Aug. 13, 1957 W. P. LANGSFELD 2,802,726

METHOD AND APPARATUS FOR SELECTIVELY REMOVING METAL FROM A METAL PART

Filed Oct. 25, 1954 2 Sheets-Sheet 1

Fig. 1.

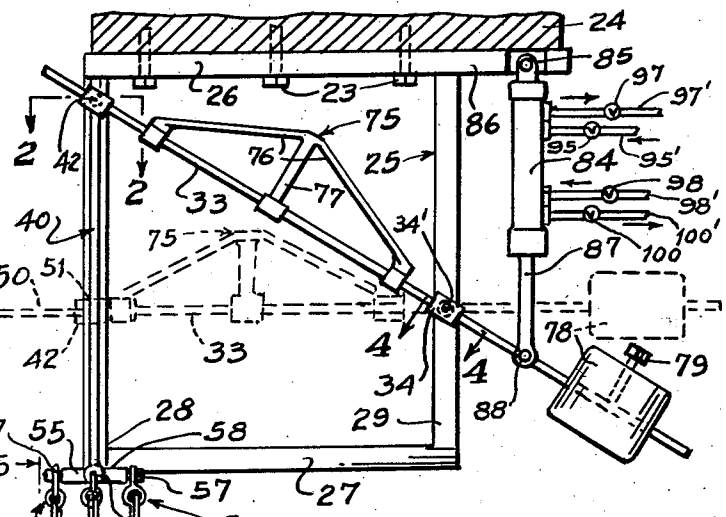
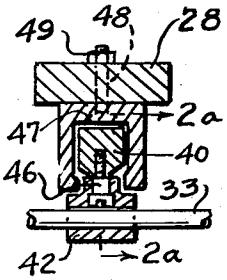


Fig. 2.



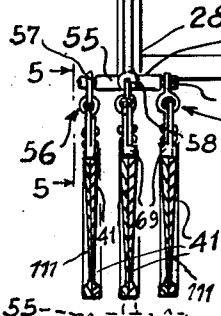


Fig. 2a.

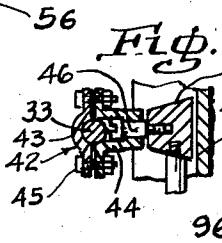
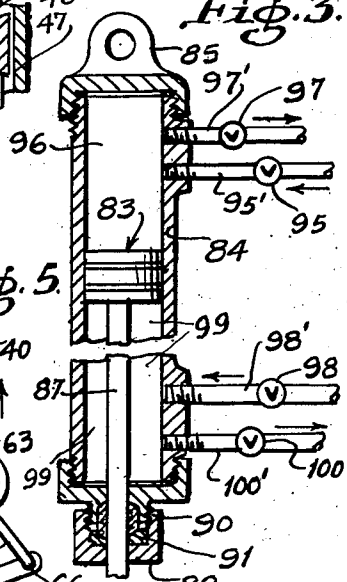


Fig. 3.



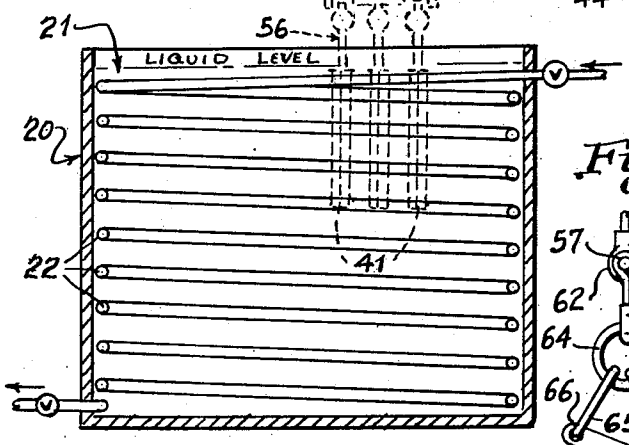


Fig. 5.

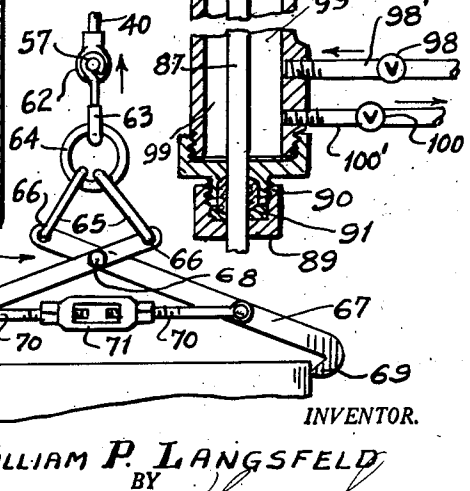
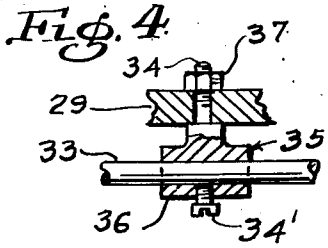


Fig. 4.



