July 21, 1959 H. A. ROBINSON 2,895,893

GALVANIC ANODE

Original Filed May 19, 1954

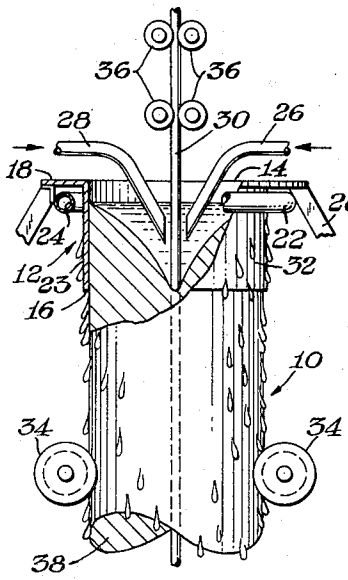


Fig. 1

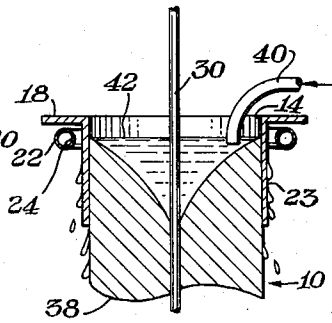


Fig. 2

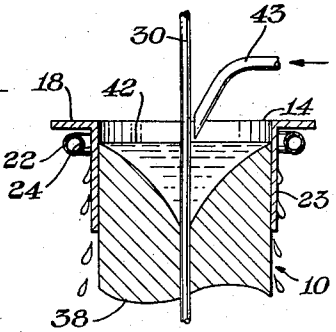


Fig. 3

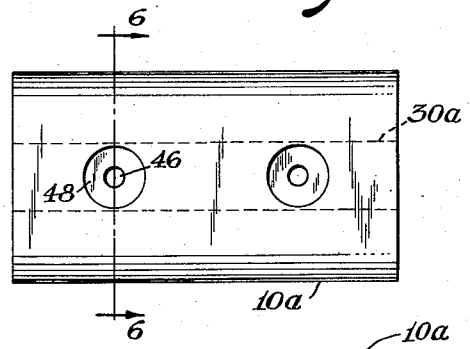


Fig. 5

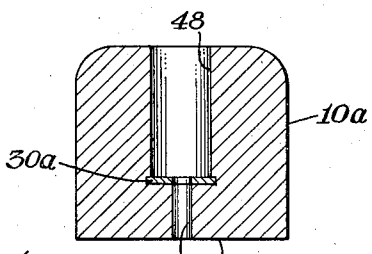


Fig. 6

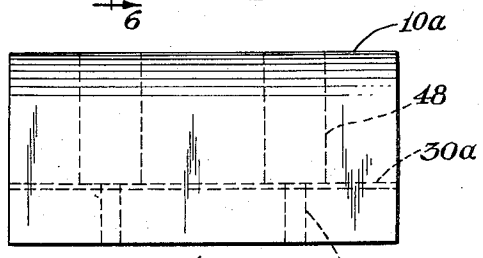


Fig. 4

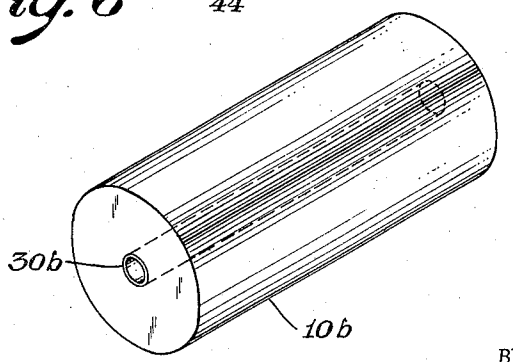


Fig. 7

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United States Patent Office 2,895,893 Patented July 21, 1959

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GALVANIC ANODE

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Original application May 19, 1954, Serial No. 430,921. Divided and this application October 18, 1956, Serial No. 616,888

3 Claims. (Cl. 204—197)

This invention relates to metal cored galvanic anodes and to a method of making the same.

Galvanic anodes comprising a consumable portion, usually magnesium, which is cast around a steel core member have found considerable use in providing cathodic protection to a wide variety of materials which are subject to electrolytic corrosion. Typical of the items receiving such cathodic protection are pipe lines, tanker compartments, ship hulls, water heaters, and steam condensers.

