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Whittaker

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[54] **REVERSAL DEVELOPMENT USING POLAR LIQUID DEVELOPERS**

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Related U.S. Application Data

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[52] **U.S. Cl.** .... **96/1 LY,** 117/37 LE, 96/1.4
[51] **Int. Cl.** **G03g 13/10,** G03g 13/22
[58] **Field of Search**............................ 96/1 R, 1 LY; 117/37 LE; 355/10

[56] **References Cited**

UNITED STATES PATENTS

3,084,043	4/1963	Gundlach	96/1 LY
3,285,741	11/1966	Gesierich et al.	96/1 R
3,383,209	5/1968	Cassiers et al.	96/1 R X
3,446,649	5/1969	Degenhardt et al.	117/37 LE
3,486,922	12/1969	Cassiers et al.	117/37 LE
3,676,215	7/1972	Gundlach	117/37 LE X

OTHER PUBLICATIONS

Crawford, "Developing Electrophotographic Images," IBM Tech. Discl. Bul., Vol. 8, No. 4, Sept. 1965, p. 488.

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[57] **ABSTRACT**

Reversal prints are obtained in an electrostatographic imaging system employing polar liquid development wherein after development the electrostatographic imaging surface is discharged in the charged undeveloped areas to reduce lateral spreading of the polar liquid developer from the developed uncharged areas into the charged background areas of the imaging surface.

8 Claims, 5 Drawing Figures

FIG. 1

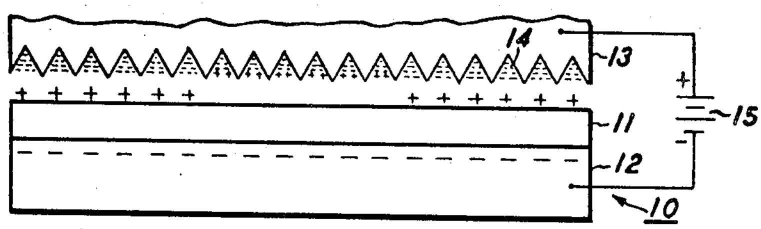


FIG. 2

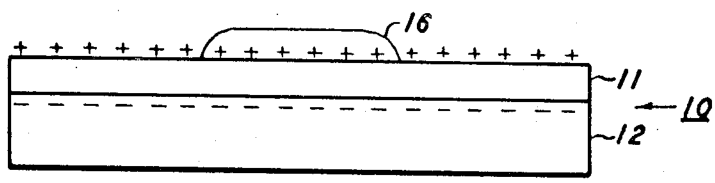


FIG. 3

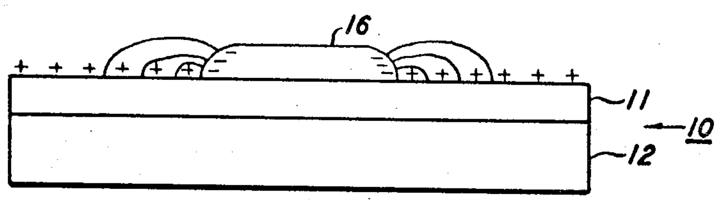


FIG. 4

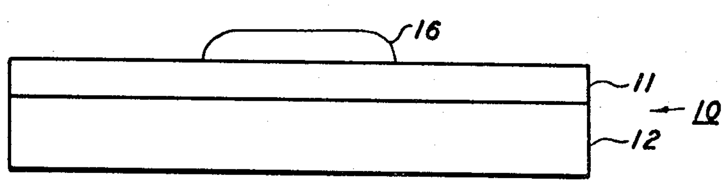
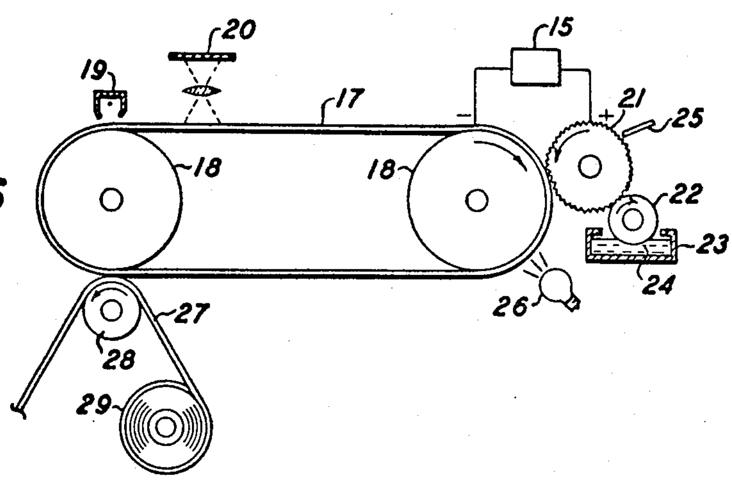


