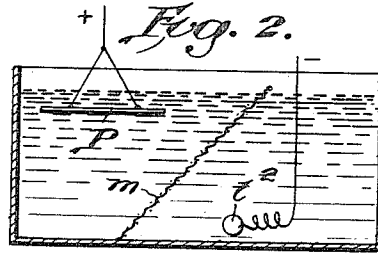
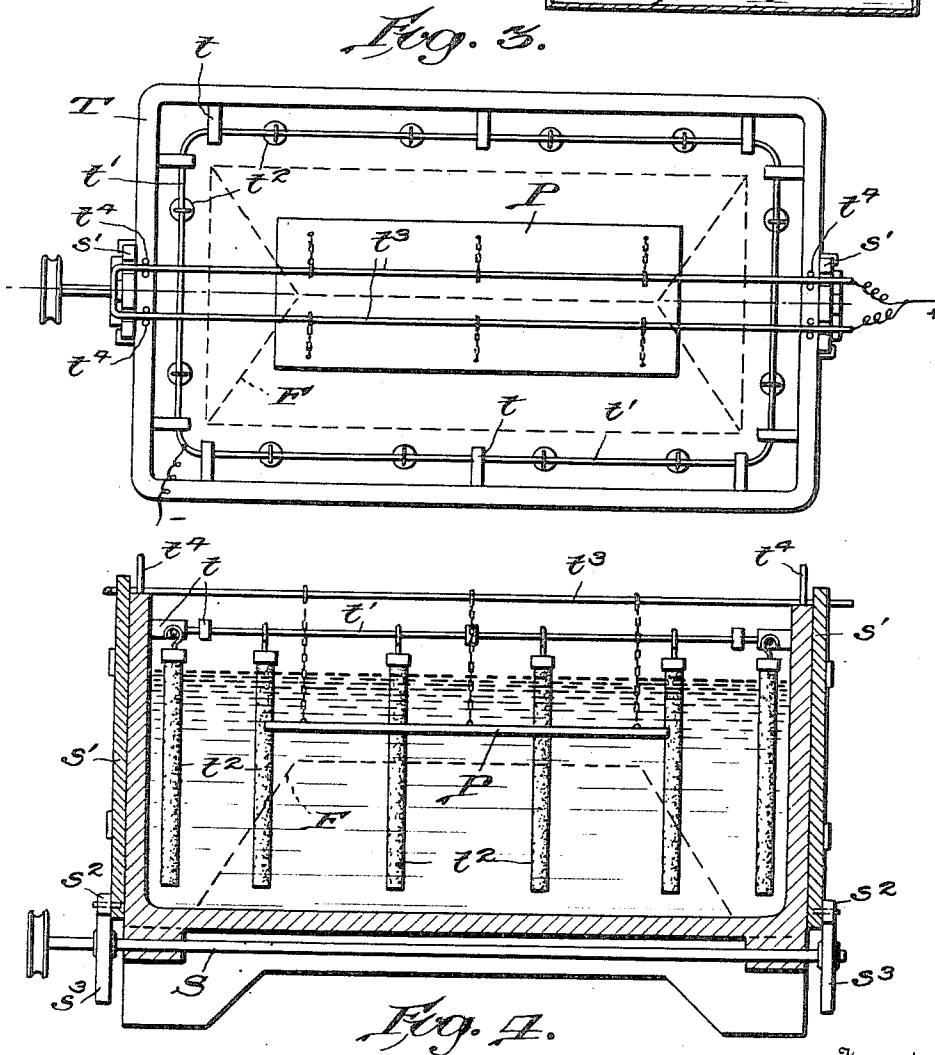


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2 SHEETS--SHEET 1.



