

Description

FIELD OF THE INVENTION

The present invention relates to image transfer techniques and apparatus for use in electrophotography.

BACKGROUND OF THE INVENTION

Liquid toner images are developed by varying the density of pigmented solids in a developer material on a latent indigo image bearing surface in accordance with an imaged pattern. The variations in density are produced by the corresponding pattern of an electric field extending outward from the latent image bearing surface, which is configured by the different latent image and background voltages on the latent image bearing surface and a voltage on a developer plate or roller.

In general, developed liquid toner images are neither solid nor homogeneous. Typically, a liquid toner developer contains about 1.5% to 2% solids and a developed image contains about 15% - 25% solids. The developed image has a higher density closer to the latent image bearing surface and a "fluffy", i.e. loosely bound, region furthest away from the latent image bearing surface.

In order to improve transfer of a clean developed image from the latent image bearing surface to a substrate it is most desirable to ensure that, before transfer, the pigmented solids adjacent background regions are substantially removed and that the density of pigmented solids in the developed image is increased, thereby compacting or rigidizing the developed image. The compacting or rigidizing of the developed image increases the image viscosity and enhances the ability of the image to maintain its integrity under the stresses encountered during image transfer. It is also desirable that excess liquid be removed from the latent image bearing surface before transfer.

It is known in the prior art, as described in U.S. Patent 3,955,533, to employ a reverse roller spaced about 50 microns from the latent image bearing surface to shear off the carrier liquid and pigmented solids in the region beyond the outer edge of the image and thus leave relatively clean areas above the background.

The technique of removing carrier liquid is known generally as metering. An alternative metering technique, described in U.S. Patents 3,767,300 and 3,741,643, employs an air knife, but has not been particularly successful due to sullying of the background as a result of turbulence and consequent mixing of the background inversion layer with the surface layer of the carrier liquid.

In U.S. Patent 3,957,016, the use of a positive biased metering roller is proposed wherein the meter-

ing roller is maintained at a voltage intermediate the image and background voltages to clean the background while somewhat compacting the image.

In the prior art it is known to effect image transfer wherein the image is brought into contact with a substrate backed by a charged roller. Unless the image is rigidized before it reaches the nip of the latent image bearing surface and the roller, image squash and flow may occur. This is particularly true if the substrate is a non-porous material, such as plastic.

In the prior art, liquid toner images are generally transferred to substrates by electrophoresis, whereby the charged image moves from the latent image bearing surface to the substrate through the carrier liquid under the influence of an electric field produced by a high voltage, associated with the substrate, which is of opposite polarity to the charge on the image particles.

The voltage and thus the field strength available for electrophoretic transfer are limited by the danger of electrical breakdown which can occur at both the input and output edges of the nip, due to the minimum of the Paschen curve being at about 8 microns. Thus, according to the Paschen curve, the voltage difference at the nip cannot exceed about 360 volts, if possible damage to the image and possible damage to the latent image bearing surface due to electrical breakdown are to be avoided.

Electrophoretic compaction of images prior to transfer thereof is described in U.S. Patent 4,286,039 which shows a metering roller followed by a negatively biased squeegee roller. The squeegee roller is operative both for compacting the image and for removing excess liquid. The voltage that can be applied to the squeegee roller is also limited by the danger of electrical breakdown. The breakdown problem is least serious at the input to the squeegee roller since the meniscus present there acts to increase the minimum effective air gap. In the image areas, the breakdown problem is more severe since the fields produced by the squeegee roller and by the latent image bearing surface add. The problem is most severe at the exit edge of the squeegee roller at which a meniscus is substantially not present.

In U.S. Patent 4,684,238 an unmetered image is initially transferred to an intermediate transfer member and is then metered by a metering roller having a voltage of opposite polarity to the charge on the toner particles making up the image. No discussion of the problem of electrical breakdown is presented.

SUMMARY OF THE INVENTION

The present invention seeks to provide improved apparatus for enhancement of image transfer.

There is therefore provided in accordance with a preferred embodiment of the invention, imaging apparatus including an image bearing surface arranged

to support a liquid toner image comprising image regions having charged toner particles of a given polarity and background regions thereon and apparatus for rigidizing the liquid toner image and removing liquid therefrom, comprising a squeegee roller at least a portion of which is electrified and urged against the image bearing surface, characterized in that the apparatus further comprises an intermediate transfer member for receiving the toner image from the image bearing surface after rigidization thereof, for transfer of the image to a substrate, and at least part of the squeegee roller is electrified to a voltage greater than about 500 volts with a polarity that is the same as the polarity of the charged toner particles.

Preferably, the imaging apparatus includes potential impression apparatus associated with at least one portion of the squeegee roller for impressing a potential on the at least one portion and energizing apparatus for energizing the potential impression means only when the at least one portion is located adjacent to the image bearing surface, thereby to provide image rigidization.

In a preferred embodiment of the invention the potential impression apparatus includes a plurality of electrical conductors associated with the squeegee roller.

Preferably, the squeegee roller has formed therein a plurality of electrical conductors the imaging apparatus also comprises apparatus for energizing at least one of the electrical conductors at an interior location with respect to the engagement of the squeegee roller and the image bearing surface wherein a voltage higher than the minimum of the Paschen curve is applied between said interior location of the squeegee roller and the image bearing surface.

Preferably the squeegee roller is electrified to a voltage which is less than about 2000 volts.

In a preferred embodiment of the invention the intermediate transfer member receives the image in an image transfer region and the imaging apparatus also includes apparatus for electrifying the intermediate transfer member at least at the image transfer region to a transfer voltage of less than 1000 volts, preferably about 500 volts.

In a preferred embodiment of the invention the electrified squeegee roller is operative to impress a potential difference of about between 1200 and 3000 volts, more preferably at least 1500 volts, between the squeegee roller and the image regions of the image bearing surface.

Preferably, the squeegee roller comprises an elastic outer layer having at least one ply of elastic material and the potential impression apparatus is contained within at least one portion of the elastic outer layer for impressing a potential on the at least one portion. Preferably, the at least one ply of elastic material comprises at least two plies and wherein the potential impression means is placed between the two

plies.

In a preferred embodiment of the invention, the squeegee roller is maintained at a potential opposite to the potential of image areas of the image bearing surface and which simultaneously compacts the image and removes excess liquid from the image.

There is further provided, in accordance with a preferred embodiment of the invention, imaging apparatus including an image bearing surface arranged to support a liquid toner image comprising image regions and background regions thereon and apparatus for rigidizing the liquid toner image utilizing an electric field, characterized in that it also includes separate squeegee apparatus for removing excess liquid from the toner image after rigidization thereof and an intermediate transfer member for receiving the toner image from the image bearing surface after rigidization thereof, for transfer of the image to a substrate.

Preferably, the apparatus for rigidizing comprises a static surface relative to which the image bearing surface moves.

In a preferred embodiment of the invention the static surface comprises at least one electrical conductor and wherein energization of the at least one electrical conductor provides a desired electrical field at a precise location for producing image rigidization. Preferably, the static surface engages the image bearing surface in an entrance region, an exit region and a third region therebetween and the energizing means is associated only with the third region.

