

March 25, 1958

W. P. LANGSFELD

2,828,192

METHOD FOR ETCHING METALS

Filed Oct. 4, 1954

2 Sheets-Sheet 1

Fig. 1

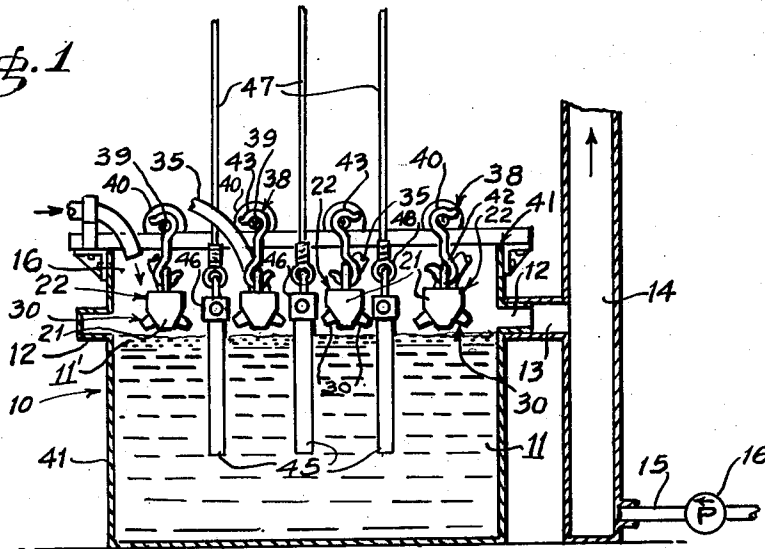


Fig. 2

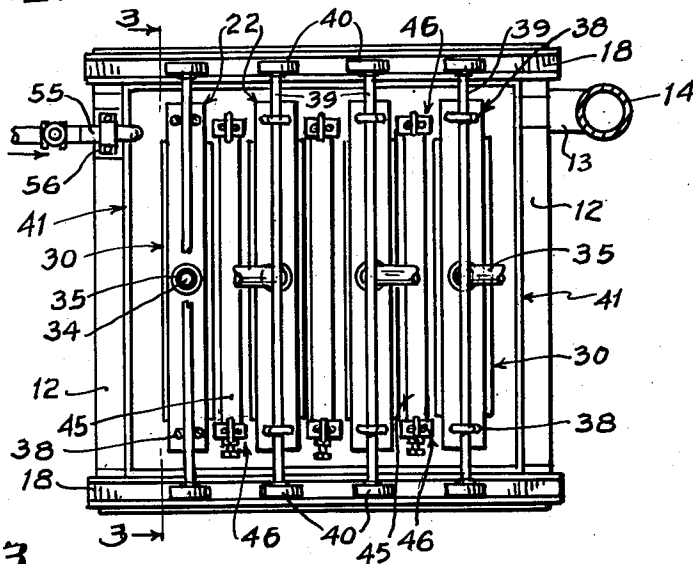
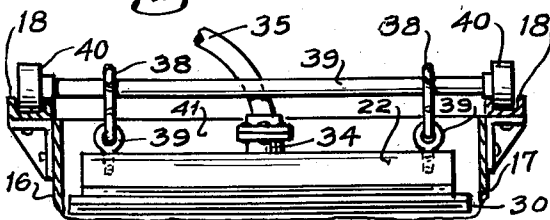


Fig. 3



INVENTOR.

WILLIAM P. LANGSFELD

BY

Philip Subkow

ATTORNEY.

March 25, 1958

W. P. LANGSFELD

2,828,192

METHOD FOR ETCHING METALS

Filed Oct. 4, 1954

2 Sheets-Sheet 2

Fig. 5.

