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METHOD FOR FUSING DEVELOPED IMAGE.

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Description

The present invention relates generally to an imaging process and apparatus and specifically to fusing of developed images.

BACKGROUND OF THE INVENTION

In known processes of electrostatic imaging, a light image of an original to be copied may be recorded in the form of an electrostatic latent image upon a photoconductive member. A developed image may then be obtained from the latent image by application of toner particles, which may be in the form of a finely powdered solid or in liquid phase.

In 'dry' electrostatic imaging processes which employ powdered solid toners, it is known to pass a substrate having a developed image formed thereon between (for example) a pair of opposed rollers. One or both of the rollers is heated and in consequence heats and thereby fuses and fixes the image on the substrate, insofar as at least to some extent the image particles flow into the fibers or pores of the substrate. For prior patents in the field of fusing and fixing the developed image, reference is made to U.S. Patents Nos. 3,249,738, 3,637,976, 3,667,742, 3,718,116 and 4,689,471.

In dry electrostatic imaging processes as described above, unintended offsetting of the developed image onto one of the rollers may occur. It is known that the incidence of offsetting may be reduced by employing a roller covered with polytetrafluoroethylene or silicone rubber, to which a release agent such as silicone oil is applied, which release agent apparently forms an interface between the roller surface and the toner images on the support.

As has been indicated above, liquid toner based electrostatic imaging is known. The basic steps of the liquid toner process are:

1. Generating an electrostatic latent image, e.g. on a photoconductive surface such as a plate or drum which has been sensitized by charging with a corona discharge and by exposure to light in the form of an image of an object - the charge is dissipated in exposed areas;
2. Developing the latent image by contact with a liquid dispersion ("toner") of fine particles which in a positive process are attracted to the charged areas and which in a reverse process are attracted to the uncharged areas;
3. Removal of excess liquid toner and particles from the background areas;
4. Transfer of the image, e.g. to a substrate such as paper, under influence of an electrical field;
5. Fixing the image by fusing the particles together and to the substrate; and
6. Cleaning the plate or drum for re-use.

In this connection reference is made to the following U.S. patents in the field of electrophotography: 3,990,696, 4,233,381, 4,253,656, 4,256,820, 4,269,504, 4,278,884, 4,286,039, 4,302,093, 4,326,644, 4,326,792, 4,334,762, 4,350,333, 4,355,883, 4,362,297, 4,364,460, 4,364,657, 4,364,661, 4,368,881, 4,378,422, 4,392,742, 4,396,187, 4,400,079, 4,411,976, 4,412,383, 4,413,048, 4,418,903, 4,420,244, 4,435,068, 4,439,035, 4,454,215, 4,460,667, 4,473,865, 4,480,825, 4,501,486, 4,522,484, 4,531,824, 4,538,899, 4,582,774, 4,585,329, 4,586,810, 4,589,761, 4,598,992, 4,603,766, 4,620,699, 4,627,705 and 4,678,317.

Following development, the excess liquid toner and particles are removed from the image, by a step often referred to as "metering". This step may be carried out by use of an electrically biased reverse roller which also shears off the "fluffy" part of the imaged regions and squeezes or compacts the imaged area to prepare it for transfer. At the transfer stage, there is likely to occur a degree of smudging, smearing or squashing of the image, which detracts from its quality. It will be appreciated that if in the fusing and fixing stage, heat and pressure are applied to the liquid toner image, as has been described above for solid toner based processes, the liquid image will be likely to again suffer from smudging, smearing or squashing.

In United States Patent 4,794,651 (Landa et al), a degree of squash-resistance is imparted to the developed image by using fibrous toner particles prepared as follows: a thermoplastic polymer (and pigment) is plasticized with a nonpolar liquid, preferably at elevated temperature, to form a sponge, the sponge is shredded, more nonpolar liquid is added, the pieces of shredded sponge are wet-ground into particles and the grinding is continued to pull the particles apart to form fibers extending therefrom (the particles preferably having a diameter less than 5 micrometers). Finally, a charge director may be added to impart a charge of predetermined polarity to the toner particles.

While the method of the aforementioned United States Patent 4,794,651 includes the imparting of squash resistance to the image, it would nevertheless be desirable to fix a liquid image on a substrate by analogy with the application of heat and pressure in dry electrostatic imaging processes, but, as has been indicated above,

this has not been possible hitherto because of the liability of liquid toner based images particularly, to smudging, smearing or squashing.

SUMMARY OF THE INVENTION

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It is thus an object of the present invention to provide in an electrostatic imaging process which makes use of liquid toner, a fixing and fusing step which includes the application of heat and pressure to the developed liquid toner image, while minimizing the possibility of smudging, smearing or squashing the developed image.

