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# UNITED STATES PATENT OFFICE

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## ALUMINUM ALLOYS

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2 Claims. (Cl. 75—1)

This invention relates to aluminum base alloys containing magnesium. The invention has for its object the improvement of alloys of this class by the addition thereto of about 0.05 to 2.0 per cent by weight of calcium. The invention is particularly concerned with the specific alloys hereinafter described.

The claims of this application cover certain matter divided from my copending application Serial No. 634,155 which is, in part, a continuation of my copending application Serial No. 595,231. Inventions disclosed but not claimed herein are claimed in my copending applications Serial Nos. 595,231, filed February 25, 1932, 645,108, to 645,114 inclusive, and 645,116 to 645,125 inclusive, all filed November 30, 1932.

Considerable difficulty has heretofore been encountered in attempts to commercially produce castings of aluminum base alloys containing substantial amounts of magnesium. This difficulty is encountered both in the making of sand castings and permanent mold or chill-mold castings, although the nature of the difficulty differs somewhat in each case. In the case of cand castings there occurs a reaction between the molten aluminum base alloy containing magnesium and the ordinary sand-mold materials, or vapors generated therefrom. There is also a reaction with the atmosphere. In addition, the magnesium-containing aluminum base alloy does not flow freely through narrow mold sections at ordinary pouring temperatures and, if the pouring temperature be raised, the solidified alloy is unsound. If the aluminum base alloy containing magnesium be cast in a chill-mold the reaction effect is minimized to some extent, but the troubles arising from cold-shuts and mis-runs are accentuated because of the more rapid chilling of the molten metal. The considerations apply to the aluminum base alloys specifically disclosed herein and particularly to such alloys.

I have discovered that when calcium is added to aluminum base alloys of the type and composition herein described, these difficulties are, to a considerable extent, eliminated. The calcium should be present in amounts ranging from 0.05 per cent to 2.0 per cent by weight subject to specific considerations as hereinafter disclosed.

In the melting of aluminum alloys of the compositions herein described, a viscous scum often forms at the surface of the molten metal. Failure of the molten metal to run properly through narrow mold apertures is caused, in part, by shreds or particles of this scum being suspended in the molten metal and offering a resistance to the free passage of the metal through the apertures. Regardless of the cause of this low fluidity, I have discovered that the addition to the alloy of relatively small amounts of calcium, in the preferred range between 0.05 to 0.5 per cent, improves the casting characteristics to a very considerable extent and simultaneously effects a reduction of the scum or dross collecting at or near the surface. In the casting of articles in sand molds, I prefer to add calcium in amounts less than about 0.5 per cent except in instances where some reduction of tensile strength or other mechanical or tensile property is immaterial. In amounts of more than 0.5 per cent the calcium addition produces the advantages enumerated herein but has a tendency to lower some of the physical properties of the alloys. This effect is not harmful when calcium is present in amounts of about 0.5 per cent or less, but when high strength is not a desideratum the calcium may be used in amounts up to about 2.0 per cent. In intricate permanent mold castings, where casting troubles are very serious if no calcium be added, the improved physical properties obtained coincident with the production of good castings more than offset the diminution in properties which might otherwise result from the use of the calcium.

I have also discovered that when calcium is added to aluminum base alloys containing magnesium, the amount of gas evolved during solidification of the alloys is considerably reduced. When from about 0.05 per cent to 2.0 per cent by weight of calcium is added to the alloys, the amount of gas evolved becomes less marked with increasing calcium content and the reduction of gas evolution may be so marked that the molten metals cools to the solidification temperature with a smooth-like surface. I prefer to restrict the amount of calcium added to 2.0 per cent or less since above this amount the physical properties of the alloys may be too seriously affected. If the best physical properties are desired with an improved, although not complete, degree of gas prevention, I keep the calcium content of the alloys between 0.05 per cent and about 0.5 per cent.

In the application of the principles of my invention I have determined that certain aluminum base alloys containing magnesium are particularly benefited thereby. For example, a very useful aluminum base alloy is one containing about 2.0 to 9.0 per cent of magnesium and 0.05 per cent to 2.0 per cent of calcium, as is also aluminum base alloy containing about 2.0 to

15.0 per cent of magnesium, 0.1 to 3.5 per cent of cobalt, and 0.05 to 2.0 per cent of calcium to which other elements such as copper, antimony, bismuth, nickel, manganese, and other well known alloying elements may be added to produce particular properties therein.

Likewise is the addition of 0.05 to 2.0 per cent of calcium beneficial to those aluminum base alloys which contain about 2.0 to 15.0 per cent of magnesium and 0.05 to 0.4 per cent of at least one of the class of metals here defined as antimony and bismuth, such alloys being very useful where use at high temperatures is contemplated. Calcium may likewise be added to improve such alloys when they contain, in addition to magnesium and antimony and/or bismuth, one or more of such alloying elements as cobalt, copper, nickel, manganese, zinc, etc. which may be added to modify or produce a specific property in the alloy.

