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M. MICHALCHIK ET AL
ELECTROTHERMOGRAPHIC MASTER

3,482,513

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FIG. 1.

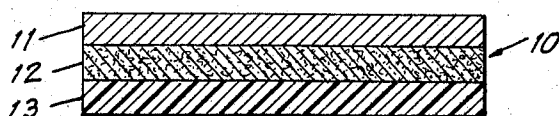


FIG. 2.

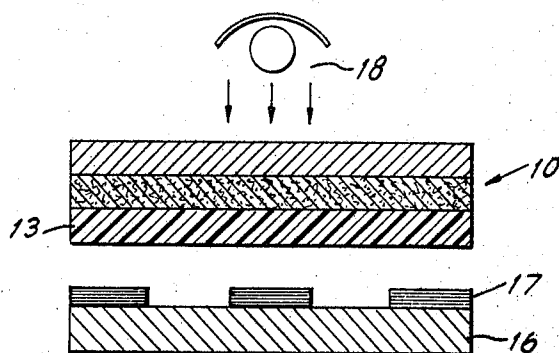


FIG. 3.

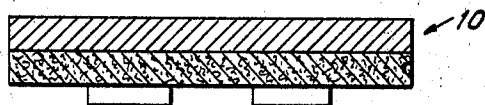
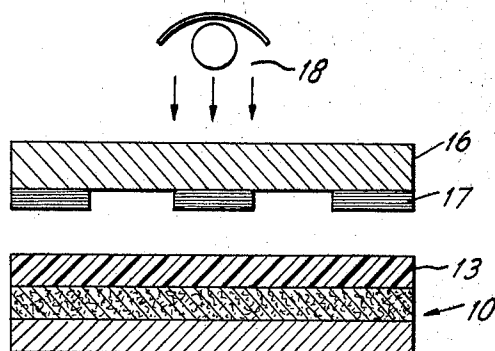


FIG. 4.



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ELECTROTHERMOGRAPHIC MASTER

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5 Claims

ABSTRACT OF THE DISCLOSURE

The master, comprised of a support having thereon an energy sensitive coating and a superposed resin film, is placed in contact with a document and then exposed to an energy source. The energy absorbed in the image areas of the document causes selective surface changes in the corresponding areas on the resin film resulting in an image formed therein having different triboelectric properties than the resin film.

Background of the invention

The present invention pertains to the electrothermographic duplicating art. In particular it relates to processes for making and using inexpensive masters for producing single and multiple copies of a document.

The prior art processes have required relatively expensive sheets coated with zinc oxide or silver halides for simple office copying, these sheets being capable of producing only a single copy for each pass through the machine. For multiple copies it has been necessary to use either a mimeograph machine or a direct office copier e.g. a Xerox (reg. trademark) type copier. The mimeograph machine requires several steps, expensive equipment and trained personnel; the direct copiers afford simple operation at a comparatively high cost per copy.

The major problems previously encountered when using electrothermographic reproduction processes were: the inability to achieve fine image resolution; and difficulty in obtaining high contrast between image and non-image areas.

Summary of the invention

This invention permits multiple copies to be made from relatively inexpensive masters by a simple process without requirements for trained personnel. The copies produced have a high degree of image resolution and excellent contrast between image and non-image areas. The present invention employs a combination of an energy sensitive coating of high resistivity with an extremely thin resin film of relatively low resistivity. Exposure of this combination to an energy source causes coaction between the resin film and the energy sensitive coating. This coaction results in a deformation of the resin film exposing areas of energy sensitive material. When the effect of the energy source on the master is controlled by means of the document to be copied, it is possible to have the deformations in the resin correspond to the image on the document.

Accordingly, it is the object of the present invention to provide an inexpensive process for making a duplicating master capable of being utilized to reproduce multiple copies.

A further object of the present invention is to provide a master for reproducing multiple copies which may be used in a machine that affords simple operation at a low cost.

These and further objects and features of the present invention will appear from a reading of the following detailed description of embodiments of the invention, to

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be read in conjunction with the accompanying drawings wherein like components in the several views are identified by the same reference numeral.

Brief description of the drawings

FIGURE 1 is a cross sectional view of the master before it has been exposed.

FIGURE 2 schematically illustrates a reflex method for exposing a master to form an image therein.

FIGURE 3 is a cross sectional view of an exposed master after an image has been formed therein.

FIGURE 4 schematically illustrates a direct method for exposing a master to form an image therein.

Description of the preferred embodiments

Briefly stated the present invention comprises placing a document in contact with a master having a thin film of friable resin superposed on a support coated with energy sensitive material. The image on the document is in contact with the resin film. The other surface of the master is exposed to an energy transmitting source. The energy thereby transferred passes through the master and is preferentially adsorbed in the image on the document. This adsorbed energy is conducted to the master in the areas corresponding to the image on the document and causes coaction between the resin and the energy sensitive coating. This coaction results in deformation of the resin film exposing areas of the energy sensitive coating whereby the image formed therein is defined. If the electrical resistivity of the energy sensitive material is relatively high compared with the resistivity of the support, the exposed master will be suitable for use in most electrostatic printing processes.

