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(54) 7000 ALUMINUM ALLOY EXTRUDATE AND PROCESS FOR PRODUCING THE SAME

(57) [Object] To provide a 7000-series aluminum alloy extruded product of which an increase in proof stress or the like due to natural aging is suppressed by suppressing the positive effect due to storage at room temperature after extrusion, and a method of producing the

same.

[Solution] An extruded product includes a 7000-series aluminum alloy, the 7000-series aluminum alloy having an excess Mg content or an excess Zn content of less than 0.5 mass% with respect to a stoichiometric composition shown by MgZn₂.

FIG. 1

	CHEMICAL COMPONENT (MASS%)													EVALUATION	
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr	Al	AMOUNT OF MgZn ₂ (A)	(A) +εMg	(A) +εZn		A-Zn 5.36Mg -2.64 ≤ A ≤ 0.50
					(B)	(C)			(D)						
EXAMPLE 1	0.04	0.16	0.00	0.01	1.00	0.01	5.40	0.02	0.00	Bal.	6.38	0.00	0.02	0.04	EX-01
EXAMPLE 2	0.05	0.17	0.25	0.02	1.25	0.01	6.70	0.02	0.20	Bal.	7.95	0.00	0.00	0.00	EX-02
EXAMPLE 3	0.05	0.17	0.25	0.01	1.80	0.01	7.50	0.02	0.19	Bal.	8.90	0.41	0.00	-2.15	EX-03
EXAMPLE 4	0.05	0.15	0.01	0.00	1.00	0.01	5.78	0.02	0.00	Bal.	6.38	0.00	0.40	0.42	EX-04
EXAMPLE 5	0.05	0.15	0.01	0.01	1.40	0.01	5.40	0.02	0.00	Bal.	6.40	0.40	0.00	-2.10	EX-05
EXAMPLE 6	0.05	0.15	0.01	0.01	1.25	0.00	7.12	0.02	0.00	Bal.	7.97	0.00	0.40	0.40	EX-06
EXAMPLE 7	0.05	0.15	0.00	0.01	1.65	0.01	6.70	0.02	0.00	Bal.	7.95	0.40	0.00	-2.14	EX-07
COMPARATIVE EXAMPLE 1	0.04	0.15	0.01	0.00	1.00	0.00	6.38	0.02	0.00	Bal.	6.38	0.00	1.00	1.02	EX-08
COMPARATIVE EXAMPLE 2	0.04	0.15	0.00	0.01	1.00	0.02	5.88	0.02	0.00	Bal.	6.38	0.00	0.50	0.52	EX-09
COMPARATIVE EXAMPLE 3	0.05	0.15	0.00	0.01	1.50	0.00	5.40	0.02	0.00	Bal.	6.40	0.50	0.00	-2.64	EX-10
COMPARATIVE EXAMPLE 4	0.04	0.17	0.01	0.00	2.00	0.01	5.40	0.03	0.00	Bal.	6.40	1.00	0.00	-5.32	EX-11
COMPARATIVE EXAMPLE 5	0.03	0.16	0.15	0.00	0.70	0.00	5.64	0.02	0.21	Bal.	4.47	0.00	1.87	1.89	EX-12
COMPARATIVE EXAMPLE 6	0.07	0.16	0.16	0.00	0.62	0.00	5.39	0.02	0.18	Bal.	3.95	0.00	2.06	2.07	EX-13
COMPARATIVE EXAMPLE 7	0.04	0.15	0.16	0.00	0.66	0.00	5.39	0.02	0.19	Bal.	4.21	0.00	1.84	1.85	EX-14
COMPARATIVE EXAMPLE 8	0.06	0.16	0.25	0.02	1.81	0.01	5.84	0.02	0.19	Bal.	6.93	0.72	0.00	-3.86	EX-15
COMPARATIVE EXAMPLE 9	0.05	0.15	0.01	0.00	0.85	0.00	4.97	0.02	0.00	Bal.	5.42	0.00	0.40	0.41	EX-16
COMPARATIVE EXAMPLE 10	0.05	0.15	0.01	0.00	0.85	0.01	4.55	0.02	0.00	Bal.	5.40	0.00	0.00	-0.01	EX-17
COMPARATIVE EXAMPLE 11	0.05	0.15	0.00	0.01	1.25	0.01	4.55	0.02	0.00	Bal.	5.40	0.40	0.00	-2.15	EX-18

EP 2 141 253 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a 7000-series aluminum alloy extruded product that advantageously suppresses a positive effect due to natural aging even when the aluminum alloy is allowed to stand at room temperature after extrusion and then subjected to artificial aging, as compared with the case of subjecting the aluminum alloy to artificial aging immediately after extrusion, and a method of producing the same.

BACKGROUND ART

[0002] An extruded product produced using a 7000-series aluminum alloy is generally subjected to artificial aging after extrusion to obtain desired mechanical properties.

[0003] When producing an automotive structural member using such an extruded product, the extruded product is generally subjected to secondary processing (e.g., bending) in a state in which the proof stress is low (i.e., before artificial aging), and then subjected to artificial aging.

