

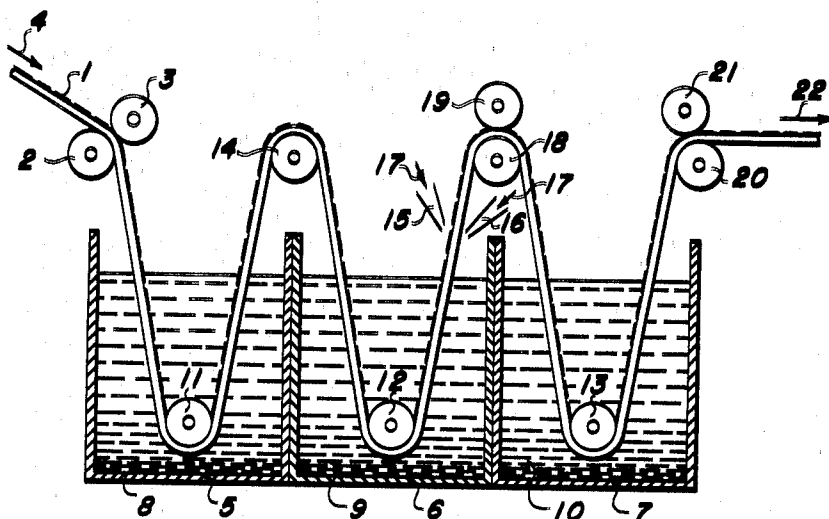
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SEIJI MATSUMOTO ET AL

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IMAGING SYSTEM

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3,671,290

IMAGING SYSTEM

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3 Claims

ABSTRACT OF THE DISCLOSURE

An electrostatic latent image bearing surface is developed with a liquid developer, rinsed with a first rinsing liquid having a boiling point between about 150° C. to about 350° C. at about atmospheric pressure, subjected to a stream of gas to remove most of the first rinsing liquid and thereafter rinsed with a second organic non-polar rinsing liquid which is soluble in and more volatile than the first rinsing liquid so as to remove developer-contaminated first rinsing liquid and any remaining background toner particles from said image bearing surface.

BACKGROUND OF THE INVENTION

This invention relates to imaging systems, and more particularly, to improved processes for developing electrostatic imaging surfaces with liquid developers.

The formation and development of images on the surface of photoconductive materials by electrostatic means is well known. One conventional process involves placing a uniform electrostatic charge on a photoconductive insulating layer comprising zinc oxide powder and a resinous binder carried on a photoconductive paper substrate, 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 charged toner which is dispersed in an insulating carrier liquid. The charged toner may be suitably colored and may have a polarity of charge identical or opposite to that of the latent image to be developed. If the polarity of the charge of the toner is identical to that of the latent image, reversal development will occur whereas a toner having a charge opposite to that of the latent image will be attracted to the latent image.

Since development is normally effected by emersion of the imaging surface in a developer bath, a thin layer of developer liquid remains on the imaged surface upon removal of the surface from the developer bath. If the thin layer of developer liquid is allowed to dry on the imaged surface, excess toner material will remain on the background areas of the imaged surface and the images will exhibit a tendency to smear. Thus, an additional cleaning step is required to reduce the effects of permitting a thin layer of developer to dry on the imaged surface. If the thin layer of liquid developer is allowed to dry completely, considerable difficulty is experienced in improving the quality of the imaged surface with a cleaning step. A thin layer of liquid developer may be removed with a squeeze roller. Unfortunately, this treatment with a squeeze roller tends to smear the imaged surface. If the imaged surface is rinsed with a rinsing liquid, image resolution is adversely affected and the resulting image is sensitive to mechanical distortion until it is completely dried. The distortion of images and the formation of background deposits is particularly acute where multi-colored images are formed because the imaging cycle is repeated for each color deposited thereby intensifying

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the distortion and background deposits. Thus, there is a continuing need for improved imaging systems.

SUMMARY OF THE INVENTION

It is therefore, an object of this invention to provide an imaging system overcoming the above-noted deficiencies.

It is another object of this invention to provide an imaging system which improves electrostatic image quality.

It is a further object of this invention to provide an imaging system which forms images having improved density.

It is still another object of this invention to provide an imaging system having reduced background deposits.

It is another object of this invention to provide an imaging system which improves multi-color image quality.

It is a further object of this invention to provide an imaging system superior to those of known imaging systems.

