This invention relates to a process for the production of improved forgings from high percentage magnesium alloys.

In the production of forgings from high percentage magnesium alloys, it is subsequently intended to improve the quality by precipitation of constituents held in supersaturated solid solution, which has hitherto been subject to the forged workpieces. After cooling, e.g., to room temperature, a solution heat treatment, followed by an artificial retardation of cooling is carried out. This formation of large crystals adversely affects the mechanical strength values of the workpieces.

It has now been ascertained that the foregoing drawback can be avoided by carrying out the forging operation at temperatures within the solid solution range of these temperatures being generally somewhat higher than hitherto customary in the forging of magnesium base alloys)

and then subjecting the workpieces in immediate succession to the forging operation, i.e., immediately on their being taken from the forging dies, to quenching, whereupon they are annealed at such temperatures as are just sufficient to effect the desired precipitation of the heterogeneous constituent. These temperatures are generally below 260°C. and their application thus does not result in a recrystallisation of the workpiece to any appreciable extent.

The forging and tempering temperatures to be employed in carrying out the invention are naturally somewhat dependent on the composition of the alloy to be worked. As far as the former are concerned, they can be taken directly from the corresponding phase diagram. In respect of the latter it is known that precipitation of the heterogeneous constituent, while always requiring temperatures below the boundary line separating the α and the α+β field of the phase diagram, is dependent on the specific temperature employed and the duration of annealing, the temperature required for producing segregation being the lower the longer the heat treatment is extended. On the other hand, with magnesium base alloys recrystallisation does, in any case, not take place at temperatures below about 200°C, and generally becomes perceptible only in the temperature range between about 230 and 250°C.

By suitably extending the duration of annealing, it is therefore always possible to produce precipitation of the heterogeneous constituent held in supersaturated solid solution by the application of temperatures below about 200°C, i.e., such temperatures as will not result in a recrystallisation of the workpiece. For example, for alloys of the composition:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>8-9</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.2-0.6</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Balance</td>
</tr>
</tbody>
</table>

a forging temperature of from 320 to 400°C is correct, while the annealing temperature should lie between 140 and 180°C.

The invention of course presupposes that the alloys, before being forged, are in the homogeneous state, this being generally brought about automatically by the heating of the alloys necessary for carrying out the forging operation.

**Example**

For the purpose of making a forged and improved propeller, a blank of flat or circular cross-section (produced e.g. by pressing a section on the extruding press and cutting the section up into pieces of suitable length) of a homogeneous magnesium alloy containing

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>6.5</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.5</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.2</td>
</tr>
</tbody>
</table>

was placed at a temperature of from 370 to 400°C. In a forging press with heated dies kept at a temperature of from 300 to 350°C, and there first converted into an intermediate shape suitable for the final forging. After the workpiece had been reheated to temperatures of from 340 to 360°C, the actual propeller blank was forged from this intermediary shape, likewise in heated dies, in a hydraulic press. After the forging operation had been completed, the propeller blank, which now had a temperature of about 300 to 330°C, was removed from the mould and immediately quenched in water. This operation was followed by an annealing treatment in an oil
bath at a temperature of 150° C., for from 4 to 6 hours. The strength values found in the finished workpiece are as follows:

Tensile strength = 32-36 kgs. per square mm.

5 Elongation = 10-14%

Yield point = 22-24 kgs. per square mm.

whereas when the alloy was treated by the usual process hereinafter referred to, the corresponding values were:

10 Tensile strength = 28-32 kgs. per square mm.

Elongation = 8-12%

Yield point = 13-22 kgs. per square mm.

I claim:

1. A process for the production of forgings from precipitation hardenable high percentage magnesium base alloys, which comprises forging the substantially homogeneous alloys at temperatures within the solid solution range, thereafter immediately quenching the workpieces, and finally annealing them at temperatures between about 140 and 180° C. so as to cause precipitation of a hardening constituent.

2. A process for the production of forgings from precipitation hardenable high percentage magnesium base alloys, which comprises forging the substantially homogeneous alloys at temperatures within the solid solution range, thereafter immediately quenching the workpieces, and finally annealing them at temperatures below about 200° C. so as to cause precipitation of a hardening constituent.

3. A process for the production of forgings from magnesium base alloys containing between about 8 and about 9% of aluminium, which comprises forging the alloys at temperatures from about 320 and about 400° C., thereafter immediately quenching the workpieces, and finally annealing them at temperatures between about 140 and 180° C. so as to cause precipitation of a hardening constituent.

4. A precipitation hardened forging produced from a magnesium base alloy containing between about 8 and about 9% of aluminium by forging said alloy at temperatures within the solid solution range and thereafter restricting all reheating to less than the recrystallization temperature, said alloy being characterized by a fine-grained crystalline structure of substantially uniform grain-size.

5. A precipitation hardened forging produced from an alloy consisting of between about 8 and about 9% of aluminium, between about 0.2 and 0.6% of zinc and about 0.2% of manganese, balance magnesium, by forging said alloy at temperatures within the solid solution range and thereafter restricting all reheating to less than the recrystallization temperature, said alloy being characterized by a fine-grained crystalline structure of substantially uniform grain-size.

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