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CERIUM BASE ALLOY

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The present invention relates to a new and novel alloy for easily introducing relatively low density, low melting point base metals into relatively high density, high melting point alloying metals in the preparation of alloys and, in particular, to alloys using cerium. Specifically, this invention relates to master alloys containing cerium, and additionally aluminum or magnesium, and to such alloys.

Aluminum and magnesium metals have found numerous and diversified applications in commerce where strength, lightness, and ease of fabrication are desired. The creep, hardness, and tensile properties of these metals can, however, be markedly improved by the addition thereto of cerium, manganese, nickel, and tungsten. Unfortunately, such aluminum or magnesium-base alloys are costly and difficult to prepare under known methods and, consequently, their employment in commerce and industry has been quite limited.

The difficulties attendant the preparation of aluminum or magnesium base alloys containing cerium, manganese, nickel, and tungsten arise to a large extent from the chemical and physical make-up of the metals and the near equality in density of the alloys and fluxes employed during the melting processes.

For example, in preparing such magnesium-base alloys, it is conventionally necessary to first make an alloy of nickel and tungsten by melting the two metals together at a temperature of from 1472 to 3370° C. The resulting melt is cooled to the solid state, rolled to thin sheets, and finally cut into strips which are dissolved or melted in molten magnesium held at a temperature of 925° C., the molten magnesium being under an inert atmosphere or covered with a sulfur type flux. The melt must be held at about 925° C. in order to dissolve nickel and tungsten but must not appreciably exceed this temperature in order to avoid burning. Manganese is then added to the magnesium-nickel-tungsten melt in the form of manganese chloride which is reduced to manganese by the magnesium producing toxic fumes of chlorine and/or magnesium chloride which are both dangerous and unpleasant to work with, and also results in a loss of magnesium, as magnesium chloride, from the melt, which loss must be replaced or compensated for in some way. In the final step, the cerium is added to the melt to make the resulting desired alloy. It could not be added prior to the addition of the manganese as the manganese chloride would cause loss of the cerium as cerium chloride similar to

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the loss of magnesium. The above procedure can be varied somewhat in that manganese chloride can be added first to the magnesium metal followed by the addition of the cerium and the nickel tungsten alloy in any order. In addition to observing the above order of steps, etc., in preparing the final alloy, the fluxes used with the magnesium are so light that when additional heavy density metals are added to the magnesium melt they tend to carry the fluxes below the surface of the molten magnesium, and to substantially remain there, causing difficulties in obtaining a homogeneous alloy with the desired properties. Hence, it would be highly desirable to have a process which would avoid or overcome the above difficulties of the known processes of producing light density base alloys containing high density metals.

It is, therefore, an object of this invention to provide a method or process for economically and readily preparing alloys containing a relatively low density, low melting point base metal and at least one relatively high density, high melting point alloying metal.

It is another object of this invention to provide a method for producing magnesium or aluminum base alloys containing relatively high density, high melting point metals.

It is still another object of this invention to provide a method for making master alloys containing cerium to be used in relatively low density, low melting point metals.

It is yet another object of this invention to provide a method of obtaining alloys containing cerium, manganese, nickel, and tungsten, and a minor portion of a low density, low melting point base metal.

It is a further object of this invention to provide master alloys containing cerium.

It is a still further object of this invention to provide master alloys containing cerium, manganese, nickel, and tungsten, and a minor portion of a relatively low density, low melting point base metal.

Other objects and advantages of the present invention will become more apparent from the following detailed description and examples.

It has now been discovered that high density, high melting point metals will readily dissolve in molten cerium under standard fluxes to produce a master alloy at a temperature well below the melting point of said high melting point metals, and, further, that a low density, low melting point base metal can finally be readily added to the cerium-high density metal melt in

amounts to produce an intermediate alloy or the final light metal base alloy.

Generally, in the practice of this invention the cerium is melted at a temperature between 640 to 850° C. under a sodium chloride flux. High density, high melting point metals, for example, metallic manganese, nickel and tungsten, are then added to the molten cerium in which they readily dissolve to form the master alloy. Since the density of the master alloy melt is greater than that of the fluxes, separation between the melt and the fluxes is readily effected. At this time minor amounts of beryllium and zirconium may be advantageously added to the melt. This master melt of cerium, manganese, nickel and tungsten can now be cooled to the solid state and used later in producing the final magnesium-base alloy, although it is more desirable to add magnesium metal to the master alloy while it is still molten, thus saving time and extra steps. The magnesium is easily added by any one of the standard immersion processes and any of the flux carried below the melt surface will rise again due to the continued higher density of the melt as compared with the flux.

