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MAGNESIUM-LITHIUM-YTTRIUM ALLOYS

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This invention relates to magnesium base alloys and more particularly to magnesium base alloys containing lithium and yttrium. Further, it concerns the beta phase of magnesium-lithium alloys employing yttrium.

Recent developments, particularly in the aircraft industry wherein stressed parts are subjected to elevated temperatures, have made it desirable to provide metals of light weight which have good stability and hardness at these elevated temperatures. Although the magnesium base alloys are among the lightest of the structural alloys, they have not met with wide acceptance in applications where stressed parts are exposed to elevated temperatures. Previous work has been done with magnesium-lithium alloys in an effort to increase hardness of the alloy at elevated temperatures without loss of the desirable properties such as lightness and ductility. These desired results are accomplished in this invention wherein the magnesium-lithium alloy is combined with yttrium to form an alloy with good stability and hardness at elevated temperatures.

Therefore it is an object of this invention to provide an improved magnesium base alloy.

It is a further object of this invention to provide a magnesium base alloy with improved hardness at elevated temperatures.

It is yet another object of the instant invention to provide a beta phase magnesium-lithium alloy with good stability at elevated temperatures.

These and other objects of this invention will become evident upon reading the more detailed description hereinbelow.

In general the objects of this invention are accomplished by alloying magnesium and lithium in the ratio by weight of 7.5 magnesium to 1 lithium, and adding amounts of yttrium not to exceed 6 percent of the total weight of the alloy. The ratio of 7.5 to 1 is necessary to insure the formation of the beta phase of the alloy wherein the lithium content cannot exceed 12 percent of the total weight of the alloy.

The order of addition of the metals to the magnesium is immaterial. The magnesium and lithium may be melted together and the yttrium added or the yttrium may be added to the molten magnesium prior to the addition of the lithium.

In accordance with the invention 10 to 12 percent by weight lithium and 4 to 6 percent by weight yttrium are alloyed with magnesium to make a 100 percent alloy. The magnesium and lithium are melted in an open top crucible with a flux protective cover. An argon mantle can be used instead of the flux protective cover. Any suitable flux known in the art can be used in this operation. The crucible is equipped with a stirring rod having a one inch flat disk fastened to the end. The yttrium is puddied into the solution using this stirring rod to insure complete stirring of the melt and better control over the addition of the yttrium. After alloying has been effected the melt is allowed to remain undisturbed for a time to permit separation of the flux as well as unalloyed metal, if any, thereby obtaining a clean melt of the alloy. This period is not required if the argon mantle is used. The settled alloy then is transferred into a suitable mold to solidify.

Small amounts of a metal selected from the group consisting of thorium and aluminum may be employed in

the beta phase magnesium-lithium-yttrium alloy. When used in amounts up to 5 percent these metals help to improve the stability of the alloy at elevated temperatures. These metals are integrated into the alloy in the same manner as described previously.

This invention is further illustrated by the following examples without being limited thereto.

Example 1

A mixture of 83.8 grams of magnesium and 11.2 grams of lithium are melted in an open top crucible with a flux protective cover. A suitable flux is one composed of 57 parts of KCl, 28 parts of $CaCl_2$, 12.5 parts of $BaCl_2$, and 2.5 parts of CaF_2. Five grams of yttrium are added to the mixture using a stirring rod with a one inch diameter flat disk fastened to the end. This allows for complete stirring of the melt and better control over the addition of the yttrium. After alloying has been effected, the melt is allowed to remain undisturbed for a time to permit separation of flux as well as unalloyed metal, if any, thereby rendering a clean melt of the alloy. The settled alloy is then transferred to a suitable mold, such as a sand or a metal mold, to solidify. The ingots (1¼" x 1¼" x 3") are subsequently hot forged at a temperature of 500° F. to a 3/16-inch thick plate.

Example 2

A mixture of 84.7 grams of magnesium, 11.3 grams of lithium, 2 grams of yttrium, and 2 grams of thorium are alloyed in the same manner as Example 1. The thorium is added in the same manner as the yttrium. The alloy is forged as in Example 1.

Example 3

A mixture of 83 grams of magnesium, 11 grams of lithium, 2 grams of yttrium, and 4 grams of aluminum are alloyed as in Example 2. The alloy is forged as in Example 1 but at a temperature of 550° F.

The following table illustrates the hardess of each of the alloys in the above examples. An alloy of 12 percent lithium and 88 percent magnesium is used as a reference.

	Nominal Alloy Composition, Wt. Percent	Forging Temp., F.	Diamond Pyramid Hardness, kg./mm.²			
			R.T.	200° F.	300° F.	400° F.
178	Mg—12 Li	450	33.2	-----	4.2	0.9
196	Mg—11.2 Li—5Y	500	29.6	25.4	15.4	9.1
195	Mg—11.3 Li—2Y—2Th	500	45.9	19.5	9.6	4.9
197	Mg—11 Li—2Y—4Al	550	80.0	31.7	17.8	9.1

It is to be understood that the examples are for purposes of illustration and that the invention is limited only by the appended claims.

We claim:

1. A magnesium base alloy consisting essentially of about 10 to 12 percent by weight lithium and about 4 to 6 percent by weight yttrium, the balance being magnesium.

2. A magnesium base alloy consisting of about 10 to 12 percent by weight lithium, about 1 to 3 percent by weight yttrium, and about 1 to 5 percent by weight of a metal selected from the group consisting of thorium and aluminum, the balance being magnesium.

3. The alloy of claim 2 wherein said metal is thorium.
4. The alloy of claim 2 wherein said metal is aluminum.

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