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(54) Aluminium alloy

(57) An Aluminium alloy containing silver and strontium in suitable amounts with improved mechanical and technological properties suitable for vehicular suspension parts. The product having an enhanced tensile strength, yield strength, and elongation percentage, and also suitable technological properties such as corrosion resistance and low hot cracking. A process for the preparation of the aluminium alloy and the vehicular suspension components made from the aluminium alloy described herein are also described.

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Description

[0001] The present invention relates to aluminium alloys. Particularly, the present invention is directed to an aluminium alloy which exhibits suitable tensile strength, yield strength and elongation percentage for its use to manufacture vehicular suspension parts.

BACKGROUND ART

[0002] Aluminium alloys are widely used as materials for various components of vehicles, industrial machines, airplanes, electric appliances for domestic use and other apparatus of various types. Among such aluminium alloys there are cast aluminium alloys, a representative of which is A356. Such cast aluminium alloys are used in important durable parts requiring higher mechanical properties such as vehicle components, metal fittings for stringing and components of hydraulic systems, and in like applications. Typical mechanical property values of the A356 alloy as treated by a T6 heat treatment (a sort of a refining treatment) are 250 MPa tensile strength, 200 MPa yield strength and 5 % elongation. The A356 alloy has widespread applications for structural components in the automotive, aerospace, and general engineering industries because of their excellent castability, corrosion resistance, and, particularly, high strength-to-weight ratio in the heat-treated condition.

[0003] The microstructures of alloy A356 are comprised of an aluminium matrix, which is strengthened by MgSi precipitates and, to a far lesser extent, by Si precipitates, and a dispersion of eutectic Al-Si particles and Fe-rich intermetallics. The variables affecting the microstructure mainly include composition, solidification conditions, and heat treatment.

[0004] The composition of A356 alloy comprises the following components: 91 to 93 wt % of Al; 6.5 to 7.5 wt % of Si; 0.20 to 0.40 wt % of Mg; 0 to 0.02 wt % of Cu; 0 to 0.20 wt % of Fe; 0 to 0.10 wt % of Mn; 0 to 0.20 wt % of Ti; and 0 to 0.10 wt % of Zn.

[0005] Another known aluminium die casting alloys for automotive structural applications have silicon contents between about 9-11 % by weight. Examples of these alloys include C448 and Silafont 36. The high Si content of these alloys results in brittle Al-Si eutectic networks in the as-cast condition. In order to increase ductility, fracture toughness, and crushability, these alloys need a high temperature solution heat treatment that serves, principally, to break down the eutectic network and to spheroidize the Si particles. The solution heat treatment increases costs and also introduces part distortion which requires straightening or machining, which adds cost in the manufacturing process.

[0006] US 6364970 is directed to a hypoeutectic aluminium-silicon alloy. The alloy according to the US 6364970patent, also known in industry as Silafont 36, contains an iron content of up to 0.15% by weight and a strontium refinement of 30 to 300 ppm (0.003 to 0.03% by weight). It has a high fracture strength resulting from the refined eutectic silicon phase and resulting from the addition of Sr to the alloy. The alloy further contains 0.5 to 0.8% by weight manganese (Mn).

[0007] A material used for a vehicular suspension part such as a steering knuckle and a suspension arm is required to have high tensile strength, high yield strength, sufficient elongation percentage, as well as other technological properties such as corrosion resistance, low hot cracking, etc. Accordingly, it is desirable to provide an aluminium alloy with said properties.

SUMMARY OF THE INVENTION

[0008] The problem to be solved by the present invention is to provide an aluminium alloy with improved mechanical and technological properties suitable for vehicular suspension parts. The solution is based on that the present inventors have found that an aluminium modified alloy containing silver and strontium in suitable amounts obtained by the process of the present invention, has an improved tensile strength, yield strength, and elongation percentage, and also suitable technological properties such as corrosion resistance and low hot cracking, compared to A356 aluminium alloy.

[0009] These characteristics of the novel alloy of the present invention make it particularly suitable for durable components requiring higher mechanical properties such as vehicle components, particularly for suspension vehicle components such as steering knuckles and suspension arms. Furthermore, the new alloy is low in cost.

[0010] Accordingly, an aspect of the invention relates to an aluminium alloy which consists essentially of, by percentage of weight:

6.5 to 7.5 % silicon;
0.2 to 0.4 % magnesium;
0.1 to 0.2 % titanium;
at least 0.1 % silver;
0.002 to 0.04 % strontium;

and the balance comprising aluminium and unavoidable impurities.

[0011] Another aspect of the invention relates to a process of making an aluminium alloy as described above, said method comprising (a) melting the raw materials, addition of alloying elements and auxiliary materials in suitable amounts to obtain the composition and properties of interest; (b) undergone the molten alloy thus obtained to a degassing process, and (c) introducing (pouring) the molten metal in a mould and reduce the temperature (cooling) until solidifying as rough casting parts.

[0012] Another aspect of the invention relates to a process of making an aluminium alloy having at least 300 MPa tensile strength, at least 230 MPa yield strength, and at least 9% elongation percentage, said method comprising submitting the aluminium alloy as defined above as rough casting part, to a T6 heat treatment which comprises homogenizing by heating in a temperature range of 500 to 600° C for 2 to 6 hours, followed by quenching and then age hardened by heating in a temperature range of 150 to 180 °C. From here on said improved aluminium alloy part is indistinctly named aluminium alloy casting part.

[0013] Another aspect of the invention relates to an aluminium alloy having at least 300 MPa tensile strength, at least 230 MPa yield strength, and at least 9% elongation percentage obtainable by the process described above.

[0014] Another aspect of the present invention relates to the use of the aluminium alloy casting described herein, as a vehicular suspension component.

[0015] By using this aluminium alloy casting, vehicular suspension components, such as steering knuckle and a suspension arms, can be manufactured properly. Therefore, another aspect of the invention provides a vehicular suspension component which is made from an aluminium alloy casting as described herein.

DETAILED DESCRIPTION OF THE INVENTION:

[0016] As it is said above, by adding the appropriate amounts of silver (Ag) and strontium (Sr) described herein to the basic composition and the method of the present invention, an improvement of the tensile strength, yield strength, and elongation percentage, suitable technological properties such as corrosion resistance and low hot cracking, of the A356 aluminium alloy (basic composition) is observed.

[0017] By the addition of the appropriate amounts of Ag and Sr to the aluminium alloy of the above basic composition, the precipitation hardening elements included in the alloy, magnesium (Mg) and silicon (Si), are more finely dispersed in the alloy and precipitate. Thus an improvement of the above mentioned mechanical and technological properties of the aluminium alloy casting by the fine precipitation of these precipitates are obtained.

[0018] Preferably, the chemical composition for the aluminium alloy according to the present invention consists essentially 6.5 to 7.5 percent silicon, 0.2 to 0.4 percent magnesium, 0.1 to 0.2 percent titanium (Ti), at least 0.1 percent silver, 0.002 to 0.04 percent strontium, and the balance comprising aluminium and unavoidable impurities. According to an embodiment of the invention, the aluminium alloy contains between 0.02 to 0.04 percent strontium.

[0019] According to an embodiment of the invention, the aluminium alloy contains, by percentage of weight, 0.2 percent silver.

[0020] Ag is an essential element of the aluminium alloys of the present invention, due to its contribution to the increased fineness of the eutectic Si structure, the increased fineness of the needle iron (Fe) structure, and the increased uniformity and fineness of the precipitation hardening alloys of Mg, and Si which is suitable for improve the properties above mentioned. In the present invention, the Ag content is at least 0.1 wt %. Preferably, the amount of the Ag added to the aluminium alloy is 0.2 wt %.

[0021] Ti is an element added for making the grains of the casting finer to improve the mechanical properties and mainly the ductility of the part. In the present invention, the Ti content is defined as within a range from 0.1 to 0.2 wt %.

