

UNITED STATES PATENT OFFICE

2,296,757

ELECTROLYTICALLY DEPOSITED IRON

John L. Young, Pittsburgh, Pa., assignor, by
mesne assignments, to Plastic Metals, Inc., a
corporation of New York

No Drawing. Application September 1, 1938,
Serial No. 227,972

1 Claim. (Cl. 204—112)

This invention relates to electrolytically deposited bodies and methods of production of such bodies. Its object is the production of bodies of superior quality and of enhanced utility.

In an application for Letters Patent of the United States, Serial No. 50,003, filed November 15, 1935, by John L. Young and Allen Cameron Jephson now Patent Number 2,128,389 of August 30, 1938; the electrolytical deposit of a sheet of iron is described; and to the deposited sheet certain valuable characteristics and adaptabilities are imputed. These characteristics and adaptabilities are due to the fact that the component crystals of the so-developed sheet extend in a direction perpendicular to the surface upon which the deposit is made, and to the further fact that small amounts of iron oxide are occluded at the grain boundaries. The sheet may by heat treatment be rendered drawable, without destruction of its characteristic and desirable crystalline grain structure; and it presents a surface that is relatively inert, not readily susceptible to chemical reaction, superior in ability to afford union with an applied material, superior in its responsiveness to welding, soldering, tinning, and to enamel coating operations, and superior in its ability to receive and carry coatings of lacquer and of paint.

I am one of the above named joint applicants. My present further invention is an improvement upon the invention of that earlier application; an improvement, by virtue of which the valuable features and characteristics already recognized may be provided and enjoyed in larger measure.

It is well known to the industry that, by the process of electroplating, a given metal may be derived from a source in which it is found in relative impurity—chemical combination or physical association with other substances—and deposited in substantial purity upon a cathode. Explanation is, in the earlier application, afforded that in such manner a deposit may be formed whose grains are of iron, a deposit that is free of impurities of a reducing nature and that carries, occluded at the grain boundaries, small quantities of iron oxide (or hydroxide). The procedure of my present invention, otherwise such as that just indicated, involves the development at the grain boundaries of the deposit, not of small quantities of iron oxide alone, but of small quantities of iron oxide in association with silica. These combined oxides, so present, afford a product that possesses in superior degree the good features and characteristics indicated—due, as I believe, to a superior toughness

strength, and inter-grain bonding of these combined oxides.

Electrolytic iron has been found to be extremely ductile, but to lack resistance to shock. As an illustration, I prepared a number of shotgun shells, using a paper shell with metal end. The metal end was made of electrolytic iron. I found that, while these shells could be fabricated satisfactorily, when the loaded shell was placed in the gun and fired the metal end split. This quality of electrolytic iron has been previously mentioned in The Metal Iron, Cleaves and Thompson. I believe that this lack of resistance to shock is caused by the iron oxide between the grains of iron being brittle, and lacking adhesion to the iron crystals. I have improved this resistance to shock greatly by adding impurities at the grain boundaries, so that during heating a strong welding agent, flux, or slag will be formed.

In the practice of my invention I may employ in the electrolytic cell a stripping cathode, a soluble anode of iron, and an electrolyte such in composition as to afford a deposit free of impurities of a reducing nature. The electrolytic operation will be conducted at such temperature and the current strength will be such as to effect the desired deposit of iron upon the cathode. These matters of electrolyte composition and of conditions of operation are within the knowledge of the art. To the electrolyte silica is added in suitable form (within the knowledge of the art), to effect simultaneously with the iron a deposit of silica. The crystalline grains of the deposited iron will be found to extend in a direction perpendicular to the surface of the cathode. The deposit will be found to be substantially free of hydrogen; but at the grain boundaries will be found moisture, iron hydroxide, and some form of silica.

The sheet so deposited may be stripped from the cathode and then heat-treated in non-oxidizing atmosphere. The silica combines with the iron oxide, forming an iron silicate at the grain boundary which essentially holds the needle structure obtained by electrodeposition, even though the sheet is heated above the upper critical point where recrystallization should take place.

By this means a sheet of iron is obtained which can be heat-treated to obtain its deep drawing properties at a point above the upper critical point. This feature is of special advantage in commercial work, where furnace temperatures are subject to considerable fluctuation and where the upper critical temperature is

liable to be exceeded. The effect, in such case, would be a great reduction in ductility, if the sheet were free of silica, or its equivalent.

While I have specified silica, I am in fact disclosing, in this and in a companion application, Serial No. 222,297, a method of holding the electrolytic structure of a sheet when heating above the upper critical, which consists in causing the iron oxide at the grain boundary to combine with another substance, thereby forming an envelope around the grain which essentially prevents the crystal from losing its identity when overheated. That other substance may be silica or the oxide of such other metals as titanium, vanadium, molybdenum, and the like, that, within the knowledge of the chemist, under the conditions of operation, combine with iron oxide, to form silicate, titanate, vanadate, etc. of iron.

While it is understood that this envelope around the electrolytic crystals would in practice be made as thin as possible to attain the desired result, for purposes of demonstration, using silicate, high pH, and low current density, a material can be made which will contain sufficient slag distributed between the electrolytic crystals to give something of the appearance under the microscope of a knobbled iron.

In the finished sheet the combined iron oxide and silica (or equivalent oxide) will be found to have effect superior to that of iron oxide so present alone. The response of the sheet to deep-drawing dies is more complete; it will endure greater strains without rupture; and the surface is of even better condition for the reception of and for the adherence of tin, solder, glass, lacquer, or paint. The inertness of surface renders the sheet peculiarly suitable as material from which to shape metal containers.

The practice of the invention does not require the use of a soluble anode. The art knows how,

variously to effect the deposit of iron free of association with any reducing impurity, and, as has been said, the concomitant deposit of silica, once suggested, may be accomplished within the knowledge of the art. In the choice of the electrolyte solutions of organic salts are ordinarily to be avoided, since, manifestly, under ordinary conditions, their use would prevent the intergranular deposit of the desired oxides.

It will have been remarked that the good and valuable characteristics of the electrolytically deposited sheet of my invention are not wholly attendant upon or limited to the peculiar crystalline structure of an electrodeposited sheet, and are such as may be enjoyed whether the sheet be shaped between dies or not. That is to say, the sheet is of such surface character and quality as to render it peculiarly suited for various welding, soldering, and coating operations. It follows that, if a body of metal otherwise produced (say a rolled sheet of steel) be electroplated with iron in the manner described, and a deposit be produced in which a small deposit of combined iron oxide and of silica (or equivalent oxide) be occluded at the grain boundaries, the article produced will be of superior quality for subsequent welding, soldering, and coating operations. I mean, therefore, to include within the field of my broader claims a metallic article that possesses superficially only the character of electrolytically deposited iron with iron oxide and silica together occluded at the grain boundaries.

I claim as my invention:

An electrolytically deposited sheet of iron capable of maintaining its fine-grained electrolytic structure when heated to a temperature exceeding the upper critical, in which the crystalline grains of the deposit are enveloped in a slag of iron oxide and silica.

JOHN L. YOUNG.