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METHOD OF TREATING ALLOYS

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4 Claims. (Cl. 148—21.1)

This invention relates to aluminum base alloys, by which is meant alloys containing more than 50 per cent of aluminum, which contain large amounts of silicon, and to treatments by which alloys of this nature may be improved for the purposes for which they are used.

Aluminum base alloys containing silicon in large amounts, that is, in amounts of 16 per cent or above, are useful because of their low heat expansivity. Particularly are they useful as a material from which pistons and other machined parts which are submitted to movement at high temperature can be made. Such alloys, however, have not heretofore met all of the requirements which such commercial uses demand, and because of the large amount of silicon present in such alloys, such amount being above the eutectic composition, machining difficulties are greatly increased. Aluminum-silicon alloys containing 16 per cent or more of silicon have not heretofore possessed the combination of high hardness at a high temperature and low heat expansivity with good machining properties and good strength.

The object of the present invention is to provide means by which an alloy having the above combination of properties may be made. Another object of the invention is to produce alloys of such characteristics which may be readily used for commercial purposes.

Other objects of the invention will appear in the following description thereof.

I have discovered that if an aluminum base alloy containing about 16 to 25 per cent of silicon, about 0.1 to 3 per cent of nickel, about 0.1 to 1.25 per cent of magnesium, and about 0.1 to 1.75 per cent of copper, preferably about 0.1 to 1 per cent of copper, is treated in the molten condition by the addition thereto of certain modifying elements and is thereafter cast in permanent molds, the casting thus produced has a remarkable combination of high hardness at high temperature, low thermal expansivity, good machining properties and good strength.

Because of the fact that these alloys have a silicon content above the eutectic composition, large amounts of primary silicon crystals separate in the alloys when they are cast in the usual manner. I have found that by a special modifying treatment it is possible to prevent the separation of these primary silicon crystals. I have likewise found that the treatment which produces this effect also induces in the alloy the novel properties above mentioned. In treating the alloys in accordance with my invention, I place them in the molten condition and add to the melt an

amount of an alkali metal such as sodium, potassium, rubidium, or caesium, or a salt or salts of alkali metals which will in contact with the molten aluminum produce an alkali metal. The amount of alkali metal introduced into the melt by the treatment may vary from 0.05 to as high as 1 per cent. When larger amounts than about 0.1 per cent by weight of an alkali metal, such as sodium, are to be added, I prefer to first cover the molten alloy with a molten salt mixture since I have found that the desired effect is more readily obtained by the use of a molten salt covering on the alloys above described.

The molten alloy, having been thus treated, is then cast into a permanent mold, i. e., into a mold, usually made of iron or steel, the walls of which afford means of conducting the heat rapidly from the molten metal poured therein.

The casting having been made in this manner, I then heat the casting, in the preferred practice of my invention, between about 100° and 150° centigrade, since I have found that by this heating, the hardness, strength and machining characteristics of this alloy are distinctly improved. While it is not necessary, in order to obtain the advantages above noted, to practice this heating step, I have found it very desirable to so do, and when such heating is practiced I have found it necessary to heat the alloys for at least 4 hours and as much as 24 hours in order to produce an alloy having the desired combination of high hardness and strength, good machining characteristics and low thermal expansivity.

As an example of the practice of my invention, an aluminum base alloy containing 20 per cent silicon, 3 per cent nickel, 0.8 per cent magnesium, and 1 per cent copper, together with the usual iron impurities, was melted. The molten alloy was then covered with a flux composed of 5 parts of calcium fluoride, 6.5 parts of sodium carbonate, and 3 parts of a mixture of 60 per cent sodium chloride and 40 per cent potassium chloride. The proportion of this mixture amounted to about 1.5 per cent of the weight of the treated alloy. After this flux was melted, metallic sodium in amount of about 0.15 per cent by weight of the total melt was introduced into the molten alloy. The alloy was then cast into an iron mold and the resultant casting was heated for 24 hours at 150° centigrade. The thus treated casting had a hardness of 150 Brinell at room temperature and 140 Brinell at 120° centigrade. The alloy had a strength of 37,500 pounds per square inch and the coefficient of thermal expansion of the alloy was below 19×10^{-6} per degree centigrade. The cast-

ing had excellent machining characteristics and was characterized by an absence of primary silicon crystals.

Having thus described my invention, I claim:

- 5 1. A method of producing castings of high hardness and low thermal expansivity by adding to a molten aluminum base alloy containing 16 to 25 per cent of silicon, 0.1 to 3 per cent of nickel, 0.1 to 1.25 per cent of magnesium, and 0.1 to 1.75 per cent of copper, a metal of the group consisting of sodium, potassium, rubidium and caesium, and thereafter casting the molten alloy in a permanent mold. 80
- 10 2. A method of producing castings of high hardness and low thermal expansivity by adding to a molten aluminum base alloy containing 16 to 25 per cent of silicon, 0.1 to 3 per cent of nickel, 0.1 to 1.25 per cent of magnesium, and 0.1 to 1.75 per cent of copper, a metal of the group consisting of sodium, potassium, rubidium and caesium, casting the molten alloy in a permanent mold and thereafter heating the resultant casting at a temperature of 100° to 150° centigrade for at least 4 hours. 85
- 15 3. A method of producing castings of high hardness and low thermal expansivity by covering a molten aluminum base alloy containing 16 to 25 per cent of silicon, 0.1 to 3 per cent of nickel, 0.1 to 1.25 per cent of magnesium, and 0.1 to 1.75 per cent of copper with a molten salt flux, adding to the thus covered molten alloy a metal of the group consisting of sodium, potassium, rubidium and caesium, and thereafter casting the molten alloy in a permanent mold. 90
- 20 4. A method of producing castings of high hardness and low thermal expansivity by covering a molten aluminum base alloy containing 16 to 25 per cent of silicon, 0.1 to 3 per cent of nickel, 0.1 to 1.25 per cent of magnesium, and 0.1 to 1.75 per cent of copper with a molten salt flux, adding to the thus covered molten alloy a metal of the group consisting of sodium, potassium, rubidium and caesium, casting the molten alloy in a permanent mold and heating the casting thus produced at a temperature of about 100° to 150° centigrade for at least 4 hours. 95

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