Patented Nov. 12, 1940

2,221,255

UNITED STATES PATENT OFFICE

2,221,255

MAGNESIUM BASE ALLOY

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No Drawing. Application November 13, 1939, Serial No. 304,132

3 Claims. (Cl. 75—168)

The invention relates to magnesium base alloys. It more particularly concerns alloys of this nature having a high degree of formability associated with other improved physical properties, such as increased tensile and yield strengths.

Magnesium alloys are being widely used in various structural and mechanical arts where a light weight metal is highly desirable, such as for use in making castings, forgings, and the like. However, the use of these alloys in the rolled form to make sheet metal articles requiring forming operations, such as bending, drawing, or the like, has not progressed as rapidly due to the fact that, in general, alloys of good formability permitting relatively sharp bends to be made without the article developing external cracks have inferior characteristics as regards their tensile and yield strengths.

It is, therefore, the principal object of the invention to provide a magnesium base alloy which may be made into rolled sheet or the like, possessing a sufficient degree of ductility or formability to be sharply bent, drawn, or otherwise shaped, while having high tensile and yield strengths.

Other objects and advantages will be apparent as the description of the invention proceeds.

My invention resides in the discovery that a magnesium base alloy composed of from 0.5 to 10 per cent of silver, from 1 to 15 per cent of cadmium, and from 0.1 to 3 per cent of manganese, the balance being substantially all magnesium, is endowed with the afore-mentioned properties. While the properties of good formability, together with increased tensile and yield strengths, are manifest over the entire range of composition indicated, I have found that, in general, the preferred combination of properties, such as the most desirable ductility for forming operations coupled with high tensile and yield strengths, is obtained when the alloy contains from 2 to 5 per cent of silver, from 6 to 8 per cent of cadmium, and from 1.5 to 2 per cent of manganese. Alloys containing the higher percentages of alloying ingredients, while still having good formability, have exceptionally high tensile and yield strengths, thus making them very suitable for use in casting operations as well as for forming operations.

The following table, which lists some of the properties of rolled sheet metal made from my new alloy, as well as the properties of rolled sheet metal made from the related ternary alloys, illustrates the improvement in strength properties of the new alloy over the closely related alloys. In the table the present elongation is to be regarded as an expression of the ductility or formability of the alloys.

Table

Nominal composition in percent (remainder = magnesium)			Annealed			Cold rolled		
Ag	Cd	Mn	Yield strength in lbs./sq. in.	Tensile strength in lbs./sq. in.	Percent elongation in 2 inches	Yield strength in lbs./sq. in.	Tensile strength in lbs./sq. in.	Percent elongation in 2 inches
	5.3	1.0	22,000	35,000	11	30,000	36,000	3
0.6		0.8	22,000	33,000	11	33,000	35,000	2
0.7	4.8		16,000	31,000	13	27,000	34,000	2
0.7	5.6	1.0	26,000	37,000	18	40,000	46,000	2
	5.3	1.0	22,000	35,000	11	30,000	36,000	3
3.8		1.7	25,000	37,000	19	41,000	47,000	8
3.8	4.8		20,000	35,000	22	36,000	43,000	4
3.8	5.3	1.3	26,000	39,000	17	43,000	48,000	4
	8.5	1.3	26,000	38,000	13	32,000	39,000	5
4.6	8.5		21,000	36,000	21	36,000	44,000	4
4.6	9.1	1.5	26,000	41,000	17	43,000	49,000	6

The properties listed in the above table under the section headed by the term annealed were obtained by first rolling the alloys at a temperature between about 600° to 800° F., and thereafter annealing them at various temperatures through a temperature range of from 400° to 800° F. The properties selected for the table were those of the annealed specimens which exhibited the maximum elongation. The properties listed under the section headed cold-rolled were obtained by subjecting specimens of the alloys which had been hot-rolled at a temperature of

from 600° to 800° F. to additional rolling in the cold state, to bring about a total reduction in thickness of from 2 to 10 per cent. The properties selected for the table were those of the cold rolled specimens which showed the greatest tensile and yield strengths, while having at least a 1 per cent elongation in 2 inches.

By comparison of the properties listed in the above table, it will be observed that the combined properties of my new quaternary alloys are superior to those of the parent ternary alloys having similar percentages of alloying ingredients. For example, it will be noted that in the lower percentage of alloying ingredients, the new alloy not only has a higher degree of elongation which is a measure of its ductility or formability, but it also has improved tensile and yield strengths. In the higher percentage range of composition, it will be noted that the elongation is still fairly good, while the strength characteristics of the alloy in both the annealed and the cold-rolled state are much superior to those of the parent alloy.

While the new alloy is most useful in wrought form, such as sheets, due to its formability characteristics, it may also be suitably used in making castings, forgings, extruded forms, and the like. It is further pointed out that my new alloy is amenable to solution and precipitation heat treatments, which, accordingly, modify its properties.

The new alloy may be compounded by any of the methods usually employed for melting and alloying metals with magnesium, such as by adding the alloying materials singly or jointly to a bath of molten magnesium, which is preferably protected from oxidation by a suitable flux.

I claim:

1. A magnesium base alloy containing from 0.5 to 10 per cent of silver, from 1 to 15 per cent of cadmium, and from 0.1 to 3 per cent of manganese, the balance being magnesium.

2. A magnesium base alloy containing from 2 to 5 per cent of silver, from 6 to 8 per cent of cadmium, and from 1.5 to 2 per cent of manganese, the balance being magnesium.

3. A magnesium base alloy containing 3 per cent of silver, 7 per cent of cadmium, and 2 per cent of manganese, the balance being magnesium.

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