

Jan. 20, 1959

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2,869,461

ELECTROPRINTING FROM A RAISED RESIST PATTERN

Filed Feb. 27, 1956

2 Sheets-Sheet 1

Fig. 1

PRIOR ART

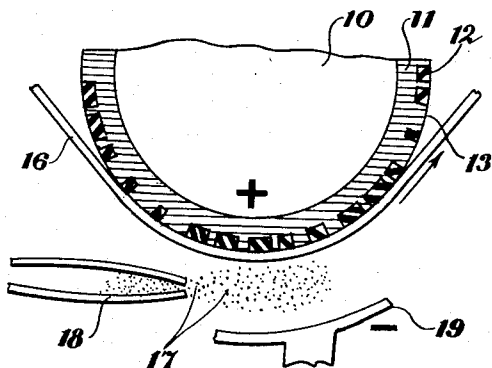


Fig. 2

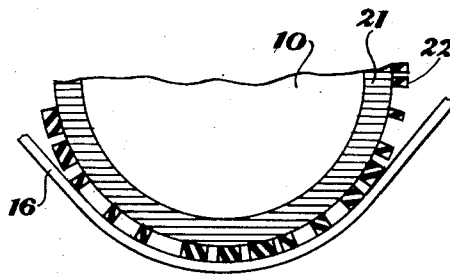


Fig. 3

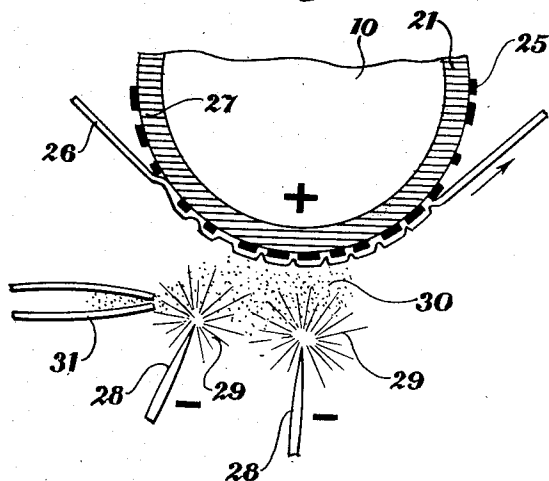


Fig.4

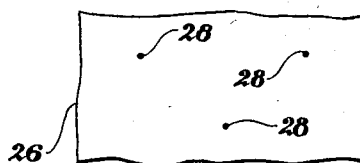
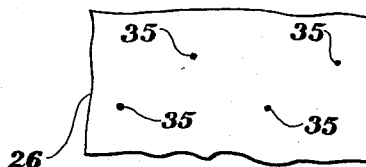


Fig.5



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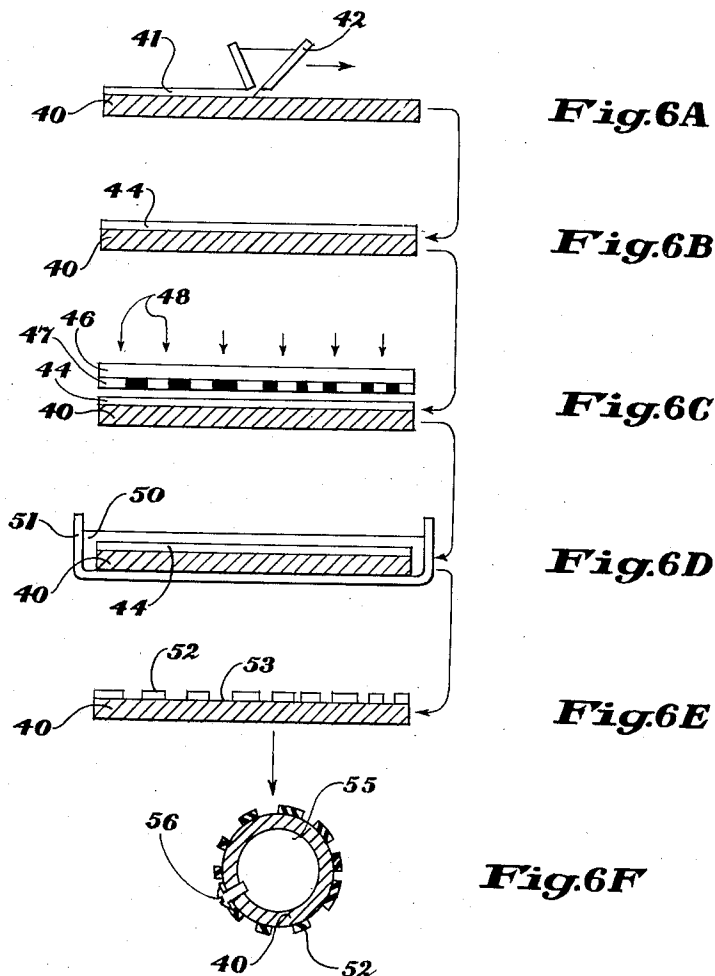
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ELECTROPRINTING FROM A RAISED RESIST PATTERN

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2 Sheets-Sheet 2



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ELECTROPRINTING FROM A RAISED RESIST PATTERN

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5 Claims. (Cl. 101—426)

This invention relates to printing processes, particularly to the type of process in which the deposit of ink in the form of dust or mist is influenced by electrical charge or field.

The object of the invention is to provide a printing process simultaneously having all of the following advantages. The plate is simple to make and is inexpensive. The ink is deposited directly on the final support which is paper, without touching the printing plate. The prints are reasonably sharp ("clean") and may be made at high speed.

The nearest prior art employed a relief metal plate with air spaces or insulating material between the areas of metal relief. Paper is rolled or placed in contact with such a plate and electrically charged ink (dust in some cases, mist in others) is introduced in front of the paper. An electric field set up between the plate and a nearby electrode causes the dust to be attracted to the areas of the paper overlying the metal relief (and also to be repelled from the areas overlying the air spaces or the insulating material). Such systems have advantages in that the printing is rapid and the ink does not touch the printing plate, but such plates are expensive and slow to make. The object of the present invention is to keep or improve these advantages and still to use an inexpensive simple plate.

The invention involves the overall process in that the method of making the plate results in a type of plate which would not be useful for this form of electrical printing except for the special features of the plate itself and the special features of the printing process. It also requires the paper to be a relatively thin or pliable one of the type usually referred to as tissue paper.

According to the invention a metal support is coated with a photosensitive but electrically insulating material, to a thickness between specified limits. The limits on the thickness will be specified below after a description of the factors which determine these limits. The material is then exposed to a halftone or line image. Any such two-tone image having light and dark areas may be used. The material is then processed to remove it from the metal support only in areas corresponding to one of the two tones; that is, the image may be processed to either a positive or negative relief image of insulating material on the metal support. A sheet of tissue paper of thickness between .0002 and .003 inch is brought into contact with the residual areas of the material. An electric field is applied through the paper and the material with as high a potential as possible at the paper, but the potential must be less than the breakdown potential. Preferably it is greater than 1/4 of said breakdown potential. This electrical field actually draws the tissue paper into contact with the bare metal support areas between the areas of the insulating material. The paper is more electrically conducting than the insulating material. Charged particles of ink either in the form of dust or mist are passed in front of the tissue paper and are

attracted to the areas of the paper in front of the bare metal areas. However, this ink is not attracted to the areas of the paper in front of the insulating material. If any of the charged ink does deposit on these areas, it is so light a deposit as not to be noticeable; it has an electric charge of the same polarity as the other ink particles and tends to repel any further deposition of ink. The unwanted background density is greater when the thickness of the insulating polymer is small so this is one of the factors determining the lower limit on polymer thickness.

The insulating material should have a thickness between .0002 and .002 inch. The lower limit is sufficient to provide adequate insulating, to withstand breakdown and to prevent excessive background density. The upper limit on this thickness still permits the tissue paper to reach the bare metal support near the edges of the relief area. This upper limit is important, but it is not an extremely precise figure. Slightly greater thicknesses can be used with extra soft or thin tissue or can be used with relatively coarse detail in the picture. On the other hand the insulating material should be thinner when relatively heavy tissue paper is used or when fine details are to be printed such as a fine halftone. The value .002 inch turns out to be a reasonably practical upper limit.

Since the upper limit of the thickness for the insulating material depends on the thickness of the paper on which it is to be used, it is pointed out that the upper limit of the thicknesses of both the material and paper should be such that the product of these thicknesses in inches is less than .00001.

If the tissue paper were not drawn down into contact with the metal, there would be no characteristic to distinguish between the image areas and the non-image areas since part of the paper would be in front of the material which is insulating and the rest of the paper would be in front of air which is similarly insulating.

Preferably, the creating of the electrical field at the printing surface and the charging of the ink particles are simultaneously accomplished by having a glow discharge from an electrode in front of the paper at a potential difference from the metal support greater than 5000 volts per inch of the distance of the electrode from the paper. Also, the potential must be less than that which would develop the breakdown potential at the surface of the insulating material.

In continuous printing processes, the metal, the material and the paper all move continuously past the glow discharge. One preferable arrangement includes a plurality of pointed electrodes arranged in two rows with the electrodes in one row symmetrically (i. e., in columns) between the electrodes of the other row and with the paper moving at right angles to the two rows. Preferably, the electrodes are separated from one another about the same distance as they are from the paper.

The invention will be more fully understood from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 illustrates the prior art;

Fig. 2 illustrates what would happen if one attempted to use insulating material in place of metal in the prior art;

Fig. 3 similarly illustrates the actual printing operation in the present invention;

Figs. 4 and 5 are plan views indicating the position of glow discharge electrodes in preferred embodiments of the invention; and

Fig. 6 is a flow chart schematically illustrating the first six steps in the present invention, the seventh step being that illustrated in Fig. 3.

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In Fig. 1 a metal printing plate 11 mounted on a drum 10 includes insulating material 12 deposited between the relief metal areas indicated at 13. A strip of paper 16 is rolled in contact with the metal 13 and insulating areas 12. Particles of dust or mist 17 from a spray nozzle 18 is passed in front of the paper. An electric field is created between the electrode 19 and the metal plate 11 as indicated by the positive and negative signs. The ink particles 17 may or may not be charged, but are preferably charged negatively. These ink particles are attracted to the paper 16 to those areas which are in front of the metal 13 since any charge on the particles immediately leaks away through the paper to the printing plate 11. However, the ink is not attracted to the areas of the paper 16 in front of insulating areas 12 since there is no opportunity for a charge to leak away and the surface of the paper 16 assumes a slight negative charge which repels the ink particles.

As illustrated in Fig. 2 this process would not work if the relief areas on the metal plate 21 were made of insulating material 22 instead of metal 13 as shown in Fig. 1. In Fig. 2 the paper 16 is in contact with the tops of the insulating relief areas and none of the paper is in contact with metal. The air and the insulating areas 22 are effectively the same electrically so that ink particles would not be attracted to any areas of the paper.

Nevertheless, in Fig. 3, which is according to the invention, the metal plate 21 does have the relief areas 25 made of insulating material, but these relief areas are not as high as in Fig. 2. The metal areas 27 between the relief areas 25 are close to the tops of the relief areas. A tissue paper 26 passing over such a roller would normally lie in contact with the tops of the relief areas 25, but I have found that the application of an electrical field causes the tissue paper to be drawn down into the areas between the relief areas 25 and into contact with the metal plate 21. In this case the field is provided by sharply pointed electrodes 28 which produce a glow discharge as indicated by the rays 29. This glow discharge tends to charge the particles 30 of ink as they pass from the nozzle 31 in front of the paper 26. The electrodes 28 also create the electrical field as required at the paper. If the paper is not too wide, a single pointed electrode will work. A simple arrangement which works for a wider strip of paper is shown in Figs. 3 and 4 in which there are two rows of electrodes 28, two electrodes in one row and a third electrode symmetrically between those of the first row but in a second row, both rows being transverse to the direction of movement of the paper 26. The paper may be moving in either direction. That is, the single electrode may be first or may follow the pair of electrodes.

In the arrangement shown in Fig. 5 four electrodes 33 are used, two in each row in order to cover the full width of the paper. I have found that this form of electrode using a plurality of spaced needles gives the most satisfactory prints with the present invention. In all cases the electrodes of one row are in columns between (the columns of) the electrodes of the other row.

The flow chart consisting of Figs. 6A to 6F inclusive schematically represents the manufacture of a printing plate according to a preferred embodiment of the present invention. A metal support 40 is coated with a thin layer of electrically insulating photosensitive material 41 from a suitable hopper 42. A spray coating or spin coating is also commonly used to apply photosensitive resists to metal plates. Such methods may be used in the present invention, the only special requirement being that the photo resist must be an electrically insulating one and need not have any particular acid resistance or sand blast resistance or electroplating resistance as is sometimes important in photo resist work. Actually the photo resist used in the present invention usually does have all of these additional properties but does not use them. A resist which has a low electrical resistance, however, cannot be used. The finished plate is shown in Fig. 6B

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and is usually a dry plate. Fig. 6C illustrates the step of exposing the plate to a two-tone image. Exposure can be either by projection printing or contact printing. In the drawing, contact printing is shown in which a positive halftone image 47 on a film 46 is trans-illuminated by light represented by arrows 48. After exposure, the plate 40 with the exposed sensitive coating 44 thereon is suitably processed in a bath 50 in a tray 51. Alternatively, processing may be by suitable shower or spray. In the arrangement shown the resist is one in which the exposed areas are hardened by the processing and the unexposed areas are removed by the processing. The hardened resist is shown at 52 and the bare metal areas are shown at 53 in Fig. 6E. This is the normal procedure with commercially available photosensitive resists. It is possible, however, to provide systems in which the exposed areas are removed and the unexposed areas remain on the metal, in which case printing would be from a halftone negative. Suitable high resistance resists are commercially available such as Kodak Photo Resist, or other high polymer photosensitive materials. These materials permit the removal of unexposed areas, leaving the exposed areas as the resist. As an example of commercially available processes in which the exposed areas are removed, surface hydrolyzed cellulose acetate when sensitized, exposed and processed removes the hydrolyzed layer exposing the cellulose acetate in the image areas. This cellulose acetate is then etched by solvent which does not appreciably attack the hydrolyzed areas. Such materials are available as "Etcholith."

In Fig. 6F the plate 40 with the insulating image 52 thereon is wrapped onto a cylinder 55 and held in place by suitable clamping means indicated at 56.

This printing plate on the roll 55 now constitutes the printing roller as indicated at 21 in Fig. 3 and the next step of the process is that illustrated in Fig. 3.

Prints obtained by this process show quite acceptable quality. This is true in practice in spite of the fact that the resist image would be expected to interfere with the metallic contact which is essential to the printing operation. The high intensity field overcomes this difficulty.

I claim:

1. The method of producing an image on tissue paper which comprises forming on a metal support a two tone image of electrically insulating material with a thickness between .0002 and .002 inch, bringing a sheet of tissue paper of thickness between .0002 and .003 inch into contact with the tops of the material, simultaneously establishing an electrical potential difference across the paper and material with a potential less than breakdown potential of the material and greater than $\frac{1}{4}$ of said breakdown potential to draw the tissue paper into contact with the bare metal support area between the areas of the material and passing charged particles of ink near the front of the tissue paper to be attracted to the areas thereof in front of said bare metal areas.

2. The method of producing an image on tissue paper which comprises forming on a metal support a two tone image of electrically insulating material with a thickness between .0002 and .002 inch, bringing a sheet of tissue paper of thickness between .0002 and .003 inch into contact with the tops of the material, creating a glow discharge from an electrode in front of the paper at a potential difference from the metal support greater than 5000 volts per inch of distance of the electrode from the paper and which establishes a potential difference across the material less than breakdown potential and passing ink particles through said glow discharge to charge the particles whereby the areas of the paper between said tops are attracted into contact with the bare metal and the charged particles are attracted to said inbetween areas.

3. The method of producing an image on tissue paper which comprises forming on a metal support a two tone image of electrically insulating material with a thickness between .0002 and approximately .002 inch, bringing a

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sheet of tissue paper of thickness between .0002 and approximately .003 inch into contact with the tops of said material, the upper limit on the thicknesses of the material and paper in inches, being such that the numerical product of such thicknesses is less than .00001, simultaneously establishing an electrical potential difference across the paper and material with a potential less than breakdown potential of the material and greater than one quarter of said breakdown potential to draw the paper into contact with the bare areas of the metal between the areas of said material and passing charged particles of ink near the front of the paper to deposit on the areas of the paper in front of said bare areas of the metal.

4. The method of producing an image on tissue paper which comprises forming on a metal support a two tone image of electrically insulating material with a thickness between .0002 and approximately .002 inch, bringing a sheet of tissue paper of thickness between .0002 and approximately .003 inch into contact with the tops of said material, the upper limit on the thicknesses of the material and paper in inches being such that the numerical product of such thicknesses is less than .00001, creating a glow discharge from at least one pointed electrode spaced a distance in front of the paper having a potential difference from the metal support greater than 5000 volts per inch of said distance and which establishes a potential difference across the material less than sufficient to break-

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down the material and passing ink particles through said glow discharge to charge the particles, whereby the paper is attracted to the bare areas of the metal between said tops of the material and the ink particles are attracted to the areas of the paper in front of said bare areas of the metal.

5. The method according to claim 4 in which the metal, the material and the paper move continuously past the glow discharge and in which there are at least three of the point electrodes arranged in two rows transverse to the direction of motion of the paper, the electrodes in one row being in columns symmetrically between the electrodes of the other row.

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