Other objects of the invention will become apparent as the description proceeds.

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There is thus provided in accordance with the present invention, an imaging process which comprises the steps of developing an image with liquid toner including a liquid carrier and toner particles, transferring the liquid toner image to an image bearing surface of a substrate and fusing and fixing the image thereto by the application of energy and pressure, characterized by selecting at least the energy applied upon fusing and fixing, and the properties of the liquid carrier, such that at least 50% of the liquid carrier in the transferred image

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remains therein after fixing and fusing.

There is also provided in accordance with the present invention an electrostatic imaging process which comprises the steps of developing an electrostatic image with liquid toner including at least pigmented thermoplastic polymer particles and a liquid carrier, transferring the developed liquid toner image to a substrate, transporting the substrate through a nip defined by a portion of the surface of the first roller and a portion of the surface of a second elastomer coated roller, fusing and fixing the substrate-supported developed image by the application of heat thereto from the surface of said first roller, characterized by selecting at least the temperature at which the fusing and fixing is effected, the rate of transport of the substrate, and the properties of the liquid carrier, such that at least 50% of the liquid carrier in the substrate supported image is not evaporated therefrom.

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Further, in accordance with a preferred embodiment of the present invention, the step of transferring comprises the sub-steps of transferring the image first to an intermediate surface and from the intermediate surface to the substrate.

Additionally in accordance with a preferred embodiment of the present invention, the application of energy and pressure is effected by applying a heated surface to the image.

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Still further in accordance with a preferred embodiment of the present invention, the heated surface is the surface of an elastomer coated roller or the surface of a continuous belt.

Further in accordance with a preferred embodiment of the present invention, the substrate is transported through a nip defined by a portion of the surface of the first elastomer-coated roller facing the image bearing surface and a portion of the surface of a second elastomer-coated roller, the coating of the second roller being softer than the coating of the first roller.

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Further in accordance with a preferred embodiment of the present invention, the coating of the second roller has a thickness greater than that of the coating of the first roller. Preferably, the ratio of the thickness of the coating of the first roller to the ratio of the thickness of the coating of the second roller is smaller than 1:10.

Further in accordance with a preferred embodiment of the invention, the toner particles are plasticized by the carrier liquid during fusing and fixing of the image to the substrate.

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Further, in accordance with the invention, there is provided imaging apparatus comprising means for developing an image with liquid toner including a liquid carrier and toner particles; and transferring and fixing means operative to transfer the liquid toner image to an image bearing surface of a substrate and to fuse and fix the image thereto by the application of energy and pressure, characterized in that the energy applied by the transferring and fixing means that arranged such that the energy applied upon fusing and fixing in combination with the properties of the liquid carrier, are such, that at least 50% of the liquid carrier in the transferred image remains therein after fixing and fusing thereof.

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Further, in accordance with the invention, there is provided imaging apparatus comprising means for developing an electrostatic image with liquid toner including at least pigmented thermoplastic polymer particles and a liquid carrier, means for transferring the developed liquid toner image to a substrate, means for transporting the substrate through a nip defined by a portion of the surface of a first roller and a portion of the surface of a second elastomer coated roller and for fusing and fixing the substrate-supported developed image by the application of heat thereto from the surface of said first roller, characterized in that the means for transporting and for fusing and fixing are so arranged such that at the temperature at which the fusing and fixing is effected and at the rate of transport of the substrate, in combination with the properties of the liquid carrier at least 50% of the liquid carrier in the substrate supported image is not evaporated therefrom.

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings, in which:

- 5 Fig. 1 is a schematic illustration of electrostatic imaging apparatus, constructed and operative in accordance with a preferred embodiment of the invention; and
 Fig. 2 is a more detailed schematic illustration of apparatus for fusing and fixing a developed image onto a carrier sheet, useful in the apparatus of Fig. 1.

10 DETAILED DESCRIPTION OF THE INVENTION

Reference is made to Fig. 1 in which there is shown electrostatic imaging apparatus employing a liquid toner. The apparatus includes a metal drum 2 which carries a photoconductor 4 and which is mounted by disks 6 onto a shaft 8. The disks are secured to shaft 8 by a key 10 so that the shown drum assembly, which is provided in a light-proof housing (not shown), is operative to rotate with shaft 8.

15 Shaft 8 is driven in any appropriate manner (not shown) in the direction of arrow 9 past a corona discharge device 12 operative to charge the surface of photoconductor 4. The image to be reproduced is projected onto the charged photoconductor by an optical system 14. Since shaft 8 is grounded at 15 and disks 6 are conductive, the areas struck by light conduct the charge, or a portion thereof, to ground, thus forming on the photoconductor an electrostatic latent image.

