

Feb. 8, 1966

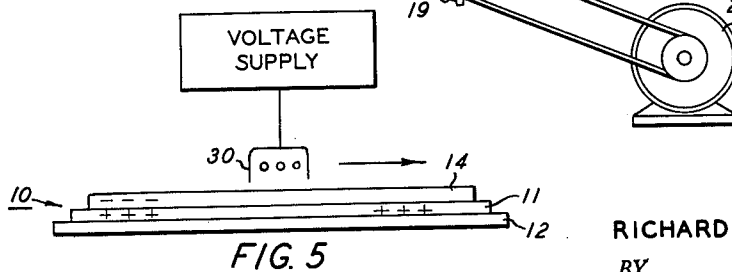
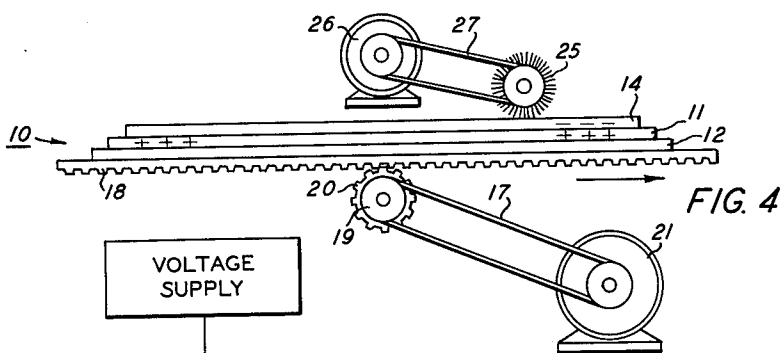
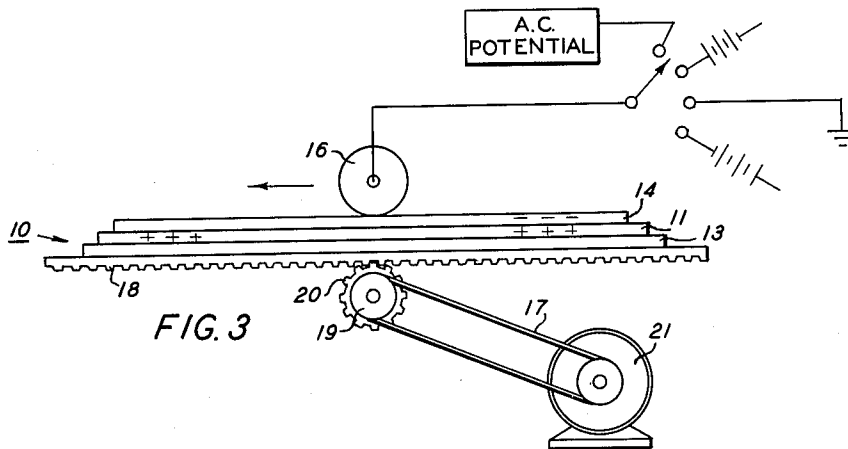
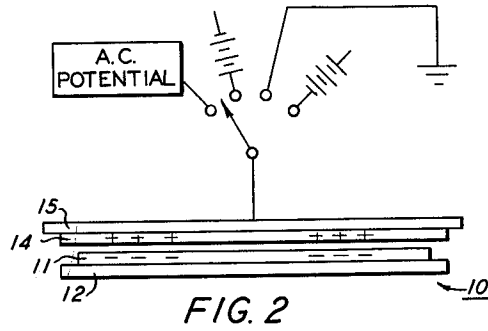
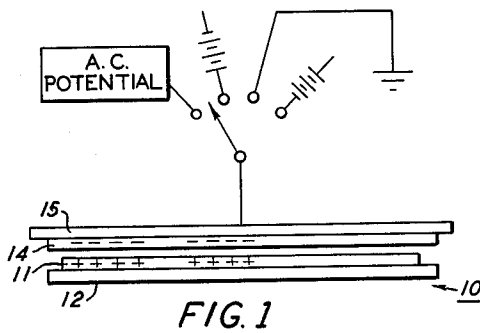
R. H. HALL

