Sept. 26, 1961 W. T. BATTIS ET AL 3,001,924

SACRIFICIAL MAGNESIUM ANODES

Filed April 1, 1959

Fig. 1.

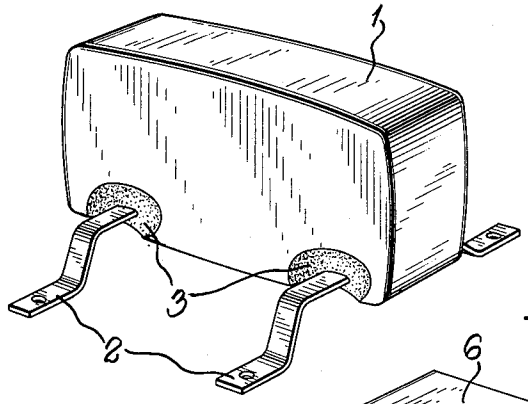
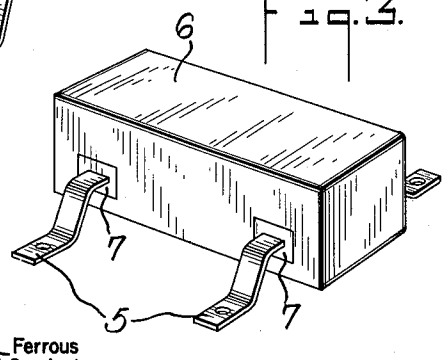


Fig. 3.



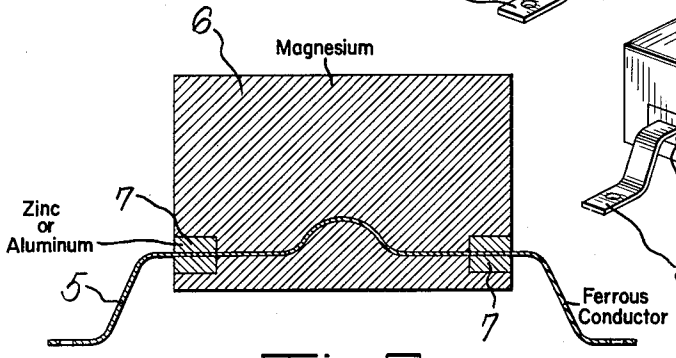
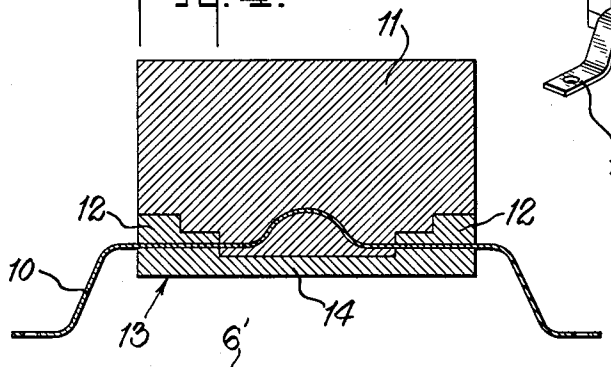


Fig. 2.

Fig. 4.



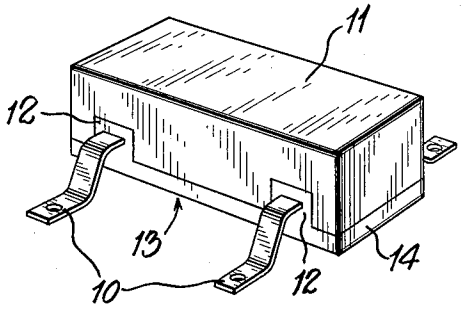


Fig. 5.

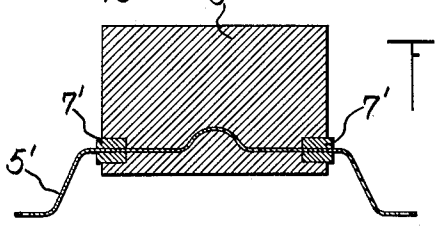


Fig. 6.

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3,001,924
SACRIFICIAL MAGNESIUM ANODES

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This invention relates to a sacrificial anode comprised of magnesium and more particularly to an improvement in the connection for electrical conductor thereof.

Sacrificial anodes having a ferrous conductor projecting therefrom generally are fabricated by casting a body of metal comprising magnesium around one or more steel brackets so that a portion of each bracket is embedded in the body of magnesium metal with the remaining portion of each bracket projected therefrom. In use, the anode is electrically connected to a less noble structure to be protected, usually a ferrous structure, by suitably attaching the projecting end or ends of the bracket or brackets to the structure, as by bolting or welding, so that the bracket or brackets may serve both as an electrical conductor and a support for the body of sacrificial metal. When the electrical circuit between the anode and the structure is completed by an electrolyte, the resulting current established by galvanic action flows from the anode to the structure and maintains the latter cathodic at the expense of the anode which is progressively dissolved, i.e., sacrificed, so that corrosion of the structure is reduced or prevented.