Referring to FIGURE 1, wherein the master of the present invention is designated by the reference numeral 10. Master 10 which comprises paper 11 utilized as a support, a coating of wax 12 utilized as a thermal energy sensitive material and a superposed thin film of friable resin 13. For purposes of the present invention, only one surface of paper 11 need be coated with wax 12, however, paper 11 may be completely impregnated and coated on both sides. The film of friable resin 13, which must be applied over one surface of paper 11 previously coated with wax 12, may be applied to both surfaces of paper 11 without departing from the spirit of this invention.

Paper 11 can be coated with wax 12 in any conventional manner. For example, rolling a cylinder coated with wax 12 over paper 11. The thickness of the coating of wax 12 can be regulated by controlling the temperature of wax 12 and the contact pressure and spacing between the cylinder and paper 11. In practice it has been found that best results are obtained when the thickness of wax 12 on paper 11 is between 5×10^{-4} and 1.5×10^{-3} inch although satisfactory results have been obtained with wax 12 thicknesses between 10^{-4} and 5×10^{-3} inch.

The film of friable resin 13 may also be applied in any conventional manner. For example, paper 11 having been coated with wax 12 is placed in a frame which will insure a level surface on which friable resin 13 is to be applied. A soft swab, dipped in resin 13 is brushed over the waxed surface of paper 11. Wax 12 and resin 13 are allowed to dry completely before master 10 is removed from the frame. The thickness of the resin film should be a maximum of 10^{-3} inch. The minimum thickness is theoretically a mono-molecular layer, although this does not seem to be commercially practical at present. The best results have been obtained with resin 13 thicknesses between 5×10^{-5} and 2×10^{-4} inch. If resin film 13 is too thick it would possess a structural integrity of its own and may not break up or dissolve when wax 12, upon which it is coated, is caused to melt.

The particular recording masters 10 that were tested

utilized bond papers of various weights and types, such as: Xerox (reg. trademark) type bond, Nekoosa (reg. trademark) type bond, ordinary legal pad paper and several types of tracing and onion skin papers. However, almost any material that is translucent and has a substantially uniform thickness may be used, e.g. cloth, plastic, fiberglass. In addition, paper 11 can be used either in single sheets or in a continuous web. A variety of waxes melting between temperatures of 40° C. and 150° C.; such as ceresin, bees wax, paraffin, paraffin-polyethylene, microcrystalline, spermaceti and caruaba were used. In fact, any thermal energy sensitive material having good surface covering properties, a relatively high resistivity when compared with the resistivity of resin 13 and a melting point within the indicated temperature range can be used instead of the waxes listed. Some resins used consisted of National Starch and Chemical Corporation's X-Link 8202, a self-reactive vinyl acetate copolymer, in various solvents. The following are typical:

- (A) 5% X-Link 8202 in ethanol
- (B) 2½% X-Link 8202 in ethanol
- (C) 2% X-Link 8202 in a 70-30 mixture of ethanol and water
- (D) 5% X-Link 8202 in methanol +5% NN₄OH
- (E) 5% X-Link 8202 in methanol
- (F) 2% X-Link 8202 in methanol

Another resin coating used was ammonium salt of styrenemaleic anhydride, such as SMA 1440H produced by Sinclair Petroleum. Other resins used, which produced the best results, were National Starch and Chemical Corporation's Resyn 78-3309 a crosslinking acrylic copolymer, Resyn 28-1300 a carboxylated polyvinyl acetate copolymer and Resyn 26-1390 an ammoniacal aqueous solution of a polyvinyl acetate copolymer. The above were used in the following solvents:

- (G) 1% to 5% resin in ethanol
- (H) 1% to 5% resin in a 70-30 mixture of ethanol and water
- (I) 1% to 5% resin in ethylacetate
- (J) 1% to 5% resin in methanol
- (K) 1% to 5% resin in methanol-toluene mixtures

Resin film 13 should be translucent, homogeneous, have low uniform resistivity compared with wax 12, be a good heat conductor and be friable or soluble in wax 12. The above itemized constituents are not intended to limit the types of support, energy sensitive material, resins, resin-solvent combinations, or solvents that may be used in practicing this invention. To assure uniform triboelectric and resistive properties so as to prevent localized differential charging of the surface of resin 13 not caused by the transferred image pattern, the constituents of resin 13 may not include filler or crystalline materials which crystallize or precipitate out of solution and form non-homogeneous or heterogeneous resin films.

