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3,130,064

METHOD OF FORMING RESIN PATTERN ON A PAPER RECORD CARD

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No Drawing. Continuation of application Ser. No. 784,048, Dec. 31, 1958. This application Nov. 29, 1961, Ser. No. 155,824

3 Claims. (Cl. 117—17.5)

This invention relates in general to xerography and in particular to a process for permanently affixing electroscopic toner images onto an image support material. This is a continuation of my formerly copending application Serial No. 784,048, filed December 31, 1958, bearing the same title, and now abandoned.

The xerographic process is described in U.S. 2,297,691 by its inventor Chester F. Carlson and involves the sensitization of a xerographic plate (as by placing an electrostatic charge thereon) and the exposure of the sensitized plate to an original image to be reproduced. The exposed plate is developed by contacting the plate surface with electroscopic powder particles to produce a powder image which is either used in situ or thereafter transferred from the plate to a final support, the transferred image being fixed thereon to form a final print. If desired, the transfer step may be omitted and the image fixed to the plate itself.

The nature of the xerographic process ideally suits it for printing the output of present day high speed computer devices, that is, the process is completely dry, gives especially high quality reproduction (thereby permitting the use of xerographic copies of the original to reproduce further copies and so on), is adaptable to high speed operation with high dependability, can copy anything written or printed, can give either positive or negative reproduction of the original, can place the image on any type of image-bearing support and, by utilizing non-sensitive paper, permits extremely low per copy cost when used in a volume operation. Despite these ideal characteristics, xerography is not yet used commercially with high speed computer devices requiring xerographic development of images on code punched business record cards of the type commonly known as IBM record cards.

The reason has been that prior methods of fixing electroscopic toner images were unable to meet the highly exacting and critical requirements imposed by the intended use. A number of patents have been issued on various approaches to this problem. Thus, Greaves in U.S. 2,726,166 discloses apparatus for subjecting the toner images to the vapors of a chemical solvent without thereby materially affecting the moisture content of the record cards. However, the complexity of the equipment required, the necessity of replacing the chemical solvent periodically and, primarily, the toxicity of the vapors from the solvent contribute to the undesirability of this proposed solution. Roshon in U.S. 2,807,703 and Allen and Lego in U.S. 2,807,707 have proposed the use of intermittently energized infra-red lamps to heat fix the toner image without heating the record card to a sufficient temperature to cause moisture evaporation thereby causing severe changes in length, width, etc. Infra-red lamps, however, have a short life time and are expensive. More important, to obtain adequate heating of the toner so as to affix the toner image to the card in the manner required, necessitates a significant lapse of time thereby severely limiting the speed of the xerographic process. For these reasons these solutions have also been found not to be satisfactory.

I have now found a means and process whereby electroscopic toner images may be fixed to a record card or other image support material by heat or the application

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of radiant energy so as to obtain the highest quality of bonding between the toner image and the record material without substantial loss of the original moisture from the record card or other image support material. In general, the foregoing has been accomplished by treating the record card or other image support material with a coating of a thermoplastic organic resin compatible with the electroscopic toner. It has been found that this treatment acts to both lower the temperature required for fixing, increases the quality of the fix and acts as a partial vapor barrier preventing the escape of moisture from the image support material and at the same time partially insulating the material from the heat or radiant energy.

For purposes of more definitively expressing the quality or state of the bonding or fix between the electroscopic toner particles and the image support material, the quality of the fix has been arbitrarily divided into four classes. A "class 1" fix is one wherein the electroscopic toner particles rest on the surface as discrete unglazed particles of powder; a "class 2" fix is one wherein the electroscopic toner particles are glazed but still exist as separate particles on the image support member. A "class 3" fix is one wherein the electroscopic toner particles are glazed and wherein the affected particles have lost their boundaries, i.e., merged together and to the surface of the image support member. A "class 4" fix is one wherein the electroscopic toner particles have so merged with the image support material that the separate fibers of image support material can be seen through the fused toner particles.

For most commercial applications of xerography a class 3 fix is adequate. However, automatic machinery for punched record cards contacts the surface of the cards with electrical probes or fingers. The abrading action attendant on this results in an accumulation of toner on the electrical contacts after a few hours of high speed operation when the toner image is affixed to the record card only by a class 3 fix. The result of this contamination of the electrical contacts is to require closing down the machine to permit thorough cleaning of the contaminating toner from the electrical contacts. Hence, for operability under these conditions it is essential to obtain uniformly a class 4 fix on the record cards. The problem is further complicated by the fact that such record cards do not lend themselves readily to printing. The durability and dimensional stability required of the record cards are obtained with a loss in other desirable properties. Thus penetration is poor and images normally lack good density. The present invention avoids all of these objections and is carried out as illustrated in the following description thereof.