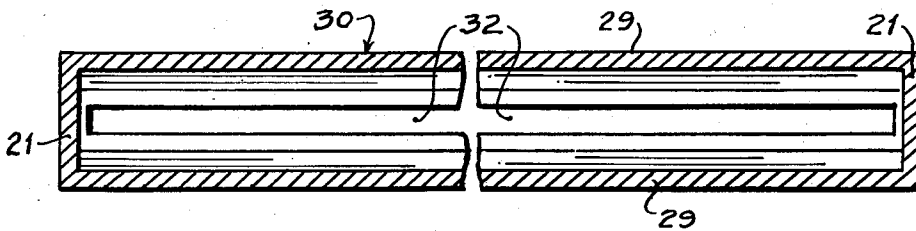


Fig. 4.

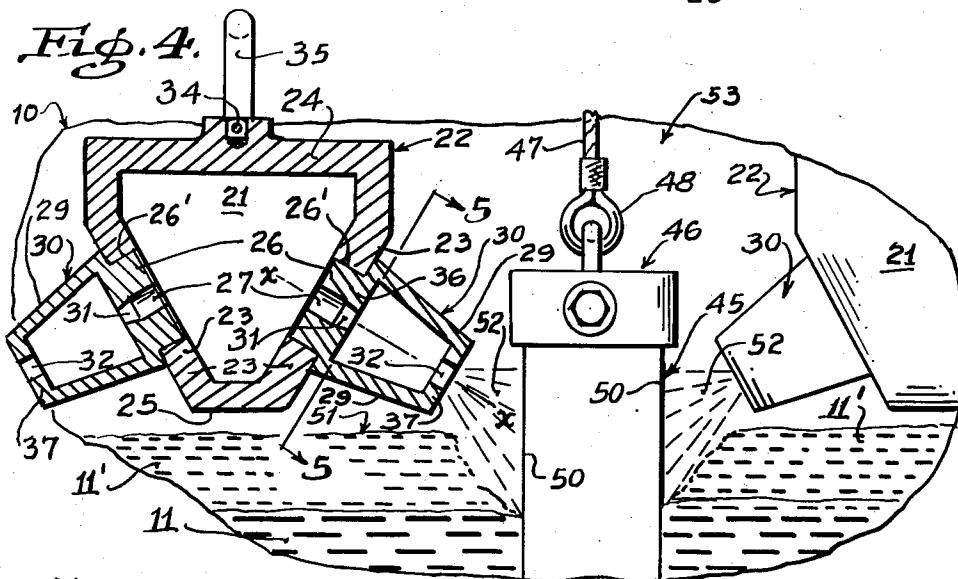
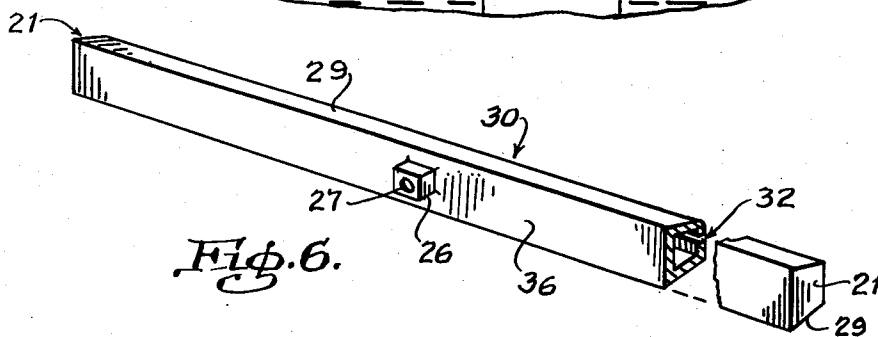


Fig. 6.



INVENTOR.

WILLIAM P. LANGSFELD

BY

Philip Subkow

ATTORNEY.

1

2,828,192

METHOD FOR ETCHING METALS

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

Application October 4, 1954, Serial No. 460,012

2 Claims. (Cl. 41—42)

This invention relates to improvements in the chemical etching of metals, and is more particularly concerned with novel procedure and apparatus for the control of foam formed on the surface of the etching bath.

It is known to etch acid soluble metals, such as magnesium, zinc, iron, titanium, nickel 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, for example, one containing sodium hydroxide.

