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XEROGRAPHIC COLOR MASKING

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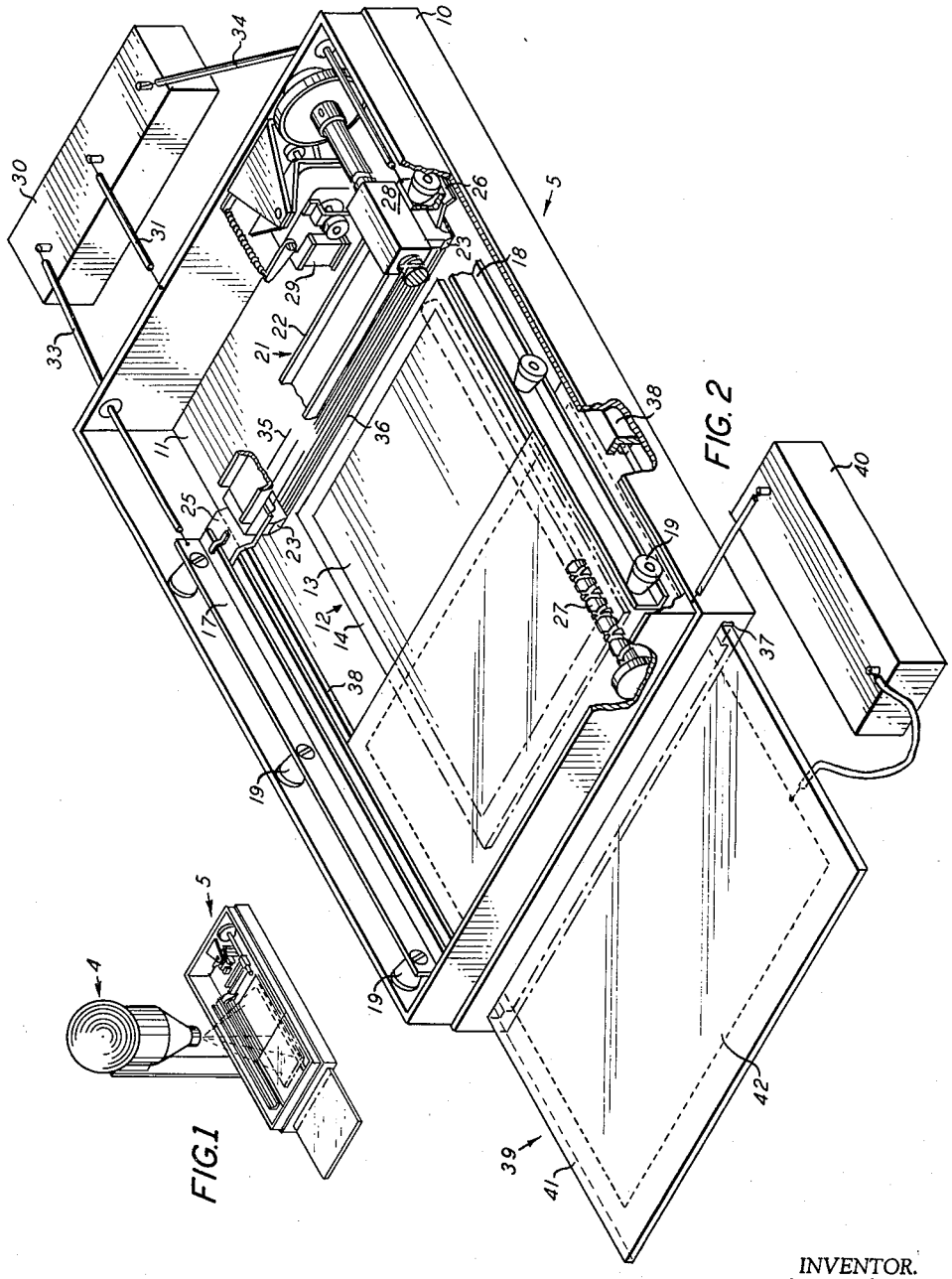


FIG. 2

FIG. 1

INVENTOR.
John T. Bickmore

BY Stanley Z Cole

ATTORNEY

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XEROGRAPHIC COLOR MASKING

John T. Bickmore, Rochester, N.Y., assignor to Xerox Corporation, a corporation of New York

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This invention pertains to xerography and more particularly to an improved technique for xerographic color masking.

