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ALADAR PACZ, OF EAST CLEVELAND, OHIO, ASSIGNOR TO ALUMINUM COMPANY OF AMERICA, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ALLOY.

No Drawing. Application filed April 3, 1922. Serial No. 549,203.

This invention relates to alloys containing principally aluminum and silicon. In my application, Serial No. 323,350, filed September 12, 1919, is disclosed an alloy of silicon and aluminum containing upwards of 2½% of silicon together with other ingredients such as copper. In my Patent No. 1,387,900 issued August 16, 1921, I have disclosed the fact that alloys of aluminum and silicon comparatively rich in silicon can be made commercially valuable, the most valuable range lying even as high as 8% to 13% of silicon, and in that patent I also disclosed certain modes of refining the grain of the alloy. In my application filed February 27, 1922, Serial No. 539,740 I have disclosed the use of manganese in connection with such an alloy, which results in the production of certain marked advantages.

The objects of the present invention are the provision of an alloy of aluminum and silicon wherein the grain structure is so minute as to render the crystals substantially invisible to the naked eye and wherein the articles made therefrom shall be longer lived and less subject to fatigue under severe conditions; the provision of an alloy of silicon and aluminum which shall possess superior physical properties, shall flow readily when molten, shall be susceptible of accurate casting in either sand or permanent molds with or without pressure, shall exhibit a minimum of warping or shrinking, may be made of inexpensive and readily available materials, and can be readily machined; while further objects and advantages of the invention will become apparent as the description proceeds.

The essence of my invention resides in the addition to an alloy of aluminum and silicon of a small quantity of metallic cobalt which I have discovered to produce an effect on such an alloy which is different from that produced by any other metal, even nickel. For die castings and castings made in permanent molds and chills I find that no grain refining process or other addition is necessary in case about $\frac{1}{10}$ percent or upward of cobalt be added to the alloy of silicon and aluminum. For sand castings wherein the cooling rate is slower it is better to employ a grain refining process in addition, preferably the incorporation of sodium fluoride as described in my Patent No. 1,387,900, although metallic sodium can also be used with results nearly as good. The sodium fluoride is preferred because the sodium is liberated in the nascent condition and over a longer period and at a higher temperature than the melting point of the alloy. The best results in point of physical properties are secured within a range of silicon 5 percent to 15 percent and about ½ percent more or less, of cobalt, the balance being aluminum.

Ordinarily such alloys of aluminum and silicon, when treated by a grain refining process as defined in any of my prior applications, disclose when broken a finely crystalline fracture such as is most highly favored in most cast metals, coupled with remarkably high physical properties, the tensile strength being above 27,000 lbs. per sq. inch with an elongation of 3% or better. When cobalt is employed as herein described the fracture loses its crystalline appearance almost completely, and the alloy becomes decidedly finer grained, and exhibits a greater toughness, a longer life, and a higher degree of immunity to fatigue and vibration.

It is also noted that, whereas the presence of iron, even in small amounts, is highly deleterious by reason of increasing the segregation and promoting the crystal growth of the silicon so that the alloy is rendered coarse, weak, and brittle; the action of cobalt is to counteract this effect of iron to such an extent that an alloy having an iron content of 1% or more can be used successfully even in sand castings whereas an iron impunity of that amount in a binary alloy of aluminum and silicon results in considerably lower physical properties. Cobalt is at least as effective as manganese in counteracting the influence of iron.

It may be that the beneficial effect of the cobalt is due entirely to neutralization of the injurious effects of the iron and other impurities, but I do not confine myself to such theory. The effect of the cobalt on the aluminum-silicon alloy is probably to produce and maintain a better dissemination of the silicon in the alloy. At any rate the effect which is produced through the use of cobalt is evidence of its beneficial function. The advantages arising from the addition of cobalt are apparent even where the cobalt comprises only about $\frac{1}{10}$ of 1 per-

cent of the alloy, although I prefer to employ at least about $\frac{5}{10}$ percent of cobalt and its proportion may be increased still further depending upon the use to which the product is to be put and also depending upon the percent of other elements, such as silicon, and also depending upon the amount of impurities such as iron.