3,234,019

METHOD FOR FORMATION OF AN ELECTROSTATIC IMAGE RESISTANT
TO DETERIORATION ON STORAGE

Filed April 10, 1961

3 Sheets-Sheet 1



INVENTOR.
RICHARD HARRISON HALL

BY *Stanley Z. Cole*

ATTORNEY

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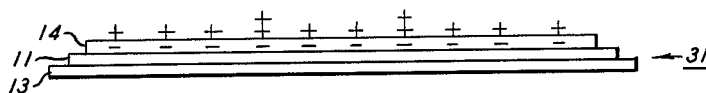
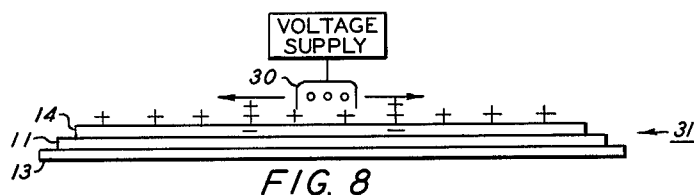
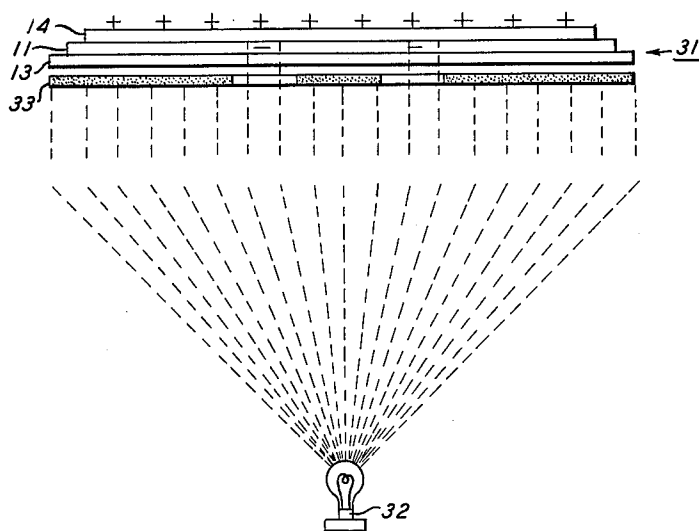
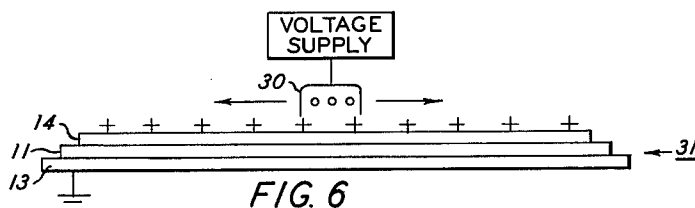
R. H. HALL

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METHOD FOR FORMATION OF AN ELECTROSTATIC IMAGE RESISTANT
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3 Sheets-Sheet 2



INVENTOR.
RICHARD HARRISON HALL

BY
Stanley Z. Cole
ATTORNEY

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R. H. HALL

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3 Sheets-Sheet 3

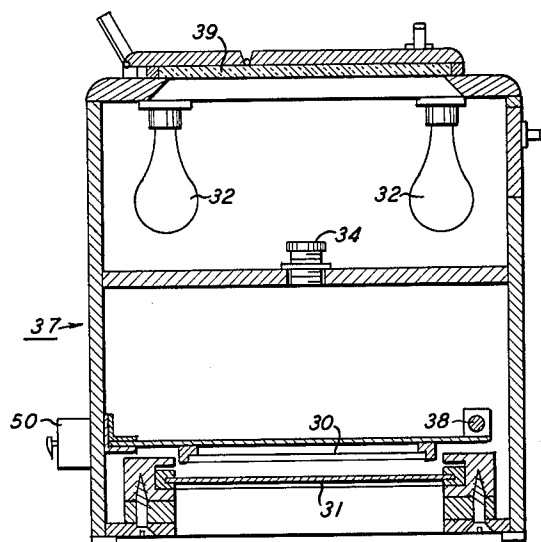


FIG. 10

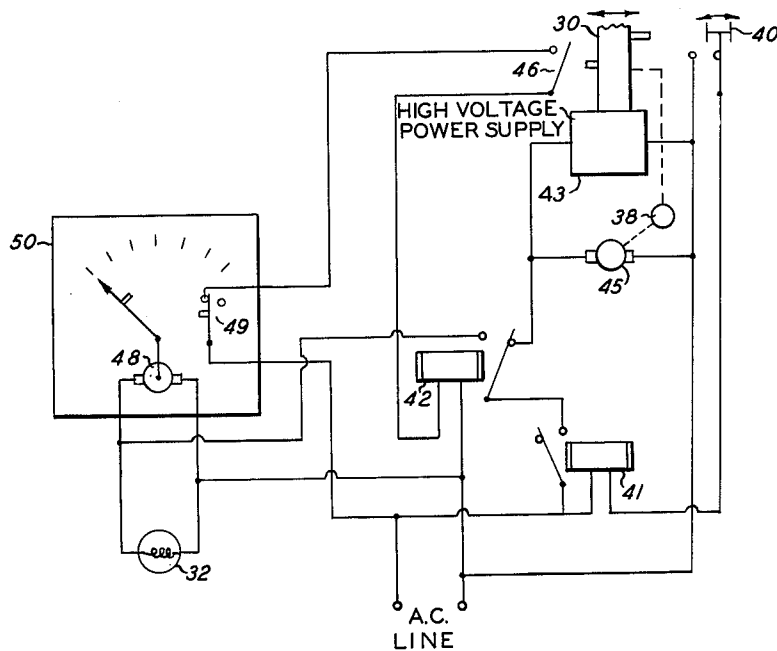


FIG. 11

INVENTOR.
RICHARD HARRISON HALL

BY

Stanley Z. Role

ATTORNEY

1

3,234,019

METHOD FOR FORMATION OF AN ELECTROSTATIC IMAGE RESISTANT TO DETERIORATION ON STORAGE

Richard Harrison Hall, Syracuse, N.Y., assignor to Xerox Corporation, a corporation of New York
Filed Apr. 10, 1961, Ser. No. 101,880
2 Claims. (Cl. 96—1)

This application is a continuation-in-part of application Serial No. 381,890 filed Sept. 23, 1953, now U.S. Patent 3,084,061, issued on April 2, 1963.

This invention relates in general to electrostatic images such as are useful in xerography or electrophotography and, in particular, to the transfer of an electrostatic pattern from a surface having such a pattern to a second surface coated on the first surface.

In xerography it is usual to form an electrostatic latent image on a surface, generally by charging a photoconductive insulating surface and dissipating the charge selectively by exposure to a pattern of activating radiation. Whether formed by this method or another, the resulting electrostatic charge pattern is conventionally utilized by the deposition of an electroscopic material thereon through electrostatic attraction, whereby there is formed a visible image or image body of electroscopic particles corresponding to the electrostatic latent image. This image body in turn may be transferred to a second surface to form an xerographic print. In some cases, however, it is desirable to carry out the development, or deposition of image material at a point apart from the photosensitive surface, either on the ultimate print-supporting surface or on some other member. Further, it is conventional that all the steps up to and including the deposition of electroscopic material must be performed in the absence of ambient illumination. In some cases, however, it is desirable to carry out the development or deposition of image material in the presence of ambient illumination or after the surface bearing the electrostatic latent image has been exposed to ambient illumination.

In accordance with the present invention, an electrostatic latent image is formed by usual methods, optionally including charging and selective charge dissipation, or by other methods of electrostatic latent image formation, and this electrostatic latent image itself is utilized to form an electrostatic image on a second insulating surface whereon it may be developed or otherwise utilized. The invention, therefore, comprises apparatus, means, and methods for forming a second electrostatic latent image on an insulating surface through the action of a first electrostatic latent image. Thus it is an object of the invention to provide new and improved apparatus, means, and methods for the formation of an electrostatic latent image on an insulating surface.

It is an additional object of the invention to provide new apparatus and methods wherein an electrostatic latent image is formed on a photoconductive insulating surface and the electrostatic latent image is employed to form a corresponding latent image on a light insensitive insulating surface.

It is an additional object of the invention to define new and improved apparatus, means and methods for the formation of a light insensitive electrostatic latent image.

It is an additional object of the invention to define a new method which will simplify xerographic apparatus.

It is an other object of the invention to define a new process by which an electrostatic image may be formed on an overcoated xerographic plate and thereafter stored, developed or otherwise utilized without deterioration due to ambient illuminations or poor insulating qualities of the photoconductor.

2

Additional objects of the invention will in part be obvious and will in part become apparent from the specification and the drawings in which:

FIG. 1 is a diagrammatic view of one embodiment of the invention.

FIGURE 2 is a diagrammatic view of the same embodiment as found in FIGURE 1 where the original latent image is of opposite polarity.

FIGURE 3 is a diagrammatic view of another embodiment of the invention, where a roller member is employed.

FIGURE 4 is a diagrammatic view of another embodiment of the invention, where a brush member is used.

FIGURE 5 is a diagrammatic view of a further embodiment of the invention wherein a corona discharge electrode is a part thereof.

FIGURES 6-9 are diagrams illustrating the flow steps of an embodiment of the process of the invention.

FIGURE 10 is a sectional view of an apparatus according to another embodiment of the invention.

FIGURE 11 is a schematic representation of a circuit which may be utilized in the apparatus of FIGURE 10.

For an understanding of the present invention it is to be recognized that the invention contemplates the formation of an electrostatic charge pattern or electrostatic latent image by various means. For example, using the methods of Carlson Patent 2,297,691, an electrostatic latent image can be formed on a photoconductive insulating surface, or on an insulating film overcoating a photoconductive insulating layer, through the steps of charging the surface and selectively allowing charge migration by exposure to a pattern of activating radiation. If desired, other methods of forming the electrostatic latent image may be used such as, for example, selective deposition of an electrostatic charge on an insulating surface to form a pattern of such charge, imposing a potential on a shaped conductor, or the like. The image thus may be formed on a xerographic photosensitive member comprising a photoconductive insulating layer overcoated with an insulating film and overlying a conductive backing member or on such other combination as may be desired of an insulating surface bearing an electrostatic latent image.

