United States Patent Office 3,194,704 Patented July 13, 1965

3,194,704

METHOD FOR THE PREPARATION OF ALUMINUM FILLER WIRES FOR ARC WELDING

Maurice Hubert, Clichy-sous-Bois, France, assignor to l'Air Liquide, Societe Anonyme pour l'Etude et l'Exploitation des Procedes Georges Claude

No Drawing. Filed Sept. 21, 1962, Ser. No. 225,360
Claims priority, application France, Sept. 28, 1961, 874,455, Patent 1,308,719
1 Claim. (Cl. 156—22)

This invention relates to the welding of aluminum and aluminum alloys, and more particularly to the welding of such metals by an electric arc with a fusible electrode in an inert-gas atmosphere.

In the construction of works requiring high-quality welded joints, notably of vessels or lines which have to be absolutely leak-proof, the presence of gas inclusions in the welded joint is a major problem.

It is universally recognized that such inclusions or blow-holes are due to hydrogen, which originates mainly from inclusions of fatty substances (residues of the wire-drawing operation) and from the mositure absorbed at the surface of the wire.

The removal of fatty inclusions is most difficult when they are lodged in micro-cracks formed during the drawing operation. Such cracks are sometimes deep and hardly to be penetrated by pickling media, as they are related to complex-shaped laps and tears in the metal, which are altered by the successive drawing passes.

Attempts have been made to remove such inclusions through deep cleaning. Up to now, chemical pickling methods have mainly been used, notably with caustic soda which has the drawback of giving a thick layer of porous alumina which absorbs and holds moisture.

Other methods of chemical pickling with acid baths require a neutralizing post-treatment, which also produces a thick layer of porous alumina, and may leave residues which are not entirely removed by rinsing and are undesirable for welding.

In practice, the only treatment giving good results has been the mechanical shaving process.

According to this invention, it has unexpectedly been found that some treatments advocated for the brightening and superficial polishing of light alloys in a single operation make it possible to eliminate with an unexpected thoroughness the residual inclusions of drawing compounds, including those which are lodged in deep micro-cracks, and that such treatment also gives unexpected advantages in the use of the treated wires in arc welding.

"Brightening" is understood to mean an operation which imparts an exceptionally high specular reflective power to the surface of aluminum or aluminum-alloy objects. It is well known that some chemical baths used for that operation are strongly corrosive, but it was hardly to be expected that such treatments might be used to remove inclusions of fatty substances from the depths of micro-cracks, and to obtain the attendant advantages to be described hereafter.

U.S. Patent 2,681,402, Muller, discloses etching an aluminum welding wire in an acid bath which may consist essentially of nitric acid, phosphoric acid and acetic acid, in order to remove the oxide film from the wire.

U.S. Patent 2,650,157, Cochran, discloses a brightening solution for aluminum articles which consists of about 73 to 83 percent phosphoric acid, about 2 to 5 percent nitric acid and about 14 to 23 percent water, with an optional addition of acetic and/or sulfuric acid in a combined amount by weight up to one half of the total weight of phosphoric acid, nitric acid and water therein.

This Cochran patent further discloses a method in which the article to be brightened is immersed for a period of about ¼ to 5 minutes in the above solution, which is maintained at a temperature above about 70° C.

French Patent 967,207, Vernal, teaches adding to a solution of the kind disclosed by Cochran a metallic salt having a catalytic action, such as salts of nickel, cobalt, copper, zinc, chromium or even aluminum. This salt may for instance consist of nickel nitrate, the amount added being 0.3 percent of the solution weight.

French Patent, 1,057,782, Vernal, discloses further adding to the above solution from 1 to 30 percent of a weak acid capable of forming a complex with phosphoric acid, this weak acid being one or several of the following acids, moylybdic, iodic, vanadic, boric, or tungstic.

Referring to the above-cited prior patents, Muller discloses an etching process, while Cochran and the two French patents are specifically concerned with the brightening of aluminum articles.

The present applicant has found that by combining the etching and brightening effects obtainable sperately by the prior treatments, an unexpected improvement in the welding properties of the treated wire could be obtained.

More specifically, the treatment according to the present invention comprises immersing a coil of the wire to be treated during about 1 minute to about 3 minutes, in a bath subjected to continuous stirring and maintained at a temperature about 80° C., the composition of the bath being approximately the following, by weight, calculated with theoretically pure constituents:

	Percent by weight
H_3PO_4	50 to 75.
H_2SO_4	5 to 20.
HNO_3	5 to 25.
Complex-forming acid	0.5 to 10.
Catalyst	0.5 to 2.
H_2O	Complement to 100%, that is approximately, 15 to 25%.

The complex-forming acid is a weak acid capable of forming a complex with phosphoric acid, and may be selected among any of those listed in the above-mentioned French Patent No. 1,057,782, while the catalyst may be any of those listed in the French Patent No. 967,207.

According to one feature of the method of this invention, the treatment is carried out so as to etch the superfical layer containing the structural defects which may contain inclusions.

As an indication, the layer of metal to be removed is usually between 15 and 30 microns thick; however, according to the initial quality of the wire, a thicker layer may have to be removed.

The removal of the incrusted hydrogenated compounds was ascertained through welding tests, purposely conducted so as to ensure a very fast cooling of the welding bath, in order to slow down the degassing of the said bath, and to provide better evidence of the presence or absence of blow-holes due to hydrogen or to other gaseous inclusions. Under such conditions, it was found that wires treated according to the invention gave welded joints with excellent compactness; radiograms showed the almost complete absence of porosities.

The method according to the invention may be carried out with, but preferably without, the application of an exterior electromotive force. Careful previous degreasing, with perchloroethylene vapor for instance, is recommended.

Electrode wires prepared according to the method of this invention are characterized by their glossy appearance; but this is only a secondary result here, the main result being the improvement of the compactness of the welded joint, through a more thorough elimination of the residual lubricant from the drawing operation.

Accessorially, the elimination of those fatty substances also manifests itself through the disappearance of the blackish carbonaceous traces usually present on the edges of the weld joint. Surprisingly, the stability of the arc is also materially improved, which seems to be due to the fact that the glossing treatment gives an extremely smooth surface, upon which a very thin, very uniform and very compact layer of alumina is formed, this reduces to a very large extent the voltage fluctuations between the electrode wire and the contact piece used to feed current to the wire. The compactness and thinness of this layer of alumina are also of advantage in preventing the absorption of moisture and of sundry impurities during the storage of the treated wire. However, it could hardly be foreseen that the treatment according to the invention, carried out in an aqueous medium, would not give rise to reabsorption of hydrogen, such as occurs with others treatments like conventional acid pickling methods.

It was also found that wires prepared according to the invention had an accessory but by no means negligible advantage for semi-automatic welding. In this method of welding, the electrode wire is guided by a fairly long flexible sheath from a wire feed reel, which is usually stationary, to the welding gun. Wires prepared according to the invention give slighter friction inside the sheath; above all, the friction is much more uniform, which materially improves the uniformly of wire feed.

Finally, possible defects in the wire, which may have escaped the glossing treatment or occurred after the said treatment, are more easily detected with the eye or by automatic means, for instance photo-electric devices, thanks to the uniformly smooth surface of the wire, which makes quality control of the wire more efficient during the rewinding after treatment.

What I claim is:

A method for the preparation of aluminum and aluminum-alloy welding wires, in particular for use as bare electrode wires in sigma welding, which comprises immersing a length of such wire in a bath consisting essentially of:

	Percent by weight
H_3PO_4	50 to 75.
H_2SO_4	5 to 20.
HNO_3	5 to 25.
H_2O	Complement to 100%.

together with:

(a) a weak acid capable of forming a complex with H_3PO_4, said weak acid being an acid of the group which comprises boric, molybdic, iodic, vanadic and tungstic acids, this weak acid representing from 0.5 to 10% by weight of the bath,

(b) a catalyst being a metallic salt of a metal of the group which comprises copper, nickel, cobalt, chromium, zinc and aluminum, this catalyst representing from 0.5 to 2% by weight of the bath, said method further comprising maintaining said bath at a temperature above 80° C. and continuously stirring said bath with said wire therein, until a layer of metal comprised between about 15 and 30 microns, has been chemically removed by said bath from the surface of said wire and said wire exhibits a specular gloss.

References Cited by the Examiner

UNITED STATES PATENTS

2,650,157	8/53	Cochran	156—21
2,681,402	6/54	Muller	219—10
2,682,503	6/54	Hesch	204—140.5 X
2,729,551	1/56	Cohn	204—140.5 X
2,797,174	6/57	Mozley	29—197.5 X
2,834,659	5/58	Mathre	204—140.5 X

FOREIGN PATENTS

967,207	10/50	France.
1,057,782	3/54	France.

OTHER REFERENCES

"How To Control the Aluminum Bright Dipping Process," by Nelson et al., Modern Metals, September 1961.

DAVID L. RECK, *Primary Examiner.*

HYLAND BIZOT, *Examiner.*