[0004] However, an automotive structural member may be required to have an impact energy absorption within a given range.

[0005] For example, when an automotive bumper reinforcement member has high strength, but exhibits a low energy absorption during side impact, the automobile is deformed to a large extent. As a result, the repair cost may increase, or the safety may be impaired.

[0006] A related-art 7000-series aluminum alloy extruded product shows an increase in proof stress after artificial aging when the extruded product is allowed to stand at room temperature after extrusion. Therefore, cracks tend to occur during side impact even if the proof stress is high so that the impact resistance (toughness) decreases.

[0007] In this case, secondary processing (e.g., bending) must be completed immediately after extrusion. This makes process management difficult.

[0008] The patent document 1 discloses an automotive bumper reinforcement member made of a 7000-series aluminum alloy. When using the 7000-series aluminum alloy disclosed in the patent document 1, transition elements such as Mn, Cr, and Zr must be added to obtain a fiber internal structure. Moreover, since overaging is required, the hardenability (quench sensitivity) must be taken into consideration. Therefore, the proof stress may not increase depending on the cross section of the extruded product. This complicates the production process so that the production cost increases.

Patent Document 1: Japanese Patent No. 3772962

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

5 **[0009]** The invention may provide a 7000-series aluminum alloy extruded product of which an increase in proof stress or the like due to natural aging is suppressed by suppressing the positive effect due to storage at room temperature after extrusion, and a method of producing the same.

Means for Solving the Problems

10 **[0010]** The invention directed to an aluminum alloy extruded product comprises a 7000-series aluminum alloy according to the Japanese Industrial Standards (JIS), the 7000-series aluminum alloy having an excess Mg content or an excess Zn content with respect to a stoichiometric composition shown by $MgZn_2$ of less than 0.5 mass%.

20 **[0011]** Note that the stoichiometric composition shown by $MgZn_2$ means that the ratio of components added is $MgZn_2$, and does not necessarily mean that the precipitate is $MgZn_2$.

25 **[0012]** In the aluminum alloy extruded product, the aluminum alloy extruded product may have an Mg content of 0.95 to 1.95 mass% and a Zn content of 5.10 to 7.90 mass%.

30 **[0013]** The alloy may be designed so that the Mg content and the Zn content are within the above ranges, and the value $A=Zn-5.36 \times Mg$ (mass%) is -2.64 to 0.50.

[0014] In the invention, other components may optionally be added to the aluminum alloy insofar as the aluminum alloy is an Al-Zn-Mg alloy containing aluminum as a base metal.

35 **[0015]** In the aluminum alloy extruded product, an increase in proof stress due to natural aging may be 15 MPa or less when comparing the proof stress of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to natural aging at 50°C or less for one week after extrusion and then subjecting the resulting product to artificial aging with the proof stress of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to artificial aging immediately after extrusion.

40 **[0016]** In the aluminum alloy extruded product, an increase in hardness HV due to natural aging may be seven or less when comparing the hardness of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to natural aging at 50°C or less for one week after extrusion and then subjecting the resulting product to artificial aging with the hardness of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to artificial aging immediately after extrusion.

[0017] Note that HV indicates Vickers hardness.

55 **[0018]** The invention directed to a method of producing an aluminum alloy extruded product comprises homogenizing a billet that is cast using the 7000-series aluminum alloy at 450 to 550°C, preheating the homogenized

product at 480 to 540°C, extruding the preheated product, and subjecting the extruded product to press quenching at a cooling rate of 29°C/min or more.

[0019] When heating a cylindrical billet to a given temperature and directly or indirectly extruding the billet using an extrusion press, a high-temperature extruded product is extruded from an extrusion die. The term "press quenching" used herein refers to cooling the extruded product using a fan or the like to achieve effects of quench (quenching effects).

[0020] In order to achieve sufficient effects of quench, it is preferable that the preheating temperature of the billet be set at 480°C or more and the cooling rate after extrusion be set at 29°C/min or more.

[0021] Each component of the aluminum alloy is described below.

Zn and Mg

[0022] Zn and Mg are bonded to improve the proof stress due to precipitation hardening.

[0023] Therefore, the Zn content and the Mg content are designed corresponding to the required proof stress. One aspect of the invention is **characterized in that** the excess Mg content or the excess Zn content with respect to the stoichiometric composition shown by $MgZn_2$ is less than 0.5 mass%.

[0024] When designing the Mg content and the Zn content as described above, it is particularly effective to set the Mg content at 0.95 to 1.95 mass% and set the Zn content at 5.10 to 7.90 mass%.

[0025] In this case, it is preferable that the value $A=Zn-5.36 \times Mg$ be -2.64 to 0.50, taking the atomic weights of Mg and Zn into consideration.

Cu

[0026] Cu reduces the potential difference between the grain boundary and the inside of the grain with a small amount of addition to improve the stress corrosion cracking resistance. Cu also improves the proof stress.

[0027] If the Cu content exceeds 0.4 mass%, the extrudability and the corrosion resistance deteriorate.

[0028] The Cu content is preferably 0.3 mass% or less from the viewpoint of corrosion resistance.

