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ALUMINUM ALLOY

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This is a continuation-in-part of application Serial No. 852,961, filed November 16, 1959, now abandoned.

This invention relates to an aluminum alloy formed of aluminum, mercury and magnesium, with or without zinc, and it relates more particularly to elements for use in electrolytic cells, such as anodes and the like formed of such aluminum alloys.

It is known in the art that aluminum, which is in contact with mercury or contains mercury, tends to oxidize in the open air very rapidly. Apparently, the mercury functions as a catalyst, greatly furthering the oxidation of aluminum, and, consequently, even extremely small quantities of mercury are sufficient to cause this undesirable effect.

It is, therefore, universally admitted that in industrial application any contamination of aluminum with mercury must be strictly avoided. Where aluminum alloys with mercury are prepared, containing a predominant percentage of aluminum, solid dispersions are obtained having a very poor stability and oxidizing very rapidly when exposed to air or an oxygen-containing medium. The oxidation occurs so rapidly that a veritable mushrooming effect of alumina can be observed. In electrolytic solutions such alloys are rapidly attacked and eventually destroyed by this highly undesirable oxidation. It is particularly disadvantageous in electrolytic cells where the anode tends to decompose very rapidly.

It is an object of the present invention to provide an aluminum alloy having an improved resistance to corrosion.

It is another object of the present invention to provide an aluminum alloy which can be easily polished and is susceptible to furnish, when polished, a surface of exceptionally high gloss and brilliancy.

It is a further object of the present invention to provide an aluminum alloy which can be more easily worked than the known aluminum alloys.

It is another object of the present invention to provide an aluminum alloy which can be most advantageously used for the production of anodes, especially as used in electrolytic cells, and it is a related object to produce a new and improved anode of said alloy.

It is still another object of the invention to provide an anode, particularly for use in electrolytic cells composed of an aluminum alloy of the present invention, having a far greater yield and a longer service life as well as having a more slightly and evenly decreasing yield than electrolytic cells using anodes composed of conventional alloys.

It is still a further object of the invention to provide an anode, particularly for use in electrolytic cells composed of an aluminum alloy of the present invention, which is particularly useful for the providing of objects with a protective layer by cathodic deposition, and wherein the anode has a far greater yield while being consumed far less rapidly and drastically than anodes composed of conventional alloys.

Further objects and advantages will become apparent upon reading the following description of the invention.

The objectives of this invention are achieved by the preferred practice of the invention by the formulation of an aluminum alloy containing mercury and magnesium as alloying elements with the magnesium present in an amount within the range of 0.5 to 15 percent by weight

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and preferably within the range of 3 to 8 percent by weight and with the mercury present in an amount within the range of 0.001 to 0.15 percent by weight and preferably in an amount within the range of 0.04 to 0.15 percent by weight, the remainder being aluminum plus small amounts of conventional impurities.

When zinc is present as an alloying element in the combination with mercury and magnesium, it is preferred to limit the amount of zinc to within the range of 0 to 4 percent by weight and preferably in an amount within the range of 0.25 to 2.0 percent by weight. Thus the aluminum alloy of this invention may be defined as having the following composition wherein the elements are given in percent by weight:

Element	Broad Range	Narrow Range
Magnesium	0.5-15	3-8
Mercury	0.001-0.15	0.04-0.15
Zinc	0-4	0.25-2.0
Aluminum	balance	balance

There are a number of ways in which the materials can be formulated in preparation of the aluminum alloy. By way of one example, the mercury can be alloyed first with zinc or with a zinc alloy having as low a melting point as possible. The alloy is then melted with the necessary amount of aluminum and magnesium to obtain the final composition.

According to a modification the alloy of mercury with zinc is prepared under a pressure exceeding 1 atmosphere, preferably in the presence of an inert gas such as argon. By following this procedure, the volatilization of mercury is reduced to a minimum. Under these conditions, the mercury is dissolved in the zinc to form an amalgam containing from 10 to 20 percent of mercury. The amalgam is then alloyed with aluminum in a quantity of, for example, 75 percent aluminum.