FIG. 5



REVERSAL DEVELOPMENT USING POLAR LIQUID DEVELOPERS

This is a division of application Ser. No. 104,331, filed Jan. 6, 1971.

BACKGROUND OF THE INVENTION

This invention relates to imaging systems and more particularly to improved reversal imaging systems and techniques.

The formation and development of images on the surface of photoconductive materials by electrostatic means is well known. The basic electrostatographic process, as taught by C. F. Carlson in U. S. Pat. No. 2,297,691 involves placing a uniform electrostatic charge on a photoconductive insulating layer, exposing the layer to a light and shadow image to dissipate the charge on the areas of the layer exposed to the light and developing the resulting electrostatic latent image by depositing on the image a finely divided electroscopic material referred to in the art as "toner." The toner will normally be attracted to those areas of the layer which retain a charge, thereby forming a toner image corresponding to the electrostatic latent image. This powder image may then be transferred to a support surface such as paper. The transferred image may subsequently be permanently affixed to a support surface as by heat. Instead of latent image formation by uniformly charging the photoconductive layer and then exposing the layer to a light and shadow image, one may form the latent image directly by charging the layer in image configuration. The powder image may be fixed to the photoconductive layer if elimination of the powder image transfer step is desired. Other suitable fixing means such as solvent or overcoating treatment may be substituted for the foregoing heat fixing step.

Similar methods are known for applying the electroscopic particles to the electrostatic latent image to be developed. Included within this group are the "cascade" development technique disclosed by E. N. Wise in U. S. Pat. No. 2,618,552; the "powder cloud" technique disclosed by C. F. Carlson in U. S. Pat. No. 2,221,776 and the "magnetic brush" process disclosed, for example in U. S. Pat. No. 2,874,063.

Development of an electrostatic latent image may also be achieved with liquid rather than dry developer materials. In conventional liquid development, more commonly referred to as electrophoretic development, an insulating liquid vehicle having finely divided solid material dispersed therein contacts the imaging surface in both charged and uncharged areas. Under the influence of the electric field associated with the charged image pattern, the suspended particles migrate toward the charged portions of the imaging surface separating out of the insulating liquid. This electrophoretic migration of charged particles results in the deposition of the charged particles on the imaging surface or image configuration.

A further technique for developing electrostatic latent images is the liquid development process disclosed by R. W. Gundlach in U. S. Pat. No. 3,084,043 hereinafter referred to as polar liquid development. In this method, an electrostatic latent image is developed or made visible by presenting to the imaging surface a conductive liquid developer on the surface of a developer dispensing member having a plurality of raised portions or "lands" defining a substantially regular patterned surface and a plurality of portions depressed below the raised portions or "valleys." The depressed portions of the developer dispensing member contain a layer of conductive liquid developer which is maintained out of contact with the electrostatographic imaging surface. Development is achieved by moving the developer dispensing member loaded with liquid developer in the depressed portions adjacent the imaging surface. While not necessary the imaging surface and the developer dispensing member may be in light or gentle contact. The liquid developer is believed to be selectively attracted from the depressed portions of the applicator surface in areas where an electrostatic field exists. With the use of a conventional electrophotographic plate which has been charged and exposed to a light and shadow pattern, the charged or image areas are developed. The developer liquid may be pigmented or dyed. The development system disclosed in U. S. Pat. No. 3,084,043 differs from electrophoretic development systems where substantial contact between the liquid developer and both the charged and uncharged areas of an electrostatic latent imaging surface occurs. Unlike electrophoretic development systems, substantial contact between the polar liquid and the areas of the electrostatic latent image bearing surface not to be developed is prevented in the polar liquid development technique. Reduced contact between a liquid developer and the nonimage areas of the surface to be developed is desirable because the formation of background deposits is thereby inhibited. Another characteristic which distinguishes the polar liquid development technique from electrophoretic development is the fact that the liquid phase of a polar developer actually takes part and physically moves during development in response to the electrostatic field. The liquid phase in electrophoretic developers functions only as a carrier medium for developer particles.

