

UNITED STATES PATENT OFFICE

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MAGNESIUM BASE ALLOYS

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This invention relates to magnesium base alloys containing at least 85% of magnesium and its object is to improve the mechanical properties of such alloys.

It has heretofore been proposed to incorporate proportions of cerium or misch metal in magnesium base alloys in order to improve mechanical properties, and in particular the resistance to creep at elevated temperatures, e. g. of the order of 200° C.

It has furthermore been proposed in the specification of British Patent No. 540,333 to provide magnesium base alloys which incorporate misch metal from which the cerium has been substantially removed with a view to improving the resistance of the alloys to corrosion without losing their desirable mechanical properties. This omission of cerium does not however appreciably affect the mechanical properties either harmfully or desirably. The optimum quantity of misch metal free from cerium to be introduced into the alloys was moreover specified to lie between 5% and 10% of the total alloy, which also contained appreciable amounts of manganese and calcium.

Misch metal free from cerium will consist essentially of lanthanum, neodymium, praseodymium and small quantities of samarium in approximately fixed proportions, as a result of the remarkably constant proportions of these rare earths in monazite, the only raw material available on a commercial scale.

We have, however, now ascertained that substantial advantages can be achieved by the incorporation of between 0.5 and 10% (preferably 2 to 4%) of rare earth metals, of which neodymium constitutes at least 50% (preferably at least 75%) and lanthanum and cerium are present, if at all, in quantities not exceeding 25%, separately or together, the balance, if any, being praseodymium and small quantities of samarium and traces of elements of the yttrium group of rare earth metals. The praseodymium is therefore about 10 to 25% of the total of rare earth metals.

We have found that such alloys offer improved static mechanical properties, particularly in the cast state, as compared with alloys containing similar or greater proportions of misch metal (with and without cerium), or lanthanum. Moreover, the alloys of the present invention have an improved creep resistance at high temperatures as compared with alloys containing similar or higher proportions of cerium or misch metal (with and without cerium) or lanthanum.

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The alloys of the present invention also may contain any other elements known in the magnesium base alloy art as alloying ingredients in these alloys. If the alloys do not contain zirconium, they may contain one or more of the following elements in the proportions stated:

		Percent
Manganese	0.02	to 2
Aluminium	0.01	to 2
Calcium	0.01	to 0.2
Thorium	0.01	to 10
Mercury	0.01	to 10
Beryllium	0.0005	to 0.1
Zinc	0.5	to 10
Cadmium	0.5	to 10

We have, moreover, ascertained that a further particular advantage can be obtained if zirconium is incorporated in the alloys; in this case the presence of a relatively large percentage of neodymium considerably reduces the tendency to grain coarsening during solidification in the mould, to which magnesium base alloys containing rare earth metals and zirconium are usually prone. The addition of zirconium, as is known, refines the grain size and effects considerable improvement in the mechanical properties of the alloys as described in the specification of British Patent No. 511,137, and in particular increases the elongate of sand cast objects. Such alloys incorporating zirconium must be substantially free from elements which precipitate zirconium from a magnesium melt, e. g. aluminium, manganese, tin, silicon, cobalt, nickel and antimony. These alloys may, however, contain one or more of the following elements in the proportions stated:

		Percent
Zinc	0.5	to 10
Cadmium	0.5	to 10
Beryllium	0.0005	to 0.1
Mercury	0.01	to 5
Thorium	0.01	to 10
Calcium	0.01	to 0.2

In general when the alloys according to the present invention contain zirconium, they should contain at least 0.4% zirconium in a condition which (together with the magnesium which contains it) is readily soluble in an aqueous solution of hydrochloric acid consisting of 30 ccs. of HCl (specific gravity 1.16) to 85 ccs. of water, sufficient acid being added during dissolution to maintain the initial concentration.

The alloys of the present invention offer advantages both in the cast and wrought conditions.

Rare earth materials consisting almost wholly of neodymium and praseodymium in which the neodymium is generally at least 60% have been known by the term "didymium."

The advantageous results which can be achieved by the present invention are illustrated by way of example by the following experimental results:

Alloy	Static Mechanical Properties		
	0.1% Proof Stress, ton/sq. in.	Ultimate Tensile Stress, ton/sq. in.	Elongation Per cent on 2"
0.7% Zr, 2½% Zn, 2½% misch metal, balance magnesium. As cast.	6.0	11.5	5.0
0.7% Zr, 2½% Zn, 2½% didymium, balance magnesium. As cast.	6.3	12.0	9.0
0.7% Zr, 4½% Zn, 2% misch metal, balance magnesium. Heat treated 24 hrs. at 330° C.	8.2	12.4	3.5
0.7% Zr, 4½% Zn, 2% didymium, balance magnesium. Heat treated 24 hrs. at 330° C.	8.4	14.0	5.0

Creep Resistance	
Alloy	Creep Rate per hour at 200° C.
0.7% Zr, 2½% Zn, 2½% misch metal, balance magnesium.	5.0×10 ⁻⁷ inch per 1" length at 2 t. s. i.
0.7% Zr, 2½% Zn, 2½% didymium, balance magnesium.	2.5×10 ⁻⁷ inch per 1" length at 2 t. s. i.

What we claim is:
1. A magnesium base alloy, consisting essentially of at least 85% magnesium and at least 0.4% of zirconium and from 0.5% to 4% of rare earth metals of which neodymium constitutes at least 50%, and in which lanthanum and cerium do not exceed 25% together, the balance of the rare earth metals being praseodymium and small quantities of samarium and traces of ele-

ments of the yttrium sub-group of rare earth metals.

2. A magnesium base alloy, consisting essentially of at least 85% magnesium and at least 0.4% zirconium and from 0.5 to 4 per cent of rare earth metals of which neodymium constitutes at least 50%, and in which lanthanum and cerium do not exceed 25% together, the balance of the rare earth metals being praseodymium and small quantities of samarium and traces of elements of the yttrium sub-group of rare earth metals, between 0.4 and 0.9% zirconium in a condition soluble in hydrochloric acid consisting of 30 cc. of HCl of specific gravity 1.16 to 85 cc. of water, sufficient acid being added during dissolution to maintain the initial concentration.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS		
Number	Name	Date
2,420,293	Beck et al.	May 13, 1947
2,461,229	Murphy et al.	Feb. 8, 1949
2,464,918	Ball et al.	Mar. 22, 1949

FOREIGN PATENTS		
Number	Country	Date
511,137	Great Britain	Nov. 8, 1938
113,802	Australia	Sept. 4, 1941

OTHER REFERENCES

Ser. No. 369,749, Sauerwald (A. P. C.), published June 15, 1943, abandoned.
Tromble et al.: treatise in Comptes Rendus, 1943, pages 603-605, inclusive (page 605 relied upon).