Dec. 6, 1955 H. T. HOLSAPPLE 2,726,200

LITHOGRAPHIC PLATES AND METHOD OF PREPARING

Filed June 7, 1952 2 Sheets-Sheet 1

Fig. 1.

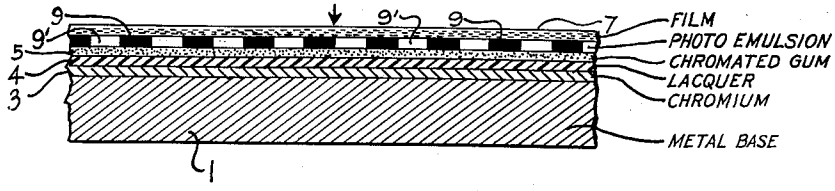


Fig. 2.

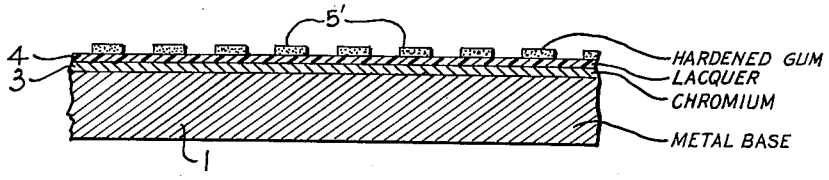


Fig. 3.

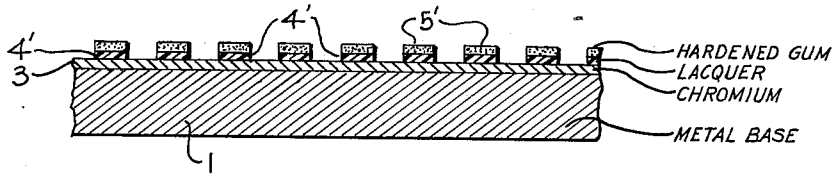


Fig. 4.

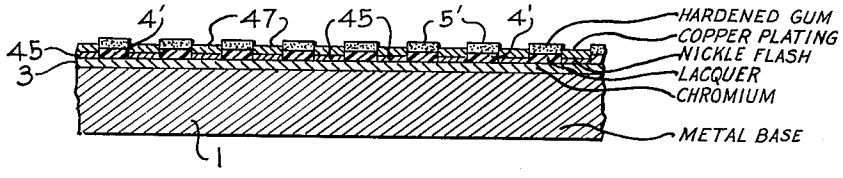
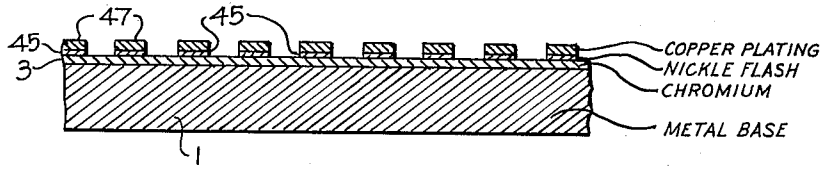


Fig. 5.



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LITHOGRAPHIC PLATES AND METHOD OF PREPARING

Filed June 7, 1952 2 Sheets-Sheet 2

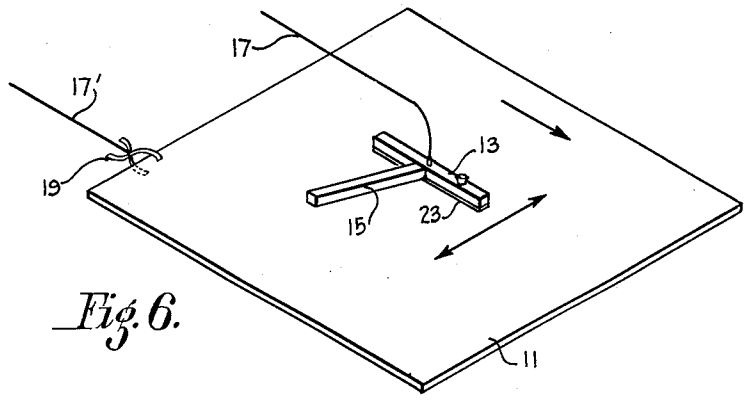


Fig. 6.

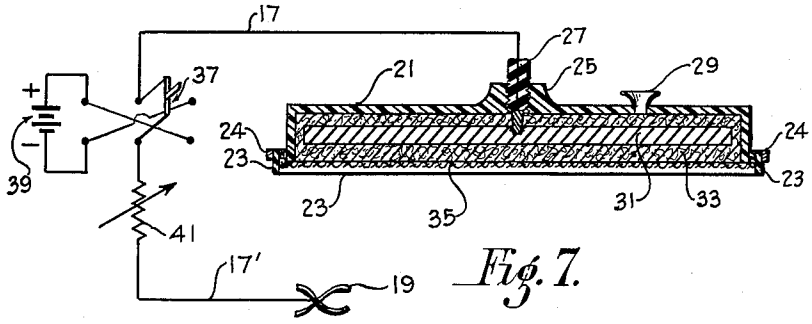


Fig. 7.

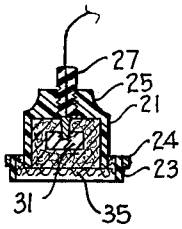


Fig. 7a.