According to one embodiment of the invention, as illustrated in FIGURE 1, an electrostatic latent image is supported on an image member generally designated 10 comprising an insulating layer 11 optionally overlying a backing member 12 which generally will be conductive material. The insulating layer 11 may be a photoconductive insulating layer such as, for example, a layer of vitreous selenium, anthracene, sulfur, tellurium, or other photoconductive insulating material including, for example, layers containing particles of a photoconductive insulator in an appropriate binder material. Alternatively layer 11 may comprise an insulating material which need not be photoconductive and may comprise an insulating layer of a suitable non-conductor including, for example, resins, plastics, and other film-forming members.

Disposed adjacent to the insulating, or photoconductive insulating layer 11, is a transfer material such as a transfer web 14 of a suitable insulating member, preferably a self-supporting film member, such as a film of cellophane, cellulose acetate, or other cellulosic material or cellulose derivative, or film of a resin such as polystyrene, an acrylic resin, or other vinyl resin, or like resin or plastic material. This transfer member 14, is characterized by being an electrical insulator whereby it can support an electric charge on its surface and whereby an electric charge pattern on its surface may be stored for subsequent utilization. Transfer member 14 is dis-

posed in contact or virtual contact with the image bearing layer 11 separated only by a very thin air gap. Disposed and positioned behind the transfer member 14 is an electrode 15 which may be supplied with negative, positive, ground, or alternating potential while in contact with all areas of the transfer member 14, and made up of a conductive material such as a conductive metal layer, metallic foil, encased liquid, an insulator such as cotton which has been soaked with a conductive liquid or is in equilibrium with normally humid air or otherwise made at least moderately conductive, conductive rubber, or any other conducting material. If desired, and depending on the material used for electrode 15, a pressure pad may be positioned to cause all areas of member 14 to be contacted by electrode 15.

In operation of the present invention, an electrostatic charge pattern or latent image is formed on the image bearing member 11, as indicated by the plus marks in the drawing, representing a pattern of positive electrostatic charge. The transfer member 14 is placed on the image bearing surface in virtual contact therewith across the entire surface. The electrode 15 is then placed behind the transfer member 14 so that all areas of transfer member 14 are contacted by electrode 15 while electrode 15 is maintained at the desired potential. Where electrode 15 is at ground potential or slightly negative potential and a positive electrostatic image is on surface 11, electrons will be attracted to areas on transfer member 14 which correspond to areas of positive charge on surface 11. Where electrode 15 is maintained at a slightly positive potential or is supplied with alternating potential, areas on the transfer surface 14 corresponding to areas on the image surface 11 where positive charges are found will hold negative charge to a greater degree than areas on insulating surface 14 corresponding to areas on image surface 10 where positive charge is not found.

As shown in FIGURE 2, an electrostatic latent image of negative polarity is supported on insulating layer 11 which optionally overlays conductive backing member 12. Where electrode 15 is at ground potential or slightly negative potential or slightly positive potential or is supplied with alternating potential, the areas of insulator 14 corresponding to areas of charge on image surface 11 will be more positively charged than areas of insulator 14 corresponding to areas of no charge on image surface 11.

The image induced on transfer member 14 corresponding to the electrostatic latent image originally supported on insulating layer 11 may be utilized by removal of the conductive member 15, which will fix an induced electrostatic image on transfer member 14. Transfer member 14 may then be removed from the surface area of the image bearing member 11, and developed or otherwise utilized in xerography or like arts.

In FIGURE 3, another embodiment of the invention is shown wherein roller 16 which may be supplied with negative, positive, ground, or alternating potential is composed of a conductive material such as conductive rubber, or metal or the like, and is positioned and disposed across the width of the image bearing member 10, so that it may be rolled across the length of image bearing member 10, on which transfer member 14 is disposed. This may be accomplished either by moving rolling electrode 16 across the surface of transfer member 14 or by moving image bearing member 10 with the transfer member 14 disposed thereon, beneath and in contact with a stationary roller electrode 16. Thus, for example, a motor 21 operating through belt 17 on pulley 19 drives a rack and pinion assembly comprising a gear wheel 20 operated by pulley 19 engaging a gear-rack 18 mounted on backing member 13. Image bearing member 10 is made up of insulating surface 11 and backing member 13 which in this embodiment is composed of an insulating material such as glass.

