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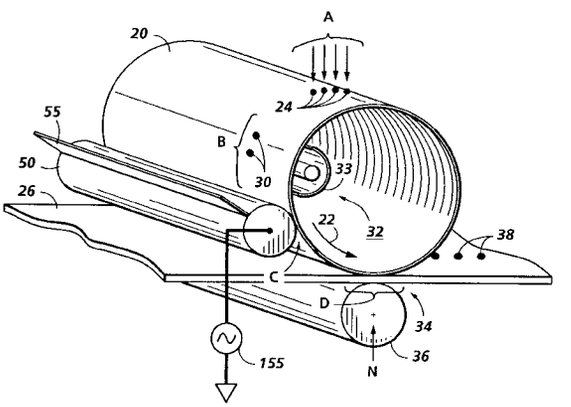
(54) Apparatus and method for conditioning a dry toner image

(57) Apparatus for color printing which employs a conditioning roller (50) for conditioning a dry toner image (24). An intermediate member (20) first acts as a receptor for marking particles representing an image, whereby the marking particles may be deposited directly or indirectly on the member. The member is then exposed, via an internal heat source (32), to an elevated temperature sufficient to cause the melting and coalescing of the marking particles. The tackified image (30) is condition by a conditioning roller. The rollers create a thinner, more cohesive image without degradation of the image for subsequent imaging. In a multicolor printing configuration, the intermediate member is advanced and at least a second color marking particles is deposited onto the previous image. The image is again conditioned by the conditioning roller. When the multicolor, tackified image is completed, or for monochrome printing, when the single color image is completed, the intermediate member is advanced so as to place the multicolored tackified marking particles present on the outer surface thereof into intimate contact with the surface of a recording sheet (26).

FIG. 1



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Description

This invention relates generally to development of dry toner images on an intermediate member, and more particularly to a method and apparatus for conditioning the dry toner image on the intermediate member prior to transferring the image to a recording sheet.

A typical electrostatographic printing machine (such as a photocopier, laser printer, facsimile machine or the like) employs an imaging member that is exposed to an image to be printed. Exposure of the imaging member records an electrostatic latent image on it corresponding to the informational areas contained within the image to be printed. The latent image is developed by bringing a developer material into contact therewith. The developed image recorded on the photoconductive member is transferred to a support material such as paper either directly or via an intermediate transport member. The developed image on the support material is generally subjected to heat and/or pressure to permanently fuse it thereto.

Development with dry developers in mono color imaging processes has many advantages over liquid developers, such as, for example, dry developers are less expensive. A need exists, however, for an electrostatic printing machine which can produce texturally attractive color prints with substantially no height build-up which employ dry developers. A simple, relatively inexpensive, and accurate approach to produce color prints in such printing systems has been a goal in the design, manufacture and use of electrophotographic printers. This need has been particularly recognized in the color and highlight color portion of electrophotography. The need to provide accurate and inexpensive color reproduction with dry developers has become more acute, as the demand for high quality, relatively inexpensive color images and the machines that produce them have increased

In accordance with the present invention, there is provided a recording apparatus for producing a latent image on a recording sheet, comprising an intermediate member. Marking means are provided for depositing dry charged marking material on the intermediate member to produce a marking image thereon. A heater, in communication with the intermediate member, heats the intermediate member so as to form a tackified marking image thereon. A conditioning roller conditions the tackified marking image. Means are provided for transferring the tackified marked image to the recording sheet with the tackified marked image being cooled upon contact with the recording sheet to become substantially permanently fixed thereto.

In accordance with yet another aspect of the present invention, there is provided a recording apparatus for producing a color image on a recording sheet comprising an intermediate member. First marking means are provided for depositing dry charged marking material of a first color on the intermediate member to produce a marking image thereon. A heater, in communication with the intermediate member, heats the intermediate member so as to form a tackified marking image thereon. A conditioning roller conditions the tackified marking image. Second marking means are provided for depositing dry charged marking material of a second color on the tackified marking image forming a composite tackified marking image on the intermediate member. Means are provided for transferring the composite tackified marked image to the recording sheet with the composite tackified marked image being cooled upon contact with the recording sheet to become substantially permanently fixed thereto.

The present invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic illustration of the various processing stages employed in the present invention;

Figure 2 is an illustration of a multicolor heated intermediate roll imaging process configuration suitable for an ionographic printing process.