20 The liquid toner is circulated from any suitable source (not shown) through a pipe 16 into a development tray 18 from which it is drawn through a pipe 20 for recirculation. Development electrodes 22, which may be appropriately biased as known to the art, assist in toning the electrostatic latent image as it passes into contact with the toner.

25 As the amount of liquid on the photoconductor surface is normally too great for satisfactory subsequent transfer of the developed image, a roller 24, whose surface moves in a direction opposite to that of the photoconductor surface, is spaced from the photoconductor surface by a spacer 25 and is operative to shear excess liquid from the developed image without disturbing it. An exemplary roller is shown in U.S. Patent No. 3,907,423.

30 Roller 24 is driven, typically by a drive belt 26 which is in turn driven by any appropriate, known speed-controllable motor means (not shown). The roller is kept clean by a wiper blade 28.

A pair of register rollers 32 and 34 is operative to feed to a transfer station, referenced generally 44, a carrier sheet 100, which is to receive the developed image. At transfer station 44, a corona discharge device 46 is operative to impress upon the rear of the carrier sheet a charge of polarity opposite to that of the toner particles forming the developed image. The developed image is thus drawn towards the carrier sheet.

35 Rollers 32 and 34 are mounted onto and secured for rotation with respective axles 36 and 38. The axles are driven in synchronism so that there is no relative motion between the points of closest approach of the rollers 32 and 34 to each other. Alternatively, if desired, only one of the register rollers need be driven.

40 A pick-off member 48 assists in the removal from the photoconductor of the carrier sheet bearing the developed image. A roller 50 co-acting with a plurality of flexible bands 52 mounted onto a plurality of rollers 54 delivers the carrier sheet to fusing and fixing apparatus, referenced generally 64. Apparatus 64 is described below in greater detail in conjunction with Fig. 2.

45 A cleaning roller 56, formed of an appropriate synthetic resin as known in the art, is driven in a direction opposite to that of photoconductor 4, so as to scrub clean the surface thereof. To assist in this action, insulating, nonpolar liquid may be fed through a pipe 58 to the surface of the cleaning roller 56. A wiper blade 60 completes the cleaning of the photoconductive surface. Any residual charge left on the photoconductive drum is extinguished by flooding the photoconductor surface with light from a lamp 62.

50 Reference is now made to Fig. 2 in which there is shown fusing and fixing apparatus, constructed and operative in accordance with a preferred embodiment of the invention. Carrier sheet 100 is fed in the direction of an arrow 66 and, with the assistance of a guide member 99, between a heated roller 68 and a pressure roller 70 (see also Fig. 1).

55 In the shown embodiment, roller 68 is driven by any suitable means (not shown) and, as it rotates in a direction shown by arrow 72, it is also operative to cause rotation of roller 70 by friction. Roller 68 typically comprises a hollow metal cylindrical core in which is provided a heat source 69 which helps in fusing the developed image borne by the carrier sheet as it is drawn between rollers 68 and 70.

The metal core of roller 68 is coated with a thin layer 71 of a synthetic material having a composition as described hereinbelow. The composition of the synthetic material of which layer 71 is formed is such that the occurrence of offset of a developed image coming into contact with the layer is negligible.

Roller 70 comprises a cylindrical metal core 74 onto which there is mounted a sleeve 76 of a synthetic material having a hardness value of not greater than about 50 on the Shore A scale. A typical synthetic material is silicone rubber. According to a preferred embodiment of the invention, the ratio of the thickness of layer 71 to thickness of sleeve 76 is typically in the range of 1 to 30 - 80. For example, layer 71 may be 0.4 mm thick and sleeve 76 may be 20 mm thick.

Due to the difference in respective thicknesses of layer 71 and sleeve 76, roller 68 is much harder than roller 70. Consequently, when roller 70 presses against roller 68 along an axis 77, the surface of roller 70 becomes indented and a continuous contact length or 'nip' is formed between the rollers and between two points indicated by arrows A and B.

It is appreciated that as the carrier sheet is drawn into the nip, it is of great importance in ensuring that effective fusing and fixing of the image on the sheet takes place without the image being squashed, smeared or smudged. There is provided, therefore, apparatus for adjusting the pressure between rollers 68 and 70.

While roller 68 preferably rotates about a fixed axis, roller 70 is mounted for rotation onto an adjustable axle 78 which is supported by a support arm 80. Support arm 80 is rotatably mounted at one end 81 thereof, about a fixed axis 82 and is further supported, at another end 83 thereof, by a spring 84. It will be appreciated that the stronger the spring, the greater the pressure that is imposed by roller 70 onto roller 68.

