The subject of the invention is a cast part with high static mechanical strength, and high hot creep strength, made of aluminum alloy of chemical composition:

Si: 0.02-0.50%, Fe: 0.02-0.30%, Cu: 3.5-4.9%, Mn: <0.70%, Mg: 0.05-0.20%, Zn: <0.30%, Ni: <0.30%, V: 0.05-0.30%, Zr: 0.05-0.25%, Ti: 0.01-0.35%, other elements in total <0.15%; and 0.05% each, the remainder being aluminum.

It more particularly relates to cylinder heads for supercharged diesel or gasoline internal combustion engines.
Figure 1

11

10

Figure 2

Heat Flow Enthalpy (nW)

Temperature (°C)

- - - 0 Mg
- - - 0.09 Mg
- - - 0.13 Mg
Figure 3

Creep at 300°C: deformation after 300h at 30 MPa

- AlCu4.7MnMgVZrTi
- AlSi7Cu3.5MnMnVZrTi

Mg %

Deformation
COPPER ALUMINUM ALLOY MOLDED PART HAVING HIGH MECHANICAL STRENGTH AND HOT CREEP RESISTANCE

FIELD OF THE INVENTION

[0001] The invention relates to parts cast in copper aluminum alloy subject to high mechanical stresses and working, at least in some of their zones, at high temperatures, in particular cylinder heads of supercharged diesel or gasoline engines.

BACKGROUND OF RELATED ART

[0002] Unless otherwise stated, all the values relating to the chemical composition of the alloys are expressed as a percentage by weight.

[0003] Alloys commonly used for cylinder heads of mass-production automotive vehicles are essentially silicon alloys (5 to 10% of Si in general) often containing copper and magnesium in order to improve their mechanical properties, in particular when hot. The main types used are: AlSi7Mg, AlSi7CuMg, AlSi(5 to 6) Cu3Mg, AlSi10Mg, AlSi10CuMg. These alloys are used with different methods of heat treatment: sometimes in state T6 without treatment, sometimes in state T5 with simple aging, sometimes in state T6 with solution heat treatment, quenching and aging at peak hardness or slightly below, and often in T7 state with solution heat treatment, quenching and over-aging or stabilization.

[0004] The reason silicon alloys are used is their superior casting properties, particularly absence of hot tearing, high flowability, and good ability to feed the shrinkage cavities. Only those alloys with a silicon content greater than or equal to 5% are appropriate for shell molding, by gravity or low pressure, which is the dominant process for mass-produced motor cylinder heads.

[0005] For manufacturing short production runs usually made using sand casting, such as cylinder heads for high performance vehicles or parts for working at high temperatures for the arms and aeronautics industries, copper alloys of the type AlCu5 are also sometimes used, with the addition of elements to promote high temperature resistance, such as Ni, Co, Ti, V and Zr. In this category AlCu5NiCoZr and AlCu4NiTi are to be noted. These alloys are highly resistant to heat, especially at 300°C where they significantly outperform aluminum silicon mentioned above, but suffer from two serious weaknesses: their high hot tearing susceptibility, together with poor ability to feed shrinkage cavities, which makes them very difficult to shell-mold for mass production, and also the mediocre of their mechanical properties at ambient temperature; in particular they have very low elongation, making them fragile and inefficient in terms of mechanical fatigue. Table 1 summarizes the properties at ambient temperature of both alloys, sand-cast and heat-treated in state T7 (Rp0.2 (or 0.2% TYS) being the yield strength in MPa; Rm (or UTS) the tensile strength in MPa, and A (or e) the elongation at fracture as a percentage):

| Table 1 |
|-----------------|-----------------|---------------|
| Alloy           | Rp0.2 (MPa)     | Rm (MPa)      | A (%)         |
| AlCu4NiTi       | Not measurable  | 343           | 0.11          |
| AlCu5NiCoZr     | 270             | 295           | 1             |

[0006] There is also an alloy previously standardized by the Aluminum Association (subsequently designated as "AA" for convenience) under number 224, which is of the AlCu5MnVZr type. It was declared "inactive" by this association, who withdraw it years ago from its regularly updated document "Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot." This alloy 224 does not contain magnesium (this element coming within the category of impurities, with a maximum set at 0.03% each and 0.10% in total), and old characterization results on sand-cast plates showed T7 state properties described in Table 2:

| Table 2 |
|-----------------|-----------------|---------------|
| Alloy           | Rp0.2 (MPa)     | Rm (MPa)      | A (%)         |
| 224             | 280             | 360           | 4.8           |

The Problem

[0007] Given that in future common rail diesel and turbocharged gasoline engines the combustion chambers of the cylinder heads, and especially the valve bridges, reach or even exceed, 300°C, and will undergo higher pressures than in previous generations of engines in service today, the use of aluminum copper alloys, is a "break-out" solution in relation to the incremental progress made by optimizing aluminum silicon alloys.

