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IRON COATED URANIUM AND ITS PRODUCTION

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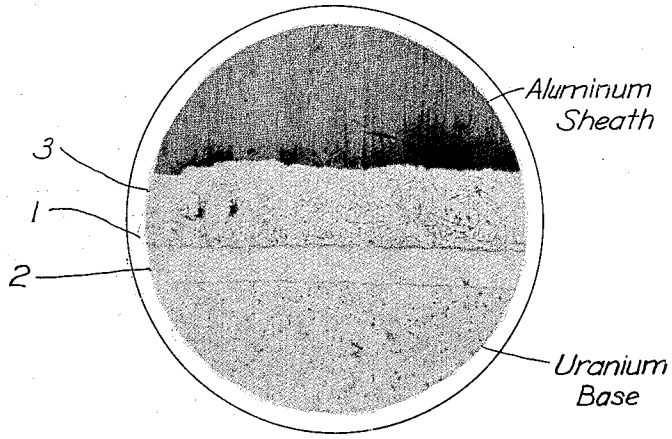


Fig. 1

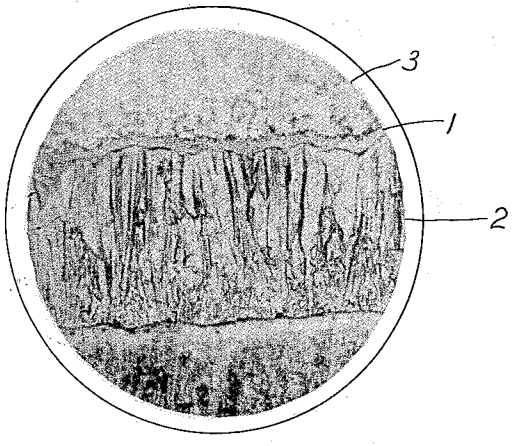


Fig. 2

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IRON COATED URANIUM AND ITS PRODUCTION

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This invention relates to the application of protective coatings on metallic uranium.

Metallic uranium is an easily oxidizable metal which is readily corroded by atmospheric oxygen and by aqueous solutions. In order to protect the metal from the injurious effect of such media, it is desirable to provide a coating of some material which is less easily acted upon.

Many common protective coating materials are unsuitable for coating uranium; lead forms a pyrophoric alloy with uranium and for this reason its use is objectionable; some metals, such as tin, permit diffusion of the uranium through coatings of these metals with consequent impairment of their protective value; other metals form very brittle alloys with the uranium, containing many cracks and crevices which reduce their effectiveness.

It is an object of the present invention to provide protective coatings for uranium which are not subject to the defects enumerated above. A further object is to provide a barrier coating for uranium over which it is possible to apply various protective coatings that normally would be unsuitable because of their behavior toward the base metal. A further object of the invention is to provide highly protective electrodeposited coatings on metallic uranium.

In accordance with the present invention, metallic uranium is provided with a protective coating comprising iron. The iron coating may be applied directly upon the metal or upon an intermediate coating of some other suitable metal possessing the property of adhering firmly to the uranium and to the iron. Nickel or zinc may be used for this purpose.

The metallic uranium preferably is prepared for application of the iron coating by an etchant treatment of the metal surface with an aqueous etchant solution containing chloride ions, for example, a hydrochloric acid solution or a molten hydrate of ferric chloride. Particularly satisfactory preparatory treatments of this type involve anodic pickling of the metal in aqueous trichloracetic acid solution, or aqueous phosphoric acid solution containing about ½% of hydrochloric acid, to remove a ½ to one mil layer of the surface metal. Prior to the etchant treatment the metal may be cleaned by sand-blasting, pumice scrubbing, treating with an organic solvent to remove grease or oily impurities, or treating with a chemical solvent for the oxide film on the metal. Aqueous nitric acid solutions containing from 30% to 55% HNO_3 by weight are especially useful for this purpose. An additional treatment with this reagent after the etchant treatment is desirable in order to remove the coating of oxide or oxychloride from the etched metal surface.

The metallic iron coating may be applied by electroplating from a conventional iron electroplating bath such as an aqueous ferrous ammonium sulfate bath. The iron coatings of the invention may vary from exceedingly thin coatings of the order of 0.000015 inch up to 0.001 inch or more. The thickness of the coating should be selected

appropriately to suit the subsequent treatment of the metal.

The iron protective coatings have the property of inhibiting diffusion of metallic uranium into other metals separated from the uranium by the iron. Thus the iron may be used as a barrier for preventing diffusion of uranium into protective coatings of lead, zinc, tin, cadmium, and other metals of relatively low resistance to uranium diffusion.

While adherent electroplatings of iron may be produced upon uranium when a suitable preparatory treatment is employed for etching the uranium, the adherence of the electroplatings may be still further improved by subjecting them to heat treatment at temperatures of 450° to 500° C. The heating may be effected by immersion of the electroplated article in a molten bath such as a bath of a molten eutectic mixture of potassium and lithium chlorides. The alloying may also be effected by inductive heating or by radiant heating in a vacuum. By appropriate control of the time and temperature of heating the extent of alloying may be controlled.

When iron coatings are applied to an intermediate coating of another metal such as nickel or zinc, these intermediate coatings can be applied by electroplating and the adherence to the base metal can be improved by a suitable alloying treatment.

Protective coatings such as electroplatings of zinc, copper or brass may be applied over the iron coatings of the invention. Protective coatings also may be applied by dipping the iron-coated uranium in a molten metal bath of these and other protective metals.

The iron electroplatings of the invention are valuable in the application of metal coatings containing aluminum. Aluminum and its alloys react with uranium to form brittle uranium aluminum alloys which are undesirable in many cases. The intermediate iron coatings prevent the reaction of the aluminum with the uranium to form these brittle uranium-aluminum layers. The aluminum and aluminum alloy coatings may be applied directly to the iron coatings or over intermediate coatings provided to improve adherence or facilitate coating. Thus in the application of aluminum-silicon alloys as protective coatings or brazing or bonding alloys, it is advantageous to provide the iron with a thin copper coating and a tin hot dip coating in order to facilitate wetting of the metal by the aluminum-silicon alloy. The excess tin may be removed by centrifuging the coated article prior to dipping it in molten aluminum-silicon alloy. When such treatment is employed, the proportions of copper and tin remaining in the final coated article are exceedingly minute and the coating is essentially a coating of aluminum-silicon on iron or uranium. However thicker coatings of copper and tin may be used if the presence of these materials in the finished product is not undesirable.

The iron electroplatings have been found to be suitable for preventing diffusion of metallic uranium into zinc-tin alloys such as aluminum solder used to unite uranium with protective aluminum sheathing. Thus the iron electroplatings can be used as a base for either aluminum-silicon brazed or common soldered unions of aluminum sheathing to uranium.

In the examples, which follow, proportions are expressed in terms of weight unless otherwise indicated.

Example 1

An extruded metallic uranium rod about 8 inches long and 1⅓ inch in diameter is prepared for electroplating by dipping in trichloroethylene to remove grease, sand blasting lightly, dipping in aqueous 35% HNO_3 solution at 30° C. for 4 minutes, rinsing with cold water, etching by anodic treatment in aqueous 50% trichloracetic acid solution at between 50° C. and 60° C. for 10 minutes a

50 amperes per square foot current density, rinsing with cold water, again dipping for 4 minutes in cold aqueous 35% HNO_3 solution to clean the etched metal surface, then rinsing again in cold water.

The cleaned etched metal rod is immediately electroplated at 60–70° C. at a current density of 20 amperes per square foot in a ferrous ammonium sulfate solution having a pH of 5.5 and containing 300 grams per liter of $Fe(NH_4)_2(SO_4)_2.6H_2O$ until a coating 0.0003 inch thick has been formed (about 10 minutes). The electroplated rod is withdrawn from the ferrous ammonium sulfate solution, rinsed with cold water and electroplated for 5 minutes in an aqueous copper electroplating bath comprising 250 grams per liter of $CuSO_4.5H_2O$ at 30° C. It is rinsed again, dried and dipped into a molten bath of tin at a temperature of 300° C. After 2 minutes in the tin bath, it is withdrawn and dipped into a molten aluminum-silicon alloy comprising 88 parts of aluminum and 12 parts of silicon by weight at a temperature of 640° C. for about one minute. It is withdrawn from this bath and inserted in a loosely fitting aluminum can containing a small amount of the aluminum-silicon alloy at 600° C. The top of the can is sealed by an aluminum plug and the assembly is cooled by immersion in water. The resulting coating comprises an aluminum sheath firmly bonded by a layer of aluminum-silicon alloy and an extremely thin layer of bronze to a barrier of iron on the metallic uranium.

Figure 1 of the drawing is a photomicrograph at 100 magnifications of a cross-section through a rod coated in this manner. In this figure the bronze layer 1 is barely discernible between the iron barrier 2 and the aluminum-silicon 3. Figure 2 is a photomicrograph at 500 magnifications of the same coating after a nital etch. In this figure the iron electroplating is shown as a striated layer 2 on the uranium. Between the iron electroplating and the aluminum-silicon alloy layer 3 is a thin but easily discernible alloy layer 1.

Example 2

A metallic uranium rod is electroplated as in Example 1, rinsed with cold water and dried. The rod is then heated in a vacuum to 475° C. and maintained at this temperature for about 2 hours. It is then dipped in aluminum solder (90% tin, 10% zinc) at a temperature of 300° C. and sheathed in an aluminum jacket while the solder is still molten. Upon cooling, the rod is firmly bonded to the aluminum sheating by the solder.

It will be understood that I intend to include variations and modifications of the invention and that the preceding examples are illustrations only and in no wise to be construed as limitations upon the invention, the scope of which is defined in the appended claims, wherein I claim:

1. A metallic uranium article having an adherent coating of iron electroplated directly on the uranium base and a corrosion-resistant adherent aluminum coating on the electroplated iron coating.

2. A metallic uranium article having a protective coating comprising a layer of corrosion-resistant metal separated from the uranium by a layer of metallic iron.

3. A metallic uranium article having a protective coating comprising a metal layer comprising metallic aluminum separated from the uranium by a barrier layer of metallic iron.

4. A metallic uranium article having a protective coating comprising a barrier layer of iron plated directly on the uranium, a thinner layer of bronze and a thicker layer comprising metallic aluminum.

5. A metallic uranium article having a protective coating comprising a barrier layer of iron plated directly on the uranium, a thinner layer of bronze and a thicker layer of aluminum-silicon alloy.

6. A metallic uranium article having a protective coating comprising an adherent barrier layer of iron and an aluminum sheath soldered to the iron barrier layer.

7. The method of applying a protective coating to a metallic uranium article, which comprises etching the surface of the article with an etchant solution containing chloride ions, cleaning the etched surface, electroplating iron thereon from a ferrous ammonium sulfate electroplating bath, and applying an aluminum protective coating to the resultant iron electroplating.

8. The method of applying a protective coating to a metallic uranium article, which comprises etching the surface of the article with an etchant solution containing chloride ions, cleaning the etched surface, electroplating iron thereon from a ferrous ammonium sulfate electroplating bath, and soldering an aluminum sheath to the resultant iron electroplating.

9. The method of applying a protective coating to a metallic uranium article, which comprises etching the surface of the article with an etchant solution containing chloride ions, cleaning the etched surface, electroplating iron thereon from a ferrous ammonium sulfate electroplating bath, applying a thin copper electroplating to the resultant iron electroplating, dipping the copper-plated article into molten tin, centrifuging to remove excess tin, and then dipping the article in a molten low-melting aluminum-silicon alloy so as to form a coating of aluminum-silicon alloy on the article.

10. A metallic uranium article having a protective coating which comprises a barrier layer of iron plating directly on the uranium, a thinner layer of bronze, and an aluminum sheath bonded to the bronze layer by an aluminum-silicon alloy.

11. The method of applying a protective coating to a metallic uranium article, which comprises etching the surface of the article with an etchant solution containing chloride ions, cleaning the etched surface, electroplating iron thereon from a ferrous ammonium sulfate electroplating bath, applying a thin copper electroplating to the resultant iron electroplating, dipping the copper-plated article into molten tin, centrifuging to remove excess tin, and brazing an aluminum sheath to the tinned article by means of a low-melting aluminum-silicon alloy.

12. A metallic uranium article as defined in claim 3 in which the barrier layer of metallic iron is attached to the uranium through a layer of zinc, and an aluminum sheath soldered to the iron barrier layer.

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