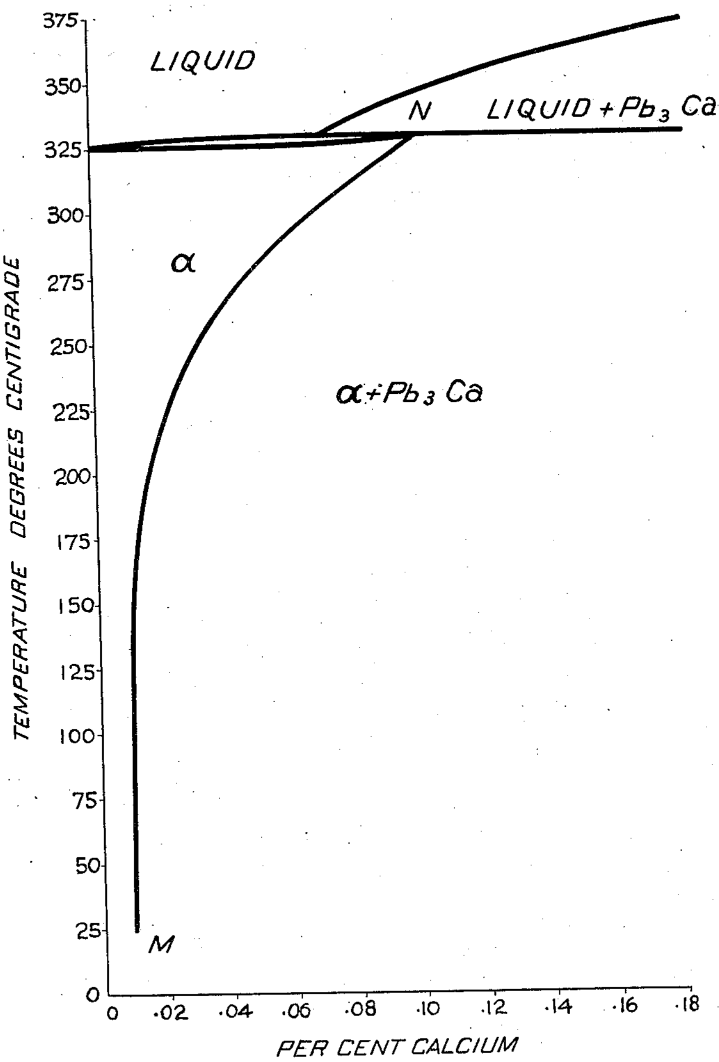
Oct. 4, 1932. G. M. BOUTON 1,880,746

LEAD ALLOY

Filed Oct. 30, 1929




INVENTOR
G. M. BOUTON
BY J. W. Schmied
ATTORNEY

Patented Oct. 4, 1932

1,880,746

# UNITED STATES PATENT OFFICE

GEORGE M. BOUTON, OF LYNBROOK, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

## LEAD ALLOY

Application filed October 30, 1929. Serial No. 403,541.

This invention relates to lead alloys and to methods of producing or treating such alloys or articles made therefrom and more particularly to lead-calcium alloys and articles made therefrom by extrusion or otherwise such for example, as cable sheath.

An object of the invention is to impart to alloys of lead and calcium or to cable sheath composed thereof such degrees of hardness, tensile strength, resistance to failure from fatigue, ductility, and stability at atmospheric temperatures as to render such alloys or cable sheath composed thereof more useful than heretofore.

Another object is to decrease the degree of hardness of lead-calcium compositions and cable sheath made therefrom; in the case of cable sheath this object has the practical end of enabling the sheathed cable to be manipulated or worked more readily than as heretofore produced.

Another object is to improve methods of heat treating lead-calcium alloys.

In the production of lead alloy suitable for cable sheaths it has been found that calcium if added to the lead is apt to produce a suitable sheath, provided the calcium percentage is kept sufficiently low, that is, between about .02% and .03%. Lead alloys containing over about .04% calcium have been found to become so hard as to be unsuitable for cable sheaths. Such small percentages as .02% to .03%, however, are exceedingly difficult to control in practice. Small proportions of impurities such as lead and other oxides, some of which have higher affinity to calcium than to lead, tend to combine with a portion or all of the small amount of calcium added. Moreover, when such small calcium percentages are used there will usually result lead-calcium alloys the calcium content of which varies greatly from the optimum percentage composition desired in each particular instance.

It has heretofore been proposed to employ lead-calcium alloys of about .02% to .1% calcium for lead cable sheath. In general the prior practice has been to extrude at a temperature at or above the point on the lead-calcium solid-solubility curve for the particular calcium content, that is, at temperatures between about 280° C. and 320° C. Lead-calcium sheathed cable made in that manner has been found to be so stiff after one month's aging that it is harder and stiffer than is desirable for bending and drawing into cable ducts by means ordinarily employed.

Lead-calcium alloys to be suitable for cable sheaths should have a Rockwell hardness of not more than about 70 S.M. 30 (soft metal scale) and a tensile strength of not more than about 4500 pounds per square inch. By Rockwell hardness, S.M. 30 (soft metal scale) is meant the hardness as measured on a Rockwell hardness tester so modified as to permit the application of a 30 kilogram load. A 1/4″ ball penetrator on a 3″ ball anvil is used. Readings are taken on the "B" scale after the full load has been applied for one minute. For principles and definitions of Rockwell hardness see S. A. E. Handbook, September 1927, page 270 et seq.

Although this invention relates to lead-calcium alloys having a calcium content of between .02% and .1%, preferably between .04% and .08%, it avoids the above mentioned difficulty by providing a method eliminating the excessive hardening inherent in prior methods.

To illustrate the improved results obtainable, reference is made to experimental data now to be set forth and considered in connection with the accompanying drawing, which is a partial constitutional diagram of lead-calcium alloys.

In accordance with the present invention lead-calcium alloys are heated at a point below the branch M—N of the curve separating the solid solution "alpha" of calcium in lead from material of which $Pb_3Ca$ particles are precipitated, then cooled rapidly, for example, in air and aged either at room temperature or artificially at a higher temperature for a sufficient length of time to develop the desired degree of hardness.

In addition to decreasing the hardness and stiffness of the cable sheath, better results are secured with the present invention in that the sheath, being extruded at a lower temperature, is less plastic as extruded and consequently is not deformed as much when wound on a cable drum immediately after its extrusion.

In the following tables lead of commercial purity was used for composing the compositions mentioned therein. Such lead usually contains small amounts of one or more of the following elements: copper, silver, bismuth, antimony, tin, arsenic and iron, but in each composition the lead used was at least 99.6% pure, and in most cases it was of greater purity. In the tables Column 1 contains an arbitrary casting number designating the alloy, Column 2 contains the percentage of calcium present, Column 3, the temperature of extrusion in degrees C., Columns 4, 5 and 6 the tensile strength after aging at room temperature after various periods of time, i. e., 1 month, 6 months, and 12 months, Column 7, 8 and 9 the Rockwell hardness (S.M. 30) after aging at room temperature after 1 month, 6 months and 12 months, respectively.

| Casting number | Per cent calcium | Extrusion temperature in °C. | Tensile strength after aging at room temperature | | | Rockwell hardness (S. M.) after aging at room temperature | | |
|---|---|---|---|---|---|---|---|---|
| | | | *1 month* | *6 months* | *12 months* | *1 month* | *6 months* | *12 months* |
| 1 | .04 | 270 | 4370 | 4920 | 4890 | 74 | 73 | 75 |
| 2 | .04 | 250 | 4128 | 4750 | 4680 | 61 | 72 | 72 |
| 3 | .04 | 240 | 3500 | 3914 | 4368 | 57 | 57 | 61 |
| 4 | .04 | 220 | 2710 | 3427 | -------- | 39 | 49 | ------- |
| 5 | .04 | 240 | 3710 | 4360 | 4369 | 63 | 67 | 73 |
| 6 | .04 | 220 | 3075 | 3234 | -------- | 36 | 42 | ------- |
| 7 | .07 | 250 | 3400 | 4365 | 4516 | 38 | 65 | 61 |

In the practical application of this invention to the manufacture of lead calcium cable sheaths, the calcium alloy is heated at a temperature below the M—N branch of the constitutional diagram and then extruded onto the cable in the form of a sheath and cooled in air which results in cooling at such a rate as to retain some calcium in supersaturated solid solution. As may be seen from the drawing and the table, for a composition containing about .04%±.005% calcium an extrusion head temperature of about 200° C. to about 245° C. is suitable. For .05% calcium a temperature of about 210° C. to about 225° C. gives best results and for .07% calcium a temperature of about 230° C. to about 265° C. is the best.

What is claimed is:

1. The method of treating an alloy composed of commercially pure lead alloyed with .02 to .1% calcium which comprises melting the alloy, cooling it to between slightly and several tens of degrees below the solid-solubility curve for the particular composition, maintaining it within such temperature range for at least a short time and then causing it to cool rapidly and age at a much lower temperature.

2. The method of heat treating an alloy comprising a main body of lead with .02 to .1% calcium which comprises heating the alloy to a liquid condition, maintaining it for some little time at a point below but not over several tens of degrees below the point on the solid-solubility curve for the particular percentage of calcium, and then cooling rapidly.

3. The method of producing a lead alloy cable sheath consisting of lead with .02 to .1% calcium which comprises extruding the sheath at an extrusion head temperature corresponding to an alloy temperature below but not over several tens of degrees below the point on the solid-solubility curve of lead-calcium corresponding to the particular alloy, and causing the sheath to cool in air and age at any moderately low temperature such as room temperature.

4. A lead-calcium alloy containing lead as a principal constituent and calcium as a constituent lying between the limits .02% and .1%, said alloy having been produced by forming a solution of the calcium in the lead, extruding and cooling the material and aging it for a period of months, after which said alloy has a tensile strength below 4500 pounds per square inch and a Rockwell S. M. 30 hardness less than about 70.

In witness whereof, I hereunto subscribe my name this 28th day of October, 1929.

GEORGE M. BOUTON.