[0008] But it still remains to find an alloy in this family that combines:

[0009] high mechanical properties at ambient temperature,

[0010] high mechanical properties in the range 250-300°C,

[0011] and high creep strength at 300°C, the temperature particularly characteristic of valve bridges, parts that are especially subject to thermo-mechanical strain.

[0012] Conventional AlCu5Mg alloys such as AlCu5MgTi (designated as 204 by the AA), and A206 and B206 (according to the AA), for parts working at ambient or moderate temperatures do not meet these requirements, particularly at 300°C.

[0013] Alloys AlCu4NiTi and AlCu5NiCoZr (203 according to the AA) mentioned above are themselves too weak and brittle at ambient temperature.

[0014] AlCu5MnVZr (formerly 224 according to the AA) for parts operating at high temperatures have a more interesting combination of properties but still lack yield strength at ambient temperature when compared to the desired improved properties: in state T7 it has a yield strength of Rp0.2–280 MPa, compared with 275 MPa for AlSi7Cu0.5 Mg0.3 Ti17 and 311 MPa for AlSi5Cu3Mg T7 (values measured by the applicant and published in the articles “Alliages d'alleminium et de cuivre” (Hommes et Fonderie—February 2008—N° 382) and “Aluminium Casting Alloys for Highly Stressed Diesel Cylinder Heads”, I. internationales Symposium Aluminium+Automobil); Düsseldorf; FRG; 3-4 Feb. 1988, pp. 154-159, 1988) respectively.

[0015] We therefore sought to obtain a considerable improvement over the former 224 in terms of yield strength and ultimate strength from ambient temperature up to 250-300°C. We also sought to improve the creep strength at 300°C of this former alloy.

Subject of the Invention

[0016] The invention therefore relates to a cast part with high static mechanical strength at ambient and high temperatures and high creep strength at high temperature, especially
at 300° C. and above, cast in aluminum alloy with the following chemical composition, expressed as percentages by weight:

- Si: 0.02-0.50%, preferably 0.02-0.20%, preferably still 0.02-0.06%
- Fe: 0.02-0.30%, preferably 0.02-0.20%, preferably still 0.02-0.12% and better 0.02-0.06%
- Cu: 3.5-4.9%, preferably 3.8-4.9% and preferably still 4.0-4.8%
- Mn: <0.70%, preferably 0.20-0.50%
- Mg: 0.05-0.20%, preferably 0.07-0.20%, and preferably still 0.08-0.20% and finally very preferably 0.09-0.13%
- Zn: <0.30%, preferably <0.10% and preferably still <0.03%
- Ni: <0.30%, preferably <0.10% and preferably still <0.03%
- V: 0.05-0.30%, preferably 0.08-0.25%, and preferably still 0.10-0.20%
- Zr: 0.05-0.25%, preferably 0.08-0.20%
- Ti: 0.01-0.35%, preferably 0.05-0.25%, and preferably still 0.10-0.20%
- other elements in total <0.15%; and preferably still <0.05% each,
- the remain being aluminum;

**DESCRIPTION OF THE FIGURES**

**Fig. 1** shows a cluster of four shell-mold test specimens made by Rio Tinto Alcan of diameter ¼" (6.35 mm).

**Fig. 2** shows differential enthalpic analysis curves for alloys AlCu4.7MnVZrTi with a magnesium content of 0.65%, 0.05% and 0.13%.

**Fig. 3** shows the results of creep tests at 300° C. on T7 treated alloys AlCu4.7MnVZrTi and AlSi7Cu3.5MnVZrTi also T7 treated with a magnesium content varying from 0% to 0.13% and 0.1% to 0.15% respectively.