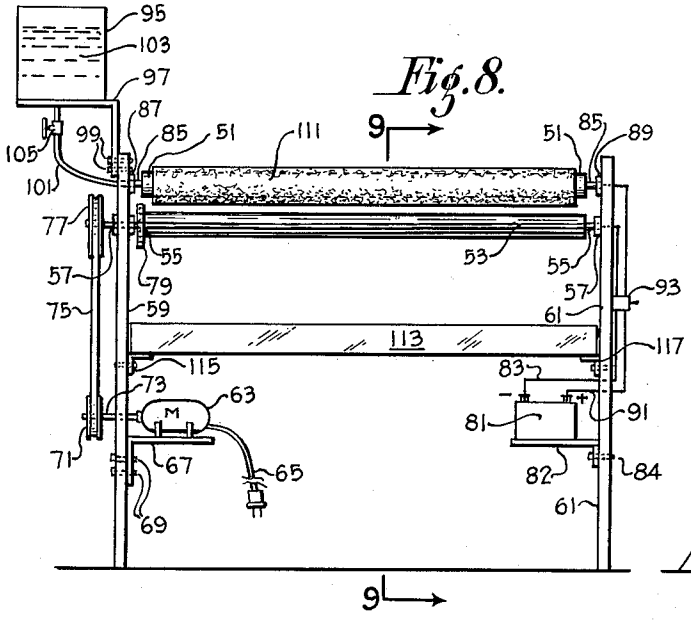


Fig. 8.

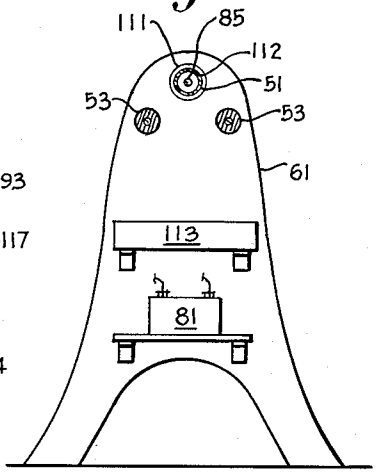


Fig. 9.

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LITHOGRAPHIC PLATES AND METHOD OF PREPARING

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Application June 7, 1952, Serial No. 292,356

2 Claims. (Cl. 204—17)

This invention relates to the preparation of photolithographic plates and specifically to plates of the "bi-metallic" type, wherein the ink-receptive and water-receptive areas which define the image are of different metals. Various terminologies have been applied to plates of this character. Such plates have been variously designated, being also known as "tri-metallic" and "poly-metallic" in cases where the ink-receptive and water-receptive surfaces have been deposited upon a base plate of some third metal, but since, so far as making the lithographic prints are concerned, it is only the surface itself which is of any importance, except structurally, the term "bi-metallic" will be used throughout this specification irrespective of whether or not other metals are used to form a substratum or support.

The fact that different metals, properly applied, will give the two surface characteristics necessary for photolithography has long been known. The materials used may be referred to as "lithographically active," the required characteristics of one of the metals being that it is readily wetted by water and aqueous solutions, or "water-receptive," but not readily wettable by greasy or fatty inks. The other "lithographically active" metals have opposite characteristics; they are "ink-receptive" and "water-repellent." Both types of characteristics are relative; practically all metals can be wetted by either water or oily materials, but experiment has developed a general knowledge in the art of the combinations of those metals differing so greatly in relative wettability with respect to water and oily materials as to produce lithographic plates of high quality; i. e., to be lithographically active. Numerous methods have been proposed for preparing such plates, differing widely in detail, but essentially all of these methods can be divided into two classes. In the first of these classes the preparation starts with a plate, the entire surface of which has one of the desired characteristics and the second metal is plated or deposited on this surface through a suitable stencil. In accordance with the second method the entire surface of a metal having one characteristic is coated with a very thin layer or film of the second metal, the stencil is formed by one of the usual methods, and the thin surface coating is etched off through the stencil. Where the first-mentioned process is used the deposition of the second metal coating can be either by an electrolytic or a chemical substitution process. Usually, however, the electrolytic process has been used as being more controllable and positive with regards to results.

Theoretically it makes no difference whether the metal which is deposited through the stencil is the one having the ink-receptive or the water-receptive properties. For practical reasons, however, the choice will usually be to deposit the ink-receptive material, as among the best of the latter are silver and copper, and since the coating is very thin—usually in the range between 0.0003 inch and 0.003 inch—the use of these more expensive metals for the coating results in a less expensive completed plate. This is not, however, of primary importance, since by using a base of any desired material with only a thin surface coating of the metal used to do the actual printing, even a more expensive material can be used for the underlying surface without making the cost prohibitive, and while, throughout this specification it will generally be assumed for illustrative purposes that it is the ink-receptive and water-repellent material which forms the overlying coating, it will be understood that the reverse may be the case.

In accordance with past practices the preparation of the stencil through which either the plating or the etching process has been accomplished has been the same as in substantially all photomechanical processes. The plate to be processed has been coated with a chromated colloid which becomes insoluble on exposure to light. The plate has been exposed through a transparency of the image to be reproduced, after which the unexposed coating has been washed off, leaving the hardened material to act as the stencil. What colloid has been used has depended upon the particular process considered, in some cases a gum arabic base has been used, in others the base material has been gelatin or albumen.

While many of the processes mentioned have produced satisfactory plates where the subject has been in the form of line drawings, type matter, or the like, these processes have not been so successful in the reproduction of halftones. In this latter class of subject matter the halftone dots, whether considered as ink-receptive dots on a water-receptive background or the reverse, are extremely small in dimension, and either the plating or the etching must be carried out with great accuracy if the true values of the subject matter are to be preserved. Any deviation whatsoever from the desired dimension results in a false tone. In those processes in which a plating technique is used it has been practically impossible to prevent portions of the stencil from "raising," permitting plating under either a portion or all of the dot area. Furthermore, since the stencil is water-absorbent even where it is not soluble, the electrolyte used in the plating process may diffuse through in minute volume and the stencil itself may act as a gelatinous electrolyte. In either case the accuracy of the resulting plate is impaired.

These difficulties have led to the more general use of the etching technique in the processing of halftone bi-metallic plates. Even this, however, is not without its disadvantages. Even when most carefully controlled there is a tendency for the etching to undercut, making the outline of the dots irregular and altering their desired size. The same comments made, as to the penetration of the electrolyte, to the colloidal stencil also apply here, but the effect is less than when the ions entering into the reaction are driven by an electrical potential.

In all of the processes generally known there is a tendency for the action, whether it be plating or etching, to creep under the edge of the stencil dot and decrease the size of this dot. The same action, of course, appears in the case of line drawings or type materials, but here it is of less importance, since the areas considered are greater. If a line one one-hundredth of an inch wide is increased in width by one thousandth of an inch and all other lines in the same drawing are varied, on the average, by the same amount, the effect is ordinarily imperceptible. If a half-tone reproduction is desired and a screen of one hundred lines to the inch is used the dots may vary from one one-hundredth of an inch on a side down to less than one thousandth of an inch in diameter. These latter may be lost entirely in the process and averages cease to be important; any variation will result in a mottling of the tone and a wholly unsatisfactory plate.

Certain processes have been used which would tend to equalize the undesired effect of the deposition and etching processes. In one of these a plate is initially prepared with an undercoat of the water-receptive metal and a surface coating of the ink-receptive material. A positive transparency is used and the plating process is employed to deposit, through the stencil, a metal resist. The plate is then "developed" by removing the initial colloidal stencil and etched with a solution which attacks the ink-receptive surface but does not affect the metallic resist. Finally the resist is removed with an abrasive, thus exposing the ink-receptive surface. The tendency of the etchant to undercut thus counteracts in some degree the tendency of the colloidal stencil to lift.

Although, from many points of view, the deposition process is more attractive than etching, there is another difficulty which has militated against its general adoption. Whether the deposition is accomplished electrolytically or by replacement there is a tendency toward the formation of bubbles on the surface where the deposition is taking place. Such bubbles may cling to the surface only briefly or they may persist. In the one case the deposition may be imperfect; in the other, a spot may remain having none of the desired metal. The result is spotting or streaking of the plate. Furthermore, as the plating method has been applied in the past it has required large and expensive plating tanks and the expense of these requirements, the space occupied by the tanks, and the high degree of skill and care necessitated by the process have all served to prevent its general use in lithographic shops. Furthermore, in general, if plates were to be reclaimed so as to receive a new image, they had to be sent to a plant having special equipment for the purpose.

The broad purpose of the present invention is to provide a process for the manufacture of lithographic plates which retains the theoretical advantages of the electroplating technique and, at the same time, avoids the practical difficulties which have been inherent with such techniques as employed in the past. More specifically, among the objects of the present invention are: to provide a stencil for forming bi-metallic lithographic printing surfaces which will not "raise" under the action of an electrolyte and hence is suitable for the preparation of such plates for halftone reproduction; to provide a method for manufacturing such plates which requires a minimum of shop equipment and is therefore suitable for small as well as large lithographic shops; to provide a method of bi-metallic plate manufacture which permits of erasures or corrections in the plates; to provide a type of bi-metallic lithographic plate which may be reclaimed for the reception of a new lithographic image without the requirement that it be sent back to the factory for this purpose, but reconditioned by the plate-maker himself in his own shop; to provide a type of lithographic plate which will last much longer than usual types; to provide a lithographic plate of the bi-metallic type which not only possesses the durability of known plates of this character, but also is capable of reproducing halftones employing as fine screens and exhibiting as minute detail as the best plates prepared by either the albumen or deep-etch processes, and, in general, to provide a type of bi-metallic plate which can be completely processed in the lithographic plate-maker's own shop, using simple techniques which do not require extraordinary skill or training on the part of the platemaker.

The process of the present invention starts with a plate having a surface receptive to either ink or water. The entire plate may be of the surface material or this material may be deposited as a thin layer on a backing or base plate which supplies mechanical strength only. Among the water-receptive materials which may be used are zinc, stainless steel, aluminum, nickel or chromium. The most generally useful ink-receptive materials are silver, copper and brass. Of the water-receptive materials, the least desirable is aluminum, because of the difficulty of plating

upon it and the preferred material is chromium, but these differences are matters of degree; steel, grained zinc, and nickel are all suitable. As has been stated, the general characteristics of ink-receptive and water-receptive materials for bi-metallic plates are well known and the particular combinations of metals used is not to be considered as a part of this invention, which relates to the manner of employment rather than the metals themselves. The plate is then given a thin coat of a resin base lacquer, the base chosen being one which is soluble in alcohol or other organic solvents but is not soluble in water. The lacquer may be sprayed or the coating done in the same manner as is employed in applying the usual dichromated colloid coating; i. e., the plate is placed on a whirling table and a small quantity of the resinous lacquer is poured on the center and spread by centrifugal force, the excess being thrown off at the edge of the plate. Preferably coloring matter is added to the lacquer in order to facilitate inspection and assure that the entire plate is coated. The plate is then dried, and the usual chromated colloid coating is applied in the same manner as described for the lacquer coating. Exposure of the plate then follows in the same manner as is employed with any photolithographic process. If the metal surface, underlying the lacquer and colloid coats, is of the water-receptive metal, exposure is made through a positive transparency; if of the ink-receptive metal a negative transparency is used. For halftone reproduction the transparency, whether positive or negative, is one which has been made by exposure of the transparency plate or film through a halftone screen. The unhardened portions of the dichromated colloid are washed off with water or an aqueous solution, "developing" the plate in the customary manner.

The plate is next redried and is again "developed," this time by washing with an organic solvent which will dissolve the lacquer undercoat that has been exposed by removal of the unhardened portions of the chromated colloid. Such solvent may be an alcohol but is preferably one of the more active solvents such as ethyl acetate, amyl acetate, acetone or a mixture of solvents of this general character. Removal of the lacquer coating may be facilitated by rubbing with a swab of cotton or other soft material. Organic solvents of the class described have no effect upon the hardened gelatin, gum or other colloid and experiments have shown that there is no tendency for the solvent to undercut protected portions of the lacquer coating. It is possible that some diffusion of the solvent in the film of lacquer beneath the colloid may take place, but if it does there is still no tendency to undercut; if there is a softening of the lacquer it nonetheless remains in place. In the ordinary course of events the washing process is so rapid that there is little time for diffusion to take place and only that portion of the lacquer surface which is directly exposed and is, moreover, subject to the rubbing of the cotton or other soft material, is removed. The result is that a lacquer stencil is formed which is an accurate replica of the chromated colloid stencil, photographically produced.

The semifinal process in the preparation of the plates is the plating. This is preferably accomplished by means of a mechanical device which concentrates the current and the electrolyte in a relatively small area, the area of contact being constantly moved and the electrolyte being held in an absorbent material which is kept in contact with the plate. This has two effects; first, all portions of the exposed metal are, at one time or another, at minimum distance from the anode which supplies the plating current, and hence if the motion is uniform receive substantially equal currents and equal deposition of the second metal. Second, the movement tends mechanically to prevent any polarization or the formation of bubbles which would interfere with the deposition of the metal. The result is a uniform deposition of the ink-receptive (or water-receptive) material. The actual stencil which controls the deposition of the second metal is the lacquer

coating, and since resins, as a class, are non-ionizing and non-electrolytic, and since they are not only insoluble in aqueous solutions generally but absorb such solutions very slightly if at all, the lacquer stencil acts as a practically perfect insulator and neither "raises" nor electrolyzes. The result is a metal image which does not extend beyond the exposed portions of the plate and which is without streaks, holes, or bubbles. The final step in the process is the successive removal of the two stencils, first the colloidal stencil, which is removed in the usual manner (e. g., by soaking in warm water and brushing); the under stencil of lacquer is washed off with the same type of solvent as was used in developing the plate by removal of the lacquer and the final plate is ready for printing.

It should be noted that in the above description the material for the undercoating has been defined merely as a "lacquer" having a resin base. The terms "lacquer" and "resin" are used in the now generally accepted sense, i. e., a "lacquer" is a solution of a "resin" (or mixture of resins) in a volatile organic solvent such as an alcohol, ether, acetone, or the ester of an alcohol, such as ethyl or amyl acetate. The term "resin" includes both the natural and the synthetic resins, which are solids completely soluble in any of the organic solvents mentioned above or a mixture thereof and are insoluble in water. The term includes only the resinous constituents of oleo-resins and gum resins, and not the essential oils or the water-soluble materials present in these products.

Owing to the rapidly growing list of synthetic resins it is impractical to list all of the suitable materials. If the natural resins are employed the obvious choice among those mentioned are the harder "varnish resins" such as the copals, which are not only insoluble in water but water absorbent to a minimum extent, but the process may be carried out with some degree of success even with the more absorbent resins such as shellac. The ready availability of the synthetic resins and their greater uniformity, however, make them preferable to the natural product. Cellulose base resins, which are available under many trade names, may be used if they are of the type which adheres to metal. Phenolformaldehyde resins are somewhat to be preferred, in that they have been found generally to give more adherent films which are still readily soluble in the organics, it being noted, however, that with this latter class of resin, the film, after drying by the evaporation of the solvent, must not be heated to a point which will cause polymerization of the resin to any material degree, as this would render it insoluble and resistant to ultimate removal. It is obvious that a lacquer formed of any resin must have the property of wetting and adhering to the metal to which it is applied, but this, in some degree at least, is a property of all commercially available lacquers, whether the metal surface be water-receptive or ink-receptive. Obviously, the more adherent the lacquer the better will be the result.

Moreover, in choosing a lacquer for the purposes of this invention, better results are obtainable with those giving a matt finish than with high-gloss types. The former adhere better to both the metal and the colloidal coat and require less careful handling. Lacquers which will not adhere well to a smooth surface, however, will hold fairly satisfactorily to one which has been grained as zinc plates ordinarily are, and a high gloss surface lacquer may itself be abraded or grained to give better adhesion to the chromated layer. Such lacquers therefore are considered to come within the scope of this invention, even though the stickier products are greatly preferable.

From the above it should be evident that many modifications as to detail are possible in the practice of this invention. For purposes of illustration, however, one specific procedure will be described in detail, with possible modifications discussed more briefly thereafter. The specific procedure, and the various steps involved therein, are illustrated in the accompanying drawings, wherein:

Fig. 1 is a diagrammatic cross-section of a plate prepared for exposure, the photographic film transparency being indicated in place ready for a contact exposure; for clarity all dimensions are shown greatly exaggerated;

Fig. 2 is a similar cross-sectional diagram illustrating the step in the process wherein the portion of the chromated surface which has not been hardened is washed away, leaving the hardened gum over the lacquer coating;

Fig. 3 is a similar illustration of the step where the lacquer has been removed;

Fig. 4 is a diagrammatic illustration indicating the plating layers prior to the removal of the gum and lacquer stencils;

Fig. 5 is a like diagrammatic illustration of the completed plate, ready for printing;

Fig. 6 is a perspective diagram showing one mode of application of the plating;

Fig. 7 is a longitudinal cross-sectional view, and Fig. 7*a* is a transverse sectional view of an applicator as illustrated in Fig. 6, the electrical connections being shown schematically in Fig. 7;

Fig. 8 is an elevation, in semi-diagrammatic form, of a mechanical plating device adapted for use with the method of this invention; and

Fig. 9 is a cross-sectional view of the apparatus illustrated in Fig. 8, the plane of section being indicated by the line 9—9 of the preceding figure.

The preferred method of practicing the invention which has been chosen for detailed description utilizes, at the outset, a plate having a water-receptive surface. By a suitable modification of detail of the plating process any of the known metals having this characteristic may be employed, such as grained zinc, aluminum, nickel, stainless steel or chromium. Because of its durability and the consequent possibility to use the same plate repeatedly, one having a chromium surface is preferred, and since it is only the surface that is involved it is usually desirable to employ a composite plate wherein a metal base 1, usually of steel or zinc, is given an electroplated surface layer 3 of chromium. It is to be noted, however, that as long as the surface has the required characteristics the actual material is not important.

Starting, then, with a plate having the required surface characteristics, this plate is first coated with a thin layer 4 of lacquer. The requirements for this lacquer have already been touched upon; one that has been used successfully employs a phenol-formaldehyde, synthetic resin as a base. A number of such resins have been tried and found satisfactory in substantially the same formula, and with them have been combined various coloring matters to make the coating visible and render flaws in the coating more readily detectable. A suitable formula is as follows:

Bakelite resin BJ16320	gms	240
Waxoline red dye	gms	6
Oil soluble yellow dye	gms	6
Ethyl acetate solvent	cc	600

The basis of the Bakelite resin is phenol-formaldehyde, but it is modified with polyvinyl butyrol. Another resin which can be substituted in the same formula without other change is Bakelite resin No. 5363. As indicating the latitude in other materials of the formula, deep-etch lithographic ink has been used in place of the dyes specified. The ethyl-acetate, used as a solvent, is sufficient to dilute the original resin (which is of approximately the consistency of natural honey) so that it will flow or spray evenly and readily, and produce a uniform and continuous film.

If desired, the lacquer can be sprayed onto the plates. If it is applied in this fashion, the spraying must be carefully done so as to produce an even coating. In a lithographic shop, where sensitizing coatings are normally applied by pouring them on the center of a plate mounted on a whirling table, this latter method of applying the

lacquer coating as well is usually more convenient and satisfactory.

Owing to the extremely volatile nature of the solvent used the lacquered plate will air dry in a few minutes at room temperature. If heat is applied it should be very moderate because high temperatures will cause the lacquer to polymerize and become practically insoluble. Certain other resins, such, for example, as cellulose nitrate, are not subject to such polymerization, but since they are themselves highly inflammable (as organic solvents are also very inflammable) drying without the direct application of heat is always to be preferred.

The dried plate is next sensitized with any of the usual solutions used in lithographic or other photomechanical processes. These is a large and well-known list of colloids which, when treated by the addition of chromic acid or its salts, become insoluble when exposed to light. Among these are egg albumen, gelatin, and gum arabic. It is characteristic of this invention that any of these may be used. A convenient and satisfactory material is gum arabic, sensitized with sodium or potassium dichromate. Many formulas for such solutions are available in the literature on this subject. The sensitized colloidal coating is represented at **5** in Fig. 1. It may be applied on the spinning table in the same manner as the lacquer coating and dried in accordance with ordinary well-known practice.

The plate as thus prepared is then exposed through a photographic transparency made through a suitable halftone screen. This is indicated in the diagram by a film or pellicle **7** carrying a developed emulsion having opaque areas **9** and transparent areas **9'**. The opaque areas are shown as of substantially uniform size, alternating with equal size transparent areas, to indicate the dot structure of a halftone transparency. Since, in the illustrative case, the process started with a plate having a water-receptive surface, the transparency used carries a positive image; if the initial plate had had a surface of, say, copper, which is ink-receptive, a negative transparency would have been used. The dots which are dark in the transparency protect the underlying gum from light and leave it soluble, whereas those portions of the sensitizer lying beneath the transparent portions of the photograph are affected by the light and rendered insoluble.

After the exposure has been completed the transparency is removed and the image "developed" by washing in a suitable solution. This washing follows usual practice; e. g., a solution frequently used is as follows:

	Ounces
Calcium chloride stock solution	64
Lactic acid (85%)	3½

The plate is then rinsed and dried in precisely the same manner as though it were a deep-etch plate, but again, if the Bakelite resin is employed for the lacquer, the temperature should not be carried high enough to polymerize it.

The condition of the plate is now somewhat as is illustrated in Fig. 2. The metal base and its chromium surface are, of course, unchanged. The lacquer coating **4** is also substantially unaffected by the "development," but the chromated gum has been dissolved except where it has been hardened by the light, leaving merely disconnected dots **5'**. It will be recognized, however, that the section shown represents neither highlight nor deep shadow, but a halftone, and that in the highlight the gum dots will merge, while in deep shadows they will practically disappear.

The next step in the process is the removal of the lacquer film except where it is protected by the hardened gum image. Almost any organic solvent may be used for this purpose; denatured alcohol, ethyl acetate, ether, chloroform, or any of the commercial lacquer thinners or removers. Some of these solvents are more dangerous to health or unpleasant to use than others. A preferred lacquer solvent which is highly effective and yet contains a relatively small proportion of the highly volatile organic is as follows:

	Parts by volume
Lactic acid	90
Ethyl lactate	10

The plate is washed with this solution, the solvent action being facilitated by swabbing the surface with a soft swab while the washing takes place. This leaves the plate as illustrated in Fig. 3, with lacquer dots **4'** underlying each of the gum dots **5'**. There is thus a double stencil imposed upon the plate; an outer stencil of gum and an underlying stencil of lacquer. The entire coating, of both gum and lacquer, is only of the order of one thousandth of an inch or less in thickness. Where an ordinary lacquer solvent, such as alcohol, or alcoholic ester, is used, the plate, when air-dried, is ready for use; if the lactic-acid-ethyl-lactate solvent is employed the plate is next rinsed and is then ready for the plating operation.

The actual plating procedure depends in some degree upon the surface material. Long and well known practice has determined that different metals may be deposited satisfactorily under different conditions. Thus, for example, chromium can be deposited directly upon copper to form an adherent coating but the reverse process is not satisfactory; an intermediate layer, preferably nickel, must be deposited if the copper is to be adherent. Since, in the example here given, the surface upon which the ink-receptive metal is to be deposited is chromium, a flash coat of nickel is first deposited through the stencil, followed by the deposition of the final printing surface of copper or silver—usually, for economic reasons, of copper. As has been mentioned, brass can also be used as the ink-receptive surface.

In order to preserve the fine dot structure of the desired image the coating of ink-receptive material must be very thin but it must also be very complete. Gaps or "holidays" in the plate are fatal to satisfactory reproduction. On the other hand, the plating, while complete, preferably should not vary too greatly in thickness. The thickness of the plating on any elementary area of the plate is in direct proportion to the quantity of the electricity flowing to that point during the plating process, or, stated in another way, is proportional to the current density to that area multiplied by the time during which such current flows. The paths of current flow tend to follow the shortest paths between the anode (preferably of the metal which is being deposited) and the lithographic plate which forms the cathode. There is, however, a spreading out of the current paths between an exposed dot on the cathode and the wholly uninsulated anode, so that exposed portions of the cathode do receive some coating from more distant portions of the anode, although not so much as from the nearer portions.

If there is to be any image at all produced (as distinguished from a uniform background) the average current density will vary over the plate surface, being densest in the shadows and least in the highlights. In an actual plating cell the anode surface and the exposed portion of the cathode surface can each be considered to be at uniform potential. The drop in potential between these two surfaces may, in general, be divided into three portions; there is a drop at the anode surface, a drop at the cathode surface, and a resistance drop through the electrolyte itself. In any practical cell both the anode and the cathode drops are uniform and since both anode and cathode are at uniform potentials the drop through the electrolyte must also be uniform. Since the drop in the electrolyte along any filamentary path is equal to the resistance of that path times the current flowing in it, the current density along any path must be inversely proportional to the resistance.

There are an infinite number of paths from the anode

to any area of the cathode; of these paths the most direct has the least resistance while other more circuitous paths have increasingly greater resistance. The shorter the length of the direct path, and hence the lower the resistance per unit area of the electrolyte, the less will be the effect of the resistance of the electrolyte on the total current flow, the longer will be the relative lengths of the more circuitous paths and the more uniform will be the coating. With a thin layer of electrolyte between the anode and cathode there will be little tendency for the current to flow laterally with consequent undue building up of the thickness of the coating in the relatively small exposed portions of the plate in the highlights.

The second factor which may lead to non-uniform plating is the formation of bubbles on the cathode surface. If proper electrolyte formulas are used the formation of such bubbles by polarization should be practically eliminated, but nonetheless, bubbles may develop due to a number of causes. Because of the minute detail required for satisfactory lithographic production, the formation of one small bubble can ruin an entire plate. In large plating baths circulation of the electrolyte may prevent any bubbles that do form from adhering, but the shorter the electrolytic path the more difficult does such elimination become. To get uniform plating by ordinary tank methods, free from streaks due to unequal current distribution at the exposed areas of the cathode and also free from spots due to bubble formation, is therefore so difficult and the percentage of spoilages so great as to make the process uneconomical.

In accordance with the present invention, therefore, in its preferred form, no plating bath is used. Instead the plating is done with an applicator which applies the current, and hence the plating resulting therefrom, to only a small area at a time, and, preferably also, this area is substantially linear in form so that any spread of the current paths must take place almost entirely in one dimension, longitudinally of the applicator, instead of spreading out in all directions from the point of application. The applicator is moved constantly with respect to the surface to be plated, and contains the anode. The electrolyte is held in absorption by a fibrous blanket, the thickness of which determines the separation of the anode from the lithographic plate, holding this separation constant and permitting it to be relatively quite small. Owing to the constant relative movement between applicator and plate any bubbles which may tend to form are immediately removed mechanically. All portions of the plate, with the exception of those immediately under the applicator, are subject to inspection at all times and the formation of the coating may, with a little experience, be immediately judged by eye.

A very simple form of applicator is illustrated in Fig. 6, which shows in perspective its relationship to the lithographic plate when in use, the applicator proper being illustrated in longitudinal cross-section in Fig. 7, this latter figure also showing, schematically, the manner of connection.

Fig. 6 shows the plate **11**, illustrated in section in Fig. 3. On the plate is the applicator **13** provided with a handle **15** and a lead **17** which connects the applicator to a source of plating current (Fig. 7); the other lead **17'** from this source is shown connected to the plate by means of a clamp or contactor **19**.

The actual structure of the applicator itself is more fully shown in Fig. 7, and in lateral cross-section in Fig. 7*a*. It comprises an outer casing **21** of insulating material, conveniently illustrated as a plastic such as Bakelite, of elongated form and open at the bottom. Around its open edges it is provided with a soft rubber lip **23** which, when it is in use, serves as a squeegee which wipes off the electrolyte from the surface as the applicator is moved and retains the electrolyte within the applicator. A suitable retaining ring or spring clamp **24** serves to retain the lip **23** in place about the casing. The casing is provided with a central boss **25**, through which there passes a connector plug **27**. The casing may be provided with a funnel **29**, through which additional electrolyte may be introduced.

A contact plug **27** connects with an anode **31** of the metal which is to be used for the plating. Replaceable anodes may be used in the same applicator, but it is more convenient to provide one applicator wherein the anode **31** is of nickel and a second one having a copper anode. Ultimately, of course, all anodes have to be replaced since their substance is attacked by the electrolyte and deposited upon the surface of the plate.

Underlying the anode bar is a layer **33** of absorbent material. This may be of absorbent cellulose (e. g., blotting paper), felt, or even of fiber glass if the latter is not treated to be water repellent. Absorbent material may be held in place by a cover layer **35** of cloth—cotton, linen, or a synthetic fiber. Most of the latter fibers may be used, but rayon, because of its low tensile strength when wet, would not be the material of choice.

The connections to the applicator are illustrated diagrammatically in Fig. 7. The leads **17** and **17'** connect to a reversing switch **37** through which they may be connected, in either direction, to a current source **39**. Normally the switch **37** will be thrown to the left, connecting the positive terminal of the source **39** to the anode **31**, but if, for any reason, it is desired to remove the plated-on coating in order to correct errors which have occurred in any portion of the process the switch may be reversed, in which case the electrolytic process is also reversed and the previously applied plating removed. A rheostat **41** is preferably included in the plating circuit, permitting the control of the currents and potentials used and by adjustment of this rheostat the potential applied across the electrolytic cell formed by the lithographic plate and the applicator can be so adjusted that a copper or silver deposit is brought into solution electrolytically but the underlying chromium layer is not attacked. One reason for preferring the use of chromium as the underlying surface of the plate is that copper is more readily removed without attacking chromium than a reverse process. Erasures and corrections are therefore more easily accomplished when this procedure is used.

Except for its manner of application the plating procedure follows well-known practice as far as the solutions used, the potentials applied, and the order of metal deposition where multiple coats must be used in order to secure adherent coatings are concerned. As has been stated an intermediate flash coat of nickel is applied in order to secure the adherence of copper to a chromium undersurface. Suitable electrolytes for applying such coatings are described in the literature; any of these solutions may be used.

The applicator is moved uniformly and continuously over the plate until the entire surface of the latter has been traversed. The necessary potential for the plating is very small, of the order of only a few volts. Only enough nickel need be deposited to cover the surface completely; ideally a monomolecular layer would be sufficient.

Following the application of the nickel flash the actual printing surface of copper, silver, or brass is applied by means of a similar applicator. Again, plating solutions of standard composition are employed. Any solution that is suitable for vat plating may be employed in the present process.

Owing to the action of the squeegee edges of the applicator very little of the electrolyte is lost in the process. The strength of the solution is maintained by the anode going into solution but a small amount of the electrolyte does adhere to the surface. This may be made up, from time to time, by adding electrolytes through the funnel **29**. As the electrolyte is always absorbed by the layers of material in the applicator there is no danger of spilling or loss except when the electrolyte is poured in.

Usually the copper coating applied will be thicker than the layer of nickel. How thick it is made depends in some degree upon the number of impressions that will be required from the plate. Impressions may be obtained with a copper coating no thicker than that used for the nickel, since it is only the surface which is important, but if the number of impressions required runs into the hundreds of thousands or more there is some water involved and the joint thicknesses of the nickel and copper layers may be as much as one ten-thousandth of an inch.

The coating is so thin that there is no observable tendency for it to build out around the edges of the stencil. Owing to the almost perfect insulating nature of the resin coat, and its adhesiveness to the underlying metal, it does not penetrate beneath the lacquer stencil. Actually the colloidal stencil which overlies the lacquer has no function so far as the plating process is concerned and it could be removed prior to doing the plating, but it does form a mechanical protection for the lacquer as the applicator is moved over the surface of the plate and since it does no harm it is preferable to leave it in place until the plating process is complete. In this stage of the process the section of the plate is as shown diagrammatically in Fig. 4. Both lacquer and colloidal stencils are still in place as is indicated by the same reference characters as shown in the diagrammatic cross-sections previously described. The portions of the surface exposed between the stencil dots are covered, first by the nickel flash coat designated by the reference character **45** and the overlying copper layer **47**.

Following the plating, first the hardened gum over the stencil and then the underlying lacquer stencil are removed. The first of these processes is accomplished in the same manner as is used in the well-known deep etch process, soaking the plate in warm water and scrubbing with a bristle brush. If the stencil proves to be very adherent it may be further softened by the addition of citric acid to the warm water. A lacquer stencil is removed by any of the suitable solvents, e. g., the same as already described for use in developing the plate. The resultant plate is illustrated in Fig. 5, the non-image portions having the original water-receptive surface exposed, the image areas comprising the ink-receptive surface and underlying nickel flash superposed on top of the water-receptive base. It is to be remembered that the dimensions of the surface layers are enormously exaggerated in all of the diagrams; in practice, the chromium layer may be less than one thousandth inch thick and the overlying nickel and copper, silver or brass layers may be of the order of one ten-thousandth of an inch. In this state the plate is washed, dried, and is ready for printing.

Figs. 8 and 9 show a motor driven machine capable of providing the nickel and copper plating steps of the process herein outlined. This machine is equipped with an upper roller **51** and a pair of lower rollers **53** between which the lithographic plates are passed to provide the nickel or copper layer depending upon the electrolyte and anode metal employed. The rollers **53** may be comprised of copper or other suitable conducting material and are each carried by a pair of shafts **55** threadably secured to the rollers or extended therethrough. The shafts are conventionally mounted for rotation in bearings **57** carried by the frame legs **59** and **61** of the machine.

A motor **63**, preferably adjustable in speed, is provided with an electrical cord or means of attachment **65** and is supported from the frame leg **59** on the bracket **67** which is affixed to the leg through screws **69**. The motor **63** drives a pulley **71** through the shaft **73** to impart rotation to the rollers **53** through a belt or chain drive **75** engaging a pulley **77** fixed to one of the shafts **55** which is coupled to the other shaft **55** through a suitable chain and sprocket drive **79**. The rollers **53** serve as a connection to the photolithographic plate which acts as the cathode in the electrolytic process and, accordingly, the negative terminal of a source of direct current, such as a battery **81**, supported on a bracket **82** secured to the frame leg **61** by bolts **84**, is connected by means of the conductor **83** through slip rings (not shown) to one of the rollers **53**.

The roller **51** is supported by a shaft **85** which is hollow throughout its length with the exception of the right-hand end which is suitably plugged. The shaft **85** is supported by the frame through bearings **87** and **89** which are respectively located in the frame legs **59** and **61**.

The positive terminal of the battery **81** is connected by a conductor **91** through a reversing switch **93** to the shaft **85** through suitable slip rings (not shown). A tank **95** is supported on a bracket **97** which is bolted to the leg **59** of the frame by, for example, bolts **99**. A tube **101** leads from an opening in the bottom of the tank **95** to the hollow end of the shaft **85** where suitable coupling means are provided to retain fluid communication between the tank **95** and the shaft **85**.

A suitable electrolytic solution **103** is contained in the tank **95** and is allowed to flow through the tube **101** to the shaft **85** under the control of a stop cock **105**. This electrolytic solution may be one bearing either copper or nickel ions dependent upon whether copper plating or nickel plating is being employed at the particular time.

A suitable glass fiber or other highly absorbent material **111** is rather snugly fitted about a major portion of the roller **51** to serve as the electrolyte dispensing medium. The shaft **85** and the roller **51** are each provided with peripheral openings **112** beneath the absorbent material **111** to permit the electrolyte **103** to pass from the tank **95** into the shaft **85** and roller **51** and thus maintain the absorbent material **111** in a saturated condition at all times. A pin **113** is provided beneath the rollers **55** and **51** and is secured to the frame legs **59** and **61** respectively by the brackets **115** and **117** in a position to catch the excess electrolytic solution.

The operation of the device of Figs. 8 and 9 is similar to the operation as outlined in connection with the wiper **13** in that a limited area of contact, in this case also substantially linear contact, is presented through which the current passes in the electroplating process. Thus, the roller **51** may comprise a copper or nickel bar which serves as the anode in the electroplating process to augment the electrolytic solution with the proper anode metal during the periods that the reversing switch **93** is closed to apply a positive potential to the roller **51** in the manner described in connection with the device of Figs. 6 and 7.

The motor **63** is preferably provided with at least a high speed and a low speed so that the nickel flash or coating may be rapidly deposited and the copper plating step may take place over a longer period of time to permit the desired depths of copper plating to be obtained. It should be apparent that although a single machine will suffice to successively plate the nickel and copper it is necessary that the roller **51** and the electrolytic solution **103** be changed for the different metals. Accordingly, it is oftentimes desirable to employ two such machines, one for the nickel and one for the copper. However, in any event the machines are compact and need only be of dimensions commensurate with the size lithographic plate required and hence two such machines are not too bulky for a local lithographer's shop.

In connection with the device of Figs. 6 and 7, and that of Figs. 8 and 9, it should be noted that the reversing switches **37** and **93** are provided for reversing the potential applied between the anode and plate being operated upon. Accordingly, plates within the contemplation of the present invention may be reused, altered, or corrected by merely reversing the current to remove the metal incorrectly deposited (or which it is desired to remove) and then proceeding with the process as outlined to correct the plates or place then in condition for reuse. In the alternative, a solution of ferric chloride may be employed to scrub off copper incorrectly deposited to permit corrections and alterations of the plate.

Having now described the invention, what is claimed is:

1. A method of preparing a lithographic plate having at least a face wherein printing portions are of a metal having the characteristic of being ink-receptive and water-repellent and non-printing portions are of a metal having the characteristic of being water-receptive and ink-repellent, comprising the steps of applying to a plate having at least a surface of metal of one of said characteristics an electrically insulating coating of lacquer, superimposing a protecting coating of chromated colloid on the lacquer, exposing the so-coated plate to light modulated in accordance with an image to be reproduced to render light-exposed portions of the colloid insoluble to water, dissolving unexposed portions of the colloid to uncover underlying lacquer, dissolving the uncovered portions of the lacquer, progressively electroplating a metal having the other of said characteristics onto portions of said surface thus exposed through substantially linear elongated areas of contact between an electrolyte medium and said surface by continuously moving one of the plate and electrolyte medium while introducing mechanical rubbing of the plate and protecting coating of colloid coincident with plating action, and then removing the remaining portions of the colloid and lacquer coatings.

2. A method of preparing a lithographic plate having at least a face wherein printing portions are of a metal having the characteristic of being ink-receptive and water-repellent and non-printing portions are of metal having the characteristic of being water-receptive and ink-repellent, comprising the steps of applying to a plate having at least a surface of metal of one of said characteristics an electrically insulating coating of lacquer, superimposing a protecting coating of chromated colloid on the lacquer, exposing the so-coated plate to light modulated in accordance with an image to be reproduced to render light-exposed portions of the colloid insoluble to water, dissolving unexposed portions of the colloid to uncover underlying lacquer, dissolving the uncovered portions of the lacquer, applying an electrolyte of a metal having the other of said characteristics to an elongated narrow area while passing an electrical current therethrough to deposit metal from said electrolyte upon said surface and while constantly changing the area to which said electrolyte is applied by relative motion transverse to the narrow dimension of said area until the entire surface has been traversed, and then removing the remaining portions of the colloid and lacquer coatings.

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