In FIGURE 4, another embodiment of the invention is

shown wherein a brush member 25 is caused to rotate and brush across the entire surface of the transfer member 14. The rotating brush member 25 is driven by motor 26 through belt 27. Image bearing member 10 with transfer member 14 placed thereon is positioned and disposed to move against and along rotating brush member 25 as motor 21, operating through belt 17 on pulley 19 to drive a rack and pinion assembly comprising gear wheel 20 operated by pulley 19 engaging a gear rack 18 mounted on backing member 12, causes image bearing member 10 carrying transfer member 14 thereon to move past the rotating brush member 25. It has been found that the bristles of brush member 25 may be composed of various materials as for example, but in no way limited, to cotton, cotton fibres, nylon bristles, wool, glass fibres, animal fur, steel wool, and the like, the fibres being either insulating or conductive and being either triboelectrically positive or triboelectrically negative with respect to the surface being brushed. The brushing of the transfer member 14 causes deposition of a differentiating charge as between areas on transfer member 14 positioned over image areas and areas on transfer member 14 positioned over non-image areas of surface 11. Transfer member 14 may be developed or otherwise used in xerography or in similar arts when removed out of contact with image bearing member 11.

In FIGURE 5, another embodiment of the invention is shown, wherein a non-contacting transfer electrode is employed for formation of the electrostatic image on transfer web 14. Such an electrode may be any of a wide variety of ion sources such as, for example, a radioactive material or other member capable of ionizing air. According to the embodiment shown a corona discharge electrode consisting of high voltage fine wires partly enclosed by a grounded shield, generally designed 30, is positioned adjacent to the path of motion of the assembly comprising image bearing layer 11, conductive backing member 12 and transfer web 14. This corona discharge electrode 30 is optionally connected to a high voltage potential source, either A.-C. or D.-C., so as to produce corona discharge from the electrode. The high voltage source may, for example, be in the order of several thousand volts, and when high voltage alternating current is utilized, it is desirable to use from 6,000 to 10,000 volts with suitable controls so that the net electric discharge from the electrode 30 will be nearly an equal balance of positive and negative charges. In using a high voltage alternating current source of several thousand volts it has been found desirable to supply suitable controls so that the net electric discharge from electrode 30 which is deposited on transfer member 14 can be made slightly negative, slightly positive or neutral as desired.

The device of FIGURE 5 achieves results comparable with that of the devices shown in FIGURES 1 through 4. Corona discharge electrode 30 passes over the assembly of transfer web 14 on member 10 whereby the substantially neutral, or slightly positive or negative, charge is deposited on the upper or outer surface of transfer web 14. When the image on image surface 11 is composed of positive charges, the point opposite the charged areas on layer 11 of layer 14 will receive a higher negative charge density than the areas opposite the areas of surface 11 carrying no image charge. Where the image areas on surface 11 are negatively charged, the corresponding areas on transfer web 14 will receive a comparably higher positive charge density than the areas on transfer web 14 corresponding to areas of no charge on image bearing surface 11. This, therefore, results in the formation on transfer web 14 of an electrostatic latent image induced by the electrostatic latent image on surface 11.

While it is not intended to limit this invention by an explanation of the theoretical mechanisms of operation, it is thought that the following description is sound in its basis and is in conformity with experimental facts. According to present understanding of the invention, the electrode 15

or other member such as roller 16, brush 25 or the like is to be regarded as a source of charge migration to which or from which electrons or ions can migrate under the influence of the field of force associated with an electrostatic image. A source of charge migration, therefore, is brought into the image field and there is controlled and directed by the electrostatic image to form a second charge image. Thus, according to the situation illustrated in FIGURE 1, electrons from this source of charge are drawn to the upper surface of layer 14 by the positive polarity electrostatic image and are retained at the layer by this field of force. In this way the negative charge of the image on layer 14 may be regarded as neutralizing the positive electrostatic latent image on layer 11.

It is interesting and valuable to note that the presence of an induced image on layer 14 is independent of the net average charge or potential on the layer. For example, the source of charge migration may supply ground or neutral potential or it may supply either net positive or net negative charge. This, in any case, is not material to the invention provided such negative or positive potential is not increased to the level of field emission or like secondary effects. If, for example, the average potential on layer 14 is negative, the image area represented by the minus signs in FIGURE 2 will be correspondingly more negative and the non-image areas correspondingly less negative. In such a case, the negative image can be experimentally measured and has been found experimentally to be capable of development by the usual xerographic methods. Conversely, if the average or net potential on layer 14 is positive, then the non-image areas will be more positive and the image areas will be either negative or comparatively less positive. In either case the induced image can be developed or otherwise utilized as a negative polarity electrostatic image.

Similarly, the situation in FIGURE 2, namely an original negative polarity image, gives rise to the formation of a usable positive polarity image and this is true regardless of average or net polarity on the entire member.