In the art of subtractive color print making it is conventional to form a full color print by superposing on a sheet of paper or the like separate cyan, magenta and yellow dye or pigment images, the density in each individual image being inversely proportional to the brightness of its complementary color in the original scene. This procedure can be carried out in the art of photography by making red, green and blue color separation negatives from an original scene or a color transparency and using each separation negative to form its corresponding color image or color printing plate through such well known photomechanical processes as the dye transfer process, photolithography or photoengraving.

Corresponding techniques can also be used in the art of xerography, which is an electrostatic image reproduction process, for color print making. Typically, in xerography as disclosed in U.S. Patents 2,297,691, 2,573,881, 2,576,047, 2,600,580, 2,618,551, 2,618,552, 2,619,418, 2,638,416, 2,659,670, 2,690,394, 2,725,304, 2,745,327, 2,751,616, 2,772,991, 2,777,957, 2,777,418, 2,808,023, 2,815,330, 2,817,598, 2,817,765 and others, a xerographic plate which includes a photoconductive insulating layer is electrostatically charged, exposed to a light pattern so as to selectively discharge the plate and form an electrostatic latent image and the latent image is then developed by the selective deposition of electrostatically attractable particles to form a visible image which may then be viewed on the xerographic plate or be transferred to another surface. In conventional xerographic color print making three separate images are made on the same or different xerographic plates, each image corresponding to a different primary color. Thus, the xerographic plates can be exposed through red, green and blue filters or to red, green and blue color separation transparencies. The three resulting images may be developed with cyan, magenta and yellow particles which may be transferred to a single support to form a color image, or by other well known xerographic techniques, each developed image may be employed to form a separate printing plate and the printing plates may then be used in a conventional multicolor press to form a plurality of prints.

Both the photographic and xerographic techniques thus far described are incapable of producing color prints of really high quality because of inherent limitations in available cyan, magenta and yellow inks, dyes or pigments which must be used in any color printing process to form the final image. An ideal cyan should absorb only red light, magenta should absorb only green light, and yellow should absorb only blue. In practice, however, it is found that while available yellow colors are reasonably close to the ideal, cyans absorb heavily in the green and to a lesser extent in the blue, and magentas absorb heavily in the blue. These deficiencies in available colors result in a serious degradation of color image quality when the above described print making techniques are used. In commercial color printing these deficiencies are largely compensated for by techniques known as masking in which the density of a printing color, i.e. cyan, magenta or yellow, is made to depend not only on the brightness of its complementary color in the original scene, but also to a lesser extent on the brightness of one or both of the other primary colors. In one method of masking

often used in photography a red color separation positive is made and bound in register with the green separation negative. This combination is then used to form the magenta dye image and the magenta printing plate. It can be seen that the density of the magenta color, which is intended primarily to absorb green, is thus decreased in those areas of the print where the cyan color occurs. It will be noted that the cyan color which is formed from the red separation negative has an unwanted absorption in the green part of the spectrum. In this way, the total green absorption of the print is made to more faithfully correspond to the amount of green in the original scene. Similarly, a weak green color separation positive is made, bound in register with the blue separation negative and the combination used to form the yellow color. Thus, in areas where the magenta color is intense and contributes unwanted blue absorption the intensity of the yellow color is correspondingly decreased.

These masking techniques can also be adapted to xerographic color print making. They are, however, very tedious and expensive in photography and no less so in xerography. In accordance with the present invention, however, we have discovered a color masking technique specifically adapted to xerography which greatly simplifies the making of color prints.

The invention will be described in connection with the drawing in which:

FIG. 1 represents a simplified schematic perspective view of an apparatus suitable for carrying out the invention;

FIG. 2 represents an enlarged perspective view of part of the apparatus of FIG. 1.

In FIG. 1, "4" is a conventional photographic enlarger for projecting a transparency such as a color transparency or a color separation positive onto a xerographic plate (not shown) located in charging apparatus **5**.