[0022] Mg is an essential hardening agent developed after heat treatment in Al-Si alloys. The hardening phase Mg_2Si is limited by solubility, which corresponds approximately until 0.7 % wherein maximum hardness is reached. In the present invention, the Mg content is defined as within a range from 0.2 to 0.4 wt %.

[0023] Si is an essential element depositing together with Mg as Mg_2Si by artificial aging to provide high strength (yield strength) for final products upon use. Its addition improves the flowability (castability), the hot strength, and other properties of the alloy. Alloys with less than 12% of Si are referred to as hypoeutectic, those with close to 12% Si as eutectic, and those with over 12% Si as hypereutectic. Modification of hypoeutectic alloys (<12% Si) is particularly advantageous in sand castings and can be effectively achieved through the addition of a controlled amount of sodium or strontium, which refines the eutectic phase. In general, the optimum range of Si depends on the process, e.g in sand castings amounts between 5 to 7 wt % , in die casting amounts between 7 to 9 wt %, in high pressure die casting between 8 to 12 wt %. The addition of Si not only improves the mechanical properties, but also reduces the density and thermal expansion rate. In the present invention, the Si content, is defined as within the range from 6.5 to 7.5 wt %.

[0024] Sr modification of aluminium alloys, reduces the size and aspect ratio of the eutectic silicon particles. In comparison with the unmodified alloys, the strontium modified alloys show higher ductility, particularly the A356 alloy, but slightly lower yield strength.

[0025] According to another embodiment of the present invention the aluminium alloy further comprises, by percentage of weight, 0.1 to 0.6 % of rare earth elements. More preferably, the aluminium alloy contains, by percentage of weight, 0.4 % of rare earth elements. Preferably, said rare earth element is at least one element selected from the group comprising La, Ce, Pr, Nb, Pm, Sm, Eu, Ga, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, and Sc. More preferred are those selected from the group consisting of La, Ce, Pr and Nd. Generally, rare earth elements are eliminated as slag in refusions

[0026] According to a preferred embodiment, the aluminium alloy contains, by percentage of weight, 0.1 percent silver and 0.4 percent of rare earth elements.

[0027] By adding slight amounts of rare earth elements the casting defects of the aluminium alloy casting are reduced, increased uniformity of structure and increased fineness of dispersion are achieved, and the strength of the aluminium alloy casting is strikingly improved. Furthermore, presence of rare earth elements contributes to make the grain size of the casting finer improving its strength and ductility, and modifies the eutectic structure of Al-Si alloys. Another advantage of the presence of rare earth elements in the aluminium alloys of the present invention, is that it reduces the costs, due to it permits to reduce the amount of Ag in the composition.

[0028] Preferably, the alloys according to the present invention are substantially free of copper and iron. The term "substantially free" means having no significant amount of that component purposely added to the alloy composition, it being understood that trace amounts of unavoidable impurities may find their way into a desired end product.

[0029] Copper substantially improves strength and hardness in the as-cast and heat-treated conditions. Alloys containing 4 to 6% Cu respond most strongly to thermal treatment. Copper generally reduces resistance to general corrosion and, in specific compositions and material conditions, stress corrosion susceptibility. Additions of copper also reduce hot tear resistance and decrease castability.

[0030] Iron improves hot tear resistance and decreases the tendency for die sticking or soldering in die casting. Increases in iron content are, however, accompanied by substantially decreased ductility. Iron reacts to form a myriad of insoluble phases in aluminium alloy melts, the most common of which are $FeAl_3$, $FeMnAl_6$ and α-AlFeSi. These essentially insoluble phases are responsible for decrease in mechanical properties, such as elongation and tensile strength, especially at elevated temperature. As the fraction of insoluble phase increases with increased iron content, casting considerations as flowability and feeding characteristics are adversely affected. Iron participates in the formation of sludging phases with manganese, chromium and other elements.

[0031] Therefore, the aluminium alloy of the present invention is substantially free of copper and iron, i.e. it has no significant amount of those components purposely added to the alloy composition, nevertheless it is understood that trace amounts of unavoidable impurities may find their way into a desired end product. Preferably, the content of iron in the aluminium alloys of the present invention is lower than 0.15 % wt.

[0032] As it is said above the aluminium alloy described herein can be prepared by a process comprising (a) melting the raw materials, alloying elements and auxiliary materials in suitable amounts to obtain the composition and properties of interest; (b) undergone the molten alloy thus obtained to a degassing process, and (c) introducing (pouring) the molten metal in a mould and reduce the temperature until solidifying as rough casting parts.

[0033] Preferably, the raw materials in solid state are introduced in the furnace as pure elements or as alloys of the components. Generally, ingots of the aluminium alloy A356 (basic composition) are introduced into the furnace, then alloying elements are added, and then when the ingots are melt, the composition of the molten metal is analyzed and optionally, if necessary, the proportions of the components in the alloy are adjusted by adding suitable amounts of such components or alternatively diluted the molten by adding aluminium ingots and then adding suitable amounts of the components to adjust their proportion. Once the molten metal contains the desired composition, additives are added in order to achieve the suitable mechanical and technological properties. Such additives are the modifying agent strontium and the refining agent titanium.

[0034] The modifying agent, is used in order to achieve that the eutectic structure aluminium-silicon, which precipitates during the solidifying step of the part, shows a rounded shape, instead of a needle shape characteristic wherein no modifying is present. When the eutectic structure shows a needle shape, the mechanical properties are reduced, due to that those needles are prone to develop cracks, which reduce the ductility and strength of the material.

[0035] In spite of that some experts thinks that strontium effect is not permanent, their effect is enough to achieve rounded shapes of the eutectic structures. Preferably, the addition of strontium is performed by use of aluminium-strontium alloys.

[0036] During melting step, due to the humidity of materials and ambient, and as a result of the avidity of the aluminium for the oxygen, Al_2O_3 (alumina) and H_2 are formed. The alumina formed happens to form part of the slag and free hydrogen that is generated dissolves in the molten metal. The presence of hydrogen in the solidified part, is the responsible of the presence of pores, which reduces the ductility and tensile strength. Then once the molten alloy contains the composition of interest, it is undergone to a degassing process, which does not modify neither its chemical composition, nor its metallurgical properties.

[0037] According to an embodiment of the invention, the degassing process (b) is carried out by treating the molten alloy with dry nitrogen or dry argon.

[0038] After degassing step, the molten metal is introduced into a mould. This step is known as pouring step. Different pouring techniques are known in the art, gravity die casting, low pressure die casting and high pressure die casting. After the mould filling, the solidifying of the part, generally leaving it to reduce the temperature, allows to taking out it from the mould without risk of breaking, marks, etc. The product thus obtained, after deburring, is known as rough casting part. i.e. without any later treatment (generally thermal treatment).

[0039] In order to be used as vehicular suspension parts such as a steering knuckle and a suspension arms, the aluminium alloy according to the present invention must satisfy mechanical and technological properties such as tensile strength, yield strength, elongation percentage, corrosion resistance, and also low hot cracking.

[0040] To improve the mechanical and technological properties of the alloy, it is submitted to a heat treatment. Different heat treatment are known, nevertheless due to the high requirements of mechanical and technological properties for durable components such as vehicle components, particularly for suspension vehicle components such as a steering knuckles and suspension arms, T6 heat treatment is which gives best results. Anyhow, another heat treatment known in the art (such as T4, T5 heat treatments) may also be suitable.

[0041] T6 heat treatment comprises 2 steps: homogenizing and quenching-age hardening. During homogenizing step, what is done is to support the rough casting part to high temperature, in the range from about 500 to 600 °C, during a period of time that can be of the order of 2 to 6 hours. Preferably the temperature is about 540 °C and the time 6 hours.