In a preferred embodiment of the invention, the imaging apparatus includes apparatus for heating the intermediate transfer member at least where the image is transferred thereto.

Preferably the imaging apparatus also includes apparatus for removing pigmented toner particles from the background regions.

There is further provided, in accordance with a preferred embodiment of the invention, an imaging method including the steps of (a) forming a liquid toner image having charged toner particles of a given polarity on an image bearing surface, (b) rigidizing the liquid toner image by urging a squeegee roller against the image bearing surface, at least a portion of the squeegee roller being electrified and (c) subsequently transferring the image to a final substrate, characterized in that it includes the step of (d) transferring the rigidized image to an intermediate transfer member and (e) electrifying at least a portion of the squeegee roller to a voltage greater than about 500 volts, and preferably less than about 200 volts with a polarity that is the same as the polarity of the charged toner particles.

Preferably the method includes the step of heating the intermediate transfer member at least where the image is transferred thereto.

In a preferred embodiment of the invention the step of transferring takes place at a transfer region

and also the method also includes step of electrifying the intermediate transfer member at least at the image transfer region to a transfer voltage of less than 1000 volts, preferably less than about 500 volts.

In a preferred embodiment of the invention the squeegee roller is electrified to a potential difference of about between 1200 and 3000 volts, preferably at least 1500 volts, between the squeegee roller and the image regions of the image bearing surface.

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:

Fig. 1 is a simplified sectional illustration of electrophotographic apparatus constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 2 is a simplified sectional illustration of electrophotographic apparatus constructed and operative in accordance with another preferred embodiment of the present invention;

Fig. 3A is a simplified conceptual sectional illustration of image transfer apparatus constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 3B is a simplified conceptual sectional illustration of image transfer apparatus constructed and operative in accordance with another preferred embodiment of the present invention;

Fig. 4 is a simplified sectional illustration of part of an intermediate transfer member constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 5 is a simplified sectional illustration of part of an intermediate transfer member constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 6 is an illustration of part of the apparatus of Fig. 3A and illustrating the supply of potential to the intermediate transfer member;

Fig. 7 is a pictorial illustration of the arrangement of conductors on the intermediate transfer member employed in the apparatus of Fig. 6;

Fig. 8 is a simplified side view illustration of the arrangement of electrical supply apparatus in association with an intermediate transfer member;

Fig. 9 is a side view illustration taken along lines IX-IX in Fig. 8 for one embodiment of the invention;

Fig. 10 is a simplified illustration of electrical supply apparatus useful in the arrangement of Fig. 8;

Fig. 11 is a simplified sectional illustration of electrophotographic apparatus constructed and operative in accordance with another preferred embodiment of the present invention;

Fig. 12 is a simplified conceptual sectional illustration of image rigidization apparatus constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 13 is a simplified conceptual sectional illustration of image rigidization apparatus constructed and operative in accordance with another preferred embodiment of the present invention; and Fig. 14 is a simplified sectional illustration of electrophotographic apparatus constructed and operative in accordance with yet another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Fig. 1 which illustrates electrophotographic imaging apparatus constructed and operative in accordance with a preferred embodiment of the present invention. This and other embodiments of the invention are described for the case of liquid toner systems with negatively charged particles, and positively charged photoconductors. For positively charged toner, the polarities of the voltages given would be reversed.

In a preferred embodiment of the invention the toner of example 1 of U. S. Patent 4,794,651 the disclosure of which is included herein by reference, can be used, but a variety of liquid toner types are useful in the practice of the invention.

As in conventional electrophotographic systems, the apparatus of Fig. 1 comprises a drum 10 arranged for rotation about an axle 12 in a direction generally indicated by arrow 14. The drum 10 is formed with a cylindrical photoconductive surface 16.

A corona discharge device 18 is operative to generally uniformly charge the photoconductor surface 16 with a positive charge. Continued rotation of the drum 10 brings the charged photoconductor surface 16 into image receiving relationship with an exposure unit including a lens 20, which focuses a desired image onto the charged photoconductor surface 16, selectively discharging the photoconductor surface, thus producing an electrostatic latent image thereon.

Continued rotation of the drum 10 brings the charged photoconductor surface 16 bearing the electrostatic latent image into a development unit 22 including development electrodes 24, which is operative to apply a liquid toner to develop the electrostatic latent image.

In accordance with a preferred embodiment of the invention, following application of toner thereto, the photoconductor surface 16 passes a typically positively charged rotating roller 26, preferably rotating in a direction indicated by an arrow 28. Typically the spatial separation of the roller 26 from the photoconductor surface 16 is about 50 microns.

Preferably the charge on roller 26 is intermediate

the voltages of the latent image areas and of the background areas on the photoconductor surface. Typical voltages are: roller 26: 200V, background area: 50V and latent image areas: up to 1000V.

It is appreciated that roller 26 may rotate in the direction opposite to that indicated by arrow 28 and function as a metering roller thereby to reduce the thickness of liquid on the photoconductor surface 16.

Alternatively, the metering function may be eliminated at this stage or carried out downstream by an appropriate technique.

In any event, the liquid which passes the roller 26 should be relatively free of pigmented particles except in the region of the latent image.

Downstream of roller 26 there is preferably provided a rigidizing roller 30. The rigidizing roller 30 is preferably formed of a resilient polymeric material, such as conductive resilient polymeric materials as described in either or both of U.S. Patents 3,959,574 and 3,863,603 and is preferably maintained in non-contacting spatial relationship with the photoconductive surface 16.

According to one embodiment of the invention, roller 30 is lightly urged against the photoconductive surface 16 as by a spring mounting (not shown). Rotation of the photoconductive surface 16 produces hydrodynamic forces on roller 30 which push it slightly away from the photoconductive surface 16, so that it typically lies at a separation of 15 microns from the photoconductive surface.

According to an alternative embodiment of the present invention, the roller 30 may be mounted at a fixed separation from photoconductive surface 16. In such a case, to take account of surface irregularities, the roller 30 lies at a separation of about 50 microns from the photoconductive surface. The surface of roller 30 typically moves in the same direction as the photoconductive surface so as not to substantially remove liquid from the image. Preferably the nip between the roller 30 and the photoconductive surface 16 is kept wet so as to minimize problems of electrical discharge. Various constructions of rigidizing rollers which reduce problems of electrical discharge are described hereinbelow.

In an embodiment of the invention, the biased squeegee described in U. S. Patent 4,286,039, the disclosure of which is incorporated herein by reference, is used as the roller 30. A negative voltage of between several hundred to 2000 volts can be used and some breakdown is experienced. Roller 30 is negatively charged to a potential of at least several hundred and up to 2000 volts with the same sign as the charge on the pigmented toner particles, so that it repels similarly charged pigmented particles and causes them to more closely approach the image areas of the photoconductor surface 16, thus compressing and rigidizing the image.

Downstream of rigidizing roller 30 there is provid-

ed an intermediate transfer member 40, which rotates in a direction opposite to that of photoconductor surface 16, as shown by arrow 41, and is operative for receiving the toner image therefrom and for transferring the toner image to a receiving substrate 42, such as paper.