Figure 1 shows the various processing stages which would be employed to carry out the heated intermediate roll imaging process of the present invention. Generally, intermediate member 20 is the primary element of the imaging system. When rotated in the direction represented by arrow 22, the intermediate member will pass through three stages: A) image deposition; B) image tackification; C) image conditioning; and D) image transfer/fusing (transfixing).

In the imaging process, intermediate member 20 is first advanced to image deposition stage A. Numerous alternative marking processes may be utilized to deposit marking materials or particles 24 on the surface of member 20 within deposition stage A. For example, indirect or interactive marking techniques may be used, where an electrostatic latent image is first deposited on the surface of the member and subsequently developed with charged marking particles which contacts the charged surface. Examples of indirect marking processes include: basic xerographic techniques commonly known to employ photoconductive members which dissipate charge in response to light images; ionographic techniques, such as, those described in US-A-4,619,515 or in US-A-4,463,363; and pyroelectric methods such as taught in US-A-5,185,619. Furthermore, direct or non-interactive marking techniques may be used to deposit marking particles 24 on the surface of member 20 as disclosed in US-A-2,968,552 and US-A-5,153,615.

Irrespective of the marking technique used at the image deposition stage, the result will be a developed image comprised of regions of marking particles, produced in response to original image data which is understood to have been an input to one of the previously described marking processes. Subsequently, marking particles 24, present on the surface of the intermediate member, are

advanced through image tackification stage B. Within stage B, which essentially encompasses the region between when the marking particles contact the surface of member 20 and when they are transferred to recording sheet 26, the particles 30 are transformed into a tackified or molten state by heat which is applied to member 20 internally. Preferably, the tackified marking particle image is transferred, and bonded, to recording sheet 26 with limited wicking by the sheet. More specifically, member 20 includes a heating element, 32, which not only heats the internal wall of the intermediate member in the region of transfix nip 34, but because of the mass and thermal conductivity of the intermediate member, generally maintains the outer wall of member 20 at a temperature sufficient to cause the marking particles present on the surface to melt. As an alternative, intermediate member 20 may be a "instant on" device as disclosed in US-A-5,087,946 or a tubular heat roller formed from a ceramic resistor material having a positive temperature coefficient of resistance as disclosed in US-A-5,191,381. The marking particles on the surface, while softening and coalescing due to the application of heat from the interior of member 20, maintain the position in which they were deposited on the outer surface of member 20, so as not to alter the image pattern which they represent.

During tackification of the marking particles placed on the outer surface of member 20, the member continues to advance in the direction of arrow 22 until the tackified marking particles, 30, reach image conditioning stage C. At image conditioning stage C, the tackified marking particles pass under a smooth, conductive roller 50 which generates a thinner, more cohesive image without degradation of the image. It is preferred that conductive roller 50 be a metal roller. Roller 50 has a polished finish, and is bias by power supply 155, preferably to the same polarity as the tacky image on the intermediate member. One advantageous feature of the present invention is that potential bias can be varied to pick up some of the excessively thick portions of the image thereby improving the quality of the image. A cleaning blade 55 cleans off toner adhering to roller 50.

Next, tackified marking particles pass to image transfixing At transfix nip 34, the tackified marking particles are forced, by a normal force N applied through backup pressure roll 36, into contact with the surface of recording sheet 26. The normal force N, produces a nip pressure which is preferably about 68.9 $x10^4$ N/m^2 (100 psi), and may also be applied to the recording sheet via a resilient blade or similar spring-like member uniformly biased against the outer surface of the intermediate member across its width.

As the recording sheet passes through the transfix nip the tackified marking particles wet the surface of the recording sheet, and due to greater attractive forces between the paper and the tackified particles, as compared to the attraction between the tackified particles and the liquid-phobic surface of member 20, the tackified particles are completely transferred to the recording sheet as image marks 38. Furthermore, as the image marks were transferred to recording sheet 26 in a tackified state, they become permanent once they are advanced past transfix nip and allowed to cool below their melting temperature.

Illustrated in Figure 2 is a schematic representation of a multicolor printing apparatus having an intermediate member 20 in a configuration suitable for an ionographic printing process. Intermediate member 20 is employed as an electroreceptor. It is preferred that intermediate member comprises a two layer structure which can be optional mounted onto a rigid cylindrical member 5. The substrate layer has a thickness between 0.1 mm and 1.0 mm and a resistivity between 10^6 ohm-cm and 10^{11} ohm-cm at temperatures between 130°C to 150°C. An insulating top layer has a thickness less than 10 μm, a dielectric constant between 10 and 1.0, and a resistivity between 10^{12} ohm-cm and 10^{14} ohm-cm at temperatures between 130°C to 150°C. The top layer also has an adhesive release surface. Also, it is preferred that both layers have matching hardness between 50 durometer and 80. Preferably, both layers are composed of Viton™ which can be laminated together.

