Oct. 28, 1958 R. F. PLOTT 2,858,262

PROTECTIVELY COVERED ARTICLE AND METHOD OF MANUFACTURE

Filed Nov. 16, 1943

FIG. 1.

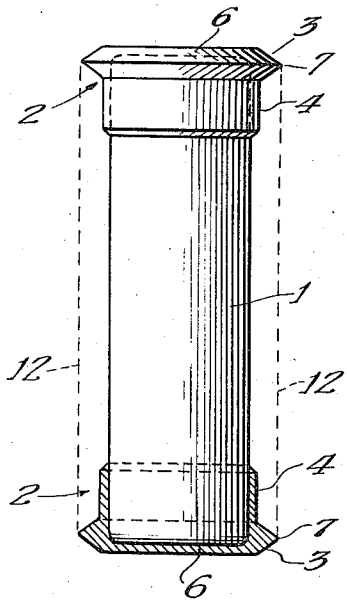


FIG. 2.

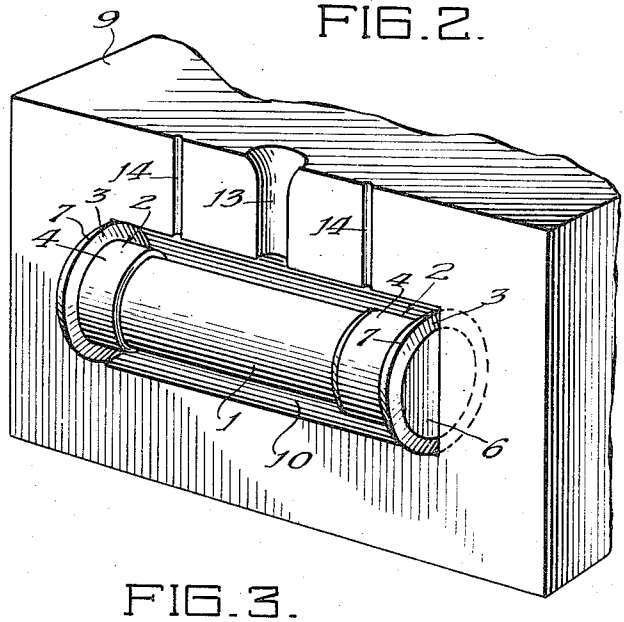


FIG. 3.

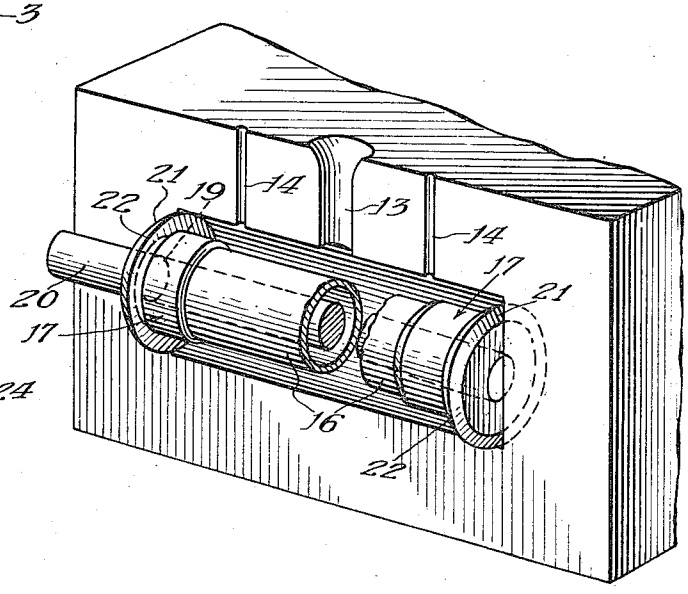
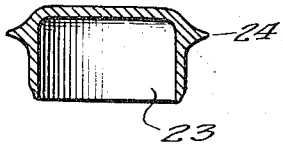


FIG. 4.



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United States Patent Office 2,858,262
Patented Oct. 28, 1958

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PROTECTIVELY COVERED ARTICLE AND METHOD OF MANUFACTURE

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Application November 16, 1943, Serial No. 510,560

11 Claims. (Cl. 204—193.2)

My invention relates to the metallic coating of metal objects and particularly to improved methods of casting metal about a metal object without the use of supporting stringers which would normally produce discontinuities in the outer cast metal coating.