In the past, some galvanic anodes have been made in batchwise manner by a permanent mold casting process. In this process, the steel or other metal core is placed in a casting mold and the molten galvanic metal then is poured around it and allowed to solidify. While anodes made up in this manner are satisfactory for many applications, they are in general subject to some limitations which somewhat reduce their utility.

First, the bond between the core and the consumable portion of the anode tends to be a mechanical bond rather than a metallurgical bond. In most cases, where the anode is several inches in length, a sufficient metallurgical bonding occurs to provide good electrical contact between the core and the consumable portion of the anode. However, in some cases, the mechanical bond is so slight that the core may be readily removed from the anode after casting.

Another difficulty with permanent mold casting of cored anodes is that the positioning of the core within the anode is difficult to control. This lack of uniformity in core placement results in difficulties in mounting the anode in certain applications where the anodes are to be attached to mounting means which are not capable of adjustment. Representative of such uses for galvanic anodes is the protection of ship hulls, in which a hollow-cored anode is fitted over mounting studs secured to the hull. If the core is warped, the anode will not easily fit over the threaded studs. A description of this type of anode may be found in the January 1953, issue of "Motorship" magazine.

A principal object of this invention is to provide improved metal cored galvanic anodes having more uniform construction characteristics.

Another object of this invention is to provide an improved, more economical metal cored galvanic anode.

Yet another object of this invention is to provide an improved method of making galvanic anodes.

An additional object of this invention is to provide an improved method of continuously casting metal cored galvanic anodes.

A further object of this invention is to provide a metal cored galvanic anode having improved metallurgical bonding between the core and the consumable portion of the anode.

In accordance with the method of the present invention, galvanic anodes are made by a continuous process in which the consumable metal part of the anode is direct chill cast around an electrically conductive core member

which is fed through the bottomless chill-casting mold at the same linear rate as that at which the casting is produced. Anodes of any reasonable length may be made in this manner, with assurance that the position of the core member within the anode may be controlled within close limits.

For the sake of brevity in the specification, the continuous process by which the consumable metal of the anode is direct chill cast is referred to as "direct chill casting." Direct chill casting of ingots or billets is a well established process. See, for example, U.S. Patents 2,135,183 (Junghans), 2,301,027 (Ennor), 2,410,837 (Peters), 2,503,819, (Gunn et al.) and 2,548,196 (Barstow et al.).

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawings, in which:

Fig. 1 is a side elevational view, partly broken away and in section, showing direct chill casting apparatus suitable for use with this invention;

Fig. 2 is a fragmentary view, partly broken away and in section, of similar direct chill casting apparatus, showing an alternative means of feeding molten metal into the mold;

Fig. 3 is a fragmentary view, partly broken away and in section, of another alternative form direct chill-casting apparatus in which the molten metal is applied along the core and above the level of molten metal in the mold;

Fig. 4 is a side elevational view, of a ship's hull type of anode in accordance with this invention;

Fig. 5 is a plan view of the anode shown in Fig. 4;

Fig. 6 is a sectional view, taken along the line 6—6 of Fig. 5, and

Fig. 7 is an isometric view of a different type of anode in accordance with this invention, of cylindrical form with a hollow core.

As shown in Fig. 1, a magnesium galvanic anode 10 is continuously formed in a hollow thin wall casting mold 12 of heat-conducting metal which is open at the top 14 and bottom 16 and attached to a flange 18 resting upon suitable supporting means 20. Surrounding the mold 12 near the upper end thereof is a cooling fluid distributor 22 which is illustrated as a pipe which has apertures or openings 24 directed towards the exterior of the mold wall 32. The cooling fluid is directed through the openings 24 upon the mold wall 32 and thence down the surface of the anode 10, rapidly solidifying and cooling the casting. Molten metal, usually magnesium or aluminum, or alloys thereof, is continuously introduced at a carefully controlled rate into the mold 12 from a source of molten metal (not shown) through two pipes 26, 28, which are disposed adjacent to a core rod or strap 30 being fed centrally into the anode 18 as it forms. The ends of the pipes 26, 28 which are adjacent to the core rod or strap 30 are so disposed that the molten metal being introduced to the mold 12 impinges on the surface of the rod or core 30. (For a description of suitable means of controlling the rate of flow of molten metal into the mold, see U.S. Patent No. 2,548,696 to Barstow et al.)