In one instance when I applied my invention to die-casting I employed successfully ½ of 1 percent of cobalt with an alloy containing 8 percent of silicon and the rest aluminum. In another instance of die-casting I employ ¼ of 1 percent of cobalt in an alloy containing 13 percent silicon and the rest aluminum. In both these cases I treated part of the melt with sodium fluoride and part was used without any treatment with sodium fluoride; the treated portions were slightly finer grained than the untreated portions although the untreated portions exhibited a tensile strength upwards of 28,000 pounds per square inch with an elongation upwards of 3 percent and a high degree of machinability. I also employed $\frac{5}{10}$ of 1 percent of cobalt in an alloy containing 13% silicon and the rest aluminum, treating the same with sodium in a reacting condition and casting the same in a sand mold, which produced castings that exhibited an extremely fine grained condition together with high ductility and tensile strength.

The cobalt may be incorporated with the aluminum-silicon alloy by any of the well known methods. It may be added by itself or as an alloy with the aluminum or with any other constituent which it is desired to incorporate in the alloy. One method which I have practiced successfully is to mix together for example, 75 grams of cobalt powder with 56 grams sodium silico-fluoride and 11 grams of aluminum powder afterwards submerging the same in the molten bath. This is in accordance with the practice set forth in my applications filed March 18, 1920, Serial Nos. 366,967 and 366,968. This mixture may be added to sufficient aluminum-silicon alloy to produce an alloy which will be comparatively high in cobalt and this composition may be added in the requisite proportions to the actual casting alloy. Another practice is to add the cobalt mixture directly to the actual casting alloy in the required proportions.

The alloys produced according to my invention may be utilized for any kind of casting, and such castings may be worked as by rolling, extruding, forging, drawing, drilling, turning, threading, etc. My invention is applicable not only to aluminum alloys containing higher percentages of silicon such as 5% and above, but may be used to advantage in any aluminum-silicon alloy regardless of the percentage of silicon. The addition of the cobalt in all cases causes a superiority of physical properties.

I do not disclaim the addition of other elements than those named. Manganese can be added, and in small quantities makes a good quaternary alloy; also doubtless other ingredients can be added for special purposes, but I have discovered that cobalt, in the particular combination with aluminum and silicon here described, exhibits features of combined action not produced by other ingredients and I therefore claim and seek to secure such invention or discovery regardless of the presence of mere addition-elements

Having thus described my invention what I claim is:

1. An alloy consisting predominantly of aluminum, containing between about 2½% and about 15% of silicon and containing cobalt in an amount less than the silicon.

2. A casting alloy consisting predominantly of aluminum and containing at least about 5% of silicon together with at least about $\frac{1}{10}$ percent of cobalt.

3. An alloy consisting predominantly of aluminum and containing silicon and cobalt, the silicon constituting between about 5 percent and about 17 percent of the alloy, and the cobalt constituting at least about $\frac{5}{10}$ percent of the same.

4. An alloy containing upwards of 80 percent of aluminum and upwards of $\frac{1}{10}$ percent of cobalt, together with at least about 5% of silicon, the amount of silicon being greater than that of cobalt.

5. An article formed from an aluminum base alloy containing between about 2½% and about 15% of silicon and at least about 0.1 percent of cobalt, and also containing sodium in amounts sufficient to refine the grain and effect a substantial improvement in the physical properties of the alloy.

6. An article formed from an aluminum base alloy containing between about 2½% and about 15% of silicon and at least about 0.1 percent of cobalt, and also containing products of the reaction between an alkali fluorine compound and molten aluminum in amounts sufficient to refine the grain and effect substantial improvement in the physical properties of the alloy.

7. Alloy of aluminum with cobalt and upwards of 5 percent silicon characterized by having an extremely fine grained structure, a ductility of at least about 3 percent and a tensile strength upwards of about 27,000 lbs. per square inch.

8. A fine grained chill casting formed of an aluminum base alloy containing between about 2½% and about 15% of silicon and at least about 0.1 percent of cobalt.

In testimony whereof, I hereunto affix my signature.

ALADAR PACZ.