INVENTOR.

WILLIAM P. LANGSFELD

BY

Philip Sukkow

ATTORNEY.

Aug. 13, 1957 W. P. LANGSFELD 2,802,726

METHOD AND APPARATUS FOR SELECTIVELY REMOVING METAL FROM A METAL PART

Filed Oct. 25, 1954 2 Sheets-Sheet 2

Fig. 6.

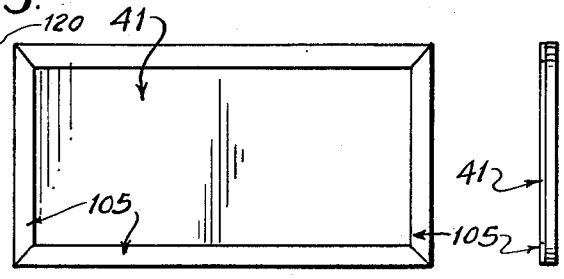


Fig. 7.

Fig. 13.

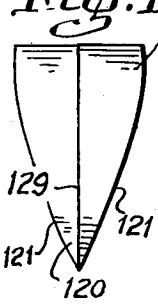


Fig. 15.

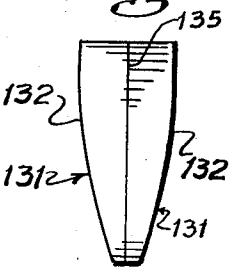


Fig. 8.

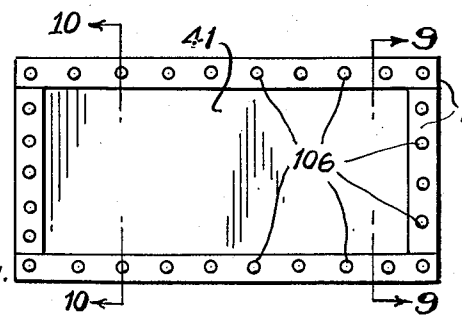


Fig. 14.

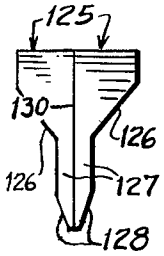


Fig. 9.

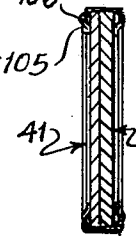


Fig. 16.

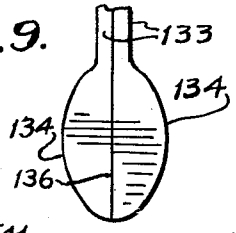


Fig. 10.

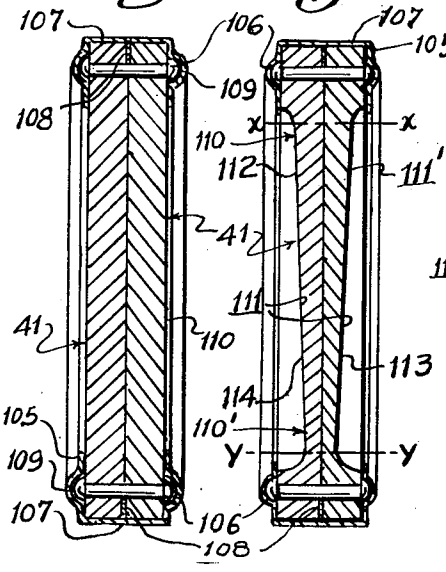
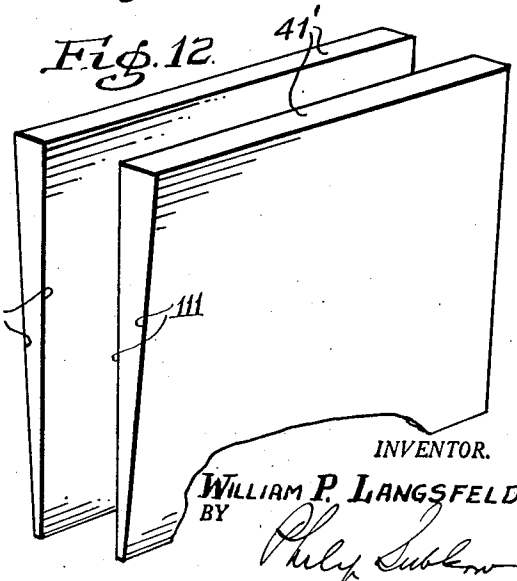


Fig. 11.