Various types of intermediate transfer members are known and are described, for example, in U.S. Patent 4,684,238 and in assignee's copending U.S. Patent application entitled METHOD AND APPARATUS FOR IMAGING USING AN INTERMEDIATE TRANSFER MEMBER filed January 4, 1989, the disclosures of which are incorporated herein by reference. Particularly beneficial constructions of intermediate transfer members in accordance with the present invention are described in detail hereinbelow.

Transfer of the image to intermediate transfer member 40 is preferably aided by providing electrification of the intermediate transfer member 40 to a voltage of polarity opposite to that of the charged particles, although other methods known in the art may be employed. Subsequent transfer of the image to substrate 42 is preferably aided by heat and pressure, with pressure applied by backer roller 43, although other methods known in the art may be employed.

It has been noted that when the negatively biased squeegee roller of U.S. Patent 4,286,039, with high negative voltage, is utilized as the roller 30, the positive voltage on the intermediate transfer member required to transfer the image thereto is sharply reduced, typically from about 1000 volts or more to about 500 volts. It is believed that this reduction is possibly due to a discharge of the charges in the image area of the image bearing surface and to a charging of the background areas of the image bearing surface.

Following transfer of the toner image to the intermediate transfer member, the photoconductive surface 16 is engaged by a cleaning roller 50, which typically rotates in a direction indicated by an arrow 52, such that its surface moves in a direction opposite to the movement of the adjacent photoconductive surface 16 which it operatively engages. The cleaning roller 50 is operative to scrub clean the surface 16. A cleaning material, such as toner, may be supplied to the cleaning roller 50, via a conduit 54. A wiper blade 56 completes the cleaning of the photoconductive surface. Any residual charge left on the photoconductive surface 16 is removed by flooding the photoconductor surface with light from a lamp 58.

Reference is now made to Fig. 2 which illustrates electrophotographic imaging apparatus constructed and operative in accordance with another preferred embodiment of the present invention. The apparatus of Fig. 2 shares many common elements with that of Fig. 1. These elements are indicated by identical reference numerals, and for the sake of conciseness are not described herein a second time.

The embodiment of Fig. 2 differs from that of Fig. 1 in that the rigidizing roller 30 is eliminated and further in that a belt-type, instead of roller type, intermediate transfer member 70 is employed. Belt-type intermediate transfer members are well known in the art and are described, inter alia, in U.S. Patents 3,893,761; 4,684,238 and 4,690,539, the disclosures of which are incorporated herein by reference.

It will be appreciated that the belt-type intermediate transfer member may be employed in the apparatus of Fig. 1 and that the rigidizing roller 30 may be omitted in the embodiment of Fig. 1 or added to the embodiment of Fig. 2.

Intermediate transfer member 70 is preferably charged so as to provide electrophoretic transfer of the image from the photoconductive surface 16 thereto. Within given limits, the efficiency of electrophoretic transfer of the image can be enhanced by increasing the potential difference between the photoconductive surface 16 and the intermediate transfer member 70. Increase in the potential difference between the photoconductive surface 16 and the intermediate transfer member 70 is limited, however, by the danger of electrical breakdown, which increases with an increase in potential difference.

The interrelationship between the minimum voltage difference at which breakdown occurs across a gap and the gap separation is given by the well-known Paschen curve. In air, the minimum breakdown voltage for a gap between two surfaces typically occurs, for a gap separation of about 8 microns, at a voltage difference of about 360V. The breakdown voltage increases significantly for gaps either smaller or larger than the indicated gap, and when dielectric liquids, such as Isopar or liquid developer, are present in the gap.

In accordance with a preferred embodiment of the invention, means are provided for significantly reducing or eliminating electrical breakdown in the vicinity of the photoconductive surface 16, which breakdown could damage the photoconductive surface and/or the image. In this connection reference is made to Figs. 3A and 3B, which illustrate conceptually an intermediate transfer member 40 having a limited charged region or regions.

Fig. 3A conceptually illustrates an intermediate transfer member 40 which is provided with an arrangement of electrical conductors whereby, at any given time, for any given rotational state of the intermediate transfer member, only an angularly delimited portion of the intermediate transfer member is energized to a sufficiently high voltage as to define a significant potential difference relative to the photoconductor surface 16.

In the illustrated embodiment, the energized portion, indicated by a reference number 60, is delimited by adjacent radii 61 and is selected so as to roughly correspond with the region of the nip 62 between the

intermediate transfer member and the photoconductor surface 16. According to one embodiment of the invention, the energized portion corresponds to the region which is filled with a liquid, thus substantially reducing or eliminating electrical discharge thereat. According to a more generalized concept of the invention, the energized portion is not necessarily limited to the region filled with a liquid but is limited to a region in which the gap does not have a separation for which the breakdown voltage is less than the potential difference between the energized portion and the photoconductor surface 16, taking into account the nature of the material disposed in the gap. Even more generally, small amounts of breakdown may be allowed.

In the embodiment of Fig. 3A a voltage difference across the gap of 1000V to 2000V should be maintained for best results, although lesser or greater voltage differences may also be employed.

Fig. 3B illustrates a further development of the structure illustrated in Fig. 3A. Here electrical voltages are supplied to the conductors in the intermediate transfer member 40 such that two different potentials are applied to the surface of the intermediate transfer member in adjacent regions 64 and 66, as illustrated.

This arrangement has particular utility in providing an intermediate transfer member 40 which serves both to rigidify the image prior to transfer and then to transfer the rigidified image from the photoconductor surface 16 to the intermediate transfer member 40.

In such an arrangement, where the pigmented particles are normally negatively charged, the image areas on the photoconductor surface positively charged, and the directions of rotation of the photoconductor surface 16 and of the intermediate transfer member 40 as indicated in Fig. 3B, portion 64 will be energized to a negative potential, typically -200V to -2000V, thereby to provide image compression or rigidization by urging the pigmented particles towards the image areas on the photoconductor surface, while portion 66 will be energized to a positive potential, typically +300V to +2500V, thus drawing the image electrophoretically from the photoconductor surface 16 through the solvent in the meniscus 68 onto the surface of intermediate transfer member 40 in portion 66. The lower positive voltage on portion 66 can be used for a relatively high negative voltage on portion 64.

One possible, but not definitive explanation of why good transfer is achieved with low positive voltage on portion 66 and high negative voltage on portion 64 is that charge transfer from the intermediate transfer member 40 to the photoconductive surface takes place, with consequent at least partial neutralization of the charge on the drum.

Normally, portions 66 and 64 may be separated by a region on the photoconductor surface of intermediate potential, so as to prevent unwanted electri-

cal discharge between portions 64 and 66. The outer boundaries of regions 64 and 66 are normally defined so as to avoid electrical breakdown between regions 64 and 66 and the photoconductor surface 16, as described above in connection with Fig. 3A.

Reference is now made to Fig. 4, which is a simplified and not necessarily to scale sectional illustration of an intermediate transfer member particularly useful in the apparatus shown in Fig. 2. The intermediate transfer member, generally indicated by reference numeral 70, typically comprises a high tensile strength substrate 72, such as Kapton, typically of thickness 10 microns, on which is preferably provided a resilient layer 74.

A resistive heating layer 76, typically formed of nickel-chrome alloy, is preferably formed onto resilient layer 74 and is coupled to a source of electrical current for providing desired heating of the intermediate transfer member 70 to assist in image transfer therefrom onto an image receiving substrate. Disposed over heating layer 76 is an insulative layer 78, typically formed of polyurethane of thickness 5 microns.

Supported on insulative layer 78 is a generally parallel array 80 of generally uniformly spaced selectively energizable electrical conductors 82. The elongate axes of the conductors 82 are generally perpendicular to the direction of movement, indicated by double headed arrow 84, of the intermediate transfer member 70 when in operation, as shown, for example, in Fig. 2.

Conductors 82 are typically of thickness 35 microns and of width 500 microns and are separated by 250 microns. They are typically embedded in a layer 86 of thermally conductive material, such as a silicone-polyurethane copolymer loaded with 2% Degussa Printex XE-2, manufactured by Degussa AG of Frankfurt, West Germany, having a thickness about 100 microns over the conductors 82 and a resistivity of about 10^{+5} ohm-cm. Disposed over layer 86 is a release layer 88, such as Syl-Off manufactured by Dow Corning, having a typical thickness of 10 microns.

Reference is now made to Fig. 5, which illustrates an intermediate transfer member which is identical to that shown in Fig. 4 except that the resistive heating layer 76 is not continuous but is rather formed of a generally parallel array 90 of generally uniformly spaced selectively energizable electrical conductors 92. The elongate axes of the conductors 92 are generally perpendicular to the direction of movement, indicated by double headed arrow 84, of the intermediate transfer member 70 when in operation as shown, for example, in Fig. 2.

The provision of array 90 instead of a continuous resistive heating layer permits the heating of the intermediate transfer member 70 to be spatially selective, for example, permitting heating of the intermediate transfer member only along that portion of its

route which extends from the photoconductor surface 16 to the substrate 42 (Fig. 2).

Heating of the image carried on the intermediate transfer member 70 along this portion of its route enables enhancement of the cohesiveness of the image to be realized without possible heat damage to the photoconductor surface 16 as described in Assignee's copending U.S. Patent Application 272,323 filed November 21, 1988 (publication no. WO-A-9015942), the disclosure of which is incorporated herein by reference, and also permits heating of the image to be terminated with a desired level of precision to enhance transfer of the image from the intermediate transfer member to the substrate. Enhancement of image transfer in this manner is described and claimed in Assignee's copending U.S. Patent Application filed January 4, 1989 and entitled: Method & Apparatus for Imaging Using an Intermediate Transfer Member, the teaching of which is hereby incorporated herein by reference.

This selective heating will be most effective if the heat capacity of the intermediate transfer member is relatively low, so that the heating and cooling can occur as described in the above-identified U.S. Patent Application.

It will be appreciated that although the intermediate transfer members having one or more arrays of selectively energizable conductors have been described and shown in Figs. 4 and 5 in the context of belts, the structure thereof may be applied equally to intermediate transfer members in the form of rollers, such as those employed in the apparatus of Fig. 1. In addition, some of the layers of the structures of Figs. 4 and 5 can be omitted, as may be desired if, for example, heating is not desired.

Reference is now made to Figs. 6-10, which illustrate the use of selectively energizable conductors in roller configurations. Figs. 6 and 7 illustrate an intermediate transfer member roller 40 having at least one array 80 of selectively energizable conductors in operative engagement with a substrate 42 and a drum 43. An electrical energizing shoe 100 applies electrical power to the array 80. The shoe 100 may comprise one or more brushes or contacts contacting one or more groups of conductors.

Fig. 7 illustrates a preferred arrangement of the array 80 on a roller 40. It is seen that the conductors 82 are circumferentially offset adjacent the edge of the roller 40. The purpose of this offset is to enable energizing shoe 100 to be located outside of the nip between roller 40 and drum 43 yet nevertheless to apply a desired voltage to the conductors 82 located in the nip for enhancing transfer thereat while minimizing electrical breakdown as described hereinabove.

Fig. 8 illustrates an arrangement by which a shoe assembly of the type illustrated in Fig. 10 may be mounted in tension in operative engagement with a roller 92. The roller 92 is similar to roller 40, illustrated

in Fig. 7, except that the conductors 82 are no longer required to be offset as shown in Fig. 7. The shoe assembly is held in tensioned contact with roller 92 and contacts 112, 114 and 116 of a shoe 110 (Fig. 10) are in contact with the extremities of conductors 82. The diameter of drum 10 is reduced at a region facing the extremities of conductors 82, as shown in Fig. 9, to provide clearance of shoe 110.

Accordingly, as seen in Fig. 10, contact 112 may be maintained at -2000 Volts, contact 114 may be maintained at 0 Volts and contact 116 may be maintained at +500 Volts. An electrical connector 120, shown in Fig. 8, may provide the desired voltages to respective connectors 122, 124 and 126 which are electrically coupled to shoe portions 112, 114 and 116 respectively.

It may be appreciated that an intermediate transfer member of the type illustrated in Fig. 5, having two arrays 80 and 90 of conductors, may receive electrical power via shoe assemblies 110 arranged at opposite ends of the roller 92, as illustrated in Fig. 9.

Reference is now made to Fig. 11, which illustrates electrophotographic imaging apparatus generally similar to that shown in Fig. 1 with the following principal exception: the use of an intermediate transfer member is abandoned in favor of direct transfer from the photoconductor surface 16 to a substrate 130, such as paper. The direct transfer is effected by the provision of guide rollers 132, 134 and 136, which guide a continuous web of substrate 130, and a drive roller 138, which cooperates with a support web 140. A suitable charging device,

as a corona discharge device 142, charges the substrate at a transfer location, for effecting electrophoretic transfer of the image from the photoconductor surface 16 to the substrate 130.

According to a preferred embodiment of the invention, the apparatus of Figs. 1 or 11 may be constructed and operative with a rigidizing roller 30 (Fig. 1, 11-13). As shown in Figs. 12-13, roller 30 includes a generally parallel array 150 of generally uniformly spaced selectively energizable electrical conductors 152. The elongate axes of the conductors 152 are generally perpendicular to the direction of movement of the rigidizing roller 30 in operation as shown, for example, in Fig. 12, wherein the motion of the rigidizing roller is indicated by an arrow 154.

Conductors 152 are typically of thickness 35 microns and of width 500 microns and are separated by 250 microns. There is defined a general region 155 between the rigidizing roller 30 and the photoconductor surface 16, delimited by imaginary radii 156, in which the chance of electrical breakdown is low due to the presence thereof of a meniscus of the dielectric toner carrier. In this region, conductors 152 are charged to a voltage of the same polarity as that of the pigmented toner particles, typically -500 to -2000 Volts when negatively charged particles are utilized.

