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METHOD OF MAKING MAGNESIUM ALLOYS

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7 Claims. (Cl. 204—19)

The metals magnesium and manganese, when heated together, alloy extremely slowly even at temperatures far above the melting point of magnesium where the tendency to alloy is somewhat greater. For this reason the direct alloying of these metals where relatively high manganese content is desired has been almost invariably considered impractical, and where such alloys have been made, the manganese content thereof has been very low (normally less than one per cent). The difficulties involved in so alloying magnesium and manganese will be found set forth in U. S. Patent No. 1,377,374 issued to W. R. Veazey, May 10, 1921. According to the method disclosed in that patent for making the magnesium-manganese alloy, manganous chloride (anhydrous) is rapidly added directly to a bath of molten magnesium, the manganous chloride being reduced to manganese by the magnesium, following which the two alloy together. By the present improved method, a description of which follows, we have found it possible to produce with greater ease and efficiency, stable magnesium-manganese alloys containing manganese largely in dissolved form, and with a minimum loss of manganese.

Among the objects of the present invention is the provision of a simple and economical method of forming an alloy of magnesium and a metal relatively difficult to alloy therewith, specifically manganese and the like. A further object is to provide an alloy of magnesium and metals difficult to alloy therewith. Still further objects and advantages will appear as the description proceeds.

The invention, then, consists of the new method of alloying magnesium with metals more or less difficultly alloyable therewith, together with the steps involved in carrying out such alloying process hereinafter fully described and particularly set forth in the claims. The following description, it will be understood, thus sets forth but several of the alloys and various ways in which the invention may be carried out.

We have discovered a method by which magnesium can be alloyed with metals difficult to alloy therewith, such as manganese, in highly efficient, easy and economical manner, as compared to the direct addition of manganese metal or the rapid addition of anhydrous manganous chloride to a molten bath of magnesium. Such improved method consists in contacting molten magnesium with a reducible compound of alloying metal diluated by a suitable bath of flux or other diluent such as, for instance, the molten bath of an electrolytic cell producing magnesium metal.

Commercial electrolytic cells for producing magnesium from a fused bath of magnesium chloride contain normally a charge weighing a thousand pounds or more. Such charge upon being electrolyzed liberates chlorine at the anode and magnesium at the cathode, the magnesium being segregated and removed from the cell as fast as it collects in sufficient quantity for handling or periodically as desired. In order to replenish the bath converted into chlorine and magnesium, it is customary in most cases to supply a corresponding amount of magnesium chloride thereto in substantially uniform manner. If it is desired to thereby produce a magnesium-manganese alloy instead of substantially pure magnesium, we have discovered that it is only necessary to add with the cell feed any reducible manganese compound such as anhydrous manganese chloride or a hydrated form thereof in amount normally ranging from a fraction of one per cent to fifteen per cent, or more, thereof, or to add such compound in an equivalent manner. The manganese content of the metal so produced normally depending upon the amount of manganese chloride in the fused bath, the higher the manganese chloride content of the bath the higher will be the manganese content of the metal produced, other factors remaining constant. While it is preferable to feed the manganese chloride uniformly to the cell along with the magnesium salt, such condition is not absolutely necessary since the manganese chloride content of the fused bath will tend to equalize such fluctuations and produce a relatively uniform composition alloy, if the manganese compound be otherwise added.

The magnesium-manganese alloy made according to our above described improved method has manganese present largely in solution form and such manganese particles as are present in the alloy are normally of very small size. On the other hand where the magnesium-manganese alloy is made by direct alloying of molten magnesium with manganese metal or by direct contact of a mass of anhydrous manganous chloride with a bath of molten magnesium the manganese particles are relatively larger and more numerous in the alloy when first made and the proportion of manganese in solution is relatively small. This makes it necessary to remelt and recast the so formed alloy several times before equilibrium conditions are reached, during which treatment a further portion of the manganese originally pres-

ent as particles goes into solution and a portion segregates out and is lost in the sludge.

