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GRID METAL ALLOY

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This invention relates to lead alloys. More particularly, it relates to an improved grid metal alloy for storage batteries of the lead-acid type.

It is generally recognized that the life of storage batteries is often limited by the corrosion of the positive grid metal structure. Lead alloys with from seven to ten percent or more antimony have been found by past experience to possess good corrosion resistance in battery acids. Small amounts of tin have been universally added to obtain better castibility. However, it has also been generally known that the antimony content results in self discharge of the battery when standing during periods of non-use and also sulfation of the negative plate; and attempts have been made to eliminate the antimony or to reduce the antimony content. In such cases, the corrosion resistance of the positive grid structure suffers as does the stiffness of the grids. Moreover, castibility of the grid alloy is affected due to lowered fluidity in the molten state and good castings of a fine thin grid structure are difficult to obtain. This has resulted in uneconomical return of pure castings to the melting pot.

In attempts to add hardening agents, the corrosion resistance has not generally been improved. The addition of a tenth percent alkaline earth metal to pure lead has resulted in an improvement in self discharge but castibility and corrosion resistance under ordinary conditions are lacking. Even in the case of silver additions, for instance, with antimony lowered to about four percent, the self discharge characteristics of the battery are not acceptable.

The principal object of this invention is to provide a lead alloy suitable for the manufacture of storage battery grids which will be characterized by improved corrosion resistance, good castibility and result in lowered self discharge, on standing idle, of batteries in which it is employed. This and other objects of the invention will be apparent from the following more complete description thereof.

In its broadest aspects, this invention contemplates the provision of a grid metal alloy containing:

Antimony from 0.2 to 0.6%
Tin from 0.2 to 2.5%
Arsenic from 0.05 to 0.75%
Silver from 0.05 to 0.25%
Copper from 0.02 to 0.10%
Tellurium from 0.05 to 0.25%
Lead, balance

A preferred alloy contains:

0.75% tin
0.45% antimony
0.35% arsenic
0.15% silver
0.08% copper
0.06% tellurium
Balance, lead

It will be noted that the anitmony content of the alloy of this invention is substantially lower than the 9% antimony grid metal heretofore generally employed. According to the present invention, antimony may be incorporated in the grid metal alloy in amounts up to the maximum of solid solution of antimony in lead at the temperature of use; for the purpose here intended, this will ordinarily be about 0.6%. The tin content has been found, in combination with the other alloying elements, to promote castibility of the alloy in the molten state. The arsenic and copper are present in amounts generally above

those heretofore considered maxims for grid metal alloys. The amounts of these metals, together with the silver and tellurium, are critical in obtaining corrosion resistance of the alloy while in service in the battery without having a deleterious effect on the self-discharge characteristics.

The alloy of this invention may be manufactured according to methods known in the art and to a molten bath of lead may be added the various alloying elements in proper proportions to form the final alloy.

In order to illustrate the practice of this invention, a grid metal alloy containing 0.75% tin, 0.45% antimony, 0.35% arsenic, 0.15% silver, 0.08% copper, and 0.06% tellurium was formed by adding these alloying elements to molten lead. Storage battery grids of the automotive starting, lighting and ignition type, having a thickness of about 0.078 inch were cast in the usual manner from this alloy. Experimental batteries were manufactured, employing the so-formed grids which were pasted with active materials in the positive plates comprising lead oxide containing about 30% finely divided metallic lead and in the negative plates with similar oxide containing about 0.5% of conventional expander materials. The batteries contained 15 plates, were of Group I size, of nominal 100 ampere hour capacity. Similar test batteries were manufactured, identical with those described above, except that the grids were cast, in one case, from conventional 9% antimony-lead grid metal alloy and, in the other case, from commercial pure lead.

The batteries described above were subjected to the standard SAE overcharge life test for which the standard calls for a minimum life for the battery of five weeks. In this test, the batteries were brought to full charge and then discharged at 300 amperes. The number of minutes for discharge was noted. The batteries were then given 990 ampere hours of continuous charge at a 9 ampere rate with batteries in a water bath thermostatically controlled at a temperature of 100°±5° F. This was done during a period of five days from each Monday to Friday and then a period of standing on open circuit for two days over the weekend ensued. The batteries were then given a 300 ampere discharge, to an end voltage of 1.20 volts per cell, or to a minimum discharge time of 30 seconds, whichever occurred first. This cycle was then repeated weekly until the battery failed to meet either of the requirements specified, at which time the battery was taken out of test. Comparative tests were also made on self discharge characteristics by noting the comparative drop in specific gravity of the electrolyte in the batteries after standing idle for twenty-eight days. The comparative figures are expressed in terms of the greatest loss, the 9% antimony grid taken as 100.

The results of these tests are summarized in the table below:

Table

Grid Metal	Overcharged SAE Life, wks.	Comparative Self Discharge	Castibility
1	18–20	63	good.
2	4–6	40	poor.
3	8–10	100	Excellent.

COMPOSITION OF ALLOYS TESTED

Grid Metal	Antimony	Tin	Arsenic	Copper	Silver	Tellurium
1. Alloy of this invention	0.45	0.75	0.35	0.08	0.15	0.06
2. Pure Lead	0.003	None	0.001	0.001	0.001	None
3. 9% antimonial lead	9.24	0.3				

It will be noted from the results above that the conventional 9% antimony-lead alloy shows excellent castibility, poor self discharge characteristics, and only fair life due to corrosion of the grids. The battery containing pure lead grids showed poor castibility, poor life and good self discharge characteristics. The grid metal alloy of this invention showed good castibility, substantially improved life, indicating superior corrosion

resistance of the grids, and better self discharge characteristics in a battery than the 9% antimony lead. The alloy of this invention therefore provides a long desired combination of properties which are not found either in the pure lead or in conventional grid metal.

While this invention has been described and illustrated by the embodiments shown, it is not intended to be strictly limited thereto and other modifications and variations may be employed within the scope of the following claims.

I claim:

1. A grid metal alloy consisting essentially of from 0.2% to 0.6% antimony, from 0.25% to 2.5% tin, from 0.05% to 0.75% arsenic, from 0.02% to 0.10% copper, from 0.05% to 0.25% silver, and from 0.05% to 0.25% tellurium and the balance lead.

2. A grid metal alloy substantially of the following composition: Antimony 0.45%, tin 0.75%, arsenic 0.35%, copper 0.08%, silver 0.15%, tellurium 0.06%, balance lead.

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