It is thought that these facts serve to explain certain aspects of the operation of the invention. It is now believed that in each of the embodiments of the invention there is a source of charge migration which permits the upper surface of layer 14 to achieve a substantially uniform potential over its entire surface. The charge pattern on layer 14 is brought about by the attracting or repelling force of the original image on layer 11 and is reflected on layer 14 by the charge density in image areas as compared to non-image areas while a uniform potential is maintained on layer 14. Thus, the source of charge migration supplies electric charge at ground, positive, or negative potential while the original image directs this charge into a pattern or image configuration.

In reference to each of the figures, it is seen that this explanation conforms with the facts. In FIGURES 1 and 2, a conductive electrode makes very close contact with layer 14, thus conducting charge to or from this layer. In FIGURE 3, an analogous result is achieved with a rolling electrode. Likewise, in FIGURES 4 and 5 and as will appear hereinafter in FIGURE 8, migration makes charge available at the surface of layer 14 while the closely positioned electrostatic image attracts or repels charge into an image configuration. This is true in all cases regardless of net positive or negative potentials on the layer, but it is to be realized that a nearly neutral potential may be desirable in order to avoid or minimize secondary effects such as field emission which may occur between closely spaced surfaces at moderately high potentials or other secondary effects which may be associated with higher potentials or potential gradients.

The embodiments described or their explanations are in no way intended to limit the scope of this invention. As an example of other possible embodiments particles may be rolled or cascaded over the surface of the transfer member which is in contact with an image bearing

member. As in the embodiment of the invention using a rotating brush member the materials cascaded over the surface may be any material. It is also possible to choose beads coated with a material having such a triboelectric relation to the transfer member as to cause electrostatic charge to be deposited on the transfer member as the beads cascade over the transfer member. Another possibility is to place a charge on particles and cascade them over the surface of the transfer member with sufficient force to prevent the particles from adhering to the transfer member due to the electrostatic field created by the charged image areas on the image bearing member while the charges on the particles will be deposited on the transfer member to create an induced electrostatic image thereon. The charge can be positive or negative as in the embodiments described and an image will be produced.

FIGURES 6 through 9 illustrate an embodiment of the invention in which an insulating film is permanently bonded to the photoconductive insulating surface. Such a member is described, for example, in U.S. Patent 2,860,048 to Deubner and in this embodiment it replaces the image bearing member 10 and transfer member 14 of the embodiment in FIGURES 1 to 5. In this embodiment an invisible electrostatic charge pattern is formed on the photoconductive insulating layer with the insulating film in position and acting through the insulating film. The charge pattern is then transferred from the photoconductive insulating layer to the surface of the insulating film in a manner similar to that explained in relation to the embodiments of FIGURES 3 to 5.

In FIGURE 6 an overcoated xerographic photosensitive member 31 is shown generally comprising a photoconductive insulating layer 11 on a backing 12 all as hereinbefore described. The member 32 additionally comprises an insulating film 14 which is permanently coated on the photoconductive layer 11 and may be a coating of the nature disclosed in U.S. Patent 2,860,048 to Deubner. The coating may be formed by any bonding method that will eliminate space between the film and the layer without significantly altering the electrical or photoelectrical characteristics of either. Any of many coating materials may be used such as cellulose acetate, polystyrenes, polytetrafluorethylene, polyethylene terephthalate, or like resin or plastic material. Film 14 may be opaque or transparent. The photosensitive member 31 is enclosed in an unilluminated space and charged by a conventional method such as described in Walkup Patent 2,777,957. Charging device 30 is depicted as a corona discharge device but is intended to encompass the various other devices suitable for the purpose. The charge potential in the illustrated embodiment is preferably positive 1000 volts but may vary from about 100 volts to any potential that the given dielectrics will effectively withstand.

In FIGURE 7 the photoconductive layer 11 is selectively illuminated from a source 32 depicted as an electric bulb but which is intended to encompass any source of illumination to which the photosensitive member 31 is sensitive including, for example, X-rays. The illumination is made selective in accordance with a pattern present on member 33 here depicted as a material such as film or microfilm which is relatively transparent in areas through which illumination is desired and relatively opaque in other areas, but which may be any subject through which illumination will selectively pass or from which illumination may be selectively reflected. The backing 12 is depicted as transparent in the embodiment of FIGURES 6 to 9 for selective illumination there-through. It is to be understood, however, that selective illumination may be made through insulating film 14 from the other side of the photosensitive member 31 as desired provided the insulating film 14 is transparent and in which case the backing 12 may be opaque. The

means of selective illumination is not significant to the invention and may be any suitable means including optical systems, cathode ray tubes, projectors capable of size variations between the subject and the pattern imposed, and others. In the areas illuminated, charge migration occurs in the photoconductive layer 11 in response to the field produced by the charge on the surface of photosensitive member 31. This migration has an equalizing effect on the surface charge reducing the potential over the illuminated areas. Complete potential equalization does not occur in these areas due to the presence of the intermediate dielectric of the insulating film. The voltages shown and the charges indicated by encircled plus and minus signs are figurative for explanation only and are not intended to show specific relationships. As figuratively indicated in FIGURE 7, there is an electrostatic latent image at the interface of layers 11 and 14.