Fig. 12.



INVENTOR.
WILLIAM P. LANGSFELD
BY
Philip Sublow
ATTORNEY.

United States Patent Office 2,802,726
Patented Aug. 13, 1957

2,802,726

METHOD AND APPARATUS FOR SELECTIVELY REMOVING METAL FROM A METAL PART

William P. Langsfeld, Huntington Park, Calif., assignor to Turco Products, Inc., Los Angeles, Calif., a corporation of California

Application October 25, 1954, Serial No. 464,301

8 Claims. (Cl. 41—43)

This invention relates to the etching or removal of metal from the surface of a metal object or part, e. g. one composed of iron, nickel, titanium, magnesium, zinc, aluminum or their alloys. More particularly the invention is concerned with novel apparatus and procedure for the controlled etching of a metal part or work piece to produce a desired contour or etch configuration thereon, and especially for the controlled simultaneous etching of a plurality of metal parts to produce substantially identical etch configurations on said parts.

It is known to etch acid soluble metals such as magnesium, zinc and their alloys with an acid solution such as aqueous nitric acid. It is also known to etch alkali soluble metals such as aluminum and its alloys with a solution having a solvent action on the aluminum or alloy surface, such as a hot aqueous alkali solution, e. g., one containing sodium hydroxide. One method of carrying out the etching process employing acids is to immerse the metal part to be etched in the etching bath, while another is to splash the solution contained in a bath against the work, the surface of which is to be etched or dissolved away. The prior art method for etching alkali soluble metals such as aluminum or its alloys is by immersion.

However, particularly where the purpose is to produce identically etched parts, I am aware of no prior art method or apparatus for the controlled selective etching of more than one part in order to successfully achieve this purpose.

One object of this invention is to devise novel apparatus and procedure for readily dissolving or removing metal in a controllable manner from the surface of a metal work piece, e. g., composed of iron, nickel, aluminum, magnesium, titanium, zinc, and the like or their alloys, to impart a preselected contour or etch configuration to said work piece.

Another object is to provide apparatus and procedure for the controlled etching of a metal part.

Another object is to design novel apparatus and procedure particularly adapted for the uniform, controlled etching or removal of metal from the surface of a work piece particularly one composed of aluminum or its alloys.

A still further object is the provision of novel apparatus and procedure for controllably etching a plurality of metal parts or pieces to produce substantially identical etch patterns on such parts.

Yet another object is to provide apparatus and procedure for producing substantially identically tapered metal sheets, particularly of an aluminum base metal, by controlled etching.

Other objects and advantages will become apparent from the following description.

According to the invention, I can obtain parts having substantially identical shapes or contours by first securing or attaching two parts together in back to back relation. This can be accomplished by suitable means such as welding, riveting and the like. The abutting surfaces of the parts so secured to each other are thus sealed together to substantially prevent ingress of etching solution between these surfaces. In this manner, only the opposite exposed surfaces of the parts can be etched or attacked by the etching solution to form the desired identical etch configurations thereon in the manner more fully described below, while the abutting surfaces of the parts are sealed and immune from attack by the etching solution. Hence this procedure automatically results in masking of the abutting or contacting surfaces of the attached parts without actually using the conventional forms of masking, e. g. a resist or wax composition, to inhibit attack of the metal surface by the etching solution.

The identical etch configurations so formed on the attached parts can have any desired shape, the formation of identically tapered parts constituting a preferred embodiment. After the attached parts have been etched to produce the desired identically shaped parts, or parts which are mirror images of each other, the parts are withdrawn from the etching solution and separated from each other in any suitable manner. Where riveting, for example, is employed to secure the parts together during etching, the outer periphery of the plates, including the rivets, can be sheared from the main body of the plates as described in greater detail below, to separate the parts.

The parts attached in back to back relation and to be identically shaped according to the invention are submerged in a bath containing a metal dissolving agent, i. e., an etching solution. Means are provided for then withdrawing the attached work pieces from the bath at a preselected rate to thus controllably vary the time of immersion and amount of attack of the etching bath on different portions of each of the work pieces placed in the bath, corresponding opposite surfaces of the work pieces being simultaneously etched the same amount. When the attached work pieces are completely withdrawn from the bath, they will each be etched to a predetermined etch pattern, and the work pieces so treated according to the invention will have substantially the same etch pattern, shape or contour as result of such treatment.

