

252/107

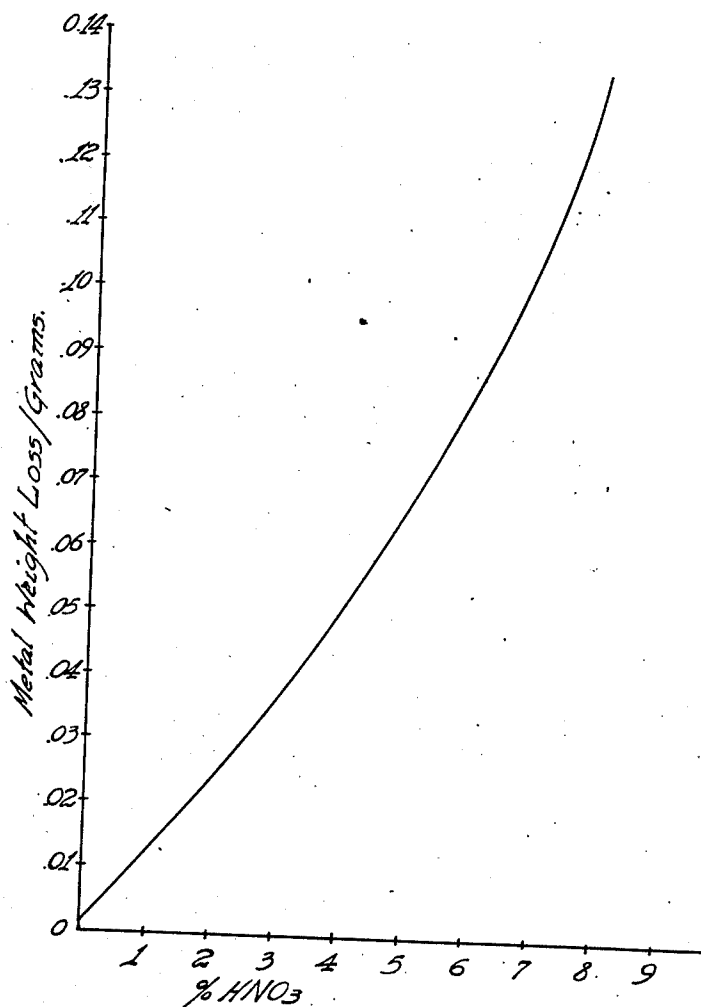
Oct. 7, 1947.

J. C. LUM ET AL

2,428,464

METHOD AND COMPOSITION FOR ETCHING METAL

Filed Feb. 9, 1945



WITNESSES:

E. Eiding.
A. Shapiro

INVENTORS

John C. Lum And
George W. Pernstedt

By
Edward W. Savage
ATTORNEY

UNITED STATES PATENT OFFICE

2,428,464

METHOD AND COMPOSITION FOR
ETCHING METAL

John C. Lum, Union, and George W. Jernstedt,
Belleville, N. J., assignors to Westinghouse
Electric Corporation, East Pittsburgh, Pa., a
corporation of Pennsylvania

Application February 9, 1945, Serial No. 576,975

7 Claims. (Cl. 41—42)

1 This invention relates to the treatment of metal, and more particularly to the etching of the surfaces thereof.

While many etching compositions are known to the art, certain undesirable actions usually occur during their use. The rate of removal of metal from the surfaces of the members being treated is generally nonuniform, the highest spots being etched at a rate many times faster than depressions or recesses. In many cases the etching compositions leave a pitted surface. The pitted surface appears to result from the fact that metal crystals of differing composition are subject to different rates of reaction with the etching composition whereby some portions are removed at a much faster rate than other portions of the same surface.

Furthermore, some etching solutions do not produce a clean bright surface after being applied to a metal. The surface may be left with a dull appearance or it may be coated with a film of some undesirable chemical product. If the metal is to be subsequently electroplated following the etching treatment, the surface chemical products left may seriously interfere with the electroplating process. In many cases the dull surfaces are unsuitable for electroplating, since the electroplated coating is likewise dull in appearance.

The object of this invention is to provide for removing metal uniformly from the surfaces of members without pitting by applying thereto an acid composition.