In order to make operations at low temperature possible, the mercury is preferably dissolved in the zinc/aluminum eutectic having an aluminum content of 5 percent by weight and which melts at a temperature of 380° C. This alloy is then diluted with the desired quantity of aluminum and magnesium to make up the desired composition.

According to a further modification, the mercury is introduced into the zinc or melted with zinc/aluminum-magnesium alloy by means of a syphon-shaped tube. The tube is tightly sealed at one end and is closed at its opposite end by a small cap composed of zinc and/or aluminum. The necessary amount of mercury is contained in the tube and the tube is then rapidly plunged with the capped end into the melt. The mercury is reduced to the temperature of the melt and is released after the cap has been melted away to introduce the heated mercury into the alloy system with any vapors formed being condensed therein.

In the preferred practice in the preparation of the alloy of this invention, the mercury is formed first into an alloy of magnesium, zinc and mercury, which may be represented by the following composition:

	Percent by weight
Magnesium	41.6
Zinc	38.4
Mercury	20.0

The necessary quantity of this alloy is then wrapped in several layers or otherwise enclosed with sheet aluminum and the entire package is then immersed into a bath of molten aluminum whereby the mercury is released while within the bath greatly to minimize the amount of mercury that might be lost by vaporization.

The new alloy can be used for various purposes but with particular advantage for producing anodes for electrolytic cells. This opens an entire new field for the use of electrolytic cells as a means of providing objects with a protective coating by cathodic deposition and for cathodic protection. The known anodes could not be used in a basic environment having a pH value above 10.8 and notably in the black liquor (aqueous solution of sodium carbonate, soda, and sodium sulphite). The anode consisting of the alloy of the invention can be safely used for these purposes. The same applies to the application to certain brines in which the dissolved salts can be precipitated by permutating their respective metals with magnesium, if an anode is used containing Mg as an adjuvant. The known anodes composed of an aluminum/zinc alloy cannot be used because of an excessive polarization even at currents as low as 20 milliamperes.

The anodes composed of the alloys of the invention have substantial negative potential generally comprised between -1.1 and -2.0 volts according to the environment in which they are used; the potentials are extremely stable over a long period of time. In addition they have a high electro-chemical yield which is generally greater than 70 percent as compared with known electrodes having a yield substantially below 70 percent, the electro-chemical yield of conventional aluminum/zinc alloy electrodes not exceeding 50 percent.

The known aluminum/copper alloys for industrial use generally have a copper content of from 0.5 to 13 percent and particularly from 3 to 5 percent. The alloys of the invention preferably contain copper in the range from 0.5 to 15 percent and more preferably yet from 1 to 5 percent.

The excellent electro-chemical quality of the new alloys of the invention makes it possible to prepare anodes for use in electrolytic or galvanic or dry cells. The potential, the current density and the yield of such electrolytic cells or dry cell batteries is greatly improved. At the same time the alloys of the invention are highly resistant to corrosion and constitute an excellent protective coating.

Most advantageously the aluminum alloys used for anodes in electrolytic cells, galvanic elements or dry cell batteries or for electroplating contain both magnesium and zinc along with the mercury, the zinc content being equal or inferior to the magnesium content. These anodes unite the advantages caused by the presence of magnesium and the higher electro-chemical yields caused by the zinc content.

Apart from the electro-chemical applications the alloys of the invention can also be used as soft metals, particularly for the production of elements coming into slight mutual frictional contact such as, for example, journal bearings, bushings and the like.

Example I

An electrolytic cell is prepared having an anode composed of an aluminum alloy containing 15 percent of Mg and 0.125 percent of Hg, the rest being aluminum. The cathode is composed of manganese dioxide and carbon. The electrolyte consists of an aqueous solution containing, for each liter of water:

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NH ₄ Cl	250
Ammonium chromate	2
Lauryldimethylbenzylammonium	0.2
Sodium benzoate	5

The pH value of this solution is brought to 9.2 by adding ammonia.