FIG. 2 shows the construction of charging apparatus **5** as shown in FIG. 1. Support frame **10** serves to position all components and includes a base plate **11** generally made of conductive material but which can optionally be made of glass or the like upon which is placed xerographic plate **12** comprising a photoconductive insulating layer **13** and a conductive support **14**. In some cases conductive support **14** may be omitted. Conductive rails **17** and **18** are positioned on opposite sides of frame **10** and each rail is secured to frame **10** but insulated therefrom by insulator **19**. A charging bar or scorotron **21** is slidably mounted in frame **10** and may be passed over xerographic plate **12** at a slight distance therefrom. It comprises a support channel **22** generally of conductive material, carrying at each end insulating blocks **23** between which are a set of three corona generating wires **35** and a set of screen wires **36**. Charging bar **21** is supported in frame **10** by hangers **25** and **26** which slide on rails **17** and **18** respectively. Hanger **25** is connected to corona generating wires **35** and hanger **26** is connected to screen wires **36** whereby the potential of each set of wires may be controlled by applying a potential to the corresponding rail. High voltage power supply **30** is connected to base plate **11** and thus to conductive support **14** through wire **31** and is connected to the two sets of wires in charging bar **21** through wires **33** and **34** connected to rails **17** and **18** respectively. Frame **10** also rotatably supports a reversing lead screw **27** which is adapted to move the charging bar back and forth over xerographic plate **12** by means of the lead screw block **28** which engages the groove in the lead screw and is attached to support channel **22**. Electric motor **29**, also attached to frame **10**, is used to rotate lead screw **27**. Conventional control apparatus such as a microswitch (not shown) may be provided to stop motor **29** in charging bar **21** after charging bar **21** passes back and forth over xerographic plate **12** and returns to the

starting position as shown. Frame **10** also includes a slot **37** and channels **38** in which may be inserted or removed in close parallel proximity to xerographic plate **12** a transparent conductive electrode **39**. Suitable material for transparent conductive electrode **39** include glass or plastic sheets with thin evaporated metal layers or with copper iodide coatings, but the preferred material is a sheet of glass having a transparent conductive tin oxide layer on the face nearest the xerographic plate **12**, i.e. the lower face. This type of conductively coated glass is commercially available under the trade names Nesa and Electropane. A high voltage may be applied to conductive electrode **39** by power supply **40**.

In a typical application of the present invention a xerographic plate **12** which may include a thin film **13** of vitreous photoconductive insulating selenium on a metal base **14** is first charged to a positive potential of several hundred volts by applying from power supply **30**, in accordance with sandard xerographic practice, a potential of several hundred volts positive to screen wires **36** and a positive potential of about 6000 to 8000 volts to corona generating wires **35** and energizing motor **29** to move charging bar **21** back and forth over the xerographic plate. Transparent conductive electrode **39**, during charging by bar **21**, is not in position in channels **38**. Enlarger **4** of FIG. 1 is then energized for a suitable length of time to project on plate **12** an image of a green separation positive of a scene or image to be reproduced. It will be understood that exposure could also be made to a color transparency through the use of a green filter. This first exposure produces on the plate an electrostatic latent image wherein those areas which have received the greatest illumination from the green separation positive retain the least electrostatic charge. Transparent conductive electrode **39** is then inserted into channels **38** (it can, of course, be in position during the exposure step described since it is transparent) and a negative potential of the order of several thousand volts is applied to electrode **39** by power supply **40**. The voltage applied to transparent electrode **39** should be sufficient to reverse the electric field in the selenium layer caused by the postive charge polarity on the surface of the xerographic plate and to make the surface negative with respect to the metal backing of the plate. No charge transfer takes place between electrode **39** and plate **12** and accordingly, the electrostatic charge pattern on the surface of plate **12** is not damaged or altered by application of voltage to electrode **39**. The teachings of patent application Serial No. 718,247 are pertinent in assuring the absence of charge transfer. Plate **12** is now exposed in register through transparent electrode **39** to a red separation positive of the same scene or image. This second exposure preferably causes a smaller change in plate potential than the first exposure through the use of a shorter second exposure, a smaller electric field, or both. Those areas of the plate receiving the most illumination from the red separation will have their negative potential reduced by the greatest amount. After removal of transparent conductive electrode **39**, plate **12** will then have a positive charge and a positive potential.

