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MAGNESIUM BASE ALLOYS

Adolf Beck, Gustav Siebel and Hugo Vosskühler, Bitterfeld, Germany; vested in the Alien Property Custodian

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This invention relates to magnesium base alloys.

The high percentage magnesium base cast alloys heretofore known, generally contain as alloying constituents substantially only aluminium and zinc, the aluminium content amounting to between about 4 and 10% and the zinc content up to about 3%, the zinc content being smaller as the aluminium content is increased. Depending on the particular composition of the alloy and on the type of casting process (sand, chill mould or pressure die casting), these known magnesium base cast alloys have in the "as cast" state, a tensile strength of from 16 to 22 kgs. per square mm., an elongation of from 3 to 12% and a yield point of from 8 to 16 kgs. per square mm. (see "Werkstoffhandbuch Nichteisenmetalle," 1936, Sheet K. 3).

However these known alloys have the disadvantage that they suffer from a tendency to micro-shrinkage on solidification. This micro-shrinkage leads to the formation of microscopic discontinuities in the structure which not only involve a certain lack of tightness of the casting against pressure of liquid or gaseous media, but which also have a notch effect and thus, on occasion, substantially impair the strength properties attainable in the case of a sound structure, particularly in highly stressed thick sections. Attempts have hitherto been made to counteract micro-shrinkage by an ample use of chill plates and other measures for the rapid cooling of such sections; such measures, however, are expensive to apply and their effect is difficult to control in practice, moreover they are frequently only partially successful.

The present invention aims at providing new magnesium base alloys which are equal and in some cases even superior to the hitherto known magnesium base cast alloys in respect of mechanical strength, whilst being much less liable to micro-shrinkage than such known alloys.

The alloys of the present invention are characterised in that they contain cerium in amounts ranging between about 0.1 and about 2% as well as zinc between about 0.5 and about 12%. Preferably, the cerium content varies between about 0.5 and about 1.5%, while the zinc content is maintained between about 4 and about 8%.

The term "cerium" used herein is intended to include the so-called "Cerium Mischmetall."

In addition to the aforementioned metals, the alloys of the present invention may contain further alloying constituents which are soluble in magnesium in the solid state in the presence of the specified amounts of the two principal alloying constituents viz. cerium and zinc. Such additional alloying constituents are especially cadmium, tin and silver. The amount of these additional alloying constituents can be up to 10%, but preferably does not exceed 4%. The alloys of the present invention may also contain aluminium but in this connection it has been found that the presence of substantial amounts of aluminium, i. e. about 1% or more, introduces an increased tendency to micro-shrinkage which becomes exceedingly pronounced when the aluminium content exceeds 3%. Consequently the alloys of the present invention are preferably free from aluminium or if they contain aluminium as an intentional constituent, the aluminium content is preferably less than 1%.

The presence of even the smallest amounts of silicon likewise has an unfavourable effect on the properties of the alloys of the present invention, so that the silicon content of the alloys should be kept below 0.05% and preferably below 0.01%. The presence of antimony is also detrimental. On the other hand, the normal iron content of magnesium (about 0.05%), which in the case of hitherto known magnesium cast alloys was regarded as undesirably high, not only has no unfavourable effect in the case of the alloys of the present invention, but even appears to improve the properties of said alloys.

For the purpose of improving their resistance to corrosion, the alloys of the invention preferably also contain between about 0.3 and 0.8% of manganese.

It has further been found that the mechanical strength properties of the hereindescribed alloys can be very considerably further improved by suitable heat treatment. This heat treatment comprises heating (soaking) the alloys for several hours, preferably at the highest possible temperatures, i. e. as closely as possible below the solidus point, and, after rapid cooling (for example in the atmosphere), annealing them for a longer period than the soaking period, at lower temperatures (between about 120 and 250° C.). For an alloy containing 0.75% of cerium and 4% of zinc, for example, heating at 515° C. for 5 hours and annealing at 175° C. for 20 hours or longer have been found convenient. The soaking can also be dispensed with on occasion and the heat treatment restricted to the annealing, in which case, however, the aforedescribed improvement of the mechanical properties is generally substantially smaller.

In the following table a number of alloys according to the invention are given by way of example, together with their mechanical strength properties. By way of comparison the corresponding values of two magnesium base alloys (No. 1 and No. 2 in the table) are indicated, the first of which contains 0.3% of manganese as sole alloying, constituent and the second 0.3% of manganese and 0.5% of zinc, as the sole, alloying constituents, both alloys thus being free from cerium.

No.	Alloy				State	Strength properties		
	Ce	Zn	Cd	Mn		Tensile strength	Elongation	Yield point
						Kgs. per square mm.		Kgs. per square mm.
1				0.3	Chill casting	14.4	7.4	3.9
2		0.5		0.3	do	10.5	4.7	3.3
3	0.25	0.5		0.3	Chill casting	19.0	20.0	6.0
4	0.75	2.0		0.3	do	20.4	17.6	8.1
5	0.75	4.0		0.3	do	21.2	13.7	8.3
6	0.75	6.0		0.3	do	20.1	8.0	8.7
7	1.0	2.0		0.3	do	19.3	12.9	7.9
8	1.0	6.0		0.3	do	22.3	11.0	8.9
9	1.5	2.0		0.5	do	17.6	7.0	7.5
10	1.5	6.0		0.5	do	18.2	7.2	7.1
11	1.0	2.0		0.5	Sand casting heat treated.	22.5	10.4	13.5
12	0.75	5.0		0.5	do	25.5	5.0	18.3
13	0.75	6.0		0.5	do	28.5	3.4	22.3
14	0.75	4.0	4.0	0.5	Sand casting heat treated.	26.3	0.4	16.8

The best strength properties are usually obtained with smaller contents of cerium; an increase in the cerium content within the limits defined by the invention, however, leads to a still more complete suppression of micro-shrinkage. By suitably proportioning the content of the alloys of the present invention it is thus possible to produce alloys having particularly good strength properties or else alloys particularly free from a tendency to micro-shrinkage, the choice between the two alternatives depending substantially on the purpose for which the alloys are intended.

The alloys of the present invention are not only suitable for the production of shaped castings, but also possess good properties in the wrought state.

ADOLF BECK.
GUSTAV SIEBEL.
HUGO VOSSKÜHLER.