In copending application of Alan B. Amidon, Joseph Mammino and Robert M. Ferguson, Ser. No. 839,801, filed July 1, 1969, now abandoned, and entitled Imaging Systems, a technique is disclosed wherein an electrostatic latent image is developed by placing the imaging surface adjacent a patterned applicator surface having a substantially uniform distribution of raised portions or "lands" and depressed portions or "valleys" and containing a relatively nonconductive liquid developer in the depressed portions of the applicator. Liquid developers having a resistivity of up to about 10^{14} ohm-cm are surprisingly attracted from the depressed portions of the applicator to areas where an electrostatic field exists without any substantial electrophoretic separation of particles from the liquid. The polar liquid development technique is therefore capable of providing development with liquid developers having resistivities of from about 10^4 ohm-cm to about 10^{14} ohm-cm.

In these polar liquid development processes, a certain minimum field termed threshold field is required between the developer applicator and the imaging surface to draw the liquid developer from the recessed portions of the applicator onto the imaging surface. This threshold field may be described in terms of potential difference which typically is from about 50 to about 100 volts. Liquid developer moves from the developer applicator to the imaging surface in areas where the local difference in potential exceeds the minimum threshold potential. The polar liquid development process is therefore independent of field polarity or direction as well as of the absolute potentials of the imaging surface and the developer applicator.

While capable of producing satisfactory images, these polar liquid development systems may be improved upon in certain areas. Particular areas of improvement include those wherein reversal imaging is to be accomplished. Reversal imaging may be accomplished by biasing the developer applicator to substantially the same potential as the maximum potential on the imaging surface. By the term "substantially the same potential" it is intended to define that potential range which may be permitted where the difference in maximum potential on the imaging surface and that placed on the developer applicator is below the threshold potential. Under these conditions, with the developer dispensing member and the polar liquid developer functioning as a development electrode, the difference of potential between the developer dispensing member and the highly charged areas of the imaging surface is below the threshold potential and a maximal difference of potential, which is sufficient for development, exists between the developer dispensing member and the discharged areas of the imaging surface. Thus, in reversal development when the biased developer dispensing member is placed adjacent to that portion of the imaging surface bearing an electrostatic charge pattern, insufficient electrostatic field exists between the imaging surface and the liquid developer on the developer dispensing member since they are at substantially the same potential. Accordingly, no developer is deposited on the imaging surface in response to the charge pattern. However, in the uncharged areas of the imaging surface, sufficient field does exist since the developer dispensing member and liquid developer are at substantially the same potential as the charged portion of the imaging surface. Accordingly, charges are induced into the liquid developer in the region of the uncharged portions of the imaging surface and the polar liquid developer is attracted to the uncharged portions of the imaging surface to provide a reversal print of the original charge pattern.

When, for example, the imaging surface is a photoconductive insulating layer which has been uniformly charged and exposed in conventional manner, the charged areas correspond to the dark areas of the original light and shadow pattern, while the discharged areas are those which have been illuminated. Biasing the developer dispensing member, as described above, causes development selectively in the illuminated areas of the imaging surface.