This potential will be greatest where the least light was received during the first exposure but will also be greatest where the most light was received during the second exposure. Thus, the resulting electrostatic latent image represents a superposition of two latent images, one of them representing the original green separation exposure in a positive image sense and the other representing the red separation exposure in a negative sense. This composite image corresponds to a red masked magenta printer in photographic color print making practice. This superposition, it will be noted, was achieved without exposing the xerographic plate **12** to a negative image. The plate **12** may then be removed from the apparatus and the electrostatic latent image thereon may be developed with a magenta developer by conventional techniques to form a masked magenta image, the magenta image then being transferred to a suitable support, or the latent image may be developed with any conventional xerographic developer which is then transferred to a lithographic master to form a printing plate to be used for printing masked magenta images. Similar techniques may be used for forming a yellow image in which case the first exposure would be to a blue separation positive and the second exposure would be to a green separation positive, preferably the same positive used in forming the magenta image, and the cyan image may conveniently be made by a single conventional exposure to a red separation positive, preferably that used for the second exposure in making the magenta image. A single xerographic plate may be used for making all images in which case the plate is cleaned of one image developer before the next succeeding color image is formed, or a separate plate may be used for each image. The three images when combined in register will form a masked color reproduction of the original scene or image.

It is also possible to leave conductive electrode **39** and plate **12** in position after the second exposure and to develop plate **12** by removing the high potential from electrode **39** and passing a suspension of developer particles between plate **12** and electrode **39**. It is further possible to make electrode **39** in the form of a wire screen or the like in which case development of the plate may be effected by passing a suspension of developer particles through the screen and to the surface of plate **12**. In both of these methods, electrode **39** functions as a so-called "development electrode" as well as fulfilling its function in forming the electrostatic latent image.

In the above description color separation positives were described because the most common xerographic development techniques yield a positive reproduction of an image; that is, areas of the plate receiving the greatest illumination retain the least potential and attract the least amount of developer material. However, reversal xerographic development techniques are also common whereby the less charged areas of a xerographic plate attract more rather than less developer than their neighbor. Where this type of development is employed the procedure described above can also be used, but color separation negatives rather than separation positives should be used. It will be understood, of course, that a direct exposure of the xerographic plates in a camera to an original scene through red, green and blue filters can replace exposure to color separations where the xerographic plates have adequate sensitivities in the three spectral regions.

The invention has been described up to this point with the first or principal exposure of the xerographic plate causing the greater potential variation and the second or masking exposure causing the lesser variation. It is, however, possible to reverse the order of exposure, making the masking exposure first and the principal one second. When this is done, however, the potential of the resulting electrostatic latent image will vary directly rather than inversely with the intensity of illumination received during the principal exposure. Accordingly, this sequence of exposure can be used where color separation negatives only are available and a conventional positive-to-positive xerographic development technique is to be used for developing the latent image. Conversely, if color separation positives are used for exposure, it may be desirable to employ a reversal development technique.

Typically, a positive charge is initially placed on the xerographic plate as described heretofore because the selenium xerographic plates commercially available at present have a higher dark resistivity when charged positively, and accordingly hold a positive charge longer than a negative one. In the above described techniques the surface of the xerographic plate always has the preferred positive potential except for the relatively short time during which the high negative potential is applied

to the adjacent transparent conductive electrode **39**. It is, however, possible to make selenium xerographic plates which have equally high dark resistivity for positive or negative charging and even to make selenium plates which have higher dark resistivity for negative than for positive charging. Other types of xerographic plates are also known which have higher dark resistivity for negative than for positive charging. As an example of this, there are presently available xerographic plates comprising a layer of photoconductive zinc oxide powder in an insulating binder with a paper support base. Where any of these latter types of xerographic plates are used it may be desirable to initially place a negative charge on the plate and then during the second exposure to place a high positive potential on the transparent conductive electrode **39**. This will result in an electrostatic latent image with a negative electric polarity which may be developed by the appropriate techniques.

A further modification of the invention utilizes xerographic plates comprising a photoconductive insulating layer on a transparent conductive support base which may be a sheet of tin oxide coated glass. Where such a transparent backed plate is used, either or both exposures may be made through the transparent back of the xerographic plate, rather than through the transparent electrode **39** adjacent the photoconductive insulating layer. In this case base plate **11** should be transparent or may be dispensed with entirely. Where both exposures are made through the back of the plate the transparency of the electrode **39** becomes immaterial, and electrode **39** may be replaced by an opaque sheet of metal or the like.