Instead of withdrawing the work pieces at a preselected rate to obtain a predetermined etch pattern, the attached work pieces may be immersed in the etching solution at a preselected rate to obtain said predetermined etch pattern, and the work pieces then quickly withdrawn simultaneously from the etching bath after such pattern has been produced, in order to stop the etching action at this point.

Alternately, the parts secured back to back according to the invention can be completely immersed in an etching bath and maintained immersed therein until the desired amount of etching takes place on the opposite exposed surfaces of the parts. The parts are then withdrawn from the solution and separated from each other to obtain parts having the same etch configuration.

The etch rate or amount of etching which takes place on the surface of a metal part in a given time is dependent on the concentration of the etching bath, the temperature thereof, and the time of immersion of the part. The etch rate for a particular bath can thus be predetermined, and by controlling the temperature and concentration of the etching bath, and the time of immersion of the part, the degree of etching at various portions of the exposed surface can be controlled to give a desired etch pattern. Thus, for example, if it is desired to produce identical tapered sheets, the portions of both sheets secured in back to back relation according to the invention, and to which the taper is to be applied can be immersed together in the etching bath, and the sheets withdrawn simultaneously vertically from the bath at a controlled uniform rate, depending on the etch rate of the sheets in that particular solution and the degree of taper desired. Or, the attached sheets can be immersed in the etch solution at a

controlled uniform rate to form the desired taper on the opposite exposed surfaces of the sheets, followed by rapid removal thereof from the solution. Hence, by securing a pair of sheets back to back according to the invention, two sheets of substantially identical taper can be produced.

The metal parts to be etched according to the invention may be coated on corresponding selected portions of the surface thereof with a protective masking coating to inhibit or prevent attack by the etching agent while adjacent portions are available for such attack. In certain instances where it is desired to permit etching to at least some degree, of all surfaces of the work pieces submerged in the solution, a mask need not be used. The etched work pieces may be used in the decorative arts or in structures or machine parts.

Apparatus found particularly advantageous for carrying out the above procedure, i. e., for controlling the rate of withdrawal from an etching tank of a pair of work pieces secured back to back according to the invention to produce the desired identical etch patterns thereon includes a beam or lever, preferably reinforced along its length, pivotally supported on a pivot intermediate its ends. An elongated vertical support for one or more pairs of work pieces is suspended from the beam near one end thereof, the support having means at its lower end for securing the attached work pieces thereto. The connecting member between the vertical support and the beam, located at the upper end of such support is slidable along the beam for a limited distance. The connection and vertical support are disposed in a vertical guide for vertical movement only of said connection and its associated support, in response to pivotal motion of said beam. During the motion of the beam, the connection slides axially with respect to the beam while moving vertically in its guide. Means, e. g. in the form of a hydraulically controlled piston, is connected to the beam for pivoting same at a preselected rate to produce the desired rate of vertical movement of the support and immersion or withdrawal of the work pieces from the solution in order to obtain a predetermined etch pattern.

The invention will be more clearly understood by reference to the following description of a preferred embodiment taken in connection with the accompanying drawings wherein:

Fig. 1 is an elevational view, partly in section, of the invention device;

Fig. 2 is an enlarged section taken on line 2—2 of Fig. 1;

Fig. 2*a* is a section taken on line 2*a*—2*a* of Fig. 2;

Fig. 3 is an enlarged vertical section of the hydraulic cylinder and piston of the device of Fig. 1;

Fig. 4 is an enlarged section taken on line 4—4 of Fig. 1;

Fig. 5 is an enlarged elevational view of the mechanism for clamping a work piece, taken on line 5—5 of Fig. 1;

Fig. 6 is an elevation of a metal sheet to be etched, showing the mask applied thereto;

Fig. 7 is an end view of the sheet of Fig. 6;

Fig. 8 is an elevation of a pair of masked metal sheets united together back to back according to the invention.

Fig. 9 is a sectional view taken on line 9—9 of Fig. 8;

Fig. 10 is an enlarged sectional view taken on line 10—10 of Fig. 8;

Fig. 11 is a sectional view of the assembly of Figs. 8 to 10, after etching of the sheets to form identical tapered sheets according to the invention;

Fig. 12 is a perspective elevational view of the tapered sheets shown in Fig. 11 after separation of the sheets from each other;

Fig. 13 shows a modification of etch configuration or contour of a pair of sheets obtainable according to the invention;

Fig. 14 shows another modification of etch configuration obtainable according to the invention;

Fig. 15 shows still another modification of etch configuration which may be produced according to the invention; and

Fig. 16 shows yet another modification of etch configuration obtainable by the invention process and apparatus.

