Patented Jan. 23, 1940 2,188,203

UNITED STATES PATENT OFFICE

2,188,203

ALUMINUM BASE ALLOY

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No Drawing. Application November 20, 1936, Serial No. 111,907

6 Claims. (Cl. 75—138)

My invention relates to aluminum base alloys and, more particularly, to aluminum base alloys having improved physical and casting properties.

Manganese has heretofore been added to aluminum to increase its tensile strength. Aluminum manganese alloys, however, are difficult to cast and while titanium has been found effective in improving to a certain extent the casting properties of such alloys, they do not have the desired grain structure which is required in high grade castings.

In accordance with my invention I have found that if a special alloying metal or ingredient is added to aluminum base alloys containing copper, nickel or zinc, or a mixture of two or more of these metals, or to aluminum base alloys containing manganese, or to aluminum base alloys containing manganese and one or more metals selected from a group consisting of copper, nickel and zinc, an alloy will be produced that has good casting properties from which castings may be prepared which have improved physical properties.

The special alloying ingredients which I have found to be effective in this respect are metals of the tungsten group, such as tungsten, molybdenum or uranium, or a metal, such as columbium, tantalum, beryllium or boron. Either one or a mixture of two or more of such metals may be employed. While the special alloying metal or ingredient improves the physical and casting properties of the alloy, it is especially effective when employed in combination with titanium.

By adding one or more of the special alloying ingredients to the alloy, it is possible to provide an aluminum base alloy without utilizing the high amount of manganese which has formerly been employed and it is even possible to provide a satisfactory alloy when manganese is absent or is present only as an impurity. I do not desire, however, to limit my invention to aluminum manganese alloys of small manganese content, as one or more of the special alloying metals or ingredients are effective in improving the physical properties of the alloys even when manganese is present in amounts ranging up to 5%. The amount of manganese, however, is preferably maintained below 3%. While any one of the special alloying metals or ingredients mentioned may be employed, I have found that boron or a metal of the tungsten group, and more particularly tungsten itself, or a mixture of boron and tungsten, are particularly effective when alloyed with aluminum or aluminum alloys, and especially when employed in combination with titanium in effective amounts up to 3%, or with titanium and manganese in the proportions specified.

It is therefore an object of my invention to provide an aluminum base alloy having good casting and physical properties.

Another object of my invention is to provide an aluminum base alloy having good casting and physical properties containing one or more metals or ingredients which are particularly effective in improving the casting and physical properties of aluminum-manganese alloys.

A further object of my invention is to provide an improved aluminum base alloy having good physical and casting properties which is substantially free from manganese or in which the amount of manganese is comparatively low.

A still further object of my invention is to provide an improved aluminum base alloy containing boron or a member of the tungsten group, or a mixture of a tungsten group metal and boron, and more particularly an alloy containing one or both of these ingredients in combination with titanium or titanium and manganese.

In practicing my invention a metal of the tungsten group, such as tunsten, molybdenum or uranium, or a metal such as columbium, tantalum, beryllium or boron, or a combination of two or more of such metals is added to aluminum in effective amounts up to 3%. While the special alloying metal or ingredient may be present in an amount ranging up to 3%, it is preferably added in amounts ranging from .05% to 1%.

The alloy may be prepared in any desired manner, such as by introducing the special alloying ingredient into molten aluminum, or if other ingredients are present the special alloying metal or ingredient may be alloyed with such metals and introduced into the molten bath. Another method is to prepare a rich alloy of the special alloying ingredient and aluminum and introduce the alloy into the molten aluminum. I may also add the special alloying ingredient in the presence of or in the form of a fluoride in a manner similar to that disclosed for the addition of antimony in Patent No. 1,997,494, granted to me on April 9, 1935.

In preparing an alloy for casting purposes in addition to aluminum and the special alloying ingredient, my improved alloy may also contain copper, nickel or zinc, or a mixture of two or more of these metals in an amount ranging from more than incidental impurities up to 15%, preferably from approximately .5% to 12%. The copper or nickel, when present, increases the

tensile strength and hardness of the alloy. Zinc, when present, tends to improve the casting properties. To further increase the hardness of the alloy it is desirable to have some magnesium present. The amount of magnesium which is present, however, should be maintained below 2% and preferably below .5% as magnesium in large amounts has a very pronounced effect upon the hot shortness of aluminum alloys, a property which is very deleterious in producing alloys in permanent or semi-permanent molds or by the die casting process. If a large amount of magnesium is present, the machinability of castings produced from the alloy is decreased and excessive breakage occurs in trimming.

The following specific example will serve to illustrate and explain my invention, although it will be understood that I do not desire to limit myself to the particular ingredients or proportions specified. An aluminum base alloy was prepared by adding the following ingredients to aluminum in approximately the proportions indicated:

	Percent
Copper	1.3
Manganese	1.4
Magnesium	.23
Boron	.05

The alloy was cast in a sand mold and was found to have a good grain structure. It had a tensile strength of 22,400 pounds per square inch and an elongation of about 8% in 2 inches. Upon adding .25% tungsten to this alloy, it was found that the tensile strength was increased to about 25,000 pounds per square inch and the elongation in 2 inches was increased to about 14%.