A xerographic toner was prepared from a co-polymer containing 70% styrene and 30% n-butyl methacrylate by mixing the copolymer resin with 5%, by weight of Neo Spectra carbon black and jet pulverizing the pigmented resin to produce finely divided toner particles having an average particle size of about 10 microns. Another lot of the same styrene-n-butyl methacrylate copolymer was dissolved in toluene to give a concentrated solution. Four baths were prepared by varying dilutions of the concentrated solution. The concentrations of copolymer in the baths were 1.25%, 2.5%, 5% and 10%, all by weight. A series of IBM record cards were then prepared by immersing one half of the card in the toner solution and then drying the card leaving one half of each card coated with the copolymer resin. Three cards were so treated in each bath. A xerographic image was prepared utilizing the electroscopic toner described in the normal xerographic process and then transferring to each IBM record card. The toner images were fixed to the cards by heating in an oven at about 130° C., one card for each con-

centration of resin being heated for 5 seconds, for 10 seconds and for 30 seconds.

In each case it was found that the use of a compatible resin coating on the card improved the "class" fix obtained by from one-half to three-fourths of a "class." This improvement was obtained from the lowest concentration of copolymer to the highest. A class 4 fix could be obtained with the half of the card immersed in the 2.5% of copolymer when heated for 30 seconds and with the half of the card immersed in the 10% solution when heated for about 10 seconds. No class 4 fix was obtained on any of the uncoated portions of the cards.

Electroscopic toner compositions are well known to those skilled in the art. Among the patents describing such compositions are U.S. 2,618,551 to Walkup, U.S. 2,618,552 to Wise, U.S. 2,638,416 to Walkup and Wise, U.S. 2,788,288 to Rheinfrank and Jones, etc. Furthermore, a variety of electroscopic toner compositions are available commercially. Obviously a resin compatible with an electroscopic toner composition will be the resin used to form the electroscopic toner. However, it is not essential in the present invention to use the identical resin for treating the image support material. Any thermoplastic resin compatible with the toner composition may be utilized as will be obvious to those skilled in the art. Thus, if a shellac toner is used, a polyester resin may be used to coat the image support material; if a polystyrene toner is used, a chlorinated rubber may be used, etc.

The conditions of use of record cards make the degree and conditions of fixing extremely critical, that is, the avoidance of card jams, the prevention of contaminating the electrical contacts used to sense the perforations in the card combine to stress importance of keeping the cards dimensionally stable, free from warping, and with the best degree of bonding or fix obtainable. While these problems are particularly critical in this use, I do not wish to be limited to this particular application. In general, the cycle time of an automatic xerographic machine is limited by the rate at which the toner is fused on the image support material and not by mechanical considerations. In order to fully utilize the potential efficiency and speed of an automatic xerographic machine, more rapid fusing at a lower temperature is a prerequisite. Thus, the instant invention, by reducing the fixing temperature required for adequate fixing makes possible more economic automatic machines as well as achieving faster operation without deterioration in image quality. Thus, highly useful results are obtained in treating the paper web utilized as the image receiving medium in commercial

automatic xerographic copying machines such as that described in U.S. 2,781,705 to Crumrine et al.

While the application of the compatible thermoplastic resin has been described herein as by immersion in a solution of the resin, other methods of application known to those skilled in the art may be used. Thus, the material may be applied either from a solution or an emulsion by a knife, dip roll, immersion or spray treatment.

What is claimed is:

1. The method of electrostatically forming a tightly bonded non-releasable resin image pattern on a paper business machine record card containing normally present moisture without substantial change in the dimensions, shape or mechanical properties thereof comprising forming a powder image of finely divided electrostatically charged resinous particles by attraction to an electrostatic image pattern corresponding to information to be recorded on the record card, coating the record card with a substantially transparent thermoplastic organic resin film compatible with the resin content of said powder particles, electrostatically transferring said powder image to the surface of said resin coated record card, and heating said record card for a time and temperature insufficient to shrink or warp said card but sufficient to merge the resinous powder particles with each other and with the card whereby the card may be repeatedly used in a business machine without fouling of the machine due to accumulation of resinous particles abraded from the resinous image.

2. The method of claim 1 in which the record card is coated with a film by immersion in a resin solution containing at least about 2.5% by weight of said thermoplastic organic resin and then dried.

3. The method of claim 1 in which the record card is coated with a resin identical with the resin content of said powder particles.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,130,064

April 21, 1964

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It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 31, after "a", second occurrence, insert
-- dilute --.

Signed and sealed this 15th day of December 1964.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents