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METAL OBJECTS COATED WITH
LEAD ALLOYS

George M. Bouton, Madison, George S. Phipps,
Chatham, and Earle E. Schumacher, Maple-
wood, N. J., assignors to Bell Telephone Labora-
tories, Incorporated, New York, N. Y., a cor-
poration of New York

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This invention relates to metal objects coated with novel lead alloys.

It is common to coat metal portions of electrical apparatus, to which solder is to be applied, with a thin layer of tin or tin-rich alloy in order to facilitate the soldering operation. Thus, copper or copper-alloy wires and ferrous or brass soldering lugs are often coated with tin for this purpose. Corrodible metal articles exposed to the weather are also often given a thin protective coating of tin or tin-rich alloys.

The present invention provides alloys containing little or no tin, which are very suitable for the same purposes. These alloys are made up almost entirely of lead and, therefore, represent a considerable saving in cost over the much more expensive tin or alloys containing large amounts of tin. Moreover, lead is not as strategic a metal as tin and supplies of this metal are not as likely to be cut off in times of war.

Although molten tin wets most metals very easily and readily forms continuous, adherent coatings, difficulty is encountered in forming coatings of lead because of the slight wetting power of this metal in the molten state. Pure lead does not wet ferrous parts to any substantial extent even when the most refined cleaning operations are employed.

The alloys of the present invention are capable of wetting metals, such as copper and iron, having a clean surface and are capable of providing a very satisfactory, continuous, adherent, non-porous coating. These alloys are made up primarily of lead containing small amounts of antimony, cadmium, tin, bismuth, arsenic and silver together with incidental impurities. The tin and bismuth perform somewhat similar functions in the alloy and, therefore, the alloy may contain either both of these ingredients or one alone. The same is true of arsenic and silver, which may be present together or individually in the alloy. If desired, copper may be added to the alloy in small amounts and has some beneficial effect in improving both the wetting properties of the alloy and the mechanical characteristics of the coating which is produced.

The cadmium appears to be the most effective ingredient for endowing the lead alloy with good wetting powers, but this action of cadmium is considerably enhanced by the presence of every

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one of the remaining ingredients. The antimony in addition to improving the wetting power of the alloy greatly reduces the tendency toward the formation of oxide films on the surface of the molten alloy and, therefore, reduces the possibility of oxide inclusion in the coating, which would lead to porosity. The tin and bismuth in addition to contributing to the wetting power of the alloy are essential ingredients for improving its fusibility. The arsenic and silver are grain-refining agents which contribute to non-porosity by reducing the size of the grain structure in the coating. Arsenic is by far the most effective grain-refining agent and may, therefore, be used in the absence of silver, if desired. For the coating of brass, however, silver alone without any substantial amount of added arsenic is used as the grain-refining agent because brass is not as readily wet by alloys containing arsenic.

The most suitable proportions of these ingredients when added to the lead base are, by weight, 1.25 per cent antimony, .25 per cent cadmium, .25 per cent bismuth, .25 per cent tin, .01 per cent arsenic, .017 per cent silver and .06 per cent copper. Smaller or larger proportions of these ingredients may be used within about the limits of .25 per cent to 2.0 per cent antimony, .05 per cent to 2.0 per cent tin, .08 per cent to .5 per cent bismuth, .05 per cent to 2.0 per cent cadmium, 0 to .1 per cent copper, .001 per cent to .5 per cent arsenic and .001 per cent to .5 per cent silver. The alloys embraced within the present invention may, therefore, be summarized as follows:

	Per cent
Antimony -----	.25 to 2.0
Tin -----	0 to 2.0
Bismuth -----	0 to .5
Cadmium -----	.05 to 2.0
Copper -----	0 to .1
Arsenic -----	0 to .5
Silver -----	0 to .5
Lead -----	Remainder

together with incidental impurities, the combined bismuth and tin being present in an amount of at least .05 per cent or preferably at least .1 per cent, the combined arsenic and silver being present in an amount of at least .001 per cent or preferably at least .01 per cent. However, under ordinary

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circumstances more satisfactory results are obtained when somewhat larger amounts of these ingredients than the lower limits set for the above are employed as, for instance, in excess of .5 per cent antimony, .15 per cent tin, .15 per cent bismuth, .15 per cent cadmium, .005 per cent arsenic and .005 per cent silver.

Some outstanding alloys for coating purposes are the following:

Ingredients	Per Cent by Weight				
	I	II	III	IV	V
Antimony.....	1.25	1.25	1.25	1.25	1.25
Tin.....	.25	.25	.25	.25	.25
Bismuth.....	.25	.25	.25	.25	.25
Cadmium.....	.25	.25	.25	.25	.25
Copper.....	.06	.06	.06	.06	.06
Arsenic.....	.01	.01	.01	.01	.01
Silver.....	.017	.017	.017	.017	.017
Lead.....	(¹)	(¹)	(¹)	(¹)	(¹)

¹ Remainder.

The alloys of the present invention are coated on higher melting metal objects as, for instance, ferrous objects or copper wire by cleaning the metal surface, fluxing, and immersing the object in the molten alloy. A typical procedure for coating ferrous objects is to clean them thoroughly by subjecting them to a solvent degreasing operation and then removing the scale from the surface in a 50 per cent hydrochloric acid solution containing about 5 grams of Rodine per liter followed by a water rinse and a second cleaning in a 50 per cent hydrochloric acid solution. After cleaning, the metal object is placed in a flux consisting of a saturated solution of zinc chloride and ammonium chloride. It is then dipped in a bath of the molten alloy maintained at a temperature in the vicinity of 450° C. This high temperature dip insures good wetting of the surface of the object with the alloy. The dipped object is then quenched in the flux, an operation which breaks open the surface of any gas-filled pockets present under the initial coating. The initially coated object is then dipped in a second bath of molten alloy maintained at as low a temperature as is consistent with economical operating speed. The low temperature bath deposits a bright, heavy coating.

Although the invention has been described in terms of its specific embodiments, certain modifications and equivalents will be apparent to those skilled in the art and are intended to be included within the scope of the present inven-

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tion, which is to be limited only by the fair and reasonable scope of the appended claims.

What is claimed is:

1. A metal object having on its surface a relatively thin adherent coating of an alloy consisting of the following ingredients in about the following proportions:

	Per cent
Antimony	1.25
Cadmium	.25
Bismuth	.25
Copper	.06
Arsenic	.01
Lead	Remainder

together with incidental impurities.

2. A ferrous metal object having on its surface a relatively thin adherent coating of an alloy consisting of the following ingredients in about the following proportions:

	Per cent
Antimony	1.25
Cadmium	.25
Bismuth	.25
Copper	.06
Arsenic	.01
Lead	Remainder

together with incidental impurities.

GEORGE M. BOUTON.

GEORGE S. PHIPPS.

EARLE E. SCHUMACHER.

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