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UNITED STATES PATENT OFFICE

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ARTICLE OF METALLIC COMPOSITIONS OR ALLOYS OF LEAD

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This invention relates to articles produced from metallic compositions or alloys of lead, antimony and tin in which the antimony is present in small amounts of the order of 1% and the tin in still smaller amounts.

The invention particularly relates to cable sheaths produced from such compositions.

An object of the invention is to improve the sheaths of lead covered cables, particularly of the type used in telephony and laid in underground conduits, by giving the sheaths improved tensile strength and fatigue resistance without unduly reducing the hardness and ductility of the lead alloy.

A further object is to utilize scrap lead in the manufacture of new cable sheaths whereby the tin, which was used in wiping the joints of old lead sheaths, is made to form a small percentage of the lead for the new sheaths.

Tin has before been regarded as an undesirable constituent in such sheathing alloys as those consisting of 99% lead and 1% antimony. The tin content has therefore been restricted to negligible amounts, in order to avoid the possibility of undesirable effects being introduced by the presence of the tin as an impurity.

In accordance with this invention somewhat larger amounts of tin than those previously permitted may be added to the antimony lead. Such amounts have been found to have no seriously detrimental effect upon the ductility and the hardness of the alloys. Furthermore, they have been found to give increased tensile strength, fatigue resistance and extrusability.

Alloys of several compositions have been made and tested. One series of these included lead known as Southeastern Missouri lead containing small amounts of copper, such as 0.02% to 0.07%, and about 1% antimony. The tin content was as nearly as possible either 0.05% or 0.1%. A similar series contained as nearly as possible 99% of substantially pure lead, known as Doe Run lead, 1% antimony and either 0.05% or 0.1% of tin.

These compositions were made for test purposes by mixing the metals composing the alloy and extruding the material in the form of tapes $1\frac{1}{2}'' \times \frac{1}{8}''$. The compositions were extruded at temperatures about 435° F. (224° C.) under conditions such that the resultant cooling rate in air was approximately equal to the rate of cooling of the lead sheath of an actual cable cooled in air. Specimens were then allowed to age for a considerable number of days at ordinary room temperature. Tests were then made on several samples of each composition which showed that small amounts of tin improved the properties of tensile strength and fatigue resistance without decreasing the hardness or the ductility beyond that required for successful extrusion of cable sheath, provided that the percentage of tin is not too great.

In the following tables are given data of test results and compositions of the two series of alloys; Table I gives the data for alloys in which the main constituent is Southeastern Missouri lead which in its natural form contains small percentages of copper, and Table II contains similar data for alloys of which the main constituent is Doe Run lead, which is practically pure.

Table I.—Alloys of S. E. Missouri lead

Alloy No.	Addition elements to lead			Fatigue resistance, cycles	Tensile strength, lbs./sq. in.	Elongation in per cent
	Sb	Cu	Sn			
1	1.04	.051	----------	3,020,000	5,610	21.6
2	.99	.068	.05	4,585,000	5,880	23.2
3	.98	.057	.10	5,396,000	5,800	26.6

Table II.—Alloys of Doe Run lead

Alloy No.	Addition elements to lead			Fatigue resistance, cycles	Tensile strength, lbs./sq. in.	Elongation in per cent
	Sb	Cu	Sn			
4	.99	----------	----------	1,855,000	3,590	39
5	1.00	----------	.05	5,115,000	5,170	24
6	.99	----------	.10	4,502,000	5,210	20.6

The fatigue resistance is given as the number of bending cycles to which the samples were subjected on a testing machine before breaking; the elongation is given in per cent for a length of 2'' and consequently is a measure of the ductility of the alloys. Sev-

eral samples were tested of each alloy and the testing data are the average figures obtained for all the samples. Other data obtained in tests on the alloys listed above showed that the hardness was not dependent upon the tin content and that the extrusion pressure may be reduced by more than 15% for alloys containing tin and extruded at the ordinary extrusion temperature of about 435° F.

It will be noted that alloys Nos. 2 and 3 have a much higher fatigue resistance than has alloy No. 1, which contains no tin, and that the fatigue resistance of alloys Nos. 5 and 6 is much higher than that of alloy No. 4 containing no tin. Alloy No. 1 is very commonly used in cable sheath and has a satisfactory ductility. It will be noted that the elongation, and therefore the ductility of alloys Nos. 2, 3 and 5 is somewhat better than that of alloy No. 1, whereas alloy No. 6 appears to have a slightly decreased ductility.

It would therefore appear that small percentages of tin, less than .10%, produce a favorable effect upon the fatigue resistance and tensile strength of the alloys; that in the case of the alloy containing Southeastern Missouri lead the ductility is appreciably improved by such addition; and that in the case of alloys containing pure lead the ductility is not diminshed below that required for cable production.

Thus in accordance with this invention, it may be seen that lead antimony alloys containing tin up to .10% and extruded at ordinary extrusion temperatures of 300 to 500° F., and preferably of 400 to 475° F. have sufficient ductility for the satisfactory production of cable lead sheath and a much increased fatigue resistance which tends to prolong the life of the cable under certain conditions often encountered.

From a microscopic examination of the alloys, it may be concluded that the tin is instrumental at ordinary temperatures in retarding the precipitation of the antimony from solid solution for several years. In other words, the tin holds the antimony in dispersed condition throughout the alloy, in consequence of which, after aging for a number of days at room temperature, tensile strength and fatigue resistance is considerably increased. In accordance with this theory, it is supposed that amounts of tin around .10% or less are sufficient to hold the antimony in dispersed condition throughout the alloy.

What is claimed is:

1. A formed lead article subjected during its formation to a heat treatment to temperatures between 300 and 500° F. and cooling to room temperatures containing about 1% of antimony and about from .05 to .10% of tin and having after said heat treatment improved mechanical qualities.

2. An elongated lead article extruded from a lead composition containing about 1% of antimony and around .05 to .10% of tin, said article having, after its extrusion at a temperature between 300° to 500° F. and after being aged, greater fatigue resistance and tensile strength than the article would have with substantially no tin content.

3. An extruded lead sheath containing about 1% of antimony and around .05 to .10% of tin and having, after its extrusion at a temperature between 300° and 500° F., fatigue resistance and tensile strength greater than a similar sheath containing substantially no tin.

In witness whereof, I hereunto subscribe my name this 12 day of March, 1929.

JOHN R. TOWNSEND.