The addition of 0.05 to 2.0 per cent of calcium is very beneficial in the case of a series of aluminum base alloys which contain as major alloying elements about 2.0 to 10.0 per cent of magnesium and about 0.2 to 5.0 per cent of nickel. For instance, an aluminum base alloy containing 3.0 to 7.5 per cent of magnesium and 0.2 to 2.0 per cent of nickel is improved by the addition of 0.05 to 2.0 per cent of calcium as is, likewise, this same alloy when it also contains about 0.05 to 0.4 per cent of one or more of the class of elements composed of antimony and bismuth. Another excellent aluminum base alloy prepared in accordance with the principles of my invention is one containing 3.0 to 8.0 per cent of magnesium, 0.5 to 4.0 per cent of nickel, 0.5 to 4.0 per cent of manganese, and 0.05 to 2.0 per cent of calcium, which alloy may also be improved, particularly for application at high temperatures, by the addition of 0.05 to 0.4 per cent of at least one of the class of elements composed of antimony and bismuth.

The principles of my invention find particular application in the case of aluminum base alloys containing magnesium, nickel, and chromium, and aluminum base alloys containing magnesium, nickel, and copper, as well as those alloys containing magnesium, nickel, and cobalt. Examples may be given of aluminum base alloys containing 2.0 to 10.0 per cent of magnesium, 0.2 to 5.0 per cent of nickel, 0.5 to 3.5 per cent of chromium, and 0.05 to 2.0 per cent of calcium. An aluminum base alloy containing 3.0 to 8.0 per cent of magnesium, 0.5 to 3.5 per cent of nickel, 0.5 to 3.5 percent of chromium, and 0.05 to 2.0 per cent of calcium has excellent casting properties and the high temperature properties of this alloy can be favorably affected by the addition of 0.05 to 0.4 per cent of at least one of a class of elements composed of bismuth and antimony. Examples may be given of aluminum base alloy containing 2.0 to 10.0 per cent of magnesium, 0.2 to 5.0 per cent of nickel, 1.0 to 6.0 per cent of copper, and 0.05 to 2.0 per cent of calcium. An excellent alloy of this type is one containing 3.0 to 8.0 per cent of magnesium, 0.5 to 5.0 per cent of nickel, 1.0 to 6.0 per cent of copper, and 0.05 to 2.0 per cent of calcium with or without 0.05 to 0.4 per cent of at least one of the class of elements composed of antimony and bismuth and with or without the further addition of 0.5 to 3.5 per cent of at least one of a class of elements composed of cobalt and chromium, and with or without the further addition of 0.1 to 1.0 per cent of at least one of a class of elements composed of tungsten, vanadium, molybdenum, titanium, and zirconium.

Other excellent alloys are those aluminum base alloys containing about 2.0 to 10.0 per cent magnesium, 0.2 to 5.0 per cent nickel, 0.1 to 3.5 per cent cobalt, and 0.05 to 2.0 per cent of calcium. A particular example of this class of alloys, which may also contain with considerable advantage 0.05 to 0.4 per cent of a class of elements composed of antimony and bismuth, is the aluminum base alloy containing 3.0 to 8.0 per cent magnesium, 0.5 to 4.0 per cent nickel, 0.1 to 3.0 per cent cobalt, and 0.05 to 2.0 per cent calcium.

Among other magnesium-containing aluminum base alloys which I have found to be particularly benefited by the presence of calcium are numbered the aluminum base alloys containing 3.0 to 8.0 per cent of magnesium, 1.0 to 6.0 per cent of copper, 0.5 to 3.5 per cent of chromium, and 0.05 to 2.0 per cent of calcium, with or without the addition of 0.05 to 0.4 per cent of at least one of a class of metals composed of antimony and bismuth and with or without the addition of other alloying elements.

The alloys herein described may be produced by the usual methods of alloying metals. The calcium is preferably added to the molten alloy by thrusting the calcium beneath the surface with tongs or other suitable instrument. The aluminum used in preparing the alloys may be pure or it may contain the impurities found in commercial grades of this metal. Ordinarily a good commercial grade of virgin aluminum will give excellent results and is preferable.

Having thus explained and described my invention, I claim:

1. A metallic alloy consisting of 2.0 to 10.0 per cent by weight of magnesium, 0.2 to 5.0 per cent by weight of nickel, 1.0 to 6.0 per cent by weight of copper, and 0.05 to 2.0 per cent by weight of calcium, the balance being aluminum.

2. A metallic alloy consisting of 3.0 to 8.0 per cent by weight of magnesium, 0.5 to 5.0 per cent by weight of nickel, 1.0 to 6.0 per cent by weight of copper and 0.05 to 2.0 per cent by weight of calcium, the balance being aluminum.

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3.

## CERTIFICATE OF CORRECTION.

Patent No. 1,932,861. October 31, 1933.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 94, for "smooth-like" read smooth mirror-like; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of December, A. D. 1933.

F. M. Hopkins

(Seal) Acting Commissioner of Patents.