This arrangement compresses the toner particles of the image, thus rigidizing the image on the photoconductor surface, for resulting enhancement of transfer therefrom. It should be understood that the roller 30 of Fig. 12 can also act as a squeegee roller, substantially removing most of the liquid from the image and further physically compressing the image.

Fig. 13 illustrates a further development of the apparatus of Fig. 12 in which roller 30 serves as a metering, background removal and rigidizing roller. In this arrangement, two regions 160 and 162 are defined and opposite voltages are applied to the conductors 152 in those regions, much in the same way as described above and illustrated in Fig. 3B.

This arrangement has particular utility in providing a background removal and rigidifying roller 30 which serves both to remove background from the image and to rigidify the image prior to transfer.

In such an arrangement, where the pigmented particles are normally negatively charged and the image areas on the photoconductor surface are positively charged, and the directions of rotation of the photoconductor surface 16 and of the roller 30 which is spaced from surface 16, are as indicated in Fig. 13, region 160 will be energized to a positive potential, typically +200 Volts, thereby to draw pigmented particles away from the background areas of the photoconductor surface 16. Region 162 will be energized to a negative potential, typically -200V to -2000V, thereby to provide image rigidization by urging the pigmented particles towards the image areas on the photoconductor surface.

Normally, between regions 160 and 162 there may be a region on the roller 30 of intermediate potential, so as to prevent unwanted electrical discharge between regions 160 and 162. The outer boundary of region 162 will normally be defined so as to avoid electrical breakdown between region 162 and the photoconductor surface 16.

Metering of excess liquid from the photoconductive surface 16 is achieved by counter rotation of roller 30 in a direction indicated by an arrow 164, as is well known in the art.

Reference is now made to Fig. 14 which illustrates electrophotographic imaging apparatus which is substantially similar to that illustrated in Fig. 11 with the following exception; roller 30 is replaced by a non-rotating rigidizing element 170 having an electrically charged region 172 which is located interiorly of the edges of element 170, such that electrical breakdown is prevented.

Region 172 is selected such that the gap separation between the element 170 and the photoconductor surface 16 is such that when the gap is filled with dielectric toner carrier liquid during operation, no electrical discharge takes place at the operating voltages, which are preferably in the range of -200 to -2000 Volts for the element 170 within region 172,

when the photoconductor surface 16 is charged to 1000 Volts at the image region and 50 Volts at the background region. The rigidizing element is preferably hydrodynamically shaped so that rotation of the roller will cause it to be spaced about 15 microns from the surface of the photoconductor, when it is lightly urged towards the photoconductor. Alternatively it may be kept at a fixed spacing from the photoconductor of the order of 50 microns.

Alternatively, a larger portion of the element 170 can be electrified, and the upstream end to the element shaped to provide a meniscus of insulating carrier liquid, until the spacing in air between the element 170 and the photoconductor are large enough to prevent breakdown or corona.

In a further preferred embodiment of the invention a squeegee means (not shown) is provided, for removing excess liquid from the toner image, separate from the rigidizing element.

It will be appreciated that the signs of the various voltages have been given for an example using negatively charged toner particles. The invention is equally applicable to the use of positively charged toner particles with a negatively charged photoconductor, appropriate changes being made in the signs of the stated voltages.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow.

Claims

1. Imaging apparatus comprising:

an image bearing surface (16) arranged to support a liquid toner image comprising image regions having charged toner particles of a given polarity and background regions thereon; and

means for rigidizing (26) said liquid toner image and removing liquid therefrom, comprising a squeegee roller at least a portion of which is electrified and urged against said image bearing surface;

characterized in that:

said apparatus further comprises an intermediate transfer member (40) for receiving said toner image from said image bearing surface (16) after rigidization thereof, for transfer of said image to a substrate (42); and

at least part of said squeegee roller is electrified to a voltage greater than about 500 volts with a polarity that is the same as the polarity of said charged toner particles.

2. Apparatus according to claim 1 wherein said electrified squeegee roller comprises:

potential impression means (82) associated with at least one portion of said squeegee roller for impressing a potential on said at least one portion; and

means (100) for energizing said potential impression means only when said at least one portion is located adjacent to said image bearing surface, thereby to provide image rigidization.

3. Apparatus according to claim 2 wherein:

said potential impression means comprises a plurality of electrical conductors (82) associated with said squeegee roller.

4. Apparatus according to claim 2 or claim 3 wherein said squeegee roller has formed therein a plurality of electrical conductors (82) and wherein said apparatus also comprises:

means for energizing at least one of said electrical conductors at an interior location with respect to the engagement of the squeegee roller and the image bearing surface wherein a voltage higher than the minimum of the Paschen curve is applied between said interior location of said squeegee roller and the image bearing surface.

5. Apparatus according to any of the preceding claims wherein said squeegee roller is electrified to a voltage which is less than about 2000 volts.

6. Apparatus according to any of the preceding claims wherein said intermediate transfer member receives said image in an image transfer region (62) and also comprising means for electrifying said intermediate transfer member at least at said image transfer region to a transfer voltage of less than 1000 volts.

7. Apparatus according to claim 6 wherein said transfer voltage is about 500 volts.

8. Apparatus according to any of the preceding claims wherein said electrified squeegee roller is operative to impress a potential difference of about between 1200 and 3000 volts between said squeegee roller and the image regions of said image bearing surface.

9. Apparatus according to claim 8 wherein said potential difference is at least 1500 volts.

10. Apparatus according to any of the preceding claims wherein said squeegee roller comprises an elastic outer layer (86) having at least one ply of elastic material and said potential impression means (82) is contained within at least one portion of said elastic outer layer for impressing a potential on said at least one portion.

when the photoconductor surface 16 is charged to 1000 Volts at the image region and 50 Volts at the background region. The rigidizing element is preferably hydrodynamically shaped so that rotation of the roller will cause it to be spaced about 15 microns from the surface of the photoconductor, when it is lightly urged towards the photoconductor. Alternatively it may be kept at a fixed spacing from the photoconductor of the order of 50 microns.

Alternatively, a larger portion of the element 170 can be electrified, and the upstream end to the element shaped to provide a meniscus of insulating carrier liquid, until the spacing in air between the element 170 and the photoconductor are large enough to prevent breakdown or corona.

In a further preferred embodiment of the invention a squeegee means (not shown) is provided, for removing excess liquid from the toner image, separate from the rigidizing element.

It will be appreciated that the signs of the various voltages have been given for an example using negatively charged toner particles. The invention is equally applicable to the use of positively charged toner particles with a negatively charged photoconductor, appropriate changes being made in the signs of the stated voltages.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow.

Claims

1. Imaging apparatus comprising:

an image bearing surface (16) arranged to support a liquid toner image comprising image regions having charged toner particles of a given polarity and background regions thereon; and

means for rigidizing (26) said liquid toner image and removing liquid therefrom, comprising a squeegee roller at least a portion of which is electrified and urged against said image bearing surface;

characterized in that:

said apparatus further comprises an intermediate transfer member (40) for receiving said toner image from said image bearing surface (16) after rigidization thereof, for transfer of said image to a substrate (42); and

at least part of said squeegee roller is electrified to a voltage greater than about 500 volts with a polarity that is the same as the polarity of said charged toner particles.