**DESCRIPTION OF THE INVENTION**

The invention is based on the finding by the applicant that it is possible to make very significant improvements to the properties mentioned above of the former alloy 224 (according to the AA), thus solving the problem, in particular by the addition of a limited amount of magnesium.

The addition of a small quantity of magnesium, of the order of 0.10 to 0.15%, considerably increases the yield strength and resistance of the alloy not only at ambient temperature but also when hot, in particular at 250-300° C. and above.

It is at ambient temperature that the relative gain is the greatest: as explained in the following examples and tables 6, 7, 8, the yield strength increases from about 190 MPa without magnesium to about 340 MPa with 0.09% and then to more than 390 MPa with 0.13%. Considering the average of results obtained with 0.09% and 0.13% magnesium, the gains in terms of yield strength and resistance at ambient temperature are remarkable: 496% and 29% respectively in relative terms. Elongation is substantially reduced by half but still retains an adequate level of 6 to 8%.

At high temperatures, 250 and 300° C., the gains from the addition of magnesium remain even though they decrease. The gains observed in terms of yield strength and resistance are 35 and 13% in relative terms at 250° C., and 27 and 8% in relative terms at 300° C. respectively. Far from harming the hot stability of hardening phases as might be thought, the addition of magnesium remains beneficial at least up to 300° C., and especially since the loss of elongation fades away at these high temperatures.

Furthermore, the addition of magnesium considerably improves the creep resistance at high temperature, reducing by approximately 2 the deformation observed after 300 h at 300° C. with a strain of 30 MPa. The addition of magnesium is not detrimental to hot stability, contrary to the philosophy that led to the definition of conventional alloys AlCu5NiCoZr (203 according to the AA) and AlCu5MnVZr (224 according to the AA) that are devoid of magnesium.

It is interesting to locate the average performance of the alloy according to the invention (for simplicity we assigned the average characteristics of alloys with 0.09% and 0.13% magnesium to the alloy designated “AlCu4.7MnMgVZrTi”) compared to some cylinder head alloys based on aluminum silicon. Table 3 summarizes the mechanical properties.

**TABLE 3**

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Ambient T°</th>
<th>250° C.</th>
<th>300° C.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rp 0.2</td>
<td>Rm</td>
<td>A %</td>
</tr>
<tr>
<td>AlCu4.7MnMgVZrTiT7</td>
<td>369</td>
<td>451</td>
<td>7.4</td>
</tr>
<tr>
<td>AlSi7Cu3Mg</td>
<td>172</td>
<td>237</td>
<td>2.1</td>
</tr>
<tr>
<td>AlSi7Mg0.3TiT7</td>
<td>257</td>
<td>299</td>
<td>9.9</td>
</tr>
<tr>
<td>AlSi7Cu0.5Mg0.3TiT7</td>
<td>275</td>
<td>327</td>
<td>9.8</td>
</tr>
<tr>
<td>AlSi7Cu3.5Mg0.15MnVZrTiT7</td>
<td>306</td>
<td>392</td>
<td>5.2</td>
</tr>
</tbody>
</table>

With regard to creep resistance at 300° C., the T7 treated alloy according to the invention can be compared to AlSi7Cu3.5Mg0.15MnVZrTi also T7 treated, which was also developed by the applicant and is, to his knowledge, the most creep-resistant of the series of aluminum silicon alloys considered in the previous table. The curve in Fig. 3 shows the great superiority of AlCu4.7MnMgVZrTi, which substantially deforms four times less in the same conditions.

It therefore appears that the "break-out" goal of progress in relation to existing alloys is achieved by adding magnesium to a base of the type AlCu5MnVZrTi.

Although the addition of magnesium gradually lowers the incipient melting temperature out of equilibrium, it remains possible to subject the alloy to a solution heat-treatment at 525° C. or 528° C. as is done fairly conventionally, with alloys A206 and D206. A stepwise treatment will ultimately make it possible to treat the alloy at a slightly higher
The magnesium content can be increased beyond the area already tested in the examples. If one is looking only for very high strength and hardness, with low ductility requirements, a maximum level of 0.38% may be considered, given that the incipient melting temperature will be lowered and the heat treatment must be adapted accordingly. The minimum for a significant hardening effect is of the order of 0.05%. A more restricted range is 0.07% to 0.30% and the preferred range, corresponding to the strength-ductility-creep compromise quantified in the examples, while having an industrially acceptable width, is 0.08-0.20% or even 0.09 to 0.13%.

