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PROCESS OF MAKING ALUMINUM BONDED STAINLESS STEEL ARTICLE

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ABSTRACT OF THE DISCLOSURE

An aluminum coating is metallurgically bonded directly to a stainless steel article by first cleaning the article of adherent oxide and then providing a protective coating of lead-tin solder on it; and after as long an interval as desired, replacing the solidified solder from the article with aluminum by contacting the solder coating with molten aluminum.

This invention relates to the bonding of aluminum or aluminum alloys to steel, particularly to stainless steel.

Heretofore, there have been many processes for the bonding of aluminum to ferrous-base alloys. The Pershing Patent No. 2,634,469 discloses a method for bonding aluminum to ferrous alloys by first coating the ferrous alloy with a zinc-base alloy containing tin and aluminum. The coated base is then promptly placed in a mold or die and before the part cools below the point where the coating is mushy, molten aluminum or aluminum-base alloy is cast therearound. This process it not satisfactory, however, because it requires handling of the coated article while the coating alloy is still fluid.

The Zwicker Patent No. 2,849,790 discloses a process for the bonding of aluminum to ferrous-base alloys by precoating the ferrous base with an alloy containing tin and/or zinc and/or cadmium, together with certain rare earth elements. The light metal is then cast on the interface, and is united to the iron surface by a bonding layer consisting essentially of tin and zinc and the necessary rare earth metals.

The bonding of aluminum to a ferrous metal is one problem of the art. A further and more difficult problem of the art is the bonding of aluminum to a stainless steel body. For example, Jepson Patent No. 3,096,566 states at column 1, line 69: "Unfortunately there has not been available any simple method of bonding aluminum and stainless steel, so that the bonded structure will withstand the high temperatures experienced in electric irons." This problem is attempted to be avoided by utilization of a mechanical attachment of the aluminum to the stainless steel. The stainless steel being a heat resistant and chemically inactive material, it is seen why it is so difficult to cast the aluminum onto the stainless steel.

It is an object of the present invention to provide a process for coating stainless steel with aluminum.

It is a further object of the present invention to provide a process for coating stainless steel with aluminum, wherein little or no intermediate metal is used to bond the aluminum and the steel.

It is a still further object of the present invention to provide a process for the bonding of stainless steel and aluminum, so that it is not necessary to transfer stainless steel with a molten coating of a metal thereon to a mold.

It has long been desired to bond stainless steel to aluminum. These results have never been achieved because the aluminum will not adhere to stainless steel. The adherence of the aluminum in this process will be maintained even under conditions where there is a large

temperature differential between the parts and/or differential mechanical stresses applied to the two materials. It has been found that the cause of the failure to direct bonding between stainless steel and aluminum is a thin coating on the stainless steel of a mixed oxide of chromium and iron. The oxides of iron are usually reduced with molten aluminum. It is believed that the aluminum does not reduce the oxide of chromium. The present process comprises the removal of any coating on the stainless steel and the protection of this surface by applying thereto a thin metal coating. This coated article, after cooling, is then placed in a mold and the aluminum cast thereon.

The casting step need not immediately follow the application of the protective metal coating. The products provided with the protection may be stored and have the aluminum cast around them at a later time.

It is desirable to clean the stainless steel surface before the metal coating is applied and particularly to eliminate oxide skin, that is, the layer of lower oxides of iron and chromium which adversely affects the application and adherence of either the coating metal or the aluminum. To accomplish this end, an aqueous salt solution is preferred. An aqueous solution of zinc chloride has proven satisfactory. A solution may be applied to the surface of the stainless steel articles, and then they may be dried in a furnace at a temperature of approximately 100° C. The surface thus treated must be quickly contacted with a molten metal coating wtihout a surface rinsing step. The dried solution gives protection to the cleaned stainless steel while the surface is being coated with the protective metal coating.

The metal coating need not form a serration bond with the stainless steel, but it must wet the steel and cover the same to provent the reformation of the iron and chromium oxide coating. These articles, when coated with a lead/tin solder melting below 600° C., may be stored until such a time as it is convenient to cast the aluminum on to the protected surface. The solder coating, it is believed, flows freely from the interface surface, and allows the aluminum to form a metallurgical bond directly with the stainless steel, there being little or none of the solder entering into the bond between the aluminum and the stainless steel.

As an example of this process, a stainless steel stamping of the following composition, chromium 18 percent, nickel 8 percent, balance iron, such as is used in the manufacture of the heating elements of a coffee percolator or electric steam iron, is cleaned with a zinc chloride solution, dried and coated with a lead/tin solder containing 60 percent lead, 40 percent tin. Also a 50 percent lead, 50 percent tin solder has been found to give satisfactory results. The treated article is then stored. This article is, at a later date, placed in a die casting machine and molten aluminum is cast against this surface. The aluminum adheres to the stainless steel and forms a metallurgical bond therewith. The aluminum alloy used in this casting process contains 9 to 10 percent silicon, 0.4 to 0.6 percent magnesium, the balance being aluminum.

The advantages of the present process are apparent when compared to the processes in which a ferrous base is coated with a metal interface, and, while this coating is still molten, has aluminum cast thereon. The articles of the present process may be prepared at the stamping mill, cleaned with a zinc chloride solution and coated with a protective solder. These can then be shipped or stored, awaiting the casting of aluminum. The type of solder required in this process is simply such that it will wet the surface of the stainless steel, and protect it and prevent the formation of an oxide coating thereon. It is not necessary that this solder form a serration bond with the stainless steel.

When reference is made to aluminum alloy in the claims, it is contemplated that commercially pure aluminum of commerce is included in the phrase.

Although the present invention has been described in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A process of providing a bond directly between a stainless steel base and aluminum cast thereon, comprising:

(a) contacting said stainless steel with a cleaning solution to remove adherent oxide,

(b) providing on the resulting clean oxide-free surface a protective coating of a solder having a melting-point temperature below 600° C.,

(c) cooling the resulting coated stainless steel article, and

(d) subsequently removing the resulting solidified solder coating from the steel article and simultaneously casting aluminum or an aluminum alloy on said coated surface by bringing the solder-coated portion of the said article into contact with molten aluminum or aluminum alloy.

2. The method of claim 1 in which the solder is a lead-tin solder and in which the molten aluminum or aluminum alloy is brought into contact with the solder coating on the stainless steel article in a die-casting operation.

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164—75, 95, 102