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MAGNESIUM-BASE ALLOYS CONTAINING METALS OF THE CERIUM GROUP OF RARE EARTH, SUBSTANTIALLY FREE FROM CERIUM

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It has long been known that the addition of small percentages of cerium to magnesium gives rise to alloys possessing interesting mechanical properties, especially at relatively high temperatures (i. e. between 200 and 300° C.).

It is also known that cerium can be replaced in these alloys by the alloy of cerium rare earth metals commonly sold under the name of mischmetal, without altering their mechanical characteristics.

Mischmetal is obtained from Monazite sand, or other minerals rich in the cerium group of rare earths, without any separation of the metallic constituents or alteration in their relative proportions except for a slight increase in the cerium content, the remainder being composed of lanthanum, praseodymium, neodymium and samarium.

Experience has shown that at relatively high temperatures no other ultra-light alloys possess such advantageous mechanical characteristics as the alloys of magnesium with cerium or mischmetal. Unfortunately such alloys do not develop their full characteristics unless they contain over 2% of cerium or mischmetal, and much higher percentages may be needed in order to obtain optimum figures. It will easily be understood therefore that the high initial cost of cerium or mischmetal has had a very prejudicial effect on the industrial development of these alloys, which have so far never been placed on the commercial market.

The present invention consists in utilising for binary, ternary and higher magnesium-base alloys, instead of cerium or mischmetal, a mixture of lanthanum, neodymium, praseodynium together with small quantities of samarium and, should it be so desired, thorium and small quantities of the yttrium group of rare earth metals. This mixture or rare earth metals may if desired contain a small amount of cerium, or be almost completely free from the same, but in the event of appreciable quantities of cerium being present, the quantity should not exceed a few per cent of the total quantity of rare earth metals.

The present invention has for its basis the following facts. In the first place, magnesium base alloys with the cerium group of rare earth metals retain their excellent and very peculiar mechanical properties even if the cerium is completely or almost completely suppressed. In the second place, the inventor has made the surprising discovery that the presence of cerium in substantial amounts has the effect of lowering the resistance to corrosion of these alloys which are so highly interesting from the point of view of their mechanical characteristics.

To cite a particular instance, an alloy containing 9.5% of mischmetal, 2% of Mn and 0.4% of Ca shows a remarkable resistance to corrosion, as the following figures show. Two samples, weighing respectively 57 grs. 150 and 54 gr. 550 were immersed for 48 hours in sea-water. Each sample lost 0 gr. 580, representing a loss of 1.01% and 1.06% respectively. Two other samples of a similar alloy identical in form but in which the 9.5% of rare earth metals was substantially free from cerium, weighing respectively 64 grs. 250 and 50 grs. 800, were similarly immersed in sea-water for 48 hours. The loss of weight found in each case was 0 gr. 400, representing a loss respectively of 0.62% and 0.79%.

As a further example may be cited a sample of an alloy containing 6% mischmetal, 2% Mn and 0.4% Ca. This sample, which weighed 50 grs. 800 lost after 30 days immersion in sea-water 5.2% of its weight. Another sample of a similar alloy, identical in form, but in which the 6% of mischmetal was substantially free from cerium, lost under identical conditions 2.1% of its weight.

When such alloys do not contain manganese, the difference in susceptibility to corrosion is still more marked. Thus a sample of an alloy containing 9% of mischmetal and 0.4% of Ca lost after 48 hours immersion in sea-water 21.3% of its weight, whereas a similar alloy substantially free from cerium only lost 12.5%.

The present invention therefore has for its object and scope ultra light alloys of magnesium and rare earth metals substantially free from cerium.

When one desires to produce an alloy relatively high in rare earth metals, it is generally preferable to prepare separately the alloy containing the rare earth metals exempt from cerium. This may be done by any appropriate process. Thus for instance the cerium may be initially separated in aqueous solution from the other rare earth metals, these latter being then isolated by electrolysis with a mercury cathode, the resulting amalgam being distilled so as to recover the rare earth metals. Or again the rare earth metals deprived of substantially all their cerium may be transformed into the chlorides which are fused and electrolysed. This method presents considerable advantages if one wishes to prepare alloys containing a high rare earth metal content, since at the normal working temperatures (650–900° C.) there is but little difference in affinity for the halogens between magnesium and the rare earth metals, and since at higher temperatures, where theoretically the reduction of rare earth-compounds by magnesium should prove easier, this reduction is rendered to a large extent impracticable by the volatility of magnesium.

If however one desires to obtain low percentage alloys, the above mentioned difficulties are less pronounced, and it is then possible to operate merely by displacing the metals of the rare earths from their halogen compounds, either by magnesium, with simultaneous formation of the desired alloy, or by means of calcium already incorporated in the magnesium or the rare earth metal alloy serving as a point of departure.

The following is a preferred method of executing the said invention, which is however given solely by way of example, and which must not be construed in any limitative spirit. Monazite sand is attacked by acid, and the cerium separated as CeO_2 by any known process. The rare earth mixture, substantially free from cerium, which may be for instance in the form of carbonates, is then converted into chlorides by treatment with hydrochloric acid, and the said chlorides are then dehydrated, fused and electrolysed in an iron crucible with a carbon anode. The resulting mischmetal free from cerium is then cast into ingots. The next step is to prepare an alloy with magnesium containing about 25% of rare earth metals, which in turn is used for preparing an alloy of magnesium containing 5% of rare earth metals substantially free from cerium, 1% of Mn and 0.2% of Ca, the remainder being Mg. The said alloy is then forged and used for pistons, propellor blades for aeroplanes etc.

The hereinbefore described invention permits of obtaining alloys of desired composition at a reasonable cost price, this being due to the separation of the cerium and its utilisation for other purposes. Moreover the resulting alloys have an increased resistance to corrosion.

The hereinbefore described invention also covers by way of new industrial products, magnesium-base alloys with rare earth metals substantially free from cerium, and also magnesium alloys containing higher percentages of the said cerium-free rare earth-metals which may serve as a starting point for the production of lower percentage alloys for commercial use.

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