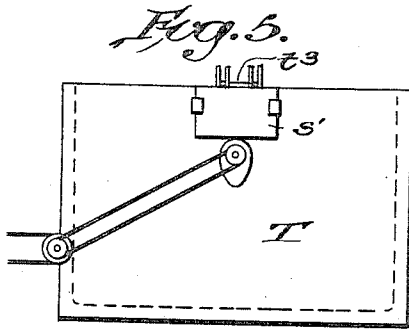
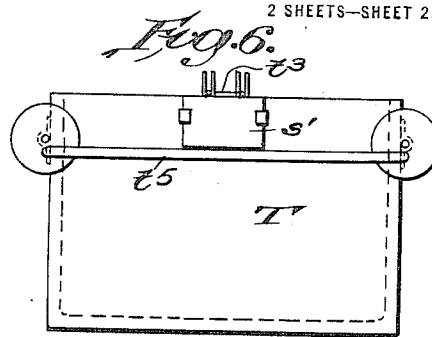
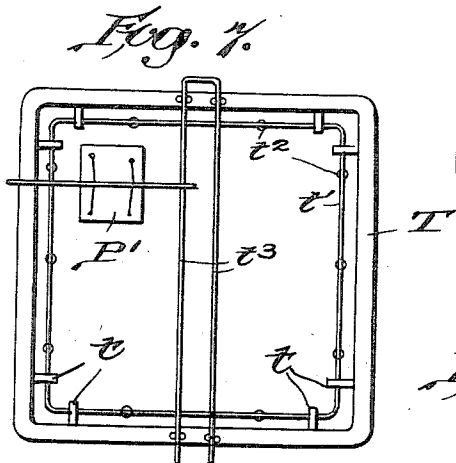
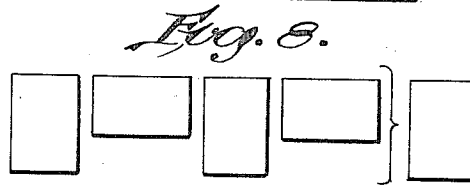
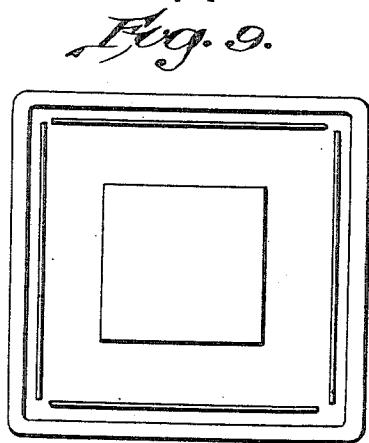
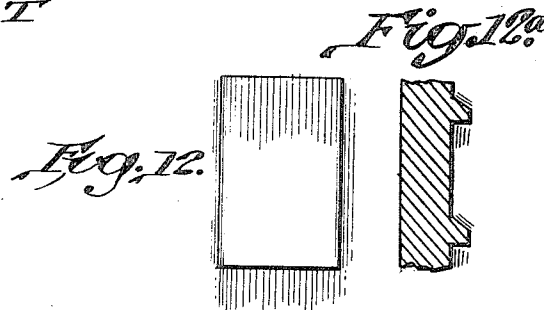
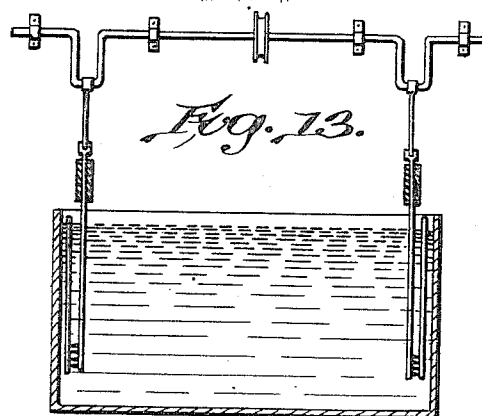
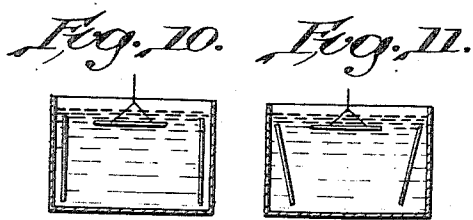
Inventor  
Joseph H. Weeks  
By Edward E. Clement  
Attorney

J. H. WEEKS.  
PROCESS OF AND APPARATUS FOR ETCHING.  
APPLICATION FILED APR. 1, 1916.

1,276,599.

Patented Aug. 20, 1918.

2 SHEETS—SHEET 2.



Inventor  
Joseph H. Weeks,  
By *Edward E. Chinn*

Attorney

# UNITED STATES PATENT OFFICE.

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## PROCESS OF AND APPARATUS FOR ETCHING.

1,276,599.

Specification of Letters Patent.

Patented Aug. 20, 1918.

Application filed April 1, 1916. Serial No. 88,362.

*To all whom it may concern:*

Be it known that I, JOSEPH H. WEEKS, a citizen of the United States, residing at Rutledge, in the county of Delaware and State of Pennsylvania, have invented certain new and useful Improvements in Processes of and Apparatus for Etching, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to electrical etching, and has for its object the improvement of existing methods of etching in the manner hereinafter stated.

My invention is applicable to either of the two classes of printing plates known as relief and as intaglio, respectively, and by it plates of either class may be produced either for direct use in printing, or for making transfers which thereafter by any suitable method may be caused to reproduce pictures, illustrations, designs, etc. The invention is also useful in the production of plates for other purposes than printing, and is not limited to any particular metal, being applicable among others to copper, zinc, brass, steel, and various alloys of metals.

Very generally stated, my improved method comprises the following principal steps: (1) coating a metal plate with a solution sensitive to light; (2) exposing the same photographically; (3) washing the plate to clear away the unexposed portions of the film or coating, in the case of some metals, owing to the character of the electrolyte to be subsequently used, immersing the plate in a special hardening solution; (4) drying the plate; (5) heating the plate to a temperature sufficient to bake or enamel the image on the metal; (6) coating the back of the plate with an insulating material; and (7) electrically etching the enameled image on the plate by suspending it in an electrolytic solution and passing current through it as the anode or positive terminal of the source of current through the electrolyte to one or more cathodes connected to the negative terminal of the source, so as to carry away metal from the plate being etched.

In practising this method there are a number of subordinate and ancillary steps to be followed, as well as many details to be observed, all of which I shall endeavor to dis-

close hereinafter in accordance with the terms and provisions of Sec. 4888 of the Revised Statutes of the United States.