There are still further ways of carrying out the present invention in accordance with the same underlying principles and with the same results. In one such modification the xerographic plate is not initially charged, but receives the first image exposure while the adjacent electrode **39** is maintained at a high negative potential. The photoconductive insulating layer **13** becomes conductive in illuminated areas and permits the migration of positive charge to the surface of the xerographic plate in response to the electric field produced by the electrode **39**. The electrode is then removed, or at least the negative potential removed therefrom, leaving on the surface of the plate an electrostatic latent image of positive charge polarity in which the most strongly illuminated areas have the highest potential. The second exposure is then made without use of the electrode **39** and during this exposure plate potential is lowered in proportion to the illumination received. Thus, by this procedure also there is formed a composite electrostatic latent image which bears a positive image relation to one of the exposures and a negative or reversal relation to the other. This procedure may also be accomplished using a high positive potential on the electrode.

In a further modification the xerographic plate is first charged to a first polarity and given the first exposure without the use of the adjacent electrode, and there is then deposited on the surface of the plate a uniform increment of charge of a second polarity sufficient to reverse the sign of the potential at the surface of the plate. Since a uniform increment of charge is applied to all areas of the plate, the electrostatic latent image formed by the first exposure is not destroyed. Those areas of the plate which have a lesser potential of the first polarity now have a greater potential of the second polarity and vice versa. Suitable techniques for applying uniform increments of charge to xerographic plates are described in U.S. Patent 2,817,765 and applications Serial No. 556,930 and 724,164. The apparatus of FIG. 2 may be adapted to this technique by replacing charging bar **21** with one of the devices shown in the above referenced applications. After the polarity of the plate potential has been reversed, the second exposure is given, again without the use of an adjacent electrode **39**. The second exposure, like the first reduces the absolute magnitude of the plate potential, but the sign of the potential change is reversed. Thus, if the plate is first charged negatively then the first exposure makes the plate less negative or more positive. The second exposure will then make the plate potential less positive. By this technique also there is formed a composite electrostatic latent image which bears an opposite relation to the two exposures.

The distinguishing feature common to all embodiments of the invention is the fact that the first exposure of the xerographic plate is made while there is an electric field of one polarity across the photoconductive insulating layer, and the second exposure is made, while preserving the latent image formed by the first exposure and with an electric field of opposite polarity across the photoconductive insulating layer. As can be seen from the various embodiments, these fields can be produced in the photoconductive insulating layer either by depositing charge on the surface of the layer, by pulling charge through the layer to the surface, or by placing a high potential electrode adjacent to the layer.

While the present invention has been described in terms of its usefulness in the art of color print making in xerography, it is to be understood that it can also be used wherever it is desired to form a single xerographic electrostatic latent image from two successive exposures in such a way that one exposure raises the potential of the final latent image while the other exposure reduces it.

What is claimed is:

The method of xerographic color masking in which there is formed a superposed composite xerographic latent charge pattern on a xerographic plate including a photoconductive insulating surface layer from two separate image exposures each being to a different primary color component of an original color image comprising charging the photoconductive insulating layer to a first polarity, exposing the photoconductive insulating layer to a first primary color component of an original thereby forming a latent charge pattern of said first polarity wherein the amount of charge remaining on the photoconductive insulating layer is inversely proportional to the amount of light received during exposure to said first primary color component, applying uniform increments per unit area of charge of a second polarity opposite to said first polarity to the surface of the photoconductive insulating layer bearing said latent charge pattern from an adjacent corona discharge device adapted to deposit charge at a rate substantially independent of the potential on said photoconductive insulating layer thereby everywhere reversing the polarity of the photoconductive insulating layer to said second polarity and charging everywhere to a sensitizing potential while maintaining the charge variations produced by said first exposure, and thereafter and as a separate and distinct operation exposing the photoconductive insulating layer in register to a second primary color component of said original image thereby forming a latent charge pattern of said second polarity in which the amount of charge varies directly with the amount of light received during the first exposure and indirectly with the amount of light received during the second exposure, one of the exposures being greater and producing more charge variation than the other.

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