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(54) Color mixing and control system for use in an electrostatographic printing machine

(57) A system and method for color mixing control in a developing material-based electrostatographic printing system. A developing reservoir containing an operative solution of customer selectable colored developing material is continuously replenished with selectively variable amounts of basic color components making up the operative solution by controlling the rate of replenishment of various color components added to the supply reservoir. A spectrophotometer is used to measure the optical spectrum of the developing material in the supply reservoir so that the actual optical spectrum thereof can be brought into agreement with a target optical spectrum associated with a customer selectable color. The present invention can be used to control and maintain the color of the developing material in the reservoir through continuous monitoring and correction in order to maintain a particular ratio of color components in the reservoir over extended periods associated with very long print runs. The present invention may also be utilized to mix a customer selectable color *in situ,* whereby approximate amounts of primary color components are initially deposited and mixed in the developing material reservoir and the resultant developing material mixture is continually monitored and adjusted until the mixture reaches a target optical spectrum.

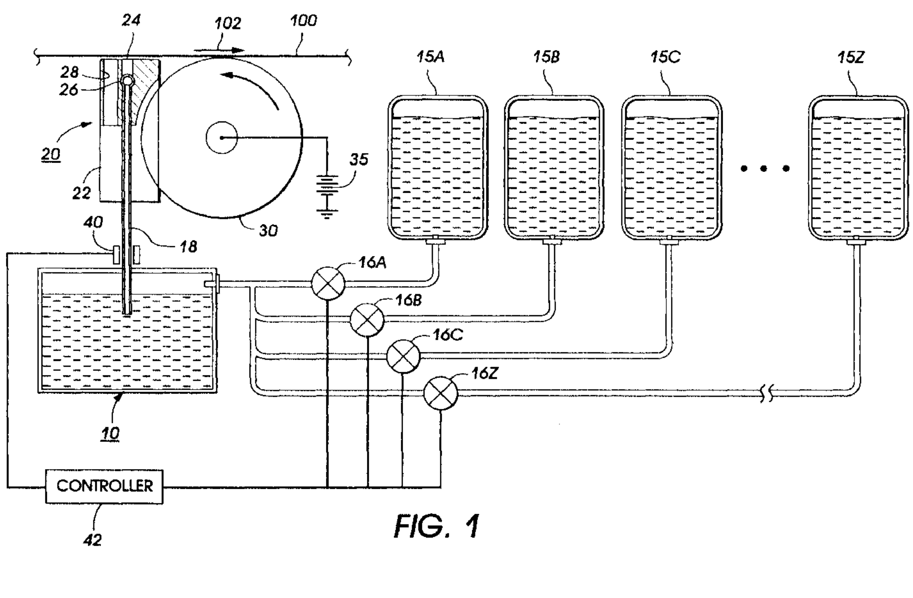

FIG. 1

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Description

This invention relates generally to a development system for creating highlight color output images in an electrostatographic printing machine and, more particularly, concerns a system for providing customized color mixing and control in an electrostatographic printing system using dry or liquid developing materials. The color mixing and control system operates by sensing the color of the developing material comprising several basic color components to control the mixture of color components making up the developing material.

It is well known that conventional electrostatographic reproduction processes can be adapted to produce multicolor images. For example, the charged photoconductive member may be sequentially exposed to a series of color separated images corresponding to the primary colors in an input image in order to form a plurality of color separated latent images. Each color separated image is developed with a complimentary developing material containing a primary color or a colorant which is the subtractive compliment of the color separated image, with each developed color separated image subsequently superimposed, in registration, on one another to produce a multicolor image output. Thus, a multicolor image is generated from patterns of different primary colors or their subtractive compliments which are blended by the eye to create a visual perception of a color image.

With the capabilities of electrostatographic technology moving into multicolor imaging, advances have also been directed to the creation of so-called "highlight color" images, wherein independent, differently colored, monochrome images are created on a single output copy sheet, preferably in a single processing cycle. Likewise, "spot color" and/or "high-fidelity" color printing has been developed, wherein a printing system capable of producing process color output images is augmented with an additional developer housing containing an additional color beyond the primary or subtractive colors used to produce the process color output. This additional developer housing is used for developing an independent image with a specific color (spot color) or for extending the color gamut of the process color output (high fidelity color). As such, several concepts derived from conventional electrostatographic imaging techniques which were previously directed to monochrome and/or process color image formation have been modified to generate output images having selected areas that are different in color than the rest of the document. Applications of highlight spot and high fidelity color include, for example, emphasis on important information, accentuation of titles, and more generally, differentiation of specific areas of text or other image information.