The solidified anode 10 is guided and withdrawn by the pinch rolls 34 as the anode 10 forms and descends below the mold 12. The rate of introducing molten metal to the mold 12 is adjusted to maintain a balance with the speed of rotation of the pinch rolls and also in accordance with the rate of solidification of the metal.

The core rod or strap 30 is guided or fed by the rolls 36 or other suitable guiding means disposed above the mold 12. The core rod or strap 30 should preferably have enough flexibility that it may be uncoiled from a spool as needed. Alternatively, the core 30 may be composed of straight sections which can be welded or

otherwise suitably secured together to form a continuous core.

The casting operation is as follows: Initially a dummy block, not shown, is inserted against or into the bottom **16** of the mold **12**. The dummy block may have a recess therein for locating the core **30**. The core **30** is inserted in the recess and the rolls **36** or other guiding means are positioned so that the core **30** is perpendicular to the top of the mold **12** (or parallel with the sides thereof). Then with the cooling fluid, which may be water, applied against the mold **12**, molten metal is introduced thereto. The metal, when solidified around the bottom part **16** and wall **32** of the mold **12**, forms a shell which actually becomes the mold for the casting. It should be noted that the center portion of the casting, as might be expected, remains molten for a considerable time after the wall portion of the casting has solidified. The solidified casting is then slowly withdrawn downwardly out of the mold **12**, normally at the rate of a few inches per minute, by pinch rolls **34**. Since the core **30** is initially adjusted to be parallel with the side of the casting or anode **10**, it remains so unless the guide rolls **36** become improperly aligned. As is usual in direct chill casting procedure for magnesium, the surface of the melt and the mold **12** may be protected by directing sulphur dioxide gas thereon.

When a length of core **30** is almost consumed in making the casting, a new length is passed through the guide rolls **36** and then is welded or otherwise electrically conductively secured to the free end of the core **30** which extends from the anode **10** in such a manner as to maintain alignment of the length of the core **30**. Since the anode is being formed at a slow rate, as previously mentioned, the welding together of the core lengths may be readily accomplished without stopping the continuous casting of the anode **10**. Obviously, core sections may be joined together above the guide rolls **36** as well as below. In some cases, this may be preferable.

In the embodiment shown in Fig. 1, the molten metal supply pipes **26**, **28** are so disposed in the melt that the molten metal sweeps against the core rod or strap **30**, and tends to wash or clean the surface thereof. The sweeping of the molten metal against the anode apparently tends to remove any oxide or other surface film which may have collected on the core **30**. This cleaning, and the fact that the core is thoroughly preheated by passing through the molten metal before the metal solidifies around the core, apparently greatly enhance the metallurgical bond between the core **30** and the consumable portion **38** of the anode **10**. Also, because the anode is direct chill cast, the anodes may be made in any length required or may be shipped in long lengths which are then cut to smaller anode lengths to fit the needs of the customer buying the anode.

Alternative means of feeding molten metal into the mold **12** are illustrated in Figs. 2 and 3. In Fig. 2, the molten metal is supplied to the mold **12** through a single pipe **40**, the metal being discharged from the pipe, as in the arrangement shown in Fig. 1, just under the surface **42** of the melt in order to avoid exposure to air of a flowing stream of molten metal and to reduce turbulence in the mold. The metal feeding arrangement of Fig. 2 has an advantage in casting anodes with various core sizes and shapes, since no close spacing to the core **30** is required as in the arrangement shown in Fig. 1.

In the arrangement shown in Fig. 3, the metal is applied through a pipe **43** disposed above the surface **42** of molten metal and allowed to flow down the core **30**. This increases the preheating and cleaning of the core **30** and tends to cause a constant flow of metal past the surface of the core **30** as it enters the molten metal in the mold **12**.

Anodes made by continuous direct chill castings may be identified either by physical appearance or by metallurgical structure. For example, an anode made by continuous direct chill casting is characterized by the lack of shrinkage depressions on the surfaces thereof and by long columnar crystal grains transverse to the core of the anode and disposed radially about it. About 80 percent of the total mass, however, may be equiaxed grains, with 10 to 20 percent being columnar grains in a surface layer.

