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[54] **CREEP RESISTANT LEAD ALLOYS**

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[63] Continuation of Ser. No. 13,156, Feb. 20, 1970, abandoned.

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[58] **Field of Search** .. 75/167, 166 R, 166 B, 166 C, 75/166 D, 166 E, 175 R

[56] **References Cited**

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[57] **ABSTRACT**

A creep resistant lead alloy comprising 0.001 - 1.0 percent by weight of barium and at least one element of the group consisting of silver, aluminum, boron, bismuth, cadmium, hydrogen, magnesium, oxygen, sulphur, antimony, selenium, silicon, tin, tellurium and zinc. The barium and the one or more elements of this group are present in a combination which has been formed either in the liquid or in the solid state of the alloy and which has a dispersion strengthening effect on which leads to order states in the lattice or to order-like states, such as a cluster formation, that produce a strengthening effect.

2 Claims, No Drawings

CREEP RESISTANT LEAD ALLOYS

This is a continuation of application Ser. No. 13,156, filed Feb. 20, 1970 now abandoned.

The present invention relates to lead alloys having improved mechanical properties and is concerned more particularly with lead alloys having high creep resistance.

It is known that lead alloys with a low creep resistance show important drawbacks when used in certain fields of application or their application is considerably limited for this reason. In this connection for example, the low creep resistance of solder alloys is often an important drawback since for example standard solder alloys do not even transmit the stress caused by the thermal expansion of soldered zinc roof gutters having a length of several meters. Furthermore in the electronics and packaging industry solder alloys are limited in their application if they must support a constant load in one direction, and also for example at elevated temperatures.

For lead alloys being used as semi-finished products such as strips, sheets, tubes, wires, the lack of creep-resistance is a particularly important drawback.

With respect to the use of lead alloys in batteries, the problems of the creep strength are not as important as the electrochemical problems. The standard alloy for batteries is the $PbSb_6$-alloy with varying As contents. The admissible load for this alloy at a limitation of the creep characteristics to 1 percent per year is in the range of 30 to 70 kp/cm^2 at room temperature (Hofman, Lead and Lead-Alloys, Springer Verlag, 2nd edition, page 227). Due to the migration of the antimony and the resulting "contamination" of the cell, there is still a tendency to reduce the antimony content of such alloys. So far, lead alloys with high creep strength and high fatigue strength without an antimony content are also advantageous for the battery manufacturing industry. Due to the higher rigidity of the alloys of the present invention, the weight of the batteries could be decreased by using grids of less thickness.

Radiation and sound protection are modern fields of application of lead and lead alloys wherein an improved creep strenght is also of importance.

Data on the creep resistance of lead-tin alloys as a function of the tin content are scarcely available from the technical literature. However, values for the creep rupture strength of lead-tin alloys are available. Hofman (Lead and Lead-Alloys, 2nd edition, page 451) indicates as creep rupture strength for a ten day service life with an Sn-content between 32 and 100 percent a tensile stress of 70 Kp/cm^2.

Tests made by the inventors have shown a creep resistance of about 10 kp/cm^2, respectively 12 kp/cm^2 for a PbSn 40 and PbSn 20 alloy with a 1 percent elongation at room temperature.

The object of the present invention is to provide lead alloys having a higher creep resistance by which the above mentioned drawbacks are overcome and new fields of application can be opened.

The lead alloys according to the present invention comprise 0.001 - 1.0 percent by weight of barium (Ba) and at least one element from the group consisting of silver (Ag), aluminum (Al), boron (B), bismuth (Bi), cadmium (Cd), magnesium (Mg), oxygen (O), hydrogen (H), sulphur (S), antimony (Sb), selenium (Se), silicon (Si), tin (Sn), zinc (Zn), tellurium (Te), the barium and the other element being present in a combination which has been formed either in the liquid or in the solid state of the alloy and which has a dispersion strengthening effect and/or which leads to order states in the lattice and/or to order like states (cluster formation) that have a strengthening effect.

The elements can advantageously be present in the alloy in the following weight percentages:

Silver	0.001 – 10 %
Aluminum	0.001 – 2 %
Boron	0.001 – 1 %
Bismuth	0.001 – 6 %
Cadmium	0.001 – 10 %
Magnesium	0.001 – 6 %
Oxygen	0.001 – 0.2%
Hydrogen	0.001 – 0.2%
Sulphur	0.001 – 2 %
Antimony	0.001 – 2 %
Selenium	0.001 – 1 %
Silicon	0.001 – 2 %
Tin	0.001 – 90 %
Tellurium	0.001 – 1 %
Zinc	0.001 – 1 %

Preferred creep resistant lead alloys are those alloys which consist of 0.01 - 1.0 percent by weight of barium (Ba) and one element in the given amounts of the mentioned group, balance lead or lead-tin.

Creep resistant tests have been made for the alloy according to the invention, Pb-Ba-O comprising for example 0.07 percent by weight of Ba and 0.006 percent by weight of oxygen. From the resulting creep curves (10.000 hours) a value inferior to the admissible 1 percent per year elongation at room temperature could be obtained for a load of 112 kp/cm^2. It results therefrom that the creep resistance was superior to 112 kp/cm^2.

In order to study the use of the alloys as semi-finished products, rolling tests were made. The alloy Pb-Ba-O could be cold rolled without any difficulty from 5 mm to 1 mm which corresponds to a cold reduction of 80 percent.

The hardness of the alloy Pb-Ba-O in comparison to high-grade lead was in HV (kp/mm^2).

	high grade lead	Pb-Ba-O
before rolling	4,15	7,91
after rolling	3,18	10,90

Since a major part of the semi-finished lead products are used in the sulphuric acid industry, the alloys according to the invention must be corrosion resistant to the attack of diluted sulphuric acid. The alloys according to the invention did not show a worse corrosion behaviour than high-grade lead.

Tests on lead-tin-base alloys have shown similar results. On the basis of the creep curves it has been shown that the lead-tin base alloys according to the present invention in comparison to the lead-tin alloys, despite a higher load, had a lower elongation. The charge capacity of the Pb-Sn-base alloys according to the invention at elevated loads is at least twice as high: at low loads there is a discontinuance of the creep action.

Soldering tests with these alloys have shown that the wetting properties of the solder on brass and zinc are at least as good as in the case of common Pb-Sn-solders.

What is claimed is:

1. A creep resistant lead alloy consisting essentially of:

0.001–1.0 percent by weight barium,

at least one additional element of the group consisting of silver, boron, hydrogen, oxygen, sulphur, selenium and silicon wherein the barium and at least one additional element are in the form of dispersions for strengthening the alloy, the additional elements being present in the following weight percentages:

Silver	0.001 –	10%
Boron	0.001 –	1%
Oxygen	0.001 –	0.2%
Hydrogen	0.001 –	0.2%
Sulphur	0.001 –	2%
Selenium	0.001 –	1%
Silicon	0.001 –	2%

the balance being lead.

2. A lead alloy as defined in claim 1 wherein tin is present in a percentage range of 0.001 – 90 percent.

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