METHOD FOR FIXING OF LIQUID TONER DEVELOPED ELECTROGRAPHIC IMAGES

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ABSTRACT OF THE DISCLOSURE

An electrophotographic station deposits an electrostatic charge image on the charge retentive surface of an electrographic recording web, such image corresponding to an image to be printed. The charge image bearing web is fed through a liquid toner development station wherein charged electrostatically charged particles fixed in a dielectric liquid are applied to the charge image for developing same. The developer image bearing web, while still wet with excess liquid toner, is passed into a fixing station wherein a blower blows air over the toned side of the image bearing web for drying the web by an amount such that the remnant liquid toner will not flow under the action of the air stream. The at least partially dried image bearing web is then fed through an infrared heating station for fixing the toned image. The source of infrared radiation is shielded from the air drying section of the fixing station to prevent running of the image.

DESCRIPTION OF THE PRIOR ART

Heretofore, electrophotographic printers have employed an electrographic recording web comprising a thin film, as of 3 to 10 microns thick, of dielectric charge retentive material, supported upon a conductive paper backing. The charge image was developed by applying liquid toner to the charge image bearing surface. The developed image bearing web then fed into a drying and fixing station wherein an air stream was directed onto the image. An electrophotographic apparatus for printing electrographic images, as above described, is disclosed and claimed in U.S. Pat. 3,502,408 issued Mar. 24, 1970 and assigned to the same assignee as the present invention.

The problem with the prior art method for fixing liquid toner developed electrographic images is that if the wet image bearing web is merely dried by directing an air stream over the web, the resultant images are not fixed. As a result, the developed images may be smudged in handling. To avoid smudging of the images, the images may be fixed by means of applying infrared radiation to the image bearing web. The infrared radiation is applied in the same region of the web and simultaneously with the application of the air stream.

However, it is found that, when the infrared radiation is applied in the same wet region of the web as the air drying stream, the infrared radiation somehow causes the toner particles to be dislodged from the web so that they are free to move about with the liquid film resulting in running and smearing of the image.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of improved method and apparatus for fixing of liquid toned electrographic images.

In one feature of the present invention, the liquid toned electrographic images on the dielectric charge retentive surface of an electrographic recording web are dried sufficiently by an air stream such that remnant liquid toner on the web will not flow under the action of the air stream. Infrared radiation is applied substantially only to the so dried portion of the web for fixing the developed image on the web, whereby running and smearing of the developed and fixed image is avoided.

In another feature of the present invention, the electrographic recording web comprises a film of dielectric material forming the charge retentive surface which is supported upon the major face of an electrically conductive paper web, whereby an inexpensive electrographic recording medium is obtained.

In another feature of the present invention, the liquid toner developed electrographic image on the charge retentive surface of that portion of the electrographic recording web which is still wet with toner is shielded from the source of infrared radiation, such that infrared radiation, utilized for fixing the image, is not applied to the recording medium while the recording medium is still wet with remnant liquid toner, whereby running and smearing of the image is avoided.

Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings, wherein:

FIG. 1 is a longitudinal sectional view, partly in schematic line and block diagram form, of an electrographic printer incorporating features of the present invention, and FIG. 2 is a sectional view of the structure of FIG. 1 taken along line 2—2 in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown an electrophotographic printer 1 incorporating features of the present invention. The electrophotographic station 2 for depositing a charge image on the charge retentive surface of an electrographic recording web 3 supplied to the electrophotographic station 2 from a supply roll, not shown.

The electrographic recording web 3 comprises a conductive paper backing 4 having a thin film of dielectric material 5 supported thereon and forming the charge retentive surface. In a typical example, the conductive paper backing 4 has a bulk resistivity of approximately 10⁸ ohm-centimeters and the dielectric film 5 has a thickness of .04 microns. Such electrographic recording paper 3, in commercially available from Plastic Coating Corporation of Holyoke, Massachusetts and from Consolidated Paper Company of Wisconsin Rapids, Wis. This type of electrographic recording web and the advantages thereof are disclosed in the aforementioned U.S. Pat. 3,502,408.

