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ZINC-BASE ALLOY.

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This invention relates to zinc base alloys and has for its object the provision of an improved zinc base alloy. More particularly, the invention aims to provide an improved zinc base alloy for die-casting and the like.

Zinc base alloys suitable for die-casting are known and in use, and under favorable conditions possess comparatively high tensile strength, high impact strength and fair ductility. The known alloys are, however, subject to a certain intercrystalline oxidation in the presence of warmth and moisture, and are liable to swelling, warping, and loss of strength when subjected to such adverse conditions. Moreover, changes occur in these alloys upon simple ageing at ordinary temperatures unaccompanied by serious intercrystalline oxidation; which may result in serious detriment to such physical properties of the alloy as tensile and impact strength.

The present invention contemplates the provision of an improved zinc base alloy adapted to be cast in permanent and sand molds, and more particularly adapted for die-casting. In the improved alloy of the invention, the tendency to intercrystalline oxidation and changes upon ageing are substantially reduced, while preserving or even improving other properties of the alloy which make it valuable for die-casting and similar purposes.

The invention involves the addition of nickel and magnesium in relatively small amounts to zinc base alloys, and more particularly to zinc base alloys containing aluminum and copper. We have found that the presence of such small amounts of nickel and magnesium in zinc base alloys materially reduces deterioration by oxidation, more particularly under conditions of warmth and moisture, and moreover prevents undersirable changes in physical properties due to structural or equilibrium changes which tend to proceed slowly in these alloys. We have found that the advantageous results contemplated by the invention are secured by the presence in the zinc base alloy of from 0.05 to 0.5% of magnesium and 0.01 to 0.5% of nickel.

Zinc base alloys containing aluminum and copper in varying proportions are materially improved by the presence of approximately 0.1% of nickel and approximately 0.1% of magnesium. Such alloys have high tensile strength, and are affected much less seriously by oxidation conditions, particularly in the presence of warmth and moisture, than similar alloys without the nickel and magnesium. Furthermore, ageing, when unaccompanied by serious oxidation, does not result in detrimental changes in physical properties, such as loss of tensile or impact strength, to such a degree as occurs in similar alloys without nickel and magnesium.

Zinc base alloys of the invention will contain not less than 85% of zinc. These alloys may contain from 1 to 15% of aluminum and up to 4% of copper. Preferably, the aluminum content of the alloy is from 3 to 5% and the copper content from 1.5 to 4%. The magnesium content, as determined by actual analysis, may vary from 0.05 to 0.5%, and the nickel content, as determined by actual analyses, may vary from 0.01 to 0.5%. Our present preferred embodiment of the invention is a zinc base alloy containing about 4% aluminum, about 3% copper, about 0.1% magnesium and about 0.1% nickel.

The equilibrium diagram for nickel-aluminum alloys shows a series of intermetallic compounds, all of which, in the high aluminum ranges, have high melting points and low specific gravities. When nickel is added to an alloy of zinc with aluminum, it forms one or more of these compounds with the aluminum. The compounds when formed separate from the melt, at normal casting temperatures, as small crystals which by virtue of their low specific gravity have a decided tendency to float to the top to form a dross scum. As a consequence of these phenomena, it appears that the actual amount of nickel which can be readily retained by a zinc-aluminum alloy, either in liquid solution or as entrapped particles of compound, is in the neighborhood of 0.02% in slowly cooled ingots and about 0.1% in die-castings. Furthermore, on account of these phenomena, the actual nickel content of the alloy cannot be accurately arrived at by calculation but must be determined by analyses of the alloy itself.

As a result of our investigations, we have found that small percentages of nickel as well as small percentages of magnesium in zinc base alloys produce an increase in the

resistance of the alloy to intercrystalline oxidation. The effect of nickel alone in this respect is not as great as that of magnesium alone. The optimum result is attained when both nickel and magnesium are present in the relatively small percentages hereinbefore mentioned. Thus, zinc base alloys containing magnesium alone, in the percentages herein contemplated, or containing nickel alone, in the percentages herein contemplated, show slight intercrystalline oxidation. On the other hand, zinc base alloys of the invention, more particularly of the optimum composition hereinbefore mentioned, show substantially no intercrystalline oxidation. In addition, the improved zinc base alloys of the invention possess excellent casting properties, and have relatively high residual impact strength after ageing in steam.

The following table further illustrates the improved characteristics of zinc base alloys of the invention:

Alloy	Tensile strength lbs. per sq. in.		Impact strength ft. lbs. per sq. in.		Expansion in. in 1 in.
	A	B	A	B	B
No. 1	41,200	17,400	92	0	.0053
No. 2	37,600	25,600	127	14	.0039
No. 3	32,600	25,300	149	7	.0020
No. 4	35,100	24,900	83	8	.0036
No. 5	43,500	25,100	113	10	.0025

A=as cast.
B=after 10 days steam exposure.

Composition of alloys in percent.

Alloy No.	Calculated				By analysis			
	Al	Cu	Ni	Mg	Al	Cu	Ni	Mg
1	4	3	0	0.1				
2	4	2.5	0.5	0.1	3.5	2.6	0.12	0.04
3	4	2.25	0.75	0.1	3.9	2.0	0.27	0.19
4	4	2.0	1.0	0.1	3.6	1.9	0.41	0.18
5	4	2.0	0.05	0.1	4.2	2.0	0.05	0.08

The alloys of the invention have high fluidity, low shrinkage, good casting properties and substantial impact strength after exposure to warmth and moisture. The reason for the improvement brought about by the inclusion of nickel and magnesium in these alloys cannot be fully explained. The combined effect of the nickel and magnesium appears to be to reduce the tendency to inter-crystalline oxidation with the result that the alloy is stabilized and prevented from deteriorating in the manner common with many zinc base die-casting alloys containing aluminum.

It is to be understood that in preparing the improved alloys of the invention, the zinc used should be substantially pure, or at least substantially free from impurities such as lead and cadmium, which are known to cause deterioration of zinc base die-casting alloys containing aluminum. A high grade zinc, such as the well-known "Horsehead" brand should therefore be used and the other metals employed in compounding the alloy should be likewise free from impurities that are likely to have a deteriorating influence.

We claim:—

1. A zinc base alloy containing 1 to 15% aluminum, 0.5 to 4% copper, 0.05 to 0.5% magnesium and 0.01 to 0.5% nickel.

2. A zinc base alloy containing 3 to 5% aluminum, 1.5 to 4% copper, 0.05 to 0.5% magnesium and 0.01 to 0.5% nickel.

3. A zinc base alloy containing about 4% aluminum, about 3% copper, 0.05 to 0.5% magnesium and 0.01 to 0.5% nickel.

4. A zinc base alloy containing 1 to 15% aluminum, 0.5 to 4% copper, about 0.1% magnesium and about 0.1% nickel.

5. A zinc base alloy containing 3 to 5% aluminum, 1.5 to 4% copper, about 0.1% magnesium, and about 0.1% nickel.

6. An alloy containing substantially 93.25% zinc, 3.0% copper, 3.0% aluminum, 0.50% magnesium and 0.25% nickel.

In testimony whereof we affix our signatures.

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