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PROCESS BY WHICH ALUMINUM METAL AND ITS ALLOYS MAY BE APPLIED TO FERROUS METAL.

No Drawing.

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To all whom it may concern:

Be it known that I, CARL W. PFEIL, a citizen of the United States, residing at Greenbank, in the county of Island and State of Washington, have invented Processes by Which Aluminum Metal and Its Alloys May be Applied to Ferrous Metals, of which the following is a specification.

My invention relates to the art of providing metals with a protective coating, as for instance, applying a coating of a rust and acid resisting metal to a baser metal.

The object of my invention is to apply a metallic protective coating in such a manner as to secure a joining of the protective and the base metals in that close and intimate manner that the protective coating cannot be scaled off, the union between the metals being more in the nature of an alloying of the two, rather than an adhesive contact between them.

The process employed by me in carrying out my invention will be hereinafter described and the features thereof which are believed to be novel will be particularly defined by the claims.

While the field for the use of my process is probably greater in the application of an aluminum coating to sheets of a ferrous metal for the manufacture of a product usable as a substitute for tin plate, it is nevertheless adapted to the application of protective alloys having an aluminum component and also for application of such a protective metal coating to cast and wrought metals irrespective of their thickness and bulk. I will herein more specifically describe the application of my invention to providing an aluminum coating for sheet metal; it is, however, to be understood that this is not done as a limitation to this use only, but only as illustrative of the principles to be employed and the manner of securing the desired results.

It has been rather generally held that proper welding or soldering of aluminum to aluminum, or to other metals, is prevented by an oxide film which promptly forms upon a newly formed surface of aluminum. This theory of an oxide film may or may not be correct. I have, however, found that if aluminum be reduced to very fine powder-like particles and during such reduction a coating of suitable protective material be provided, such a mass applied as a coating

to a ferrous metal and suitably treated, may be joined therewith in an integral and permanent manner suggestive of the formation of an alloy on the plane of contact.

It is believed that the welding or alloying action occurring between the ferrous base and the aluminum or aluminum alloy is materially facilitated or controlled by the electric relationship existing between the two and by electric action occurring when they are brought into contact. Such electrical action is also probably intensified by the heat.

I have noticed that success in getting a welding or alloying union between the base and coating metal appears to depend very much upon the base metal being electronegative to the coating metal. It would appear probable that an action occurs which is of an electrolytical character and this supplements the ordinary fusing action of heat.

The surface thus formed has the protective and resistant qualities of the material forming the coating and cannot by ordinary means be separated from the metal which forms the base.

As the protective material for the fine particles of the coating metal I have employed oils, fats, waxes, fatty acids, resins and the like, and other substances and combinations thereof capable of forming air-excluding films and of being volatilized or otherwise eliminated or dissipated by heat at temperatures lower than the melting point of the coating metal used. The ideal is a substance or mixture which will not be dissipated until the fusing temperature is nearly reached.

This protective material may be of animal, vegetable or mineral origin. I have found a large number of products to be adapted for such use. The chief requirement appears to be their ability to coat the metallic particles with a thin film which excludes the air and the quality of being volatilized or dissipated by heat at temperatures below that of fusing of the coating metal.

Among the substances which I have found adapted to this use are the mineral oils, of which kerosene is a type; mineral waxes, of which paraffin is a type; vegetable oils, of which palm oil is a type. Or I may use combinations of two or more of such substances as the protective film forming ma-

terial, this including chemicals such as ammonium chloride.

In preparing the metal for the coating material I finely divide and grind, or otherwise pulverize, it in a bath of the protective film forming material. The means employed in grinding the metal is immaterial if it will reduce it to fine particles. It is desirable that the particles be reduced as fine as possible. The result of this work is a colloidal-like sludge or paste which should contain the largest possible amount of metallic particles.

In carrying out the coating process this product is heated to a temperature which will vary with the metal contained therein and with the kind of film forming material which has been used. The temperature should be as high as possible, less than that which will volatilize or otherwise eliminate the film forming material, or less than the fusing point of the metal, depending upon which is the lower.

The body of the metal to be coated is heated to a temperature in excess of that of the bath and is coated either by dipping the heated metal in the bath or by applying the bath to the heated metal, as best suits the conditions. If the body to be coated is dipped in the bath, it is left therein only momentarily. The heat of the metal base, being higher than that of the bath dissipates a portion of the film forming agent. The metal content of the bath adheres as a thin coating to the base.

The metal body being coated is further heated after removal from the bath, thus completing the driving off of the film forming materials from the compound which has adhered to the base. This coating has apparently been alloyed with the base so as to secure the coating to be in effect an integral part of the base. There is no cleavage plane between the two which will permit separation.

The protective coating may be applied to the base or article to be coated, by brushing or flowing it thereon. The conditions as to temperatures should, however, be essentially the same. The heat and temperature needed to evaporate or drive off the protective film must be applied, in part at least, after the film has been applied. The fundamental temperature conditions which are desirable or necessary are, first, that the temperature of the metal bath be less than that which will volatilize or drive off the protective film forming material and that of the metal base after the application of the film be such as will volatilize or drive off this film forming material.

The temperature of the bath and of the metal base at the time of applying the coating contributes to the perfection of the union between them, a higher temperature

producing better results than a lower temperature. I also prefer that the metal base be of a temperature somewhat above that at which the protective film forming material is driven off at the time of applying the coating. Under such conditions the heat stored in the metal base acts to drive off some of the film forming material and thus to secure union between the base and the coating metals while immersed in the bath.

By applying the coating bath to the base without immersion, or by partial immersion, it is possible to apply a protective coat locally. The surface after coating may be rolled, burnished or given any treatment which may be given to metals coated by other processes.

I have found a coating thus applied to be more perfect in its continuity than an ordinary tinplate coating. It does not seem to possess the microscopical uncoated points or holes in the protective layer through which acids may act upon the metal base and rust take place.

I have found this process to be applicable to applying coatings of aluminum or alloys in which aluminum forms a material part. The process is, however, not limited to use with these metals alone. One of the chief applications of this process is the application of aluminum and alloys of aluminum to iron plates to form a substitute for tin plate. I have found it possible in this way to make what may be called aluminum plate which may be worked exactly as commercial tin plate and in which the protective qualities against the action of acids, corrosive agents and heat is superior to that of tin plate, both by reason of the superior resistant quality of aluminum to such agents and by reason of its superior mechanical condition in its freedom from minute perforations and its higher resistance to heat and also its non-poisonous qualities.

Such coatings are superior to tin plate in this that heating to a temperature less than the melting point of aluminum will not cause loosening of the coating from the base as may be done with tin plate. There appears to be an inter-penetration or alloying of the coating and base metal which prevents separation and is not affected by any heat which will not actually melt the coating metal.

The essential feature in the success of welding where at least one of the metals is aluminum or an aluminum alloy appears to be the provision of a fresh surface on the aluminum and protecting it from the action of the air by giving it a protective film, as of an oil or wax or other air-excluding substances which has a high dissipating point, and then eliminating this film at the time of joining the surfaces, whereby the aluminum or aluminum alloy is presented to the

surface to which it is to be welded in an absolutely clean condition without the invisible film formed thereon by the action of air whereby it readily forms a true welding union.

While I have chiefly herein dwelt upon the application of a very thin coating of the protective metal and by the use of the protective metal in the form of powder, the same principle is believed to apply to the union of distinct sheets, the surfaces to be welded being first treated by grinding or otherwise removing a surface film and protecting this by a protective film until the welding action occurs.

Commercial aluminum powder may be used by my process but the results are not as satisfactory. A coating made by using commercial aluminum powder will scale, especially when plates so coated are bent or seamed.

What I claim as my invention is:—

1. The process of producing a protective coating of one metal upon another which consists in very finely dividing the coating metal in a bath of a film producing material which may be driven off by heat, applying the product thus formed to the metal to be protected and heating to a temperature which will drive off the protective film and fuse the coating and base metal.

2. The process of applying an aluminum coating to a base metal which consists in very finely dividing the aluminum in a bath of an air-excluding film-producing material, applying the compound thus formed to the metal to be coated and heating.

3. The process of giving a metal a protective coating of another metal which consists in grinding the coating metal while subjected to a film producing agent, heating the product thus produced to a temperature below that which will dissipate the film, heating the metal to be coated to a temperature higher than that required to dissipate the film and then applying the coating product to the metal to be coated.

4. The process of applying an aluminum alloy coating to another metal which consists in finely reducing the aluminum alloy metal while subjected to an air excluding film-producing agent, heating this product to a temperature below that which will dissipate the film producing agent, heating the metal base which is to be coated to a temperature sufficiently higher to dissipate the film and applying the coating product to the base.

5. The process of applying an aluminum alloy coating to a ferrous metal which consists in finely dividing the coating metal under air-excluding conditions and while still subject to such air-excluding conditions heating it and the metal to be coated and bringing the two together.

6. The process of coating a ferrous metal with aluminum which consists in grinding the aluminum under a bath of an air-excluding medium having a high volatilization temperature, applying a coating of the resulting mixture to the metal to be coated and heating to a temperature which will volatilize the air-excluding medium used and cause the coating metal to fuse with the base metal.

7. The process of applying a protective coating of one metal to a base metal which consists in simultaneously finely dividing the coating metal and applying thereto as divided a film to protect it from the atmosphere, applying said product to the metal to be coated and then eliminating the coating film and causing the coating metal to adhere to the base by the action of heat.

8. The process of applying a protective aluminum coating to a base metal which consists in simultaneously finely dividing the aluminum and applying thereto as divided an air-excluding film, applying said product to the metal to be coated and then eliminating the coating film and causing the aluminum to adhere to the base by the application of heat thereto.

9. The process of securing welding union with aluminum which consists in removal of a surface film from the aluminum and at the same time providing the new surface with an air-protective film of a material which can be disposed of by heat at a temperature not exceeding the melting point of aluminum, applying the aluminum to the surface to which it is to be joined and heating to a temperature sufficient to dissipate said protective film and to produce welding union.

10. The process of securing welding union with aluminum which consists in giving the aluminum a fresh surface by abrasion and at the same time giving it an air-protective film which may be dissipated by heat at a temperature slightly lower than the welding heat for aluminum, applying the aluminum to the surface to which it is to be secured and heating both to a welding temperature.

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