A further object of the invention is to provide an acid composition capable of uniformly etching metal surfaces without pitting or leaving an undesirable chemical product thereon.

Other objects of the invention will in part be obvious and will in part appear hereinafter. For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description and the single figure of the drawing in which the amount of metal removed is plotted against composition.

According to the present invention, an acid composition, composed of nitric and phosphoric acids, is prepared whereby exceptional etching results are attained in practice. The acid composition is critical both as to the components and their proportions. The active ingredient in the

2 etching composition is nitric acid, and its proportion may be varied from about 1% to 18% of the weight of the composition. From about 5% to 20% by weight of water is present. The balance is substantially all phosphoric acid. Investigation shows that the phosphoric acid is a critical ingredient but it does not actively take part in the etching reaction. Baths of the composition have been employed for prolonged periods of time with substantially no change in the amount of phosphoric acid. Orthophosphoric acid is preferred, but other phosphoric acids such as pyrophosphoric acid and the like may be employed. For treating certain metals such as carbon steel containing a small amount of alloying ingredients which tend to passivate the surfaces, the bath composition may include an inorganic chloride in the amount of the order of 1% of the weight of the bath. Suitable inorganic chlorides are sodium chloride, hydrochloric acid, potassium chloride, calcium chloride, ferric chloride and the like.

A particularly satisfactory composition for commercial use is one containing about 4% nitric acid, 15% to 16% water, and the balance orthophosphoric acid. The composition may be prepared by admixing 93 gallons of 85% phosphoric acid and 7 gallons 71% nitric acid. This composition etches metal at a slow enough rate over one containing, for example, 25% nitric acid, to enable more accurate control of the thickness of the metal removed.

The metals that may be etched with the above composition with good results are copper and copper alloys containing substantial amounts of copper. Many varieties of brasses and bronzes have been successfully treated therewith. Ferrous metals and low alloy steels which are not passive also have been etched with satisfactory results.

3 In employing the compositions, a porcelain or glass jar or tank is filled with the composition and the metal members to be etched are dipped therein for a predetermined period of time. With the composition of 4% nitric acid and 15% to 16% water at room temperature, ten minutes' immersion will remove approximately 0.001 inch thickness of metal. By controlling the time of immersion, the amount of metal removed may be controlled to a very accurate degree. In practice, we have been able to remove a few ten-thou-

sandths of an inch of metal from machine screws in order to accommodate an equal thickness of electroplated metal with such accuracy that the plated screws meet the most precise requirements. Machine screws and other small parts, for example, may be put into a perforated porcelain basket and immersed in the composition of this invention. When removed from the bath at the end of a predetermined period of time, it will be found that all the screws or other members have been etched an identical amount. In other words, the acid composition is as reactive at the interior of a large basket of metal pieces immersed therein as it is at the surface portions. This feature is extremely important for commercial practice.

In carrying out the etching operation, it is desirable to prepare the work by treating it initially to remove all grease, dirt and other interfering foreign matter from the surfaces of the metal. After the cleaning operation the metal, however, is liable to carry a small amount of water which, when introduced into the bath, would raise the water content above the indicated desirable amount and thereby render the composition less effective. Therefore, it is advisable to predip momentarily the work in a bath of the same composition as that in which the etching is to take place and thereby remove any moisture or water thereon. A partially spent bath of the composition may be employed for this purpose. This step will ensure that the actual etching bath will be maintained within predetermined condition.

Referring to the drawing there is plotted a graph of the weight of metal removed from a 1½ inch x 10—32 fillet head steel screw when immersed for ten minutes in an aqueous solution containing 15 parts by weight of water and 85 parts orthophosphoric acid, the remainder being percent of 70% nitric acid.

As shown in the drawing, the amount of metal removed is dependent on the nitric acid content of the composition. As the nitric acid content falls, the metal removed per unit area diminishes correspondingly.

Accordingly as metal is treated over a period in the composition, it will be necessary to replenish the nitric acid from time to time. The amount of nitric acid to be added is determined by finding out the nitric acid in the composition. A convenient method for doing this is to place a weighed sample of metal having a predetermined surface area in the composition for a predetermined length of time and determine the amount of metal removed by reweighing at the end of the period of time. The addition of nitric acid is made in accordance with the chart of the drawing. Obviously chemical analysis may be made of the solution to determine how much nitric acid has been spent.

Eventually, the composition will have dissolved a substantial quantity of metal as a salt, and will be less suitable for further use as an active etching agent. A fresh bath of the composition is prepared and the old composition may then be used as a predip in order to remove any excess moisture present on the surface of metal to be etched.

The rate of removal of the metal from the surfaces of members is quite uniform over the entire surface, regardless of whether or not the surface is regular. Even in screw threads the rate of etching of the lands to the root is about 7 to 4, whereas conventional etching acids will etch as a ratio of 7 to 1. Substantial amounts of metal may be removed by the compositions of this invention. The final product will not only

be closely similar to the original member, but will be bright and free from any observable pitting.

The surface of the etched metals will be clean and adapted for the reception of electroplated coatings. Electroplating may be carried out with excellent adhesion being attained. Copper, nickel, zinc, cadmium, chromium or tin may be deposited on the etched surfaces without any further treatment. The contour and dimensions of the original article may be brought back with great fidelity by electroplating after etching. For example, ordinary plating is deposited on screw threads in almost precisely the same proportions as the metal is removed therefrom by the etching composition of this invention.

The composition of the present invention is employed without an electrical current being applied. The use of an electrical current is detrimental and should be avoided.

A further advantage characteristic of the composition is that rough machined members carrying small burs may be readily deburred by the etching composition. The main contours of the machined members are maintained, but the burs disappear when treated for a period of time sufficient to remove a thickness of metal corresponding to about one-half the thickness of the bur. The surface of the metal is brightened and therefore the application of the etching composition to machine work that is not ground and polished is suggested.

Since certain changes in carrying out the above processes and certain modifications in the compositions which embody the invention may be made without departing from its scope, it is intended that all the matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. An acid etching composition comprising essentially of from about 1% to 18% by weight of nitric acid, from about 5% to 30% by weight of water, and the balance being substantially all a phosphoric acid.

2. An acid etching composition comprising essentially of from about 1% to 18% by weight of nitric acid, from about 5% to 30% by weight of water, and the balance being substantially all orthophosphoric acid.

3. An acid etching composition comprising essentially about 4% by weight of nitric acid, about 16% water and the balance substantially all phosphoric acid.

4. An acid etching composition comprising essentially of from about 1% to 18% by weight of nitric acid, from about 5% to 30% by weight of water, about 1% of an inorganic chloride to improve etching, and the balance being substantially all a phosphoric acid.

5. An acid etching composition comprising essentially of from about 1% to 18% by weight of nitric acid, from about 5% to 30% by weight of water, an inorganic chloride of the order of 1% of the weight of the composition, and the balance being substantially all orthophosphoric acid.

6. The process of etching the surface of metals of the group of copper, copper alloys and ferrous metals to provide for effecting a uniform removal of the metal without pitting comprising applying to the surface of the member an etching composition composed of from about 1% to 18% by weight of nitric acid, from about 5% to 30% by weight of water and the balance substantially all phosphoric acid.

5

7. The process of etching the surface of metals of the group of copper, copper alloys and ferrous metals to provide for effecting a uniform removal of the metal without pitting comprising applying to the surface of the member an etching composition composed of from about 4% by weight of nitric acid, about 15% to 16% by weight of water and the balance substantially all orthophosphoric acid.

JOHN C. LUM.
GEORGE W. JERNSTEDT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,776,535	Bekk	Sept. 23, 1930

6

Number	Name	Date
1,994,500	Boller	Mar. 19, 1935
2,311,047	Hagelin	Feb. 16, 1943
2,087,230	Bigeon	July 20, 1937
2,037,633	Kelvie	Apr. 14, 1936
1,434,798	Stafford	Nov. 7, 1922

FOREIGN PATENTS

Number	Country	Date
412,641	Great Britain	Feb. 6, 1934

OTHER REFERENCES

15 Metal Finishing, June 1943, pages 343 to 347 of article on "Chromium Plating of Dies and Tools" by D. A. Cotton.