It has been found that where such anodes are fabricated with brackets comprising ferrous metal, for example, iron, steel or other ferrous metal, accelerated local corrosion occurs at the magnesium metal-bracket interface when the anodes are in use, especially in sea water and particularly in running sea water. It has been found that such local corrosion occurs whether or not bare or galvanized brackets are used in fabricating the anode; and that this corrosion may be so severe that in a comparatively short time the anode becomes loose on its brackets with the result that the anode becomes ineffective and fails in that current flow from it to the cathode is reduced or stopped. In most instances in protecting a structure from corrosion in sea water, such local corrosion causes the anode to fail before the body of the magnesium metal has been consumed and, in running sea water, much before the magnesium metal has been half consumed. As a result of such failure, a large portion of the body of magnesium metal is wasted and the structure or portion thereof served by the anode is without protection until the latter is replaced. In addition, such local corrosion, even if failure does not occur, represents a wasteful and inefficient use of the magnesium metal.

The principal object and advantage of the invention is that it provides an anode in which such local corrosion is greatly reduced or eliminated. Another object and advantage of the invention is that it provides an anode in which the body of sacrificial metal is used more efficiently. A further object and advantage is that the structure to be protected is provided with more effective protection by the anode of the invention. These and other objects and advantages will become apparent from the following more detailed description of the invention.

Broadly, the improvement comprehended by the invention is the provision in the body of the anode of a plug of metal which is less active galvanically than magnesium, the plug being at least partially embedded in the body of the magnesium metal of the anode and surrounding the ferrous conductor in the portion of the anode where the conductor emerges from the anode. While a

portion of the plug may project beyond the body of the anode, it is essential in obtaining satisfactory reduction of local corrosion where the conductor emerges from the anode that at least a portion of the plug be disposed within the body of the anode.

Good results are obtained with a plug which surrounds the conductor with at least ¼ inch of plug metal. Enhanced results are obtained when the conductor is surrounded with at least ½ inch of such metal and in most instances a plug which surrounds the conductor with ½ to 2 inches of metal is adequate. Good results are also obtained when the plug surrounding the conductor extends at least ¼ inch into the body of the anode. Preferably, the plug extends at least ½ inch into the body of the anode and most preferably each plug extends into the anode for at least about one-quarter of the length of the portion of the conductor which is embedded in the body of the anode.

Any metal which is less active galvanically than the body of the sacrificial metal may be used. Thus, with a body of sacrificial metal comprising magnesium, the plug metal may be, for example, a metal comprising zinc, cadmium, aluminum, lead, or tin, or their alloys. For best results, however, the plug metal is also more active galvanically than is the metal of the electrical conductor. The preferred plug metal for a ferrous conductor is one which is composed predominately of zinc or aluminum. For example, the preferred plug metal may be commercially available aluminum or aluminum alloyed with up to 6% zinc; or it may be commercial pure zinc or zinc alloyed with up to 0.5% aluminum or up to 0.2% cadmium, or both of these alloying constituents. Most preferably, the plug metal is composed of commercially pure zinc or a zinc alloy.

The body of magnesium metal in the anode may be composed of magnesium or a magnesium-base alloy. Preferably, it is composed of a magnesium-base alloy which, most preferably, contains up to 10% aluminum and up to 5% zinc as alloying constituents. The anode may be fabricated in any desired manner although best results are obtained by conventional casting procedures. Thus, in the preferred mode of fabrication, the conductor or conductors are placed in a desired position of the mold cavity of a suitable mold. The mold cavity is also provided with suitable spacers around the conductors corresponding to the position of the plug metal which is ultimately cast therein. The magnesium metal is then cast about the conductors and, after solidification, the spacers are removed and the plug metal is cast in the space formerly occupied by the spacers. Upon solidification of the plug metal, the finished anode is removed from the mold.

The invention is further illustrated in the accompanying drawings and in the following examples. It should be understood, however, that the drawings and examples are given for purposes of illustration and that the invention in its broader aspects is not limited thereto.

In the drawings:

FIG. 1 is a perspective view of an anode showing the local corrosion which occurs in the absence of the invention;

FIG. 2 is a transverse cross-section of an anode employing the invention in its preferred form;

FIG. 3 is a perspective view of the anode of FIG. 2;

FIG. 4 is a transverse cross-section of another anode employing the plug metal of the invention;

FIG. 5 is a perspective view of the anode of FIG. 4; and

FIG. 6 is a view similar to FIG. 2 showing an anode employing the invention in an alternative form.

