resensitization and a new cycle.

In the device of FIGURE 2 it is to be realized that development does not take place on the surface of drum **20** and accordingly following removal of the charge pattern at erasure station **53** no further processing of drum **20** is necessary. If, however, the image pattern were developed, as illustrated in FIGURE 1 by depositing particles directly on the surface of drum **20** then a cleaning station should be positioned in the path of movement of drum **20** between erasure station **53** and charging or sensitizing station **27**.

The electrode may be electrically biased, as for example, by power supply **62** and lead **63** if desired. To a large extent the bias applied will depend on the results desired in the copy being produced. Thus, it is possible to obtain image reversal through development by biasing the electrode at a potential equal to and of the same polarity as the highest point of potential of the image pattern being developed. The electrode is maintained at the point of lowest potential and of the same polarity of the image pattern being developed if positive-to-positive reproductions which are substantially background free are desired.

When applying a bias to the electrode in a system in which the plate is conductively backed one must observe caution in not biasing too high in view of the closeness between the electrode and the backing member of the plate and of the potential difference between these members. If too high a potential is applied sparking between the backing member and the electrode can take place, resulting in destruction of the photosensitive member as well as the developed image pattern. Preferably positive-to-positive image development according to this invention is carried out with the development electrode either grounded through contact with the backing member of a backed plate or through a ground bias applied from power supply **62** or at a bias of a few volts and up to about the minimum voltage on the image surface. Preferably the voltage applied is of the same polarity as that of the image pattern. Obviously, also guide roller **48** in FIGURE 2 may, for example, act as the element to supply bias to the conductive electrode **47**.

The developer material may comprise any of the known xerographic developer materials and to a large extent will depend on the particular developing system being employed. Thus, and for example, if a cascade developing system as illustrated in FIGURE 1 is being used, then known cascade developing material should be employed. These will include such materials as those disclosed in Walkup U.S. Patent 2,618,551, Wise U.S. Patent 2,618,552, Walkup and Wise U.S. Patent 2,638,416 and the like. Generally, developing materials available from Haloid Xerox Inc., Rochester, New York, sold under the trademark XeroX Developer and XeroX Toner are of the type described in these patents and may be employed carrying out this invention. If powder cloud developing systems are employed, then normal powder cloud developer materials as, for example, charcoal, treated charcoal, or the like may be used. If a magnetic developing system is employed, then the normal magnetic developer materials such as iron filings mixed with a finely divided pigmented plastic toner or the like may be used. Generally any developing system which employs particle deposition to visualize the image works effectively in accordance with this invention and is intended to be included herein.

The foraminous structure described may comprise any open-worked conductive material including, for example, fine mesh conductive screens generally in the range of from about 120 to 300 mesh, perforated conductive sheets with fine perforations or other similar element such as electrolytically deposited metal sheets containing closely spaced small apertures such as Lektromesh, available

from C. O. Jelliff Manufacturing Corporation, Southport, Connecticut. The choice of mesh size or opening pattern is dependent on such features as avoiding the deposition of lines or the like of the foraminous structure on the surface being developed on the one hand and on the other hand having sufficiently large openings to avoid plugging up of openings and thus image development distortion during the development process.

It is to be realized that the invention has been described in terms of specific embodiments and that there is no intention to be limited thereto. Instead it is intended to cover the invention broadly within the scope of the claims appended hereto and to include within, and scope modifications which will readily occur to those skilled in the art. Thus, and for example, although a continuous web machine is illustrated in FIGURE 2, the machine may be modified to accommodate single sheets fed in sequence controlled by the pattern copy being projected to the drum to result in frame copy in accordance with the projected image. Similarly the apparatus may be modified for full frame exposure and stop-and-go movement. Synchronized with such exposure, a single sheet or the like may be moved into position for full development if, for example, a moving cascade system or powder cloud system is used. Further, the developing brush of FIGURE 2 may be made to move and the plate held stationary and also liquid developing systems which result in solid particle deposition and the like may be employed. Other similar modifications which will readily occur to those skilled in the art are also intended to be encompassed herein.

What is claimed is:

1. Xerographic apparatus comprising, in combination, means to support a photoconductive insulating layer, an image forming station including means to form an electrostatic latent image of varying electric charge on the photoconductive insulating layer, a development station including means to position in intimate physical contact and across the photoconductive insulating layer an electrically conductive substantially uniformly foraminous member and to maintain said foraminous member in a fixed position relative to the photoconductive insulating layer and means to direct developer material through said foraminous member to selectively deposit developer material on said photoconductive insulating layer in accordance with the electrostatic latent image formed at said image forming station, and means to move said support means first through said image forming station and then to said developing station.

2. Apparatus according to claim 1 including means to apply an electrical bias to said foraminous member.

3. Apparatus according to claim 1 including means to apply a bias of substantially ground to said foraminous member.

4. Apparatus according to claim 1 in which said foraminous member comprises a screen in the range of from about 120 to about 300 mesh.

5. Xerographic apparatus comprising, in combination, means to support a photoconductive insulating layer, an image forming station including means to form an electrostatic latent image of varying electric charge on a photoconductive insulating layer on said support, web positioning means to position across and in physical contact with said photoconductive insulating layer an insulating web of material and to maintain said insulating web of material in a fixed position relative to said photoconductive insulating layer, a development station including means to position in intimate physical contact and across said insulating material on said photoconductive insulating layer an electrically conductive substantially uniform foraminous member and to maintain said foraminous member in a fixed position relative to said photoconductive insulating layer and means to direct developer material through said foraminous member to selectively deposit said developer material on said insulating web between said photoconductive insulating layer and said foraminous member in accordance with the electrostatic

latent image formed at said image forming station, and means to move said support means first through said image forming station and then through said development station, said web positioning means being positioned and disposed relative to said development station to position said web of insulating material on said photoconductive insulating layer at least prior to moving said support means to said developing station.

6. Apparatus according to claim 5 including means to apply an electrical bias to said foraminous member.

7. Apparatus according to claim 5 including means to apply a bias of substantially ground potential to said foraminous member.

8. Apparatus according to claim 5 in which said foraminous member comprises a screen in the range of about 120 to about 300 mesh.

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