One common method of carrying out the etching operation is to immerse the metal part to be etched in an etching bath contained in a tank. However, during the etching reaction, hydrogen gas is liberated, and this gas, together with entrained water vapor including droplets containing etchant, generally produces a layer of froth or foam on the surface of the etching solution. When the part or work piece being etched is removed from the bath, the froth causes a wavy etch pattern to be superimposed on the etch of the part due to passage thereof through this froth layer. Also, the etchant contained in the entrained vapors above the bath tends to coat and pre-etch the metal part prior to and during immersion thereof, thereby resulting in a non-uniform final etch pattern. Also, when the part is only partially immersed during the etching period, non-uniform etching takes place in the area of contact of the froth with the exposed surfaces of the work piece.

One object of the invention is to provide novel apparatus and procedure for efficiently etching a metal part.

Another object is the provision of procedure and apparatus for etching a metal part while eliminating or minimizing undesired additional etching caused by stationary contact of the part with the surface froth, or by passage of the part through the surface froth during immersion or removal of the part from the etching solution.

Yet another object is to provide novel apparatus and procedure for controlling the surface froth in an etching bath.

Still another object of the invention is to substantially remove such surface froth from around a part to be etched during immersion thereof in or withdrawal thereof from the bath following the etching operation.

Still another object is to minimize the proportion of entrained etching agent in the vapors in the zone above the etching bath.

A still further object is to cool the zone above the etching bath.

Another aim of the invention is to achieve the foregoing objects employing an alkali solution as the etching agent for treatment of an aluminum or aluminum alloy part, that is, one composed of aluminum as the base metal.

Other objects and advantages will appear from the following description of my invention:

I have found that the adverse effects of such froth or

2

foam on a metal part being immersed in or withdrawn from the etching solution, or while the part is partially immersed in such solution during the etching period, can be substantially eliminated or to a great extent alleviated by directing a stream of air or an air blast, preferably containing moisture, at the liquid etching bath surface below the froth line and against the part. Preferably, means in the form of a fan shaped spray nozzle is employed to emit a stream of spray which acts like a knife to sweep away the froth and to strip adherent etchant from the surface of the part. The air stream destroys the froth around, or in the immediate vicinity of, the part by breaking up the bubbles of foam. The nozzle is preferably positioned a short distance above the surface of the froth and is mounted so that it is inclined downwardly at an acute angle to the liquid surface. In this manner, impingement of the air stream or blast through the froth and against the metal part while it is partially submerged in the bath during etching, or while such part is passing through the froth, pushes the froth back and restrains it from making contact with the part.

The moisture to air ratio in the moist air stream preferably employed may be adjusted to include the desired amount of moisture in the air blast. For example, the amount of water in the air stream may be small in comparison to the loss of water in the system by evaporation and chemical reaction in such etching process, wherein water is consumed in the reaction, as in the case for example in etching aluminum with caustic soda. Preferably, the amount of water in the air stream is adjusted to add approximately the water necessary to maintain solution level as well as the concentration of the etching bath. The presence of water in the air blast tends to prevent any undesired etching in the exposed portions of the work piece above the bath surface, or any further etching of the work piece after withdrawal thereof from the etching solution and while passing through the zone above the liquid surface, by any acidic or caustic etchant which may be entrained in the vapors rising from the bath, since the moist air stream washes such extraneous etchant off the surface of the part.

I have also found that by employment of one or more relatively cool air streams in the foregoing manner, a relatively high pressure air blanket is formed in the zone just above the surface of the etching bath, preventing the rise of vapors containing entrained etching agent through such blanket and into the space above the tank. This greatly reduces the extent of undesirable pre-etching which takes place due to coating of the metal surface of the work piece with such entrained etchant while the work piece extends into or is passing through the zone above the bath prior to and during immersion thereof in the bath. It also aids in preventing formation of a coat of etchant solution on the work piece while being withdrawn from the bath. Reduction of the amount of entrained etchant solution above the bath also materially decreases corrosion of overhead tank equipment. Also, by using additional air streams, preferably moist air, the froth or foam can be controlled over the entire tank surface, and the air stream or streams impinging in a partially lateral direction on the froth layer, direct or sweep the liberated hydrogen gas and entrained etchant vapors to the exhaust outlets at the sides of the tank.