Numeral 20 represents a tank in which the metal work pieces, parts or sheets of the invention are etched or subjected to the solvent action of a body of solution 21 maintained in the tank. Where the work pieces are composed of an acid soluble metal such as magnesium, iron, titanium, zinc or their alloys, the solvent solution can be of suitable acid composition such as aqueous nitric acid, aqueous hydrofluoric acid or mixtures thereof depending on the nature of the metal. According to the preferred embodiment of the invention for etching or removing metal from an aluminum or alluminum alloy material, which is alkali soluble, a hot aqueous solution is employed containing an alkali such as sodium or potassium hydroxide, trisodium phosphate, soda ash or the like, or mixtures thereof. Preferably a sodium hydroxide solution is used. Temperature of the solution in the etching tank is generally maintained in a range say from 100° F. to about boiling during treatment. However, lower temperatures may also be used. The tank 20 has a series of coils 22 therein for circulation of steam or hot water to maintain the temperature of the solution in the tank.

Where an alkali soluble metal, e. g. aluminum, is being etched, the alkali concentrations employed in the bath range from 0.1 to 10 normal. Instead of NaOH I may use any of the other equivalent alkalis referred to above, adjusting the concentration to give the desired OH ion concentration. If desired, an acid etchant such hydrofluoric acid solution or solutions of salts such as ferric sulfate may be used for aluminum or aluminum alloys instead of alkali solutions.

Suspended over the top of tank 20 by means of bolts 23 passing into a supporting fixture 24 is a bracket 25 of essentially square configuration, having an upper horizontal member 26, a lower horizontal member 27, and vertical side arms 28 and 29. A beam or lever 33, normally inclined as seen in Fig. 1, is pivoted intermediate its ends on a pin 34 positioned on side arm 29, somewhat below the center thereof. The pin 34 is in the form of a threaded stud integrally positioned at one end of a T-shaped member 35 (see Fig. 4), the horizontal portion 36 of which receives the beam 33. A nut 37 threadably engages one end of the pivot pin 34 for adjustment thereof, and a stud 34′ is threadably received within portion 36, the end of stud 34′ frictionally engaging beam 33 to prevent axial movement thereof with respect to member 35.

Suspended from a point near the upper end of beam 33 is an elongated vertical support 40 to the lower end of which, as will be described hereinafter, is attached one or more work pieces 41 which are treated in the etching solution in tank 20.

The vertical support 40 is suspended from beam 33 by means of a slidable connection or sleeve 42 which receives the beam and which is arranged from limited slidable movement therealong, as will be made clear below. The sleeve 42 is composed of half sections 43 and 44 (see Fig. 2*a*) clamped together at their adjacent ends by nut and bolt assemblies 45. Sleeve 42 is pivotally connected to the upper end of vertical support 40 by means of a pivot pin 46. Vertical support 40 slides in a vertical channel or guide 47, having a U-shaped cross section and mounted on side arm 28 by means of countersunk screws 48 passing through the channel and side arm 28, the screws 48 having nuts 49 engaging their outer ends.

It is thus seen that when beam 33 is pivoted at 34 to

rotate the beam counterclockwise or clockwise, connection or sleeve **42** will move up or down in a vertical direction only in guide **47** while at the same time sliding inward or outward along beam **33** only a limited amount because of the restraint against lateral movement of the sleeve, due to its engagement within the guide **47**. Thus, when beam **33** moves counterclockwise from its full line position shown in Fig. 1 to its horizontal dotted line position, sleeve **42** will have moved vertically downward along guide **47** and also laterally with respect to the horizontal position of the beam, for example, from about point **50** to point **51**. Of course, support **40** and the work pieces **41** suspended therefrom will also move only vertically up or down along guide **47** in response to vertical movement of sleeve **42** actuated by rotation of the beam **33**.

Support **40** has attached to the lower end thereof a horizontal cross member **55**. In the embodiment shown, three similar clamp assemblies **56** are supported on member **55**, two from grooves **57** at opposite ends of member **55**, and one from an eye **58** in the center of cross member **55**. As seen in Fig. 5, each of clamp assemblies **56** includes a ring **62** extended downward to form a hook **63** at its lower end, such hook in turn supporting a ring **64**. To the lower end of ring **64** is connected a pair of links **65**, the lower ends of which pivotally engage at **66** a pair of clamping levers **67** pivoted in scissors fashion on a pin **68** near their upper ends. Levers **67** have hooks **69** at their outer ends for engaging the upper ends of work pieces **41** to maintain same in vertically suspended position. Rods **70** are connected across levers **67**, the tension on rods **70** being adjusted by means of turnbuckle **71** for regulating the clamping force applied to levers **67**.

