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3,469,301
PROCESS FOR THE PRODUCTION OF
BONDED METAL STRUCTURES

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The portion of the term of the patent subsequent to Jan. 24, 1984, has been disclaimed
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7 Claims

ABSTRACT OF THE DISCLOSURE

A coated steel or iron article is produced by spraying a non-refractory molten metal with an oxy-acetylene gas. The non-refractory metal can be nickel, copper or mixtures of nickel and copper. The metal is sprayed on a plate and a second plate sandwiches the sprayed layer between the plates so that the sprayed metal becomes bonded upon being heated under reducing atmosphere conditions.

This application is a continuation-in-part of copending application Ser. No. 305,519, filed Aug. 29, 1963, now Patent No. 3,299,503.

This invention relates to a method of coating a steel or iron article with a nonrefractory molten metal such as copper, nickel or mixtures thereof. More particularly, this invention is concerned with a method of spraying a coating of the aforementioned metals using an oxy-acetylene mixture. Coatings which are thus formed are particularly useful as interlayers in clad articles or as cladding layers. The general purpose of this invention is substantially the same as explained in application Ser. No. 305,519. However, instead of using the plasma-arc spray method, an oxy-acetylene mixture is used. The main advantage of the present invention is that there is no limit to the size of the plates being coated and the coating itself is firmly bonded to the plates. In other coating methods, particularly electroplating methods, the size of the plate being processed is limited.

An iron or steel plate is first coated with copper, nickel or mixtures thereof by spraying same with an oxy-acetylene mixture. The coated article can be iron or steel, including mild or stainless steel. Thereafter a pack or sandwich is formed with a second plate so that the coated surface of the plate is interposed between the plates, the edges of the plates are then substantially sealed, by welding for instance, and the pack is heated to a temperature in excess of about 1,200° F., preferably about 2,000°–2,350° F. It will be understood that a pack or sandwich can be formed in any conventional way and more than one coated plate can be confined within such a pack.

It is necessary that at least one of the plates has a minimum carbon content of about 0.1%. Usually one plate is a mild steel plate with a carbon content of about 0.1–0.35% by weight, and the other plate is stainless steel. In this latter instance, either plate can have its surface sprayed with the molten, nonrefractory metal. The effect of subsequently heating the sprayed surface within the pack is to form a reducing atmosphere in situ which reduces oxides and permits substantial diffusion of the sprayed coating into bonding surfaces of the plates so that a firm bond is achieved. If one of the plates is stainless steel, then the pack should be hot worked, preferably by forging or rolling at temperatures in excess of 1,200° F. and preferably 2,000–2,350° F.

In the preferred form of this invention, the oxy-acetylene mixture is used to melt the metal being applied, preferably a nickel wire or rod, with the force of the oxy-acetylene stream spraying the nickel on the surface of the steel plate. It will be understood that both iron and steel plates, ingots, slabs and the like are included in the method described herein.

Using backing steel plates 5¼" square and 1⅞" thick of #212 Grade B mild steel as one plate in each of two specimens, two 321 stainless steel insert plates were coated with nickel coatings. Specimen A was coated by the plasma-arc spray method using nickel powder and Specimen B was coated using an oxy-acetylene stream and a nickel wire. The stainless steel plates were 4" square and ⅝" thick. The nickel sprayed on each specimen was about 3 mils thick.

Each insert was cleaned with alcohol and a chromic oxide parting compound was applied on the parting side of each plate in the conventional manner. The bond sides of the backing plates were grit blasted and a single assembly was formed of the two specimens with the stainless steel inserts being confined within the assembly. The sides of the assembly were closed with weld seams and a vent hole was drilled in the center of one of the weld seams in the assembly.

The assembly was then heated to 2,300° F. and held until the temperature was uniform. Thereafter the assembly was forged and separated into two specimens which were approximately 1" gage but the reduction was not totally uniform. In a shear test carried out in accordance with ASTM 263–63, the results were as follows:

A (plasma-arc), p.s.i. B (oxy-acetylene), p.s.i.		
P-1	13,739	38,438
P-2	29,430	35,849
P-3	28,750	38,365
P-4	27,044	36,943

Micro-examination indicated that the fracture in Specimen A occurred at the nickel-stainless steel interface. The oxy-acetylene Specimen B sheared in the nickel.

Bend tests were made on each material, one with the clad in tension and the other with the clad in compression. The materials were bent around a 1½" diameter mandrel with no separation at the bonds.

Metallographic examination of the nickel indicated that foreign inclusions were absent in Specimen A except at the nickel-stainless steel interface. In Specimen B, the stainless steel interface was clear but the nickel layer itself had some foreign inclusions.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. A method of producing a coated steel or iron article comprising the steps of spraying with oxy-acetylene gas a nonrefractory molten metal selected from the group consisting of nickel, copper and mixtures thereof, on the surface of a steel plate, forming a substantially sealed pack with said plate and at least one other plate, the sprayed surface being interposed within said plates, at least one of said plates having a minimum carbon content of about 0.1%, raising the temperature of said pack to form a reducing atmosphere within said pack to reduce oxides whereby the sprayed metal becomes bonded to said first mentioned plate.

2. The method of claim 1 wherein the plates are clad to one another.

3. The method of claim 1 wherein the molten metal is nickel.

4. The method of claim 3 wherein the first mentioned plate is stainless steel and the said other plate is carbon steel.

5. The method of claim 4 wherein the pack is worked after the pack is heated.

6. The method of claim 3 wherein the pack is heated to about 2,000° F. to 2,350° F.

7. The method of claim 3 wherein the nickel is initially in the form of a wire or rod which is sprayed on the surface of said steel plate.

References Cited

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29—492, 502; 117—105.2