In practising this method, I have found it convenient to make use of certain forms of apparatus, and in the description it will be desirable to present certain diagrams to illustrate certain operations which take place. This apparatus and the said diagrams appear in the accompanying drawings in which—

Figure 1 is a diagram indicating on a greatly enlarged scale the substantial difference between an etched plate as ordinarily produced by electrical etching and the etched plate produced by my method.

Fig. 2 is a sectional diagram showing a screen interposed between the anode and cathode to prevent the passage of sludge to the anode.

Fig. 3 is a plan view of a tank with a plate suspended therein, face down, and cathodes hung vertically upon wires along the sides and ends of the tank.

Fig. 4 is a longitudinal view of the same partly in section, showing cams and slides for raising and lowering the plate in the solution while etching.

Fig. 5 is an end view showing another form of cam arrangement and driving mechanism for moving the plate up and down.

Fig. 6 is an end view of still another arrangement of mechanism for raising and lowering the plate.

Fig. 7 is a diagram showing a modified arrangement for supporting a small plate while being etched so as to bring it nearer to the cathodes with consequent saving in current.

Fig. 8 is a diagram showing the cumulative value of the effect on each of the four edges of a plate suspended vertically in the electrolyte, and having its position changed periodically so that each edge rests in each of the four positions one quarter of the total time.

Fig. 9 is a diagrammatic plan view of a tank with the anode plate suspended face downward and the cathodes suspended vertically and extending almost completely around the inside walls of the tank and thereby almost entirely surrounding the body of the electrolyte between the anode or anodes and themselves.

Fig. 10 is a similar diagram showing a tank in section, with the cathodes vertical.

Fig. 11 is a similar diagram showing the cathodes inclined.

Fig. 12 is a diagram suggesting by shade lines the action of gravity on a vertically suspended plate.

Fig. 12<sup>a</sup> is a fragmentary sectional view of a plate very much enlarged, showing how the underside of lines are etched clean and sharp.

Fig. 13 is a vertical sectional view of a tank with vertically suspended cathodes around the inner walls, brushes adapted to move up and down over the faces of said cathodes, and a motor driven shaft having cranks connected to and moving said brushes as the shaft revolves.

In the production of printing plates there are two kinds, known respectively as line plates and half-tone plates. Line plates are the reproduction of any drawing or print, or any subject where the original copy consists of white and black portions, such as a proof of a type form, sample of handwriting, pen, or pencil, or crayon, or stipple drawings, or drawings made with mechanical shading devices, or any copy which permits of the making of what is known as a line negative, that is to say a negative consisting solely of uniformly clear and uniformly opaque portions. Half tone plates are the direct reproduction of objects or of drawings, prints, photographs, etc., photographed through a screen composed of crossed lines, grains, stipples, or a single set of lines. The negative made through such a screen is known as a half tone negative.

For the production of intaglio printing and embossing plates in line work where the sunken portions of the plate are to correspond with the black portions of the copy, a positive must be made from the line negative. This also applies to the production of relief plates where the result desired is a reversal of the effect of the drawing, that is, where the black portions of the drawing are required to be the white portions of the print made from the plate.

Where, however, an embossing or reverse plate is to be made from a line plate or type form, or other similar subjects, from which a proof on transparent or semi-transparent material can be made, this proof can be used as a substitute for a positive in making the photographic image on the plate. For the production of intaglio printing plates in half tone two methods of securing the positive are in use: (1) The making of an ordinary photographic negative without the use of a screen and then photographing such negative through a screen, as previously described, which of course produces a half tone positive, and (2) the making of a half tone negative through a screen and subsequently

photographing that to produce a half tone positive. There is also what might be termed a third kind of plate, which consists in parts of both line and half tone negatives combined, either by duplicate exposures with and without the screen, by employing masking out methods or by stripping together of various line negatives or positives and various half tone negatives and positives, either or all onto one glass plate as the case may require. These are known as combination plates. I have designated these classes and kinds of plates so that I might refer to them herein as "line," "half-tone," "combination," "relief" and "intaglio" negatives, positives or plates.

In the production of any plate as described, whether for printing purposes or other useful or decorative purposes, where the same are etched by electricity, and where the image on the plate to be etched is produced by photographic means, all other inventors and users of other methods known to me have found it necessary, before etching, to reinforce the insulating or resisting materials, on which the image is first obtained or formed by photographic action. The most practical of these methods involves a double reinforcement, making a triple coating on the plate, to wit, (1) the sensitized material which is acted upon by the light, (2) the subsequent ink coating, and (3) the final application of resinous or other powder. An examination of such reinforced prints in fine work will show a lack of smoothness on the edges and a lack of clearness and sharpness of minute detail. Where the latter is very fine and close together, in some cases a complete loss occurs through the filling over action of these various layers and the melting on of the powder, constituting the final application. The reinforcement of such images also involves additional time. In my method I employ what is of extreme importance in the production of electrically etched half tone plates, or half-tone portions of combination plates, for either class of printing, an insulating or resisting image composed of a single film which remains upon the plate during and after the operation of etching and proving, and which is not affected thereby and is absolutely smooth and has a practically negligible thickness, and is insoluble in benzin, turpentine and diluted acids or other chemical etching fluid, such as a solution of perchlorid of iron, nitric acid, etc. When the plate is presumed to be fully etched a proof on paper may be taken for examination, and if the effect produced indicates that the entire plate must be etched more, the ink of proving can be quickly washed off, as with benzin or other cleaning fluid, and the traces removed with a cleaning acid, such as a dilute solution of

