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ALUMINUM BASE ALLOY FOR DIE CASTINGS
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This invention relates to aluminum base alloys and more particularly to alloys of this nature, suitable for die casting, and adapted to exhibit a pleasing finish when an anodic coating is applied thereto. This application is a continuation-in-part of my co-pending application, Serial No. 762,213, filed September 22, 1958, now abandoned, for Aluminum Base Alloy for Die Castings.

As is well known to those skilled in the art of die casting aluminum base alloys, as an alloy approaches closer and closer to the composition of pure aluminum, it becomes more and more difficult to produce acceptable die castings therefrom. The lower the alloy content in the aluminum, the higher is the melting point of the heat of metal, and of course the metal must be introduced into the die at a temperature sufficiently above its melting point so that it will fill the interstices of the casting cavity before the metal begins to solidify. On the other hand, a high alloy content of the alloying ingredients induces a lower melting point, so that the metal, the dies, and the various items of casting equipment, can be run at a substantially lower temperature.

When die casting is attempted at the higher temperatures, because of lower alloy content in the melt, certain disadvantages are encountered, principally the sluggishness of the metal and its tendency to adhere to the die surface constituting the casting cavity walls. Since, for a purpose to be hereinafter explained, it is desirable that certain metal parts be die cast from low alloy stock, those working in the art have expended considerable efforts to avoid this "soldering" or "welding" effect by applying various coatings to the casting cavity wall, but these coatings wear away rapidly, and it is usually quite impracticable to attempt to maintain such coating. Such procedure also disturbs the thermal equilibrium so desirable in a continuous die casting process wherein castings are made and ejected in uniform short cycle succession, every few seconds. It might therefore be concluded that the easiest way to run a successful die casting process is to load the alloy with some of the usual alloying ingredients which are known to afford good casting properties with adequate mechanical and physical properties.

There is however a large demand for die cast aluminum items which will present a pleasing finish as to texture, grain, and color when subjected to any suitable oxide coating process, such as those coatings which can be applied chemically or electro-chemically by various etching agents. Merely as an example I may mention the class of hardware including automobile door and window operating handles, control knobs, trim items, escutcheon plates, drawer pulls, etc. More and more these and similar items are beginning to illustrate the fact that eye appeal is one of the best sales arguments, and the female taste on a relatively inexpensive portion of the complete article may determine whether or not a sale is made.

It is therefore desirable, first that these articles be made as die castings, if their contour permits easy ejection from the die, because die casting becomes economically feasible when thousands of articles are to be produced. It is also desirable that the die cast article accept a pleasing oxide finish, either of the whitish satin type, or one of the many color tinted coatings now available, principally by anodic processes.

Unfortunately the manufacturer has heretofore been

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confronted by a dilemma which is this: if the article has a low alloy content, approaching commercial aluminum ingot, it will yield an excellent oxide coated finish, either plain or in color, but for reasons hereinabove noted it will not be an easy or profitable die-casting job. If on the other hand the composition be changed to an aluminum alloy base with a substantial content of alloying ingredients which make for good die casting properties the cast article will not take a good oxide coating. It will be of uneven finish and texture, and colored coatings will be dull and nonuniform.

An object of the present invention is to provide an aluminum base alloy having excellent die casting properties which nevertheless yields a most pleasing oxide-coated finish.

A further object of the invention is to provide an aluminum base alloy as defined in the last preceding paragraph which contains alloying ingredients effective to give adequate physical properties either in the as-cast or heat-treated condition.

A further object of the invention is to provide an aluminum base alloy as defined in the two immediately preceding paragraphs, and containing specifically limited amounts of zinc, antimony, and iron, with possible specifically limited amounts of magnesium, manganese, silicon, and copper.

Other objects and advantages of the invention will appear as the following description proceeds.

The principal alloying ingredient of my alloy is zinc which should be present in the alloy in an amount between 3.5 percent and 6.0 percent. The alloy also contains between about 0.6 percent and 2.0 percent of total iron, which includes any iron present inadvertently as an impurity. The alloy further contains between 0.25 percent and 2.0 percent of antimony.

As a preferred composition within the above range I suggest the following: 4.5 percent of zinc, 0.9 percent of iron, and 1.0 percent of antimony, the balance being substantially aluminum with the usual impurities.

Alloys within the range indicated, and especially of the preferred composition, can be die cast without any difficulty and exhibit a surface, when oxide-coated, equal to the best surface heretofore available even with relatively pure aluminum unalloyed ingot. An alloy of the preferred composition, in the cast condition, has, on the average, a tensile strength of twenty eight thousand pounds per square inch, a yield strength of twenty thousand pounds per square inch, and about twelve percent elongation. These properties may be varied by suitable thermal treatments, as will be understood by those skilled in the process of heat treating aluminum base alloys. I have discovered that the addition of antimony not only contributes to a very pleasing oxide-coated finish, but also materially reduces the tendency of the alloy to "weld" or stick to the die.

I have further discovered that the casting properties of the alloys described hereinabove may be improved without harmful deterioration of the coating characteristics by the addition of 0.15 to 0.5 percent of manganese, 0.15 to 0.5 percent of magnesium, and/or up to 2.0 percent of silicon, and/or 0.1 to 2.0 percent of copper. The lower limit of the silicon has not been specifically defined since silicon is present as an impurity in all commercial aluminum base alloys. Silicon will improve the casting characteristics considerably, but, when used with the base alloy in the amounts noted, causes only slight deterioration in the oxide-coated finish, and this is permissible for certain adaptations in cases where die configurations may demand exceptional casting characteristics, and a slight variation in coated appearance is not objectionable. The magnesium, silicon and copper within the noted range

may be used singly or in any suitable combination. The silicon is most helpful in improving casting characteristics, with copper and magnesium following in the order herein noted. The manganese assists the non-sticking characteristics of the alloy, and the copper hardens and strengthens the alloy.

Coating methods form no part of the present invention but it may be mentioned here that suitable frosted-finished coatings are achieved, for example, by a chemical dip in alkaline or acid reagents, which may produce a colored effect by the inclusion of suitable dyes. Anodic coatings are formed electrochemically, and may be produced in an extensive variety of colors by the use of dyes. The alloys herein disclosed and claimed lend themselves readily both to the chemical and electrochemical methods of coating.

What is claimed is:

1. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, and between 0.25 percent and 2.0 percent of antimony, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

2. An aluminum base alloy suitable for die castings, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, and about 1.0 percent of antimony, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

3. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.50 percent of manganese, and between 0.15 and 0.5 percent of magnesium, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

4. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.50 percent of manganese, and up to 2.0 percent of silicon, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

5. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.50 percent of manganese, and between 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

6. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.5 percent of magnesium, and up to 2.0 percent of silicon, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

7. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.50 percent of man-

ganese, between 0.15 percent and 0.5 percent of magnesium, and between 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum.

8. An aluminum base alloy suitable for die castings, and consisting essentially of between 3.5 percent and 6.0 percent of zinc, between 0.6 percent and 2.0 percent of iron, between about 0.25 percent and 2.0 percent of antimony, between 0.15 percent and 0.50 percent of manganese, between 0.15 percent and 0.5 percent of magnesium, up to 2.0 percent of silicon, and between 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum.

9. An aluminum base alloy suitable for die castings, and adapted to acquire an excellent finish when oxide-coated, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 0.25 percent of manganese, about 1.0 percent of antimony, about 0.3 percent of magnesium, the balance being substantially of aluminum.

10. An aluminum base alloy suitable for die castings, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 1.0 percent of antimony, and up to 2.0 percent of silicon, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

11. An aluminum base alloy suitable for die castings, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 1.0 percent of antimony, about 0.25 percent of manganese, and up to 2.0 percent of silicon, the balance being substantially all aluminum, and characterized by an adaptability to acquire an excellent finish when oxide coated.

12. An aluminum base alloy suitable for die castings, and adapted to acquire an excellent finish when oxide-coated, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 1.0 percent of antimony, about 0.25 percent of manganese, and between 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum.

13. An aluminum base alloy suitable for die castings, and adapted to acquire an excellent finish when oxide-coated, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 0.25 percent of manganese, about 1.0 percent of antimony, between about 0.15 percent and 0.5 percent of magnesium, and between about 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum.

14. An aluminum base alloy suitable for die castings, and adapted to acquire an excellent finish when oxide-coated, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 0.25 percent of manganese, about 1.0 percent of antimony, between about 0.15 percent and 0.5 percent of magnesium, and up to 2.0 percent of silicon, the balance being substantially of aluminum.

15. An aluminum base alloy suitable for die castings, and adapted to acquire an excellent finish when oxide-coated, and consisting essentially of about 4.5 percent of zinc, about 0.9 percent of iron, about 1.0 percent of antimony, about 0.25 percent of manganese, between about 0.15 percent and 0.5 percent of magnesium, up to 2.0 percent of silicon, and between about 0.1 percent and 2.0 percent of copper, the balance being substantially all aluminum.

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