The above objects and others are accomplished, generally speaking, by providing an imaging member having a recording surface bearing an electrostatic latent image, developing the electrostatic latent image with a liquid developer to form an imaged recording surface having a thin layer of developer liquid thereon, treating said imaged recording surface substantially immediately after developing with a first rinse liquid of relatively low volatility, directing a stream of gas against the imaged recording surface to remove the first rinsing liquid and thereafter treating said imaged recording surface with a second rinsing liquid.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of the improved electrostatic imaging system of this invention will become further apparent upon consideration of the following disclosure, particularly when taken in conjunction with the accompanying drawing illustrating a schematic cross-sectional view of an electrostatic developing and treating apparatus of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Any conventional liquid developer comprising toner particles suspended in an electrically insulating carrier liquid may be employed. Typical liquid developers are disclosed, for example, in Xerography and Related Processes, by J. H. Dessauer and H. E. Clark, The Focal Press, 1965.

Any suitable liquid having sufficiently low volatility may be employed as the first rinsing liquid. The first rinsing liquid is readily contaminated with the thin film of liquid developer remaining on the surface of the imaged recording member after development. Thus, even after treatment with the first rinsing liquid, the imaged recording surface carries a slight amount of toner particles in the background areas. Most of the first rinsing liquid should be removed prior to application of the second rinsing liquid in order to reduce contamination of the second rinsing liquid with toner particles suspended in the first rinsing liquid. It is apparent that total removal of the first rinsing liquid prior to treatment with the second rinsing liquid should be avoided to prevent adhesion of any dry residual toner particles to the background areas of the imaged recording surface.

To prevent degradation of the deposited toner images, at least one air stream is employed to remove the contaminated first rinsing liquid from the imaged recording surface. Numerous factors affect the selection of a first rinsing liquid having a sufficiently low volatility. For example, both the temperature and velocity of the air stream

or air streams affect the rate and therefore the degree of drying of the image recording surface after treatment with the first rinsing liquid. Since total removal of the first rinsing liquid from the recording surface is undesirable, the first rinsing liquid should have a volatility sufficiently low to maintain the imaged recording surface in a dampened state after treatment with the air stream and until the second rinsing liquid is applied. Obviously, the first rinsing liquid should not adversely affect the resinous ingredient of a binder plate of a photoreceptor, if a binder plate photoreceptor is employed. Satisfactory results are obtained, for example, with non-polar organic liquids having a boiling point in the range between about 150° C. to about 350° C. at about atmospheric pressure. Typical first rinsing liquids include kerosene having a boiling range between about 180° C. to about 290° C. and the like.

Any suitable non-polar organic second rinsing liquid having a higher volatility than the first rinsing liquid may be employed. Obviously, the second rinsing liquid should also not adversely affect any resinous ingredients in the recording surface. The second rinsing liquid should also be mutually soluble with the first rinsing liquid. A second rinsing liquid having a higher volatility at about room temperature than the first rinsing liquid is desirable because more rapid drying of the imaged recording surface is achieved. Typical liquids which may be employed as the second rinsing liquid include isoparaffinic hydrocarbon solvents such as Isopar E (Esso Chemical Company) having a boiling range from about 150° C. to about 200° C., tetrachlorodifluoroethane having a boiling point from about 92.8° C., ligroin having a boiling range of about 70° C. to about 130° C. and the like.

Although it is not entirely clear, treatment with the first and second rinsing liquids enhances the stability of the deposited toner image and permits passage of the imaged recording surface between a pair of squeeze rollers after the treatment with the second rinsing liquid without any significant adverse effects on the deposited toner image. It is also not entirely clear why the rinsing operation with a mixture of the first rinsing liquid and second rinsing liquid fails to provide the degree of deposited toner image stability obtained when the imaging surface is treated with the first rinsing liquid, subjected to a stream of gas and thereafter rinsed with the second rinsing liquid.

Removal of the second rinsing liquid from the processed image recording member is preferably effected by means of squeeze rollers because more rapid and complete removal of the volatile second rinsing liquid is achieved.

Obviously, there are other modifications such as a multi-air stream treatment to remove the first rinsing liquid may be utilized. Also, it is apparent that the first rinsing liquid may be recycled and should be replenished or purified after the degree of contamination reaches an undesirable level. Surprisingly, the first rinsing liquid may be contaminated with as much as 10 percent toner material without significantly increasing the amount of background toner deposits appearing in the final imaged copy.

Referring now to the drawing, a flexible electrophotographic recording web 1 is transported into the processing apparatus by rollers 2 and 3. The rollers 2 and 3 are rotated by means not shown to move the electrophotographic paper 1 in the direction indicated by arrow 4. The recording web 1 comprises a conventional paper substrate treated to lower its electrical resistivity and coated with a photoconductive layer comprising zinc oxide particles dispersed in an insulating resin binder.

