

- [54] **CADMIUM-ANTIMONY-LEAD ALLOY**
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Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 185,434, Sept. 30, 1971, abandoned, which is a continuation of Ser. No. 842,457, July 17, 1969, abandoned.
[52] **U.S. Cl.**..... **75/166 B**
[51] **Int. Cl.**..... **C22c 11/00**
[58] **Field of Search** **75/166 B, 166 R, 166 C**

References Cited

UNITED STATES PATENTS

- 1,722,358 7/1929 Seljesaeter 75/166 B
1,766,871 6/1930 Beckinsale et al. 75/166 C
2,446,996 8/1948 Bovton et al. 75/166 B

FOREIGN PATENTS OR APPLICATIONS

- 362,973 12/1931 Great Britain 75/166 B

613,308 11/1948 Great Britain 75/166 B

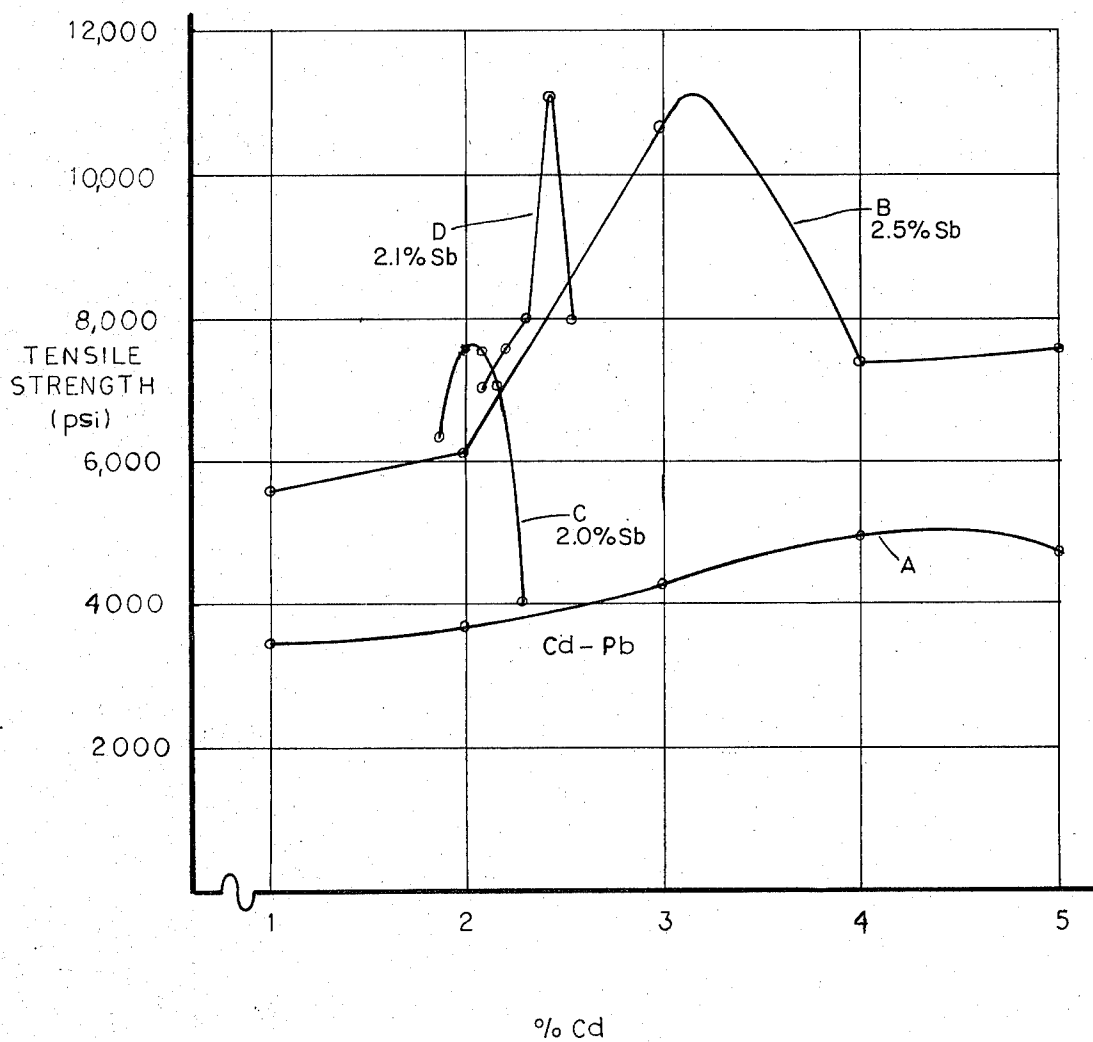
OTHER PUBLICATIONS

Abel et al.: "Ternary System Lead-Antimony-Cadmium," Z. Anorg. Allgem. Chem., Vol. 174, pp. 269-271, (1928).
Tilman: Bureau of Mines RPI 7285, pp. 4-5, (Aug. 1969).
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ABSTRACT