Following development, the electrostatographic imaging surface has liquid developer present in the uncharged areas and retains the charge in image configuration in the charged area. The polar liquid developer present in the uncharged areas of the imaging surface spreads from the reversal image areas into the adjacent charged areas of the imaging surface. This is believed to be due to the fact that since the liquid developer is polar and therefore conductive, it is attracted to regions of high field gradients. The edge gradient is particularly strong in the immediately adjacent charged area surrounding the liquid developer and therefore the conductive developer tends to creep into the charged areas of the edge. This lateral spreading of the liquid developer on the imaging surface results in a reduction in resolution and very marked reduction in the sharpness of the reversal image produced during development. This spreading can be so severe in the case of broad lines that the liquid developer actually splits into two portions leaving an open space in between. In addition to the polar liquid developers being conductive and thereby contributing to lateral movement, the developers are by virtue of the fact that they are liquids more readily capable of flow to the charged areas of the imaging surface. This situation is quite unlike development with dry toner powder wherein the toner is not fluid enough to flow to adjacent charged areas but rather, is held in the image areas since the force required for movement of the dry powder into the charged areas is insufficient. It is clear, therefore, that there is a continuing need for an improved reversal imaging technique employing polar liquid development.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an imaging system which overcomes the above noted deficiencies.

It is another object of this invention to provide a reversal polar liquid development system which produces prints in which the liquid does not spread and laterally feather into nonimage areas.

It is another object of this invention to provide a polar liquid development technique capable of producing sharp high resolution, reversal images.

It is another object of this invention to provide a novel reversal polar liquid development imaging system.

It is another object of this invention to provide high resolution reversal prints which have little or no lateral feathering and good image density.

The above objects and others are accomplished generally speaking by providing an electrostatographic imaging system wherein after reversal development of an electrostatic charge pattern placed on an imaging surface, the imaging surface is discharged in the charged undeveloped areas.

More specifically, in a reversal development system employing polar liquid development, after the development step is completed in which the polar liquid is placed on the imaging surface in the noncharged areas, the charged areas of the imaging surface are discharged to at least that level where there will be substantially no lateral spread of the liquid developer on the imaging surface from the uncharged developed areas to the charged undeveloped image areas.

The electrostatographic imaging member may be discharged in any suitable manner. Typically, with an electrostatographic imaging member comprising a photoconductive insulating layer, the charge pattern may be discharged by blanket illumination of the photoconductor following development. Alternatively, the electrostatographic imaging surface may be electrostatically discharged by means, for example, of a corona discharge device. In addition, any other suitable source of radiation may be employed to discharge the charged image area of the imaging surface. Typically, the discharge is to a level such that the electrostatic field between the charged areas on the imaging surface and the polar liquid developer is insufficient to cause the polar liquid developer to spread into the charged areas. Following reversal development of the electrostatic latent image present on the electrostatographic imaging surface, spreading of the polar liquid developer is observed to take place with time. Accordingly, it is desired to discharge the charged undeveloped portions of the imaging surface as soon after development as possible. Preferably, this is accomplished within a period of time such that there is substantially no lateral spreading or feathering of the polar liquid developer into the charged areas of the imaging surface. The rate of lateral spreading is partially dependent upon the magnitude of potential on the imaging surface in the undeveloped areas and upon the viscosity of the liquid developer. Generally, with increasing magnitude of potential, the rate of spreading also increases. The rate of lateral spreading is generally inversely proportional to the viscosity of the liquid developer. Thus, for a low viscosity liquid developer, of the order of 300 centipoises, spreading will occur more rapidly than with a high viscosity developer of the order of about 5,000 centipoises. Accordingly, the period of time between development and discharge should be such as to minimize the adverse lateral spreading effects which may be attributable to these parameters. The rate of spreading may also, to a minor extent, be dependent upon the structure of the imaging surface such as its thickness and dielectric constant. Generally, for imaging systems employing polar liquid developers having viscosities of from about 300 to about 5,000 centipoises at 25°C. as measured by a Model LVT Brockfield viscometer and for imaging surfaces bearing maximum potentials of about 1,000 volts if discharge of the charged nondeveloped areas of the imaging surface is accomplished within about 0.5 seconds following development, substantially no lateral spreading of the liquid developer will take place. In insuring a minimum lateral spreading of the developer, it is preferred to discharge the charged portions of the imaging surface within about 0.2 following development.

The invention may be further illustrated by reference to the accompanying drawings in which:

FIGS. **1** through **4** are schematic illustrations of the reversal development system according to this invention.