In the electrophotographic station 2, the electrographic recording web 3 is positioned with the charge retentive surface facing a photo conductive plate member 6 which is supported upon a light transmissive substrate 7, as of glass. An optically transparent electrode 8, as of tin oxide, is deposited on the transparent substrate 7 intermediate the substrate 7 and the photoductor 6 for applying an electrical potential across the photoductor. A conductive backing plate 9 overlays the conductive side 4 of the electrographic recording web 3 and is pressed into nominal physical contact with the web 3 for sandwiching the web 3 between the photoductor 6 and the conductive plate 9. Springs 11 spring bias the plate 9 into engagement with the conductive side 4 of the electrographic recording web 3.

A projection lens 12 projects an image 13, such as that produced by an illuminated strip of microfilm, onto the photoductor 6. A source of DC potential 14, as of 400—1000 v. is applied between the electrode 8 and the backing plate 9, and thus across the photoductor 6 and the electrographic recording web 3, by means of a
timer switch 15 which applies the potential for a predetermined exposure time.

The photoconductor 6 is rendered conductive in accordance with the pattern of illumination projected thereon via the projection lens 12. The applied potential, supplied from source 14 via switch 15 transfers a charge image, corresponding to the optical image 13, onto the charge retentive surface 5 of the electrographic recording web 3. A pair of motorized paper pulling rollers 16, which are sequenced in accordance with other operations of the camera such as raising the backing plate 9, advances the charge image bearing web 3 by an appropriate amount through the electrographic station 2. After a pre-determined length of paper 3 has been pulled through the electrophotographic station 2 by the drive rollers 16, a signal is fed from a paper cutting control to a solenoid operated paper cutter 17 for cutting the electrographic recording paper 3 into lengths or widths, as the case may be, corresponding to the length or width of each electrographic frame being printed.

The cut sections of the electrographic recording web 3, indicated by a single line on the diagram of FIG. 1, are pulled into a liquid toner development station 18 via a pair of drive rollers 19. The liquid toner development station 18 includes an electrically conductive perforated drum 21 which is rotated in the periphery of the web 3 at an angular velocity such that the peripheral velocity of the drum 21 is approximately ten times the velocity of the web 3 as it is pulled through the development station 18. Liquid electrographic toner is applied to the charge image bearing surface of the web 3 by being forced through the perforated drum from a supply channel 22 located near the top dead center position of the drum 21. A sheet metal paper deflector 23 is positioned over the drum 21 for directing the paper 3 over the drum 21.

The electrographic liquid toner comprises a colloidal suspension of submicron sized carbon particles in an insulating hydrocarbon vehicle such as Isopar manufactured by Humble Oil Company. A suitable electrographic liquid toner is commercially available from Hunt Chemical Corporation.

The differential peripheral velocity of the perforated development drum 21 disturbs the boundary layer of liquid electrographic toner adjacent to the boundary of the web 3, such that depleted toner is continuously replenished to produce full development of the electrographic charge image. Excess toner is collected in a reservoir 24 and re-circulated through the channel 23.

A pickoff finger 25 picks the developed web off the rotating drum 21 and deflects the developed web through a pair of squeegee rollers 26 for squeegee excess liquid electrophotographic toner from the developed web 3.

The squeegeed and developed electrographic web 3 is fed from the squeegee rollers 26 into a fixing station 27 for drying and fixing the developed electrographic image on the recording web 3.

The fixing station 27 includes a sheet metal housing 28 having a lower section 29 communicating with a drum section 31 via an elongated rectangular port 32. The liquid toner developed electrographic web 3 is fed from the squeegee rollers 26 through paper guides 33 into the drum 31. A pair of wire grids 34 as of stainless steel are disposed across the drum 31 in spaced relation to define a rack like passageway for the electrographic web 3. The drum 31 includes a drying section 35 followed by a fixing section 36.

