Aug. 30, 1960 H. R. DALTON 2,951,019

METHOD OF MAKING PLATED INTAGLIO PRINTING FORM

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FIG. 2.

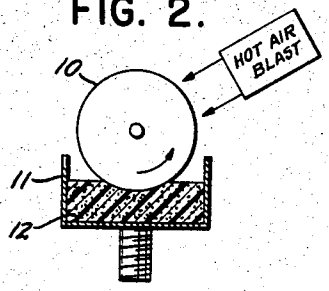


FIG. 1.

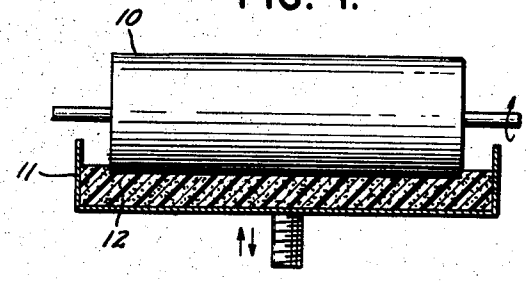


FIG. 4.

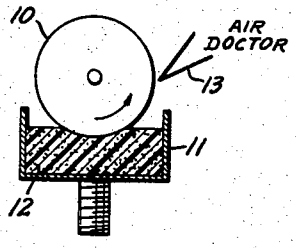


FIG. 3.

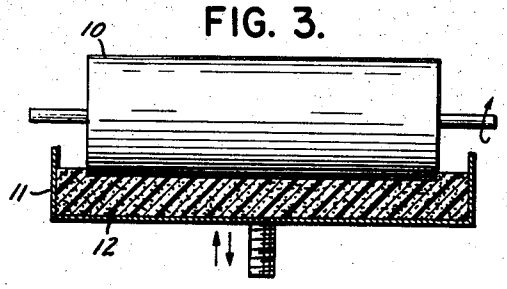


FIG. 5.

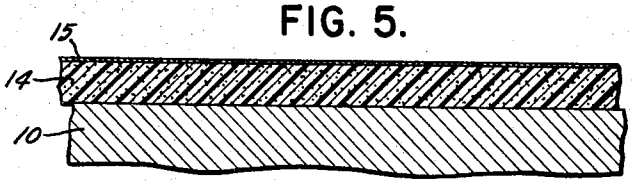


FIG. 6.

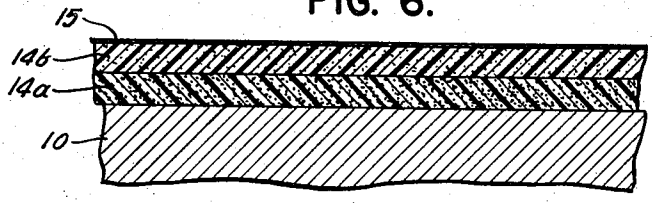
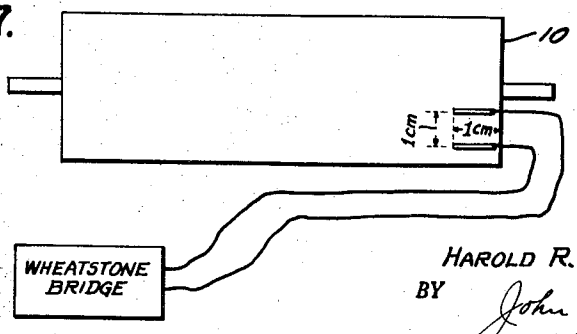


FIG. 7.