2. Apparatus according to claim 1 wherein said electrified squeegee roller comprises:

potential impression means (82) associated with at least one portion of said squeegee roller for impressing a potential on said at least one portion; and

means (100) for energizing said potential impression means only when said at least one portion is located adjacent to said image bearing surface, thereby to provide image rigidization.

3. Apparatus according to claim 2 wherein:

said potential impression means comprises a plurality of electrical conductors (82) associated with said squeegee roller.

4. Apparatus according to claim 2 or claim 3 wherein said squeegee roller has formed therein a plurality of electrical conductors (82) and wherein said apparatus also comprises:

means for energizing at least one of said electrical conductors at an interior location with respect to the engagement of the squeegee roller and the image bearing surface wherein a voltage higher than the minimum of the Paschen curve is applied between said interior location of said squeegee roller and the image bearing surface.

5. Apparatus according to any of the preceding claims wherein said squeegee roller is electrified to a voltage which is less than about 2000 volts.

6. Apparatus according to any of the preceding claims wherein said intermediate transfer member receives said image in an image transfer region (82) and also comprising means for electrifying said intermediate transfer member at least at said image transfer region to a transfer voltage of less than 1000 volts.

7. Apparatus according to claim 6 wherein said transfer voltage is about 500 volts.

8. Apparatus according to any of the preceding claims wherein said electrified squeegee roller is operative to impress a potential difference of about between 1200 and 3000 volts between said squeegee roller and the image regions of said image bearing surface.

9. Apparatus according to claim 8 wherein said potential difference is at least 1500 volts.

10. Apparatus according to any of the preceding claims wherein said squeegee roller comprises an elastic outer layer (86) having at least one ply of elastic material and said potential impression means (82) is contained within at least one portion of said elastic outer layer for impressing a potential on said at least one portion.



11. Apparatus according to claim 10 wherein said at least one ply of elastic material comprises at least two plies (82, 88) and wherein said potential impression means is placed between said two plies.
12. Apparatus according to any of the preceding claims wherein said squeegee roller is maintained at a potential opposite to the potential of image areas of the image bearing surface whereby said squeegee roller simultaneously compacts the image and removes excess liquid from the image.
13. Imaging apparatus comprising:
 - an image bearing surface (16) arranged to support a liquid toner image comprising image regions and background regions thereon; and
 - means for rigidizing (26, 110) said liquid toner image utilizing an electric field; characterized in that it also includes:
 - separate squeegee means for removing excess liquid from said toner image after rigidization thereof; and
 - an intermediate transfer member for receiving said toner image from said image bearing surface after rigidization thereof, for transfer of said image to a substrate.
14. Apparatus according to claim 13 and wherein said means for rigidizing comprises a static surface (110) relative to which the image bearing surface moves.
15. Apparatus according to claim 14 and wherein said static surface comprises at least one electrical conductor (82) and wherein energization of said at least one electrical conductor provides a desired electrical field at a precise location for producing image rigidization.
16. Apparatus according to claim 14 or claim 18 wherein said static surface engages said image bearing surface in an entrance region, an exit region and a third region therebetween and said energizing means is associated only with said third region.
17. Apparatus according to any of the preceding claims and including means for heating said intermediate transfer member at least where said image is transferred thereto.
18. Apparatus according to any of the preceding claims wherein said apparatus also comprises: means for removing pigmented toner particles from said background regions.
19. A method for imaging comprising the steps of:

forming a liquid toner image having charged toner particles of a given polarity on an image bearing surface;

rigidizing said liquid toner image by urging a squeegee roller against said image bearing surface, at least a portion of said squeegee roller being electrified; and

subsequently transferring said image to a final substrate,

characterized in that:

it includes the step of transferring said rigidized image to an intermediate transfer member; and

electrifying at least a portion of the squeegee roller to a voltage greater than about 500 volts with a polarity that is the same as the polarity of said charged toner particles.

20. A method according to claim 19 and including the step of:

heating said intermediate transfer member at least where said image is transferred thereto.

21. A method according to claim 19 or claim 20 wherein said squeegee roller is electrified to a voltage which is less than about 2000 volts.

22. A method according to any one of claims 19-21 wherein said step of transferring takes place at a transfer region and also including the step of electrifying said intermediate transfer member at least at said image transfer region to a transfer voltage of less than 1000 volts.

23. A method according to claim 22 wherein said transfer voltage is less than about 500 volts.

24. A method according to any of claims 19-23 wherein said squeegee roller is electrified to a potential difference of about between 1200 and 3000 volts between said squeegee roller and the image regions of said image bearing surface.

25. A method according to claim 24 wherein said potential difference is at least 1500 volts.

Patentansprüche

1. Bilderzeugungsgerät, mit
 - einer ein Bild tragenden Fläche (16), die so angeordnet ist, um ein Flüssigtonerbild zu tragen, welches Bildbereiche mit geladenen Tonerpartikeln einer gegebenen Polarität und Hintergrundbereiche aufweist, und
 - einer Einrichtung (26) zum Versteifen oder Verfestigen des Flüssigtonerbildes und zum Ent-



fernen der Flüssigkeit aus demselben, die eine Quetschrolle aufweist, von der wenigstens ein Abschnitt elektrisch versorgt ist und gegen die ein Bild tragende Fläche gedrückt wird, dadurch gekennzeichnet, daß

das Gerät ein Zwischenübertragungsteil (40) aufweist, um das Tonerbild von der das Bild tragenden Fläche (16) nach Versteifung oder Verfestigung desselben aufzunehmen, um das Bild auf ein Substrat (42) zu übertragen, und wenigstens ein Teil der Quetschrolle elektrisch mit einer Spannung versehen ist, die größer ist als ca 500 Volt mit einer Polarität, welche die gleiche ist wie die Polarität der geladenen Tonerpartikeln.

2. Gerät nach Anspruch 1, bei dem die elektrisch versorgte Quetschrolle folgendes aufweist:
eine ein Potential zuführende Einrichtung (82), die wenigstens einem Abschnitt der Quetschrolle zugeordnet ist, um dem wenigstens einen Abschnitt ein Potential aufzudrücken, und eine Einrichtung (100) zum Erregen der das Potential anlegenden Einrichtung nur dann, wenn der wenigstens eine Abschnitt nahe bei der das Bild tragenden Fläche gelegen ist, um dadurch eine Bildverfestigung oder Versteifung zu erzielen.
3. Gerät nach Anspruch 2, bei dem die das Potential anlegende Einrichtung eine Vielzahl von elektrischen Leitern (82) aufweist, die der Quetschrolle zugeordnet sind.
4. Gerät nach Anspruch 2 oder 3, bei dem die Quetschrolle eine Vielzahl von elektrischen Leitern (82) in sich aufweist und das Gerät ferner enthält:
eine Einrichtung zum Erregen von wenigstens einem der elektrischen Leiter an einer Innenstelle hinsichtlich der Anlage der Quetschrolle an der das Bild tragenden Fläche, wobei eine Spannung, die höher ist als das Minimum der Paschen-Kurve, zwischen der Innenstelle der Quetschrolle und der das Bild tragenden Fläche angelegt ist.
5. Gerät nach irgendeinem der vorhergehenden Ansprüche, bei dem die Quetschrolle elektrisch mit einer Spannung angetrieben bzw. versorgt ist, die kleiner ist als ca 2000 Volt.
6. Gerät nach irgendeinem der vorhergehenden Ansprüche, bei dem das Zwischenübertragungsteil das Bild an einer Bildübertragungszone (62) empfängt und ferner eine Einrichtung enthält, um das Zwischenübertragungsteil wenigstens elektrisch mit einer Übertragungsspannung von we-

niger als 1000 Volt zu versorgen.

