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METHOD OF MAKING MALLEABLE ZINC-ALLOY BODIES

Erich Pelzer, Stolberg, Germany, assignor to Stolberger
Zink AG, Aachen, Germany

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8 Claims

ABSTRACT OF THE DISCLOSURE

A method of making malleable zinc-alloy bodies in which a zinc alloy of the following composition: 0.05 to 1.2% by weight aluminum, 0.05 to 0.8% by weight copper, 0.0005 to 0.015% by weight magnesium and 0 to 0.05% nickel, balance high-purity zinc, is maintained at a temperature of 250° to 350° C. to effect homogenization. Thereafter, the zinc-alloy body is subjected at a temperature between 200° and 300° C. to deformation to reduce its cross-section by at least 50% and, at a temperature between about room temperature (ca. 20° C.) and 80° C. is subjected to a further deformation to reduce its cross-section by at least 70%.

My present invention relates to a method of making zinc-alloy bodies and, more particularly, to a method of treating zinc-alloy bodies consisting at least in major part of high-purity zinc and containing, as alloying ingredients, aluminum, copper, magnesium and, possibly, nickel.

The use of zinc bodies, generally in the form of sheets, bands, strips and bars, especially in the construction industry, has hitherto been limited because of the unsatisfactory mechanical characteristics of such bodies. For example, while ductility of the zinc-alloy bodies is advantageous to permit satisfactory bending and deformation without breaking, cracking or tearing, various other mechanical properties have been adversely affected by the attempts to gain a satisfactory level of ductility. Included among these properties are the elastic limit, the compressive or tensile strength, the hardness and the elongation of the bodies.

However, of crucial importance to the use of zinc-alloy bodies or members in the construction trades, is the creep resistance of the body which may be measured, for the present purposes, in terms of the load capable of subjecting the body to 1% deformation per year. Considerable effort has been expended in an attempt to develop zinc-alloy bodies with satisfactory ductility, compressive strength or tensile strength, hardness and elastic limit and yet with a relatively low compressive strength.

For example, there has been proposed a malleable alloy of aluminum, copper and zinc in which the aluminum content ranges up to 1.2% and the copper content up to about 2%. Such alloys have satisfactory strength characteristics but low creep resistance. Attempts have also been made to improve the creep resistance of such alloys by the addition of other components such as small quantities of magnesium, but it has been found that these attempts yield a sharp reduction in the ductility of the alloy.

In other efforts along similar lines, attempts have been made to provide heat treatments for zinc-alloy bodies, e.g. bodies of the compositions specified above, by subjecting them to temperatures of 120° to 220° C. These efforts have yielded zinc-alloy bodies of relatively high elongation such that the strips, bands or sheets composed of the alloy may be bent or folded sharply without breakage. Here again, however, the creep resistance of the body is relatively low, i.e. about 1 kg./mm.² for a 1%

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yield over a period of one year (for an alloy consisting of zinc, 0.05 to 1.2% aluminum and 0.05 to 0.8% copper and subjected to a heat treatment at 120° to 220° C.).

It is, therefore, the principal object of the present invention to provide an improved zinc-alloy body with high creep resistance and good mechanical properties, especially for use as strips, bands and sheets in construction.

It is another object of my invention to provide a method of treating zinc-alloy bodies to increase their creep resistance without detracting from other advantageous mechanical properties.

A further object of the invention is to provide a zinc-alloy body having good mechanical properties and high creep resistance.

I have found, quite surprisingly, that these objects may be obtained by the use of a zinc alloy of a well-defined composition which is subjected to a critical series of treatment steps including a hot deformation, a cold deformation and a subsequent heat treatment whereby the resulting body has a creep resistance which may be five to ten times greater than the creep resistance of zinc bodies containing, for example, aluminum and copper, as specified earlier.

More specifically, the present invention resides in the use of a zinc alloy of the following composition:

	Percent by weight
Aluminum	0.05 to 1.2
Copper	0.05 to 0.8
Magnesium	0.0005 to 0.015
Nickel	0 to 0.05
High-purity zinc	Balance

Preferably, the zinc alloy is:

	Percent by weight
Aluminum	0.1 to 1.2
Copper	0.05 to 0.8
Magnesium	0.0005 to 0.15
Nickel	0.005 to 0.05
High-purity zinc	Balance

The term "high-purity zinc" is used herein to describe high-grade or special high-grade zinc in accordance with ASTM specification B6-49. In accordance with the specification, special high-grade zinc may contain up to 0.006% by weight lead, up to 0.005% by weight iron and up to 0.004% by weight cadmium, the total of lead, iron and zinc not exceeding 0.01% by weight. High-grade zinc, in accordance with the specification, may contain up to 0.07% by weight lead, up to 0.02% iron, up to 0.07% by weight cadmium and the total of lead, iron and cadmium ranging up to 0.1% by weight.

According to the present invention, the zinc-alloy body, of a composition within the ranges given above, is subjected to a three-stage treatment including a hot deformation, a cold deformation and a subsequent heat treatment.

Prior to the first stage of this treatment, however, the zinc-alloy body is subjected to a homogenizing heat treatment for a period ranging from 10 minutes to several hours, e.g. five hours, at a temperature of 250° to 350° C. to ensure complete uniformity of the grain and crystal structure throughout the cross section of the body which may be extruded or cast.

In the first stage, the body is subjected to hot deformation at a temperature between 200° and 300° C. and designed to reduce the cross section of the body by at least 50%, preferably 85 to 95%. The second stage, or cold deformation, is carried out at a temperature between ambient or room temperature (e.g. 20° C.) and 80° C. and reduces the cross section of the body by a minimum of 70% (preferably 85 to 98%). The subsequent heat treatment is effected at a temperature be-

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tween 120° and 220° C., preferably 160° C. and represents a tempering of the body. The tempered step may be carried out for a period ranging from about 10 minutes to several hours (e.g. 5 hours) and is preferably performed for a period of about 2 hours.

The resulting zinc-alloy body is found to have a high ductility in spite of its magnesium content and yet excellent creep resistance which appears to result from an ideal distribution of the magnesium in the crystal structure of the zinc alloy in the form of a fine-grain segregation or precipitation uniformly distributed by virtue of the cold deformation, throughout the cross section. While the use of nickel is optional, as noted above, it has been found that the nickel accelerates the segregation of the magnesium from the alloy-solid solution.

EXAMPLE I

An alloy is prepared of the following composition:

	Percent by weight
Aluminum -----	0.8
Copper -----	0.4
Magnesium -----	0.008
High-purity zinc -----	Balance

and is cast into a bar. The bar is maintained for a period of 2 hours at a temperature of about 300° C. to ensure homogenization and then is rolled to a thickness of 2 mm., corresponding to a cross-sectional reduction of about 90% at a temperature of about 250° C. Subsequently, the bar is cold-rolled at a temperature of about 40° C. to reduce its cross-section by 60% and yield a strip having a thickness of 0.8 mm. The zinc-alloy strip is tempered for 2 hours at 160° C.

The tensile strength of the strip was found to be 30 kg. per mm.² and the creep resistance 7.5 kg. per mm.² for a deformation of 1% per year. Upon folding, through 180°, breakage occurred.

EXAMPLE II

The alloy of Example I is hot-rolled to a thickness of 8 mm. with a cross-sectional reduction as in Example I and thereafter is subjected to a cold rolling at a temperature of 40° C. to the thickness of 0.8 mm. but with a cross-sectional reduction of 90%. After 2 hours of tempering at 160° C., the body was tested and found to have a tensile strength of 28 kg. per mm.², a creep resistance of 6.5 kg. per mm.² for a 1% deformation per year, and to be break-free upon folding through 180°.

A comparison of Example I with Example II demonstrates that, while both zinc-alloy bodies have a high creep resistance, the indicated extent of the cold deformation is essential to provide the ductility necessary for practical application of the alloy in construction. However, both alloys represent an improvement over conventional systems.

EXAMPLE III

To the alloy of Example I was added 0.01% nickel and the body was subjected to the same treatment as set forth in Example II. Equivalent physical properties were obtained.

I claim:

1. A method of treating a zinc-alloy body of the following composition:

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	Percent by weight
Aluminum -----	0.05 to 1.2
Copper -----	0.05 to 0.8
Magnesium -----	0.0005 to 0.015
Nickel -----	0 to 0.05

to increase its creep resistance while maintaining substantial ductility, comprising the steps of:

(a) maintaining the body at a temperature of 250° to 350° C. for a period sufficient to insure crystalline homogeneity of the body;

(b) thereafter subjecting said body to a treatment consisting of hot-deforming said body at a temperature between 200° and 300° C. with a cross-sectional reduction of at least 50% and cold-deforming the thus hot deformed body at a temperature from about room temperature to about 80° C. by a cross-sectional reduction of at least 70%; and

(c) tempering the cold deformed body of step (b) at a temperature of 120° to 220° C.

2. The method defined in claim 1 wherein said body has the following composition:

	Percent by weight
Aluminum -----	0.01 to 1.2
Copper -----	0.05 to 0.8
Magnesium -----	0.0005 to 0.015
Nickel -----	0.005 to 0.05

3. The method defined in claim 1 wherein said body is hot deformed in step (b) with a cross-sectional reduction of 85 to 95%.

4. The method defined in claim 3 wherein said body is cold deformed in step (c) to a cross-section reduction of 85 to 98%.

5. The method defined in claim 4 wherein said body is tempered in step (d) at a temperature of about 160° C.

6. The method defined in claim 5 wherein said body is maintained at said temperature between 250° and 350° C. in step (a) for a period ranging between 10 minutes and 5 hours and is tempered in step (c) for a period ranging between 10 minutes and 5 hours.

7. The method defined in claim 6 wherein said body consists of:

	Percent by weight
Aluminum -----	0.8
Copper -----	0.4
Magnesium -----	0.008

8. The method defined in claim 7 wherein said body is cold rolled in step (c) with a cross-sectional reduction of about 90%.

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WAYLAND W. STALLARD, Primary Examiner

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