It will be understood that more or less than three pairs of plates **41** or plate assemblies may be suspended from support **40** for immersion in the etching bath, and that various types of clamping means other than clamp assemblies **56** may be employed for receiving the work pieces at the lower end of support **40**.

A reinforcing member **75** having a pair of outwardly extending arms **76** and a central depending support **77** is connected at its lower ends to beam **33** intermediate pivot pin **34** and sleeve **42**. Connected to the lower end of beam **33** beyond pivot pin **34** is a counterweight **78** adjustable along beam **33** by means of the set screw **79**.

Beam **33** is actuated for pivotal motion thereof by a piston **83** sliding in a cylinder **84**. The cylinder **84** is pivotally mounted by means of pivot pin **85** on an extension **86** of the upper horizontal member **26** of bracket **25**, and the external lower end of the piston arm **87** is connected by pivot pin **88** to beam **33** between its pivot point **34** and the counterweight **78**. A packing gland **89** (see Fig. 3) threadably engaging a depending flange **90** at the bottom of the cylinder **84** receives piston arm **87**, for slidable movement thereof, and maintains packing **91** within flange **90** in proper position to prevent leakage of fluid from cylinder **84**.

It will be seen that passage of fluid through valve **95** and pipe **95'** into the upper chanber **96** of cylinder **84**, while valve **97** in outlet **97'** is closed, will force piston **83** downward, causing beam **33** to pivot or rotate clockwise to raise vertical support **40** and the work pieces **41** supported thereon; and passage of fluid through valve **98** in line **98'** into the lower chamber **99** of cylinder **84**, while valve **100** in outlet **100'** is closed, will force piston **83** upward, causing beam **33** to pivot counterclockwise to lower support **40** and the work pieces thereon. When fluid is being introduced into the upper chamber **96** to lower piston **83**, fluid in lower chamber **99** is bled through line **100'** and valve **100**, and when fluid is introduced into the lower chamber **99** to raise piston **83**, fluid in upper chamber **96** is bled through line **97'** and valve **97**.

Referring now particularly to Figs. 6 to 12, according

to the invention for producing metal parts or sheets having the same contour or etch configuration, for example, identically tapered sheets, the sheets **41** of stock are cut oversize, for example, about ½" about the entire outer periphery. A masking coat **105** is then applied to this peripheral area on one side of each sheet, forming in effect a frame of coating about the sheets to be treated. Two such sheets are then placed back to back in contact with each other, the mask **105** on each of the plates facing outward. The sheets are then riveted together as seen in Fig. 9, by means of rivets **106** positioned in the outer peripheral area of the plates covered by mask **105**, as shown in Fig. 8. A masking coat **107** is then applied about all four outer edges of both sheets **41** and also between the sheets along their mating peripheral edges to form a gasket **108** to prevent introduction of etching fluid between the plates. The rivets **106** may be made of a metal which is not attached by the etching solution, such as soft steel or other metal where the sheets **41** to be etched according to the invention are aluminum or an aluminum alloy, and where the etching bath is caustic alkali. For further protection, the rivets may also be coated with a coat **109** of masking material, as seen in Fig. 10. If desired, means other than riveting, as for example clamps, may be used to hold the plates **41** together in back to back relation.

Any number of the assemblies shown in Fig. 10, for example three such assemblies as seen in Fig. 1, are then mounted at the lower end of the vertical support **40** of Fig. 1, by means of the clamp assemblies **56** shown in Fig. 5, and the sheets **41** are lowered into the etching solution **21** by actuation of piston **83** upward to rotate beam **33** clockwise, until such sheets are entirely immersed in the solution, as shown in dotted lines in Fig. 1. Piston **83** is then actuated to move slowly downward at a preselected uniform rate, causing beam **33** to rotate clockwise at a uniform rate, which in turn permits the sheets **41** to be simultaneously slowly and uniformly withdrawn from the etching solution **21**. Since the sheets are gradually removed from the etching bath in this manner, the upper areas **110** of sheets **41** not covered by masks **105** will be etched the least, those areas below and adjacent thereto will be etched more, and so on, so that the lowermost portions **110'** of the uncovered areas of sheets **41** will be etched most, inasmuch as the latter portions are the last to be removed from the solution. By this means, a gradual downward taper **111** is formed on the outer surface of each of sheets **41**. The amount of taper can be increased or decreased by controlling the rate of uniform vertical upward movement of support **40** through regulation of the rate of actuation of piston **83**.