Example II

An electric cell is prepared having a cathode consisting of a carbon cylinder of a diameter of 6 millimeters

and a length of 65 millimeters. The depolarizer consists of:

	Percent
MnO ₂	75
Acetylene black	20
Barium chromate	5

The following solution is used for wetting the depolarizer: an aqueous solution having a specific gravity of .28° Baumé of calcium chloride containing per liter 1 gram of barium chromate and 3 cubic centimeters of a 10% solution of the bromide of lauryldimethylbenzylammonium.

The same solution, but with the addition of a jellifying substance, is used as the electrolyte.

The anode consists of an aluminum alloy containing 0.066 percent by weight of mercury, 6 percent of magnesium, the rest being aluminum. The anode has an outer diameter of 33 millimeters and a length of 62 millimeters, corresponding to the conventional dimensions of a conventional dry cell torch battery.

The electromotive force of the cell is 2.10 volts. The cell has a constant yield of 250 milliamperes during 24 hours, i.e. 6 a.h., until the voltage has been reduced to substantially half the initial voltage, i.e. 1.1 volts. Thereafter the discharge is continued for 12 hours whereafter the voltage is 0.9 volt and the total capacity 9 a.h.

In comparison a cell comprising a conventional zinc anode is tested in the same manner. The discharge is continued for 16 hours, and the obtained capacity is thus 4 a.h., the initial voltage being 0.5 volt and the final voltage being 0.75 volt.

Thus, the alloy of the invention is greatly superior in that the discharge up to 50 percent of normal capacity furnishes 6 ampere hours compared with only 4 a.h. when using a conventional composition. In addition, the alloy of the invention is capable of furnishing a further appreciable amount of electricity in the order of 9 ampere hours after the voltage has dropped to 50 percent of the initial voltage which is not possible with conventional compositions.

Instead of forming the anode in the previous example of the composition set forth therein, the anode can be formed of an aluminum alloy containing 0.06 percent by weight of mercury, 6.0 percent by weight of magnesium, 1.5 percent by weight of zinc, with the remainder aluminum plus impurities.

It will be understood that this invention is susceptible to further modification and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. An aluminum alloy consisting essentially of 0.5 to 15 percent by weight magnesium, 0.001 to 0.15 percent by weight mercury, up to 4 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

2. An aluminum alloy consisting essentially of 3 to 8 percent by weight magnesium, 0.04 to 0.15 percent by weight mercury, up to 4 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

3. An aluminum alloy consisting essentially of 0.5 to 15 percent by weight magnesium, 0.001 to 0.15 percent by weight mercury, 0.25 to 2.0 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

4. An aluminum alloy consisting essentially of 3 to 8 percent by weight magnesium, 0.04 to 0.15 percent by weight mercury, 0.25 to 2.0 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

5. An anode for electrolytic cells formed of an aluminum alloy consisting essentially of 0.5 to 15 percent by weight magnesium, 0.001 to 0.15 percent by weight mercury, up to 4 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

6. An anode for electrolytic cells formed of an aluminum alloy consisting essentially of 3 to 8 percent by

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weight magnesium, 0.04 to 0.15 percent by weight mercury, up to 4 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

7. An anode for electrolytic cells formed of an aluminum alloy consisting essentially of 0.5 to 15 percent by weight magnesium, 0.001 to 0.15 percent by weight mercury, 0.25 to 2.0 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

8. An anode for electrolytic cells formed of an aluminum alloy consisting essentially of 3 to 8 percent by weight magnesium, 0.04 to 0.15 percent by weight mercury, 0.25 to 2.0 percent by weight zinc, the remainder aluminum plus a small amount of impurities.

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References Cited by the Examiner

UNITED STATES PATENTS

1,120,768	12/1914	Uyeno	75—169
2,063,023	12/1936	Beck	75—147
2,106,827	2/1938	Brown	75—146
2,124,553	7/1938	Gann	75—169
2,270,660	1/1942	Misfeldt	75—169
2,758,082	8/1956	Rohrman	75—138
2,808,327	10/1957	Pierce	75—146

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