[0042] Once the microstructure is homogenized, the part is quenched, i.e. is undergone to a sudden cooling. The step from the homogenizing furnace to the quenching must be realized in an as short as possible period of time, since otherwise it would begin the selective precipitation. According to a preferred embodiment, this time is less than 15 seconds.

[0043] Next, the quenched parts are introduced again in another treatment furnace, wherein it occurs the age-hardening step. This age-hardening step is carried out at low temperature, preferably in the range of about 150 to 180 °C. The age-hardening step gives the mechanical and technological properties to the casting part.

[0044] The casting part may be subjected to a shot-blasting step, to achieve a more bright superficial aspect.

[0045] The aluminium alloy thus obtained, has at least 300 MPa tensile strength, at least 230 MPa yield strength, and at least 9% elongation percentage.

[0046] Throughout the description and claims the word "comprise" and variations of the word, such as "comprising", is not intended to exclude other technical features, additives, components, or steps.

[0047] Additional objects, advantages and features of the invention will become apparent to those skilled in the art upon examination of the description or may be learned by practice of the invention. The following examples and drawings are provided by way of illustration, and are not intended to be limiting of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048]

Figure 1. Tensile bar obtained from the step-shape mould

Figure 1A. Graphical representation of the tensile bars obtained from the different areas of the step-shape mould (1-6).

Figure 1 B. Wall thickness of the different areas (mm)

Figure 2. Tensile strength (TS) and yield strength (YS) of tensile bar samples from thin area 5 made with external refrigeration.
Graphical representation of tensile strength (TS) and yield strength (YS) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thin area 5 with external refrigeration, and standard A356 alloy bar.

Figure 3. % Elongation (% E) of tensile bar samples from thin area 5 made with external refrigeration.
Graphical representation of elongation (E) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thin area 5 with external refrigeration, and standard A356 alloy bar.

Figure 4. Tensile strength (TS) and yield strength (YS) of tensile bar samples from thin area 5 made without external refrigeration.
Graphical representation of tensile strength (TS) and yield strength (YS) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thin area 5 without external refrigeration, and standard A356 alloy bar.

Figure 5. % Elongation (% E) of tensile bar samples from thin area 5 made without external refrigeration.
Graphical representation of elongation (E) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thin area 5 without external refrigeration, and standard A356 alloy bar.

Figure 6. Tensile strength (TS) and yield strength (YS) of tensile bar samples from thick area 3 made with external refrigeration.
Graphical representation of tensile strength (TS) and yield strength (YS) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thick area 3 with external refrigeration, and standard A356 alloy bar.

Figure 7. % Elongation (% E) of tensile bar samples from thick area 3 made with external refrigeration.
Graphical representation of elongation (E) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thick area 3 with external refrigeration, and standard A356 alloy bar.

Figure 8. Tensile strength (TS) and yield strength (YS) of tensile bar samples from thick area 3 made without external refrigeration.
Graphical representation of tensile strength (TS) and yield strength (YS) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thick area 3 without external refrigeration, and standard A356 alloy bar.

Figure 9. % Elongation (% E) of tensile bar samples from thick area 3 made without external refrigeration.
Graphical representation of elongation (E) of the tensile bars, made from the aluminium alloy castings of example 1, prepared from thick area 3 without external refrigeration, and standard A356 alloy bar.

DETAILED DESCRIPTION OF PARTICULAR EMBODIMENTS

Example 1. Process of preparation of the aluminium alloy.

[0049] The raw materials in solid state were introduced in the furnace as pure elements and as ingots of alloys of the components. Ingots of the aluminium alloy A356 (basic composition) were used. And the different proportions of the different components of the alloy were adjusted by adding suitable amounts of such components.

[0050] The compositions thus obtained were:

Composition	
A	A356 alloy
B	Si 7% + Mg 0.3% + Ag 0,2% + Ti 0.1% + Sr 0.02% + Al balance
C	Si 7% + Mg 0.3% + Ag 0,1% + Ti 0.1% + Sr 0.02 + RE 0,2% + Al balance
D	Si 7% + Mg 0.3% + Ag 0,1% + Ti 0.1% + Sr 0.02 + RE 0,4% + Al balance
RE: Rare earth elements	

[0051] Once the molten alloy contains the composition of interest, it was undergone to a degassing process, by treating the molten alloy with dry nitrogen.

[0052] After degassing step, the molten metal was introduced into a mould by gravity pouring. After the mould filling, the molten metal in the mould was leaving to reduce the temperature, and then taking it out from the mould. The product thus obtained, as rough casting part, was deburred.

[0053] The product as rough casting part was undergone to a T6 heat treatment. During homogenizing step, the rough casting part was heated to 540 °C, during a period of time of 6 hours. Then, the part was quenched, wherein the step from the homogenizing furnace to the quenching was carried out in less than 15 seconds.

[0054] Next, the quenched parts were introduced again in another treatment furnace, to carry out the age-hardening step. This age-hardening step was carried out at 160 °C.

Example 2. Mechanical properties.

[0055] To test the mechanical properties of the aluminium alloy casting in accordance with the present invention, a number of tensile bar samples with different content of Ag and rare earth elements, were prepared and subjected to testing, and compared with A356 alloy.

[0056] Tensile strength, yield strength and elongation were measured. The results of the tests, and the compositions of each of the tested alloy castings are set forth in Table 1.

Table 1. Mechanical properties of tested alloy castings.

Composition	Refrigeration	Area 3			Area 5		
		Tensile strength (MPa)	Yield strength (MPa)	Elongation (%)	Tensile strength (MPa)	Yield strength (MPa)	Elongation (%)
(A) A-356 alloy	Yes	256	196	4,8	272	201	6,2
	No	243	187	4,2	264	199	5,6
(B) Si 7% + Mg 0.3% + Ag 0,2% + Ti0.1%+Sr 0.02% + Al balance	Yes	285	219	7,5	305	234	10,6
	No	278	213	6,6	292	226	9,6
(C) Si 7% + Mg 0.3% + Ag 0,1 % + Ti 0.1% + Sr 0.02 + RE 0,2% + Al balance	Yes	277	209	5,7	292	221	7,5
	No	265	197	4,8	286	222	8
(D) Si 7% + Mg 0.3% + Ag 0,1% + Ti 0.1% + Sr 0.02 + RE 0,4% + Al balance	Yes	282	208	6,3	296	215	8,4
	No	273	202	5,1	292	210	6,8

[0057] The aluminium alloy castings of the invention, shown an improvement of their mechanical properties, when content of Ag is above 0.1%. Best results are obtained whit Ag 0.2% (composition B).

Example 3. Mechanical properties of tensile bars obtained in a mould with a step-shape.

[0058] Different tensile bars were prepared using the mould with a step-shape, as shows Figure 1. Thus, tensile bars, made from the aluminium alloy castings of example 1, were prepared from each area (2 per area), and the influence of thickness and improvement of results were determined. Parameters taken into account were composition and cooling speed when tests were running with and without refrigeration.

[0059] The results of the tests, with and without refrigeration, of tested tensile bars from areas 5 (thin area) and 3 (thick area) are set forth in Figures 2 to 9.

[0060] Aluminium alloy castings with Ag 0.2% (composition B of example 2), i.e. thin area bar (5), with external refrigeration, the mechanical properties resulted in a substantial improvement respect to A356 properties.

[0061] Bars prepared with Ag 0.1 % and RE 0.2% and RE 0.4 % (compositions C and D of example 2), shown an improvement in the mechanical properties respect to A356 properties.

Claims

1. An aluminium alloy consisting essentially of, by percentage of weight:

   6.5 to 7.5 percent silicon;
   0.2 to 0.4 percent magnesium;
   0.1 to 0.2 percent titanium;
   at least 0.1 percent silver;
   0.002 to 0.04 percent strontium;

   and the balance aluminium and unavoidable impurities.