FIG. **5** is a schematic view of a preferred imaging system.

In FIG. **1**, an electrostatographic member here illustrated as the photoconductive insulating layer **10** which comprises a photoconductive layer **11** on a conductive substrate **12** is charged and exposed to a light and shadow pattern in conventional manner to produce the electrostatic charge pattern depicted. Development is obtained by positioning a developing dispensing member **13** having a substantially uniform surface pattern of raised and depressed portions with the polar liquid developer present in the depressed portions **14** adjacent to the photoconductor. The developer dispensing member and polar liquid developer present thereon are biased to a polarity, the same as the polarity of charge placed on the photoconductor by means of potential source **15** and in an amount substantially the same as the potential applied to the image areas of the photoconductor.

FIG. **2**, substantially depicts the imaging surface immediately following development in which the polar liquid developer has been deposited in the nonimage uncharged areas of the photoconductive insulating layer.

FIG. **3** schematically illustrates the imaging surface shortly following development and after discharge of the polar liquid developer as will be discussed hereinafter. Due to the potential difference existing between the liquid developer and the surrounding charged undeveloped areas of the photoconductor, charges of opposite polarity are induced at the surface of the liquid developer adjacent the surrounding undeveloped areas which establish a field producing a force on the liquid developer outward and normal to the surface of the liquid which is sufficient to cause the liquid developer to laterally flow at the edge into the undeveloped areas.

FIG. **4** schematically illustrates the imaging surface after development and after it has been uniformly discharged to a level which reduces the field on the liquid developer to values which are insufficient to produce any significant lateral spreading of the liquid developer. Typically, this discharge of the imaging surface is to a level less than about 100 volts.

In FIG. **5**, a reversal development system is depicted wherein a photoconductor here illustrated as endless belt **17** is positioned around driving and tensioning rollers **18** and is passed through the sequential imaging operations. The photoconductor is charged by means of corona discharge device **19** and exposed to a light and shadow pattern by exposure means **20**. Development takes place by supplying liquid developer **24** from bath **23** by means of feed roll **22** to applicator roll **21**. The applicator roll has a trihelicoid grooved pattern cut into the surface and the raised portions or lands are wiped substantially clean of polar liquid developer by means of doctor blade **25**. The applicator roll and liquid developer thereon are biased to a potential substantially the same as that on the photoconductor by means of potential source **30**. Following development the electrostatographic imaging member is uniformly illuminated by means of lamp **26**. If desired the developed image on the electrostatographic imaging member may be transferred to receiving member **27**, fed into pressure contact with driving and tensioning roller **18** by means of backup roll **28**. The supply of transfer image receiving member may be either sheet like or in the form of a continuous roll fed from feed roll **29**.

The electrostatic charge pattern may be formed in any suitable manner on any suitable electrostatographic imaging surface. The electrostatic charge pattern may, for example, be formed by charging the imaging surface in image configuration or alternatively, by uniformly charging a photoconductive insulating layer and then exposing the layer to a light and shadow pattern. Basically, any surface upon which an electrostatic charge pattern may be formed and maintained for a short period of time during which it is developed may be employed. Typical electrostatographic imaging surfaces include dielectrics such as plastic coated papers, masters comprising insulating layers in image configuration on conductive substrates and photoconductors. Typical photoconductors that may be employed include selenium and selenium alloys, cadmium sulfide, cadmium sulfoselenide, phthalocyanine binder coatings and polyvinyl carbazole sensitized with 2,4,7, trinitrofluorenone. The electrostatographic imaging surface may be employed in any suitable structure including, plates, belts or drums and may be employed in the form of a binder layer coated on the substrate. The imaging surfaces may be overcoated with suitable dielectric materials in conventional manner.

Reversal development on the electrostatographic imaging surface may be obtained in any suitable manner.