Intermediate member 20 moves around in the direction indicated by the arrow. Intermediate member 20 receives a first latent image to be developed with a first color from ionographic or ionic projection writing head 7, which latent image is then developed with a first developer at one of a plurality of development stations 9a, 9b, 9c, and 9d; Figure 2 illustrates development with station 9a engaged. Development stations 9a, 9b, 9c, and 9d employ a non-interactive marking technique to deposit marking particles on the surface of intermediate member 20. The marking particles are transformed into a tackified or molten state by heat which is applied to intermediate member 20 internally. Intermediate member 20 includes a plurality of heating elements 32a, 32b, 32c, and 32d which not only heats the internal wall of the intermediate member in the region, but generally maintains the outer wall of member 20 at a temperature sufficient to cause the marking particles present on the surface to melt. Preferably heat controller 21 keeps intermediate member temperature between the temperatures of 130°C to 150°C. An advantageous feature of maintaining the between temperatures of 130°C to 150°C is that it enables the development of a second latent image without disturbing the previous developed latent image, thereby producing color images with uniform, low noise transfer ,and low paper curl. It is believe that the developed latent image composed of loose marking particles quickly tackified to the intermediate member. As the marking particles tackified, the developed latent image flow into greater contact and higher capacitance with the intermediate member, and the charges on the marking particles relax. This, in turn, reduces contributions to blooming by previous developed images, and also reduce tendency of loose toner to shift under high lateral electrostatic fields at the boundaries of the latent image

for the next color.

After each development stations, conductive roller 50 biased to the same polarity as the toner charge rolls over the tackified toner image. The rollers create a thinner, more cohesive image without degradation of the image before subsequent imaging by ionic projection writing head 7. The roller compresses the toner image to lower its pile height and further enhancing capacitance for subsequent charging of the image. An advantage of the present invention is that the conductive rollers further reduce both the blooming of charges on each of image toner, but also reduce the tendency of previously developed toner from jumping laterally at boundaries of high voltage contrast.

When images of more than one color are desired, the imaging means again moves past ionic projection writing head 7, at which point another latent image is formed on top of the first developed image, and the latent image moves past development stations 9, where it is developed with a second marking particle of a color different from that of the first developer at, for example, development station 9b. The process is repeated, with the subsequent latent images being developed at development stations 9c and 9d, until the final full color image has been formed. The full color image move to transfix nip 34

At transfix nip 34, the liquefied marking particles of the full color image are forced, by a normal force N applied through backup pressure roll 36, into contact with the surface of recording sheet 26. As the recording sheet passes through the transfix nip the tackified marking particles wet the surface of the recording sheet, and due to greater attractive forces between the paper and the tackified particles, as compared to the attraction between the tackified particles and the liquid-phobic surface of member 20, the tackified particles are completely transferred to the recording sheet. Furthermore, as the full color image image transferred to recording sheet 26 in a tackified state becomes permanent once the full color image advances past transfix nip and allowed to cool.

The present invention is a method and apparatus for printing which employs a conditioning roller for conditioning a tackified, dry toner image. An intermediate member first acts as a receptor for marking particles representing an image, whereby the marking particles may be deposited directly or indirectly on the member. The member is then exposed, via an internal heat source, to an elevated temperature sufficient to cause the melting and coalescing of the marking particles. The tackified image is condition by a conditioning roller. In a multicolor recording apparatus, the intermediate member is advanced at least once and a second color marking particles is deposited onto the previous image. The image is again conditioned by the conditioning roller. Subsequently, the intermediate member is advanced so as to place the multicolor tackified marking particles present on the outer surface of the intermediate member into intimate contact with the surface of a recording sheet. The present .invention provides the advantage of dimensional stability of the intermediate member to provide a uniform image deposition stage, resulting in a controlled image transfer gap and better image registration. Further advantages include reduced blooming of ionographic charges, as well as reduced lateral jumping of previously developed toner at boundaries of high voltage contrast.