One exemplary highlight color process is described in U.S. Pat. No. 4,078,929 to Gundlach, wherein independent images are created using a raster output scanner to form a tri-level image including a pair of image areas having different potential values and a non-image background area generally having a potential value intermediate the two image areas.

One specific application of highlight color processing is customer selectable color printing, wherein a very specific highlight color is required. Customer selectable colors are typically utilized to provide instant identification and authenticity to a document. As such, the customer is usually highly concerned that the color meets particular color specifications. For example, the red color associated with Xerox' digital stylized "X" is a customer selectable color having a particular shade, hue and color value. Likewise, the particular shade of orange associated with Syracuse University is a good example of a customer selectable color. A more specialized example of customer selectable color output can be found in the field of custom color, which specifically refers to registered proprietary colors, such as used, for example, in corporate logos, authorized letterhead and official seals. The yellow associated with Kodak brand products, and the brown associated with Hershey brand products are good examples of custom colors which are required to meet exacting color standards in a highlight color or spot color printing application.

The various colors typically utilized for standard highlighting processes generally do not precisely match customer selectable colors. Moreover, customer selectable colors typically cannot be accurately generated via halftone process color methods because the production of solid image areas of a particular color using halftone image processing techniques typically yields nonuniformity of the color in the image area. Further, lines and text produced by halftone process color are very sensitive to misregistration of the multiple color images such that blurring, color variances, and other image quality defects may result.

As a result of the deficiencies noted above, customer selectable color production in electrostatographic printing systems is typically carried out by providing a singular premixed developing material composition made up of a mixture of multiple color toner particles blended in preselected concentrations for producing the desired customer selectable color output. This method of mixing multiple color toners to produce a particular color developing material is analogous to processes used to produce customer selectable color paints and inks. In offset printing, for example, a customer selectable color output image is produced by printing a solid image pattern with a premixed customer selectable color printing ink as opposed to printing a plurality of halftone image patterns with various primary colors or compliments thereof. This concept has generally been extended to electrostatographic printing technology, as disclosed, for example, in U.S. Patent No. 5,557,393, wherein an electrostatic latent image is developed by a dry powder developing material comprising two or more compatible toner compositions to produce a customer selectable color output.

Customer selectable color printing materials including paints, printing inks and developing materials can be manufactured by determining precise amounts of constituent basic color components making up a given customer selectable color material, providing precisely measured amounts of each constituent basic color component, and thoroughly mixing these color components. This process is commonly facilitated by reference to a color guide or swatch book containing hundreds or even thousands of swatches illustrating different colors, wherein each color swatch is associated with a specific formulation of colorants. Probably the most popular of these color guides is published by Pantone®, Inc. of Moonachie, New Jersey. The Pantone® Color Formula Guide expresses colors using a certified matching system and provides the precise formulation necessary to produce a specific customer selectable color by physically intermixing predetermined concentrations of up to four colors from a set of up to 18 principal or basic colors. There are many colors available using the Pantone® system or other color formula guides of this nature that cannot be produced via typical halftone process color methods.

The present invention contemplates a development system including a color mixing and control system, wherein the color value of the developing material in a supply reservoir can be controlled and the rate of replenishment of various color components added to the supply reservoir can be selectively varied. By adding precise amounts of specific colors from a set of basic color components, the actual color of the developing material in the reservoir is brought into agreement with a predetermined selected color in order to produce a wide range of customer selectable color liquid developing materials. Moreover, by monitoring the output color of an image produced by the mixed developing materials, and controlling the replenishment process in response thereto, a wide range of customer selectable color liquid developing materials can be produced and maintained over very long print runs.

In accordance with one aspect of the present invention, a system for providing a selected color developing material in an electrostatographic printing machine for producing a customer selectable color output image is provided, comprising: a plurality of developing material supply receptacles, each containing a different color developing material concentrate corresponding to a basic color component of a color matching system; a developing material reservoir for providing a supply of the selected color developing material, the developing material reservoir having at least two of the plurality of developing material supply receptacles coupled thereto; and a system for systematically dispensing a selective amount of developing material concentrate from at least a selected one of the plurality of developing material supply receptacles to the developing material reservoir for providing a selected amount of a selected basic color component to the supply of selected color developing material.