7. Gerät nach Anspruch 6, bei dem die Übertragungsspannung ca 500 Volt beträgt.
8. Gerät nach irgendeinem der vorhergehenden Ansprüche, bei dem die elektrisch versorgte Quetschrolle dafür ausgebildet ist, um eine Potentialdifferenz von ca 1200 bis 3000 Volt zwischen der Quetschrolle und den Bildbereichen der das Bild tragenden Fläche aufzudrücken.
9. Gerät nach Anspruch 8, bei dem die Potentialdifferenz wenigstens 1500 Volt beträgt.
10. Gerät nach irgendeinem der vorhergehenden Ansprüche, bei dem die Quetschrolle eine elastische äußere Schicht (86) mit wenigstens einer Lage aus einem elastischen Material aufweist und bei dem die das Potential anlegende Einrichtung (82) innerhalb wenigstens eines Abschnitts der elastischen äußeren Schicht enthalten ist, um ein Potential dem wenigstens einen Abschnitt aufzudrücken.
11. Gerät nach Anspruch 10, bei dem die wenigstens eine Lage aus elastischem Material wenigstens zwei Lagen (82, 88) umfaßt und bei dem die das Potential anlegende Einrichtung zwischen den zwei Lagen angeordnet ist.
12. Gerät nach irgendeinem der vorhergehenden Ansprüche, bei dem die Quetschrolle auf einem Potential gehalten ist, welches entgegengesetzt dem Potential der Bildbereiche der das Bild tragenden Fläche ist, wobei die Quetschrolle das Bild gleichzeitig verdichtet und Überschußflüssigkeit aus dem Bild entfernt.
13. Bilderzeugungsgerät mit
einer ein Bild tragenden Fläche (16), die dafür ausgebildet ist, ein Flüssigtonerbild mit Bildbereichen und Hintergrundbereichen zu tragen, und
mit einer Einrichtung (26, 110) zum Versteifen des Flüssigtonerbildes unter Verwendung eines elektrischen Feldes, dadurch gekennzeichnet, daß das Gerät enthält:
getrennte Quetscheinrichtungen, um Überschußflüssigkeit aus dem Tonerbild nach Verfestigung desselben zu entfernen, und
ein Zwischenübertragungsteil, um das Tonerbild von der das Bild tragenden Fläche nach Verfestigung desselben aufzunehmen, um das Bild auf ein Substrat zu übertragen.
14. Gerät nach Anspruch 13, bei dem die Einrichtung zur Verfestigung eine statische Oberfläche (110)



umfaßt, zu der sich die das Bild tragende Oberfläche relativ bewegt.

15. Gerät nach Anspruch 14, bei dem die statische Oberfläche wenigstens einen elektrischen Leiter (82) umfaßt und bei dem die Erregung des wenigstens einen elektrischen Leiters ein gewünschtes elektrisches Feld an einer genau definierten Stelle zum Erzeugen einer Bildverfestigung oder Versteifung herauf.

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16. Gerät nach Anspruch 14 oder 18, bei dem die statische Oberfläche an die das Bild tragende Oberfläche an einem Eintrittsbereich, einem Austrittsbereich und einem dritten Bereich dazwischen angreift und bei dem die Erregungseinrichtung lediglich dem dritten Bereich zugeordnet ist.

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17. Gerät nach irgendeinem der vorhergehenden Ansprüche, mit einer Einrichtung zum Erhitzen des Zwischenübertragungsteiles wenigstens an der Stelle, an welcher das Bild auf dieses übertragen wird.

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18. Gerät nach irgendeinem der vorhergehenden Ansprüche, welches ferner enthält:

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eine Einrichtung zum Entfernen von pigmentierten Tonerteilchen aus den Hintergrundbereichen.

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19. Verfahren zur Bilderzeugung mit den folgenden Schritten:

Herstellen eines Flüssigtonerbildes mit geladenen Tonerteilchen einer gegebenen Polarität auf einer bildtragenden Oberfläche,

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Versteifung oder Verfestigung des Flüssigtonerbildes indem eine Quetschrolle gegen die das Bild tragende Fläche gedrückt wird, wobei wenigstens ein Abschnitt der Quetschrolle mit Elektrizität versorgt wird, und

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anschließendes Übertragen des Bildes auf ein endgültiges Substrat, dadurch gekennzeichnet, daß

das verfestigte Bild auf ein Zwischenübertragungsteil übertragen wird, und

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wenigstens ein Abschnitt der Quetschrolle mit einer Spannung versorgt wird, die größer ist als ca 500 Volt mit einer Polarität, welche die gleiche ist wie die Polarität der geladenen Tonerteilchen.

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20. Verfahren nach Anspruch 19, bei dem das Zwischenübertragungsteil wenigstens dort erhitzt wird, wo das Bild auf dasselbe übertragen wird.

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21. Verfahren nach Anspruch 19 oder 20, bei dem die Spannung, mit welcher die Quetschrolle elektrisch versorgt wird, kleiner ist als ca 2000 Volt.

22. Verfahren nach irgendeinem der Ansprüche 19 bis 21, bei dem der Schritt der Übertragung an einer Übertragungszone stattfindet, und bei dem das Zwischenübertragungsteil wenigstens an der Bildübertragungszone mit einer Übertragungsspannung von weniger als 1000 Volt elektrisch versorgt wird.

23. Verfahren nach Anspruch 22, bei dem die Übertragungsspannung kleiner ist als ca 500 Volt.

24. Verfahren nach irgendeinem der Ansprüche 19 bis 23, bei dem die Quetschrolle mit einer Potentialdifferenz von 1200 bis 3000 Volt zwischen der Quetschrolle und den Bildbereichen der das Bild tragenden Fläche elektrisch versorgt wird.

25. Verfahren nach Anspruch 24, bei dem die Potentialdifferenz wenigstens 1500 Volt beträgt.

Revendications

1. Appareil de formation d'image qui comprend :

- une surface (16) de support de l'image disposée pour supporter une image de toner liquide qui comprend des régions d'image avec des particules de toner chargées d'une polarité donnée et des régions d'arrière-plan, et

- un moyen (26) pour rigidifier ladite image de toner liquide et en supprimer le liquide, qui comprend un rouleau-poussoir dont une partie au moins est électrisée et qui est poussé contre la surface de support de l'image,

caractérisé en ce que :

- ledit appareil comprend en outre un élément de transfert intermédiaire (40) destiné à recevoir ladite image de toner en provenance de ladite surface (16) de support de l'image, après sa rigidification, pour transférer ladite image sur un substrat (42), et
- une partie au moins dudit rouleau-poussoir est électrisée à une tension supérieure à environ 500 volts, avec une polarité qui est la même que la polarité desdites particules de toner chargées.