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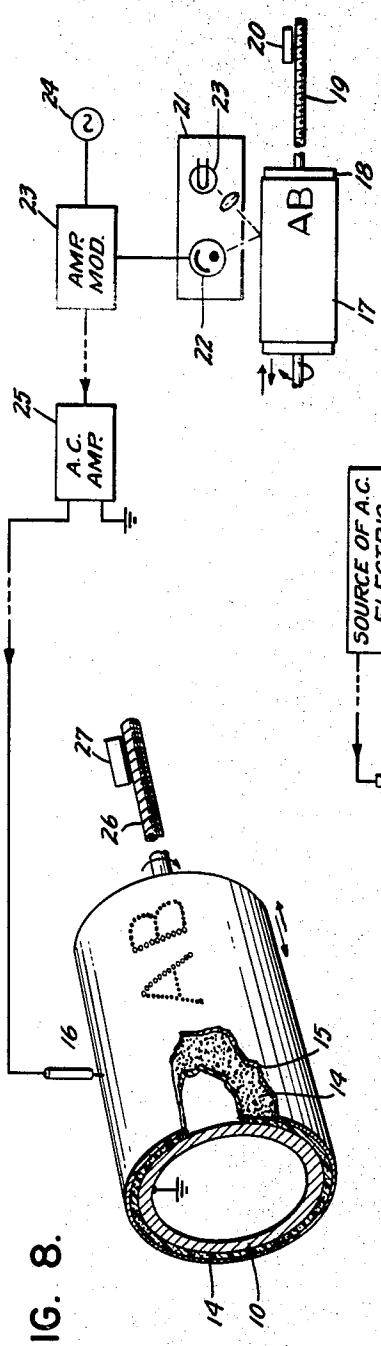


FIG. 8.

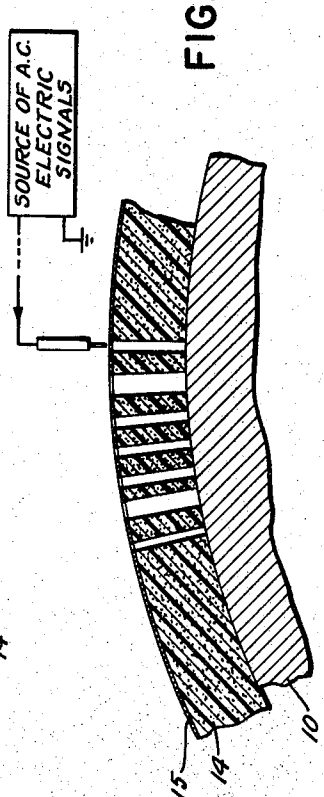


FIG. 9.

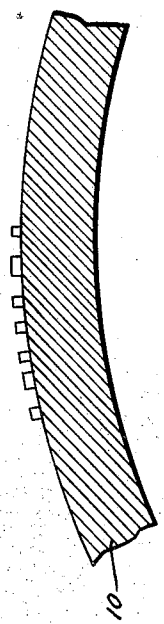


FIG. 10.

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METHOD OF MAKING PLATED INTAGLIO PRINTING FORM

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6 Claims. (Cl. 204—17)

This invention relates to the art of printing, and more especially it is concerned with improvements in printing processes using plated printing forms whether as rolls or flat plates.

One of the principal objects of this invention is to provide methods and apparatus for producing a plated intaglio printing form, but without requiring the numerous steps of conventional intaglio processes.

Another object is to provide apparatus and methods for making a plated intaglio printing form at a much faster rate than is possible with conventional processes.

Another object is to provide apparatus and methods for making a plated printing form employing electric facsimile signals.

Another object is to provide methods and apparatus for making a plated printing form, whereby any kind of original subject matter can be selectively plated on to the form, regardless of whether such subject matter is line work, half tone, or photographic material.

Another object is to provide a method of gravure printing which eliminates the necessity of employing the conventional gravure screen.

A feature of the invention relates to methods and apparatus whereby the original subject matter is electro-optically scanned in successive elemental areas to produce corresponding electric voltages whose amplitudes represent the shade gradations of the corresponding scanned areas; and stylus-applying these voltages to an electro-responsive layer in the nature of a film-forming resin, plastic, or elastomer, which has been previously attached to the surface of the metal printing plate or roll. The said layer is prepared so as to have a predetermined electric conductivity whereby the stylus-applied voltages result in electric current flow into corresponding elemental-areas which thereby are perforated to expose the metal surface of the printing form. This form is then subjected to a plating operation through the perforations in said layer, to produce a corresponding plated record on the surface of the said form. Since the said layer is substantially non-porous, it is possible to produce satisfactory gravure or intaglio printing effects without using the conventional gravure methods.

Other features and advantages not particularly enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing,

Fig. 1 represents, in elevational view, apparatus for carrying out certain steps according to the invention;

Fig. 2 is an end view of Fig. 1;

Fig. 3 represents a modification of the apparatus of Fig. 1;

Fig. 4 is an end view of Fig. 3;

Fig. 5 represents, in magnified section, a portion of a printing form according to the invention;

Fig. 6 is a preferred modification of Fig. 5;

Fig. 7 shows how the predetermined conductivity of the printing form according to the invention can be measured;

Fig. 8 is a composite schematic view of the electrical system for producing the printing form;

Fig. 9 is an enlarged view of a section of the form of Fig. 8, showing the manner in which the plastic film or layer is perforated by the electric signals;

Fig. 10 shows a section of the finished form of Fig. 8, with the plastic layer or film removed.

In carrying out the invention, a form such as a metal plate or roll, has its surface thoroughly cleaned or otherwise treated to receive an adherent coating or sheath in the form of a film or a combination of films prepared from resinous film-forming materials, such for example as vinyl chloride-vinyl acetate copolymers; cellulose derivatives; methacrylate polymers; or any one of a large number of film-forming resins or elastomers, whether synthetic or natural. It will be understood, therefore, that where a polyvinyl resin or similar film-forming resin is referred to herein, that any one of a large number of natural or synthetic film-forming resinous materials or elastomers can be used with satisfactory results.

In accordance with the invention, the metal printing form, whether plate or roll, has deposited thereon, so as to be adhesively attached thereto, the film or sheath as above mentioned. This coated form is then subjected to the action of stylus-applied electric signal voltages so as to perforate the said coating, and to expose the metal surface of the form beneath the coating in minute elemental areas. However, in order that the desired results may be obtained, it is necessary to incorporate into the film, powdered electrically-conductive carbon, so as to impart a predetermined electric conductivity to the film, which conductivity should be uniform for each elemental cross-section of the film. Preferably, the carbon is introduced into the film material in the form of colloidal carbon having the desired electric conductivity, such as acetylene black, channel black, thermal decomposition carbons, etc. The invention is not limited to any particular method of manufacturing the conductive carbon, and almost any colloidal carbon black of good electrical conductivity can be used in place of those specifically mentioned in the examples given hereinbelow.

The film or sheath which is attached to the metal printing form is prepared in a liquid state, and applied in that state and in any well-known manner directly to the surface of the said form, which may be any well-known rotogravure cylinder or roll. Preferably the said form is provided with two such superposed films each containing different kinds of conducting carbon, or containing carbon blacks of widely different electrical resistances. Thus, the base coating which constitutes the first layer of the film attached to the printing form, should be of higher electrical conductivity than the second coating or film which is adhesively superposed on the first coating or film. By this arrangement, improved results are obtained, since most of the current from the stylus is carried through the thickness of the film or films to the ground connection for the system, with very little loss.

In the case where the coating on the printing form consists of a plurality of superposed films, special methods may be used to keep the films from intermingling during the coating operation. Thus, the resin or resins which are used for the respective coatings are selected so that the solvent for the resin of the second coating or film does not have any effect upon the previously-applied undercoating or film. Nevertheless the materials are such that when the films or coatings are applied over each other, they form in effect a single composite thickness, but with the strata thereof of different respective electric conductivities. If the first film is

rapidly and thoroughly dried before applying the next film, such intermingling can also be easily avoided. It will be understood, of course, that whichever method of coating is employed, when the series of films have been applied to the printing form, they constitute in effect a unitary composite sheath, and this sheath has an electrical conductivity gradient which increases in the direction considered from the stylus towards the metal form. While such a plural-stratum film or coating produces the best results, satisfactory printing results have been obtained where the printing form is coated with a film or sheath having a uniform conductivity through its thickness, as distinguished from a graduated conductivity, as disclosed for example in application Serial No. 755,263, filed June 17, 1947 (U.S. Patent 2,664,043).

For certain purposes to be described hereinbelow, the outer surface of the coating on the printing form may have applied thereto an extremely thin whitish or light-colored pigmented masking coat of which the following is a representative formulation.

	Parts by weight
Polyvinyl butyral (intrinsic viscosity of approximately 1.2)	6.0
Methanol	120.0
Tricresyl phosphate	2.0
Zinc sulphide	30.1

The above ingredients are placed in a ball mill, and ground for approximately 18 to 24 hours. At the end of this time, the zinc sulphide should have been thoroughly dispersed and the polyvinyl butyral resin completely dissolved. It will be observed that this masking coat does not contain any conductive carbon, and its function is mainly to provide the thinnest possible mask, so as to effect a contrasting appearance with the carbon-bearing conductive film underneath it when the latter is exposed. In fact, this masking coat is such that its thickness cannot be measured independently by known thickness-measuring instruments, and its thinness does not interfere in any way with its perforation or the perforation of the film coatings in response to the stylus-applied voltages.

Referring to Figs. 1 and 2, there is shown one particular organization of apparatus that may be used for coating the electrosensitive film or combination of films onto a rotogravure roll **10** which may have the usual copper peripheral surface. The roll **10** is supported above a tray or tank **11** containing the electrosensitive film-forming material **12** in liquid form, and so that the surface of the roll **10** dips into the material **12** a predetermined and accurately controlled depth. For this latter purpose, either the tray **11** or the roll **10** can be provided with suitable adjustable elevating mechanism (not shown). The roll **10** while so immersed, is rotated slowly, and the surface of the roll above the coating liquid is subjected to a gentle stream of hot air. When the proper thickness of the film coating has been applied, the roll **10** is removed from the coating liquid, and the hot air drying is continued until all the solvent has been removed from the coating, which thereupon adheres to the surface of the roll.

An alternative method of coating the roll is shown in Figs. 3 and 4. The main difference between the method of Figs. 3 and 4 and that of Figs. 1 and 2, is that the amount or thickness of the film-forming material applied to roll **10** is controlled by an "air knife" or "air doctor" **13** of well-known construction. After the desired thickness has been applied to the printing roll, the latter is removed from the coating liquid, and is subjected to drying until all the solvent is removed. It will be understood that the film-forming material may be coated onto the printing roll by any other process, for example by air brush, spray gun, and the like.

Fig. 5 shows in magnified sectional view, a portion of a rotogravure printing roll carrying on its peripheral surface the electrically conductive and electrosensitive film **14**, and the outer whitish pigmented masking coating **15**, such for example as disclosed in application Serial No. 755,263, filed June 17, 1947 (U.S. Patent 2,664,043).

Fig. 6 shows a similar magnified section of a rotogravure printing roll **10** having the film **14** constituted of two layers **14***a*, **14***b*, prepared similar to film **14** of Fig. 5, but with the lower or base film coat **14***a* of much higher electric conductivity than the next film coat **14***b*.

A description will now be given of one typical procedure to be followed in producing the coated rotogravure printing roll or plate such as shown in Fig. 6. The mixture for forming the film coat **14***a* is prepared as a liquid solution, as follows. Any well-known resinous film-forming material or elastomer is mixed with a suitable solvent and with a predetermined amount of colloidal conductive carbon. If desired, the mixture may contain a small percentage of a plasticizer and a small percentage of a stabilizer. The mixture is then ball-milled and ground until the carbon has become thoroughly dispersed and the film-forming material is completely dissolved in the solvent. A typical mixture can be prepared according to the following formula.

	Typical parts by weight
Vinylite resin	60.0
Methyl ethyl ketone (solvent)	475.0
Acetylene carbon black (conductive)	100.0
Dioctyl phthalate (plasticizer)	30.0
Calcium-2-ethyl acetoacetate (stabilizer)	1.0
Basic lead carbonate (stabilizer)	1.0
Sodium-2-ethylhexyl polyphosphate (stabilizer)	8.0

The above ingredients are placed in a ball mill and ground for approximately 18 to 24 hours, and until the acetylene carbon black is thoroughly dispersed and the vinylite resin completely dissolved. This coating material is then flowed into the tray **11**, and the roll **10** is slowly rotated until a dry thickness of approximately 0.00025 inch to 0.0005 inch is applied as described above. The electrical resistance of the finished film coating as applied for example to a rotogravure roll, should be approximately 2 to 10 ohms as measured on the roll between two wire electrodes spaced 1 centimeter apart, and each wire contacting the film for a distance of 1 centimeter, as indicated in Fig. 7, these wire electrodes being connected to a suitable resistance or conductivity measuring device such as a Wheatstone bridge.

After the base film coat **14***a* has been thus applied and dried, the second film coat **14***b* is applied thereover. The material for the film coat **14***b* can consist of a mixture similar to that for coat **14***a*. However, since the coat **14***b* should be of very much lower conductivity than the coating **14***a*, it is necessary to employ a very much smaller proportion of conductive carbon. For example, the percentage of conductive carbon in the coating **14***b* may be as low as $\frac{1}{10}$ of the percentage of carbon in the coating **14***a*. A typical formula for preparing the coating material **14***b* is as follows:

	Parts by weight
Vinylite resin	30.0
Methyl ethyl ketone (solvent)	375.00
Methyl isobutyl ketone (solvent)	75.0
Carbon black (channel black)	8.0
Acetylene black	1.0
Dioctyl phthalate (plasticizer)	15.0
Calcium-2-ethyl acetoacetate (stabilizer)	.5
Basic lead carbonate (stabilizer)	.5
Sodium-2-ethylhexyl polyphosphate (stabilizer)	4.0

Here again the above ingredients are placed in a ball-mill and ground for approximately 18 to 24 hours to thoroughly disperse the carbon blacks and to thoroughly dissolve the resin. This second mixture can then be supplied in another tray similar to tray **11**, and the roller **10** carrying the previous coat **14***a* is rotated therein un-

til a dry thickness of approximately 0.0005 inch to 0.0025 inch of this coating is applied. The combined resistance of the two film coats **14***a* and **14***b* when measured on the roll **10**, should be approximately 50,000 to 5,000,000 ohms as measured in the manner indicated in Fig. 7 with the electrodes in contact with film **14***b*. In other words, the conductivity of the base coat **14***a* when measured by itself on the roll **10** is from 25,000 to 500,000 times greater than the conductivity when both coats **14***a* and **14***b* are superposed and measured on the roll **10**.

In order to make it possible to observe the progress of the stylus action on the coated printing plate or roll, or in order to conveniently examine it after completion and prior to plating, the top light-colored coat **15** can then be applied over the coat **14***b*. It will be understood, however, that this extremely thin masking coat **15** is not necessary unless it is desired to inspect the roll at any time before plating.

While the descriptions given herein involve the formation of films from solvent solutions, it is possible to preform the films as for instance by a calendering process or on a carrier base as described in copending application Serial No. 755,263 (U.S. Patent 2,664,043), and apply the films to the rotogravure roll by means of heat, adhesive, etc.

The next step in preparing the printing roll, is to subject the coated roll to the action of an electrically-energized stylus. Thus, as shown in Fig. 8, the stylus **16** is supplied with electric signals resulting from the electro-optical scanning of the original subject matter **17**. This subject matter can be scanned in successive elemental areas by any method well-known in the telefacsimile transmission art, for example it may be wrapped around a scanning drum **18** which is arranged to be rotated and advanced in the direction of its length by means of a suitable lead screw **19** and associated half-nut **20**. The successive elemental areas of the subject matter **17** are thus exposed to a facsimile pick-up head **21** comprising a photoelectric cell **22** and a light source **23**. In the well-known manner, the light source **23** projects a minute spot of light on the subject matter **17**, and the light reflected therefrom is picked-up by the photoelectric cell **22**. Preferably, although not necessarily, the direct current signals from the cell **22** are converted into corresponding amplitude-modulated alternating current, for example by applying them to a suitable amplifier-modulator **23** which can be supplied with alternating current of the desired frequency from a source **24**. This source may be of any suitable frequency, for example from 60 cycles to 20,000 cycles, and whatever frequency is supplied from the course **24**, it is amplitude-modulated by the signals from cell **22**. These alternating current signals can be further amplified in a suitable amplifier **25** before being impressed upon the stylus **16**. It will be understood, of course, that for certain purposes the direct current signals can be amplified and applied as amplified direct currents to the stylus **16**, instead of converting them to alternating current signals.

The rotogravure roll **10** carrying the plastic film coat **14**, as above described, is then scanned in successive elemental areas underneath the stylus **16** in synchronism with the scanning of the corresponding elemental areas on the subject matter **17**. Thus, the coated roll **10** can be rotated and advanced longitudinally by means of a lead screw **26** and half-nut **27**, it being understood that the rotary and longitudinal motions of the roll **10** are synchronized in any well-known manner with the rotary and longitudinal motions of the scanning drum **18**. If desired, the roll **10** may be mechanically coupled to the same shaft which carries the drum **18**, and a single motor may be used to drive the drum **18** and the coated printing roll **10**.

As a result of the action of the voltages on the stylus **16** and the grounded printing roll **10**, the coat **14** is perforated in minute holes by electric current flow, as indicated in Fig. 9, it being understood, of course, that the masking coating **15** is likewise perforated if such a masking coating is employed. The size or diameter of the respective perforations in the coat **14** and the coat **15**, if used, is then proportional to the amplitude of the signal voltage impressed upon the stylus **16**. Thus, the subject matter **17** is reproduced in the form of minute perforations in the coat **14**, which perforations, of course, extend through to the surface of the roll **10**.

After the subject matter has thus been produced on the coated roll **10**, this coated roll is then immersed in any well known electro-plating bath wherein the roll **10** itself acts as one of the plating electrodes. For example, this bath may be a nickel or copper plating bath. Therefore, the surface of roll **10**, in alignment with each of the recorded perforations in the film coat **13**, receives a corresponding plated dot, the facial area of which corresponds to the size of the corresponding perforation in film coat **13**. The depth or thickness of each dot can be controlled by the strength and duration of the electroplating current. In other words, there is produced on the surface of the metal roll **10**, by the electro-optical scanning and plating steps, a plated facsimile of the original subject matter in the form of minute raised metal dots, each corresponding to a particular elemental area of the original subject matter. After the plating operation has been completed, the roll is removed from the plating bath and subjected to any well known washing operation. The film coat **14** can then be removed by stripping or in any other convenient way. Thus, in the case of the example given above, methyl ethyl ketone could be used to dissolve and remove the film coating. The final product is, therefore, a printing roll **10** having the subject matter integrally formed on the surface thereof in the form of raised plated dots and this roll can be used in any well known printing press as a raised or embossed surface printing form.

Various changes and modifications may be made in the disclosed embodiment without departing from the spirit and scope of the invention.

Features disclosed in this application but not claimed herein are claimed in copending application Serial No. 226,987, filed May 18, 1951.

What is claimed is:

1. The method of making a printing form of the plated intaglio surface type, which comprises applying to a metal plate two successive coats of electrically-conductive film-forming resinous plastic with the second coat of very much lower electrical conductivity than the first coat but forming therewith a unitary non-porous sheath which is readily stripped from said plate, perforating said sheath therethrough to expose directly the surface of said plate in successive elemental areas under control of electric signals derived from corresponding elemental areas of a subject matter to be printed, plating the said surface through said perforations, and then stripping said perforated sheath from said plate.

2. The method of making a printing form of the plated intaglio surface kind, which comprises applying to a metal form two successive coats of dark colored electrically conductive film-forming resinous plastic with the second coat of very much lower electrical conductivity than the first coat but forming therewith a unitary non-porous sheath which is readily stripped from said metal form, applying a light-colored masking coat over said sheath, perforating said sheath and masking coat therethrough to expose the surface of said plate in successive elemental areas under control of electric signals derived from corresponding elemental areas of a subject matter to be printed to form directly a perforated record of the subject matter, plating the said exposed metal surface through said perforations, and then stripping said perforated sheath from said metal form.

3. The method of making a printing form of the plated intaglio surface type, which comprises mixing a film-

forming resinous plastic with a solvent and with powdered electrically conductive carbon, coating the surface of a conductive backing plate with said mixture while it is in liquid state to form thereon a uniformly adherent non-porous film with a predetermined electric conductivity, mixing a film-forming resinous plastic with powdered electrically conductive carbon to form a mixture having a lesser amount of carbon than the first mixture and a much lower electric conductivity than the first mixture, applying the second mixture over the first mixture without substantial intermingling of them and to form a second non-porous film which is an adherent unit with the first film and which is readily stripped from said backing plate, perforating both films by electric signals applied thereto to expose the surface of said plate in successive elemental areas corresponding to the successive elemental areas of a subject matter to be printed to form directly a perforated record of the subject matter, plating said exposed elemental areas of the plate through said perforations, and then stripping both said films as a unit from said backing plate.

4. The method of making a plated intaglio surface printing plate, which comprises mixing a film-forming resin with a solvent and with a predetermined percent of powdered electrically conductive carbon, applying said mixture in liquid form to a copper plate, drying said mixture to form a substantially non-porous film uniformly adherent to said plate and having a predetermined electric conductivity, mixing a film-forming resin with a solvent and with a predetermined percent of powdered electrically conductive carbon which percent is less than one half the carbon in the first mixture, applying the second mixture in liquid form over said film, drying said second mixture to form a second film which adheres as a unit to the first film, stylus-applying electric signals representing successive elemental areas of a subject matter to be printed to perforate said films and to expose correspondingly the surface of said plate and simultaneously to produce directly in said films a perforated record of the subject matter, plating said surface of said plate through said perforations, and then stripping both films as a unit from said copper plate.

5. The method of making a plated intaglio surface printing form, which comprises covering a metal base with a sheath of a film-forming resinous plastic which is normally non-porous and contains powdered carbon and is readily strippable from the metal base, electrically perforating said sheath in minute discrete areas by electric signals applied thereto and controlled by corresponding elemental areas of the subject matter to be printed to form directly a perforated record of the subject matter, plating said base through said perforations to form raised plated dots corresponding to the perforations in said sheath, and then stripping said sheath from said base.

6. The method of making a printing form of the plated intaglio surface kind, which comprises mixing a film-forming resinous plastic material with a solvent and with powdered electrically-conductive carbon, coating the surface of a metal plate with the resulting mixture while the mixture is in liquid state, drying said mixture on said plate to form thereon an electrically-conducting film which is substantially non-porous and readily strippable from the metal base, perforating said film by electric signals directly applied thereto and controlled by corresponding elemental areas of the subject matter to be printed to form directly a perforated record of the subject matter, plating the surface of said plate through said perforations to form corresponding thereby embossed areas, and then stripping said perforated film from said metal plate.

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