In accordance with another aspect of the present invention, there is provided an apparatus for developing an electrostatic latent image with a developing material having a specified color value. This developing apparatus comprises: a plurality of developing material supply dispensers, each containing a differently colored developing material concentrate corresponding to a basic color component of a color matching system; a developing material reservoir, for providing an operative supply of developing material having the specified color value, the reservoir having at lest one of the developing material supply dispensers coupled thereto; and a system for systematically dispensing a selected amount of developing material concentrate from at least a selected one of the developing material supply dispensers to the developing material reservoir to provide a selected basic color component to the operative supply of developing material.

In accordance with a further aspect of the present invention, an electrostatographic printing process is provided, wherein at least a portion of an electrostatic latent image is developed with a developing material having a specified color value. The process comprises the steps of: providing a plurality of differently colored developing concentrate materials corresponding to a plurality of basic color components of a color matching system; selectively delivering at least one of the plurality of differently colored developing concentrate materials to a developing material reservoir for producing an operative supply of developing material having the specified color value; and systematically dispensing a selected amount of developing material concentrate of a selected basic color component to the developing material reservoir for providing a selected basic color component to the operative supply of developing material.

Another important aspect of the present invention is that the process and apparatus thereof may be utilized to mix a customer selectable color *in situ,* whereby the dispensing system is adapted to initially deliver approximate amounts of basic color to the developing material reservoir, and sensing and control systems are provided to continually monitor the developing material mixture and systematically dispense selective amounts of selected basic color components to the reservoir until the mixture reaches a target spectrum.

Other aspects of the present invention will become apparent as the following description proceeds and upon reference to FIG. 1, which provides a schematic, elevational view of an exemplary liquid developing material applicator and an exemplary liquid developing material development system incorporating a liquid developing material color mixing and control system in accordance with the present invention. While the present invention will be described with respect to a liquid developing apparatus, it will be understood that the mixing and control system of the present invention is not limited to liquid developing materials and may be utilized in dry powder electrostatographic applications as well as liquid electrostatographic applications.

While the present invention may find particular application in tri-level highlight color imaging, it will become apparent from the following discussion that the color mixing and control system of the present invention may be equally wellsuited for use in a wide variety of printing machines and is not necessarily limited in its application to the particular single-pass highlight tri-level electrostatographic process described by Gundlach. In fact, it is intended that the color mixing and control system of the present invention may be extended to any electrostatographic printing process intended to produce a customer selectable color image area including multi-color printing machines which may be provided with an ancillary customer selectable color development housing, as well as printing machines which carry out ionographic printing processes and the like. More generally, while the color mixing and control system of the present invention will hereinafter be described in connection with one of numerous various embodiments thereof, it will be understood that the description of the invention is not intended to limit the scope of the present invention to this preferred embodiment. On the contrary, the present invention is intended to cover all alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning now to FIG. 1, an exemplary apparatus for developing an electrostatic latent image, wherein liquid developing materials are utilized is depicted in schematic form. Typically, a highlight color electrostatographic printing machine would include at least two developing apparatus operating with different color liquid developing materials for developing latent image areas into different colored visible images. By way of example, in a tri-level system of the type described hereinabove, a first developer apparatus might be utilized to develop the positively charged image area with black colored liquid developing material, while a second developer apparatus might be used to develop the negatively charged image area image with a customized color. In the case of liquid developing materials, each different color developing material comprises pigmented toner or marking particles, as well as charge control additives and charge directors, all disseminated through a liquid carrier, wherein the marking particles are charged to a polarity opposite in polarity to the charged latent image to be developed.

The developing apparatus of FIG. 1 operates primarily to transport liquid developer material into contact with a latent image on a photoreceptor surface, generally identified by reference numeral 100, wherein the marking particles are attracted, via electrophoresis, to the electrostatic latent image for creating a visible developed image thereof. With respect to the developing material transport and application process, the basic manner of operation of each developer apparatus is generally identical to one another and the developing apparatus shown in FIG. 1 represents only one of various known apparatus that can be utilized to apply liquid developing material to the photoconductive surface. It will be understood that the basic development system incorporating the mixing and control system of the present invention may be directed to liquid or dry powder development, and may take many forms, as for example, systems described in U.S. Patents 3,357,402; 3,618,552; 4,733,273; 4,883,018; 5,270,782 and 5,355,201. Such development systems may be utilized in a multicolor electrophotographic printing machine, a highlight color machine, or in a monochromatic printing machine.