In FIGURE 8 the surface of plate 31 is again presented to a source of charges, such as charging device 30, bringing the surface area of the plate to a uniform potential. Note that the latent image remains at the interface of layers 11 and 14.

In FIGURE 9 the photoconductive layer 11 is uniformly illuminated by a source of illumination here depicted as light bulb 32 but which is intended to comprehend other sources such as sunlight, X-rays or ambient illumination. This illumination effectively short circuits the photoconductive layer eliminating the effects of the latent image pattern at the interface of layers 11 and 14. The result of eliminating the effects of the pattern at the interface is the appearance of potential gradients in accordance with the pattern appearing on the surface of plate 31. This step is comparable to the removal of web 14 from the surface of the photoconductive layer 11 in the embodiments discussed in relation to FIGURES 3, 4 and 5.

It is to be noted that the above described process has proved itself in extensive experimentation and any inaccuracy in the exact theoretical operation as described and illustrated is to be in no way limiting.

Further theoretical support, while again to be in no way limiting as to its accuracy, has been derived for explanatory purposes. Assume that our overcoated xerographic plate 31 has been designed so that the capacitance presented by the insulating film 14 is one microfarad and that the same is true of the photoconductive layer 11 in the absence of light. For the purpose of theoretical discussion, further assume that the photoconductive layer becomes a perfect conductor in any area exposed to light. Considering a 1000 volt electrostatic charging device, it is then possible to explain the operation in terms of the equation $Q=CE$ in which Q represents the charge quantity in coulombs, C represents the effective capacity in microfarads and E represents the voltage. In FIGURE 6 the charge is determined as follows:

$$\begin{aligned} Q &= CE \\ Q &= .5 \text{ mfd.} \times 1000 \text{ v.} \\ Q &= .0005 \text{ coulomb} \end{aligned}$$

In FIGURE 6 the effective capacities of the insulating film and the photoconductive layer are in series and

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} = \frac{1}{\frac{1}{1} + \frac{1}{1}} = \frac{1}{2}$$

or .5 mfd. where C represents the total effective capacity, C_1 represents the effective capacity of the insulating film and C_2 represents the effective capacity of the photoconductive layer. In FIGURE 7 there is no way for the charge to leave the surface of the insulating film so it will remain constant and the voltage over the exposed

areas of the photoconductive layer may be determined as follows:

$$\begin{aligned} E &= Q/C \\ E &= .0005/1 \text{ mfd.} \\ E &= 500 \text{ volts} \end{aligned}$$

Here the effective capacity is one microfarad since the illumination has short circuited the photoconductive layer and the only effective capacity is that of the insulating film. In FIGURE 8 the amount of charge picked up by recharging the surface of the selenium plate can be determined as follows:

$$\begin{aligned} Q &= CE \\ Q &= .5 \text{ mfd.} \times 500 \\ Q &= .00025 \end{aligned}$$

Bearing in mind that we are considering only the areas that were exposed to light in FIGURE 7, C represents the capacity across the insulating film and the photoconductive layer in series since there is no illumination. E represents the effective applied charging potential which is only 500 volts since the area being charged still carries a residual 500 volts. The added charge of .00025 coulomb brings the total charge on the areas under consideration to .00025 + .0005 or .00075 coulomb. After full illumination in FIGURE 9 we can determine the voltage at the surface of the area that was exposed to light in FIGURE 7 by the equation:

$$\begin{aligned} E &= Q/C \\ E &= \frac{.00075}{1 \text{ mfd.}} = 750 \text{ volts} \end{aligned}$$

We are using one microfarad again for C since the illumination of the photoconductive layer has short circuited its capacity. The voltage over the area not exposed to light in FIGURE 7 can be determined similarly:

$$\begin{aligned} E &= Q/C \\ E &= \frac{.0005}{1 \text{ mfd.}} = 500 \text{ volts} \end{aligned}$$

The charge in this area has not changed since FIGURE 6 but the effective change in capacity has introduced a voltage change. We now discover that we have voltage gradients on the surface of our xerographic plate varying from 500 volts to 750 volts and representative of the selective illumination illustrated in FIGURE 7. These voltage gradients will allow development of the image by known processes of electrostatic development.

While the above discussion has been in terms of total capacitance and total charges, the reasoning is equally applicable in terms of unit area capacitance and unit area charge density.