As a matter of convenience in regard to later operations, only a portion of the magnesium required in the final alloy may be added to the master alloy, i. e., an amount sufficient to bring the melting point of the cerium-manganese-nickel-tungsten-magnesium alloy down to about 730° C. This will provide an intermediate alloy containing magnesium and having a melting point and density such that the balance of the magnesium will readily dissolve or melt in it without the complicating problems of flux interference. Of course, if the melting point of the master alloy has been adjusted to a desired value by the addition of an amount of magnesium, this fact should be taken into account in preparing the final alloy and, thus, only the balance of the requisite amount of magnesium need be added in preparing the final magnesium base alloy. The master alloy containing magnesium, thus, is a sort of additive and permits the obtaining of an alloy which at some later time can be combined with the remainder of the magnesium and is, thus, invaluable where it is not desired to make the final alloy immediately.

The melting processes when carried out in the order and manner above-described will be found to introduce no particular problems and, further, to admit of the use of standard fluxes without difficulty, and further yet, to avoid completely the production of dangerous and otherwise objectionable fumes, since, as stated above, the manganese is used in its metallic form rather than in the form of the manganese chloride of the conventional method.

The amount of cerium present in the master alloy is dependent on the amount of cerium required to give the final, light density, low melting point base metal the desired characteristics and also on the dissolving powers of the cerium for high density, high melting point alloying metal or metals up to a temperature of about 850° C. From 20 to 95% of the master alloy is cerium, the balance being one or more relatively high density, high melting point metals.

The total amount of the relatively high density, high melting point metals varies from 5 to 80% by weight of the master alloy. Examples of high density, high melting point metals which readily dissolve in molten cerium within the temperature range of 640 to 850° C. and which, in

combination with cerium, produce excellent creep and tensile strength in relatively low density, low melting point metal base alloys, are manganese, nickel and tungsten. They are added to the cerium prior to the addition of the light metal, so that the master alloy will have a density higher than the light metal base and the fluxes. Moreover, they are added in the metallic state and in quantities which are required to be present in the final light metal base alloy and are added in any order.

Beryllium and/or zirconium, if desired, may be added to the master alloy in amounts of from 0.01 to 2.5% of the total weight of the master alloy. The actual amounts of beryllium and zirconium present are, however, somewhat dependent on the amounts of these metals desired in the final alloy. The beryllium and zirconium respectively, act to reduce the oxidation and increase the grain refining of the final light metal base alloy. These metals can be added at any step in the process, either to the molten cerium, the molten master alloy, to the magnesium-master alloy melt, or to the final alloy melt.

The relatively low density, low melting point metal used herein is magnesium, although aluminum will likewise prove successful in the process disclosed herein and can be substituted in part or in full for the magnesium. The final product, i. e., magnesium base alloy, will be more than 50% magnesium, generally around 90%. When enough magnesium is added to bring the master alloy melt down to about 730° C., the intermediate alloy will contain from about 20 to 30% magnesium and will have a density appreciably above that of the fluxes and a melting point well below the burning temperature of the magnesium. Thus, in later foundry operations, when desired, it can be remelted as needed, and the balance of the magnesium added thereto with ease and rapidity. This range is somewhat variable, and it is possible and desirable to add more or less magnesium so that the melting point of the alloy will be between 700 and 760° C. It is, of course, obvious that the amount of the elements in the master alloy and their ratio are dependent on the amount and ratio of these elements to be ultimately desired in the magnesium base to give it the desired properties. For example, a magnesium base alloy having excellent creep and tensile properties, has a composition of 6.00% cerium, 1.7 manganese, 0.2 nickel, 0.02 tungsten and 92.08% magnesium while the master alloy used in making this magnesium base alloy would have about 76% cerium, 21% manganese, 2.53% nickel, and .25% tungsten.

In the melting procedures disclosed herein, barium chloride fluxes can be substituted for the sodium chloride fluxes without altering the results obtained. Potassium chloride can likewise be used. All of these salts are immiscible in the melts used and remain on the surface. They can be used singly or mixed in any proportions, although it is preferred to use the eutectic mixture of 40% sodium chloride and 60% barium chloride in many cases.

Minor amounts of impurities are probably present in the melts although the kind and amount thereof are not precisely known. While not absolutely necessary, it is obviously desirable that the materials used in the process disclosed herein should be substantially pure to decrease possible contamination and insure the constant obtaining of reproducible results. It is, thus, preferred to employ chemically pure, or the "C. P."

grade of materials whenever possible in practicing this invention.