Below is described a novel apparatus for carrying out the invention procedure, taken in connection with the accompanying drawings, wherein:

Fig. 1 is a cross section in elevation of the invention device;

Fig. 2 is a plan view of the device of Fig. 1;

Fig. 3 is a fragmentary section in elevation taken on line 3—3 of Fig. 2;

Fig. 4 is essentially an enlarged fragmentary section

3

of a manifold, its associated nozzles and an associated work piece, as seen in Fig. 1;

Fig. 5 is a section taken on line 5—5 of Fig. 4; and Fig. 6 is a perspective view of a nozzle member of the device.

Numeral 10 represents a tank in which metal work pieces, parts or sheets are etched or subjected to the solvent action of a body of solution 11 maintained in the tank. Where the work pieces are composed of an acid soluble metal such as titanium, iron, copper, stainless steel, magnesium, zinc or their alloys, the solvent solution can be of suitable acid composition such as aqueous nitric, aqueous hydrofluoric acid, and mixtures thereof depending on the nature of the metal used. According to the preferred embodiment of the invention for etching or removing metal from an aluminum or aluminum 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. The alkali concentrations employed in these etching solutions may range from 0.1 to 10 normal. Temperature of the solution in the etching tank is generally maintained in a range say from 100 degrees F. to about boiling during treatment. However, lower temperatures may also be used. Numeral 11' represents a layer of froth or foam which forms on the surface of the liquid in tank 10 from the etching reaction as previously pointed out.

Tank 10 has a hollow flange 12 disposed about the entire periphery of the tank, such hollow flange forming a trough for the froth or foam 11'. A short conduit 13 communicates with the trough 12, the other end of conduit 13 being connected to a vertical stack 14 primarily for removal of such gas and vapors from the interior of the tank. A pipe 15 is connected to the lower end of stack 14, for removal by pump 16 of any froth or liquid overflowing trough 12 and passing through conduit 13 into the bottom of stack 14. Mounted along the upper edges of the opposite sides 16 and 17 of tank 10 is a pair of tracks or guide channels 18.

A number of manifolds 22, shown as four in Fig. 1, are suspended in the upper portion of tank 10. The manifolds 22 are elongated hollow members which extend almost across the entire width of the tank, each of such manifolds having end walls 21 and inclined side portions 23 which slope downward and inwardly at equal angles to the vertical, as seen in Fig. 4. The top 24 and bottom 25 of the manifolds are parallel to each other.

Positioned on the outer surface of each of the sloping sides 23 of the manifolds is a nozzle 30 preferably having a fan shaped cross section, with forwardly tapering sides 29. The nozzles 30 are of a width substantially coextensive with the length of the manifolds 22, as seen in Fig. 2, and are secured by suitable means such as bolts (not shown) to sides 23 of the manifolds, with the longitudinal axis of the nozzles parallel to the longitudinal axis of the manifolds. Nozzles 30 each have a square integral lug 26 centrally positioned along the rear wall 36 thereof, which lug fits into a square aperture 26' in the center of the sloping sides 23 of the manifold, each lug 26 having a central aperture 27 therein which is in alignment with an aperture 31 in the rear wall 36 of the nozzle. A discharge orifice or slot 32 is centrally positioned in the forward end 37 of the nozzles 30, opposite apertures 27 and 31. It is seen that the nozzles 30, that is, along the transverse X—X axis thereof, are inclined at an angle to the horizontal axis of tank 10, and that such nozzles are approximately on a level with trough 12 for a reason pointed out below. Each of the manifolds has an inlet 34 centrally connected to the top 24 thereof for introduction of air under pressure into the manifolds by means of a pipe 35.

