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PROCESS AND COMPOSITION FOR PRODUCING MAGNESIUM-ZIRCONIUM ALLOYS

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8 Claims. (Cl. 75—168)

1

This invention relates to magnesium base alloys which contain zirconium.

The addition of zirconium to magnesium or magnesium base alloys facilitates the production of castings and wrought goods having a fine grained crystalline texture and desirable mechanical properties.

However, considerable difficulties have been experienced in alloying zirconium with magnesium in amounts of at least 0.4% zirconium which are necessary if alloys having the most desirable mechanical properties are to be produced. Research on this problem resulted in the invention described in British Patent No. 511,137 according to which, elements such as aluminium, silicon, tin, manganese, cobalt, nickel, and antimony, which form high melting point compounds with zirconium, and which we term "zirconium alloying inhibitor elements," are omitted from the alloy, whilst other elements (which we term "permissible alloying elements") such as zinc and cadmium may be included.

In order to introduce the zirconium into the alloy I have experimented with the addition of zirconium chloride and various other compounds or mixtures which, however, are attended by various disadvantages.

Amongst other substances I have tried mixtures or compounds consisting of zirconium fluoride with potassium and/or sodium fluoride. I have found however that when these substances are used in the form of powder considerable burning of the magnesium occurs, and very little zirconium is taken up into the alloy. If however these substances are added to the magnesium in the molten form or in the form of prefused lumps, reaction is still more violent, and indeed frequently results in dangerous explosions.

I have now ascertained that such mixtures or compounds when mixed with certain chlorides can be reacted with molten magnesium without violent reaction. This even applies when the chloride employed is that of the same alkali metal, the fluoride of which has been incorporated in the alloying mixture, i. e. potassium chloride will inhibit the violent reaction in the presence of potassium fluoride and similarly sodium chloride will inhibit the violent reaction in the presence of sodium fluoride.

According to the present invention, therefore, an alloying substance to introduce zirconium into magnesium consists of mixtures of one or more chlorides of alkali and alkaline earth metals including magnesium with the aforesaid mixtures or compounds of zirconium fluoride with potassium or sodium fluorides.

For the purpose of alloying zirconium with magnesium the use of magnesium, calcium, and to a lesser extent, strontium and barium chlorides, was originally found to be undesirable, as this is

2

accompanied by more or less marked volatilisation of zirconium chloride. This difficulty can however be overcome by taking suitable precautions e. g., (*a*), the composition of the chloride mixture is preferably selected so that it is substantially fluid at 700° C. or less, (*b*) the fluozirconate is melted separately from the chloride melt and the two melts at comparatively low temperatures e. g. below 750° C., are then mixed, (*c*) the molten mixture is either cast rapidly into moulds for subsequent use or the magnesium required to make the final alloy is poured on without delay, and (*d*) if it is necessary to hold the mixture molten for any appreciable period a close fitting lid should be applied to the crucible containing the mixture. I prefer to avoid the presence of excessive quantities of sodium salts as the presence of sodium in the finished alloy has a deleterious effect on the mechanical properties of the alloy.

It is therefore preferable to mix potassium chloride with one of the aforesaid mixtures or compounds of zirconium fluoride with potassium fluoride and a good example of a suitable alloying substance is as follows:

	Per cent
K_2ZrF_6	50
KCl	50

The zirconium fluoride goes into chemical association with the other fluoride. It cannot be separated by mere physical processes.

The alloying substance may be cast into lumps which may be stirred into the melted magnesium or the magnesium may be poured on the alloying substance which is first placed in the bottom of the crucible. The alloying substance may be contacted with the molten magnesium whilst itself in molten condition. The alloying substance may also incorporate reducible halides of permissible alloying elements.

The ratio of zirconium fluoride to potassium fluoride may exceed that in K_2ZrF_6.

I claim:

1. A composition for introducing zirconium into magnesium and magnesium base alloys consisting essentially of a fused mixture of at least one of the alkali metal chlorides, zirconium fluoride, and at least one of the fluorides of the group consisting of potassium fluoride and sodium fluoride.

2. A composition for introducing zirconium into magnesium and magnesium base alloys consisting essentially of a fused mixture of at least one chloride selected from the group consisting of the chlorides of the metals calcium, barium, strontium, magnesium and alkali metals, together with zirconium fluoride, at least one of the fluorides of the group consisting of potassium fluoride and sodium fluoride and any reaction products of the aforementioned salts.

3. A composition as claimed in claim 1 which

also contains at least one reducible halide of metals which do not form high melting point compounds with zirconium in molten magnesium.

4. A composition for introducing zirconium into magnesium and magnesium base alloys consisting essentially of a mixture of at least one chloride selected from the group consisting of the chlorides of calcium, barium, strontium, and magnesium and optionally at least one alkali metal chloride with a product which is a chemical association of potassium fluoride and zirconium fluoride, in which product the ratio of the zirconium fluoride to potassium fluoride exceeds that in K_2ZrF_6, and reaction products of such chloride and product.

5. A method of preparing a composition for introducing zirconium into magnesium and magnesium base alloys consisting in fusing together at least one chloride selected from the group consisting of the chlorides of the metals calcium, barium, strontium, magnesium, and alkali metals, with at least one substance selected from the group consisting of mixtures and compound salts of zirconium fluoride with at least one of the fluorides of potassium and sodium.

6. A method of preparing a composition for introducing zirconium into magnesium and magnesium base alloys consisting of making a fused mixture of zirconium fluoride with at least one of the fluorides of potassium and sodium, and adding to this mixture at least one chloride selected from the group consisting of the chlorides of the

metals calcium, barium, strontium, magnesium and alkali metals.

7. A method of introducing zirconium into magnesium and magnesium base alloys consisting in contacting the magnesium and magnesium base alloys with a mixture of a product which is a chemical association of zirconium fluoride and potassium fluoride with at least one chloride selected from the group consisting of the chlorides of the metals calcium, barium, strontium, magnesium and alkali metals, together with any reaction products of the aforementioned salts.

8. A method of preparing a composition for introducing zirconium into magnesium and magnesium base alloys consisting in fusing together at least one chloride selected from the group consisting of the chlorides of the metals calcium, barium, strontium, magnesium and alkali metals, with a product which is a chemical association of zirconium fluoride and potassium fluoride, in which product the ratio of the zirconium fluoride to potassium fluoride exceeds that in K_2ZrF_6.

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The following references are of record in the file of this patent:

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