As the carrier sheet is drawn between rollers 68 and 70, heat applied to the sheet from source 69 is effective, in combination with the pressure applied to the sheet by the rollers, to fuse and fix the developed image onto the sheet. According to the shown embodiment, the sheet is fed between the rollers such that the developed image, shown generally at 101, contacts the surface of roller 68. In known electrostatic imaging processes, it is expected that some offset onto roller 68 of the developed image will occur.

The layer 71 has a material composition that virtually eliminates offset while not giving rise to squashing, smudging or smearing of the developed image when used in a liquid toner process. While it is expected that offset of the image onto roller 68 is negligible, there is provided, nonetheless, a stripper 85 for removing any slight offset deposits that do occur and for ensuring proper paper removal.

A composition of matter having a shore A hardness of less than about 50 and comprising a release coating silicone polymer and a soft silicone rubber formulation is used for layer 71 of roller 68. The soft silicone rubber compound comprises, for example, an admixture of: (i) about 1 to about 4 parts by weight of a curable silicone oil including curing agent therefor; (ii) about 10 parts by weight of a hard rubber forming room temperature vulcanizable silicone polymer; and (iii) sufficient silicone polymer curing agent to effect a cure of component (ii), the ratio of components (i):(ii):(iii) being preferably about 1-4: about 10: about 0.8-1.2, parts by weight.

Examples of components (i), (ii) and (iii) are

- | | | | |
|-------|--------------------|---|------------------------|
| (i) | RTV 910 | } | Manufactured by |
| (ii) | RTV 615A, RTV 630A | } | General Electric (USA) |
| (iii) | RTV 615B, RTV 630B | } | |

Such components may be used in a weight ratio of, for example, about 2: 10: 1.

An example of a suitable release coating silicone polymer is Syl-Off 7600, an organofunctional siloxane polymer (cross-linkable with Syl-Off 7601 or Syl-Off 7048), manufactured by Dow Corning (U.S.A.), in particular in a ratio of approximately 200 : 1 of Syl-Off 7600 to Syl-Off 7601 or a ratio of approximately 500 : 1 of Syl-Off 7600 to Syl-Off 7048. These ratios are substantially higher than the manufacturers recommendation. For example Dow Corning recommends that 100 parts of Syl-Off 7600 be used with 4.8 parts of Syl-Off 7601 cross linker, a ratio of about 20.8:1.

While in general, weight ratios of release coating silicone polymer to soft silicone rubber formulation in the range of from about 1:1.5 to about 1:20 are believed to be generally operable, ratios of 1 : 3 to 1.6 give good results and it is presently preferred to use a weight ratio of about 1:4.

It has been found that when the composition of matter as defined herein is formed into a shaped article, the surface of this article has a reduced adhesivity at elevated temperatures, as compared with the surface of such an article from a soft silicone rubber formulation only. Such an article, especially when possessing a curved surface, is useful in the form of a roller, such as roller 68, or an endless band, as used in various electrostatic imaging processes.

As has already been indicated above, the application of heat and pressure in the fusing and fixing step of an electrostatic imaging process utilizing solid powdered toner is subject to the drawback that the developed image may, because of (*inter alia*) partial adhesion to the curved surface of the shaped article which it contacts, be undesirably reproduced by offsetting, as for example on heated roller 68 which, as described above, to-

gether with pressure roller 70 provides the required nip.

If the coating on roller 68 is made from the above composition its surface which when heated contacts the toner image is much less liable to offsetting than when using known compositions for this purpose.

Also, whereas the application of heat and pressure in the fusing and fixing step of an electrostatic imaging process utilizing liquid phase toner has to the knowledge of the inventors proved to be impractical hitherto because of liability of the liquid toner image to smudging, smearing or squashing, the composition of the present invention now makes possible for the first time, the introduction of a step including the application of heat and pressure, in such liquid phase toner processes, by analogy with a corresponding step in powdered solid toner processes.

Thus, in accordance with an embodiment of the invention and with reference to Figs. 1 and 2, an electrostatic imaging process is provided which includes the steps of generating a latent electrostatic image on photoconductor 4, developing the latent image with liquid toner from development tray 18, transferring the developed image to carrier sheet 100 and fusing and fixing the transferred image on the substrate by heat and pressure applied thereto preferably by passing it between rollers 68 and 70, roller 68 being formed from the above composition.

With further reference to Fig. 2, there is also provided apparatus for wetting heated roller 68 with silicone oil, such as 350F. It will be appreciated that wetting of roller 68 is important so as to prevent drying out of coating 71 thereon, due to oozing out from the rubber composition of a non-cross-linked silicone oil used therein, for example, RTV 910.

