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COMPOSITE METAL ARTICLE WITH A PLATINUM COATING

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FIG. 1

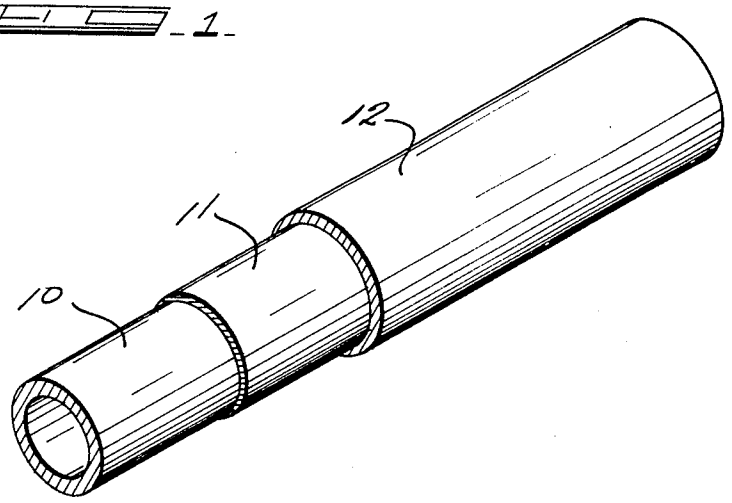
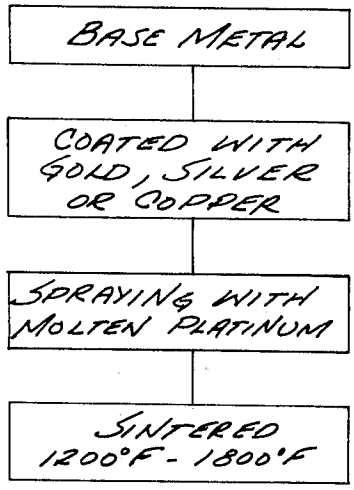


FIG. 2



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COMPOSITE METAL ARTICLE WITH A PLATINUM COATING

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ABSTRACT OF THE DISCLOSURE

There is disclosed a corrosion resistant metal article comprising a base metal, a thin intermediate layer of an easily reduced metal, and an outer layer of platinum applied in molten droplet form by means of a plasma-jet spray or flame-spray. The thickness of the platinum layer is at least .007 inch, e.g., .007 to .015 inch. The base metal is iron, nickel, or alloys thereof. The easily reduced metal is copper, silver, or gold.

The present invention relates generally to the art of coating metal articles and in particular is concerned with a novel corrosion resistant metal article having a platinum coating which is metallurgically bonded to the base metal.

In the chemical industry many corrosive atmospheres are present within which metal parts must be located. One metal which has exceptionally good corrosion and/or heat resistance is platinum. However, platinum is quite expensive and, therefore, it has been desirable to use as little platinum as is necessary to provide sufficient protection to metal parts which may be subjected to high temperatures and/or corrosive atmospheres. Many iron or nickel base alloys exhibit sufficient thermal resistance so as to be capable of use at fairly high temperatures; however, in a corrosive atmosphere these metals oxidize and corrode quickly.

It has been the practice in the past to mechanically clad such base metals with platinum sheeting. However, one serious drawback is that the thermal expansion characteristics of platinum and the base metals are such that there is a tendency for the platinum to buckle and warp under temperatures in the 2000° F. and above range.

In recent times it has been the practice to flame-spray metals with coatings of other types of metals. However, in these situations, particularly when an attempt is made to flame-spray platinum over Inconel or other iron or nickel base alloys, the flame used in spraying the metal will oxidize the base metal, thus producing a poor bond between the platinum and the base metal.

With the foregoing in mind, it is an object of this invention to provide a method of metallurgically bonding platinum to base metals.

It is an additional object of this invention to provide a method of metallurgically bonding platinum to a base metal by utilizing an easily reduced metal as an intermediate plated-on layer.

It is a further object of this invention to provide a corrosion resistant metal article having a metallurgically bonded platinum coating.

Other and additional objects will be apparent from the following description taken in conjunction with the annexed sheet of drawings, wherein:

FIG. 1 is a perspective view of a metal pipe having platinum applied thereto by my improved method; and,

FIG. 2 is a block diagram illustrating the successive steps of my improved method.

In accordance with the present invention, applicant has found that base metals such as iron or nickel base alloys such as Inconel, Nichrome and the like may be flame-sprayed with platinum successfully to produce a

metallurgically bonded, continuous layer of platinum over the base metal without the production of "pin holes." In accordance with the preferred embodiment of the invention, this is accomplished by first plating the base metal with a thin, .00025, layer of gold or other noble or easily reduced metal which will not oxidize or can be reduced during flame-spraying of platinum thereon. After the gold is plated on the base metal, a flame-spray or plasma-jet spray technique may be utilized to apply the platinum to the gold to a thickness of .007–.015 inch or more. Whether the platinum is applied by the flame-spray or plasma-jet spray technique is immaterial so long as there is a deposition of molten platinum in droplet form on the gold plated article. After the spray cladding, it is desirable to stress relieve and sinter the composite structure, for example by heating to 1800° F. for two hours for an Inconel-gold-platinum combination. In this particular arrangement the gold serves two purposes (1) it provides a non-oxidized surface for the platinum and (2) it also serves as a brazing metal in that the platinum diffuses into the gold and the gold diffuses into the Inconel. Thus a metallurgical bond is established between the Inconel and the platinum. The surface of the base metal may be roughened prior to the gold plating so as to avoid any possibility of the applied platinum separating from the base metal during subsequent sintering. Furthermore, it has been found desirable and is preferred that the gold plated base metal article be preheated to a temperature of approximately 1200° F. and that the spray-cladding of platinum be carried out while the plated article is hot. By this technique, the impingement and impact of the platinum droplets, as they strike the gold plating, will assume a more flattened contour since there is a somewhat less temperature difference between the molten platinum particles and the article to be clad. In this manner a more tenacious and better bond will be provided, and the formation of pin holes or random spots where the platinum, even if sprayed with several layers, might provide an intrusion or passage through the platinum through the gold, is prevented. As can be seen when referring to FIG. 1 of the drawing, the base metal **10**, such as Inconel, is plated with a layer of pure gold **11** and then flame-sprayed or plasma-jet sprayed with platinum to form the coating or cladding **12**.

While gold has been disclosed as the preferred metal which is plated to the clean iron or nickel base alloy, it is also possible to use copper in place of gold. However, when copper is used as the metal plated to the iron or nickel base alloy, it is necessary to use a reducing gas shield over the plated article prior to the spraying of platinum thereon in order to ensure that the copper does not have an oxide layer or surface when the platinum is applied thereto. Copper does exhibit the property that when it is being flame-sprayed, for example in a platinum flame-spraying system, it tends to lose its oxide coating and appear as a bright metal under the extreme heats involved in the flame-spraying. Thus there is the tendency of the copper to clean itself of oxide during the flame-spraying of platinum thereon.

A third plating material which may be used in accordance with the invention is silver. Silver may be plated over the Inconel for example, in a relatively thin layer; however, it would be necessary to heat the silver-plated article to a temperature sufficient to decompose all the silver oxide on the surface of the silver, for example at 1200° F. This heating will effectively clean the silver and permit the flame-spraying of platinum thereon, with the result that the platinum would adhere and form a metallurgical bond with the silver and the silver in turn would metallurgically bond with the Inconel to produce a metallurgically bonded article when sintered.

As previously described, the base metal may be rough-

ened prior to the plating of the gold, copper or silver. However, this roughening may not be necessary, particularly in the situation where the plating is to occur on the outside surface, for example of a piece of pipe, since the sprayed platinum will shrink tightly around the base metal pipe. In those situations where the platinum is to be put on the inside of the article such as a pipe, either roughening, preheating or both would be required in order to keep the sprayed platinum from pulling loose.

In all instances the step of heating to stress relieve and sinter the composite article is desirable in order to ensure the production of a good metallurgical bond of the platinum to the substrate.

Having described the best mode of carrying out the invention, the scope of the invention should not be limited except as required by the scope of the appended claims.

I claim:

1. A corrosion resistant metal article comprising a base metal of iron, nickel, or alloys thereof, a thin intermediate layer of a reduced metal selected from copper, silver

or gold and an outer layer of platinum applied in molten droplet form onto the reduced metal so as to be metallurgically bonded thereto, said outer layer having a thickness of at least .007 inch.

2. The article of claim **1** wherein the base metal is Inconel, the reduced metal is gold, and the outer layer has a thickness of .007 to .015 inch.

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29—194, 196.3, 199