Claims

1. A recording apparatus for producing an image (38) on a recording sheet (26), comprising:

   marking means for depositing dry charged marking material (24) on an intermediate member (20) to produce a marking image thereon;
   heating means (32) for heating said intermediate member (20) so as to form a tackified marking image (30) thereon; and
   transfer means (36) for transferring the tackified marking image (38) to the recording sheet (26) with the tackified marking image being cooled upon contact with the recording sheet to become substantially permanently fixed thereto; characterised by:
   a conditioning roller (50) operatively associated with said intermediate member, for conditioning the tackified marking images prior to transfer of the image to the recording sheet (26).

2. The apparatus of claim 1, wherein said conditioning roller comprises a metal roller having a polished finish.

3. The apparatus of claims 1 or 2, further comprising means (155) for electrically biasing said conditioning roller.

4. The apparatus of claim 3, wherein said biasing means electrically biases said conditioning roller to a polarity that is the same as that of the marking material.

5. The apparatus of any of the preceding claims, further comprising an ion generating means for recording an electrostatic latent image on said intermediate member, said marking means developing the electrostatic latent image with the marking material to produce a developed image on said intermediate member.

6. A recording apparatus for producing a color image on a recording sheet, comprising:

   an intermediate member (20);
   first marking means (9a) for depositing dry charged marking material of a first color on said

intermediate member to produce a first marking image thereon;
a heater (32a-32d), in communication with said intermediate member, for heating said intermediate member so as to form a tackified marking image thereon;
a conditioning roller (50) operatively associated with said intermediate member, for conditioning the tackified marking image;
at least a second marking means (9b) for depositing dry charged marking material of a second color on the tackified first marking image thereby forming a composite tackified marking image on said intermediate member, the intermediate member being rotated past the conditioning roller, so that said conditioning roller conditions said composite tackified marking image; and
means (36) for transferring the composite tackified marked image to the recording sheet (26) with the composite tackified marked image being cooled upon contact with the recording sheet to become substantially permanently fixed thereto.

7. The apparatus of claim 6, wherein said conditioning roller comprises a metal roller having a polished finish; and wherein said conditioning roller is electrically biased.

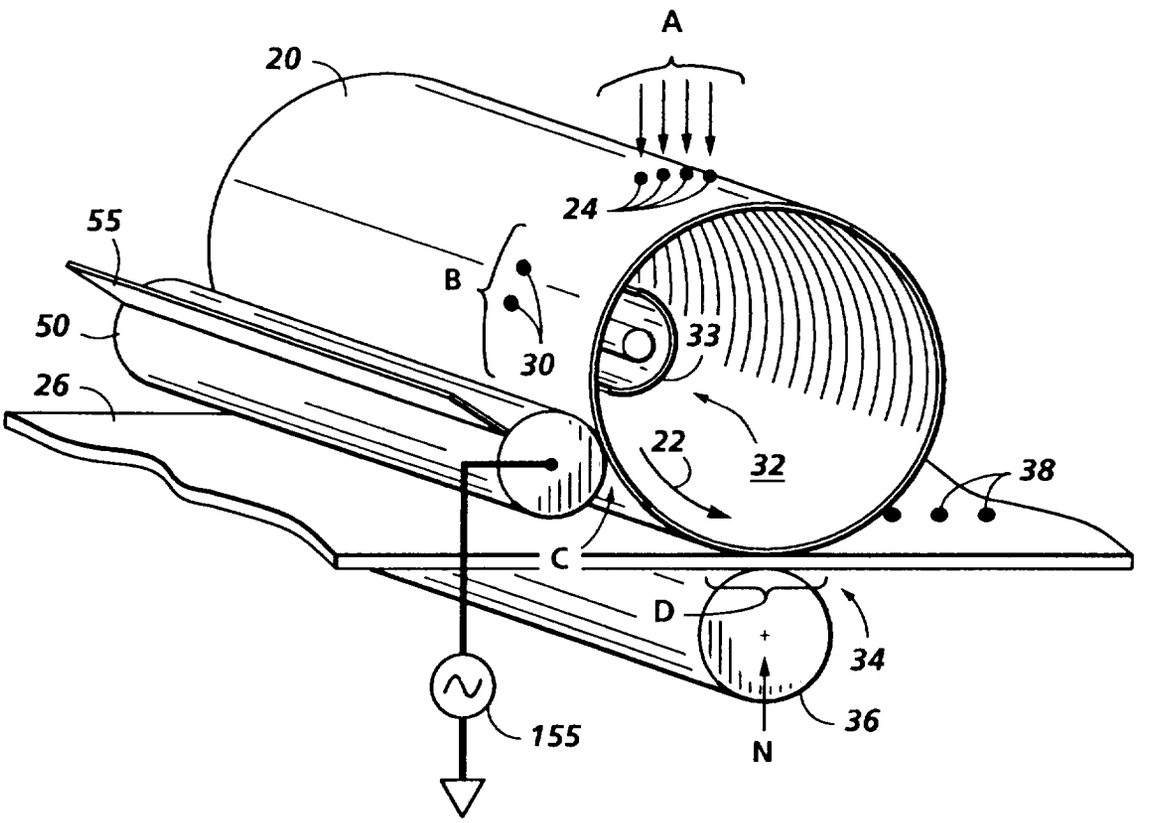
8. The apparatus of claim 7, wherein said biasing means electrically biases said conditioning roller to a polarity that is the same as that of the marking material .