Manifolds 22 with the nozzles 30 positioned thereon are each suspended over the body of etching fluid 11

4

in the tank by means of a pair of double hooked arms 38; the lower hooks 42 of which are received in ring bolts 39 which are threadedly received in the top of the manifolds. The upper hooks 43 of the arms 38 are looped over a shaft 39 to be supported thereon. A pair of wheels 40 are suitably mounted at the opposite ends of each of shafts 39, said wheels being disposed in the opposite channels or tracks 18 for guided movement therein along the top of tank 10. It is thus seen that the manifolds 22 and their associated parts, including nozzles 30, can be moved to any desired position across the tank between the end walls 41 thereof.

The work pieces or metal parts 45, for example, in the form of aluminum or aluminum alloy plates, are suspended from suitable clamp members 46 supported from rings 48 on ropes or chains 47 in turn controlled by a hoisting mechanism such as a crane, not shown. The manifold assemblies are moved to the desired position, for example, as shown in Figs. 1 and 2, and the metal plates 45 to be etched are immersed vertically in the solution adjacent the manifold assemblies. Figs. 1 and 2 show three plates 45 with a pair of manifold assemblies disposed between each of the three plates. It is obvious, of course, that the number of work pieces 45 and the number of manifold assemblies may be varied as desired, provided that at least one of the nozzles 30 is directed toward each metal surface undergoing etching in the tank.

In order to immerse the work pieces or plates 45 in the etching bath 11, or to remove them from the bath after the etching operation, the plates must be passed either downwardly or upwardly through the froth layer 11'. Referring to Fig. 4, whether the plates are moved downwardly for immersion thereof or upwardly for withdrawal, as the plates 45 pass through the froth layer 11', a stream of, preferably moist air from manifolds 22 is ejected from the orifice 32 of nozzles 30 against the surfaces 50 of the plates 45.

It is noted that the nozzles 30 are located just above the surface 51 of the froth layer 11', such surface being located at about the level of trough 12. The discharge orifice 32 of each of the nozzles 30 is designed to emit a relatively highly divergent stream 52 of air, so that there is a relatively large area of impingement of the air stream against the adjacent surface 50 of the plates 45. Also, it is noted that the jets or streams of preferably moist air are directed downward at such an angle as to sweep the froth back away from the surfaces 50 of the plates extending through the froth layer 11', while the plates are stationary therein or are being lowered or lifted through the froth layer, so that the froth is substantially prevented from thus contacting the plates 45. The discharge orifice 32 may be designed to have a size and shape dependent on the desired velocity of air stream.

In this manner, surfaces 50 of plates 45 being immersed in the solution for etching are stripped of any entrained etchant deposited on the surfaces thereof especially during passage through the zone 53 above the etching solution in the tank. Further, and of particular significance, where the plates 45 are being withdrawn from the etching solution following treatment therein, surfaces 50 of plates 45 are stripped and rinsed of adhering etchant by the blasts of preferably moist air which wash down the plate surfaces 50. Also, as to any etchant unrinsed from the surfaces of the plates 50 by the moist air blasts, the latter will provide the metal surfaces with a protective coating which will materially reduce or halt the action of any residual adhering etchant and prevent attack by any entrained caustic etchant in the vapors above the bath.

The ratio of moisture in the air streams can be varied to produce certain effects. Thus, for example, sufficient water may be present in the air streams to result in a washing down of the surfaces of the work piece extending through the froth layer, and a substantial elimina-

tion of any adhering etching agent. This washing phenomenon can be accentuated by still further increasing the amount of moisture in the air streams so long as any undesired dilution of the etching bath is not obtained. If desired, such washing action can be reduced by decreasing the amount of moisture in the air streams and relying on the sweeping effect of the air streams to give the protection against the foam action previously discussed. However, it is preferable to have sufficient water in the air streams to give a washing effect and to compensate for water lost in the etching bath.

