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PROCESS OF IMPROVING ALUMINUM ALLOYS.

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This invention relates to a process of improving aluminum alloys, particularly aluminum-zinc-magnesium alloys.

The properties of this alloy are greatly improved if the zinc and magnesium are completely transformed into the compound $MgZn_2$, this compound consists of about 15.6% magnesium and 84.4% zinc. This compound is not decomposed by aluminum and behaves towards it as a new element with its characteristic properties.

Although aluminum-zinc-magnesium alloys are well-known, the zinc and magnesium components have not been alloyed in such proportions as to combine completely to form the compound $MgZn_2$, even when these alloys were subjected to a heat treatment or ageing process.

Exhaustive experiments have shown that the improvement in tensile strength, etc., for pure aluminum-$MgZn_2$ alloys commences with the presence of about 4% by weight of $MgZn_2$. In practice the amount of this constituent of the alloy is not increased to more than 26% by weight because the increasing amount of hard and brittle crystalline $MgZn_2$ decreases the workability of the alloy and the increasing brittleness of the alloy counteracts the improving action. The best results with respect to workability and strength are obtained if the amount of the compound $MgZn_2$ lies between 4% and 12% by weight.

Additions of other substances forming a solid solution with aluminum such as for example beryllium, silicon, copper and the like not only do not interfere with the improving process but on the contrary effect a further improvement. Care must naturally be taken to adjust the amounts of the $MgZn_2$ correspondingly on the addition of such other substances because the addition of these components alters the solubility of the $MgZn_2$ compound in aluminum in the solid state. If components are added which have a greater affinity for magnesium or zinc, such as silicon, which forms a compound Mg_2Si which is more stable than $MgZn_2$, then the amount of the zinc must be reduced correspondingly in accordance with the added amount of such component, so that the remaining free magnesium can be completely transformed with the zinc into the compound $MgZn_2$.

The strength of the aluminum alloy containing $MgZn_2$ as the main component, may be considerably increased by adding small amounts of high-melting components such as manganese, nickel, titanium, tungsten, molybdenum and the like. The amount of these additions must not exceed about 1% because the workability of the alloy will otherwise be adversely affected.

A further improvement may be obtained if the ageing of the alloy after annealing and quenching is carried out at high temperatures. This applies particularly to alloys containing a high proportion of $MgZn_2$. The ageing at high temperatures can be effected immediately after quenching, after an intermediate ageing at room temperature or also after a completely finishing ageing at room temperature. This enables alloys of various different strengths and elongation properties to be obtained as desired.

High strength values can be obtained if after being aged at room temperature (about 5 to 8 days) the alloys are submitted to a further after-ageing at higher temperatures. It is also possible by suitably selecting the ageing temperature to obtain a material of different strengths and elongations. It is of course necessary for every case, to ascertain the most favourable temperature and duration of the ageing corresponding to the composition of the alloys by practical tests. In general, these temperatures lie between 50 to 150° C., whilst the duration of ageing is from 3 to 48 hours.

In order to obtain the high strength values the following method is preferably used:

The mechanically worked alloy is annealed for some time at temperatures going up to about 550° C. The best annealing temperatures lie between 450 and 520° C. The time for annealing the product depends on the size of the latter and generally varies from 15 to 60 minutes. After annealing the material is removed from the annealing furnace and subjected to a quick cooling, for instance by quenching in water having a temperature of from 15 to 20° C. A slower

cooling is advantageous if a higher elongation but less strength is desired. For this purpose the material is preferably quenched in oil at a temperature of 20 to 100° C. After such treatment the material is either subjected to a self-ageing measure by storing it for five days at room-temperature (about 15 to 25° C.), whereby the strength increases while the elongation remains the same or decreases but little, or the annealed and quenched material is subjected for a shorter period (3 to 48 hours) to ageing at higher temperature (about 50 to 150° C.). When working in such a manner especially high values of strength are obtained, the elongation values however, being lower.

Example I.

An alloy containing 9% $MgZn_2$ shows after ageing at room-temperature (about 15 to 25°) strength valves of about 44 kg/mm² and elongation values of 18 to 22%.

Example II.

The same alloy shows after an ageing of 15 hours at 60° C. a strength of 46 to 48 kg/mm² and elongations of 17 to 19%.

A further improvement will be obtained if small amounts of components having high melting points are added to the aluminum-$MgZn_2$-alloys. By this means not only the strength but also the resistance to corrosion is increased. These alloys are not affected by overheating. Even if they are considerably overheated as may be the case by an interannealing during the rolling-process, they do not show any tendency for recrystallization, which would result in formation of a coarse grain and would be very detrimental to the strength qualities.

Example III.

An alloy containing 9% $MgZn_2$ and 1% manganese, nickel, titanium or other metals of a high melting point, rolled into sheets having a thickness of 1.5 mm. shows after annealing, quenching and tempering at 60° C. during 15 hours a strength of 47 to 52 kg/mm² and elongations of 15 to 18%. The same values were obtained when the sheet was intentionally overheated by an intermediary annealing during the rolling process.

Further experiments have shown that more improvement of the alloys can be obtained if other components are added, such as the compound Mg_2Si for instance, forming a solid solution with the aluminum.

Example IV.

An alloy containing 9% $MgZn_2$, 1% manganese, 0.5% Mg_2Si shows after the prescribed process of improvement strength values of 52 to 57 kg/mm² and elongations of 12 to 15%.

Aluminum alloys possessing such high strength values have not heretofore been produced. The strength values of these alloys may be further increased by using higher tempering temperatures, for instance 110° C. However, the elongation will decrease in such a case. Generally a tempering temperature of 60 to 75° C. and a tempering time of up to 15 hours will be sufficient.

What we claim is:—

1. A process for producing alloys of high tensile strength comprising alloying aluminum with $MgZn_2$, said compound forming from 4% to 26% by weight of the alloy, and subjecting the alloy to annealing, quenching, and ageing.

2. A process for producing alloys of high tensile strength comprising alloying aluminum with $MgZn_2$, said compound forming from 4% to 26% by weight of the alloy, and subjecting the alloy to annealing, quenching, and ageing at temperatures ranging from 50 to 150° C.

3. A process for producing alloys of high tensile strength comprising alloying aluminum with $MgZn_2$, said compound forming from 4% to 26% by weight of the alloy, adding minor quantities of elements forming solid solutions with aluminum, and subjecting the alloy to annealing, quenching, and ageing.

4. A process for producing alloys of high tensile strength comprising alloying aluminum with $MgZn_2$, said compound forming from 4% to 26% by weight of the alloy, adding minor quantities of elements having high melting points, adding minor quantities of elements forming solid solutions with aluminum, and subjecting the alloy to annealing, quenching, and ageing.

In testimony whereof we affix our signatures.

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