The shown wetting apparatus comprises a wetting roller 86 which is mounted onto an adjustable axle 88, roller 86 being operative to rotate together with heated roller 68. There is also provided a spring-retained arm 90 which maintains contact between wetting roller 86 and roller 68 by applying pressure onto axle 88 in the direction of roller 68.

Wetting roller 86 is kept moist by a liquid absorbing element 92 which communicates with a trough 94 and which is maintained in touching contact with roller 86. Element 92 may, for example, comprise a layer of velvet mounted on a support. Trough 94 is typically supplied with silicone oil to a depth that is sufficient to keep element 92 damp enough so as to moisten wetting roller 86. A doctor blade 110 presses against roller 86 to reduce liquid thickness to preferably approximately 7 micrometers. Liquid is provided to trough 94 from an external reservoir 96 and is pumped therefrom at a very slow rate, by means of a pump 98 and an entry conduit 102. Excess liquid in trough 94 drains therefrom back into reservoir 96 via an outlet conduit 104.

A suitable toner solution for the process of the present invention may be prepared as follows. ELVAX II 5720 (Dupont) (1000 g.) and ISOPAR L (Exxon) (500 g.) are mixed together at a temperature of $90 \pm 10^\circ\text{C}$ for 1 hour, using a Ross Double Planetary mixture. Carbon black (Mogul L (Cabot), 250 g.) and ISOPAR L (500 g.) are added, and mixing is continued for 1 hour. ISOPAR L (2000 g.), preheated to 110°C is added, and mixing is continued for a further 1 hour. The source of heat is withdrawn, while continuing mixing until the temperature has fallen to less than 40°C . Of the resultant mixture, 3050 g. are milled at a temperature of $40 \pm 2 - 3^\circ\text{C}$ for about 22 hours with ISOPAR L (4000 g.) in a Sweco M18 Vibratory Mill containing 0.5" alumina cylinders. The product is a 12.5% solids concentrate; a working dispersion is obtained by diluting with ISOPAR L to a 1.5% solids content. In the Examples which follow, the Savin 870 photocopier requires 1.5 kg. of this working solution, to which is added 7 - 8 ml. of 10% lecithin in ISOPAR L as charge director, while the Savin V45 photocopier requires 0.8 kg. of this working solution, to which is added 3.5 - 4 ml. of 10% lecithin in ISOPAR L as charge director.

Elvax II type 5720 solvates substantial amounts of ISOPAR L (and is thereby plasticized) at temperatures in the range of about 65°C to 100°C . In the method of toner manufacture described above, a temperature of between 70°C and 90°C is used.

The non-volatile portion of the toner solution has a viscosity of not less than 2×10^6 centipoise at a temperature of $121 \pm 1^\circ\text{C}$.

The invention will now be illustrated by the following non-limitative Examples:

50 Example 1

A Savin V45 photocopier which was modified to incorporate at the fixing and fusing stage a hot roller system as described above at an optimum temperature of $120 \pm 10^\circ\text{C}$ for minimum offset, was operated with a substrate speed of about 314 mm./sec., with a pressure of 6 kg. applied at each side of the pair of rollers, and using the liquid toner prepared as above. The length of the nip was about 4 - 6 mm. Under these conditions the major part of the ISOPAR L in the toner image was retained therein, while fusing and fixing was achieved.

Example 2

A Savin 870 photocopier, having its internal fuser rendered inoperative, was used to generate copies on paper using the liquid toner prepared as described hereinabove. The copies were then subjected to flash illumination of about 0.75 Joule/cm² and 400 microsecond pulse duration. Under these conditions the major part of the ISOPAR L in the toner image was retained therein, while fusing and fixing was achieved.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. The scope of the present invention is limited, rather, solely by the claims which follow:

Claims

1. An imaging process which comprises the steps of developing an image with liquid toner including a liquid carrier and toner particles, transferring the liquid toner image to an image bearing surface of a substrate and fusing and fixing the image thereto by the application of energy and pressure, characterized by selecting at least the energy applied upon fusing and fixing and the properties of the liquid carrier, such that at least 50% of the liquid carrier in the transferred image remains therein after fixing and fusing thereof.
2. An electrostatic imaging process comprising the steps of:
 - developing an electrostatic image with liquid toner including at least pigmented thermoplastic polymer particles and a liquid carrier;
 - transferring the developed liquid toner image to a substrate;
 - transporting the substrate through a nip defined by a portion of the surface of a first roller and a portion of the surface of a second elastomer coated roller; and
 - fusing and fixing the substrate-supported developed image by the application of heat thereto from the surface of said first roller,
 - characterized by selecting at least the temperature at which the fusing and fixing is effected, the rate of transport of the substrate, and the properties of the liquid carrier, such that at least 50% of the liquid carrier in the substrate supported image is not evaporated therefrom.
3. A process according to claim 2 wherein said step of transferring comprises the sub-steps of transferring the image first to an intermediate surface and from the intermediate surface to the substrate.
4. A process according to claim 1 wherein said application of energy and pressure is effected by applying a heated surface to the image.
5. A process according to claim 4, wherein said heated surface is the surface of a first elastomer-coated roller.
6. A process according to claim 4, wherein said heated surface is the surface of a continuous belt.
7. A process according to claim 5, wherein the substrate is transported through a nip defined by a portion of the surface of said first elastomer-coated roller facing said image bearing surface and portion of the surface of a second elastomer-coated roller, the coating of said second roller being softer than the coating of said first roller.
8. A process according to claim 5, wherein the substrate is transported through a nip defined by a portion of the surface of said first elastomer-coated roller facing said image bearing surface and a portion of the surface of a second elastomer-coated roller, wherein the coating of said second roller has a thickness greater than that of the coating of said first roller.
9. A process according to claim 8, wherein the ratio of the thickness of the coating of said first roller to the ratio of the thickness of the coating of said second roller is smaller than 1:10.
10. A process according to any of the preceding claims wherein said particles are plasticized by said carrier liquid during fusing and fixing of the image to the substrate.
11. Imaging apparatus comprising:

means (2, 16, 18, 20, 22) for developing an image with liquid toner including a liquid carrier and toner particles; and

transferring and fixing apparatus (46, 68, 70) operative to transfer the liquid toner image to an image bearing surface of a substrate and to fuse and fix the image thereto by the application of energy and pressure,

characterized in that the energy applied, by the transferring and fixing apparatus is arranged such that the energy applied upon fusing and fixing in combination with the properties of the liquid carrier, are such, that at least 50% of the liquid carrier in the transferred image remains therein after fixing and fusing thereof.

12. Imaging apparatus comprising:

means (2, 16, 18, 20, 22) for developing an electrostatic image with liquid toner including at least pigmented thermoplastic polymer particles and a liquid carrier;

means (46) for transferring the developed liquid toner image to a substrate (100);

means (68, 70) for transporting the substrate through a nip defined by a portion of the surface of a first roller (68) and a portion of the surface of a second elastomer coated roller (70) and for fusing and fixing the substrate-supported developed image by the application of heat thereto from the surface of said first roller,

characterized in that the means for transporting and for fusing and fixing are so arranged such that at the temperature at which the fusing and fixing is effected and at the rate of transport of the substrate, in combination with the properties of the liquid carrier at least 50% of the liquid carrier in the substrate supported image is not evaporated therefrom.

Patentansprüche

1. Bilderzeugungsverfahren mit den folgenden Schritten:

Entwickeln eines Bilds mit flüssigem Toner, einschließlich eines flüssigen Trägers und Tonerteilchen, Übertragen des flüssigen Tonerbilds auf eine bildtragende Fläche eines Substrats und Schmelzen sowie Fixieren des Bilds auf dieser Fläche durch Anwendung von Energie und Druck, **gekennzeichnet**

durch Wählen wenigstens der beim Schmelzen und Fixieren ausgeübten Energie und der Eigenschaften des flüssigen Trägers derart, daß wenigstens 50 % des flüssigen Trägers im übertragenen Bild nach dessen Fixieren und Schmelzen darin verbleiben.

2. Elektrostatisches Bilderzeugungsverfahren mit den folgenden Schritten:

Entwickeln eines elektrostatischen Bilds mit flüssigem Toner, einschließlich wenigstens pigmentierter, thermoplastischer Polymerteilchen und eines flüssigen Trägers, Übertragen des entwickelten flüssigen Tonerbildes auf ein Substrat,

Transportieren des Substrats durch einen Spalt, der durch einen Teil der Oberfläche einer ersten Walze und einen Teil der Oberfläche einer zweiten, elastomerbeschichteten Walze gebildet ist, und Schmelzen sowie Fixieren des vom Substrat getragenen, entwickelten Bilds durch darauf erfolgreiches Ausüben von Wärme von der Oberfläche der ersten Walze, **gekennzeichnet**

durch Wählen wenigstens der Temperatur, bei der das Schmelzen und Fixieren erfolgt, der Transportgeschwindigkeit des Substrats und der Eigenschaften des flüssigen Trägers derart, daß wenigstens 50 % des flüssigen Trägers im vom Substrat getragenen Bild daraus nicht verdampft werden.

3. Verfahren nach Anspruch 2, wobei der Schritt des Übertragens die folgenden Teilschritte umfaßt: Übertragen des Bilds zuerst auf eine Zwischenfläche und von der Zwischenfläche auf das Substrat.