While the application of the invention has been described above chiefly with respect to passage of a work piece through the froth layer during its immersion into or withdrawal from the solution, the streams of moist air can be directed against the part while the latter is maintained stationary in the bath during etching, where only a portion of the part is immersed. Under these circumstances the streams of air keep the froth substantially free from contact with the exposed surfaces of the part extending through the layer, as in the case where the part is moving through such layer during immersion in or removal of the part from the etching solution.

Also, the relatively cool streams of air emitted from the nozzles 30 have a lateral pressure component and form a sort of blanket of cool air above the froth layer in tank 10. Since the warm vapors containing entrained etchant and the hydrogen gas evolved in the etching reaction rise from the solution at about atmospheric pressure, such vapors and hydrogen gas are essentially prevented from rising through the streams of air emitted from the nozzles and acting as a blanket, and are swept laterally toward the sides of the tank beneath the air streams from the nozzles, and into suitable outlets such as conduit 13 and the stack 14. This materially cuts down the amount of entrained etchant in the zone above the bath and thus reduces pre-etching of a metal part passing through this zone into the solution, and prevents formation of a residual coat of etchant on the part during removal thereof following etching.

As previously noted, the ratio of water to air in the moist air streams directed against plates 45 may be adjusted to approximately balance the amount of water lost in tank 10. If, however, smaller ratios of water are employed in the air stream or blast, additional water may be added to the tank, as desired, through pipe 55 connected by bracket 56 to the top of the tank. Vapors and hydrogen gas liberated in the reaction and passing with any overflowing froth into pipe 13 and stack 14 are vented therein, and froth dropping into the bottom of the stack is drained therefrom through line 15.

The instant invention is applicable to the etching of any suitable metals including, in addition to aluminum, iron, nickel, magnesium, zinc, titanium, stainless steel, etc., and their alloys. Further, it is noted that aluminum and its alloys may be etched in acid solutions such as hydrochloric acid or salts as for example ferric sulfate, as well as alkali solutions.

The following advantages are obtainable according to

the invention: (1) control of foam and froth, (2) uniform etching of a metal part in an etching bath containing a froth layer on the surface thereof, (3) directing of the hydrogen gas and entrained etchant fumes to the exhaust equipment, (4) reduction of the amount of entrained etchant, for example, caustic alkali, in the vapors above the etching bath, (5) prevention or reduction of attack by any such entrained etchant on the metal part as aluminum or an alloy thereof, being treated, particularly by washing down of the part by the air streams, (6) cooling of the metal part by the air streams to reduce or stop the action of any etchant unrinsed from the surface of the metal part, (7) cooling of the zone above the bath, and (8) protecting the overhead equipment from the corrosive action of vapors containing entrained etchant.

Of course, it will be understood that the apparatus described herein 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. The process of etching a metal work piece in an etching solution containing a layer of froth on the surface thereof, which comprises passing said work piece through said layer into said solution, etching said work piece in said solution, passing said work piece out of said solution and through said froth layer, and directing a moist air stream from a point above the surface of the froth into said froth at an acute angle to the surface of said solution below the froth line and against said work piece during passage thereof through said froth layer both into and out of said solution.

2. The process of etching a metal work piece in an etching solution containing a layer of froth on the surface thereof, which comprises passing said work piece through said layer into said solution, etching said work piece in said solution, passing said work piece out of said solution and through said froth layer, and directing a moist air stream from a point above the surface of the froth, into said froth at an acute angle to the surface of said solution below the froth line and against said work piece during passage thereof through said froth layer out of said solution.

References Cited in the file of this patent

UNITED STATES PATENTS

1,081,289	Albert	Dec. 16, 1913
2,293,201	Gaebel	Aug. 18, 1942
2,347,511	Scarzello et al.	Apr. 25, 1944
2,370,495	Sebell	Feb. 27, 1945
2,390,007	Sherman	Nov. 27, 1945
2,566,142	Powers	Aug. 28, 1951
2,724,918	Triman	Nov. 29, 1955