In the manufacture of uranium bodies such as rods, cylinders or other shapes it is desirable to provide protective coatings of relatively inert metals over their exposed surfaces. Coated uranium is suitable for use in a neutronic reactor such as the "Clinton Pile," which was built during 1943, and is described in Fermi et al. Patent 2,708,656, dated May 17, 1955. Unless this is done prior to subjecting the uranium metal to reactive gases or liquids, excessive oxidation of the surfaces will take place. In several uses for shaped uranium bodies it is likewise necessary to provide relatively thin protective coatings without discontinuities therein through which the uranium might be subjected to oxidizing influences, especially when such bodies are subjected to oxidizing conditions at elevated temperatures. If supporting cores or stringers are used to support the uranium bodies during casting of the protective metal coatings, discontinuities exist which, even though later filled or covered with coating material, are subject to failure such as produced by electrolytic action, abrasion or corrosion. In addition, it is desirable to provide metallic coatings that are not only impermeable to gases and liquids but that at the same time offer low thermal resistance to the flow of heat across the metal-coating interface.

Objects of my invention are to provide methods of casting metal coatings about metal objects without producing discontinuities in the coating surface, to provide coatings for metal objects by casting without the use of removable cores that produce discontinuities in the coating surface, to provide a method of casting a hermetic, protective metal covering about uranium and to provide a uranium object with a protective metal covering having good heat conducting properties.

In accordance with my invention, and as applied to uranium, I place the uranium object in a casting die and support the object therein between two end members or caps of metal, the caps being so formed that the edges thereof fuse with the casting metal to form a unitary continuous metal coating or jacket completely enclosing the uranium object.

The above and other objects of my invention will become apparent when considered in view of the following description and the accompanying drawing wherein:

Fig. 1 is a partly sectioned elevation view of a metal body partially prepared for receiving a cast coating in accordance with my invention;

Fig. 2 is a side perspective view of the metal body shown in Fig. 1 supported in a casting die block;

Fig. 3 is a partially sectioned perspective view of a die block containing a modified metal body which may be coated in accordance with my invention; and

Fig. 4 is a longitudinal section view of a modified cap structure suitable for practicing my invention.

Referring to the drawing, I have shown in Fig. 1 an elongated body **1**, of uranium or other metal, about which the coating of metal is to be cast. The casting metal is preferably one of lighter metal, such as aluminum, and for use with uranium bodies I have found a specific aluminum alloy containing 13 percent silicon and the balance aluminum to be particularly advantageous in forming a good heat conducting bond with the uranium. It appears that the use of silicon in the aluminum casting metal facilitates the formation of an alloy with the uranium so that high heat conductivity is obtained while at the same time providing a coating of high ductility that prevents hot shortness or cracking of the aluminum from the uranium upon cooling.

In accordance with my invention I provide on each end of the uranium body **1** a cylindrical cap member **2** of the metal or alloy with which the body **1** is to be coated. These cap members **2, 2** provide a support for the body **1** in a die block **9** and at the same time, due to their shape provide a metallic bond with the cast metal. To facilitate the formation of this bond I provide the cap members **2** with a relatively sharp, annular, integral flange or rim **3** extending outwardly from, and of larger diameter than, a main body **4** of the cap member **2**. The body **4** is of sufficient internal diameter to fit snugly over the body **1**, the thickness being substantially the same as the top portion **6**. The rim **3** is made sufficiently thin at its edge **7**, in comparison to the surrounding metal, that during the casting process it is heated to its melting point by the cast metal and fuses therewith.

The cap members **2** may be slipped over the ends of the uranium body **1** or may be formed in place such as by casting. This latter method of affixing the cap members is particularly advantageous where high heat conductivity between the uranium and the cap members is desired. For example, in various uses the diameter of the uranium body is great in comparison to the length and for efficient total heat transfer closely contacting cap members are desired. For casting the cap members **2** onto the uranium body **1**, the latter is centrally supported in a suitable die with the ends properly spaced from the die walls. The end cap members **2** may then be cast into intimate and continuous contact with the body **1**. However, where the length of the uranium body is great in comparison to the diameter, lower heat transfer at the ends of the body may be tolerated, whereupon the cap members may be made slightly larger than the uranium body at the ends thereof and slipped thereover into sufficiently good contact.