Focusing on the development process before describing the color mixing and control system of the present invention, in the exemplary developing apparatus of FIG. 1, liquid developing material is transported from an supply reservoir 10 to the latent image on the photoreceptor 100 via a liquid developing material applicator 20. Supply reservoir 10 acts as a holding receptacle for providing an operative solution of liquid developing material comprised of liquid carrier, a charge director compound, and toner material, which, in the case of the customer selectable color application of the present invention, includes a blend of different colored marking particles. In accordance with the present invention, a plurality of replaceable supply dispensers 15A - 15Z, each containing a concentrated supply of marking particles and carrier liquid corresponding to a basic color component in a color matching system, are provided in association with the operational supply reservoir 10 and coupled thereto for replenishing the liquid developing material therein, as will be described.

The exemplary developing material applicator 20 includes a housing 22, having an elongated aperture 24 extending along a longitudinal axis thereof so as to be oriented substantially transverse to the surface of photoreceptor 100, along the direction of travel thereof as indicated by arrow 102. The aperture 24 is coupled to an inlet port 26 which is further coupled to reservoir 10 via transport conduit 18. Transport conduit 18 operates in conjunction with aperture 24 to provide a path of travel for liquid developing material being transported from reservoir 10 and also defines a developing material application region in which the liquid developing material can freely flow in order to contact the surface of the photoreceptor belt 100 for developing the latent image thereon. Thus, liquid developing material is pumped or otherwise transported from the supply reservoir 10 to the applicator 20 through at least one inlet port 26, such that the liquid developing material flows out of the elongated aperture 24 and into contact with the surface of photoreceptor belt 100. An overflow drainage channel (not shown), partially surrounds the aperture 24, may also be provided for collecting excess developing material which may not be transferred over to the photoreceptor surface during development. Such an overflow channel would be connected to an outlet channel 28 for removal of excess or extraneous liquid developing material and, preferably, for directing this excess material back to reservoir 10 or to a waste sump whereat the liquid developing material can preferably be collected and the individual components thereof can be recycled for subsequent use.

Slightly downstream of and adjacent to the developing material applicator 20, in the direction of movement of the photoreceptor surface 100, is an electrically biased developer roller 30, the peripheral surface thereof being situated in close proximity to the surface of the photoreceptor 100. The developer roller 30 rotates in a direction opposite the movement of the photoconductor surface 100 so as to apply a substantial shear force to the thin layer of liquid developing material present in the area of the nip between the developer roller 30 and the photoreceptor 100, for minimizing the thickness of the liquid developing material on the surface thereof. This shear force removes a predetermined amount of excess liquid developing material from the surface of the photoreceptor and transports this excess developing material in the direction of the developing material applicator 20. The excess developing material eventually falls away from the rotating metering roll for collection in the reservoir 10 or a waste sump (not shown). A DC power supply 35 is also provided for maintaining an electrical bias on the metering roll 30 at a selected polarity and magnitude such that image areas of the electrostatic latent image on the photoconductive surface will attract marking particles from the developing material for developing the electrostatic latent image. This electrophoretic development process minimizes the existence of marking particles in background regions and maximizes the deposit of marking particles in image areas on the photoreceptor.

In operation, liquid developing material is transported in the direction of the photoreceptor 100, filling the gap between the surface of the photoreceptor and the liquid developing material applicator 20. As the belt 100 moves in the direction of arrow 102, a portion of the liquid developing material in contact with the photoreceptor moves therewith toward the developing roll 30 where marking particles in the liquid developer material are attracted to the electrostatic latent image areas on the photoreceptor. The developing roller 30 also meters a predetermined amount of liquid developing material adhering to the photoconductive surface of belt 100 and acts as a seal to prevent extraneous liquid developing material from being carried on by the photoreceptor.

