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MAGNESIUM BASE ALLOY

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The invention relates to magnesium base alloys and more particularly concerns an alloy of this nature having a high degree of formability associated with other desirable physical properties, such as good tensile strength, yield strength, and improved cold rollability.

Magnesium base alloys are being widely used in the structural 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, and the like, has not progressed as rapidly due to the fact that, in general, alloys having good formability or ductility permitting relatively sharp bends to be made without the article developing external cracks, usually have inferior characteristics as regards their tensile and yield strengths.

strengths are manifest over the entire range of composition indicated, I have found that in general alloys containing from about 0.5 to 3 per cent of thorium are endowed with the most satisfactory strength and formability characteristics, on the other hand, the presence of from about 0.15 to 0.3 per cent of thorium produces an alloy having greatly improved cold rollability properties.

The following tables list some of the properties of rolled sheet metal made from my new binary alloy and compares these properties with those of magnesium.

Table 1 illustrates the improvement in yield strength, tensile strength and ductility or formability of my new alloy, over that of commercially obtainable magnesium. In the table the per cent elongation is to be regarded as a measure of the ductility or formability of the alloy.

Table 1

Nominal composition in per cent (magnesium=remainder) Th	Annealed			Cold rolled	
	Per cent elongation in 2 inches	Yield strength in lbs./sq. in.	Tensile strength in lbs./sq. in.	Yield strength in lbs./sq. in.	Tensile strength in lbs./sq. in.
0.4	7	7,000	25,000	14,000	24,000
0.6	10	17,000	32,000	22,000	30,000
2.5	22	19,000	34,000	28,000	31,000
	22	20,000	34,000	28,000	32,000

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

Another object of the invention is to provide a magnesium base alloy possessing improved cold rollability.

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 about 0.1 to 10.0 per cent of thorium, the balance being magnesium, possesses the aforementioned properties. The term "magnesium" used herein and in the appended claims is intended to include magnesium containing the ordinary impurities that are found in the commercially pure metal, such as traces of iron, copper, nickel, and silicon. While the property of high tensile and yield

The magnesium used in preparing these alloys and for purposes of comparison was obtained by subliming commercial magnesium.

The properties set forth in Table 1 under the term "annealed" were obtained by first rolling the alloys at a temperature of between 450° and 700° and thereafter annealing them at various temperatures through a range of from 400° to 800° F. The properties selected for the tables were those of the annealed specimens which exhibited the maximum elongation. The properties set forth under the term "cold rolled" were obtained by subjecting specimens of the alloys which had first been hot rolled at a temperature of between 450° and 700° F. to additional rolling in the cold state. The properties selected for the tables 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.

A comparison of the properties listed in Table 1 shows that all of the properties of my new

binary alloy are superior to those of the related magnesium. For example, it will be noted that the alloys containing lower percentages of alloying ingredients have better elongation coupled with superior strength characteristics in both the annealed and the cold rolled state. This improvement is also exhibited in the higher percentages of alloying ingredients.

In Table 2, following, the improved cold rollability of the new alloy containing smaller amounts of thorium, in comparison to commercial magnesium, is shown.

Table 2

Nominal composition in per cent (magnesium=remainder) Th	Per cent reduction before edge cracking of first, second, and third de- grees		
	First	Second	Third
0.24	5.0 25.4	20.0 90.0	33.3 90.0

Table 2 indicates the improvement of cold rollability of a binary magnesium-thorium alloy over commercial magnesium when a sheet having a .070 gauge was rolled in an 8" mill at a 5% reduction per pass. In the table, the amount of edge cracking of the rolled sheet is indicated by first; second, and third degrees. The first degree of edge cracking is defined as the point where very slight cracks appear at the edge of the rolled article, the second degree as the point where a moderate number of cracks appear at the edge of the rolled article, and the third degree as the point where severe edge cracking occurs, so severe as to cause the sheet to almost completely break apart.

It will be noted from an examination of Table 2, that in the extremely low percentage range of thorium addition, i. e., 0.24 per cent, the cold rollability of the new alloy shows outstanding improvement over that of commercial magnesium.

While the new alloy is most useful in wrought form, such as sheets, due to its formability characteristics, it may also be used for making castings, 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 thorium to a bath of molten magnesium, which is preferably protected from oxidation by a suitable flux. It is sometimes desirable to add more than the theoretical amount of thorium, since the alloying efficiency is not always 100 per cent and some loss may be incurred.

This application is a continuation-in-part of my co-pending application Serial No. 426,707, filed January 14, 1942; which, in turn, is a continuation-in-part of my application Serial No. 340,789, filed June 15, 1940.

I claim:

1. A magnesium base alloy containing from 0.1 to 10 per cent of thorium, the balance being magnesium.

2. A magnesium base alloy containing from 0.5 to 3 per cent of thorium, the balance being magnesium.

3. A magnesium base alloy containing from 0.15 to 0.3 per cent of thorium, the balance being magnesium.

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