4. Verfahren nach Anspruch 1, wobei die Anwendung von Energie und Druck durch Aufbringen einer erwärmten Fläche auf das Bild erfolgt.

5. Verfahren nach Anspruch 4, wobei die erwärmte Fläche die Fläche einer ersten elastomerbeschichteten Walze ist.

6. Verfahren nach Anspruch 4, wobei die erwärmte Fläche die Fläche eines endlosen Bands ist.

7. Verfahren nach Anspruch 5, wobei das Substrat durch einen Spalt hindurchtransportiert wird, der durch

einen, der bildtragenden Fläche zugewandten Teil der oberfläche der ersten, elastomerbeschichteten Walze und einen Teil der Oberfläche einer zweiten, elastomerschichteten Walze gebildet ist, wobei die Beschichtung der zweiten Walze weicher als die Beschichtung der ersten Walze ist.

- 5 8. Verfahren nach Anspruch 5, wobei das Substrat durch einen Spalt hindurchtransportiert wird, der durch einen der bildtragenden Fläche zugewandten Teile der Oberfläche der ersten, elastomerbeschichteten Walze und einen Teil der Oberfläche einer zweiten, elastomerbeschichteten Walze gebildet ist, wobei die Dicke der Beschichtung der zweiten Walze größer als die Dicke der Beschichtung der ersten Walze ist.
- 10 9. Verfahren nach Anspruch 8, wobei das Verhältnis der Dicke der Beschichtung der ersten Walze zur Dicke der Beschichtung der zweiten Walze kleiner als 1:10 ist.
- 10 10. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Teilchen während des Schmelzens und Fixierens des Bilds auf dem Substrat durch die Trägerflüssigkeit plastifiziert werden.
- 15 11. Bilderzeugungsvorrichtung, enthaltend:
eine Einrichtung (2, 16, 18, 20, 22) zum Entwickeln eines Bilds mit flüssigem Toner, einschließlich eines flüssigen Trägers und Tonerteilchen, und eine Einrichtung (46, 68, 70) zum Übertragen des flüssigen Tonerbilds auf eine bildtragende Fläche eines Substrats (100) und eine Einrichtung zum Schmelzen und Fixieren des Bilds auf dieser Fläche durch Anwendung von Energie und Druck,
20 dadurch **gekennzeichnet**,
daß die Einrichtung zum Schmelzen und Fixieren derart angeordnet ist, daß die beim Schmelzen und Fixieren aufgebrauchte Energie in Verbindung mit den Eigenschaften des flüssigen Trägers von der Art sind, daß wenigstens 50 % des flüssigen Trägers im übertragenen Bild nach dessen Fixieren und Schmelzen darin verbleiben.
- 25 12. Bilderzeugungsvorrichtung, enthaltend:
eine Einrichtung (2, 16, 18, 20, 22) zum Entwickeln eines elektrostatischen Bilds mit flüssigem Toner, einschließlich wenigstens pigmentierter, thermoplastischer Polymerteilchen und eines flüssigen Trägers,
30 eine Einrichtung (46) zum Übertragen des entwickelten, flüssigen Tonerbilds auf ein Substrat (100) und eine Einrichtung (68, 70) zum Transportieren des Substrats durch einen Spalt, der durch einen Teil der Oberfläche einer ersten Walze (68) und einen Teil der Oberfläche einer zweiten, elastomerbeschichteten Walze (70) gebildet ist, und zum Schmelzen sowie Fixieren des vom Substrat getragenen, entwickelten Bilds durch darauf erfolgende Anwendung von Wärme von der Oberfläche der ersten Walze,
35 dadurch **gekennzeichnet**,
daß die Einrichtungen zum Transportieren und zum Schmelzen sowie Fixieren derart angeordnet sind, daß die Temperatur, bei der das Schmelzen und Fixieren erfolgt, und die Transportgeschwindigkeit des Substrats in Verbindung mit den Eigenschaften des flüssigen Trägers von der Art sind, daß wenigstens 50 % des flüssigen Trägers im vom Substrat getragenen Bild daraus nicht verdampft werden.
- 40