The drying section 35 comprises a length of drum 31 which is supplied with an air stream produced by a blower 37, such as a squirrel cage blower. The blower draws air in through an input duct 38 and directs the output air stream via port 32 against the wet side of the developed electrographic recording web 3 in the drying section 35 of the drum 31. In a typical example, the blower 37 supplies between 60 and 80 cubic feet of air per minute at ambient temperature for drying the web 3 which has been squeegeed and which is approximately 11" wide in the direction into the paper of FIG. 1. The web 3 is moving at a rate of approximately 214 2/3' per second. This volume of air flow in the duct of this size, where the air stream is directed against the moist side of the web, dries the squeezed web sufficiently, in a length of travel within the drum 31 of approximately 3', such that the remaining liquid toner is reduced sufficiently such that it will not flow under the action of the air stream. When the web 3 has reached this degree of dryness, it enters the fixing station 36 wherein the web 3, is exposed to infrared radiation for heating the toned images sufficiently to fix the developed images on the web 3. The developed images fixed in this manner are smudge resistant.

The fixing station 36 includes an infra-red heat lamp 41 having a heating element of approximately 10" in length and delivering approximately 700 watts of infra-red energy to the image side of the web 3. Polished aluminum reflectors 42 and 43, are located within the drum 31 and around the lamp 41 for reflecting the infra-red radiation against the image bearing surface of the recording web 3. That infra-red energy which passes through the web 3, is reflected back onto the web by an upper reflector 44. The lower infra-red reflectors 42 and 43 are spaced apart to form an advancement key for permitting cooling of the lamp 41 by means of air flow directed through the reflector structure, as indicated by air flow arrow 45.

The downstream end of the drum 31 is open at 46 to reduce the back pressure on the blower 37 and to allow the air stream to exit from the housing 28. Two sets of paper pulling motorized drive wheels 47 pull the web 3 through the housing 28 and into a copy tray 48 to be picked up by the operator. The drive wheels 47 protrude through the openings in the wire grids 34.

The electrographic web 3, in drying section 35 of the drum 31, is shielded from infrared radiation emanating from the lamp 41 to prevent smudging of the developed image on the web 3. More particularly, it has been found that if the infrared radiation, utilized for fixing the toned image on the web 3, is applied while the web is still wet with electrographic liquid toner, the infrared radiation causes the deposited pigment particles to be dislodged from the web. The dislodged pigment particles are then free to move about with the liquid film thereby causing running and smearing of the image. However, by shielding that portion of the web 3 which is wet with toner from the infrared radiation such as reflectors 42 and 44 and smudging of the image is avoided.

Although the fixing station has been described herein as utilizing an infra-red lamp 41 for fixing the image, radiant energy applied for fixing the image need not be confined to the infrared spectrum but may include the visible and invisible range as well or be entirely confined to the visible or invisible range either above or below the infrared spectrum.

What is claimed:

1. A method for fixing a liquid toner developed electrographic image on a dielectric charge retentive surface of an electrographic recording web comprising the steps of, passing an air stream over the surface of such recording web having a liquid toner developed electrographic image thereon for partially drying the surface of such recording web and the developed image thereon such that liquid toner remaining on the surface of such recording web will not flow under the action of the air stream, and applying radiant energy only to the partially dried surface of such recording web while simultaneously passing an air stream over the partially dried surface of such recording web for fixing the partially dried developed image on the surface of such recording web and completely drying the surface of such recording web and the developed image thereon, whereby running and smearing of the developed image on the surface of such recording web due
to the simultaneous application of the air stream and the radiant energy is avoided.

2. The method of claim 1 wherein said electrographic recording web comprises a film of dielectric material, forming a charge retentive surface, which is supported upon the face of an electrically conductive paper web.

3. The method of claim 2 wherein the step of passing an air stream over the surface of such recording web having thereon the developed electrographic image comprises the step of blowing an air stream over the liquid toner developed image.

4. The method of claim 2 wherein the step of passing an air stream over the surface of such recording web having thereon the liquid toner developed image comprises the steps of passing such recording web, while wet with liquid toner, into an air duct and passing a stream of air through such duct adjacent such recording web for drying such recording web.

5. The method of claim 4 wherein the step of applying radiant energy to the partially dried surface of such recording web comprises the steps of, passing the partially dried recording web over a source of radiant energy disposed in such duct and shielding the partially dried surface of such recording web within such duct from the radiant energy emanating from such source of radiant energy prior to the passing of the partially dried surface of such recording web over such source of radiant energy.

6. The method of claim 5 including the step of squeegeeing such recording web before passage thereof into such duct to remove excess liquid toner from such recording.

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