The application of developing material to the photoconductive surface clearly depletes the overall amount of the operative solution of developing material in supply reservoir 10. In the case of the liquid developing materials, marking particles are depleted in the image areas; carrier liquid is depleted in the image areas (trapped by marking particles) and in background areas, and may also be depleted by evaporation; and charge director is depleted in the image areas (trapped in the carrier liquid), in the image areas adsorbed onto marking particles, and in the background areas. In general practice, therefore, reservoir 10 is continuously replenished, as necessary, by the addition of developing material or selective components thereof, for example in the case of liquid developing materials, by the addition of liquid carrier, marking particles, and/or charge director into the supply reservoir 10. Since the total amount of any one component making up the developing material utilized to develop the image may vary as a function of the area of the developed image areas and the background portions of the latent image on the photoconductive surface, the specific amount of each component of the liquid developing material which must be added to the supply reservoir 10 varies with each development cycle. For example, a developed image having a large proportion of printed image area will cause a greater depletion of marking particles and/or charge director from a developing material reservoir as compared to a developed image with a small amount of printed image area.

The present invention provides contemplates a liquid developing material replenishing system capable of systematically replenishing individual color components making up a customer selectable color liquid developing material composition. As such, the replenishment system of the present invention includes a plurality of differently colored developing material supply dispensers 15A, 15B, 15C, ... 15Z, each coupled to the operative supply reservoir via an associated valve member 16A, 16B 16C, ... 16Z, or other appropriate liquid flow control device. Preferably, each supply dispenser contains a developing material concentrate of a known basic or primary color such as Cyan, Magenta, and Yellow. In one specific embodiment, the replenishment system includes sixteen supply dispensers, wherein each supply container provides a different basic color liquid developing material corresponding to the sixteen basic or constituent colors of the Pantone® Color Matching System. This embodiment contemplates that color formulations conveniently provided by the Pantone® System can be utilized to produce more than a thousand desirable colors and shades in a customer selectable color printing environment. Using this system, as few as two different color liquid developing materials, from supply containers 15A and 15B for example, can be combined in reservoir 10 to expand the color gamut of customer selectable colors far beyond the colors available via halftone imaging techniques.

An essential component of the developing material color mixing and control system of the present invention is a color control system. That is, since different components of the blended liquid developing material in reservoir 10 may develop at different rates, a customer selectable color mixing controller 42 is provided in order to determine appropriate amounts of each color liquid developing material in supply containers 15A, 15B...or 15Z which can be systematically added to supply reservoir 10, and to controllably supply each of such appropriate amounts of liquid developing material. Controller 42 may take the form of any known microprocessor based memory and processing device, as are well known in the art.

The approach provided by the color mixing control system of the present invention includes a sensing device 40, for example an optical sensor for monitoring the color of the liquid developing material in the reservoir 10. While this sensing device 40 is shown in FIG. 1 in a position so as to monitor the liquid developing material being transported from the liquid developing material reservoir 10 to the developing material applicator 20, it will be understood by those of skill in the art that various multi-wavelength light attenuation sensors may be utilized to detect the color of the liquid developing material including devices which are submerged in the liquid developing material reservoir 10, or devices which monitor the light attenuation across the entire volume of the reservoir 10. At any rate, sensor 40 is connected to controller 42 for controlling the flow of the variously colored replenishing liquid developing materials from dispensers 15A - 15Z, corresponding to the basic constituent colors of a color matching system, to be delivered into the liquid developing material supply reservoir 10 from each of the supply containers 15A - 15Z. In a preferred embodiment, as shown in FIG. 1, the controller 42 is coupled to control valves 16A - 16Z for selective actuation thereof to control the flow of liquid developing material from each supply container 15A - 15Z. It will be understood that these valves may be replaced by pump devices or any other suitable flow control mechanisms as known in the art, so as to be substituted thereby.

In one particular embodiment of the present invention, sensor 40 is provided in the form of a spectrophotometer of the type well known in the art, such that spectrographic methods can be utilized to provide color mixing control. Thus, a spectrophotometer typically measures an optical spectrum associated with a given color sample, such as the transmission spectrum of a blended liquid developing material (or the reflection emission spectrum of a blended powder developing material) in the reservoir 10 and can also measure the emission spectrum of certain developing materials such as fluoroscents and the like. This optical spectrum is subsequently transmitted to the controller 42, which compares the measured optical spectrum to the optical spectrum of the desired output color (stored in memory). This information, in combination with the known transmission, reflection and/or emission spectra of each of the primary color components contained in supply containers 15A - 15Z, is used to determine the appropriate amounts of each color component which should be added to the reservoir 10 via actuation of valves 16A - 16Z, respectively.

