Feb. 3, 1959 E. W. COLBECK 2,871,558

SHEATHING URANIUM

Filed July 2, 1946

FIG. 1.

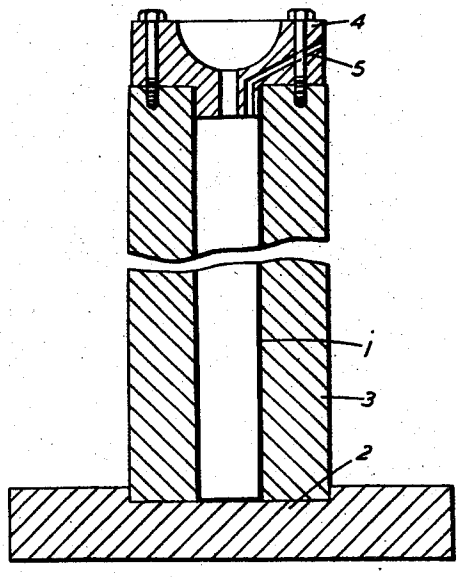


FIG. 2.

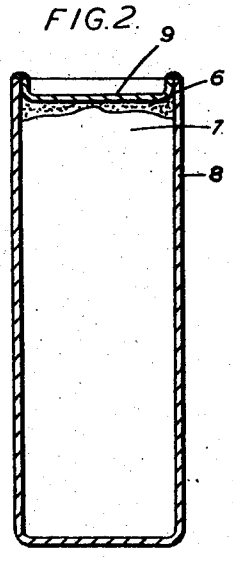
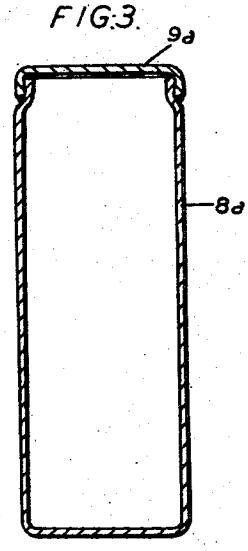


FIG. 3.



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SHEATHING URANIUM

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1 Claim. (Cl. 29—528)

This invention relates to a method of sheathing uranium which, at least in its purer forms, tends to deteriorate rapidly on contact with air, steam or water. Although it is possible to protect uranium when it has been rolled or extruded into the form of rods by drawing down on to these rods protective tubes, there is a wastage of up to 50% of the weight of the original cast metal in machining operations prior to and after extrusion. This wastage is due to the necessity of removing scale, oxides, unsound metal etc. from the surface of the crude billets and again from the extruded rods.

An object of the present invention is to facilitate the working of uranium metal.

Another object is to facilitate the fabrication of protectively-sheathed uranium bodies.

Another object is to provide an improved method of making composite rods of uranium sheathed in another metal.

According to the present invention sheathed uranium is made by casting molten uranium into a container of protective metal.

The sheathing operation may be in accordance with the invention, for the primary purpose of facilitating the working of a cast billet of uranium to reduce it, for example by extrusion or rolling, to rod or wire or other form of predetermined cross-sectional shape and dimensions, and such working may include heat-treatment in one or more stages for modifying the ductility or for other purpose. The sheathing is then an integral part of a uranium metal working process. In such cases, when the uranium metal has been brought to its desired final shape and size, the sheathing metal may be stripped off by a chemical, electrolytic or mechanical method or by a combination of such methods.

The sheathing operation may however serve the further purpose of providing a protective skin upon the worked uranium body to be effective during its useful life.

Alternatively, the sheathing operation may be carried out using a thin-walled container of protective metal conforming to the desired final dimensions of the sheathed uranium body. In this case, working of the cast uranium is unnecessary (although heat treatment may be applied) and the casting of the uranium into the container constitutes a direct method of making a protectively-sheathed shaped uranium body. Previous methods of making such sheathed bodies have involved the working and machining to shape of the uranium body from an initially-formed billet with various measures to protect the metal from deterioration followed by either the fitting of the uranium body into a pre-formed container with measures to obtain close continuous contact or the surface treatment of the uranium body with the object of establishing a protective coating.

The choice of metal for the container depends upon the functions which the sheathing is required to have and upon the conditions which arise in the casting operation. Suitable metals include those having a melting point above 850° C. and which have a good corrosion resistance, for example to steam at 200–400° C. Metals of lower melting point can be used if provision is made for cooling the container or sheath during the casting. Where it is desired to reduce the diameter of the initial assembly of uranium cast in the container, the sheath metal needs to have a capacity for deformation at rolling temperature for example 600° or 800° C., approximately equal to that of uranium so that the sheathed product can be readily rolled or extruded. It is also desirable for certain purposes, including the use of the product in an energy-producing pile, that the metal shall have a high thermal conductivity. Moreover the coefficient of thermal expansion of the sheathing metal should preferably approximate to that of uranium in order that excessive stress shall not arise between the sheath and the core and that cavities shall not be formed between them with changes of temperature. Where the sheathed uranium is required for use in an energy producing pile, a sheath metal of low neutron capture cross-section is desirable.

Convenient metals which have usefully favourable properties are for example copper and its alloys, aluminium and austenitic chromium-nickel stainless steel. Of these, aluminum while less convenient than copper for metal working has a reasonably low capture cross-section.

In one method of carrying out this invention, we employ uranium metal of 99.9% purity. This metal is melted in a crucible, e. g. of graphite or thoria, conveniently having a means for bottom pouring, and means for avoiding contact with air is employed such as a flux, or enclosure and evacuation of the apparatus. The molten metal is then poured into a previously prepared sheath of a suitable metal and allowed to solidify. The composite billet may then be rolled down into rods of say ¾"–1¼" diameter which have on their surfaces a thin film of say 1/64"–⅛" thickness.

It is clear that the thickness of the protecting metal sheath into which the molten metal is initially cast can be chosen so as to provide any desired thickness of protective skin in the finished bars.

In another method embodying the invention uranium is cast directly into thin-walled tubular containers which are thereafter closed and sealed to form composite rods for use in a uranium pile. An arrangement for carrying out this method is shown in Figure 1 of the accompanying drawings. Figures 2 and 3 of the drawings show sectional views of finished composite rods illustrative of alternative process details.

Referring to Figure 1, a preformed tubular aluminium cannister 1 of diameter of the order of one inch, wall thickness of the order of 0.03 inch and length between three and twelve inches and with its bottom end closed is set up upon a thick copper base 2 and within a thick walled cylindrical copper mould 3 split longitudinally to facilitate assembly. A graphite crown ring 4 mounted over the open end of the cannister and mould and serves firstly as a funnel through which molten uranium is poured to fill the cannister and secondly as an upper boundary for the resultant casting. A vent 5 in the crown ring allows air to escape from the cannister during the casting operation.

Because of the rapidity with which the molten metal cools, the exposed surface of the casting tends to be irregular. If the crown ring be omitted, the uranium metal surface presents an irregular peak as indicated in Figure 2. The effect of the crown ring is to localise this peak so that it may more readily be removed by drilling or milling to leave a flat surface ready for a subsequent can-closing operation.

Various other methods may be employed to reach a level surface. For example the irregular surface resulting from casting with or without the use of the crown ring, may be drilled to present a countersunk or other uniform surface over which is placed an aluminum disc of similar contour and with a flat upper face. Or the irregular surface may be covered with packing material, for example a brazing flux consisting of aluminum-silicon alloy as shown at **6** in Figure 2. In this figure the cast uranium **7** is shown in a cannister **8** having a closure disc **9**.

The closing of the cannister is then effected in any of the ways already proposed for sealing previously-machined uranium rods in thin-walled cannisters or in other convenient manner affording a gas-tight seal. For example a closure disc of aluminium may be applied and the cannister wall turned over and welded upon it or the closure disc may be flanged as shown in Figure 2 and the seal completed by a peripheral weld between the edges of the cannister and the disc.

The process details may be modified to yield a sheathed rod of the section shown in Figure 3. After the casting operation the end of the composite rod, including the end of the cannister *8a*, is cut back to present a flat surface over which a lid *9a* is fitted and brazed or welded in position.

I claim:

A method of forming a conveniently handled corrosion resistant uranium article, comprising pouring molten uranium into an open-ended corrosion resistant metal container in which the metal is selected from the group consisting of copper and its alloys, aluminum, and austenitic-nickel stainless steel, covering the exposed surface of the cast uranium with a metallic packing material, sealing the container in contact with substantially the entire exposed surface of said packing material, and then mechanically working said article to reduce the cross section thereof.

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