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[54] **ELECTROSTATIC COPY METHOD EMPLOYING PRESSURE SENSITIVE TRANSFER OF DIELECTRIC TO FORM A MASTER**
4 Claims, 10 Drawing Figs.

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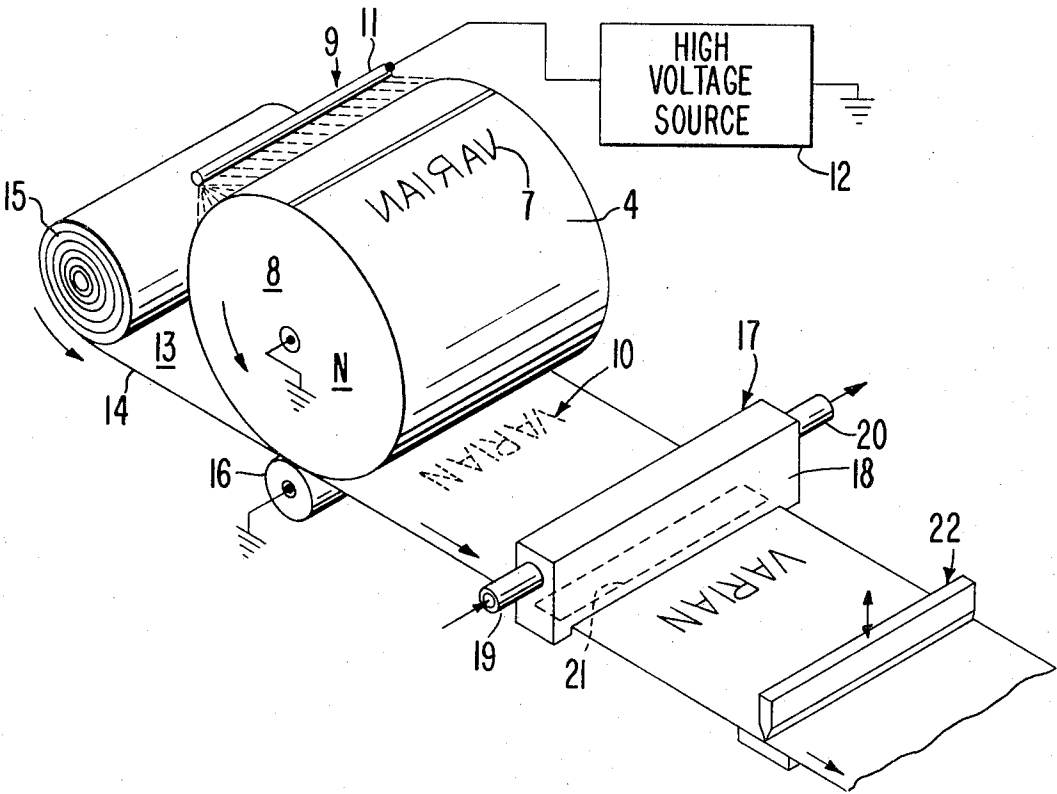
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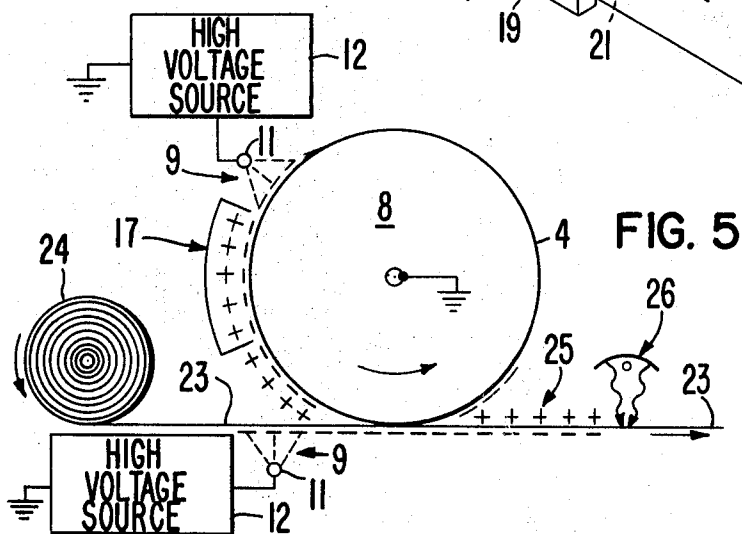
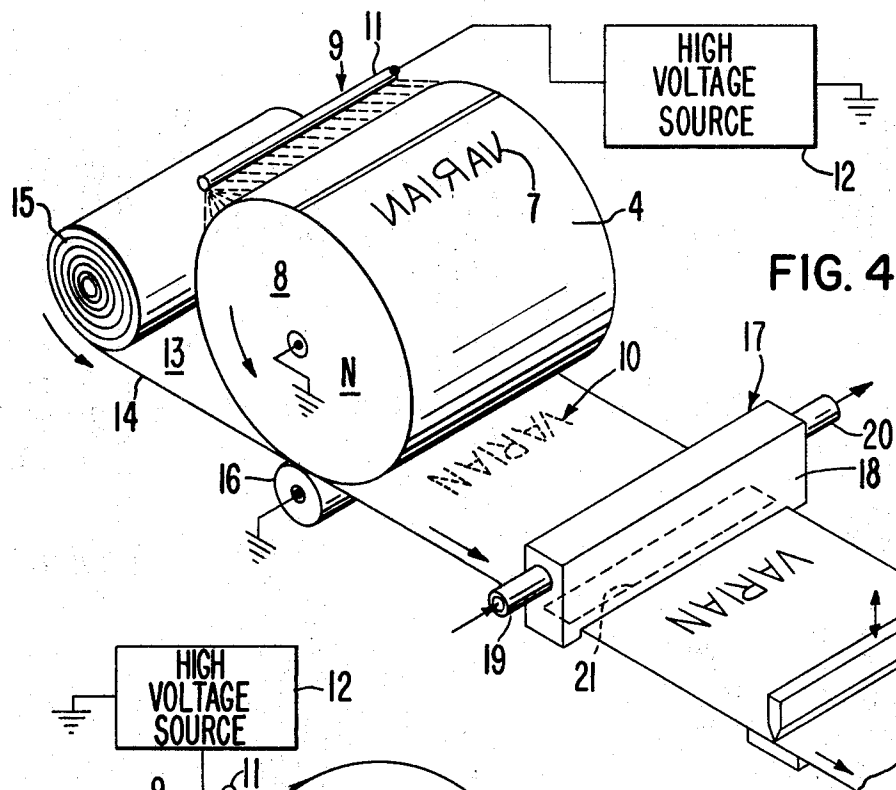
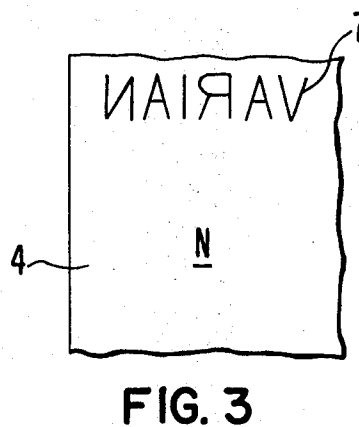
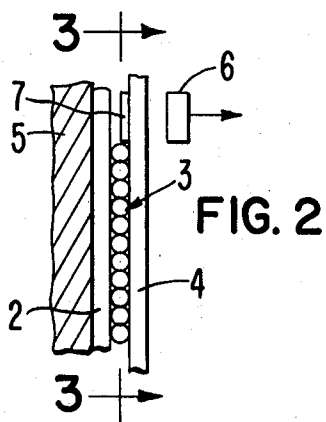
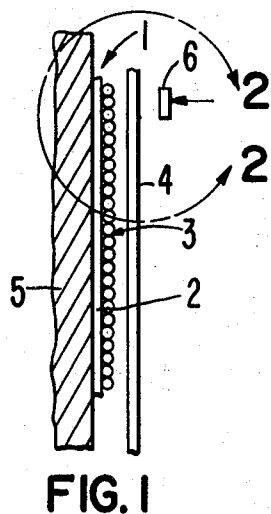
[50] Field of Search..... **117/17.5;**
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637; 117/37.212

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ABSTRACT: Alphanumeric and other symbols and figures are formed on a conductive master sheet, such as conductive paper. The symbols and figures comprise an electrostatic charge image retentive dielectric material. One means for forming the dielectric images on the master is in the nature of a typewriter ribbon comprising microcapsules of liquid dielectric material. The microcapsules are caused to be ruptured upon being struck by the key hammer to form an image of the symbol on the hammer on the master. The dielectric images thus formed on the master are then uniformly charged by a suitable means. Oppositely charged dry or liquid toner is then cascaded over the charged master and the visible image transferred to and fixed on ordinary copy paper. Alternatively, the charge on the master images may be transferred before development to a dielectric coated conductive medium and then developed in the manner described thereby eliminating dirtying the master.





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ELECTROSTATIC COPY METHOD EMPLOYING PRESSURE SENSITIVE TRANSFER OF DIELECTRIC TO FORM A MASTER

The present invention relates in general to copy machines and, more particularly, to an improved electrostatic copier employing a pressure sensitive transfer means for producing a master copy with dielectric images which may be charged to form charge images. These charge images may be inked and the ink transferred or the charge images transferred for subsequent inking. In the present invention, the master copy can be made of relatively inexpensive paper. In certain embodiments of the present invention the master is used for making practically an unlimited number of copies without degradation of the master or copies made therefrom because the master does not have to transfer the ink. In other embodiments the master does transfer the ink.

Heretofore, duplicating machines have employed a master or mat. The master typically comprises a special paper having a porous central core or mat impregnated with an impervious deformable material such as, for example, wax. When the paper is struck by a hammer or key, embossed with the character to be copied, the deformable material is displaced from the mat in the pattern of the embossed character. As a result, the mat is made permeable to ink in the pattern of the struck character. After the master has been typed it is wrapped around an ink permeable wall of a drum containing ink. As the drum is rotated, ink is caused to flow through the deformed ink permeable portions of the master and onto a blank piece of paper to duplicate the information typed onto the master.

The problem with this arrangement is that the master breaks down with use because the ink flow through the master tends to erode the edges of the deformed portions and to break the porous mat. As a result, the master has a limited life of on the order of hundreds of copies. Moreover, the masters are relatively expensive and storing and reusing the masters is messy and generally impractical.

One prior electrostatic duplicating process employs a metallic master sheet onto which is formed dielectric images by photoresist techniques. The master sheet is wrapped over a drum, the images charged, and then electrostatically inked by powder pigment applied to the master on the drum. The powder images are then transferred to a copy blank and fixed, as by heating, onto the copy. The problem with this scheme is that the masters are relatively expensive and time consuming to prepare.

In the present invention, a conductive sheet, preferably of conductive paper, forms the master sheet. Dielectric images are transferred to the master sheet by pressure sensitive transfer from a transfer sheet coated with microcapsules containing liquid dielectric material. The dielectric images, transferred to the conductive master sheet, are then electrostatically charged. Images are transferred from the master to the copy paper in one of two ways. In a first way, the charge images on the master are transferred to electrostatic copy paper and subsequently inked (developed) on the copy. In a second way, the master copy is electrostatically inked with charged pigment particles which are then transferred to ordinary nonconductive paper and subsequently fixed on the paper. Both of these duplicating processes have the advantage that the master is formed in an inexpensive way. The process, wherein the charge image is transferred to the copy, has the additional advantage that the inking function is separated from the master copy and, thus, the wear and tear on the master is reduced and handling the master for storage and reuse is clean. However, special, but still relatively inexpensive, electrographic copy paper is required for the copy sheet material. On the other hand, the pigment transfer process has the advantage that the copy sheet material may be inexpensive ordinary paper.

The principal object of the present invention is the provision of an improved duplicating method and apparatus.

One feature of the present invention is the provision of an improved method and apparatus for forming dielectric images on a conductive master sheet wherein a transfer medium which is coated with microcapsules of dielectric material is brought into pressure contact with the master sheet for transfer of dielectric images to the master sheet, whereby a relatively inexpensive master copy is formed for use in an electrostatic duplication process.

Another feature of the present invention is an electrostatic duplication method and apparatus wherein dielectric images on a conductive master sheet are charged to form charge images and the charge images are transferred to a charge retentive surface layer on a conductive copy sheet for subsequent development on the copy sheet, whereby the inking function is separated from the image transfer function of the duplication process to avoid wear and tear on, and inking of, the master copy.

Another feature of the present invention is the same as any one or more of the preceding features wherein the master copy is a positive copy obtained by striking the front surface of the master copy through a typewriter ribbon, or transfer sheet, coated on its face adjacent the master copy with microcapsules of dielectric material for transfer of the dielectric images to the conductive master copy.

Another feature of the present invention is the same as any one or more of the preceding features wherein the microcapsule coated transfer medium also includes an inking pigment for transfer to the master, such that the transferred dielectric images are rendered visible on the master copy.

Another feature of the present invention is the provision of a pressure sensitive dielectric image transfer medium comprising a web coated on at least one surface with microcapsules of liquid dielectric material, whereby upon striking of the transfer web the microcapsules are ruptured to release the dielectric liquid onto an adjacent receiving surface.

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 schematic side elevational view of a transfer process for transferring dielectric images to a master sheet,

FIG. 2 is an enlarged detail view of a portion of the structure of FIG. 1 delineated by line 2-2 and showing the completed transfer,

FIG. 3 is a plan view of the negative dielectric image formed on the master sheet of FIG. 2 as taken along line 3-3 of FIG. 2,

FIG. 4 is a schematic perspective view of a duplicating machine using features of the present invention,

FIG. 5 is a schematic line diagram of an alternative duplicating machine employing features of the present invention,

FIG. 6 is a schematic side view, similar to that of FIG. 1, depicting an alternative transfer process for producing a positive dielectric image,

FIG. 7 is a detail view of a portion of the structure of FIG. 6 depicting a completed transfer,

FIG. 8 is a plan view of the positive master sheet of

FIG. 7 taken along line 8-8 thereof in the direction of the arrows, and

FIGS. 9 and 10 are schematic line diagrams of alternative duplicating machines employing the positive master of FIG. 8.

Referring now to FIGS. 1-3, there is shown a process according to the present invention for forming dielectric images upon a conductive master sheet. More particularly, a transfer medium 1 is formed by a sheet of paper 2 coated on one surface with a layer of microcapsules 3 containing liquid dielectric material. Microcapsules are simply containers for tiny amounts of liquids, slurries or solids. They may be as small as a few microns, or as big as a fraction of an inch. Their walls may be of wax, natural polymers like gelatin, plastics, or metals, and their payload may vary from 20 percent of the total capsule weight to almost 100 percent.

In a preferred embodiment of the present invention, the encapsulated material is a pigmented liquid dielectric having good charge retentive properties, such as, for example, shellac

or methyl methacrylate. The capsules are made of gelatin a few microns in diameter. These capsules are mixed with a binder and coated on the surface of the transfer paper 2.

The coated surface of the transfer sheet 1 is placed against the back side of a conductive master sheet 4, as of conductive paper. The transfer sheet 1 and master sheet 4 are placed against a support 5 and struck from the front side of the master 4 with a typewriter key 6 embossed with an alphanumeric character image to be reproduced. The pressure produced by the key 6, striking against the transfer sheet 1 and master sheet 4, causes the compressed microcapsules to be ruptured and to release their contents onto the back side of the master sheet 4 to form a dielectric image 7 thereon. The image that is produced is a visible negative image, *i.e.*, a mirror image of the information as written on the front side of the master sheet 4. The image 7 is rendered visible due to dye or pigment added to the dielectric in the microcapsules 3.

Referring now to FIG. 4, there is shown a duplicating machine employing the master sheet 4 of FIG. 3. The master sheet 4 is wrapped around a conductive metal drum 8 and affixed thereto with the conductive side of the master sheet against the circumference of the drum 8 and with the dielectric images 7 facing the outside of the drum 8.

The drum 8 is rotated past an electrical charging station 9, such as, for example, a corona discharge device 11 or conductive roller, energized from a high negative voltage source 12, *i.e.*, greater than 300 v., for applying negative charged particles to the dielectric images 7 on the conductive master 4. Thus, the dielectric images 7 are charged to form negative charge images.

The negative charge images on the master sheet 4 are transferred at 10 to an electrostatic charge retentive surface 13 on an electrographic paper web 14 drawn from a roll 15 between the drum 8 and a conductive roller 16. The roller 16 operates at, for example, ground potential, which is a positive potential relative to the voltage of the negative charge images on the master sheet 4. A suitable electrographic paper 14 comprises a slightly conductive paper backing with a thin film of dielectric coated on one surface to form the charge retentive surface 13.

The charge images 10 on the web 14 are developed at an inking station 17 by application of positively charged inking particles to the negative charge images 10 on the web 14. The inking particles are applied to the web in the form of a colloidal suspension of inking particles in a dielectric fluid, such as air or liquid. In a preferred embodiment, the inking pigment comprises a liquid colloidal suspension formed by a 2 percent to 4 percent mixture of electrographic toner concentrate in a fast drying dielectric solvent, such as Shell Chemical's number 72 solvent. The toner concentrate is marketed by Philip A. Hunt Company.

The liquid ink (toner) is applied to the imaged side of the web 14 by flowing the ink through a hollow inking channel 18 having an input port 19 at one end, to receive toner from a reservoir, not shown, and an output port 20 at the other end which is connected to the suction end of a pump, not shown. The channel 18 includes an elongated inking slot 21 cut through the side wall of the channel 18 on the side adjacent the web 14. The slot 21 extends laterally of the web 14. Ink, at less than atmospheric pressure, is drawn through the channel 18. Atmospheric pressure pushes the web 14 up against the marginal edges of the inking slot 21, sealing same and causing the ink to come into contact with the web 14. The positively charged ink particles are drawn out of suspension and electrostatically bound essentially only to the negative charge image on the web 14, thereby rendering the images visible. As the web 14 is drawn past the slot 21, the trailing marginal edge of slot 21 performs a squeegee action on the web to remove excess toner liquid. A cutter 22 cuts the copy paper 14 to size. Each time the drum 8 revolves, a new copy is made. The charge which is transferred to the copy web 14 is continuously replaced by the charging station 9.

The advantage of the duplicating machine of FIG. 4 is that a relatively inexpensive paper master may be employed which is made easily and quickly and that the inking function is separated from the image transfer function of the duplicating process such that the master copy remains clean and therefore can be stored and reused. In addition, wear and tear on the master copy 4 is minimized due to the separation of the inking function such that essentially an unlimited number of copies may be made from the same master copy 4.

Referring now to FIG. 5 there is shown an alternative copy machine incorporating features of the present invention. In this embodiment, the structure is quite similar to that of FIG. 4 except that the inking station 17 is moved up to the drum 8 and the charged ink particles, as previously described, are applied to the negative charge images on the master copy 4, as carried on the drum 8. The charged ink particle images are then transferred to an ordinary paper web 23, drawn from a supply roll 24 or from flat stock into contact with the inked images on the master copy 4. The underside of the copy paper 23 is charged to a high negative potential by a second charging station 9. Thus, the positively charged ink image patterns, as deposited on the master copy 4, are transferred to the copy paper 23 at 25. The transferred ink image patterns 25 are, if of a dry powder form, fixed by an infrared lamp 26 or other heating means to cause a meltable coating on the particles or on the paper 22 to melt and fuse the particles to the paper in the conventional manner.

The advantages of the duplicating machine of FIG. 5 include the use of an inexpensive paper master and the ability to use ordinary copy paper which is less expensive than the electrographic copy paper used in the machine of FIG. 4.

Referring now to FIGS. 6-8, there is shown an alternative embodiment of the present invention wherein a positive master copy is obtained. More particularly, the dielectric transfer paper 1, previously described, is placed with its coated face 3 adjacent the front surface of the conductive master sheet 4'. The back side of the transfer sheet is struck by the key 6 to squeeze the coated side 3 of the transfer paper 1 against the front face of the master 4' which is back supported by support 5. As a consequence, a positive dielectric image 31 is deposited on the conductive master sheet 4'. The transfer sheet 1 may be in the form of a typewriter ribbon or merely a full sized sheet overlaying the master sheet 4'.

Referring now to FIG. 9 the positive master sheet 4' is wrapped over a first conductive drum 32. A second conductive drum 33 bears against the first drum 32. A sheet of material 34 having charge retentive properties, such as a dielectric sheet, or electrographic paper having its charge retentive surface facing the first drum 32, is wrapped completely around the second drum 33, preferably in the form of a continuous loop or band fitted over the drum 33. A first electrical charging station 9, as previously described, applies negative electrical charge to the dielectric images on the master 4' to produce charge images. The charge images are transferred to the charge retentive surface of the sheet 34 as fitted around the second drum 33. These charge images are then transferred from the sheet 34 to the charge retentive surface 13 of electrographic copy paper 14, in the manner as previously described with regard to FIG. 4. The transferred charge images 10 are inked at inking station 17, as previously described.

A charge removing station 36, which may include a grounded conductive roller, brush, or radioactive source removes the charge image patterns from the charge retentive surface of the drum 33, thereby preventing ghost images on the transferred copy 10.

Referring now to FIG. 10 there is shown an alternative copy machine of the present invention which employs the positive master copy 4' and ordinary copy paper 23. In this embodiment, the structure is essentially the same as that of FIG. 9 except that the charge images on the charge retentive surface of the sheet 34, as fitted over the second drum 33, are inked by inker 17 in the manner as previously described with regard to FIG. 5. These ink images are transferred to the ordinary paper

web 23 and fixed at fixing station 26, all is previously described in regard to FIG. 5. An ink removing station 37 which may comprise a conductive brush for dry powdered ink or a conductive squeegee for liquid ink is preferably grounded for removing charge and ink images from the charge retentive surface of the sheet 34. In addition, a second charge image removing station 36 may be provided to further assure complete removal of charge images from the sheet 34 before it receives new charge images from the positive master sheet 4'.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. The method of forming a dielectric image on a conductive medium serving as a master and duplicating the image in an electrostatic duplicating apparatus, comprising the steps of:
 - positioning a transfer medium with microcapsules containing an electrostatic charge retentive liquid dielectric material adjacent the image receiving surface of the master conductive medium;
 - producing a pressure contact in the pattern of the image to be transferred between the image receiving surface of the master conductive medium and the transfer medium for rupturing the microcapsules and transferring at least some of the contained liquid dielectric material to the receiving

surface of the master conductive medium forming the dielectric image on the master conductive medium; and applying electrical charge to the dielectric image on the master conductive medium to produce a charge image pattern thereon conforming to the dielectric image; and producing a visible image on a copy medium from said charge image pattern on the master conductive medium.

2. The method of claim 1 wherein the visible image is produced on the copy medium by:
 - transferring the electrical charge image from the master conductive medium to a charge retentive surface on a copy medium; and
 - applying charged particles of pigment to the copy medium for developing a visible image of the electrical charge image on the charge retentive surface of the copy medium.
3. The method of claim 1 wherein the visible image is produced on the copy medium by:
 - applying charged particles of pigment to the master conductive medium for developing a visible image of the charge image thereon; and
 - transferring the visible image on the master conductive medium to a copy medium.
4. The method of claim 1, wherein the microcapsules containing the liquid dielectric material form a coating over the surface of the transfer medium.

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