2. The aluminium alloy of claim 1, which contains, by percentage of weight, 0.2 percent silver.

3. The aluminium alloy according to any of claims 1 and 2, which further comprises, as an alloy component, 0.1 to 0.6 %, by percentage of weight, of rare earth elements.

4. The aluminium alloy according to any of claims 1 to 3, which contains, by percentage of weight, 0.1 percent silver and 0.4 percent of rare earth elements.

5. The aluminium alloy according to any of claims 3 and 4, wherein said rare earth element is at least one element selected from the group consisting of La, Ce, Pr, Nb, Pm, Sm, Eu, Ga, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, and Sc.

6. A process for the preparation of the aluminium alloy of claims 1 to 5, comprising (a) melting the raw materials, alloying elements and auxiliary materials in suitable amounts to obtain the composition and properties of interest; (b) undergone the molten alloy thus obtained to a degassing process, and (c) introducing the molten metal in a mould and reduce the temperature until solidifying as rough casting parts.

7. The process according to claim 6, wherein the degassing process is carried out by treating the molten alloy with dry nitrogen or dry argon.

8. The process according to any of claims 6 and 7, wherein the raw materials are introduced in the furnace as pure elements or as alloys of the elements.

9. The process according to any of claims 6 to 8, wherein the proportions of the components in the alloy are adjusted by adding suitable amounts of such components, or alternatively diluting the molten by adding aluminium ingot moulds and then add suitable amounts of the components to adjust their proportion.

10. A process of making an aluminium alloy having at least 300 MPa tensile strength, at least 230 MPa yield strength, and at least 9% elongation percentage, said method comprising submitting the aluminium alloy as defined in claims 1 to 5 as rough casting part, to a T6 heat treatment which comprises homogenizing by heating in a temperature

range of 500 to 600° C for 2 to 6 hours, followed by quenching the part and then age hardened by heating in a temperature range of 150 to 180° C.

11. An aluminium alloy having at least 300 MPa tensile strength, at least 230 MPa yield strength, and at least 9% elongation percentage, obtainable by the process of claim 10.

12. Use of the aluminium alloy of claim 11, as a vehicular suspension component.

13. Use of the aluminium alloy according to claim 12, wherein the vehicular suspension component is selected from steering knuckle and suspension arms.