Regarding the other elements making up the type of alloy according to the invention, their contents are justified by the following considerations:

Silicon: generally detrimental to ductility and may lower the incipient melting temperature. However, it improves the foundry properties and in particular is likely, even at low levels, to reduce hot tearing susceptibility, as described in the ASM Handbook, Volume 15, 2008 edition. A minimum level of 0.02% is necessary. A maximum level of 0.50% is a possibility for parts that are solidified very quickly requiring little or no elongation, but generally less than 0.20% or 0.60% is to be preferred.

Iron: detrimental to ductility but decreases hot tearing susceptibility, as is also described in the ASM Handbook, Volume 15, 2008 edition. Furthermore, limiting it to a very low level obviously increases the cost of the part. A minimum level of 0.02% is therefore advantageous. A maximum level of 0.30% is a possibility for parts that are solidified very quickly requiring little or no elongation, but generally less than 0.20% is to be generally preferred for large production runs for the automotive industry, or even 0.12% or 0.06% for parts under significant strain.

Copper: hardens the alloy, increasing yield strength and resistance but decreases elongation. The range of the former alloy 224 was 4.5 to 5.5%. The experience gained by the applicant with B206 indicates that it is a good idea to limit copper to a maximum of 4.9% because above this it is very difficult to dissolve all the copper. As the present results, obtained with copper from 4.7 to 4.8%, show that the strength at ambient temperature obtained with the addition of magnesium is very high but elongation is reduced compared to the old 224 alloy without magnesium, it seems logical to allow for the possibility of lowering copper to below 4.5%, and especially down to 3.5%. The applicant performed work on the B206 alloy, the results of which can be transferred to the alloy of the invention, and show that lowering copper from 5.0% to 4.0% leads to a significant saving in elongation at the expense of strength, but that the latter remains greater than 400 MPa. From the perspective of some cylinder heads, it is even conceivable to accept a somewhat larger decrease in strength so as to favor elongation and reduce copper down to 3.5%. Sub-ranges may be chosen between 3.5% and 4.9% depending on the compromise of properties aimed at for the specific part. In general, sub-ranges centered on 4.3% or 4.4% such as 3.8-4.9% and better 4.0-4.8% lead to a fairly balanced compromise.

Manganese: this element should not exceed 0.70% at the risk of forming coarse intermetallic phases. As it usually improves mechanical properties, particularly when hot, a range of 0.20-0.50% similar to that of alloys of type 206 is preferred.

Zinc: this is an impurity that at high levels may decrease the mechanical properties and make the liquid both more oxidizable. It is conceivable to tolerate up to 0.30% in order to facilitate the use of recycled metal, but less than 0.10% is preferred, and, better, less than 0.03% for high-performance parts.

Nickel: contributes in general to the mechanical strength when hot but significantly reduces elongation. As hot strength is provided in the invention by the addition of other elements—copper, magnesium, zirconium and vanadium—nickel is considered here as an impurity, which is kept down to a maximum of 0.30% in order to facilitate the use of recycled metal, and preferably 0.10% and most preferably 0.03% for high-performance parts.

Vanadium: This peritectic element particularly improves the high temperature creep strength. The applicant observed that in another alloy base containing silicon, the creep strength was significantly improved between 0 and 0.05%, then improved more gradually from 0.05% to 0.17% and was stable above 0.17% at an excellent level. Limiting the maximum level of vanadium to 0.15% as in the former 224 does not therefore seem desirable. In the alloy according to the invention, a level of 0.05 to 0.30% is planned, which may be restricted to sub-domains closer to 0.08-0.25% and preferably 0.10-0.20%.

Zirconium: this peritectic element also especially improves high temperature creep strength, and its effect is additive to that of vanadium. A content of 0.05-0.25% and preferably 0.08-0.20% is chosen.

Titanium: this peritectic element has two different effects: firstly, it is often used as a grain-refining element, often in combination with the addition of a master alloy or salt adding titanium and boron. However, there are other refining practices consisting of adding only products introducing titanium and boron, or even boron alone, and in the latter case the presence of titanium is not favorable. Secondly, titanium contributes to good high temperature creep strength, though less strongly than vanadium and zirconium, as noted by the applicant. We therefore chose a maximum content of 0.35%, but generally prefer an addition of 0.05 to 0.25% and more preferably from 0.10 to 0.20%.