From the foregoing example it is apparent that aluminum base alloys may be improved by the addition of boron or tungsten, or a mixture thereof. The boron may be conveniently introduced into the alloy in the form of manganese-boron or other boron alloy, such as ferroboron, when small amounts of iron are permissible.

As further illustrating the effect of tungsten in improving the casting properties of aluminum base alloys, aluminum base alloys were prepared containing the following metals in approximately the proportions indicated:

	Percent
Copper	1.35
Manganese	1.35
Titanium	.18
Magnesium	.25

The alloy was difficult to cast. When tungsten was added to the alloy in proportions varying up to .25%, however, the casting properties were greatly improved. In such alloys the titanium may be entirely replaced by the tungsten or titanium may be present in amounts ranging up to .5% and the tungsten may be present in amounts ranging up to .5%, the total amount of both metals ranging up to 1%. Tungsten or titanium, or both, may be replaced in whole or part by boron in which case the boron may be varied from .01% to .5%.

Molybdenum is also effective in improving the casting properties of aluminum base alloys. For example, approximately .75% of molybdenum was added to an aluminum base alloy containing about 3% manganese. Sand castings prepared from such an alloy had improved properties and when copper was added to the alloy the physical and casting properties were still more marked.

In order to obtain satisfactory castings, the amount of the special alloying metal or ingredient should preferably be at least .05%. When boron is employed, however, it is effective when the amount is even less than .05%. The amount of aluminum which is present will of course depend upon the alloying ingredients and may range from approximately 75% to 97%. Ordinarily 90% to 97% of aluminum will be present.

By employing a special alloying metal or ingredient, such as one or more of those specified and particularly a metal of the tungsten group, or boron, or a mixture or a combination of boron or tungsten with titanium and an aluminum base metal, it is possible to provide an alloy having good casting properties when manganese is entirely absent or is present only as an incidental impurity. In such alloys, however, copper, nickel or zinc, or a mixture of two or more of these metals should be present. For instance, an aluminum base alloy containing 3.1% copper was cast in a sand mold. It had a tensile strength of 15,500 pounds per square inch, an elongation of 3.12% in 2 inches and a fracture of the casting showed a mixed crystalline grain structure. Upon adding 2% of tungsten to the alloy and casting in a similar manner, the tensile strength was increased to 17,150 pounds per square inch and the elongation to 4.3% in 2 inches. A fracture of the casting showed a good fine grain structure.

The special alloying metal or ingredient not only improves the grain structure of the metal but also counteracts to a certain extent the presence of iron and consequently whereas it has previously been necessary to maintain the iron below 1.5% and preferably below 1.25%, iron may be present in my improved alloy in amounts ranging from approximately 1.5% to 4% . Secondary aluminum may accordingly be employed in preparing my improved alloys. Silicon may also be present in amounts ranging from effective amounts up to 15%, but preferably is maintained below 12%.

It will also be apparent that by providing a special alloying metal or ingredient, the amount of manganese which is present may be omitted or may be present in small amounts or only as incidental impurities.

To those skilled in the art many modifications and widely differing embodiments and applications of my invention will suggest themselves without departing from the spirit and scope thereof. My disclosure and the description herein are not intended to be in any sense limiting.

What I claim is:

1. An aluminum-manganese-boron alloy having better casting properties, a finer grain structure and a higher tensile strength than an aluminum-manganese alloy of a similar composition, said alloy consisting of effective amounts up to 5% manganese, boron in effective amounts up to .5% and the remainder of aluminum and any other metal or metals which are not subversive of the above characteristics.

2. An aluminum-manganese-boron alloy having better casting properties, a finer grain structure and a higher tensile strength than an aluminum-manganese alloy of a similar composition, said alloy consisting of effective amounts up to 5% manganese, from .01% to .5% boron and the remainder of aluminum and any other metal or metals which are not subversive of the above characteristics.

3. An aluminum-manganese-boron alloy having better casting properties, a finer grain

structure and a higher tensile strength than an aluminum-manganese alloy of similar composition, said alloy consisting of effective amounts up to 5% manganese, copper in effective amounts up to 12% and boron in effective amounts up to .5%, and the remainder aluminum and any other metal or metals which are not subversive of the above characteristics.

4. An aluminum-manganese-boron alloy having better casting properties, a finer grain structure and a higher tensile strength than an aluminum-manganese alloy of a similar composition, said alloy consisting of effective amounts up to 5% manganese, boron in effective amounts up to .5%, copper in effective amounts up to 12%, magnesium in effective amounts up to 2%, and the remainder consisting of aluminum and any other metal or metals which are not subversive of the above characteristics.

5. An aluminum-manganese-boron alloy having better casting properties, a finer grain structure and a higher tensile strength than an aluminum-manganese alloy of similar composition, said alloy consisting of effective amounts up to 5% manganese, boron in effective amounts up to .5%, nickel in effective amounts up to 12%, and the remainder consisting of aluminum and any other metal or metals which are not subversive of the above characteristics.

6. An aluminum-manganese-boron alloy having better casting properties, more ductility and a finer grain structure than an aluminum-manganese alloy of similar composition, said alloy consisting of effective amounts up to 5% manganese, boron in effective amounts up to .5%, tungsten in effective amounts up to 3%, and the remainder consisting of aluminum and any other metal or metals which are not subversive of the above characteristics.

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