A lead alloy having excellent tensile strength and electrical characteristics for use in storage battery grids, cable sheathing, or the like is obtained by mixing antimony and cadmium with lead in prescribed exact amounts.

6 Claims, 1 Drawing Figure



CADMIUM-ANTIMONY-LEAD ALLOY

BACKGROUND OF RELATED APPLICATIONS

This application is a continuation-in-part of my application titled "Cadmium-Antimony-Lead Alloy," filed Sept. 30, 1971, U.S. Ser. No. 185,434 now abandoned which is a continuation of my application U.S. Ser. No. 842,457 filed July 17, 1969 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is directed for use in the field of lead alloys having certain electrical and physical strength characteristics. More specifically, this invention is directed for use to the area of grids for storage battery plates and for cable sheathing.

2. Description of the Prior Art

There are a number of patents and publications concerned with the matter of strengthening the lead alloys which are used for storage battery plate grids, cable sheathing, and the like. The electrical and chemical characteristics of lead as well as its low cost make it very suitable as a primary material but because of its inherent physical weakness, it is difficult to use. A large number of different alloying materials have been suggested and used in various percentages and in various mixtures. Each one of them appears to achieve some beneficial result but yet the search goes on for still better results since the goal continues to be to make storage batteries as efficient as possible in order to be able to reduce their size or at least get the maximum output from a given size.

SUMMARY OF THE INVENTION

The invention resides in the unexpected discovery of the increased tensile strength that results from alloying about 2.0% to 2.5% antimony with cadmium ranging from 2.0% to 4.0% where the cadmium content is greater than the antimony content with the balance lead.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a set of curves of the tensile strength of different percentages of cadmium-antimony-lead alloy as compared to a curve of the tensile strength of different percentage mixtures of an alloy of only cadmium and lead.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The alloy is produced in the conventional manner by adding the prescribed ingredients to the molten lead and mixing until the mass is homogeneous. For comparison purposes, rods of cadmium-lead alloy were prepared having different percentages of cadmium in the alloy. First, a set of rods were made from an alloy having 1% cadmium, the remainder lead; then a set of rods with 2% cadmium, and so forth up to 5% cadmium, the remainder being lead. From three to five rods of each alloy mixture were tested for tensile strength and, as shown on curve A of the drawing, there was almost a linear increase of the tensile strength as the amount of cadmium increased from 1% to 4% but then a slight drop occurred with an increase from 4% to 5% cadmium. The tensile strength ranged from approximately 3,400 psi. for the 1% cadmium-lead alloy to approximately 4,900 psi. for the 4% cadmium-lead alloy. Each

of the readings shown on curve A is the average of the three to five rods of each mixture which were tested.

Turning next to curve B, cadmium was added in different percentages to an alloy consisting of about 2.5% antimony and the remainder lead. Again the tensile strength was tested of three to five rods of each of the respective mixtures ranging from 1% cadmium up to 5% cadmium with 2.5% antimony and the remainder lead. The readings shown in the curve are the averages of the three to five rods which were tested. Initially when the cadmium was increased from 1% to 2%, it appeared that the tensile strength would follow almost a linear increase similar to curve A since the tensile strength rose from about 5,600 psi. to about 6,100 psi. However, when the cadmium was increased from 2% to 3%, with the antimony remaining at 2.5%, there was a decided jump or abrupt increase in the tensile strength from about 6,100 psi. to about 10,600 psi. The latter appears to be near a peak reading and further increase of the percentage of cadmium while maintaining the percentage of antimony the same gradually decreased the tensile strength. This unexpected discovery of an abrupt increase in tensile strength points to a unique and critical mixture of cadmium, antimony and lead where one can obtain the desired characteristics of greater tensile strength for a lead alloy having a minimum of alloying constituents. Thus, grids for storage batteries made with the alloy of this invention may be made thinner and still be able to withstand the forces normally encountered during processing and handling, thereby permitting greater active volume within the confines of the battery casing and increasing its efficiency considerably. There are no apparent harmful effects on the electrical and chemical characteristics of battery plates which contain grids formed from this alloy.