Instead of forming taper **111** of sheets **41** by controlled rate of withdrawal of sheets **41** from the solution as described immediately above, piston **83** can be actuated to move slowly upward at a preselected uniform rate, to cause beam **33** to rotate counterclockwise and permitting sheets **41** to be immersed simultaneously and at a uniform controlled rate to produce the tapered etch pattern **111**. Following complete immersion of sheets **41** and formation of the taper **111**, piston **83** is then actuated downward at a rate permitting beam **33** to rotate clockwise for rapid withdrawal of sheets **41** from the solution. It is seen that this mode of procedure involving controlled rate of immersion also results in a longer period of attack of the lower portion of the sheets **41** by the solution than the upper portion of such sheets, forming the downward taper **111**.

Since the two sheets **41** in each of the assemblies as shown in Fig. 10 are immersed in or withdrawn from the etch bath **21** simultaneously and at identical rates, the degree of etching taking place at corresponding points at the same height will be identical. For example, the amount of etching at points **111'** and **112** will be the same, and that at points **113** and **114** will be the same. Thus, the two sheets **41** in each of the assemblies as

represented in Fig. 11 will have identical etch contours or tapers.

When the treated sheets have been completely removed from the etching solution, as shown in Fig. 1, the sheet assemblies are removed from clamping levers **67**, and the pairs of tapered sheets in such assemblies are separated by shearing off the peripheral portions of the sheets covered by masks **105**, **107**, **108** and **109**, and containing rivets **106**. Thus, for example, the portions of tapered sheets **41** above line *x*—*x* and below line *y*—*y* in Fig. 11, as well as the corresponding end portions of these sheets are removed, leaving the finished identically tapered plates **41'** shown in Fig. 12.

From the foregoing, it is seen that two identical parts, that is, having identical contours, can be produced according to the invention, or a right hand and left hand part can be produced simultaneously. Further, the original finish and surface of one side of each part can be preserved by utilizing that side as the backing mask, that is, by placing that side in back to back abutting relation with a side of the companion part to be similarly contoured according to the invention.

Also, parts having identical shapes or contours other than tapered can be produced by my invention. Thus, in Fig. 13 two identical parts **120** each having a rounded outer surface **121** can be formed, e. g. by proper control of the rate of withdrawal of the part from the etching solution. In Fig. 14 is shown another modification consisting of two identical parts **125** each having an upper tapered portion **126**, an intermediate non-tapered portion **127** and a lower tapered portion **128**. The intermediate straight portion **127** can be formed, for example, by quickly withdrawing the part from the solution a distance equal to that between the upper and lower tapered portions **126** and **128**. With respect to parts **120** and **125**, the back surfaces **129** and **130**, respectively, thereof are masked by securing the parts together in abutting back to back relation prior to etching according to the invention, to prevent attack of these surfaces by the etching bath. In Fig. 15 is shown two identical parts **131** each having its opposite exposed surface **132** identically contoured according to the invention. In Fig. 16 is shown yet another modification wherein parts **133** have their opposite sides **134** identically shaped in the form of a half oval by means of the back to back etching principles of the invention. The respective pairs of parts **131** and **133** are secured in back to back relation along their abutting surfaces **135** and **136** respectively prior to etching.

It is understood that in order to produce parts having the same final three dimensional shape as a result of the etching procedure according to the invention without further operation on the etched portions, the geometrical shape and dimensions of the original parts whose shape is to be altered by the etching solution should preferably be substantially the same. However, where it is desired to etch the surface of the parts to produce substantially identical etch patterns on such surface portions, it is not necessary that the original parts have the same geometry in all dimensions. In this case the two parts may be properly masked so as to leave exposed surface portions of substantially identical shape and area, the parts secured back to back to leave said opposite exposed surface portions of the parts available for attack by the etching solution, and the parts subjected to simultaneous treatment by the etching solution according to the invention, for example, by controlled rate of immersion in or withdrawal from the solution, or by complete immersion of the parts for the desired period.

It is not necessary to maintain concentration and temperature of the etching bath constant, since regardless of these parameters, the two parts secured back to back according to the invention will always be subjected to the same etching conditions and hence will be etched to the same degree. However, where it is desired to obtain specific predetermined identical shapes such as identically tapered parts, for example, by controlled withdrawal from or immersion in the etching bath, it is preferred to control the etch bath temperature and concentration, that is, so as to maintain these parameters substantially constant.