muriatic acid, or a solution of acetic acid  
 with chlorid of sodium, etc., so as to remove  
 any light film left from the cleaning off of  
 the ink and any film caused by exposure to  
 the atmosphere. During all of this the  
 image film remains intact, and the plate  
 may then be subjected to further etching  
 by electrical means, or, if desired, some  
 parts may be stopped out with shellac dis-  
 solved in alcohol or other suitable resistant  
 material to prevent further etching in such  
 parts; but such stopping out may only be  
 successfully employed where the portions  
 stopped out and those portions desired to  
 be further etched have well defined edges  
 existing between them. Otherwise a de-  
 cided and unnatural demarcation would take  
 place in the final plate between such por-  
 tions. The proof, after the first etching,  
 or subsequent etchings (except in newspa-  
 per work), in practically every case in half  
 tone, or the half tone portions of combina-  
 tion plates for relief or intaglio purposes,  
 will indicate that some hand chemical etch-  
 ing is necessary in certain portions to pro-  
 duce the most artistic results, so as to lighten  
 effects in such portions in relief plates, or  
 darken in intaglio plates, and in these por-  
 tions where there is not a definite edge or  
 line of demarcation between, but which  
 might be termed a blending from lighter  
 portions to a darker tone. This hand etch-  
 ing by chemical means is of prime impor-  
 tance in the finishing stages of all fine half  
 tone work and is termed reëtching. It is  
 therefore of great importance that the ma-  
 terial of which the image consists be capable  
 of resisting the action of both electrical and  
 chemical etching, and such an image I em-  
 ploy. The image which I produce fully  
 withstands the electric etching, and is after-  
 ward capable of being successfully chemi-  
 cally reëtched and is unharmed by proving  
 operations.  
 A half tone plate containing an image  
 reinforced with ink, or with ink and any  
 of the known powders, is not capable of be-  
 ing locally hand etched to produce the effects  
 demanded for high grade work, on almost  
 all half tone plates for other than newspaper  
 work. Where it is indicated that a further  
 etching of such an ordinary plate is desir-  
 able, it becomes necessary with the rein-  
 forced image methods to restore the image  
 which had to be removed for the purpose of  
 proving, by a tedious method of rolling up  
 with fatty ink and reinforcing with some  
 kind of insulating powder which must be  
 melted thereon. In applying the powder at  
 this stage, it is extremely difficult, and in  
 some cases impossible, to brush or blow it  
 out of the very small openings. If, however,  
 these are not entirely free of such powder,  
 the further etching of such openings will be  
 prevented, and a spotty or mottled effect

will be produced in the printing from such plate.

In line plates or what is known as line  
 portions of combination plates, after a cer-  
 tain depth is attained, which is technically  
 termed (in chemical etching), the "first  
 bite" or "first etch," powdering with resinous  
 or waxous powder is necessary. A variety  
 of such powders have been in use, for a long  
 time, by photo-engravers and others em-  
 ploying acid chemical means, to prevent the  
 thinning of the lines by side etching, which  
 would soon be followed by under cutting,  
 or under etching of the lines, and if carried  
 to an extreme degree, would necessarily take  
 the line away entirely, or if only to a slight  
 extent, would interfere with the duplication  
 of the plate by electro-typing or stereotyp-  
 ing. To prevent side etching and thinning  
 of the lines after having obtained a certain  
 depth; reinforcing the side of the lines must  
 be done in four directions, whether the plate  
 be etched electrically or chemically, and this  
 I must therefore do in my electrical etching  
 method, although I am able to obtain a  
 greater depth before this becomes necessary  
 than is possible in chemical etching. The  
 procedure is, after covering the plate with  
 a waxous or resinous powder, such as dragon  
 blood or a powder composed wholly or in  
 part of asphaltum, to constantly brush the  
 powder in one direction to bank the same  
 on one side of each of the lines, this being  
 continued until the surplus powder is cleared  
 from the intervening spaces. The plate is  
 then heated to melt the powder and insure  
 its adhering to the plate. The operation of  
 powdering and each time heating is re-  
 peated three times, or until the powder has  
 been brushed in four different directions,  
 and heated after each brushing, that is,  
 from the top to the bottom; from the bottom  
 to the top; from left to right; and from  
 right to left; (but not necessarily in this  
 order). It may readily be seen that in very  
 small spaces, such as between lines that are  
 approximately one fiftieth of an inch  
 apart, the powder entirely fills the opening  
 and this receives no further etching after  
 the first etching, so that the depth of the  
 plate in such fine portions, therefore, de-  
 pends entirely upon the first etching. Here-  
 in I claim great superiority owing to the  
 fact that my plate is 50% to 100% deeper  
 than the old plates before the necessity for  
 powdering arises.

After powdering more or less of a shoul-  
 der is produced, hence by getting my plate  
 so much deeper in the first etching, the pos-  
 sibility of shoulders on the sides of the lines  
 near the printing surface is entirely ob-  
 viated. Shoulders it may be added increase  
 the difficulty of printing any plate.

Referring to the drawings, I shall first  
 briefly describe the apparatus illustrated

therein, and then proceed to set forth in detail the steps in operation of my process.

In Fig. 1, A shows roughly in section on a greatly exaggerated scale the effect of electrochemical etching by the ordinary methods. The depth of the etch or bite is not uniform, and the breadth of the face portions is reduced. On the other hand the section indicated by B shows on an exaggerated scale the approximate results of my process.

Figs. 3 and 4 show the form and arrangement of a tank T and appurtenances for carrying out my processes. In these figures, projections  $t$  on the inside of the tank carry a wire or rod  $t'$  extending around the entire inside of the upper part of the tank and having an extension terminal connected to the negative terminal of the source of current. My cathodes  $t^2$ , consisting preferably of carbon rods provided with metal caps and hooks at their upper ends, are hung from this wire. In Fig. 3 twelve of these cathodes are shown, but the number is immaterial, so long as their combined surface is greater than the surface of the anode or plate to be etched. A liberal allowance in this respect is productive of good results. The anode or plate is shown at P, suspended face downward from a pair of rods  $t^3$ , consisting of copper wire bent in U-shape at one end, and connected at the other to the positive terminal of the source of current, which is preferably a dynamo of low voltage, but may be any convenient and suitable source.

I find that a considerable advantage is attained by moving the plate slowly up and down in the liquid during the progress of the etching. When a large quantity of solution is employed, the motion can be dispensed with, but I consider it very desirable to thus gently agitate the anode. Mechanism for producing this motion of the plate is shown in Figs. 3 and 4 and modified forms thereof in Figs. 5 and 6. In the first two figures, I show a shaft S beneath the tank, with its ends journaled in bearings secured thereto, provided with a pulley  $s$  at one end for attachment to any suitable driving means. Vertical slides  $s'$  are provided on the ends of the tank which at their upper ends carry the wires or rods  $t^3$  and at their lower ends are slotted to slide up and down on the shaft, with roller bearings  $s^2$  resting upon the surface of rotary cams  $s^3$  on the shaft. As the shaft rotates, the cams  $s^3$  raise and lower the rollers  $s^2$  and the slides  $s'$  to which they are attached, thereby raising and lowering the wires  $t^3$ , which play between guides  $t^4$  in the top of the tank. In Figs. 5 and 6 I have shown modified forms of motion for this vertical agitation, the shaft in Fig. 5 being mounted on the side of the tank and carrying cams which work directly on blocks carrying the wires

$t^3$ ; while in Fig. 6 is shown a form of parallel motion, a pair of pulleys mounted at each end of the shafts running along the opposite sides of the tank, carrying a connecting rod  $t^5$  having its ends pivoted on eccentric wrist pins on both pulleys so that it is raised and lowered as the pulleys rotate, communicating the motion moreover from the driving pulley to its mate. Other devices for imparting motion to the anode may of course be employed.

I consider it novel and original with me to arrange the cathodes in the manner described so as to permit an even distribution of the current in all parts of the bath. I have hitherto worked upon the generally accepted theory that the anode and cathode must face each other in parallelism so that the passage of current from one to the other through the bath should be in line as nearly normal to both surfaces as possible; but experience has shown me that this is unnecessary, provided that the points of sufficient surface and even distribution of current are taken care of.

The cathodes  $t^2$  which I have used successfully are ordinary round carbon pencils similar to those used in arc lamps. Other shapes and material can be used but I find these the most satisfactory. In practice the operator should have a bunch of these carbon pencils at hand with wire hooks attached, because the cathodes in the bath collect sludge, becoming coated therewith; and as this occurs the operator lifts out the coated pencils, throws them in a bucket of water, and hangs on clean ones, the change of an entire set requiring in this way less than half a minute. The fouled carbons may be thoroughly cleaned by slight wiping.

In order to retard the collection of sludge, and prevent the same from falling into the bath, and perhaps being carried to the anode, I provide small cheesecloth bags and hang these in the bath, either as screens for all the cathodes, or as individual inclosures therefor. A screen of this general character is shown in Fig. 2. When such an electrolyte is employed that hydrogen is liberated at the cathode, I place the cathode slightly above the bottom of the tank, and then place between it and the anode plate a screen—preferably of muslin, although it may be of other material not too dense—to guide the bubbles of hydrogen away from the anode. Otherwise these bubbles adhering to the face of the anode have a tendency to cause irregularity in etching. In Fig. 2 P is the anode and  $n$  represents the muslin or cheesecloth screen. This screen must be of such a character as not to possess insulating qualities and not to interfere with the free passage or flowing of the electrolytic solution. In an electrolyte where a heavy coating of sludge forms on the cathode plate,

which would loosen and float around the bath when even slowly agitated, with danger of adhering to the anode plate, or at least necessitating the filtration of the electrolytic solution—I surround the cathode loosely as in a bag, with a material such as thin muslin or a couple of thicknesses of cheesecloth which catches all of said coating or sludge, and which neither insulates the electrodes nor prevents the passage of the solution. I should also observe that where considerable excess surface is given to the cathodes they do not coat so quickly, and the accumulation of sludge does not require such frequent removal. As a matter of fact, in some electrolytes the cathodes do not need cleaning at all. For the solution or electrolyte in the tank, I may employ any one of a number of formulas, all well known to those skilled in the art. The regular electrotypers' formula so-called, consists of sulfate of copper dissolved in water to make a solution testing 10 on the Baumé hydrometer, with sufficient sulfuric acid added to bring the hydrometer test to 15. This may be used, but I prefer certain formulas of my own, which I shall now state and shall hereinafter claim as a part of my invention.

Solution No. 1: Dissolve calcium chlorid in water until the solution registers from 5 (with heavy Baumé hydrometer) to a point of almost saturation. This solution can be used alone, but preferably I add one of the following acids or combinations thereof: Nitric, hydrochloric, chromic, citric, salicylic, formic or acetic. Other acids may be employed if desired. The proportion of acid as well as the strength of calcium chlorid vary with the character of the work to be done. It is obvious that with the stronger acids, a smaller quantity thereof is required; and the stronger the calcium chlorid solution, the larger the amount of acid which may be employed. These acids increase the conductivity of the solution, which also varies with the strength of the chlorid solution. The acids also serve to keep the face of the anode clean and bright.

Solution No. 2: This is made according to the foregoing formula, following the same remarks, but substituting sodium chlorid (common salt) in place of calcium chlorid.

Solution No. 3: This solution is made in exactly the same way and according to the same directions as No. 1, but ammonium chlorid (sal ammoniac) is substituted for the calcium chlorid.

Solution No. 4: Dissolve sodium chlorid in water until the solution tests 5 to 20 Baumé, and combine in proper proportions a solution of ammonium chlorid of from 5 to 20 Baumé, adding any of the above named acids until the desired conductivity and effect on the anode are produced. In this solution, it is not advisable to carry the

strength of the initial chlorid solution beyond 20 Baumé, as acid is to be added.

As illustrations of solutions produced by these formulas, I may note the following:

|                                      |           |
|--------------------------------------|-----------|
| No. 1. Calcium chlorid in water to   | 70        |
| Baumé test 20-----                   | 1 gal.    |
| Hydrochloric acid C. P-----          | 1½ oz.    |
| No. 2. Ammonium chlorid in water     |           |
| to Baumé test 20-----                | 1 gal. 75 |
| Sulfuric acid-----                   | 1 oz.     |
| No. 3. Sodium chlorid in water Baumé |           |
| test 20-----                         | 1 gal.    |
| Sulfuric acid C. P-----              | 1¼ oz. 80 |
| No. 4. Sodium chlorid in water test  |           |
| 15-----                              | ½ gal.    |
| Ammonium chlorid in water            |           |
| test 15-----                         | ½ gal.    |
| Hydrochloric acid-----               | 1 oz. 85  |

All of the formulas thus given will keep the face of the anode plate clean and clear, free from films and coatings, so as to insure even and uniform etching at all stages. 90

When using solutions in which sludge is formed, and especially when I use a solid plate cathode instead of the carbon pencils above described (although it may be employed with those also), I provide mechanical means for disengaging the sludge and keeping the cathode clean, consisting of a series of four brushes connected together as indicated in the diagram Fig. 13. These brushes are connected with a motor driven device preferably above the tank, whose cranks or reciprocating parts have a considerable amplitude of motion, so as to work the brushes up and down over the cathode plates. The motor device is arranged so that several tanks can be operated at the same time. With this device, it is not absolutely necessary to move the anode up and down, because the movement of the brushes causes a sufficient agitation of the solution. 110

In order to lessen the quantity of solution required in the tank, and also to draw the heavy solution flowing from the anode plate directly to the base of the cathode or cathodes, I insert a filler shown in Figs. 3 and 4. This is geometrically shaped, preferably with triangular ends, sloping sides, and its longitudinal ridge lying directly under the anode plate. It is made of acid-resistant material or wood or metal coated with the same and water-tight. 115

Fig. 7 shows a tank similar to that of Figs. 3 and 4, with a small plate P' supported on a cross wire, one end of which rests on one side of the anode terminal rod 125, and the other end of which rests on the side of the tank. By this means the small plate is brought nearer to the cathodes, and a number of plates of this size may be treated at the same time, 120

While I have found it very advantageous to hang my anode plate face down in the solution, it is also possible to get good results, as will be hereinafter pointed out, by suspending the plate vertically in the solution, provided certain details are attended to. One of these is the turning of the plate so that it shall be in each of four positions, one end up, one side up, the other end up, and the other side up, each for one-fourth of the total time of etching. The effect of this is shown in Fig. 8 which represents the plate in four positions.