Referring to Fig. 2, the assembly shown in Fig. 1, that is, the uranium body **1** with the two end cap members **2**, is placed in a die block **9**, half of which is shown, the other half being identical. The die block **9** has a recess or cavity **10** of substantially the same overall length as the assembly shown in Fig. 1, and of slightly greater diameter than the overall diameter of the end cap members **2**, the diameter of the cavity **10** determining the diameter of the finished coated article comprising the uranium body **1**, the end cap members **2**, and a coating **12** of cast metal or alloy, the lateral boundaries of which are shown in dashed line detail in Fig. 1. The die block **9** is likewise provided with a gate **13** through which the molten casting metal may be poured and vent channels **14** through which entrapped air or gases may escape.

The initial steps in practicing my invention comprise forming the end members or caps **2** with the thin protruding edge **7**, placing these end caps over each end of the uranium body **1**, and placing the assembly in the portion of the die block **9** shown in Fig. 2. The end caps **2** effectively support and center the uranium body **1** in the die block cavity **10** so that the metal when cast about the body **1** is of uniform thickness. In addition,

the casting metal upon contacting the caps **2** heats the thin edge portions **7** thereof to substantially the melting point of the end cap metal so that the edge portions **7** unite with and become firmly bonded to the cast metal. Consequently, the entire uranium body **1** is enclosed with a coating of metal, there being no discontinuities such as would occur with removable stringers or supports used to maintain the body **1** centrally of the die block cavity.

While I have described my invention with particular reference to the formation of a coating wholly enclosing a metal body it will be appreciated that my invention is equally applicable to external coating of tubular cylinders or other tubular shapes. Referring to Fig. 3, I have shown a tubular cylinder **16** to be covered with a metal on its lateral and end surfaces. In accordance with my invention I provide tubular cap members **17** which are substantially identical with the cap members **2**, shown in Fig. 1, except for a central aperture **19** in each cap into which a removable plug **20** is placed merely to close the apertures. The cap members **17** are likewise, as in the previous example, provided with a rim **21** having a thin annular edge **22**, the rim **21** on each of the caps **17** supporting the cylinder **16** in the die block **9***a*, only half of which is shown in the drawing.

Following assembly of the end caps **17** on the cylinder **16** to be coated and the insertion of the plug **20**, the two halves of the die block are clamped together and the molten casting metal introduced into the gate **13** in the die block, whereupon the action of fusing with the rim portions **21** about the thin annular edge **22** is identical with that described in connection with Fig. 2.

While the flange or rim **3** shown in Fig. 1 and the rim **21** shown in Fig. 3 are in the form of angular bevels on the cap members, the cap may be as shown in Fig. 4 wherein a cap **23** otherwise similar to the cap **2** is provided with a thin annular web **24** surrounding the cap and being relatively thin in comparison with the transverse thickness of the cap metal. It will also be understood that the cap members may take any form necessary to fit the objects to be covered, provided that some peripheral portion of the cap member is of the proper thickness so that it will fuse when contacted with the molten casting metal. Furthermore, the end cap members need not be made of the same metal as the covering on the lateral surfaces of the object, but may be made of any desired metal that will not contaminate the object and will fuse with the casting metal.

Following solidification of the cast metal the die block portions are separated and the coated member is removed therefrom, the excess metal such as that remaining in the gate and that flowing into the vent holes being removed. The success of my invention appears to reside in the provision of the relatively thin edges on the cap members in that the time lag in the conduction of heat into the metal core results in only the thin edge being raised to the melting point by the molten cast metal so that an incipient fusion of the thin edge is produced providing a continuous metal coating without leaving discontinuities in the coating over any portion thereof.

While I have described my invention with particular reference to the application of coatings to only two specific structures it will be apparent that many variations may be made in the manner of applying the coating and that other modifications of my invention will at once occur to those skilled in the art without departing from the scope of the appended claims.

I claim:

1. The method of coating an elongated metal object comprising the steps of providing on each end of said object a cap member having a tubular portion telescoping over the end of said object and an outwardly extending rim portion, casting metal at a temperature slightly above the melting point of the cap members and below that of the object over and in contact with said object and tubular portions between said rim portions, and fusing the cast metal to the extending rim portions only of said cap members by the heat of the cast metal and cooling to below the melting point.