On the other hand, an anode made by the non-continuous permanent mold casting process heretofore used is characterized by shrinkage depressions on at least one surface thereof and by the fact that columnar crystal grains extend towards the central axis not only from the sides, but also from the ends of the anode.

It should be emphasized that the term magnesium, as applied to materials for anodes in this specification, also includes alloys of magnesium.

In Figs. 4, 5, and 6, there is shown an anode **10***a* made from a short length of anode which was made by direct chill casting according to the invention. The anode **10***a* is cut as a section of a continuous piece or blank cast according to the process of Fig. 1 in roughly rectangular cross-section, having a sharp-cornered flat face **44** on one side and rounded corners at the other side. The core **30***a*, in the form of a flat steel strap, is cast axially in the anode near the center with its flat transverse face parallel with the flat face **44** of the anode. Holes **46** for mounting the anode on stud bolts are drilled in the flat face **44** normal thereto and projecting through the strap **30***a*, being of substantially smaller diameter than the width of the strap. Enlarged counterbores **48** are drilled into the anode from the opposite face coaxial with the holes **46** and extending to the strap **30***a*. These bores serve to admit the washers and nuts required for holding the anode on mounting studs. The core strap **30***a* is sufficiently thick to permit the apertures **48** to be drilled deep enough to leave a clean surface of strap metal exposed without unduly weakening the strap at that point. The core strap **30***a* is often galvanized or aluminized, but the use of a coated core strap is not essential to the formation of a good bond between the core **30***a* and the consumable portion of the anode **10***a*.

It can be appreciated that galvanic anode blanks made in accordance with this invention may be readily and economically converted into anodes of any required length which are capable of being mounted on studs of any desired mounting center distance. Because of the metallurgical bond between the core and the consumable portion of the anode, good electrical contact is assured therebetween. This same metallurgical bond also protects the anode from seepage of fluid between the core and the consumable portion of the anode. Such seepage may result in the consuming of the anode portion which is adjacent to the core, finally destroying electrical contact between the two parts of the anode.

Fig. 7 illustrates a cylindrical anode **10***b* having a pipe core **30***b* in accordance with this invention. This type of anode may be cast in long lengths and then sliced up into disc-like anodes which may be conveniently mounted, as by a bolt through the pipe core **30***b*. The cylindrical anode **10***b*, however, may also be mounted, if desired, in somewhat the same manner as the anode **10***a* shown in Figs. 4, 5, and 6 by drilling holes through the anode and core transversely to the axis of the core.

The uniformity of spacing of the core **30***a* within the anodes **10***a* of this invention contributes substantially to their utility, since the drilling means may be set to a predetermined depth and then the drilling of the apertures **46** and **48** may be accomplished on automatic drill presses, if desired. In anodes made according to prior art practices, it has been difficult to accurately position the core **30** within the anode **10** in an economical manner.

The excellent metallurgical bond between the core **30** and the consumable portion of the anode assures that a continuously good electrical contact will be made therebetween for the life of the consumable portion of the anode. This is of considerable importance, since some an-

odes are designed to provide cathodic protection over a period of years to surfaces which cannot easily be visually inspected, yet if good electrical contact between the core and the consumable portion of the anode were broken, little or no cathodic protection would be provided.

Thus, anodes in accordance with this invention are economical to manufacture, may be adapted to use in a variety of manners, and are reliable in performance.

This application is a division of copending application, Serial No. 430,921, filed May 19, 1954, now abandoned.

I claim:

1. A block like unitary galvanic anode having at least one flat surface, a straight straplike metal core extending through said anode parallel with said flat surface, at least one aperture extending from said flat surface through said core, said aperture being smaller than the width of said core, and at least a second aperture of larger diameter than said first mentioned aperture, said second aperture being concentric with said first aperture and extending from a surface of said anode other than said flat surface to said core member, said first and second apertures providing a passageway which extends between oppositely disposed surfaces of the anode.

2. An anode in accordance with claim 1, wherein said metal core is galvanized.

3. An anode in accordance with claim 1, wherein said metal core has an aluminized coating thereon.

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