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ZINC ALLOY

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Our invention relates to new and useful alloys of zinc whose advantages will be hereinafter set forth. The alloy is prepared by adding to 100 parts of zinc from $\frac{1}{10}$ to 2¼ parts of metallic copper and from 1/100 to 2 parts of antimony. The alloy should be free from aluminum or magnesium, preferably completely, but in any event in proportions so substantial as to affect adversely their valuable characteristics hereinafter described.

The use of zinc, particularly when rolled into the form of sheets or strips, is limited because of its low tensile strength, its slight hardness, and the rapid dulling of its surface. These disadvantages are overcome if there be added to the zinc both copper in the proportion of $\frac{1}{10}$ to 2¼ parts, but preferably ¼ to 2 parts, and antimony in the proportion of 1/100 to 1 part, altho up to 2 parts may be used to advantage and is within the scope of our invention. An alloy thus produced may be rolled into sheets or strips whose surface can be brought to an attractive condition by polishing and have a much higher tensile strength than sheets or strips rolled from zinc or known zinc base alloys. At the same time the natural advantages of the zinc, and particularly its ductility, are not reduced, in any event, to any appreciable or substantial extent.

The zinc used in the production of the alloy may be either a "high grade" zinc such as electrolytic zinc, or the lower grades of commercial slab zinc or spelter which should, however, not contain ingredients in quantities which detrimentally affect the alloy. For instance, the presence of more than .60% of cadmium or .04% of iron renders the zinc too brittle for rolling into thin gauges. However, the presence of less than .60% of lead, a frequent impurity in commercial zinc, may be disregarded as its presence in such amounts has no material effect upon the alloy. The presence of even a small trace of aluminum causes the alloy, after rolling, to develop cracks and to disintegrate. For practical purposes we prefer to use a grade of spelter known in the trade as "Intermediate" whose maximum iron content is .03%, maximum lead content .20% and maximum cadmium content .50%, but not more than a total of .50% of all such metals, and which is substantially free from aluminum and magnesium.

We may, however, use to advantage the grade of spelter known as "Brass special" (maximum impurities, iron .03%, lead .60%, cadmium .50%, total not over 1.00%); or the grade known as "High grade" (maximum impurities, iron .03%, lead .07%, cadmium .07%, total not over .10%). For specifications of these three grades of commercial zinc as laid down by the American Society for Testing Materials see "Metal Statistics 1930," page 413.

When commerical zinc which contains no appreciable amount of cadmium or iron, especially electrolytic grade, is used, we prefer to add a small quantity of either or both of these elements for the purpose of increasing the hardness and tensile strength.

The exact proportion of copper and of antimony will depend upon the particular qualities of the alloy to be produced and also upon the various conditions of the process, for instance, rolling, to which the alloy is to be subjected. The particular proportions may easily be adjusted by simple experiment until the correct proportions suitable for the desired alloy are determined.

Example 1

1000 grams of commercial spelter containing .02% iron, .25% lead, and .125% cadmium are melted in an electrically heated crucible. When the zinc is thoroughly molten there are added 10 grams of sheet copper and 1 gram of metallic antimony. The resulting alloy is cast into a slab 1 inch thick. When rolled down to gauge .050″ the finished alloy tests approximately as follows:

Tensile strength with the grain	33,600 lbs. sq. in.
Rockwell hardness	95½
Dynamic ductility	320

When the same commercial spelter is rolled down to gauge .050″ it has a tensile strength of 24,300 pounds per square inch, a dynamic

ductility of 325, and a Rockwell hardness of 86½.

Example 2

2 pounds of commercial zinc are melted in an electrically heated crucible, then 120 grains of copper and 30 grains of antimony are added and thoroughly mixed with the molten zinc. The molten alloy is cast into a slab and cross-rolled to .050" thickness as in the rolling of commercial sheet zinc. The assay and physical properties of the rolled alloy compared with commercial zinc rolled in the same way to like gauge are as follows:

	Alloy	Commercial zinc
Gauge—inches	.050	.050
Assay—		
Per cent iron	.024	.024
Per cent lead	.15	.258
Per cent cadmium	.132	.124
Per cent copper	.886	None.
Per cent antimony	.225	None.
Zinc	Balance.	Balance.
Physical properties—		
Hardness, Rockwell	95	86
Ductility, dynamic	370	325

Attention is called to the fact that these physical tests are significant only when compared with ordinary zinc rolled under identical conditions. For instance, the alloy of Example 1 would, if rolled to a thinner gauge, have its tensile strength increased but its ductility decreased.

Sheets rolled at customary zinc rolling temperatures and made of alloys within the proportions given exhibit a marked freedom from the ordinary strain crystals appearing in rolled zinc. If sheets made of such alloys are subjected to the action of the standard etching solution for zinc, photo-micrographs (250X) thereof disclose a striated formation remarkably free, and in some cases apparently almost absolutely free, from such crystals. This standard solution consists of chromic-oxide 20 grams, sodium sulphate 1.5 grams, and water 100 cc.

If such sheets be submitted to a special etching solution consisting of 10 grams of chromic-oxide, 1.5 grams of sodium sulphate, and 100 cc. of water, the photo-micrographs show a surface made as if by very fine stippling, the striations being practically invisible.

The peculiar advantages of our invention begin to be evident both in the behavior and in the characteristics of the alloy and in the photo-micrographs thereof when a copper content as low as $\frac{1}{10}$ part is used. On the other hand, if more than 2 parts of copper are used or more than 2 parts antimony, the advantages of our alloy begin to diminish. As already stated, we prefer to use for commercial purposes ¼ to 2 parts of copper. We are at present of the opinion that the copper and antimony are, when used within the limits herein specified, held in solid solution by the zinc grains or produce compounds with one another or with the zinc itself which are in turn held in solid solution by the zinc grain. The copper and antimony should not, for best results, be used in so large an amount which would result in the production of a secondary crystalline structure in the alloy, thus destroying its homogeneity and rendering it brittle. It is, however, to be understood that the temperature conditions under which the alloy is cast or mechanically worked may influence the degree of solubility of these metals in the zinc grain.

So far as we know, no alloy of zinc copper and antimony in the proportions specified has ever been used commercially for producing articles by mechanically working, for instance, by extrusion, by spinning, by drawing, by forging or by rolling into sheets or strips, for all of which purposes our alloy is specially suitable. We therefore claim as novel a mechanically worked zinc product made of our alloy.

Having described the invention, what we claim as new and desire to secure by Letters Patent of the United States is:

As a composition of matter an alloy characterized by the fact that it is of substantially greater hardness than zinc and capable of being mechanically worked, composed of zinc 100 parts, copper $\frac{1}{10}$ to 2¼ parts and antimony 1/100 to 2 parts.

In testimony whereof we have hereunto set our signatures.

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