Any suitable polar liquid developer may be employed. Typically, the developers for which the reversal development technique of this invention are effective have resistivities of from about 10^4 ohm-cm to about 10^{14} ohm-cm. The liquid developers employed in the practice of this invention are polar in that they have the ability of having charge of either positive or negative polarity induced in them with equal ability. Typical vehicles within this group providing these properties include glycerol, polypropylene glycol, 2,5,hexanediol, mineral oil, the vegetable oils including castor oil, peanut oil, coconut oil, sunflower seed oil, corn oil, rapeseed oil, and sesame oil. Also included are mineral spirits, fluorinated hydrocarbon oils such as duPont's Freon solvents and Krytox oils, silicone oils, fatty acid esters, kerosene, decane, toluene, and oleic acid. In addition, as is well known in the art, the developers may contain one or more secondary vehicles, dispersants, pigments or dyes, viscosity controlling agents or additives which contribute to fixing the pigment on copy paper.

The liquid developers employed may be of any suitable viscosity. Since during development it is generally desirable to have the liquid flow from the developer dispensing member to the imaging surface developers having viscosities of from about 300 to about 5,000 centipoises measured at 25°C. are preferred. Since the difficulties in the reversal development system discussed above depend to some extent on the ability of the liquid developer to flow it may be desirable to select a developer having a viscosity consistent with other development parameters and most resistant to flow. This balance between optimum viscosity for reduced spreading and viscosity necessary for any particular development speed or image density may be readily determined by one skilled in the art.

Development may be obtained by placing the applicator surface sufficiently close to the electrostatographic imaging surface such that the polar liquid developer is pulled from the recessed portions of the applicator surface to the imaging surface in the reversal image configuration. Generally, to provide maximum image density, it is preferred to place the raised portions of the applicator surface in slight or gentle contact with the imaging surface provided that the raised portions are substantially free of liquid developer. Reversal development is obtained by applying to the developer applicator a potential of the same polarity and of substantially the same magnitude as the potential applied to the charged areas of the imaging surface. This provides an electrostatic field between the uncharged areas of the imaging surface and the developer on the applicator surface. A charge is induced in the developer in response to the electrostatic field and the developer creeps up the recessed portions of the applicator surface adjacent areas of the imaging surface which are uncharged. In this development system, the developer applicator together with the polar liquid developer present on the applicator surface function as a development electrode in known manner. If for example, an electrostatographic imaging surface is positively charged and the developer applicator has applied to it a positive potential of about the same magnitude as the potential on the imaging surface, no field will exist between the developer applicator and the charged areas of the imaging surface and therefore, no liquid developer will be pulled from the recessed portions of the developer applicator to the imaging surface in the charged areas. However, in the uncharged areas of the imaging surface, a field does exist between the applicator functioning as a development electrode and the imaging surface and the polar liquid developer will be pulled from the recessed portions of the applicator surface to the imaging surface to develop the uncharged background areas providing a reversal print.

Any suitable applicator surface may be employed to dispense the polar liquid developer. Typically, the applicator surfaces have substantially uniform patterns of raised portions and depressed portions with the depressed portions being sufficiently large to hold sufficient liquid developer to provide adequate image density during development. However, to minimize wear on the imaging surfaces, it is preferred to provide raised portions which are uniformly curved or substantially flat on the surfaces which contact the imaging surface. Typical applicator surfaces include among others porous ceramics, metallic sponge, patterned webs or belts, capillary combs and cylindrical rolls having surface patterns such as single screwcuts or trihelicoid, pyramidal or quadragravure indentations. To provide good image resolution, it is preferred that the applicator surface have a pattern comprising between about 100 and 300 demarcations of raised or depressed areas per inch. Generally, with more coarse patterns, insufficient resolution is obtained and with finer patterns, insufficient loading of developer in the recessed portions is obtained to provide good image density. It is generally preferred to employ a pattern of recessed grooves such as in the trihelicoid pattern since this pattern facilitates better doctoring of the applicator surface.

The applicator surface may be loaded with developer in any suitable manner. Typical developer loading techniques include applying developer from a roll or sponge roll or immersing the applicator in a bath. Prior to contacting the imaging surface, the applicator surface should be wiped or "doctored" clean to remove substantially all liquid developer from the raised portions of the applicator surface. Any suitable means may be provided as the doctoring device. Typical doctoring devices include scraper blades and squeegee rolls. The doctoring in addition to removing liquid developer from the raised portions of the applicator surface preferably provides a slight wiping action of the liquid developer in the recessed portions of the applicator surface to thereby maintain the level of the liquid developer in the recessed portions slightly below the level of the raised portions. Such a loading of developer on the applicator surface minimizes deposits in the nonimage areas.