Referring now to the drawings, in FIG. 1 there is shown

a conventional anode as it appears after a short period of use. The numeral **1** represents a body of sacrificial metal comprising magnesium, and **2** represents ferrous metal electrical conductors which also serve as means for supporting the anode on the structure to be protected. The area designated by the numeral **3** illustrates the local corrosion that occurs at the magnesium metal-bracket interface.

FIGS. 2 and 3 illustrate an anode employing the invention, which anode is especially useful in protecting ship hull surfaces. The ferrous metal brackets **5** embedded as shown in the body of the magnesium metal **6** are provided with plugs **7** of a metal less active galvanically than the body of the magnesium metal. In use, the projecting ends of the brackets, are attached, as by bolting, to the structure to be protected so as to support the body of the sacrificial metal away from the structure and also to electrically connect the sacrificial metal to the structure.

In FIGS. 4 and 5, a portion of the ferrous metal brackets **10** are also embedded in the body of magnesium metal **11**. In addition to surrounding the brackets in portions **12** of the anode where the brackets emerge therefrom, the plug metal **13** also covers the surface **14** which is intended to be placed against the cathodic surface to be protected. The anode illustrated in FIGS. 4 and 5 is most advantageously used to protect the exterior of ship hulls. In use, the projecting ends of the anodes are attached to the exterior of the hulls with the bottom of the anode held tightly against the hull.

An anode employing the invention in an alternative form is shown in FIG. 6. As shown in this figure, a portion of the body of the plug metal **7'** projects outside of the body of the magnesium metal **6'**.

Two 44 pound anodes of the type illustrated in FIGS. 4 and 5 were fabricated by conventional casting procedures. The anodes were generally rectangular in shape. The sacrificial magnesium metal was a magnesium alloy containing 6% aluminum, 3% zinc and the balance commercial grade magnesium. The brackets **10** were bare steel (so-called black iron) brackets. The magnesium alloy was cast about the brackets so that the middle portion of each bracket was embedded in and surrounded by the magnesium alloy. Suitable spacers were placed in the mold cavity prior to casting the magnesium alloy so as to enable the plug metal **13** to be subsequently cast about the brackets in the portions **12** of the anode and also to cover surface **14**. After the magnesium metal was cast, the spacers were removed, and the plug metal was cast on the anode in the position shown in FIGS. 4 and 5. In each of the portions **12**, the plug metal extended along and surrounded the bracket **10** for a distance of 1¾ inches. Also in each of the portions **12**, the outermost portion of the plug metal was 3½ inches wide by 2 inches deep and, in the innermost portion, the plug metal was 3½ inches wide and 1¼ inches deep. In one anode the plug metal was commercial grade aluminum and in the other high purity zinc metal containing 99.99+% zinc was used.

Each of the thus prepared anodes was mounted on 4 foot x 4 foot x ⅛ inch cold rolled steel plates with the bottom **14** (see FIG. 5) of each anode held tightly against the plate. The plates with the anodes were then immersed in a flume of running sea water for four and one-half months. At the end of this period the plates were removed from the flume and the anodes examined. It was found that more than half of the body of the sacrificial magnesium metal in each of the anodes was consumed in affording galvanic protection to the plates but that no local corrosion of the magnesium metal or the plug metal occurred where the brackets **10** emerged from the body of the anode.

The foregoing results are to be compared with the results obtained in a similar test with an anode which was otherwise the same as the two foregoing test anodes except that no plug metal was used. Within 80 days local corrosion of the type illustrated in FIG. 1 had occurred to such an extent that the anode became loose on brackets **2** (see FIG. 1). Likewise, in another similar test with anodes having plug metal cast in the brackets against the body of the magnesium metal but not recessed therein, it was found that local corrosion also occurred at the interface between the plug metal and the body of the anode.

What is claimed is:

1. In a sacrificial anode having a body of sacrificial metal comprising magnesium and a ferrous metal conductor projecting from the anode with a portion of the conductor embedded in the body of said sacrificial metal, the improvement comprising a plug of metal which is less active galvanically than magnesium and more active galvanically than said ferrous metal conductor, said plug being at least partially embedded in said body of magnesium metal and surrounding said conductor in the portion of the anode where the conductor emerges therefrom.

2. A sacrificial anode according to claim 1 in which said plug comprises a metal selected from the group consisting of zinc and aluminum.

3. A sacrificial anode according to claim 1 in which said plug surrounds said conductor with at least ¼ inch of plug metal and said plug extends at least ¼ inch into the body of the anode.

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