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COMPOSITE MAGNESIUM-IRON ARTICLES

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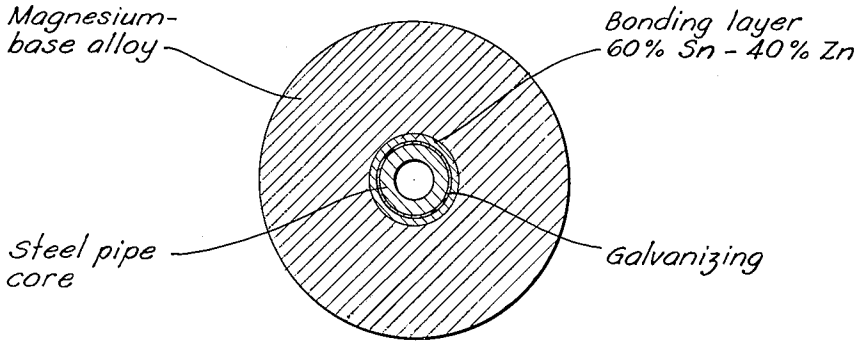


Fig. 2

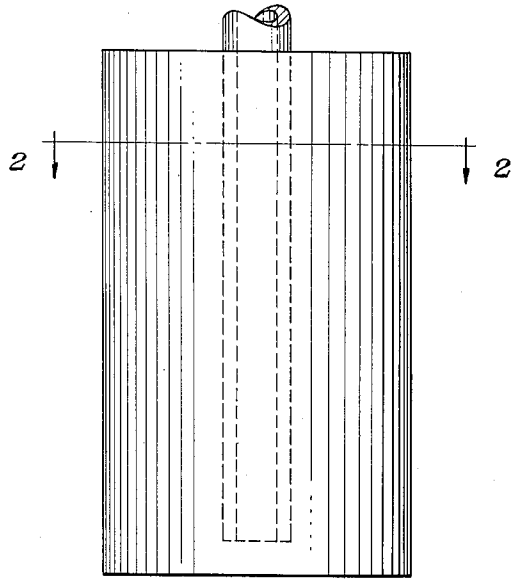


Fig. 1

INVENTORS.
William B. Brooks
Claire M. Shigley
BY
Griswold & Burdick
ATTORNEYS

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COMPOSITE MAGNESIUM-IRON ARTICLES

William B. Brooks and Claire M. Shigley, Lake Jackson, Tex., assignors to The Dow Chemical Company, Midland, Mich., a corporation of Delaware

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4 Claims. (Cl. 29—196.2)

This invention relates to composite articles formed of a magnesium metal and a ferrous metal integrally bonded together, and to a method of making such articles.

In the cathodic protection of pipelines and other underground steel structures, consumable bodies of magnesium or other metal anodic to the steel are buried in the earth near the structure and connected to it by electrical conductors. The resulting flow of current maintains the structure cathodic to the soil and minimizes its corrosion.

Magnesium anodes for this service are often provided with a steel core to insure good electrical connection to all portions of the active metal and to prevent the anode from breaking into separate pieces as it is consumed (see U. S. Patent 2,478,478). It is, of course, highly desirable that the core be well bonded to the magnesium, to cut down electrical resistance at the bond and to prevent the core from loosening in service. A number of bonding agents have been used for the purpose, and some serve reasonably well. However, bond strengths have seldom exceeded two or three tons per square inch, and considerable difficulty has been encountered during commercial production in obtaining even these values repeatedly.

It is therefore an object of the present invention to provide an improved method of bonding steel cores into consumable magnesium anodes which affords reproducible bond strengths significantly higher than those heretofore obtained. A related object is to provide an improved bond between iron and magnesium useful generally in making composite articles of these metals.

According to the invention, excellent bonds may be produced between a ferrous metal and a magnesium metal by first coating the ferrous metal with a tin-zinc alloy containing 40 to 75 per cent by weight of tin, balance substantially zinc, and then applying the magnesium metal to the coated surface. The process should be carried out at a temperature above the melting point of the tin-zinc alloy. For best results, the ferrous metal should be galvanized, i. e. coated with zinc, before applying the tin-zinc bonding agent.