In addition to the formation of parts having identical etch patterns or shapes, the invention may be applied where it is desired to etch down the surfaces of two parts the same amount regardless of the geometrical shape of such surfaces. Here, the parts are connected together in back to back relation, leaving the surfaces to be etched exposed. The parts are then immersed in the solution and the etching treatment continued for a time sufficient to etch the desired thickness of metal from the exposed surfaces of both parts. The parts are then withdrawn from the solution and separated from each other.

Of course it will be understood that the apparatus described herein for supporting the work pieces in the etching solution in back to back relation according to the invention, should be constructed of materials which are substantially inert to attack by the etchant solutions employed, and those skilled in this art will know how to select such materials.

While I have described a particular embodiment of my invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. A method of substantially equally and correspondingly etching metal parts with an etching solution, which comprises securing a pair of said parts together in back to back relation so as to mask the adjacent back surfaces of said parts, said parts having respective opposite surface portions exposed for attack by said etching solution, simultaneously immersing said parts in an etching solution with the plane of said backs substantially normal to the surface of said solution, said parts being introduced into and withdrawn from the solution at a rate selected to vary the period of immersion and amount of attack of the etching solution on different sections of the exposed surface portions of each of said parts, corresponding opposite sections of the exposed surface portions of said parts, with reference to the surface of the solution, being thereby etched substantially the same amount.

2. A method as set forth in claim 1, wherein the selected variation in the period of immersion is effected during the withdrawal of said parts from said solution.

3. A method as set forth in claim 1, wherein the selected variation in the period of immersion is effected during the introduction of said parts into said solution.

4. A device for controlling the rate of movement of a work piece into and out of a body of liquid, which comprises a beam, said beam being pivotally supported intermediate its ends, a support for said work piece slidably suspended adjacent one end on said beam, means for guiding said support for vertical movement in response to pivotal motion of said beam, and means connected to said beam for pivoting same at a preselected rate to produce a corresponding vertical movement along said guiding means, of said support for said work piece.

5. A device for controlling the rate of movement of a work piece into and out of a body of liquid, which comprises a beam, said beam being pivotally supported intermediate its ends, an elongated support for said work piece slidably mounted on said beam adjacent one end thereof, means for guiding said support for vertical movement only, in response to pivotal motion of said beam, and means connected to said beam for pivoting same at a preselected rate to produce a corresponding vertical movement along said guiding means of said support for said work piece.

6. A device for controlling the rate of movement of a work piece into and out of a body of liquid, which comprises a beam, said beam being supported for pivotal movement on a pivot intermediate its ends, an elongated

vertical support for said work piece suspended from said beam near one end thereof, a connection between said support and said beam, said connection being slidable for a limited distance on said beam, a guide for vertical movement only of said connection and said support in response to pivotal motion of said beam, and means connected to said beam for pivoting same at a preselected rate to produce a corresponding vertical movement along said guide of said support for said work piece.

7. A device for controlling the rate of movement of a work piece into and out of a body of liquid, which comprises a beam, said beam being supported for pivotal movement on a pivot intermediate its ends, an elongated vertical support for said work piece suspended from said beam near one end thereof, means at the lower end of said support for securing a work piece thereto, a connection between said support and said beam, said connection being located at the upper end of said support and being slidable for a limited distance on said beam, a guide for vertical movement only of said connection and said support, in response to pivotal motion of said beam, and hydraulic means connected to said beam for pivoting same at a preselected rate to produce a corresponding vertical movement along said guide of said support for said work piece.

8. A device for controlling the rate of movement of a work piece into and out of a body of liquid, which comprises a beam, said beam being supported for pivotal movement on a pivot intermediate its ends, an elongated vertical support for said work piece suspended from said beam near one end thereof, means at the lower end of said support for securing a work piece thereto, a connection between said support and said beam, reinforcing means on said beam between said connection and said pivot, a counterweight on said beam on the opposite side of said pivot, said connection being located at the upper end of said support and being slidable for a limited distance on said beam, a guide for vertical movement only of said connection and said support, in response to pivotal motion of said beam, and hydraulic means connected to said beam for pivoting same at a preselected rate to produce a corresponding vertical movement along said guide of said support for said work piece.

References Cited in the file of this patent

UNITED STATES PATENTS

196,467	Macbrair	Oct. 23, 1877
493,027	Hoggson	Mar. 7, 1893
2,157,845	Bernarde	May 9, 1939

FOREIGN PATENTS

104,510	Great Britain	Aug. 2, 1917