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ALUMINUM ALLOY AND ANODES
FORMED THEREOF

Bernard Raclot, Paris, France, assignor to Societe
Generale du Magnesium, Paris, France

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6 Claims

ABSTRACT OF THE DISCLOSURE

A galvanic anode for cathodic protection of tanks formed of a non-sparking aluminum alloy characterized by high constant potential and high electrochemical efficiency consisting of .1 to 4 percent by weight zinc, 0.2 to 0.6 percent by weight manganese, 0.005 to 0.1 percent by weight titanium, 0.001 to 0.005 percent by weight beryllium, 0.05 to 0.15 percent by weight mercury, with the balance being aluminum and impurities.

This invention relates to an aluminum alloy containing mercury, titanium, manganese, beryllium and zinc as essential alloying elements and to the method for preparation of same. It relates more particularly to anodes, such as may be used for cathodic protection or for galvanic cells, formed of an alloy of the type described.

To the present, anodes having a practically constant potential and characterized by high electrochemical efficiency have been produced for use in cathodic protection of alloys formed of aluminum and mercury. However, when aluminum is in contact with mercury or when formulated with mercury, the materials are subject to rapid oxidation in air. It appears that mercury functions somewhat as a catalyst for the oxidation of aluminum whereby extremely small quantities of mercury are sufficient to give the undesirable effects.

Stabilization against oxidation, without disturbing the electrical potential or electrochemical efficiency, can be effected by formulation of the aluminum-mercury alloy to include magnesium as an alloying component. However, such aluminum-mercury-magnesium alloys are subject to sparking responsive to engagement between the alloy and iron, particularly iron surfaces having a rust layer formed thereon. As a result, such alloys present a danger when employed as an anode for the cathodic protection of tanks or containers housing combustible materials, such as petroleum products.

Anodes of magnesium or of aluminum-magnesium alloys are faced with the serious defect of spark generation when dropped or otherwise brought into frictional engagement with rusty iron surfaces. This is a disadvantage which has required the avoidance of such alloys and particularly aluminum-mercury alloys containing magnesium in the construction of anodes for the protection of tanks containing inflammable materials such as petroleum products.

It is an object of this invention to produce and to provide a method for producing an alloy based upon the presence of aluminum and mercury, which retains the desirable properties of relatively constant potential and

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high electrochemical efficiency characteristic of aluminum-mercury or aluminum-mercury-magnesium alloys, which is free from the dangers of oxidation of the aluminum-mercury alloys and free from the dangers or sparking present in some of the aluminum-mercury-magnesium alloys.

The concepts of this invention are embodied in an alloy system having the following composition:

	Percent by wt.
Zinc -----	.1-4
Manganese -----	.2-.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

In the preparation of the alloy, the alloying elements are preferably introduced into the molten aluminum as master alloys although other techniques may be employed. For example, the titanium content can be introduced by means of a master alloy of aluminum containing 4 percent by weight titanium. The manganese can be introduced as the master alloy of aluminum containing 10 percent by weight manganese, and the mercury can be introduced with the zinc in a master alloy of zinc containing 15 percent by weight mercury.

Mercury introduction is preferably performed by enclosing the mercury containing alloy in aluminum foil for submergence as a package into the molten bath of aluminum. This operates to free the mercury below the surface of the bath thereby to avoid loss of mercury by vaporization. Thus fuller and safer utilization is made of the mercury introduced thereby to provide for better control of composition.

The following examples are given by way of illustration, but not by way of limitation, of alloys embodying the practice of this invention and the electrical characteristics of anodes formed thereof:

EXAMPLE 1

	Percent
Zinc -----	2.3
Manganese -----	0.48
Titanium -----	0.03
Beryllium -----	0.003
Mercury -----	0.125
Balance, 99.85% pure aluminum.	

In sea water, this alloy has the following characteristics:

	Volts
Potential with an intensity of 50 ma./dm. ² -----	1.05
Potential with an intensity of 100 ma./dm. ² -----	1.00
Potential with an intensity of 200 ma./dm. ² -----	0.92

EXAMPLE 2

	Percent
Zinc -----	1.75
Manganese -----	0.36
Titanium -----	0.04
Beryllium -----	0.004
Mercury -----	0.11
Balance, 99.85% pure aluminum.	