The process of the invention is equally applicable to commercially pure magnesium and to the commercial magnesium-base alloys, all such materials being herein termed "magnesium metal." In making consumable anodes, it is important to choose a magnesium-base alloy having electrochemical characteristics particularly suited to the service for which the anode is designed. The factors influencing this choice are discussed in Chem. Eng. News 23, 1051 (1945) and in Trans. Electrochem Soc. 90, 485 (1946). The ferrous metal core is ordinarily rod, pipe, or stranded cable, of common carbon steel, although other ferrous metals are equally operable. If the core is galvanized, the zinc coating may be applied in any convenient way, commercial galvanized pipe being entirely satisfactory.

The tin-zinc alloy used for the bonding metal is preferably a binary alloy of these two metals, and containing 40 to 75 per cent by weight of tin. However, small proportions of other metals may be tolerated. The strongest bonds are obtained with a tin-zinc alloy containing 55 to 65 per cent of tin, the optimum being about 60 per cent tin.

In making anodes according to the invention, an elongated ferrous metal core is, if necessary, degreased, and is then cleaned thoroughly of scale by sand-blasting, pickling, or other means. Galvanized iron cores are most readily cleaned by pickling in dilute sulfuric or hydrochloric acid.

The bare, bright metal is then coated with the tin-zinc alloy by any desired procedure. Most conveniently, the tin-zinc alloy is melted and then either wiped on the core to be coated, or the core may be dipped into the molten alloy. In using the wiping technique with galvanized steel articles, the surface is first coated with a chloride flux, as by dipping in a strong aqueous solution of zinc chloride and ammonium chloride. For the dipping procedure with galvanized cores, the molten tin-zinc alloy bath is covered with a flux blanket formed of a mixture of zinc chloride and ammonium chloride in equal proportions by weight and the core is inserted into the bath through the flux blanket.

After the ferrous core has been coated, any excess tin-zinc alloy and flux are wiped off, and the magnesium metal to be bonded to the core is then quickly applied to the coated surface, as by casting. Preferably, the coated core is centered in a conventional treated-sand or permanent mold, and the molten magnesium metal is poured in. When the latter has solidified, the cast anode is removed from the mold and is ready for use.

The bond between the ferrous metal core and the magnesium metal produced in this way is extremely strong and of low electrical resistance. Bond strengths of three to five tons per square inch are easily obtained.

The construction of an anode according to the invention will be readily apparent from the accompanying drawing, in which

Fig. 1 is an elevation showing a completed anode, with the exposed portion of the core being indicated only fragmentarily, and

Fig. 2 is a section along the line 2—2 in Fig. 1.

While the invention is primarily useful in making consumable magnesium anodes with well-bonded steel cores, the principle involved is applicable generally in making composite articles in which a magnesium metal is bonded to a ferrous metal. The step of coating with tin-zinc alloy may be carried out by spraying or other means as well as by wiping on or dipping. The magnesium may be applied to the tin-zinc coated surface by processes other than casting, as by forging or rolling. It is necessary only that at some stage of the process the tin-zinc alloy be at a temperature above its melting point to insure good bonding.

Example

Cylindrical anodes 4 inches in diameter and 60 inches long were cast around lengths of ¾-inch standard galvanized steel pipe according to the preferred procedure described above. The magnesium metal was a commercial magnesium-base alloy containing about 6 per cent aluminum, 3 per cent zinc, and 0.2 per cent manganese, balance substantially magnesium, the alloy being specially treated to remove iron and nickel impurities. The mechanical strength of the bonding layer, as measured by the force required to push the cores axially out of 1-inch long cross-sections sawed out of the anodes, was from 30,000 to 50,000 pounds, corresponding to bond strengths of 9100 to 15,100 pounds per square inch.

What is claimed is:

1. A composite metal article comprising a galvanized ferrous metal and a magnesium metal integrally bonded

together by an intermediate thin layer of a tin-zinc alloy containing 40 to 75 per cent by weight of tin, balance substantially zinc.

2. A composite metal article comprising a galvanized ferrous metal core surrounded by and integrally bonded to a body of a magnesium metal by an intermediate thin layer of a tin-zinc alloy containing 55 to 65 per cent by weight of tin, balance substantially zinc.

3. A composite metal article comprising an elongated galvanized steel core surrounded by and integrally bonded to an elongated body of cast magnesium metal by an intermediate thin layer of an alloy containing about 60 per cent by weight of tin, balance substantially zinc.

4. The method of forming a composite metal article which comprises dipping a galvanized steel core in a molten tin-zinc alloy containing about 60 per cent by weight of tin, balance zinc to coat the same with the alloy, and then casting a magnesium metal about the coated core.

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