Referring to FIGURE 2, master 10 is brought into contact with a document 16. Image 17 on document 16 is placed in contact with resin 13. Energy source 18 transfers energy through master 10 to document 16. This energy is preferentially absorbed by image 17 on document 16 and reflexed to master 10 causing coaction between wax 12 and resin 13 whereby the film of resin 13 is removed from the areas of master 10 which correspond to the image areas 17 of document 16. The energy selectively transferred to master 10 causes resin 13 to break up and/or dissolve in wax 12 and/or bead up around the periphery of the individual characters which define the image transferred to master 10. This is due to the friable nature of resin 13 as well as its extreme thinness which is not capable of supporting itself when wax 12, upon which it is coated, melts. In addition some resins used were at least partly soluble in wax 12. To insure that wax 12 does not flow in non-image areas causing unwanted fracture in resin 13, it is necessary that the energy employed be

transmitted through master 10 without being substantially absorbed therein. In actual tests it has been found that light sources with wave lengths between 3000 and 12000 angstroms were satisfactory with best results obtained in the green and blue range around 4500 angstroms. However, if image 17 on document 16 has very high heat absorption properties compared with document 16 itself and a heat source is used at a temperature only slightly below that which will melt wax 12 on initial incidence, then satisfactory results may be obtained if the exposure time is properly adjusted. In effect any energy source may be used if the energy is converted to thermal energy after reaching image 17. Other energy sources may be used which require that heat energy, as such, be transmitted through master 10. However, in this latter case a substantial portion of the energy must be transmitted to avoid melting wax in the non-image areas.

An additional operation may be included wherein master 10 is preheated, prior to exposure, to a temperature slightly below the melting point of wax 12. In this situation the thermal energy absorbed by image 17 of document 16 need only supply the differential between the pre-heat temperature and the melting point of wax 12.

Referring to FIGURE 4, if desired it is possible to expose master 10 and form an image therein by a direct process as opposed to the reflex process described previously. The image bearing surface of document 16 is brought into contact with the resin coated surface of master 10. The other surface of document 16 is exposed to energy source 18. Energy is absorbed by image 17 and transferred therefrom to the resin coated surface causing coaction between wax 12 and resin 13 as previously explained.

In order for the exposed master 10, see Figure 3, resulting from the above described processes to be usable in conventional electrostatic printing processes, waxes 12 and resins 13 with particular electrical characteristics must be selected. The resistivity of wax 12 should be relatively high with respect to the resistivity of resin 13. To consistently obtain satisfactory results a resistivity difference factor of at least 10² should exist between wax 12 and resin 13 and a factor of at least 10⁴ would be preferable. The sample recording masters 10 used for test purposes had waxes 12 having resistivities ranging between 10¹⁴ and 10¹⁶ ohm-centimeters and resins 13 with resistivities ranging between 10¹⁰ and 10¹² ohm-centimeters. The overall capacitance of the film of resin 13 must be greater than the capacitance of the exposed areas of wax 12 in order for the electrostatic charge to be built up on the areas of exposed wax 12 in an electrostatic printing process. In other words, the higher conductivity of resin 13 permits the charge to be distributed over the entire surface of master 10 resulting in a lower overall voltage thereon when compared with the voltage of the exposed areas of wax 12. This voltage differential may be increased by coating both sides of paper 11 with resin 13 so that the non-image surface of master 10 can be effectively grounded or subjected to a corona field of opposite polarity thereby further increasing the voltage differential between wax 12 and resin 13. This same effect may be accomplished without coating both surfaces of paper 11 with resin 13 if paper 11 is pretreated with a suitable conductive agent prior to wax 12 or resin 13 being applied, e.g. sodium chloride (NaCl). The above specified ranges are not intended to limit the scope of this invention, but are merely presented as examples.

One of the many conventional electrostatic printing processes which can utilize the exposed masters 10 resulting from the process described comprises: electrostatically charging master 10 causing a voltage differential to exist between wax 12 and resin 13; applying toner to master 10 by any conventional method, e.g. cascading, whereby toner, due to triboelectric forces of attraction, adheres only to the exposed wax image; placing a blank sheet of paper or other suitable copy support in contact with

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the toned side of master 10; subjecting the combination to an electrostatic field thereby transferring the toner image from master 10 to the copy support; separating the copy support from master 10; and fixing the toner image to the copy support by some means, e.g. heat. Master 10 may be reused to produce multiple copies of the image formed therein. In actual tests as many as 50 copies were made from a single exposed master.

What is claimed is:

1. For use in electrothermographic reproduction processes, a master which comprises
 - an image support;
 - a thermal energy sensitive coating having a bulk resistivity greater than 10^{11} ohm-centimeters on at least one surface of said image support; and
 - a substantially translucent and homogenous resin film having a thickness less than 5×10^{-4} inch superposed on a surface having said energy sensitive coating.
2. The master recited in claim 1 wherein said energy sensitive coating has a melting point between 40°C. and 100°C.
3. The master recited in claim 1 wherein said energy sensitive coating is a wax selected from the group consist-

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ing of ceresin, bees wax, paraffin, paraffin-polyethylene, microcrystalline, spermaceti and caruaba wax.

4. The master recited in claim 1 wherein said energy sensitive coating has a thickness between 10^{-4} and 5×10^{-3} inch.

5. The recording master recited in claim 1 wherein said resin film has a bulk resistivity less than 10^{12} ohm-centimeters.

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