One method of carrying out the color mixing control process provided by the present invention will be described as follows: Initially, the transmission spectrum of a liquid developing material mixture made up of two or more color components can be successfully approximated as

$$T(\lambda) \approx Exp\left[-w_a \alpha_a(\lambda) - w_b \alpha_b(\lambda) - \ldots\right]$$

where $w_{a\text{-}z\ldots}$ are weight percentage solids of the primary color components found in each of the supply containers 15A - 15Z. Likewise, the $\alpha_{a\text{-}z}$ represent extinction and/or emission functions of the primary color components making up the liquid developer material mixture in the reservoir 10. The target color can be represented by its transmission spectrum $T^0(\lambda)$. Thus, the color control provided by the present invention can be achieved by maintaining the color of the liquid developing material mixture in reservoir 10 equivalent to the target color transmission spectrum $T^0(\lambda)$. Thus, the color control provided by the present invention an be achieved by maintaining the color of the liquid developing material mixture in reservoir 10 equivalent to the target color transmission spectrum $T^0(\lambda)$.

A general and powerful method for calculating toner correction from the difference between the transmission spectra of the liquid developing material in the reservoir 10 and the target transmission spectra can be achieved by approximating the target color transmission spectrum as follows:

$$T^0(\lambda) \approx Exp\left[-w_a^0 \alpha_a(\lambda) - w_b^0\, \alpha_b(\lambda) - \ldots\right]$$

After each transmission spectrum measurement the difference between the transmission spectrum of the measured sample and the target transmission spectrum can be defined as follows:

$$D(\lambda) \equiv Ln\left[T(\lambda)\right] - Ln\left[T^0(\lambda)\right] \approx \left(w_a^0 - w_a\right)\alpha_a(\lambda) + \left(w_b^0 - w_b\right)\alpha_b(\lambda) - \ldots,$$

wherein an error can be defined as follows:

$$\text{Error} \equiv \Sigma_\lambda \{D(\lambda) - \delta_a \alpha_a(\lambda) - \delta_b \alpha_b(\lambda) - \ldots\}^2,$$

The correction necessary from any given primary developing material component provided by containers 15A - 15Z can therefore be given by:

$$\delta_i \equiv w_i^0 - w_i \qquad , I = a, b, ...$$

wherein the $\delta_{a\text{-}z}$ necessary to minimize error are found from:

$$\partial(Error) / \partial \delta_i) = 0$$

The foregoing calculations yield N equations corresponding to the number of corrections necessary for each color component of the liquid developing material in reservoir 10. These equations can be solved by standard mathematical methods such that the corrections to the basic color component concentrations in the reservoir 10 can be calculated without having explicit toner concentration values for the target concentrations (w_i^0), or the current concentrations (w_i) although they may be known in some embodiments.

It will be understood that, for any given primary color component, if $w_i^0 - w_i$ is greater than 0, then that primary color component should be added to the reservoir 10. Conversely, the concentration of a given color component can, if necessary, be reduced in the liquid developing material reservoir 10 by simply adding carrier liquid thereto. Further, it should be noted that the mere addition of developing material concentrate from one of the containers may result in the simultaneous increase in the weight percent solids of that particular primary component while decreasing the weight percent solids of another color component.

It will be understood that, the forgoing algorithm description represents one of numerous various methods for controlling the mixture of color components in order to provide a specified color output. Alternative methods, including the use of the so-called "p-matrix" algorithm, as described in U.S. Patent No. 5, 512,978, or the use of a double beam spectrophotometer may be considered to be suitable in the practice of the present invention

In review, the present invention provides a system and method for color mixing control in an electrostatographic printing system. A developing reservoir containing an operative solution of customer selectable colored developing material is continuously replenished with the color thereof being controlled and maintained by selectively varying the rate of replenishment of various color components added to the supply reservoir. A spectrophotometer is used to measure the optical spectrum of the developing material in the supply reservoir so that the actual spectrum thereof can be brought into agreement with a target spectrum. The present invention can be used to control and maintain the color of the developing material in the reservoir through continuous monitoring and correction thereof in order to maintain a particular ratio of color components in the reservoir over extended periods associated with very long print runs. The present invention may also be utilized to mix a customer selectable color *in situ,* whereby approximate amounts of primary color components are initially deposited and mixed in the developing material reservoir, this developing material mixture being continually monitored and adjusted until the mixture reaches a target spectrum.

Claims

1. A system for providing a selected color developing material in an electrostatographic printing machine for producing a customer selectable color output image, comprising:

   a plurality of developing material supply receptacles (15A,15B,15C...15Z), each containing a different color developing material concentrate corresponding to a basic color component of a color matching system;
   a developing material reservoir (10) for providing a supply of the selected color developing material, said developing material reservoir having at least two of said plurality of developing material supply receptacles (15A,15B,15C...15Z) coupled thereto; and
   a system including a color sensing device (40) for sensing the color of said supply of the selected color developing material for systematically dispensing a selective amount of developing material concentrate from at least a selected one of said plurality of developing material supply receptacles (15A,15B,15C...15Z) to said developing material reservoir (10) for providing a selected amount of a selected basic color component to said supply of selected color developing material wherein said color sensing device (40) includes a spectrophotometer for sensing an optical spectrum of the selected color developing material.

2. The system of claim 1, wherein said spectrophotometer is adapted for measuring a transmission, a reflactance or an omission spectrum of said supply of the selected color developing material.

3. The system of any of claims 1 to 2, further including a control system (42) coupled to said color sensing device

(40) for selectively actuating said systematic dispensing system in response to the sensed color of said supply of the selected color developing material to adjust the selected color developing material so as to produce the customer selectable color output image.

4. The system of claim 3, wherein the customer selectable color is selected from a color guide illustrating a plurality of different colors, wherein said color guide further provides a specific formulation of basic color components necessary to produce the selected color, and further wherein said control system (42) is adapted to automatically blend predetermined amounts of basic color components in accordance with the specific formulation provided by said color guide.

5. The system of claim 4, wherein the control system (42) is adapted to add selected amounts of basic color components to said supply of the selected color developing material in response to the sensed color thereof for correcting the selected color developing material to match the customer selectable color selected from the color guide.

6. The system of any of claims 3 to 5, wherein the control system is adapted to compare an optical spectrum of the selected color developing material from said sensing device (40) to a target optical spectrum corresponding to said customer selectable color.

7. An apparatus for developing an electrostatic latent image with a developing material having a specified color value, comprising:

a plurality of developing material supply receptacles (15A,15B,15C...15Z), each containing a differently colored developing material concentrate corresponding to a basic color component of a color matching system;
a developing material reservoir (10), having at least one of said developing material supply receptacles (15A, 15B,15C...15Z) coupled thereto, for providing a supply of operative developing material having the specified color value; and
a system, including a color sensing device (40) for monitoring the color of said supply of operative developing material, for systematically dispensing a selected amount of developing material concentrate from at least a selected one of said developing material supply receptacles (15A,15B,15C...15Z) to said developing material reservoir (10) to provide a selected basic color component to said supply of operative developing material wherein said sensing device (40) includes a spectrophotometer for sensing an optical spectrum of the supply of operative developing material.

8. The apparatus of claim 7, including a control system (42) coupled to said sensing device (40) for selectively actuating said systematic dispensing system, wherein said control system includes:

means for determining a weight percent solids for each of the basic color components making up said supply of operative developing material in said developing material reservoir; and
means for providing a spectral function for each of the basic color components making up said supply of operative developing material in said developing material reservoir;
means for comparing the weight percent solids and the spectral function for each of the basic color components making up said supply of operative developing material in said developing material reservoir against the weight percent solids and the spectral function for each of the basic color components making up a desired customer selectable color output; and
means for calculating a correction function corresponding to an amount of each basic color component which must be added to said supply of operative developing material to produce the desired customer selectable color in said reservoir.

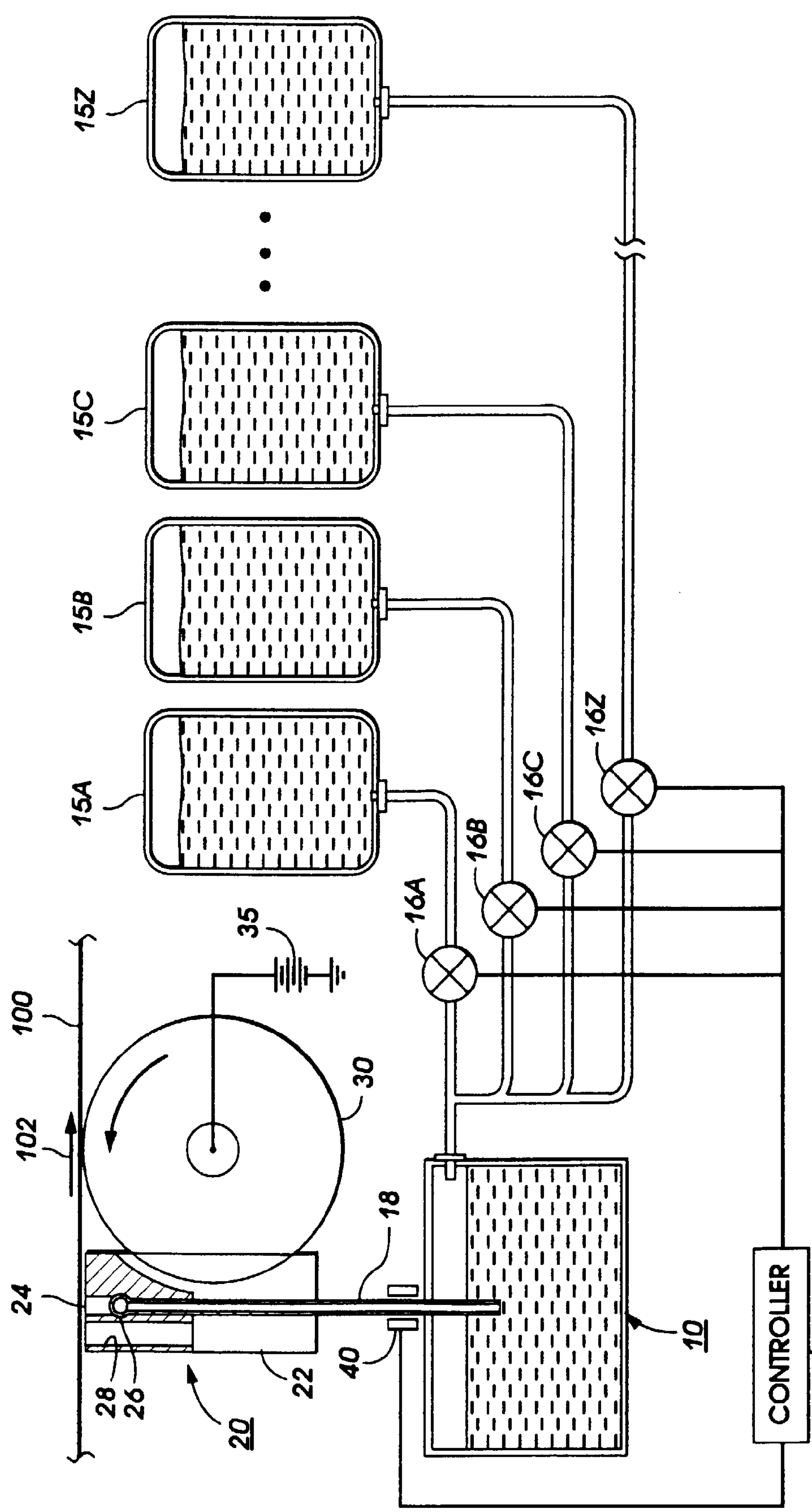
9. The apparatus of either of claims 8 or 9, further including a developing material applicator (20) coupled to said developing material supply reservoir (10), adapted for transporting developing material into contact with the electrostatic latent image.

10. An electrostatographic printing process wherein at least a portion of an electrostatic latent image is developed with a developing material having a specified color, comprising the steps of:

providing a plurality of differently colored developing concentrate materials, each corresponding to a basic color component of a color matching system;
selectively delivering at least one of said plurality of differently colored developing concentrate materials to a

developing material reservoir (10) for producing an operative supply of developing material having the specified color value;
systematically dispensing a selected amount of developing material concentrate of a selected basic color component to said developing material reservoir (10) for providing a selected basic color component to said operative supply of developing material; and
monitoring the color of said supply of operative developing material,

wherein said sensing step includes measuring an optical transmission spectrum of said supply of operative developing material.


15A
15B
15C
15Z
16A
16B
16C
16Z
35
100
102
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18
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28
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40
10
CONTROLLER
42

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 30 7325

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 111 151 A (RUCKDESCHEL FREDERICK R) * the whole document *	1,7,10	G03G15/10 G03G15/01 G03G15/08
X	US 4 113 371 A (FRASER LAWRENCE J ET AL) * the whole document *	1,7,10	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	4 December 1997	Hoppe, H

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X : particularly relevant if taken alone
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