Following reversal development on the imaging surface, if desired, the developed image may be transferred to a receiving sheet such as ordinary paper in any suitable manner. It may, for example, be accomplished by contacting the imaging surface with the receiving member while under pressure. While pressure transfer is generally preferred because of its simplicity and effectiveness electrostatic transfer by means of a corona transfer device located at or immediately before the line of contact between the receiving surface and the imaging surface during the transfer operation may also be employed. In operation, the electrostatic field created by the corona transfer device is effective to tack the developer receiving material electrostatically to the imaging surface whereby it moves synchronously with the imaging surface while in contact. Simultaneously, the electrostatic field is effective to attract the developer in image configuration from the imaging surface and cause it to adhere electrostatically to the surface of the receiving member.

The exact mechanism involved in which the sharpness contrast and resolution of reversal images obtained in a polar liquid development technique is improved is not fully understood at the current time. Theoretically, the spreading of the polar liquid developer after development should not occur since as seen in FIG. 2 of the drawings, the liquid developer has a charge of the same polarity as is present in the charged undeveloped areas of the imaging surface and initially is of very nearly the same potential. This condition however, has not been observed. The mechanism by which the developer loses its charge is however, quite uncertain. It is speculated, for example, that the developer may not be fully charged during development. It has been suggested that a potential difference exists between the liquid developer and the surrounding charged dielectric surface, which is due to a rapid discharge of the liquid after it reaches the dielectric surface. It has been speculated that this discharge of the charged developer may take place by contact with the grounded backing behind the dielectric imaging layer, for example, through some pinhole defect in the imaging surface or perhaps by some type of charge injection mechanism through the bulk of the imaging layer. In any event, a lateral field is quickly built up between the charged portions of the imaging surface and the polar liquid developer which field exerts a force sufficient to cause the liquid developer to flow as depicted in FIG. 3. It has been observed that this flow is not necessarily uniform and in fact is quite erratic at times, suggesting that perhaps the liquid developer flows toward areas of highest potential gradients. As a result of this nonuniform advancement of the polar liquid developer on the imaging surface, it is speculated that the potential on the imaging surface varies spatially on a microscopic scale and that the developer follows a path of highest potential gradients, i.e. where the potential difference between the developer and adjacent local surface is great. Further explanation of the mechanism suggests that the edge gradient is strong not only in the discharged area, but in the immediately adjacent charged area and that the conductive developer tends to creep into the remaining charged side of the edge. Once in that position, it discharges that area. After this occurs, the position of the edge gradients will have moved forward. As it moves forward, it carries with it the potential gradient pattern. The new position of the potential gradient pattern will again cause the liquid developer to be attracted into the new edge of the charged area where it will again cause discharge. The process of spreading is a continuing one in which the polar liquid developer follows the gradient and pushes it outward as it does so. Following discharge of the undeveloped charged areas of the imaging surface according to the technique of the present invention, the difficulties encountered with the spreading of the developed polar liquid developer image are substantially completely avoided. If following development and before any substantial spreading of the liquid developer on the imaging surface occurs, the charged portions of the imaging surface are discharged to a level below which there will be insufficient potential gradient to cause the conductive liquid developer to spread images of excellent sharpness, resolution and contrast density will be achieved.

DESCRIPTION OF PREFERRED EMBODIMENTS

The following preferred nonlimiting examples further define, describe and compare preferred methods and systems of the present invention. Examples II and IV are presented for purposes of comparison. In the examples, all parts and percentages are by weight unless otherwise specified.