Using such methods of alloying, the efficiency of conversion of the available manganese used into manganese alloyed with magnesium is very low. A comparison, however, of the amount of manganese compound used to produce a given percentage of manganese in the alloy made by that method relative to the amount used by our improved method to produce the same alloy composition indicates that the latter is at least fifty per cent more efficient. It is further to be noted that where our improved alloying method is carried out in an electrolytic cell producing magnesium, the manganese compound, which is highly diluted with the molten bath, reacts with the molten magnesium in the cell to liberate manganese metal simultaneously with the liberation of a further amount of manganese by electrolysis of the manganese compound, the liberated manganese alloying with the molten magnesium initially as exceedingly small particles which largely pass into solution during the interval (normally several hours to a day) between periods of dipping the molten metal from the cell. The reaction of a manganese chloride compound upon the magnesium in the cell has two other advantages. First, the chloride product of the reaction is magnesium chloride, which is the same as the bath being electrolyzed according to processes now in common use, and second, the magnesium-manganese alloy formed in the cell does not oxidize as readily as substantially pure magnesium with the result that less magnesium oxide is formed and lost in the sludge.

While we prefer to carry out our improved process in an electrolytic cell where an almost negligible amount of labor is involved in the forming of the alloy, such alloying can be accomplished by agitating molten magnesium in a bath of flux containing a reducible manganese compound and is to be considered one phase of our invention.

Our invention is not limited to alloying manganese with magnesium but is equally applicable for use in forming other magnesium alloys, and is particularly advantageous when used to produce magnesium alloys with certain other metals. For instance, if a magnesium-beryllium alloy is desired, we may use the double fluoride of beryllium and sodium. In like manner, if it is desired to alloy molybdenum. or nickel, with magnesium, we have found that it is only necessary to add to the fused bath a reducible compound of such metal, for instance a chloride. In like manner, it is within the scope of our invention to alloy two or more of the above noted metals with magnesium by introducing suitable compounds of the metals into the fused magnesium chloride bath.

Other modes of applying the principle of our invention may be employed instead of those explained, change being made as regards the composition and method herein disclosed, provided the ingredients or steps stated by any of the following claims or the equivalent of such stated ingredients or steps be employed.

We therefore particularly point out and distinctly claim as our invention:—

1. In a method of alloying magnesium with manganese, the steps which consist in continuously subjecting molten magnesium to the action of a reducible manganese compound mixed with a fused magnesium chloride bath in a magnesium-producing electrolytic cell, removing a portion of the magnesium-manganese alloy so produced, further supplying magnesium chloride and reducible manganese compound to the fused cell bath and removing further portions of the alloy.

2. In a method of making a magnesium-manganese alloy, the step which up to 15 per cent of a reducible manganese compound to the fused bath of a magnesium-producing electrolytic cell.

3. In a method of making a magnesium-manganese alloy, the step which up to 10 per cent of manganous chloride to the fused bath of a magnesium-producing electrolytic cell.

4. The method of making a magnesium-manganese alloy, which consists in electrolyzing a fused bath of magnesium chloride containing up to 15 per cent of a manganese compound reducible by magnesium, and then removing the so formed alloy from the bath.

5. The method of alloying manganese with magnesium which comprises treating molten magnesium with a bath of a fluid flux containing up to 15 per cent of a reducible manganese compound.

6. The method of alloying manganese with magnesium which comprises stirring molten magnesium with a bath of a magnesium chloride flux containing up to 15 per cent of a reducible manganese compound.

7. The method of alloying manganese with magnesium which comprises stirring molten magnesium with a bath of a magnesium chloride flux containing up to 15 per cent of manganous chloride.

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CERTIFICATE OF CORRECTION.

Patent No. 1,960,700. **May 29, 1934.**

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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 54, for "diluated" read diluted; page 2, lines 100 and 104, claims 2 and 3, respectively, after "which" insert the words consists in adding; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of July, A. D. 1934,

Bryan M. Battey