2. The method of providing an elongated metal object with a hermetically closed cast metal coating comprising the steps of providing for each end of said object a cap member of metal with a rim portion of reduced thickness in comparison with the body portion of the cap and a tubular portion of slightly larger internal diameter than the external diameter of said object, positioning one of said cap members on each end of the elongated metal object with the tubular portion in telescopic relation with said object, casting metal at a temperature slightly above the melting point of the cap members and below that of the object between the rim portion and over the tubular portion, and fusing the cast metal to the rim portions only of said cap members by the heat of the cast metal and cooling to below the melting point.

3. The method of producing a continuous coating of metal on a metal object comprising the steps of supporting the object in a die between two metal cap members each provided with an integral thin web and a tubular portion partially enclosing said metal object, then casting metal at a temperature slightly above the melting point of the cap members and below that of the object between the walls of said die and said object in one direction and between the integral webs in a transverse direction, and fusing the cast metal to the web portions only of said caps members by the heat of the molten metal and cooling to below the melting point.

4. The method of coating an elongated metal object comprising the steps of providing a cap member for each end of said metal object, each of said members having a tubular portion adapted to fit snugly over the end of said metal object and a thin web extending in a radial direction from said tubular portion, positioning said cap members on said metal object with the tubular portions extending toward one another, casting metal at a temperature slightly above the melting point of the cap members and below that of the object between said radially extending webs and fusing the cast metal to said thin webs only to form therebetween a hermetically closed coating over said metal object and a firm bond comprising the cast metal.

5. The method of covering an elongated metal body with a metal jacket comprising casting a metal cap on each end of said body, allowing said caps to solidify, and then casting metal at a temperature slightly above the melting point of the cap members and below that of the body about said body between said caps so that the cast metal is fused to said metal caps by the heat of the cast metal and cooling to below the melting point.

6. The method of die casting a metallic coating on an object that comprises providing a metallic centering cap on said object, said centering cap having a protruding metallic edge, supporting said object in a die by means of said centering cap, pouring molten metal at a temperature slightly above the melting point of the centering cap and below that of the object into the die and in contact with the protruding edge of the centering cap, and fusing the protruding edge only, said cap to form a bond and seal therewith by the heat of the molten metal and cooling to below the melting point.

7. The method of covering an elongated uranium body with an aluminum alloy jacket comprising providing tubular radially flanged caps of aluminum alloy in telescopic relationship with and on opposite ends of said body, casting an aluminum alloy at a temperature slightly above the melting point of the tubular caps and below that of the body about said tubular caps and said uranium body, and fusing the peripheral edge only of said caps to the cast aluminum alloy before solidification thereof by the heat of the aluminum alloy and cooling to below the melting point.

8. A coated metal object comprising an elongated metal

member, a cap with a radially extending flange on each end of said elongated member, and a cast metal coating having a pouring temperature slightly above the melting point of the cap and below that of the metal member on said member extending between the flanges and forming with the cap on each end a continuous covering for said metal member, the area of fusion between the cap member and cast metal being limited to the rim flange, the cast metal, cap and member retaining their identities.

9. A coated metal object comprising an elongated metal member, a tubular cap having an integral flange portion over each end of said member, and a cast metal coating having a pouring temperature slightly above the melting point of the cap and below that of the metal member fused to the flange portion only of each cap and extending in overlying relation to said metal member between the said caps, the cast metal, cap and member retaining their identities.

10. A covered metal member comprising an elongated body portion of cylindrical shape, a cylindrical metal cap member fitted over each end of said body portion, an integral flange on each of said cap members extending from a position adjacent the ends of said body portion radially of said cap members, and a metal coating enveloping having a pouring temperature slightly above the melting point of the cap and below that of the metal member and hermetically enclosing said body portion extending over said cylindrical cap members, filling the space between said flanges, and being fused to the peripheral portion only of said flanges said metal coating, cap members and body portion retaining their identities.

11. The combination comprising an elongated body of uranium and a metal covering for said body formed of an alloy composed of approximately 87 percent aluminum and 13 percent silicon having a pouring temperature below the melting point of the uranium body, said covering including a cylindrical cap of said alloy positioned in telescopic relation over each end of the elongated body each of said caps having a peripheral edge fused to the adjacent portion of the metal covering, and said metal covering, caps and uranium body retaining their identities except for the area of fusion over the peripheral fused edges of said caps.

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