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PRODUCING ALUMINUM-COATED IRON OR STEEL

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1 Claim. (Cl. 148—16.6)

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This invention relates to coating ferrous metals or their alloys, and more particularly to producing aluminum-coated iron and steel.

An object of the invention is to provide improved aluminum-coated ferrous metals such as iron and steel.

Another object is to provide an impervious aluminum coating for iron and steel which prevents the corrosion of the iron or steel.

Another object is to provide an aluminum coating integrally bonded or alloyed to iron or steel, which will not chip, flake or peel.

Another object is to provide an aluminum coating for iron or steel sheets, the sheets being adapted to be shaped into articles by deep drawing operations, or the like, without damaging the coating.

Another object is to provide iron and steel articles having an improved aluminum coating.

Another object is to provide aluminum-coated iron or steel articles, which simulate aluminum articles and are as serviceable as aluminum articles, but can be produced at a lower cost.

Another object is to provide an improved process of coating iron or steel with aluminum.

A further object is to provide a simple and inexpensive process for coating iron or steel with aluminum, and bonding or alloying the coating to the iron or steel.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claim, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the invention, these objects are generally accomplished by subjecting an iron or steel base to a nitrogenous medium, coating the iron or steel base with aluminum, and causing the coating to be bonded to the base. The nitrogenous medium forms a superficial layer on the iron or steel which serves to bond or alloy the coating thereto.

Any suitable iron or steel may be used in connection with practicing the invention, but preferably, iron or steel having a relatively low carbon content, for example, less than about .40 percent by weight, is employed. Iron or steel of the deep drawing variety may be used, which can be readily shaped into articles, such as kitchen utensils, fixtures, containers or receptacles, bottle caps, and the like. Such iron or steel, usually, has a low carbon content, for example, between about .05 and about .08 percent by weight, and has a

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negligible aluminum content. The aluminum in such iron or steel is present as an impurity, rather than as an alloying ingredient.

Also, low alloying, high tensile steels, which may be formed into structural members and the like, are suitable for use in connection with practicing the invention. Such steels usually contain between about .10 and about .40 percent of carbon by weight. The aluminum content thereof is negligible, and is present as an impurity, rather than as an alloying ingredient.

The nitrogenous medium employed, preferably, is nascent nitrogen (N) produced by cracking ammonia gas at temperatures between about 1100 and about 1150° F.

Any suitable types of commercially available aluminum may be used, ranging from substantially pure aluminum to various alloys of aluminum, wherein aluminum is the principal metal.

The aluminum coating may be applied to sheets or plates, or the like, of iron or steel adapted to be thereafter formed into articles, and may likewise be applied to prefabricated iron or steel articles. By the term "base," as used herein and in the appended claim, is meant the surface of sheets, plates or the like, or the articles made therefrom.

In practice, the ferrous base to be coated is first cleaned and degreased in any suitable or customary manner. The base is then subjected to nascent nitrogen at a temperature between about 950 and about 1150° F., for a sufficient duration of time to produce a nitrogenized or nitrogen treated superficial film or layer having a thickness of between about .0005 and about .001 inch. This layer is produced by the action of the nitrogen on the ferrous base, and comprises minute needles of an iron-nitrogen compound or complex, usually identified as iron nitride. These needles have a high affinity for aluminum and readily alloy with aluminum, as will be described hereinafter.

The nitrogen treated or nitrogenized ferrous base is then coated with aluminum by electroplating, by dipping in a bath of molten aluminum, by spraying with aluminum, or in any other suitable manner. The thickness of the coating may vary, depending upon the intended use of the coated base, or the character and intended use of the article or member made therefrom. For example, the coating may have a thickness of between about .0003 and about .010 inch.

After the coating of aluminum is applied, the base is passed through or is placed into a suitably heated furnace, oven or the like. Where the shape of the base permits, induction heating methods

may be utilized. The base is subjected to a temperature of between about 400 and about 950° F. for a period of between about 30 minutes and about 10 hours. The heating period usually varies in proportion to the thickness of the coating, the shape and size of the article, and the percentage of diffusion required. When using higher heating temperatures, the heating period may be slightly shortened.

The heating step causes the portion of the aluminum coating contiguous with the layer of nitrogenized iron to diffuse into the layer. Due to the affinity between aluminum and iron nitride, the portion of the aluminum coating in contact with the layer combines with the iron nitride to form a compound or complex comprising iron, aluminum and nitrogen. In this manner, the aluminum is atomically bonded or alloyed with the ferrous base, to form a strong bond between the coating and the base. This enables the base to be subjected to severe bending strains, deep drawing operations or polishing operations without chipping, flaking, cracking, peeling or spalling of the aluminum coating.

From the foregoing description, it will be seen that the present invention provides improved aluminum-coated iron and steel, and a process of producing the same. The coating is integrally bonded or alloyed to the iron or steel and will remain permanently thereon. The coating can readily withstand any rough usage to which it may be subjected.

The process employed is simple and inexpensive and does not involve the use of complicated machinery, equipment or apparatus. Iron or steel plates, sheets or the like, coated in accordance with the process herein, can be readily fabricated into articles heretofore made of aluminum. Also, the articles formed of iron or steel may be thereafter coated with aluminum by following the process of the invention. The process likewise may be employed in connection with aluminum

coatings on previously used iron or steel articles or members, to recondition the same.

As various changes may be made without departing from the spirit and scope of the invention, it is desired that the foregoing description be understood as illustrative and not in a limiting sense.

I claim:

The process of aluminum coating an iron or steel base, which comprises subjecting the base to nascent nitrogen at a temperature of between about 950° and about 1150° F. for a time sufficient to produce a superficial layer of iron nitride having a thickness of between about .0005 and about .001 inch, providing the base with an aluminum coating having a thickness of between about .0003 and about .010 inch, and subjecting the base and the coating to a temperature of between about 400° and about 950° F. for a period of between 30 minutes and about 10 hours to form an iron-nitrogen-aluminum complex between the base and the coating adapted to alloy the coating to the base.

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