The other elements are considered as impurities. In order to facilitate recycling, for some parts a total maximum level of 0.50% can be tolerated, but preferably for parts undergoing strain more than 0.15% overall and 0.05% each will be adopted.

Examples

In a 35 kg electric furnace a series of three alloy compositions described in Table 4 above was produced. All elements expressed as a percentage by weight.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Mg</th>
<th>Ti</th>
<th>V</th>
<th>Zr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.09</td>
<td>0.14</td>
<td>4.83</td>
<td>0.34</td>
<td>0.00</td>
<td>0.18</td>
<td>0.21</td>
<td>0.14</td>
</tr>
<tr>
<td>0.09</td>
<td>0.08</td>
<td>0.14</td>
<td>4.74</td>
<td>0.33</td>
<td>0.09</td>
<td>0.22</td>
<td>0.17</td>
<td>0.13</td>
</tr>
<tr>
<td>0.13</td>
<td>0.09</td>
<td>0.14</td>
<td>4.81</td>
<td>0.33</td>
<td>0.13</td>
<td>0.20</td>
<td>0.17</td>
<td>0.13</td>
</tr>
</tbody>
</table>
These alloys were refined by the addition of AlTi5B (30 ppm titanium added) and degassed by a 10-minute treatment using a graphite impeller rotating at 300 r.p.m. with an argon flow of 5 liters/minute, all covered by an MgCl₂ 60%-40% KCl washing flow.

Shell-mold test specimens diameter ⅛" (6.5 mm) were then cast, of the Rio Tinto Alcan type shown in FIG. 1 designed for tensile testing and shell-mold test specimens ASTM B108 diameter ¼" (12.7 mm) designed to serve as blanks for creep specimens of 4 mm in diameter. FIG. 1 shows in particular a cluster of four shell-mold specimens 11 by Rio Tinto Alcan with a stem diameter ¼" (6.35 mm). This cluster 10 uses, at a scale of ½, the design of the ASTM B108 test specimen.

We first determined the incipient melting temperature of different compositions by performing differential enthalpic analyses (DEA) on pellets machined from the tensile test specimens cast. The rate of temperature rise was 20° C/minute. DEA curves are shown in FIG. 2. The incipient melting temperatures observed to correspond to melting peaks obviously depend on the magnesium content as shown in Table 5:

<table>
<thead>
<tr>
<th>Mg content (%)</th>
<th>Incipient melting temperature (°C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>542.7</td>
</tr>
<tr>
<td>0.09</td>
<td>538.2</td>
</tr>
<tr>
<td>0.13</td>
<td>533.9</td>
</tr>
</tbody>
</table>

The incipient temperature gradually shifts to lower temperatures when the Mg content increases from 0% to 0.09% and then 0.13%.

These three alloys were then heat-treated by applying solution heat treatment comprising a preliminary stage for 2 hours at 495° C. and then a main stage of 12 hours at 528° C., followed by water quenching at 65° C. and aging for 4 hours at 200° C. This produces a state T7 alloy.

Prior to this heat treatment, blanks for the creep tests underwent hot isotropic pressing at 1000 bar at 485° C. for 2 hours to remove any microporosity that could seriously affect the tests given the small diameter of the specimen.

The static mechanical properties were measured at ambient temperature and at 250° C. and 300° C. In the latter two cases, the specimens were preheated for 100 hours at that temperature before being stretched.

The results are shown in Tables 6, 7 and 8:

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Rp0.2 (MPa)</th>
<th>Rm (MPa)</th>
<th>A (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>187.8</td>
<td>349.3</td>
<td>15.3</td>
</tr>
<tr>
<td>0.09</td>
<td>344.5</td>
<td>435.0</td>
<td>8.2</td>
</tr>
<tr>
<td>0.13</td>
<td>393.4</td>
<td>466.4</td>
<td>6.6</td>
</tr>
</tbody>
</table>

These results are plotted in FIG. 3 which also shows, as a reference, the results obtained by the applicant with a series of AlSi7Cu3.5MnVZrTi type alloys with different Mg contents.