9. The apparatus of claim 6, wherein said ion generating means (7) records at least a second electrostatic latent image at least partially on the developed image, said second marking means developing the second electrostatic latent image with the marking material of the second color to produce a composite developed image of tackified charged marking particles on the surface of said intermediate member.

10. A method of producing an image (38) on a recording sheet (26), comprising:

providing an intermediate member (20);
forming a latent image on the intermediate member;
developing the latent image with dry charged marking material to produce a marking image (24); and
heating the marking image on the intermediate member to produce a tackified marking image (30);
characterised by conditioning the tackified marking image with a conditioning roller (50) which contacts and flattens the tackified marking image; and
transferring the conditioned tackified marking image to the recording sheet (26) by a pressure roll (36).

FIG. 1



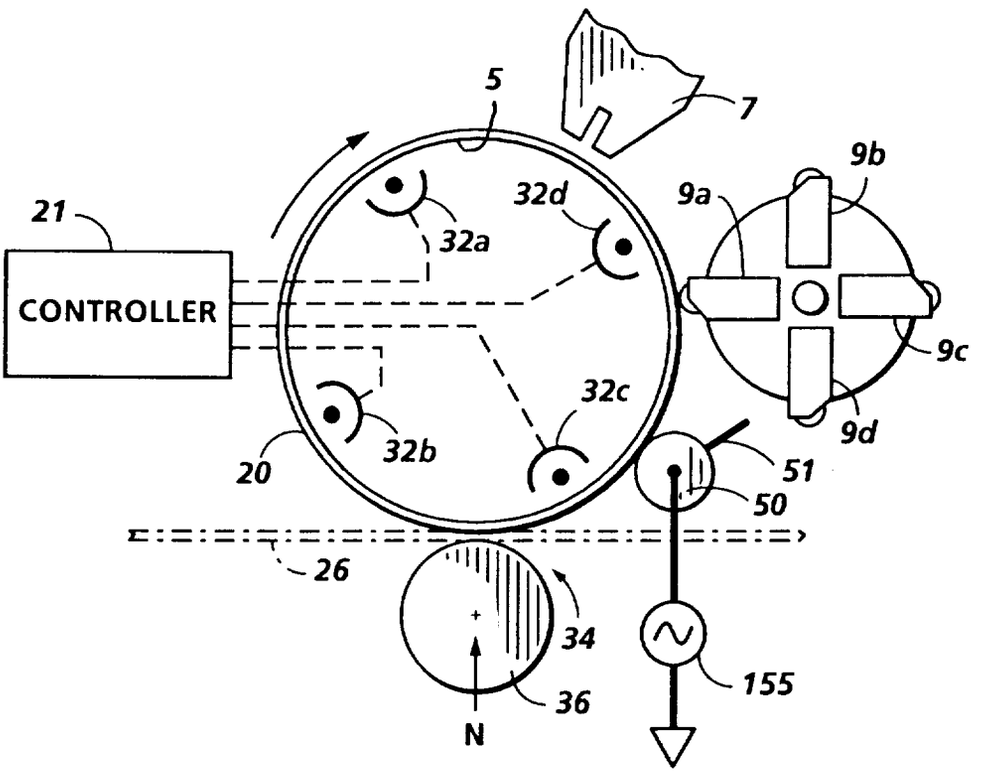

5
7
9b
9a
21
32d
32a
CONTROLLER
9c
32c
9d
32b
20
51
50
26
34
155
36
N

FIG. 2