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PROCESS FOR HEAT TREATING ALUMINUM ALLOYS

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The present invention relates to precipitation hardenable aluminum base alloys and more particularly to aluminum base die and permanent mold cast alloys which contain about 5 to 25% silicon, .02% to 3% magnesium with the remainder substantialy all aluminum.

Aluminum alloys when molten have a high solubility for gases. This is particularly true with respect to alloys cast in dies or permanent molds. While gases absorbed in melting the alloys are liberated somewhat freely from sand castings during cooling, such freedom of liberation does not occur with either aluminum alloy die castings or aluminum alloy permanent mold castings. Both types of castings retain most of the dissolved gas, generally hydrogen, in the solidified castings.

If aluminum base die castings or permanent mold aluminum base castings are given a relatively high temperature heat treatment, for example heated for several hours at about 538° C. as in a precipitation hardening process or heated at elevated temperatures such as encountered in cooking utensils the castings will show considerable porosity as well as surface blistering. They also may exhibit some warping due to variation in porosity with change of cross section. The expulsion of gas at such elevated temperatures results first in the formation of minute internal pores in the casting. As the internal gas pressure increases due to heating the gases expand into increased volume and thereby enlarge the porosity in the casting.

It is one of the objects of the present invention to provide a process for heat treating precipitation hardenable aluminum base alloy castings to remove occluded gas therefrom whereby such alloys when precipitation hardened will have a high degree of elongation and as a result high shock and fatigue resistance, and a high proportional limit and tensile strength.

In the copending application of Richards H. Harrington, Serial No. 221,975, filed July 29, 1938, there is disclosed a method for improving the properties of aluminum base alloys containing silicon and magnesium. The method disclosed in that application consists substantially in heating the aluminum casting for about two hours at a temperature of about 530° C., quenching and then reheating for about 10 to 20 hours at 155° C. This treatment results in an alloy which has a high tensile strength as well as an unusually high proportional limit. For example, a die cast aluminum alloy consisting of about 7% silicon, 0.3% magnesium and the remainder aluminum which has been heat treated in accordance with the Harrington process has a tensile strength of about 30,000 to 47,000 pounds per square inch, a proportional limit of about 20,000 to 24,000 pounds per square inch and an elongation of about 3% in two inches.

Prior to the Harrington process the heat treatment applied to aluminum castings of the above composition was applied only to sand castings and consisted in heating the castings for about 12 to 20 hours at a temperature of 538° C., quenching and reheating for about 3 to 5 hours at 160° C. When so treated the castings had a relatively low proportional limit, for example about 11,000 to 14,000 pounds per square inch and an elongation of about 3.5%.

In carrying out the present invention a permanent mold casting or a die cast aluminum base alloy of the above noted composition which has been either water quenched or air cooled from the die is given a preliminary heat treatment at a temperature of about 155 to 160° C. for about 4 to 20 hours, air cooled and thereafter precipitation hardened preferably in accordance with the above noted Harrington process. An aluminum base alloy casting of the above composition which has been given a preliminary heat treatment at about 155° C. for about 20 hours, air cooled, then heated for about 2 hours at 530° C., quenched and thereafter given a draw for about 20 hours at 155° C. has a proportional limit of about 24,300 pounds per square inch, a tensile strength of about 48,000 pounds per square inch and an elongation of 4% in two inches. When the same alloy is given a preliminary heat treatment at 160° C. for about 4 hours, air cooled, and then precipitation hardened by heating for about 20 hours at 538° C., quenching and reheating for about 4 hours at 160° C. it has a proportional limit of about 21,000 pounds per square inch, a tensile strength of 46,000 pounds per square inch and an elongation of about 4.5% in two inches.

The preliminary heat treatment which I employ is applied to the aluminum base alloy casting prior to any high temperature treatment, for example the solution treatment usually employed in precipitation hardening processes. The preliminary heat treatment effects the release of occluded gases in the alloy casting and is particularly effective in reducing porosity and in improving the percentage elongation of the alloy without deleteriously affecting the other properties.

In the preliminary heat treatment, if the aluminum base casting is held at a temperature

of about 155 to 160° C. for a period of time varying from about 4 to 20 hours satisfactory results will be obtained but the temperature employed in my process is not limited to 155° C. or 160° C. If lower temperatures are employed the time required to drive out the occluded gases will be increased and the process will not be economical. On the other hand, if higher temperatures are employed the time to drive out the occluded gases will be lessened. However, if the temperature is too high the diffusion of gases will be so rapid as to cause porosity in the casting. In any event, the temperature employed in the preliminary heat treatment should be well below the solution temperature employed in the precipitation hardening process so that the gases will not be driven off too slowly or so quickly as to cause undue porosity in the casting.

Although I have illustrated my invention particularly in connection with a permanent mold or die cast aluminum alloy consisting of aluminum, silicon and magnesium, it is also applicable to alloys of the same composition which contain a small quantity of copper, for example an alloy consisting of 5% silicon, about .5% magnesium, about 1.3% copper with the remainder aluminum, also to alloys which contain for example 5% zinc, 1% magnesium, 2% iron and about 92% aluminum and in general to all aluminum base castings which are precipitation hardenable.

While I prefer to degas the alloy castings by heating them to a temperature in the neighborhood of 155 to 160° C. the same result may be obtained if the castings while very hot are removed from the permanent mold or die and placed in a furnace heated to the desired temperature and held therein for a sufficient time to remove the occluded gas from the castings.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A preliminary heat treatment for precipitation hardenable aluminum base alloy castings in which the precipitation hardening process comprises heating the casting at an elevated temperature to effect a condition of solution in the castings, said preliminary heat treatment comprising maintaining the casting at a temperature well below said elevated temperature and for a period of time sufficient to remove substantially all the occluded gas from the casting, said preliminary heat treatment being applied prior to said precipitation hardening process.

2. A preliminary heat treatment for precipitation hardenable aluminum base permanent mold or die castings in which the precipitation hardening process comprises heating the said castings to an elevated temperature to effect a condition of solution in the alloy, said preliminary heat treatment comprising maintaining the castings at a temperature in the neighborhood of 155 to 160° C. for several hours.

3. A preliminary heat treatment for a precipitation hardenable aluminum base die casting in which the precipitation hardening process comprises heating the casting at an elevated temperature to effect a condition of solution in the casting, said preliminary heat treatment comprising heating the alloy at a temperature in the neighborhood of 155 to 160° C. for about 4 to 20 hours.

4. A preliminary heat treatment for precipitation hardenable permanent mold or die castings, said castings consisting of about 5 to 25% silicon, about 0.2 to 3% magnesium with the remainder substantially aluminum, said preliminary heat treatment comprising maintaining said castings, prior to a precipitation hardening treatment, at an elevated temperature for a period of time sufficient to remove the occluded gas therefrom without causing undue porosity in said castings.

5. A preliminary heat treatment for a precipitation hardenable die casting consisting of about 5 to 25% silicon, about 0.2 to 3% magnesium with the remainder substantially aluminum, said preliminary treatment being applied prior to the usual heat treatment to effect a condition of solution in the casting and at a temperature well below the solution temperature employed in the precipitation hardening process.

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