A part can then be cast from the advantageous alloy defined above; this part may in particular be a cylinder head or an insert of a cylinder head or other parts which require high static mechanical strength at ambient temperature and at high temperature and high creep resistance at high temperature, especially at 300° C.

The part is advantageously T7 treated, although T6 treatment is also possible.

A new foundry process called “Ablation Casting” has recently been introduced in North America. This process was described in the article “Ablation Casting” by J. Grassi, J. Campbell, M. Hartlieb and F. Major presented at the TMS 2008. This process consists of first casting the part in a fairly insulating mold of sand+binder, and then when it has reached a sufficient solid fraction at least locally, spraying the mold with one (or more) water jets that instantly dissolve the sand binder, causing the mold to collapse. The part being solidified.
is then directly exposed to the impact of the water which extracts the heat very quickly (in a similar way to that observed, for example, during continuous vertical casting of aluminum billets). This leads to a very rapid solidification of the alloy and gives fine structures with high mechanical properties, equal to, or even greater than those obtained by shell molding with a metal mold.

Ablation casting is particularly suitable for casting alloys with high hot tearing susceptibility. Initially, this is sand casting that has little adverse effect on shrinkage, and then after ablation of the mold the end of the solidification process takes place without any rigid mold at all. In addition to providing a high solidification rate, the process also leads to high temperature gradients because spraying is usually gradual, starting on selected areas and advancing towards end-of-solidification points where it is possible to attach feeders. This advantageously also promotes the use of alloys with a low ability to feed shrinkage cavities, such as aluminum copper alloys, including the alloy according to the invention.

The invention also therefore relates to a method for molding a part from the alloy according to the invention, in particular an insert or a cylinder head, comprising stages of:

- providing a mold formed from an aggregate and a water-soluble binder;
- casting the alloy in the mold;
- spraying water on the mold so as to break up the mold and cool the insert or cylinder head to accelerate solidification of the alloy.

The implementation of this method advantageously allows the mass production of cast parts with the alloy according to the invention having much higher hot mechanical properties than aluminum silicon alloys.

The prospects for using copper aluminum alloys with high strength at high temperatures are not, however, restricted to the ablation process: there are other ways in which conventional sand casting, possibly combined with metal coolers, and shell molding with a metal mold, possibly with modifications to the design of parts making it possible to accept the inferior foundry properties of this family of alloys.

1. Cast part with high static mechanical strength at ambient and hot temperatures and high creep strength at high temperature, cast in aluminum alloy with a chemical composition comprising, expressed as percentages by weight:

   - Si: 0.02-0.50%
   - Fe: 0.02-0.30%
   - Cu: 3.54-4.9%
   - Mn: <0.70%
   - Mg: 0.05-0.20%
   - Zn: <0.30%
   - Ni: <0.30%
   - V: 0.05-0.30%
   - Zr: 0.05-0.25%
   - Ti: 0.01-0.35%
   - other elements in total <0.15%; and less than 0.05% each, the remainder being aluminum.

2. Cast part according to claim 1, characterized in that the magnesium content of the alloy is between 0.07 and 0.20%.

3. Cast part according to claim 1, characterized in that the magnesium content lies between 0.08 and 0.20%.

4. Cast part according to claim 1, characterized in that the copper content lies between 3.8 and 4.9%.

5. Cast part according to claim 1, characterized in that the vanadium content is between 0.08-0.25%.

6. Cast part according to claim 1, characterized in that the zirconium content lies between 0.08 and 0.20%.

7. Cast part according to claim 1, characterized in that the titanium content lies between 0.05 and 0.25%.

8. Cast part according to claim 1, characterized in that the silicon content lies between 0.02 and 0.20%.

9. Cast part according to claim 1, characterized in that the iron content lies between 0.02 and 0.20%.

10. Cast part according to claim 1, characterized in that the manganese content lies between 0.20 and 0.50%.

11. Cast part according to claim 1, characterized in that the zinc content is less than 0.10%.

12. Cast part according to claim 1, characterized in that the nickel content is less than 0.10%.

13. Cast part according to claim 1, having undergone T7 or T6 type heat treatment.

14. Insert comprising a cast part according to claim 1.

15. Insert according to claim 14, having undergone T7 or T6 type heat treatment.

16. Method for casting cylinder head according to claim 1.

17. Method for casting cylinder head according to claim 16.