The recording web is fed into developing tank 5 with the photoconductive insulating layer on the upper surface. The photoconductive insulating layer carries an electrostatic latent image on the outer surface thereof. The surface of roller 3 is electrically insulated to avoid de-

struction of the electrostatic latent image carried on the upper surface of recording web 1. Web 1 is immersed into a conventional liquid developer 8. The periphery of roller 11 is enlarged at each end in a manner similar to wheels at each end of an axle so that only the ends of roller 11 contact recording web 1. Clearance between the axial portion of roller 11 between the enlarged end prevents contact between the axial portion of the roller and deposited toner images on the upper surface of recording web 1. The configuration of rollers 12 and 13 is similar to that of roller 11. Roller 14 is driven by means not shown to transport recording web 1 from developing tank 5 to a first rinsing tank 6. Rinsing tank 6 is filled with a first rinsing liquid 9, kerosene. Since roller 14 merely contacts the rear surface of recording web 1, the roller may comprise either insulating or conductive materials. The excess liquid developer adhering to the surfaces of recording web 1 is rinsed off in rinsing tank 6. As the recording web 1 emerges from a bath of first rinsing liquid 9, it is subjected to streams of gas directed onto the surface of recording web 1 by nozzles 15 and 16. The streams of gas remove most of the first rinsing liquid from the outer surfaces of recording web 1. Since the volatility of the first rinsing liquid is low, the outer surface of recording web 1 remains wetted with some of the first rinsing liquid after being subjected to the gas streams. Because the recording web 1 is merely wetted with the first rinsing liquid, the amount of the first rinsing liquid carried over into the second rinsing liquid, tetrachlorodifluoroethane, by recording web 1 is maintained at a minimum. Also, since the toner image carried on the recording web 1 is protected by an extremely thin film of the first rinsing liquid, no significant adverse effects are observed when the recording web 1 is transported between a pair of rollers 18 and 19. If desired, the roller 19 may be omitted. If the roller 19 is employed, a smooth polished outer surface is preferred to aid in transporting the recording web 1 into rinsing tank 7. The second rinsing liquid 10 should be highly volatile to accelerate drying of recording web 1 after processing. As a result of the treatment with the first and second rinsing liquids the deposited toner image on recording web 1 is sufficiently durable mechanically to withstand the pressures applied by squeeze rollers 20 and 21.

Since background toner deposits present a serious problem in multi-color imaging processes where one color is overprinted over another electrophotographically, the process of this invention is ideally suited to form multi-colored images having reduced background toner deposits.

Although specific materials and conditions are set forth in the foregoing examples, these are merely intended as illustrations of the present invention. Various other suitable liquid developers, rinsing liquids, photoreceptors and gaseous materials for the gas stream may be employed to sensitize, synergize or otherwise improve the imaging properties or other properties of the system. Also, conventional techniques to charge and develop the electrophotographic insulating layer may be employed, including for example, the well known double corona charging technique.

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. An imaging process comprising providing an electrostatic latent image bearing surface, contacting said electrostatic latent image bearing surface with a liquid developer comprising toner particles and an electrically insulating carrier liquid whereby at least a portion of said toner particles deposits on said surface in image configuration to form a deposited toner image, rinsing said surface bearing said deposited toner image with a first non-polar organic rinsing liquid having a boiling point between about 150° C. to about 350° C. at about atmos-

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pheric pressure, directing a stream of gas against said surface bearing said deposited toner image to remove excess first rinsing liquid whereby the surface bearing said toner image is merely wetted with said first rinsing liquid, and rinsing said surface bearing said toner image with a second organic non-polar organic rinsing liquid which is mutually soluble with said first rinsing liquid and which is more volatile at about room temperature than said first rinsing liquid, so as to remove developer-contaminated first rinsing liquid and any remaining background toner particles from said image bearing surface.

2. An imaging process according to claim 1 including removing said second rinsing liquid from surface bearing said deposited toner image by contacting said surface with a roller.

3. An imaging process according to claim 1 including rinsing said surface bearing said deposited toner image with said first rinsing liquid substantially immediately after said toner image is deposited.

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References Cited

UNITED STATES PATENTS

	3,276,896	10/1966	Fisher	117—37
	3,038,073	6/1962	Johnson	117—37 X
5	3,509,061	4/1970	Zisman et al.	134—40 X
	2,570,627	10/1951	Albin	95—94
	2,940,847	6/1960	Kaprelian	117—37 X
	3,368,526	2/1968	Matsumoto et al.	118—637
	3,330,189	7/1967	Vil	118—637 X
10	3,023,686	3/1962	Meyer	95—94
	3,356,497	12/1967	Moe et al.	96—1
	3,356,498	12/1967	Moe et al.	96—1

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