2. Appareil selon la revendication 1, dans lequel ledit rouleau électrisé comprend :

- un moyen (82) d'application de potentiel, associé à une partie au moins dudit rouleau-poussoir pour appliquer un potentiel à ladite partie, et

- un moyen (100) pour alimenter en énergie ledit moyen d'application de potentiel uniquement lorsque ladite partie se trouve ad-



jacente à ladite surface de support de l'image, pour provoquer ainsi une rigidification de l'image.

3. Appareil selon la revendication 2, dans lequel ledit moyen d'application de potentiel comprend une pluralité de conducteurs électriques (82) associés audit rouleau-poussoir. 5
4. Appareil selon la revendication 2 ou la revendication 3, dans lequel une pluralité de conducteurs électriques (82) sont formés dans ledit rouleau-poussoir et dans lequel ledit appareil comprend aussi un moyen pour alimenter en énergie l'un au moins desdits conducteurs électriques au niveau d'un emplacement intérieur par rapport au contact du rouleau-poussoir et de la surface de support de l'image, sachant qu'une tension supérieure au minimum de la courbe de Paschen est appliquée entre ledit emplacement intérieur du rouleau-poussoir et la surface de support de l'image. 10 15 20
5. Appareil selon l'une quelconque des précédentes revendications, dans lequel ledit rouleau-poussoir est porté à une tension qui est inférieure à environ 2000 volts. 25
6. Appareil selon l'une quelconque des précédentes revendications, dans lequel ledit élément de transfert intermédiaire reçoit ladite image dans une région (62) de transfert de l'image, et qui comprend aussi un moyen pour porter ledit élément de transfert intermédiaire, au niveau de ladite région de transfert de l'image au moins, à une tension de transfert inférieure à 1000 volts. 30 35
7. Appareil selon la revendication 6, dans lequel ladite tension de transfert vaut environ 500 volts. 40
8. Appareil selon l'une quelconque des précédentes revendications, dans lequel ledit rouleau-poussoir électrisé sert à appliquer une différence de potentiel d'entre 1200 et 3000 volts environ entre ledit rouleau-poussoir et les régions d'image de ladite surface de support de l'image. 45
9. Appareil selon la revendication 8, dans lequel ladite différence de potentiel est d'au moins 1500 volts. 50
10. Appareil selon l'une quelconque des précédentes revendications, dans lequel ledit rouleau-poussoir comprend une couche extérieure (86) élastique qui comporte au moins un pli de matériau élastique, et ledit moyen (82) d'application de potentiel est contenu dans une partie au moins de ladite couche extérieure élastique pour appliquer 55

un potentiel sur ladite partie.

11. Appareil selon la revendication 10, dans lequel ledit pli de matériau élastique au nombre d'au moins un comprend au moins deux plis (82, 88) et dans lequel ledit moyen d'application de potentiel est placé entre lesdits deux plis.
12. Appareil selon l'une quelconque des précédentes revendications, dans lequel ledit rouleau-poussoir est maintenu à un potentiel opposé au potentiel des régions d'image de la surface de support de l'image, ce qui fait que ledit rouleau-poussoir peut simultanément comprimer l'image et supprimer l'excès de liquide de l'image.
13. Appareil de formation d'image qui comprend :
 - une surface (16) de support de l'image disposée pour supporter une image de toner liquide qui comprend des régions d'image et des régions d'arrière-plan, et
 - un moyen (26, 110) pour rigidifier ladite image de toner liquide en utilisant un champ électrique, caractérisé en ce qu'il comprend aussi :
 - un moyen séparé formant raclette pour supprimer l'excès de liquide de ladite image de toner après sa rigidification, et
 - un élément de transfert intermédiaire destiné à recevoir ladite image de toner en provenance de ladite surface de support de l'image, après sa rigidification, pour transférer ladite image sur un substrat.
14. Appareil selon la revendication 13, dans lequel ledit moyen de rigidification comprend une surface statique (110) par rapport à laquelle la surface de support de l'image se déplace.
15. Appareil selon la revendication 14, dans lequel ladite surface statique comprend au moins un conducteur électrique (82) et dans lequel l'alimentation en énergie dudit conducteur électrique au nombre d'au moins un fournit un champ électrique voulu en un emplacement précis pour produire une rigidification de l'image.
16. Appareil selon la revendication 14 ou la revendication 18, dans lequel ladite surface statique vient toucher ladite surface de support de l'image dans une région d'entrée, une région de sortie et une troisième régions placées entre elles, et ledit moyen d'alimentation en énergie est associé uniquement à ladite troisième région.
17. Appareil selon l'une quelconque des précédentes revendications, comprenant également un moyen pour chauffer ledit élément de transfert in-



termédiaire, là au moins où lui est transférée ladite image.

poussoir et les régions d'image de ladite surface de support de l'image.

18. Appareil selon l'une quelconque des précédentes revendications, comprenant également un moyen pour supprimer des particules de toner pigmentées desdites régions d'arrière-plan.

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25. Procédé selon la revendication 24, dans lequel ladite différence de potentiel est d'au moins 1500 volts.

19. Procédé de formation d'image, qui comprend les étapes consistant à :

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- former, sur une surface de support de l'image, une image de toner liquide comportant des particules de toner chargées d'une polarité donnée,

- rigidifier ladite image de toner liquide en poussant un rouleau-poussoir contre ladite surface de support de l'image, une partie au moins dudit rouleau-poussoir étant électrisée, et

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- transférer ensuite ladite image sur un substrat final, caractérisé en ce qu'il comprend :

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- l'étape de transfert de ladite image rigidifiée sur un élément de transfert intermédiaire, et

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- l'électrisation d'une partie au moins du rouleau-poussoir à une tension supérieure à environ 500 volts, avec une polarité qui est la même que la polarité desdites particules de toner chargées.

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20. Procédé selon la revendication 19, qui comprend l'étape consistant à chauffer ledit élément de transfert intermédiaire, là au moins où lui est transférée ladite image.

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21. Procédé selon la revendication 19 ou la revendication 20, dans lequel ledit rouleau-poussoir est porté à une tension qui est inférieure à environ 2000 volts.

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22. Procédé selon l'une quelconque des revendications 19 à 21, dans lequel ladite étape de transfert a lieu au niveau d'une région de transfert, et comprenant également l'étape d'électrisation dudit élément de transfert intermédiaire, au niveau de ladite région de transfert de l'image au moins, à une tension de transfert qui est inférieure à 1000 volts.

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23. Procédé selon la revendication 22, dans lequel ladite tension de transfert est inférieure à environ 500 volts.

24. Appareil selon l'une quelconque des revendications 19 à 23, dans lequel ledit 1 rouleau-poussoir est porté à une différence de potentiel d'entre 1200 et 3000 volts environ entre ledit rouleau-

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