EXAMPLE I

An electrophotographic imaging member comprising a binder layer containing photoconductive phthalocyanine particles overcoated on a conductive substrate is charged positively to a potential between 500 and 600 volts and subsequently, imagewise exposed. Reversal development is obtained by moving the photoconductor layer past and in light contact with a cylindrical roll having a surface trihelicoid pattern of about 180 lines per inch cut at an angle of 45° to the axis of the roller. The grooved portion of the roller is supplied with polar liquid developer in a manner similar to that depicted in the development section of FIG. 4. The liquid developer is of the following composition by weight:

Light mineral oil	30 parts
Ganex V-216	15 parts
Microlith CT Black	18 parts
VM550 methyl violet tannate flushed pigment	3 parts
Paraflint RG wax	0.5 parts

Ganex V–216 is an alkylated polyvinyl pyrrolidone available from GAF corporation. Microlith CT Black is a resinated, predispersed carbon black pigment composed of about 40 percent carbon black and 60 percent ester gum resin and available from CIBA. VM550 methyl violet tannate is a pigment available from Magruder Color Company and Paraflint RG is a hydrocarbon wax available from Moore and Munger Corporation. The liquid developer has a resistivity of about 10^{10} ohm-cm. Reversal development is obtained by applying a bias of +500 volts to the developer applicator and within about 0.2 seconds following development the imaging member is blanket illuminated to discharge the charged undeveloped areas. The developed image, which is of acceptable commercial quality, is sharp and clear and characters of ordinary typewriter dimension are accurately reproduced and easily read.

EXAMPLE II

The procedure of Example I is repeated except that immediately following development, the developed image is allowed to remain on the photoreceptor in the dark for about 1 minute, after which it is blanket illuminated. When compared with the image produced in Example I, this image shows considerable ink spreading giving a feathery appearance and loss of sharpness to such a degree that ordinary typewriter size characters are not accurately reproduced and cannot be read.

EXAMPLE III

The procedure of Example I is repeated except that within about 0.5 seconds following development the electrophotographic imaging member is uniformly illuminated to discharge the charged undeveloped areas. Within 3 seconds of development, the liquid developer is transferred to ordinary bond paper. The image on bond paper is as clean and sharp and of quality comparable to Example I.

EXAMPLE IV

The procedure of Example III is repeated except that the illumination step is completely omitted. When compared to the print obtained in Example III, the image on bond paper shows considerable spreading of the liquid developer giving a very feathery appearance and marked loss of sharpness.

Although specific techniques and systems are set forth above, in the drawings and in the above exemplary embodiments employing the developer technique and system of this invention, these are merely intended as illustrations of the present invention. There are other techniques and systems such as those listed above which may be substituted for those in the examples with similar results. For example, it is contemplated that something other than the developer applicator may effectively serve as a development electrode. Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure which modifications are intended to be included within the scope of this invention.

What is claimed is:

1. A reversal imaging method comprising forming an electrostatic charge pattern corresponding to an original image on an electrostatographic imaging surface, developing the uncharged areas of the imaging surface by placing said imaging surface adjacent a developer dispensing member having a substantially uniform pattern of raised portions and depressed portions, said depressed portions containing a polar liquid developer, said raised portions of said developer applicator being substantially free of liquid developer, simultaneously placing substantially the same potential as the maximum potential on the imaging surface on the developer dispensing member such that the liquid developer is electrostatically pulled from the depressed portions of the dispensing member to the imaging surface in the uncharged areas and following development, discharging said charged areas of said imaging surface to a level such that the electrostatic field between said charged areas and the polar liquid developer is insufficient to cause substantial lateral spreading of the liquid developer into the charged areas.

2. The method of claim 1 wherein said imaging surface is a photoconductive insulating layer and said charged area is discharged by blanket illumination.

3. The method of claim 1 wherein said imaging surface is electrostatically discharged.

4. The method of claim 1 wherein said liquid developer has a bulk resistivity of from about 10^4 ohm-cm to about 10^{14} ohm-cm.

5. The method of claim 1 wherein said imaging surface is discharged within about 0.5 second after development.

6. The method of claim 1 wherein said imaging surface is discharged within about 0.2 second after development.

7. The method of claim 1 wherein after discharge of the charged areas of the polar liquid developer is transferred from the imaging surface to a developer receiving surface.

8. The method of claim 1 wherein said charged areas of said electrostatographic imaging surface are discharged following development before there is any substantial lateral spreading of the polar liquid developer into said charged areas.

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