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This alloy has the following potentials in sea water:

	Volts
Potential with an intensity of 50 ma./dm. ² -----	1.06
Potential with an intensity of 100 ma./dm. ² -----	1.02
Potential with an intensity of 200 ma./dm. ² -----	0.96

EXAMPLE 3

	Percent
Zinc -----	3.4
Manganese -----	0.58
Titanium -----	0.03
Beryllium -----	0.005
Mercury -----	0.10
Balance, 99.85% pure aluminum.	

The potentials found in sea water are as follows:

	Volts
Potential with an intensity of 50 ma./dm. ² -----	1.04
Potential with an intensity of 100 ma./dm. ² -----	0.98
Potential with an intensity of 200 ma./dm. ² -----	0.90

In the foregoing, the potential measurements are made with reference to silver-silver chloride.

The electrochemical efficiency of the alloys exceeds 75% and may urge to as high as 85%, depending somewhat on the purity of the metals used in the preparation of the alloy.

In the combination described, the zinc brings about a certain amount of depassivation of the aluminum but the amount of depassivation is insufficient, in the combination described, for efficient cathodic protection and the mercury component seems to overcome this disadvantage.

The manganese content operates in the combination described to stabilize the alloy and prevent rapid oxidation, even when the mercury content exceeds the amount necessary to obtain the desired potential. However, when the amount of manganese exceeds the upper limit described, the amount of passivation becomes excessive.

The beryllium operates in the combination to retard oxidation at elevated temperatures which might otherwise result in the formation of a resistant aluminum skin on the surface of the alloy.

When employed within the described range, the titanium operates in the combination to provide improvements in the potential that is obtained with the alloy. When the titanium is employed in an amount in excess of that described, excessive passivation occurs.

While it is preferred to make use of an alloy containing zinc in the amounts described in combination with manganese, titanium and beryllium in the aluminum-mercury alloy, zinc is not essential. Thus an improved alloy embodying the concepts of this invention may be formulated of the following composition:

	Percent by wt.
Zinc -----	0-4
Manganese -----	.2-1.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance, aluminum plus impurities.	

The alloy embodying the above modification may be represented by the following example:

EXAMPLE 4

	Percent
Manganese -----	1.44
Titanium -----	0.04
Beryllium -----	0.004
Mercury -----	0.12
Balance, 99.036% pure aluminum.	

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It will be apparent from the foregoing that I have provided a new and improved aluminum alloy system and one which finds particularly beneficial use when employed as an anode, especially in cathodic protection of tanks containing combustible materials.

It will be understood that changes may be made in the details of formulation and construction without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. A nonsparking aluminum alloy characterized by a relatively constant high potential and high electro-chemical efficiency consisting essentially of:

	Percent by wt.
Zinc -----	.1-4
Manganese -----	.2-.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

2. A galvanic anode formed of aluminum - mercury alloy consisting essentially of:

	Percent by wt.
Zinc -----	.1-4
Manganese -----	.2-.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

3. A non-sparking aluminum alloy characterized by a relatively high constant potential and high electro-chemical efficiency consisting essentially of:

	Percent by wt.
Zinc -----	.1-4
Manganese -----	.2-1.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

4. A non-sparking aluminum alloy characterized by a relatively constant high potential and high electrochemical efficiency consisting essentially of:

	Percent by wt.
Manganese -----	.2-1.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

5. A galvanic anode for cathode protection of tanks containing combustible materials consisting essentially of:

	Percent by wt.
Zinc -----	.1-4
Manganese -----	.2-1.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

6. A galvanic anode for cathodic protection of tanks containing combustible materials consisting essentially of:

	Percent by wt.
Manganese -----	.2-1.6
Titanium -----	.005-.1
Beryllium -----	.001-.005
Mercury -----	.05-.15
Balance aluminum, plus minor impurities of less than .2 percent.	

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JOHN H. MACK, Primary Examiner
T. TUNG, Assistant Examiner
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