The image present as a varied charge density in FIGURE 3 has not proved developable by conventional methods. After the step of FIGURE 4, however, the image is again developable by usual methods and may be developed either in the presence or absence of light. The operation described in connection with FIGURES 6 to 9 is by way of example and some variation is useful for particular purposes. In one such variation a positive-to-positive process starts with a field produced in the photoconductive layer only. This may be achieved by applying a field across the overcoated plate while illuminating the plate uniformly. When the illumination is removed and then the field is interrupted, a charge will exist in the photoconductive layer but not in the overcoating. Charging a photoconductive insulator in this way is disclosed in U.S. Patent 2,995,938. Exposure to an image, dielectrically neutralizing the overcoating as by an A.C. corona discharge and then fully illuminating the plate will form a developable electrostatic latent image.

As is evident, the method described above is of particu-

lar value when it is desirable to use fast dark decay photoconductive insulating layers. Since the latent electrostatic image is formed on an insulating film, the charge pattern will remain on the film despite the charge decay in the photoconductive layer.

FIGURE 10, by way of example, illustrates a novel apparatus in accordance with this invention. With no greater complexity than known and commercial equipment, the apparatus of FIGURE 10 permits the production of an electrostatic latent image that avoids the requirement that the xerographic plate be sealed from light and moved during the process steps. In the apparatus of FIGURE 10 an overcoated xerographic plate is sensitized, exposed, and charged in accordance with the process discussed in connection with the embodiment of FIGURES 6 to 9. The plate may then be removed from the apparatus in view of full ambient illumination and developed by usual methods, but without the requirement of a light seal. Referring to FIGURE 10, an overcoated xerographic plate 31 is placed in the apparatus 37, charging device 30, which may be a corona discharge device, is driven across the surface of the plate by drive member 38, the source of illumination 32 reflects a selective pattern of relative light and shadow from an image placed in exposure panel 39, and the charging device 30 is thereafter redriven across the surface of the plate. Final illumination in accordance with the inventive process may then be performed by withdrawing the plate 31 and exposing it to ambient illumination. Accordingly the apparatus produces an electrostatic latent image that may be developed in full light.

FIGURE 11 shows a schematic representation of an automatic sequencing circuit for operation of the apparatus in FIGURE 10. This circuit permits full automatic operation of the apparatus. In operation switch 40 is actuated by a manual push button and closes the energizing circuit for starting relay 41. Line current then flows through the contacts of relay 41 to the power supply 43 for the charging device 30 and simultaneously to the drive motor 45 which causes charging device 30 to move from front to back of the apparatus 37 by means of drive member 38. When charging device 30 reaches the back of the apparatus it actuates normally open expose switch 46 closing the energizing circuit for expose relay 42. Operation of relay 42 breaks the circuit to power supply 43 and drive motor 45 and simultaneously closes the circuit to expose light 32 and timer motor 48. After the timer 50 reaches the end of its preselected cycle, it opens the normally closed timer switch 49 breaking the energizing circuit for relay 42. Deenergizing relay 42 breaks the circuit to the expose light 32 and timer motor 48 and simultaneously reactivates the circuit to the power supply 43 and drive motor 45. When the drive motor 45 has driven the charging device 30 back to the front of apparatus 37, by means of reversibly threaded drive member 38, the charging device opens the switch 40 by mechanical contact thus deenergizing the entire apparatus.

In practice the moving charging device is audible and its silence signals the completion of the cycle. However, a signal light may readily be included in this circuit to indicate a cycle is in progress.

It is to be understood that the above described methods and arrangements are simply illustrative of the application of the principles of the invention, and that many other modifications may be made without departing from the spirit and scope thereof.

What is claimed is:

1. A method of forming a latent electrostatic image developable under normal ambient lighting conditions comprising:

- (a) coating a xerographic plate comprising a conductive substrate and a photoconductive insulating layer with a permanent electrically insulating film applied over said layer and capable of supporting an applied electrostatic charge on its surface,
- (b) sensitizing said plate by applying a uniform electrostatic charge to the exposed surface of said film,
- (c) selectively illuminating said plate in accordance with an image pattern to effect charge migration from a source through said layer to the interface of said layer and said film,
- (d) applying a second electrostatic charge to the exposed surface of said film bringing it to a uniform potential, and
- (e) uniformly illuminating said plate whereby a developable latent electrostatic image is formed on the exposed surface of said film capable of development under ambient light conditions.

2. The method of image formation set forth in claim 1 and including the development of the image on said exposed surface by deposition of marking material.

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NORMAN G. TORCHIN, *Primary Examiner*.

PHILIP E. MANGAN, *Examiner*.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,234,019

DATED : February 8, 1966

INVENTOR(S) : Richard H. Hall

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 8, line 70, change "U.S. Patent 2,995,938"
to --U.S. Patent 2,955,938--.

Signed and Sealed this

twenty-fourth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks