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METHOD OF MAKING PHOTO ENGRAVING PLATE

Robert T. Hendrich and Dudley L. O'Brien, Jr., Cleveland, Ohio, assignors to The Wire Coating & Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

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From the very beginning of the acid etching type of engraving, the engraver has been plagued with the lateral action of the etchant. This action is referred to as undercutting. Many schemes and devices have been suggested as remedies for this problem, but until recently, one method alone has maintained its position of practical importance. The method referred to is called powdering or powder banking and is in essence the heart of the engraving process.

In practice the engraver etches the prepared engraving plate to a maximum depth as defined by the finest or most delicate details in the drawing or photograph. If this maximum depth is exceeded, excessive under-cutting takes place rendering the plate useless for stereotyping operations. Beyond this point the supporting structure of the character may be dissolved or so weakened that direct printing will cause it to separate completely from the base metal. The engraver must not, therefore, exceed this maximum depth. He must stop the etching process and powder bank the engraving in order to protect the finest details. This is done by dusting a finely powdered thermoplastic resin over the surface of the engraving and with a brush sweep the loose powder from top to bottom. This action banks the powder against the top edge of the relieved character. The engraving plate must then be heated to the fusing point of the resin and then cooled. The cooling is generally done with an air blower and then with cold water. The plate must then be dryed and powder-banked again from left to right. This protects the left side of the relieved character. The same process is repeated from right to left and from bottom to top. At this point the engraver is ready to etch the plate deeper. The second etch, or "bite" as it is referred to has its maximum depth limits, though somewhat broader, as did the preceding etch, or first "bite." If a third "bite" is to be taken, the powder banking operation must be again performed. The number of "bites" to be taken and consequently the number of powder-banks made is determined by the nature of the characters and the type of work for which the engraving is intended. Fine screen characters require relatively shallow engraving depths, heavy line engravings which are to be used for stereotyping must be deeply etched. Engravings intended for direct printing can have less depth than those intended for stereotyping. Direct printing on fine paper stock requires less etching depth than direct printing on coarse stock, etc. In essence, a great deal of skill and time is required to produce a commercial engraving by the standard methods.

Recently, a group of patents issued to Messrs. Easley and Swaze of which 2,640,766 is representative and which seek to solve this problem of undercutting by the inclusion in a nitric acid etching bath of a carboxylic acid or the esters or salts thereof. The functions of the addition agent is not fully explained by the patentees, however, the process of such patents is accompanied by many disadvantages and high cost of operation because in order to utilize it to any extent whatsoever, it is necessary to employ expensive machinery. In the utilization of the Easley-Swaze process, the plate to be etched is supported with its active face downwardly in an appropriate machine which contains the etching bath and which propels the etching medium at high velocity against the downwardly directed face of the plate. Any such process is quite expensive in that the machinery required for the production of a uniform product is complicated

and difficult to maintain. Moreover, the baths provided in said Easley-Swaze patents have very short shelf life since they degenerate in seven or eight hours whether used or not and furthermore a special hot top or burned in enamel is required. A further disadvantage to the Easley-Swaze process is that printing plates formed entirely of magnesium must be employed in order that the process may be successful.

It is a principal object of our invention to provide a process which eliminates undercutting and which is not only a full solution to the problem, but may be performed and carried out with a minimum of effort and at a minimum of cost.

It is a further and more particular object of the invention to provide a bath of the character described which is stable over long periods of time, relatively inexpensive, is not subject to becoming unbalanced in use and may be utilized on a variety of printing plates.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principal of the invention may be employed.

Broadly stated, the method of our invention may be described as the method of etching the surface of an acid-soluble metal object having local areas thereon masked with an acid-resistant coating which comprises supporting the object, with said surface thereon facing either upwardly or downwardly in an acidic bath which will corrode the unmasked portion of said surface and which bath contains a finely-divided solid which is insoluble in the bath, but which will for one reason or another, adhere to the work being corroded and actually build up at the junction between the masked and unmasked portions to prevent corrosive effect of the etching bath in those areas and accordingly prevent undercutting.

THE WORK OBJECT

The invention will be described in conjunction with the formation of printing plates, although it will be quite evident to those skilled in the art that our invention has a wider field of utility.

The present invention is applicable to a wide variety of work materials, that is, the metals or alloys from which the sheet or other object to be etched is formed. The present method finds application to printing plates made entirely of magnesium. In its most refined and commercially acceptable form, our method is preferably utilized in the preparation of printing plates from a composite sheet in which the body is magnesium or magnesium alloy and which has applied thereover a thin continuous layer of zinc. The subject matter of such a plate is described and claimed in our co-pending application, Serial No. 256,162, filed November 13, 1951, and therein are given processes by which such a plate may be satisfactorily produced. It is believed to suffice for the present description, to state that when a composite plate is used the base or major portion of the body is preferably magnesium or a magnesium alloy and the superficial coating of a thickness of not more than about .0008" is deposited thereon so as to be smooth, uniform and adherent.

When using a magnesium base alloy for the body of the sheet, generally best results will be secured if such alloy contains not more than about 5% of aluminum.

The plate whether it be of a single composition such as made entirely of magnesium or magnesium alloy or whether it be the composite type just described, will be prepared in the usual manner conventional in the preparation of plates of this kind. Such preparation will include the forming of a design on the plate whether by scratching or otherwise removing an acid-resistant barrier in local areas or the application of such a barrier in local areas only.

In any event this stage of the preparation of the plate

is conventional and forms no part of the present invention and, therefore, is believed need not be described in greater detail.

THE ETCHING BATH

The etching bath is preferably one which during its attack on the plate will form a precipitate which is insoluble in the bath and capable of being inductively charged. We shall presently give examples of baths which although quite different in composition nevertheless are both capable of forming such a precipitate.

While we thus prefer a bath which will form the precipitate in situ it is nevertheless within the contemplation of our invention to add to the bath a finely divided material which has the same properties described above requisite of the precipitate, namely that it must be an extremely finely divided form, it must be insoluble in the bath and preferably must be capable of being inductively charged. There are many natural gums and synthetic resins which adequately satisfy all of these needs and which, accordingly can be used for this purpose.

When pre-formed solid material in finely divided form is added to the bath, it will, of course be necessary to agitate mildly during the etching operation, inasmuch as such mild agitation is usually desirable for the purpose of insuring uniformity of effect of the etching acid and also to speed up the etching time or rate, the conditions which are otherwise maintained in the bath in carrying out our invention utilizing an added solid material are conventional to the processes currently in use.

As indicated above, however, the preferred embodiment of our invention utilizes a bath which will in situ form a precipitate as the etching operation proceeds.

Example 1

Aluminum nitrate (crystal)	11 oz.
Ammonium persulfate	2 lbs., 5 oz.
Water, sufficient to make	1 gal.

Various concentrations and ratios of aluminum nitrate to ammonium persulfate have been tried. As the ratio of nitrate to persulfate increases, the etching rate decreases. As the ratio decreases, i. e., the relative concentration of persulfate increases, the etching rate increases as does the rate of formation of the protective banking precipitate. The best weight ratio of aluminum nitrate to ammonium persulfate is about 1 to 3. Concentrations are workable from 5% total salts to saturation, but the more dilute solutions are slower working. The etchant has been used at temperatures ranging from 40 to 200 degrees Fahrenheit, but the most suitable range appears to be between 70 and 120 degrees Fahrenheit.

The following is another example of a bath which may be used successfully in carrying out our method:

Example 2

$KMnO_4$	.38 oz.
$HClO_4$ (70%)	4.00 fluid oz.
Water	To make 1 gal.

The baths referred to above which are each capable, when etching a magnesium base plate of forming a precipitate of the character referred to above may be used, as indicated, on sheets composed entirely of magnesium and magnesium alloys. When such a sheet is used, it is preferable to support the sheet in the bath with its surface to be etched facing upwardly so that as the precipitate is formed during the etching operation, it will settle onto the work face. Because the chemical action decreases in intensity toward the areas where the surface of the plate has been masked, the precipitate as it settles has been found to have a tendency to collect at the point of juncture between the area to be etched and the area which has been masked and this piling up continues as the etching depth progresses so that there is, in effect formed in situ, a powder-bank like that referred to previously as being produced manually.

As indicated above, our method finds its greatest usefulness in the preparation of printing plates made from a magnesium base sheet to which has been applied a thin uniform adherent layer of zinc. When such a plate is used, it is best to first subject the masked or otherwise properly prepared plate to a short etch of a conventional nitric acid bath which will be sufficient to remove substantially all of the zinc in the unmasked areas of the plate. The plate is then rinsed off and placed in a tray or tank of the type of bath referred to above which may be used in practicing our invention. When the base plate is thus formed of magnesium, and the plate has a coating thereon of zinc, there is provided a two-component system establishing a primary cell having a potential of about 1.58 volts. As the precipitate which may be inductively charged is formed, it is electrostatically attracted to the juncture line or the area of these primary cells and caused to bank in the same manner that powder banking has been accomplished manually.

By having reference to the bath of Example 1, it will be noted that the primary function of the ammonium persulfate is that of an oxidizing agent, and the precipitate formed in this bath is aluminum hydroxide.

In the case of zinc on magnesium, oxidation substances other than ammonium persulfate may be used, as for example the sodium, potassium, or aluminum persulfates, the peroxides, the perborates, permanganates, etc. The protective precipitates may be derived from manganese, aluminum, uranium, beryllium, or metals in the electromotive series situated between zinc and magnesium. Also included are complexes, compounds both organic and inorganic which have oxidation potentials in this interval.

As the surface coating becomes more noble, as for example cadmium on magnesium, copper or cadmium on magnesium, etc., the possible number of oxidizing agents and protective precipitates increases. As the base metal becomes more noble the number of possibilities decreases, as does the etching rate.

It should be noted that whereas when operating on a plate composed entirely of magnesium so that the primary cell action is not present, it is practically necessary under all circumstances to support the printing plate with the surface to be etched facing upwardly in the printing bath so that the precipitate as it forms may settle on the plate. When, however, using a composite plate such as a magnesium plate coated with zinc, it is possible to carry on the self-banking etching method of our invention by having the face of the plate extending downwardly since the galvanic action will hold the self-banking precipitate on the plate.

The etching rate increases rapidly with increasing temperature, but the protective bank has a tendency to dislodge itself at the higher temperature levels.

The etching bath has been used successfully in standard equipment, and the ordinary cold-top enamels are suitable resists for the etchant. The etching chemicals themselves are quite stable, and have stood for several days without any apparent breakdown. By the protective banking action of the etchant any etching depths are possible, thus permitting the engraver to handle all types of work from fine screen half-tones to line drawings, or combinations of both.

The etching baths of our invention may be used in conventional type etching machines and it is found that at the end of 20 to 40 minutes depending upon the temperature of the bath, the plate will have been etched to a depth suitable for direct printing or stereotyping, as for example, from about 20 to 30 thousandths of an inch. The etching rate is considerably increased when vigorous agitation is employed as in the case of a standard splash-type etching machine. More control is possible under these conditions also, for premature fill-in of the half-tone areas can be prevented.

The principles of our invention are applicable to the etching of a wide variety of materials in addition to those referred to above merely as illustrative examples. It is thus within the contemplation of our invention to apply our methods to objects made of all types and kinds of acid-soluble metals and alloys such as iron, stel, copper, tin, magnesium, zinc and the like as well as non-metallic objects such as those formed of glass, enamel and the like.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. The method of etching the surface of a metal object having local areas thereon masked with an acid-resistant coating and simultaneously banking the sides of the relieved portions of the etched surface to protect them against undercutting which comprises contacting such partially masked surface with an acidic aqueous medium

which will corrode the unmasked areas of said surface and thereby create an electrical potential across the interfaces between the masked and unmasked portions of said surface, providing in said solution a hydrosol and continuing said contact of acidic medium with said surface in the presence of said hydrosol to form a precipitate at said interfaces creating a bank to protect said relieved portions from undercutting.

2. The method of etching a printing image in a metal printing plate having local areas thereon masked with an acid-resistant coating and simultaneously banking the sides of the relieved portions of the etched surface to protect them against undercutting which comprises contacting said partially masked printing plate with an acidic aqueous medium which will corrode the unmasked areas of the plate and thereby create an electrical potential across the interfaces between the masked and unmasked portions of said plate, providing in said solution a hydrosol which is insoluble in said acidic solution, and continuing said contact of acidic medium with said plate in the presence of said hydrosol to form a precipitate at said interfaces creating a bank to protect said relieved portions from undercutting.

3. The method of etching a printing image in a bimetallic printing plate comprising a base metal sheet and a metal surface coating having local areas thereon masked with an acid-resistant coating and simultaneously banking the sides of the relieved portions of the etched plate to protect them against undercutting which comprises contacting said partially masked printing plate with an acidic aqueous medium which will corrode the unmasked areas of the plate and thereby create an electrical potential across the interfaces between the masked unetched surface coating metal areas of the plate and the unmasked etched base metal areas, providing in said solution a hydrosol which is capable of being inductively charged with a polarity which will cause the hydrosol to be preferentially attracted to said electrically charged interface areas of the plate, and continuing said contact of acidic medium with said plate in the presence of said hydrosol to form a precipitate at said interfaces creating a bank to protect relieved portions of the plate formed by the etching process from undercutting.

4. The method of forming a printing plate which comprises providing a metal plate having a surface thereof coated with a metal which is lower in the electromotive force series of metals than the metal of the base sheet, forming an image thereon of local areas masked with an acid-resistant coating, contacting said partially masked plate with an acidic aqueous medium which will corrode the unmasked areas of the plate and thereby create an electrical potential across the interfaces between the masked and unmasked portions of said plate, providing in said solution a hydrosol which is insoluble in said solution, and continuing said contact of acidic medium with said plate in the presence of said hydrosol to form a precipitate of the hydrosol at said interfaces creating a bank to protect relieved portions of the plate from undercutting simultaneously with their formation.

5. The method of claim 4 wherein said hydrosol is provided in said solution by adding a preformed hydrosol thereto prior to said contact of the solution with the plate.

6. The method of claim 4 wherein said hydrosol is provided in said solution by dissolving in the solution prior to contact of the solution with the plate an inorganic salt the cation of which is a metal having a position on the electromotive force series of metals between said metal of the base sheet and the metal forming said coating.

7. The method of claim 2 wherein said plate is a monometallic plate.

8. The method of claim 2 wherein said plate is a bimetallic plate.

9. The method of claim 4 wherein said plate is supported with the masked surface thereof facing upwardly during said contact of the plate with the acidic solution.

10. The method of forming an etched printing plate without need to manually bank the plate which comprises providing a bi-metallic printing plate consisting of a base metal sheet and a metallic coating thereon of a metal which has a position in the electromotive force series of metals below the metal of the base sheet, providing an acidic solution which will corrode said base metal of said plate containing the inorganic salt of a metal which has a position on the electromotive force series of metals between said metal of said base sheet and said metal of said metallic coating and which forms a water insoluble hydroxide, forming an image thereon of local areas masked with an acid-resistant coating, removing said surface metal coating from the unmasked areas of said plate, contacting said partially masked plate with said acidic solution and thereby create an electrical potential across the interfaces between the masked and unmasked portions of said plate, continuing said contact of said acidic medium with said plate whereby a hydrosol comprising the metal of said dissolved salt is formed in said solution adjacent said interfaces which precipitates at said interfaces creating a bank to protect relieved portions of the plate from undercutting simultaneously with their formation.

11. The method of etching a printing image in a bimetallic printing plate comprising a base sheet consisting principally of magnesium metal and a surface coating consisting principally of zinc metal having local areas thereon masked with an acid-resistant coating and simultaneously banking the sides of the relieved portions of the etched plate to protect them against undercutting which comprises contacting said partially masked printing plate with an acidic aqueous medium which will corrode the unmasked areas of the plate and thereby create an electrical potential across the interfaces between the masked unetched zinc coating areas of the plate and the unmasked etched magnesium metal areas containing dissolved therein an aluminum salt, and continuing said contact of acidic medium with said plate whereby an aluminum hydroxide hydrosol is formed in the medium adjacent said interfaces and is electrostatically attracted to said interfaces forming a precipitate at said interfaces creating a bank to protect relieved portions of the plate formed by the etching process from undercutting.

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