In Fig. 9 is shown a tank which may be similar in every respect to that in Figs. 3 and 4, but in which the cathodes, instead of being carbon pencils, are solid plates hanging down inside the walls or around it. This form of cathode may be employed with the anode in either of the positions described, and if the brushes of Fig. 13 are employed, it is quite as effective and as easy to handle as the pencil cathodes.

Fig. 10 is a diagram showing the relation between the cathodes and anode of Fig. 9, in cross section. In Fig. 11, which is a similar diagram, the cathodes are shown arranged obliquely, so as to bring them into closer relation with the anode and perform functions somewhat similar to those to the inclined face of the filler F in Figs. 3 and 4.

In Fig. 12 the short lines indicate gravity action on the vertical suspended plate of Fig. 8 and make clear the reason why I consider it necessary to turn the plate at intervals in the solution. I do not consider the vertical suspension as good as the horizontal suspension with the face down, but the reason for this is not derived from any theoretical considerations, but from purely practical ones. It is difficult for the average workman to determine at the beginning how many minutes a particular plate is going to require before turning, and the difficulty is not lessened by the fact that the time may vary with the temperature and therefore with the season, and that some pieces of the same metal are softer than others and etch more quickly. The great advantages possessed by the horizontal suspension, however, are also possessed in great part by the vertical suspension, provided that the plate is properly turned. The great desideratum in both cases is to facilitate the transit by gravity away from the face of the anode, of the heavier solution caused by the dissolving of the anode formed by the action of the anion, also all impurities which may be present, thus assuring cleaner and more uniform etching throughout.

As a modification of the cathode suspension shown in Fig. 11, I may suspend the cathode horizontally near the bottom of the tank, beneath the anode.

Having thus described the apparatus, I shall now proceed to the steps in operation.

The first step consists in coating the plate, copper, brass, steel, zinc, or other metals, or combinations of metals, with a solution sensitive to light, and drying the same. This solution may be varied somewhat as to the ingredients and as to the proportions of each ingredient, but the formula which I have found to give good results is as follows:

|                     |            |    |
|---------------------|------------|----|
| Albumen of-----     | 7 eggs     |    |
| Rock candy-----     | 120 grains |    |
| Gum arabic-----     | 180 grains | 30 |
| Gelatin-----        | 40 grains  |    |
| Ammonium bichromate | 90 grains  |    |
| Water -----         | 12 oz.     |    |

This formula may be varied as for example I may use the albumen of 5 to 8 eggs; from 90 to 150 grains of rock candy, from 120 to 250 grains of gum arabic; from 25 to 80 grains of gelatin, and from 50 to 150 grains of ammonium bichromate. I state these variations to enable those who desire, to experiment. It should be noted that fish glue may be substituted wholly or in part for the gelatin in the foregoing formula, and potassium bichromate may be substituted in suitable proportion for ammonium bichromate.

As an alternative formula for the enamel solution the following may be used:

|                     |            |     |
|---------------------|------------|-----|
| Albumen of-----     | 6 eggs     | 100 |
| Gum arabic-----     | 200 grains |     |
| Rock candy-----     | 120 grains |     |
| Ammonium bichromate | 70 grains  |     |
| Water -----         | 8 oz.      |     |

In this alternative formula gelatin or fish glue may be added if desired, and the several ingredients may be varied as follows: albumen from 4 to 7 eggs; gum arabic from 130 to 250; rock candy from 90 to 150; ammonium bichromate from 40 to 150. Any one of the ingredients may be varied without varying the whole, and this is true of both the formulas given. Potassium bichromate may be substituted in the second formula in suitable proportions for the ammonium bichromate. These formulas are original and will be claimed herein as a part of my invention.

After drying, the plate coated as described from one of the foregoing solutions, is exposed under and in contact with a negative or positive or other form of design carrier, to the action of sunlight or artificial light. Afterward the plate is immersed in water, and gently rocked for two or three minutes, until the unexposed portions are absolutely and entirely dissolved and cleared away. (In the case of some metals, owing to the character of the electrolyte to be subsequently used, the plate is next placed for about two minutes in a hardening solution

of grain alcohol 95 percent. or wood alcohol, but in most cases, this is unnecessary.)

The plate is next dried and at this stage the image is barely visible. It is then heated to a temperature sufficient to bake or enamel the image on the metal, at which stage the image becomes plainly visible in every detail, having changed in color by the baking or enameling. This change in color to a brownish tone, is the test for proper duration of baking. The surface of the image is then very hard and cannot be damaged by the bare hands and is not easily affected by any handling. It is as smooth as polished glass and the edges of the lines, etc., of which the image is composed, are as sharp as in the negative or positive under which it has been exposed. It is extremely thin, presenting practically no relief from the surface of the plate even when examined under a low power magnifying glass, but is an excellent insulator.

The back of the plate is next coated with an insulating material, which may be chosen from a great variety, such as shellac dissolved in alcohol, a solution of asphaltum and paraffin, or almost any waxy substance, to which has been added a resin or asphaltum, or both.

The plate is then connected with the positive wire of a dynamo or battery and immersed in a suitable electrolyte, constituting the anode terminal therein. I have found it preferable and shall claim it as original, to maintain the plate horizontally in the electrolyte with the face (the side containing the image) downward, as hereinbefore described.

For cathodes, where a single large plate, or a number of small plates are to be etched at one time, I use either one large cathode, or several smaller ones in different parts of the tank, all connected with the same negative wire, so as to fairly equalize the distance the current need travel through the electrolyte, and thus insure uniformity in the depth of etching of the whole.

During etching, an occasional interruption of the current is desirable, and in fact important, because it tends to keep the face of the anode clean, and assists in producing smoothness of etching.

It will be apparent to those skilled in the art that some sundry changes and modifications may be made in the apparatus, in the method and in such details as the formulas of the electrolyte, etc. Thus, I may employ plates of various metals or substances, to be etched, and I may employ divers metals or other substances instead of carbon for the cathode, without departing from my invention. I may also vary the formula for the enamel as stated in the paragraph commencing on line 105, page 6, or otherwise, and generally speaking, I contemplate all non-

essential changes and modifications as fairly fall within the scope of the appended claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. The process of etching plates for printing and for other useful and ornamental purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of the coating or film; (4) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are not to be etched; (6) immersing the plate in an electrolytic solution, and passing a current from the plate as an anode through the solution to a suitable cathode therein.

2. The process of etching plates for printing and for other useful and ornamental purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portion of the coating or film; (4) immersing the plate in a hardening solution for a sufficient length of time to harden the coating thereon; (5) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (6) insulating those portions of the plate which are not to be etched; (7) immersing the plate in an electrolytic solution, and passing a current from the plate as an anode through the solution to a suitable cathode therein.

3. The process of etching plates for printing and for other useful and ornamental purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of the light; (3) dissolving the unexposed portions of the coating or film; (4) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are not to be etched; (6) immersing the plate in an electrolytic solution, and passing a current from the plate as an anode through the solution to a suitable cathode therein; (7) moving the anode only in the solution during etching and in a direction perpendicular to the surface being etched.

4. The process of etching plates for printing and for other useful and ornamental purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of the coating or film; (4) heating the plate

to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are not to be etched; (6) 5 immersing the plate in an electrolytic solution, and passing a current from the plate as an anode through the solution to a suitable cathode therein; (7) raising and lowering the anode only continuously in the solution during etching and in a 10 direction perpendicular to the surface being etched and parallel to the direction of current flow.

5. The process of etching plates for printing and for other useful and ornamental 15 purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of the 20 coating or film; (4) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are not to be etched; (6) 25 suspending the plate in an electrolytic solution in such position that the heavier solution formed at the surface of the plate and in the recesses therein in etching will tend to flow away therefrom by gravity, passing a 30 current through the plate as an anode and through the solution to a suitable cathode therein and reciprocating said plate during etching in a direction parallel to the natural 35 direction of flow of said heavier solution.

6. The process of etching plates for printing and for other useful and ornamental purposes which comprises the following 40 steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of the coating or film; (4) heating the plate to a 45 temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are to be etched; (6) suspending the plate in an electrolytic solution in such position that the heavier solution 50 formed at the surface of the plate in etching by the dissolving of the anode will tend to flow away therefrom by gravity, and passing a current through the plate as an anode and through the solution to a suitable 55 cathode therein; (7) periodically changing

the angular position of the plate in the plane of the plate, so that uniform and equal effects will be produced on all parts of the plate and in all directions during etching.

7. The process of etching plates for printing and for other useful and ornamental 60 purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of the 65 coating or film; (4) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions of the plate which are not to be etched; (6) 70 suspending the plate with the face or design downward, and passing a current through the plate as an anode, and through the solution to a cathode therein; (7) moving the 75 plate up and down periodically in the solution at right angles to the surface of the plate and in a direction parallel to the flow of current.

8. The process of etching plates for printing and for other useful and ornamental 80 purposes which comprises the following steps: (1) coating the plate with a solution sensitive to light; (2) exposing the same under a design carrier to the action of light; (3) dissolving the unexposed portions of 85 the coating or film; (4) heating the plate to a temperature sufficient to bake or enamel the exposed portions of the coating or film of the plate; (5) insulating those portions 90 of the plate which are not to be etched; (6) suspending the plate with the face or design downward, and passing a current through the plate as an anode, and through the solution to a cathode therein; (7) mechanically removing substantially all deposits 95 from the cathode during the process.

9. The process of etching plates for printing and for other useful and ornamental 100 purposes which comprises the following steps: (1) coating the plate with a substance sensitive to light; (2) exposing the same to action of light to produce a pattern thereon; (3) developing the image; (4) baking the 105 plate to enamel the image thereon, whereby the portions of the plate covered by the image are insulated and protected in a single film; (5) electrochemically etching the plate.

In testimony whereof I affix my signature.

JOSEPH H. WEEKS.