14. A vehicular suspension component made from the aluminium alloy of claim 11.

15. The vehicular suspension component of claim 14, which is selected from steering knuckle and suspension arms.

FIGURE 1A

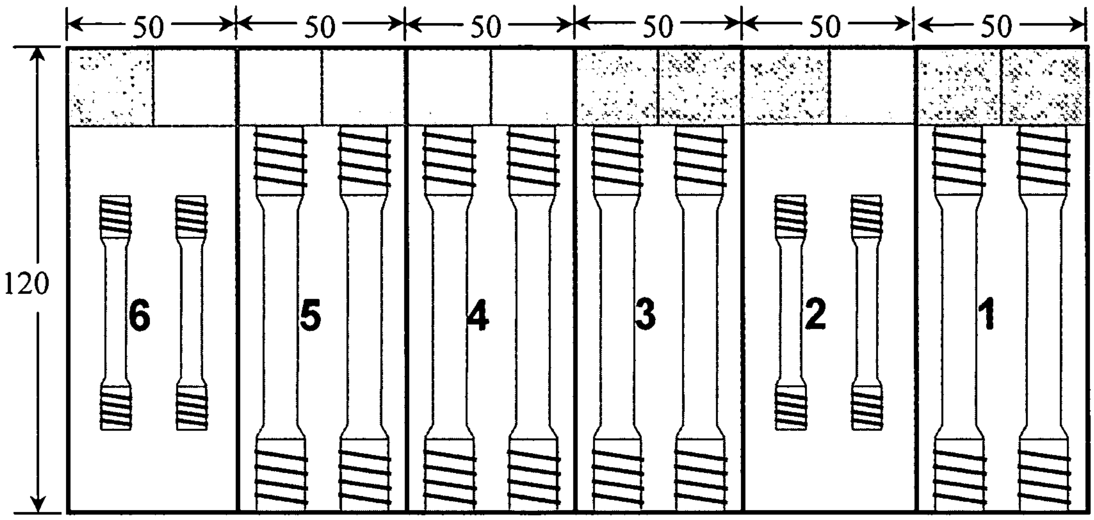


FIGURE 1B

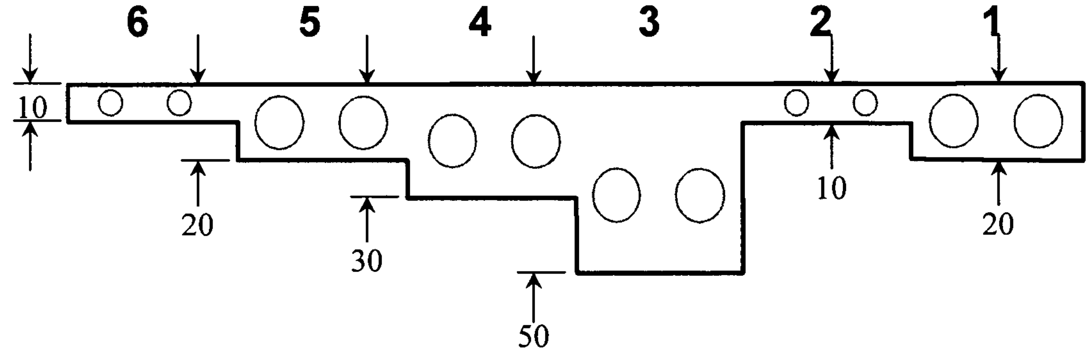


FIGURE 2

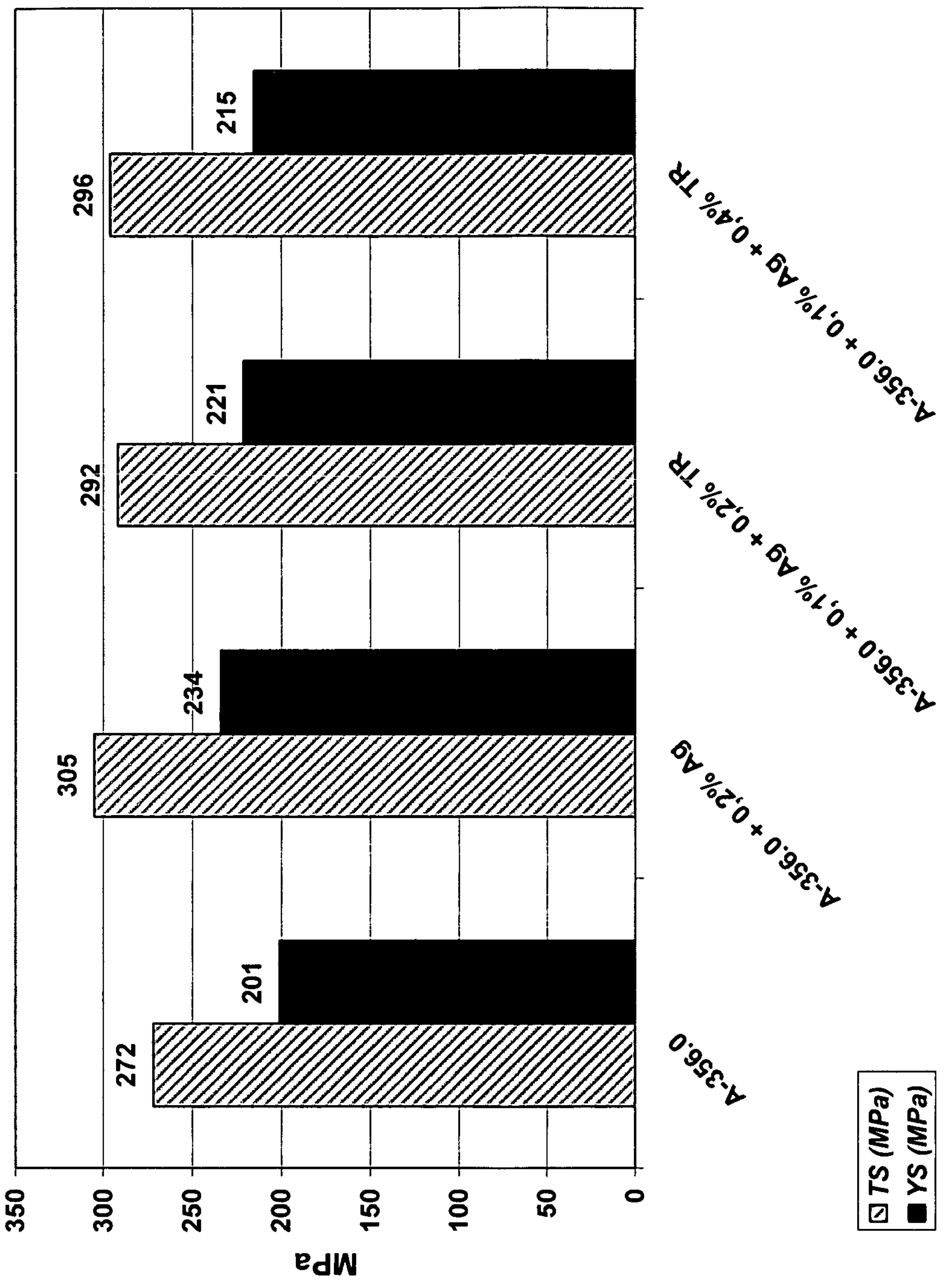

MPa
350
300
250
200
150
100
50
0
272
201
305
234
292
221
296
215
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR
▨ TS (MPa)
■ YS (MPa)

FIGURE 3

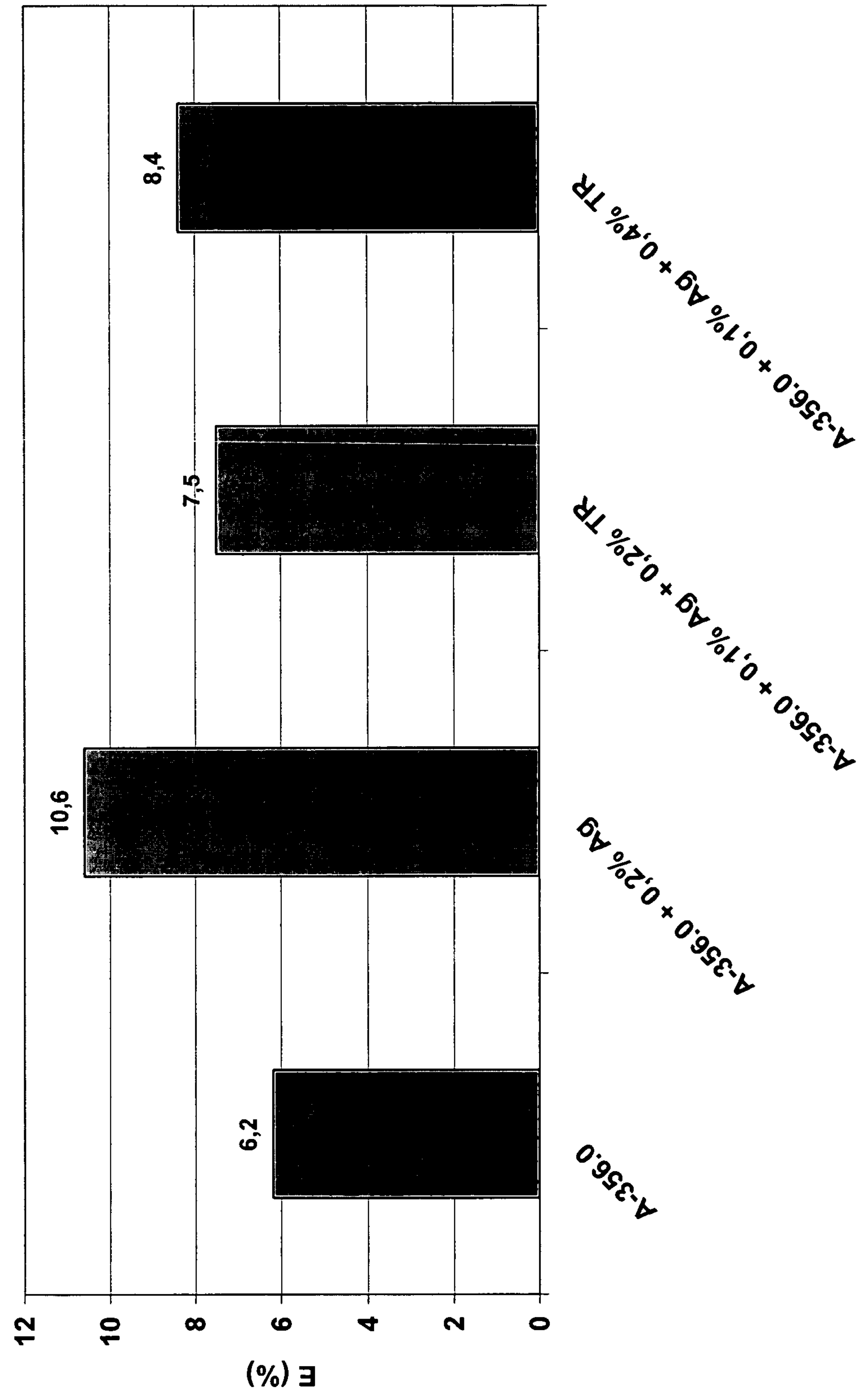

E (%)
0
2
4
6
8
10
12
6,2
10,6
7,5
8,4
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR

FIGURE 4

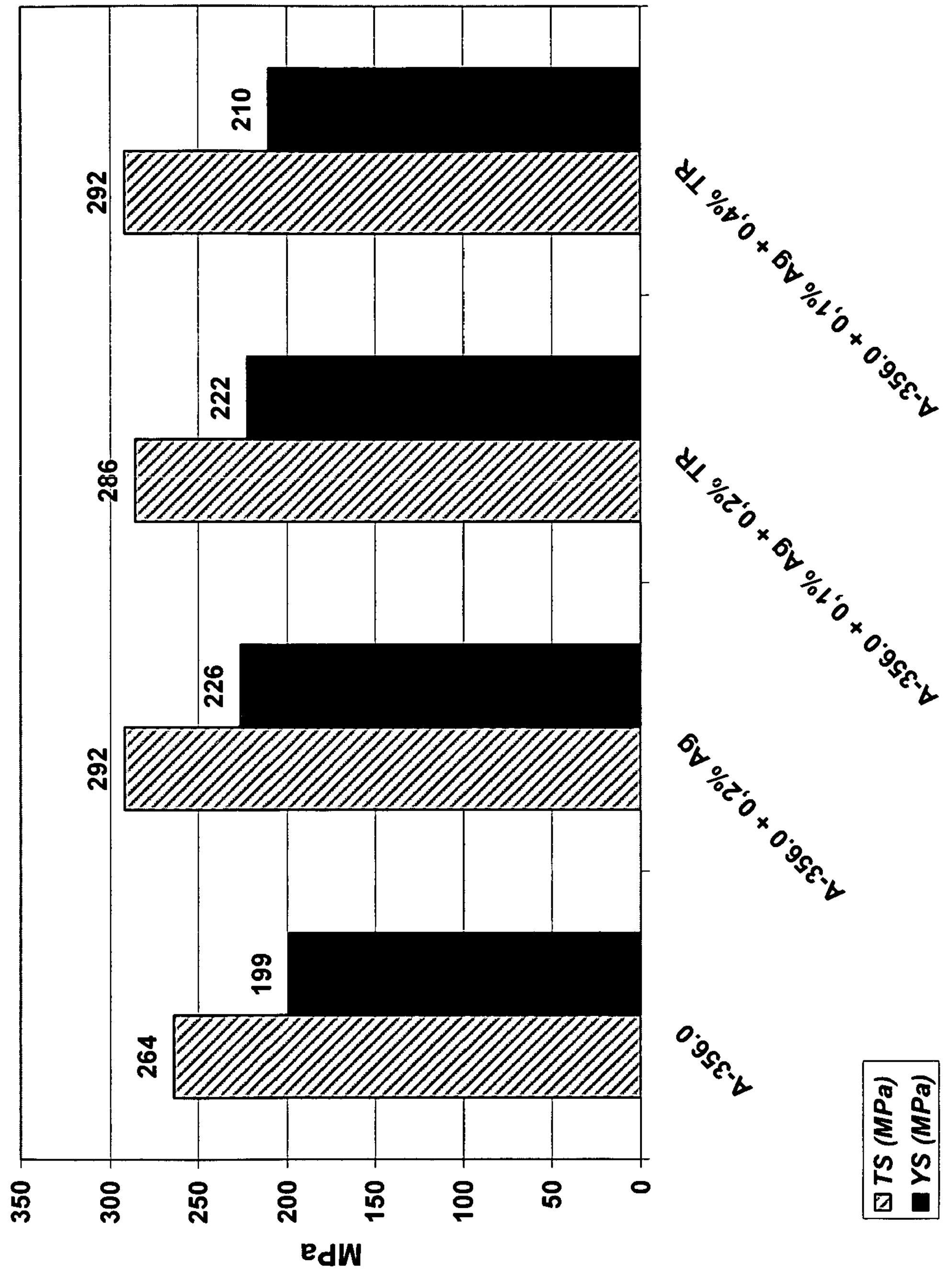

MPa
0
50
100
150
200
250
300
350
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR
264
199
292
226
286
222
292
210
▨ TS (MPa)
■ YS (MPa)

FIGURE 5

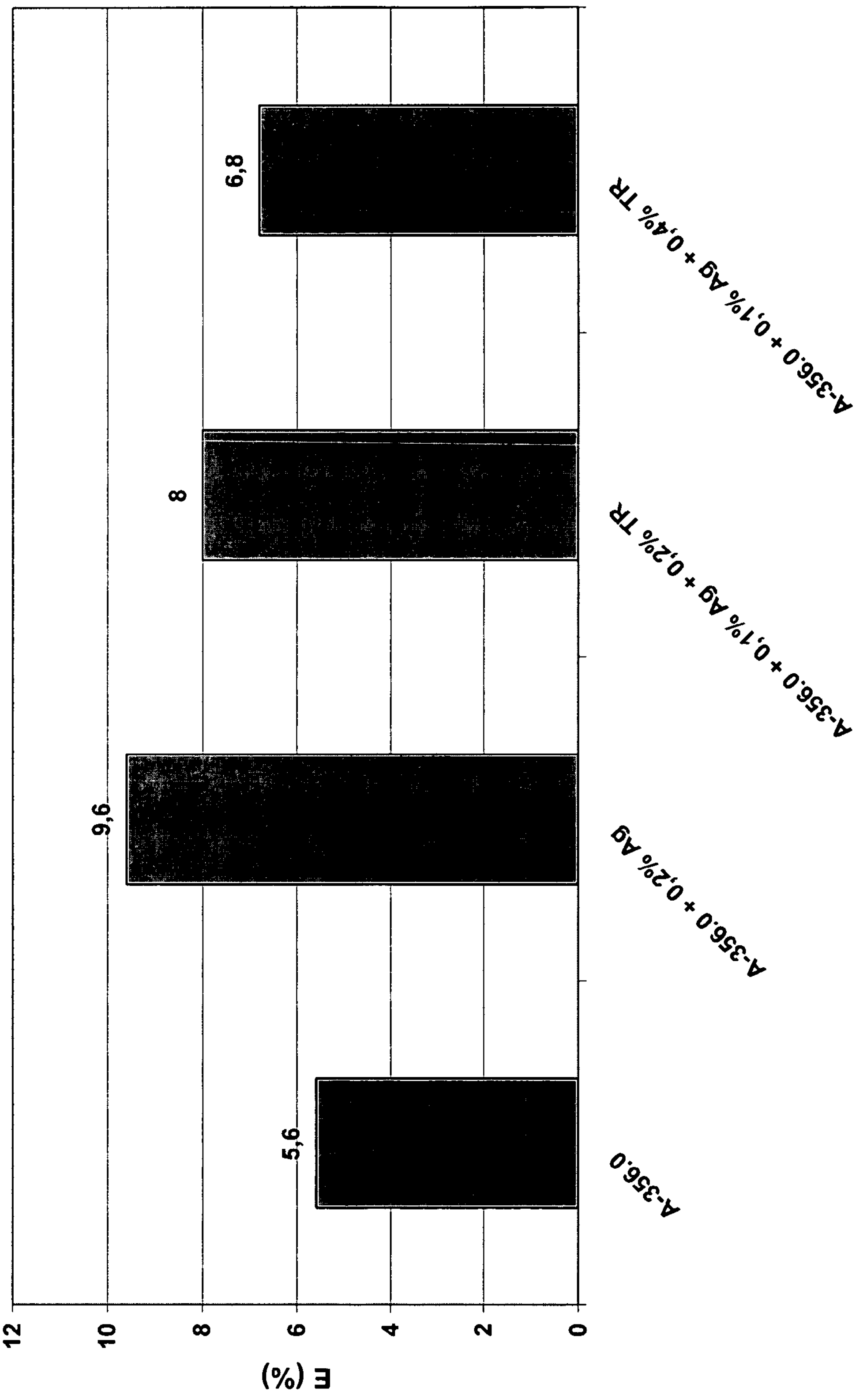

E (%)
0
2
4
6
8
10
12
5,6
9,6
8
6,8
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR

FIGURE 6

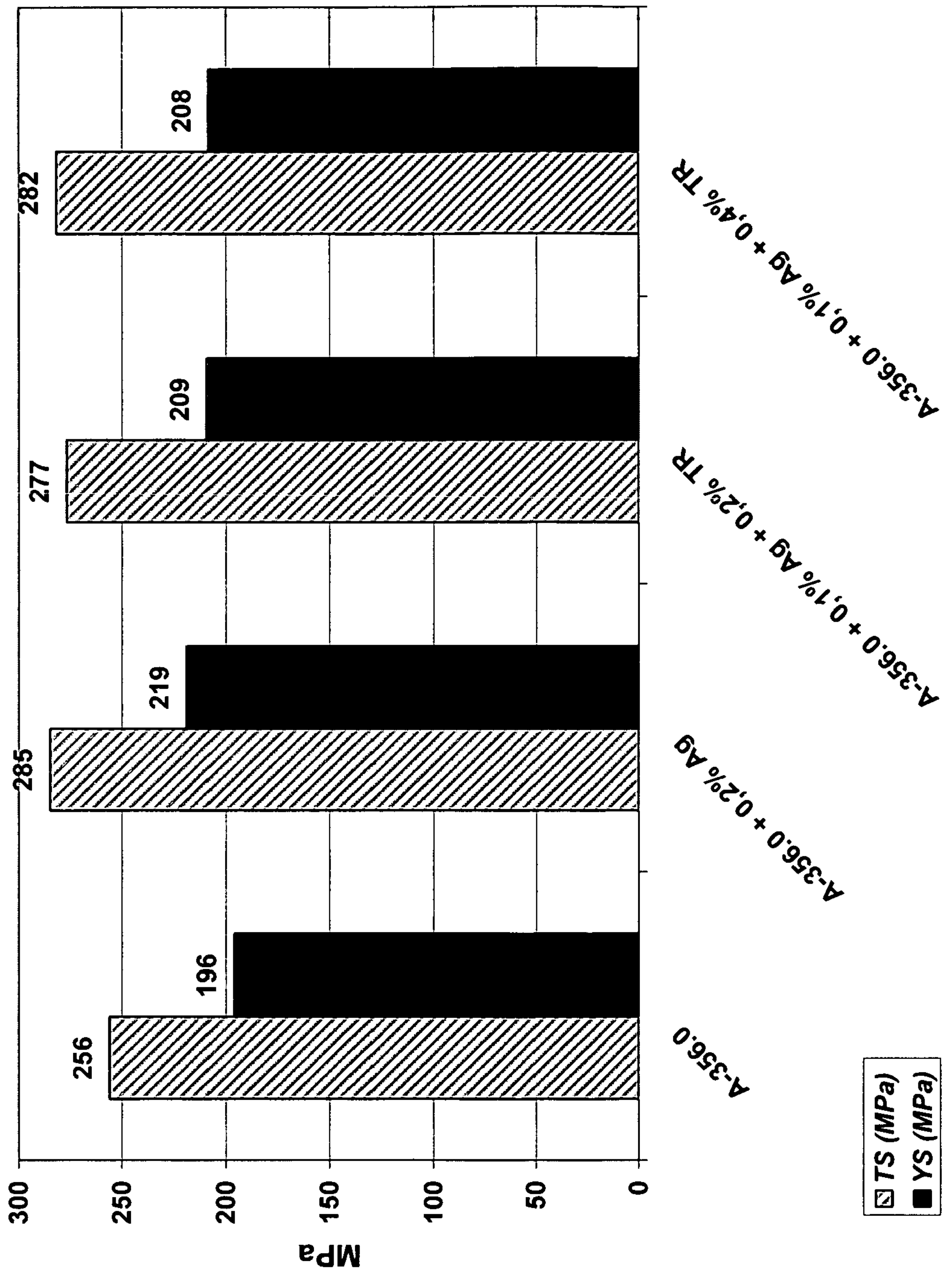

MPa
300
250
200
150
100
50
0
256
196
285
219
277
209
282
208
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR
▨ TS (MPa)
■ YS (MPa)

FIGURE 7

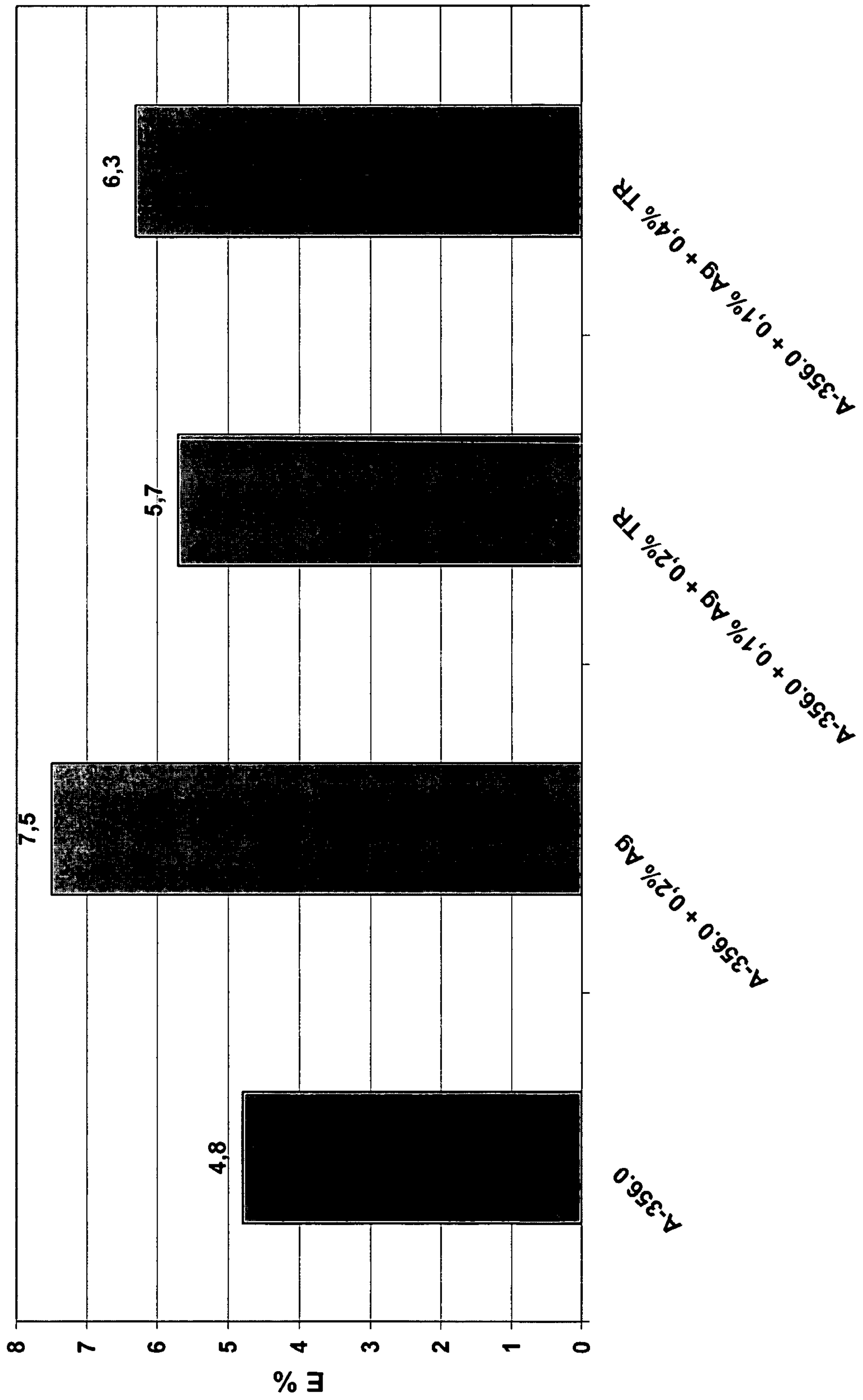

E %
0
1
2
3
4
5
6
7
8
4,8
7,5
5,7
6,3
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR

FIGURE 8

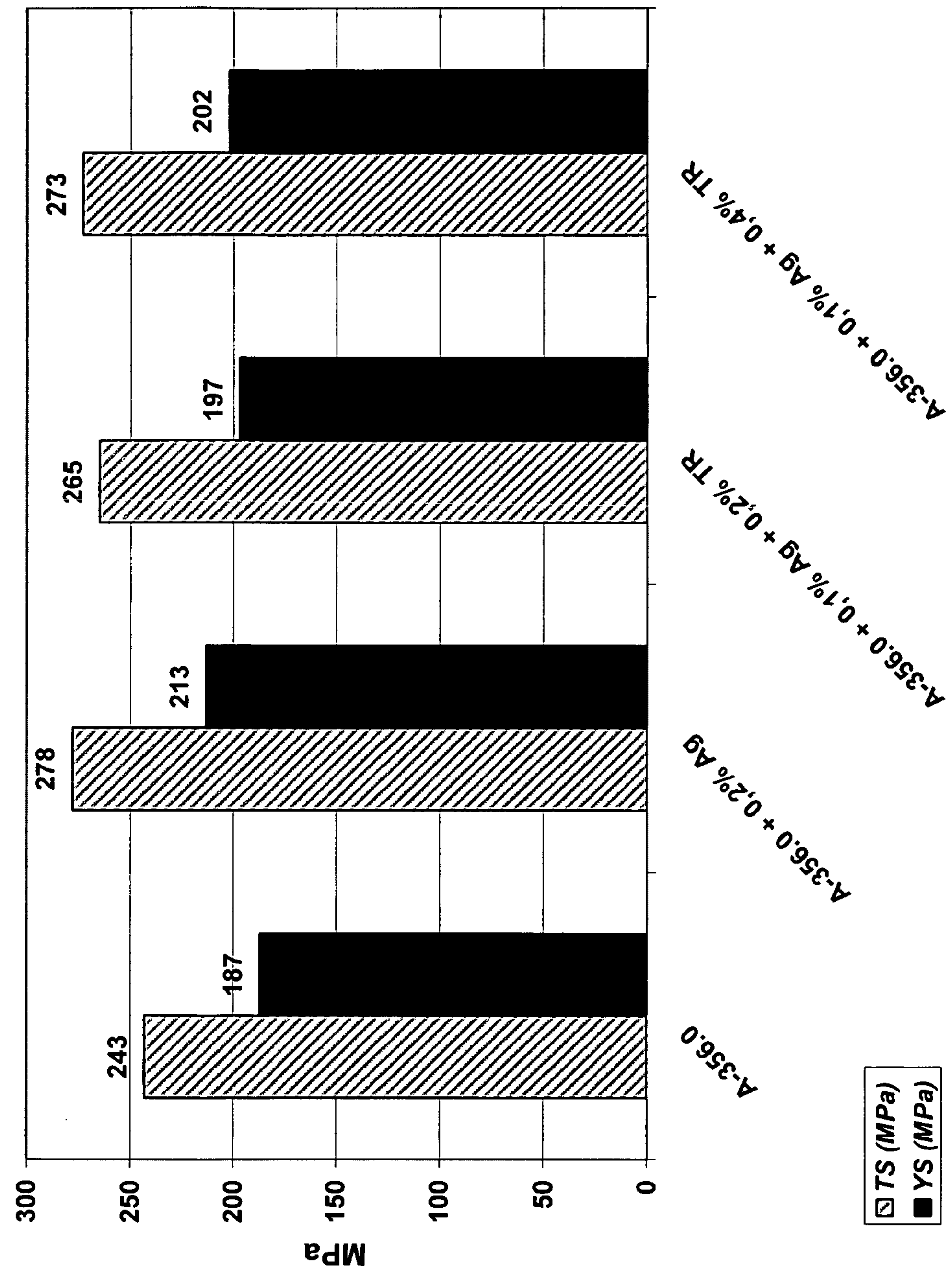
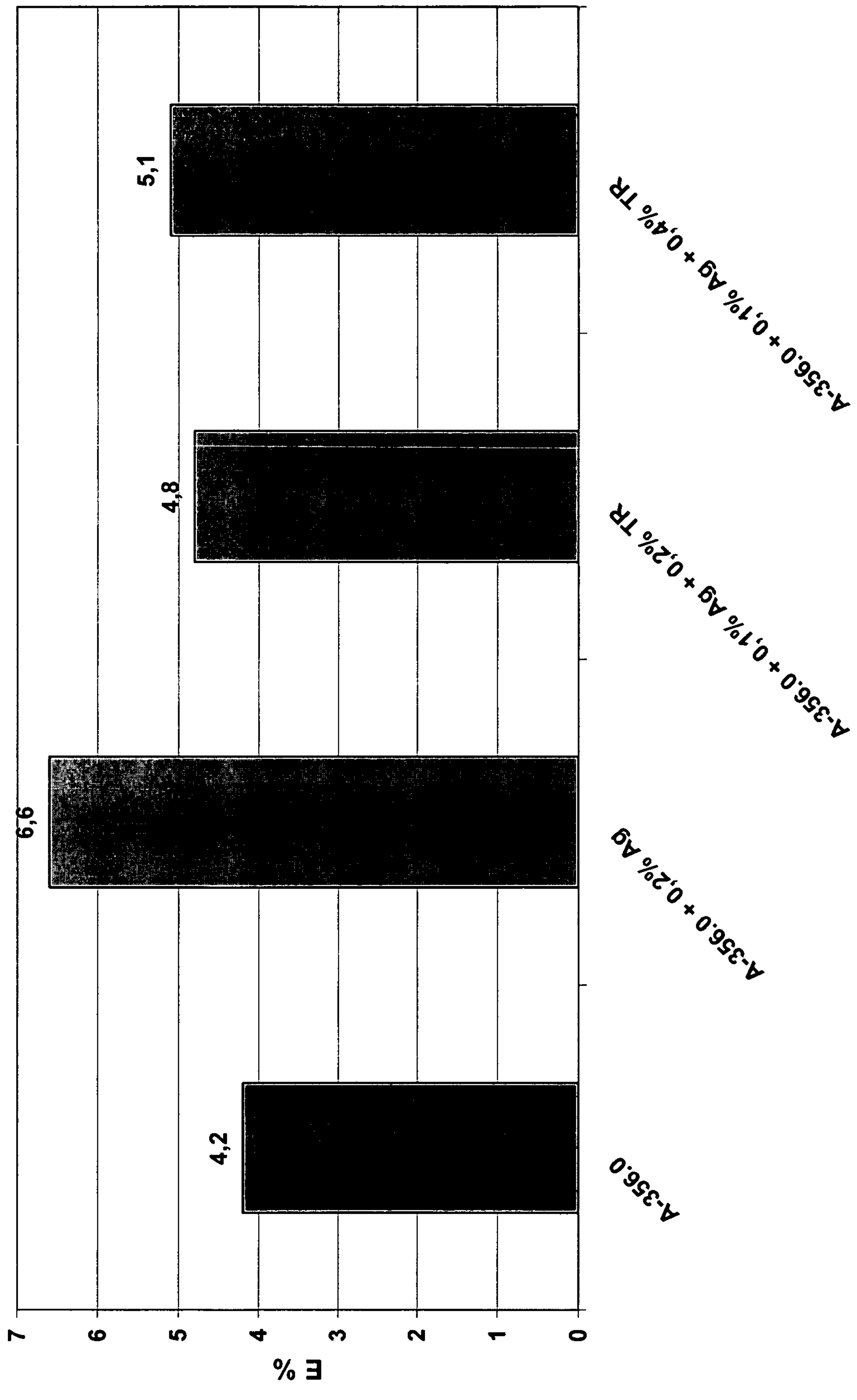

MPa
0
50
100
150
200
250
300
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR
243
187
278
213
265
197
273
202
▨ TS (MPa)
■ YS (MPa)

FIGURE 9


E %
0
1
2
3
4
5
6
7
4,2
6,6
4,8
5,1
A-356.0
A-356.0 + 0,2% Ag
A-356.0 + 0,1% Ag + 0,2% TR
A-356.0 + 0,1% Ag + 0,4% TR

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 5671

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DIVERSE: "Hüttenaluminium Gusslegierungen" 1994, ALUMINIUM RHEINFELDEN GMBH , XP002405005 * the whole document * -----	1-15	INV. C22C21/02 C22C21/04 ADD. C22C1/02 C22F1/04
Y	EP 1 657 319 A (BAYERISCHE MOTOREN WERKE AG [DE]) 17 May 2006 (2006-05-17) * claim 1 * * table 1 * -----	1-15	
Y	VASILAKOS A N ET AL: "THERMODYNAMIC ANALYSIS AND MECHANICAL PROPERTIES OF CAST ALUMINUM ALLOY A357 WITH CU, AG AND SM ADDITIONS" METALL, HUETHIG, HEIDELBERG, DE, vol. 50, no. 9, 1996, pages 556-560, XP009057849 ISSN: 0026-0746 * page 558 - page 559 * * table 1 * * figure 9 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC)
Y	CN 1 693 508 A (NIPPON KOGAKU KK [JP]) 9 November 2005 (2005-11-09) * page 9 * -----	1-15	C22C C22F
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The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	27 November 2006	Zimmermann, Frank

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