Stirring, agitating, etc., of course, can be utilized when necessary to aid dissolution or melting of the metals and reduce the operating times. Such procedures are obvious to those skilled in the art.

The following examples will serve to illustrate to those skilled in the art specific procedures followed in preparing suitable master alloys in accordance with the present invention. Of course, it will be understood that the examples are for illustrative purposes only and are not to be interpreted as in any way limiting the present invention.

Example 1

About 77 parts by weight of metallic cerium were melted in a crucible at a temperature of 825° C. under a flux of 40% sodium chloride and 60% barium chloride. Eighteen parts by weight of manganese, as the metal, were next dissolved in the melt followed by 4.54 parts by weight of metallic nickel and 0.46 part by weight of metallic tungsten. Heat was removed and metallic magnesium was then added to the resulting melt until it solidified at about 730° C. The resulting master alloy was later remelted and heated to 830° C. under the sodium chloride-barium chloride flux and to it was added sufficient additional magnesium to provide a magnesium base alloy having excellent creep and tensile properties.

Example 2

Metallic cerium in an amount of about 89 parts by weight, was heated and melted in a crucible at a temperature of 800° C. under a barium chloride flux. To the molten cerium were then added 0.27 part by weight of tungsten, 8 parts by weight of manganese and 2.7 parts by weight of nickel. Magnesium was next dissolved in the resulting melt in an amount necessary to provide the final type of magnesium-base alloy desired, keeping the temperature of the melt below 850° C.

Example 3

Seventy-eight parts by weight of metallic cerium were melted in a crucible under a potassium chloride flux at a temperature of 775° C. 0.25 part by weight of metallic tungsten, 19.2 parts by weight of metallic manganese, and 2.52 parts by weight of metallic nickel were next dissolved in the cerium melt. The master alloy was allowed to cool and was later remelted under a standard flux at a temperature of 825° C. To the master alloy was added sufficient magnesium to provide the final magnesium base alloy with the desired properties.

In summary this invention teaches that cerium can be utilized as a solvent for relatively high density, high melting point metals into which low density, low melting point metals can be introduced to make valuable alloys, and, in particular, describes a new and hitherto unknown master alloy to which can be added magnesium and aluminum base metals. The specific weight of the cerium is always higher than the fluxes and increases somewhat as the manganese, nickel, and tungsten are added; later, it is progressively reduced as the magnesium or other light metal is added but the specific density or weight of the melt is always greater than that of the fluxes used and the magnesium. The application of the

principle, which consists in that the specific weight of the melt is progressively reduced from that of the heavy cerium down to the specific weight of the final melt without ever becoming as low as the specific weight of the magnesium, is not limited to an alloy containing one of the specifically mentioned metals, manganese, nickel and tungsten. Thus, for instance, in the preparation of a conventional alloy of cerium, zirconium, and magnesium, the magnesium should be added after the zirconium has been dissolved in the molten cerium. Therefore, the term "high density, high melting point metals" used in the present specification and claims is to be understood in comparison with the low density, low melting point metals, magnesium and aluminum. Thus, the process disclosed herein avoids the exacting techniques and difficulties of the prior art by permitting the metallic high density, high melting point metals to be added in any order and over a wide range to the cerium prior to the addition of the magnesium, enables the process to be performed with standard fluxes eliminating the problems of using special fluxes and of the fluxes dispersing or remaining in the melt rather than on the surface of the melt, and avoids the necessity for inert atmospheres and the disagreeable and objectionable fumes occasioned by the former requirement of manganese chloride. Moreover, it is, at once, apparent that an economical and practical process and alloy have been developed which will promote the widespread use of aluminum and magnesium base alloys containing cerium, manganese, nickel and tungsten.

While certain preferred embodiments of the invention have been disclosed, it will be understood that the invention is not limited thereto but may be otherwise practiced within the scope of the following claims.

Having thus described the invention, what is claimed to be new and novel and is desired to be secured by Letters Patent is:

1. A master alloy useful in the preparation of magnesium-base alloys, consisting essentially of from 77% to 89% cerium, from 8% to 20% manganese, from 2% to 5% nickel and from .2% to .5% tungsten.

2. A master alloy for use in the preparation of magnesium-base alloys, consisting essentially of 78% cerium, 19.2% manganese, 2.52% nickel, and .25% tungsten.

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