Revendications

- 45 1. Procédé de formation d'image qui comprend les étapes consistant à révéler une image avec un toner liquide qui contient un porteur liquide et des particules de toner, transférer l'image de toner liquide sur une surface de support d'image d'un substrat et fixer par fusion ladite image à celle-ci grâce à l'application d'énergie et de pression, caractérisé par le fait de choisir au moins l'énergie appliquée lors du fixage par fusion et les propriétés du porteur liquide pour que 50% au moins du porteur liquide contenu dans l'image transférée y reste après la fusion et la fixation de celle-ci.
- 50 2. Procédé de formation d'image électrostatique qui comprend les étapes consistant à :
 - révéler une image électrostatique avec un toner liquide qui contient au moins des particules de polymère thermoplastique pigmentées et un porteur liquide,
 - transférer l'image de toner liquide révélée sur un substrat,
 - transporter le substrat à travers une zone de pincement définie par une partie de la surface d'un premier rouleau et une partie de la surface d'un second rouleau recouvert d'élastomère, et
 - 55 - faire fondre et fixer l'image révélée et supportée sur le substrat en lui appliquant de la chaleur depuis la surface dudit premier rouleau,
 caractérisé par le fait de choisir au moins la température à laquelle s'effectue la fusion et le fixage,

la vitesse de transport du substrat et les propriétés du porteur liquide pour que 50% au moins du porteur liquide contenu dans l'image portée par le substrat ne s'en évapore pas.

- 5 3. Procédé selon la revendication 2, dans lequel ladite étape de transfert comprend les sous-étapes consistant à transférer l'image d'abord sur une surface intermédiaire, puis de la surface intermédiaire au substrat.
4. Procédé selon la revendication 1, dans lequel ladite étape d'application d'énergie et de pression est obtenue par application d'une surface chauffée sur l'image.
- 10 5. Procédé selon la revendication 4, dans lequel ladite surface chauffée est la surface d'un premier rouleau recouvert d'élastomère.
6. Procédé selon la revendication 4, dans lequel ladite surface chauffée est la surface d'une courroie continue.
- 15 7. Procédé selon la revendication 5, dans lequel le substrat est transporté à travers une zone de pincement définie par une partie de la surface dudit premier rouleau recouvert d'élastomère, qui est en vis-à-vis de ladite surface de support d'image, et une partie de la surface d'un second rouleau recouvert d'élastomère, le revêtement dudit second rouleau étant plus tendre que le revêtement dudit premier rouleau.
- 20 8. Procédé selon la revendication 5, dans lequel le substrat est transporté à travers une zone de pincement définie par une partie de la surface dudit premier rouleau recouvert d'élastomère, qui est en vis-à-vis de ladite surface de support d'image, et une partie de la surface d'un second rouleau recouvert d'élastomère, sachant que le revêtement dudit second rouleau a une épaisseur plus importante que celle du revêtement dudit premier rouleau.
- 25 9. Procédé selon la revendication 8, dans lequel le rapport de l'épaisseur du revêtement dudit premier rouleau à l'épaisseur du revêtement dudit second rouleau est plus petit que 1 : 10.
- 30 10. Procédé selon l'une quelconque des précédentes revendications, dans lequel lesdites particules sont plastifiées par ledit liquide porteur pendant la fusion et le fixage de l'image sur le substrat.
- 35 11. Appareil de formation d'image, qui comprend :
 - des moyens (2, 16, 18, 20, 22) pour révéler une image avec un toner liquide qui contient un porteur liquide et des particules de toner, et
 - des moyens (46, 68, 70) pour transférer l'image de toner liquide sur une surface de support d'image d'un substrat (100) ainsi que des moyens pour fixer par fusion ladite image à celle-ci grâce à l'application d'énergie et de pression,
- 40 caractérisé en ce que les moyens pour fixer par fusion ladite image sont disposés de telle sorte que l'énergie appliquée lors de la fusion et du fixage, associée aux propriétés du liquide porteur, sont telles que 50% au moins du porteur liquide contenu dans l'image transférée y reste après la fusion et la fixation de celle-ci.
- 45 12. Appareil de formation d'image, qui comprend :
 - des moyens (2, 16, 18, 20, 22) pour révéler une image électrostatique avec un toner liquide qui contient au moins des particules de polymère thermoplastique pigmentées et un porteur liquide,
 - des moyens (46) pour transférer l'image de toner liquide révélée sur un substrat (100),
 - des moyens (68, 70) pour transporter le substrat à travers une zone de pincement définie par une
- 50 partie de la surface d'un premier rouleau (68) et une partie de la surface d'un second rouleau (70) recouvert d'élastomère, et pour faire fondre et fixer l'image révélée et supportée sur le substrat en lui appliquant de la chaleur depuis la surface dudit premier rouleau,
- caractérisé en ce que les moyens pour transporter le substrat et pour fixer par fusion ladite image sont disposés de telle sorte que la température à laquelle s'effectue la fusion et le fixage, la vitesse de transport du substrat associées aux propriétés du porteur liquide sont telles que 50% au moins du porteur liquide contenu dans l'image portée par le substrat ne s'en évapore pas.
- 55

FIG.1