In order to further define the range of the alloy to the precise region where the increase in tensile strength occurred, a number of different cadmium-antimony-lead alloys were cast. The tests have more precisely revealed the range of alloys that produces the abrupt increase in the tensile strength. More specifically, it was found that none of the alloys in which the amount of antimony was 2.7% or higher produced a sudden increase in tensile strength. It should be pointed out that it is known that generally alloying lead with increasing amounts of antimony and cadmium causes a gradual increase in the tensile strength of the alloy. However, it is not this gradual increase which is the subject of this invention but the abrupt increase in tensile strength which is shown by curves B, C and D. In order to more closely verify the range, additional sets of alloys 1/8 inch thick were cast with the following compositions:

EXAMPLE 1

In one set of alloys, the antimony contents was 2.0% by weight with the cadmium ranging from 1.9% to 2.3% with the balance lead. This set of alloys is shown as curve C and demonstrates the unexpected abrupt increase in tensile strength when the cadmium content was above 2.0%. With this set of alloys at its peak, the tensile strength increased about 1,200 psi. or about 20% from 6,400 psi. to about 7,600 psi.

EXAMPLE 2

In another set of alloys, the antimony content was 2.1% by weight with the cadmium content ranging from

2.1% to 2.5% by weight with the balance lead. This set of alloys also demonstrated the unexpected increase in tensile strength when the cadmium content was above 2.3%. With this set of alloys the tensile strength had an abrupt increase of about 3,000 psi. or about a 38% increase from 8,000 psi. to 11,000 psi. with the latter appearing to be a peak reading. (Curve D).

EXAMPLE 3

A set of alloys with the antimony content of 2.7% by weight and the cadmium content ranging from 2.8% to 3.3% and the balance lead was also tested. This set of alloys did not show abrupt increase in tensile strength as demonstrated by the alloys shown in curves B, C and D.

EXAMPLE 4

A set of alloys with the antimony content 2.9% by weight and the cadmium content ranging from 2.8% to 3.2% and the balance lead was also tested. This set of alloys also did not show the abrupt increase in tensile strength as demonstrated by the alloy shown in curves B, C and D.

These tests revealed that the sudden or abrupt increase in tensile strength occurred if the cadmium content of the alloy was greater than the antimony content and the cadmium content of the alloy ranged from 2.0% by weight to 4.0% by weight and the antimony content of the alloy ranged from 2.0% by weight to 2.5% by weight with the balance lead. More specifically, there appears to be a family of curves for each antimony alloy ranging between 2.0% and 2.5% where an abrupt increase in the tensile strength occurs if the cadmium content is maintained greater than the antimony content. In the broadest range the cadmium produces an increase in tensile strength if the cadmium ranges from 2.0% to 4.0%. However, the other curves

indicate that as the antimony content decreases the amount of cadmium necessary to produce an abrupt increase in the tensile strength also decreases.

Thus the greater tensile strength alloy is claimed as part of this invention. The invention, in part, resides in the discovery of a unique combination of specific amounts of antimony, cadmium and lead to produce an alloy suitable for use as battery plate grids having a peaked relatively high tensile strength. Also, part of the invention is the further discovery that the amounts of antimony and cadmium can be varied over a somewhat narrow range to produce an alloy with lead that has a range of high tensile strength.

I claim:

1. For use as cable sheathing or as grids for storage battery plates or the like, a lead alloy consisting of antimony ranging from 2.0% to 2.5% by weight, cadmium ranging from 2.0% to 4.0% by weight with the cadmium content of said lead alloy being greater than the antimony content of said lead alloy with the remainder lead.

2. The invention of claim 1 wherein said lead alloy has a tensile strength in excess of 6,100 psi.

3. The lead alloy of claim 1 wherein the antimony content is 2.0% by weight and the maximum cadmium content is 2.2% by weight.

4. The lead alloy of claim 1 wherein the antimony content is 2.1% by weight and the maximum cadmium content is 2.5% by weight.

5. The alloy as set forth in claim 1 wherein the antimony and cadmium are generally in the respective amounts defined by the peaks of a family of curves typified by curves B, C and D.

6. The alloy as set forth in claim 1 wherein the antimony content is 2.5% by weight.

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