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ALUMINUM ALLOY

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This invention relates to alloys, and more particularly to machinable aluminum base alloys having low thermal expansion and relatively high wear resistance.

Aluminum alloys having relatively low thermal expansion, together with relatively high strength and hardness, and retaining these properties after exposure to prolonged high temperatures, are especially desirable for the manufacture of castings, such as pistons or other parts, for use in internal combustion engines and the like.

Aluminum-silicon alloys containing suitable amounts of manganese and magnesium have been used in the production of pistons and the like. In these alloys, as the proportion of the silicon is increased, the thermal expansion of the alloy is decreased and the hardness increased. The machinability and fatigue resistance are decreased substantially as the percentage of silicon is increased and, therefore, about 10% to 15% silicon is the amount ordinarily used in these alloys, although still greater wear resistance and still lower expansion are sometimes desirable.

It is an object of the present invention to provide a machinable aluminum alloy having improved wear resistance and greater hardness than alloys heretofore used.

It is another object of this invention to provide a machinable aluminum base casting alloy having relatively low thermal expansion, improved resistance to wear, and relatively high thermal conductivity.

It is a further object of the invention to provide a machinable alloy having improved wear resistance, relatively high strength and fatigue resistance, and a low thermal expansion, and which will retain these properties when exposed to relatively high temperatures encountered in the operation of internal combustion engines.

It has now been found that these objects are accomplished in an aluminum base alloy by properly proportioning silicon, magnesium, manganese, iron and copper in the alloy. My improved alloy has about 20% or 21% to 30% silicon, .2% to 3% magnesium, .3% to 2% manganese, .4% to 2.5% iron, and 1% to 5% copper, with the balance substantially aluminum which may contain small amounts of minor impurities. The alloy may contain some boron or titanium, or other known grain refiner, if desired, depending upon the casting technique used.

Silicon is preferably present in the amount of 22% to 26% of the alloy, and increases the hardness and wear resistance of the alloy and decreases the thermal expansion. Silicon in such large proportions, without suitable quantities of the other above mentioned constituents, however, has the tendency to crystallize into relatively large crystals and to decrease machinability.

Iron and manganese tend to further harden the alloy and decrease the thermal expansion. These elements also increase the machinability and are beneficial, in that they tend to stabilize the alloy so that its properties are maintained at relatively high temperatures, such as encountered in internal combustion engines. The iron and manganese appear to perform substantially the same functions, aiding in the machinability and maintaining the properties of the metal at high temperatures.

Iron, like silicon, has the property of tending to crystallize in relatively large crystals, but manganese has the additional property of tending to inhibit the growth of large iron crystals. Consequently, it is desirable to have manganese present, even though there be present a relatively large quantity of iron. With an iron content of 2% or 2.5%, a smaller amount of manganese may be used to obtain the same properties as when a smaller amount of iron, such as .7% to 1% or 1.5%, be present. Preferably, the amount of iron in the alloy is about .7% to 1.5%.

The manganese may be present in an amount ranging from .3% to 3%, and when a substantial amount of iron is present the preferred amount of manganese is from .6% to 1% of the alloy.

Magnesium as well as improving the hardness and tensile strength of aluminum-silicon alloys increases the elastic properties of the alloy. Preferably, magnesium is present in the alloy in the amount of .5% to 1% or 1.5%, although as much as 3% is sometimes desirable. The magnesium and also the copper are beneficial in improving the machinability of the alloy, but the copper additionally aids in increasing the fatigue strength. The preferred amount of copper is 1.5% to 3%.

An alloy illustrating the present invention and desirable for the making of pistons contains about 21% to 25% silicon, about .4% to .8% magnesium, about .6% to 1% manganese, about .7% to 1.5% iron, about 1.5% to 2.5% copper, with the balance commercial aluminum and a small amount of titanium, boron, or other grain refiner, if desired. This alloy may be readily

machined with tools now available. The alloy has relatively low thermal expansion, is relatively hard and has relatively great wear resistance. It also has comparatively high heat conductivity, excellent fatigue strength and elastic properties, and maintains these over long exposures at high temperatures, such as those encountered in internal combustion engines, motor parts and the like.

While it is unnecessary to use a grain refiner in the alloy if the alloy is to be cast in permanent and chill molds and the molds are of such a design that the casting is chilled relatively rapidly throughout its thicknesses, yet it is within the purview of this invention to use boron or titanium, or other known grain refiners, when it is desired to have the benefit of such known grain refiners. When used, titanium should be present in the amount of about .1% or .2%, or so.

An alloy containing 22% silicon, .7% magnesium, .7% manganese, .8% iron, and 1.8% copper was chill cast, and upon being tested, it was found to have a thermal expansion of 16.5×10^{-6} inch per inch per degree centigrade, between a temperature range of 20° and 100° C. It had a Brinell hardness of 130 to 145 kilograms per square millimeter, and a tensile strength of 26,000 to 30,000 lbs. per square inch. This alloy, when heat treated six hours at 975° F., quenched, and aged at 355° F. for twelve hours, had a tensile strength of 34,000 to 38,000 lbs. per square inch, and a Brinell hardness of 120 to 140 kilograms per square millimeter.

The alloys of the present invention are particularly desirable for the production of castings, and the castings are susceptible to the usual heat treatments and have tensile strengths and hardnesses substantially improved thereby.

Furthermore, it is to be understood that various modifications of said alloy disclosed herein can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. An aluminum base alloy having relatively low thermal coefficient of expansion and relatively great wear resistance, containing about 20% to 30% silicon, about .2% to 3% magnesium, about .3% to 2% manganese, about .4% to 2.5% iron, and about 1% to 5% copper, with the balance substantially all aluminum and minor impurities.

2. An aluminum base alloy having a low coefficient thermal expansion and relatively great wear resistance, containing 21% to 26% silicon, .5% to 1.5% magnesium, .6% to 1% manganese, .7% to 2% iron, and 1.5% to 3% copper, with the balance substantially all aluminum and minor impurities.

3. An aluminum base alloy containing about 21% to 26% silicon, about .2% to .8% magnesium, about .6% to 1% manganese, about .7% to 1.5% iron, and about 1.5% to 3% copper, with the balance substantially all aluminum and minor impurities.

4. An aluminum base alloy containing about 21% to 26% silicon, about .5% to 1% magnesium, about .3% to 1% manganese, about .7% to 1.5% iron, and about 1% to 5% copper, with the balance substantially all aluminum and minor impurities.

5. An aluminum base alloy containing about 20% to 30% silicon, about .2 to 3% magnesium, about .6% to 2% manganese, about 1% to 2.5% iron, and about 1.5% to 3% copper, with the balance substantially all aluminum and minor impurities.

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