Mn, Cr, and Zr

[0029] Mn, Cr, and Zr are bonded to Al to form minute compounds to suppress recrystallization so that a fiber structure can be obtained.

[0030] Although each of Mn, Cr, and Zr serves as a fiber structure-forming element, it is effective to add these elements in combination. In particular, it is preferable to add Zr in an amount greater than those of Mn and Cr from the viewpoint of suppressing recrystallization. It is necessary to control the content of each of these elements to less than 0.25 mass%. If the total content of

these elements exceeds 0.25 mass%, the hardenability increases so that a sufficient strength cannot be obtained by air cooling.

[0031] Moreover, the size of compounds increases so that the toughness deteriorates.

Fe

[0032] Fe is an unavoidable impurity. Fe is bonded to Al and Si to form an Al-Fe-Si compound, or is bonded to Al to form an Al-Fe compound.

[0033] Such a compound tends to serve as a breakage starting point to decrease the toughness. Therefore, the Fe content is 0.35 mass% or less, and preferably 0.20 mass% or less.

Si

[0034] Si is an unavoidable impurity. Si is bonded to Al and Fe to form an Al-Fe-Si compound.

[0035] Such a compound tends to serve as a breakage starting point to decrease the toughness. Therefore, the Si content is 0.1 mass% or less, and preferably 0.05 mass% or less.

Homogenization of billet

[0036] A billet is homogenized to eliminate segregation of the main components (e.g., Mg, Zn, and Cu) in the billet and to divide and reduce the size of coarse Mn, Cr, Zr, Fe, and Si compounds that are crystallized during casting to decrease the toughness.

[0037] The homogenization temperature differs depending on the aluminum alloy components (alloy series). The solution treatment temperature suitable for a 7000-series Al-Zn-Mg alloy is 450 to 550°C.

[0038] It is preferable that the homogenization temperature of the billet be high, preferably 480°C or more, and ideally 520°C or more, while controlling the total content of elements (e.g., Mn, Cr, and Zr) that tend to undergo segregation at 0.25 mass% or less.

[0039] The upper limit of the homogenization temperature is set at 550°C because local melting may occur if the billet is held at a temperature of more than 550°C for a specific period of time.

[0040] If the homogenization temperature is less than 450°C, crystallized products produced when casting the billet are not sufficiently divided and reduced in size. As a result, the toughness decreases.

Extrusion conditions

[0041] An Al-Zn-Mg high-strength aluminum alloy exhibits poor extrudability as compared with a 6000-series alloy. Therefore, the extrusion conditions are also important factors.

[0042] The heating temperature of the billet is preferably 480 to 540°C. If the heating temperature is less than

480°C, the billet may not be extruded due to high extrusion resistance. If the heating temperature exceeds 540°C, the proof stress tends to decrease.

[0043] The temperature of the extrusion die is preferably 440 to 500°C. If the temperature of the extrusion die is less than 440°C, the billet may not be extruded due to a decrease in material temperature. If the temperature of the extrusion die exceeds 500°C, the die tends to break during annealing.

[0044] The temperature of the extruded product immediately after extrusion is preferably 580°C or less. If the temperature of the extruded product exceeds 580°C, a pickup occurs on the surface of the extruded product, whereby the appearance may deteriorate.

Hollow cross-sectional shape of extruded product

[0045] FIGS. 3, 4A and 4B show cross section examples used for evaluation tests.

[0046] A double hollow cross section shown in FIG. 3 has a dimension a of 70 to 150 mm, a dimension b of 50 to 100 mm, and a thickness t of 1 to 6 mm.

[0047] A triple hollow cross section shown in FIG. 4A has a dimension a of $40 \text{ mm} < a \leq 75 \text{ mm}$, a dimension b of $b \leq 120 \text{ mm}$, and rib thicknesses of $3 \leq t_1 \leq 8$, $1 \leq t_2 \leq 6$, $1 \leq t_{31} \leq 6$, and $1 \leq t_{32} \leq 6$.

[0048] A cross section shown in FIG. 4B has a dimension a of $a \leq 40 \text{ mm}$, a dimension b of $b \leq 140 \text{ mm}$, and rib thicknesses of $3 \leq t_1 \leq 8$, $1 \leq t_2 \leq 6$, $1 \leq t_{31} \leq 6$, and $1 \leq t_{32} \leq 6$.

[0049] Note that FIGS. 4A and 4B show schematic cross sections. An upright rib may be provided outside the peripheral rib.

[0050] The cross sections shown in FIGS. 3, 4A and 4B are examples of the cross section of a bumper reinforcement member provided on the front side and the rear side of an automobile.

[0051] The side impact energy absorption during collision is increased by forming a bumper reinforcement member having a double hollow cross section or a triple hollow cross section.

[0052] Moreover, cracks rarely occur during side impact so that the toughness increases.

Effects of the Invention

[0053] In the invention, the content of Mg and Zn as the main components of the 7000-series aluminum alloy are set so that the excess Mg content or the excess Zn content with respect to the stoichiometric composition shown by MgZn_2 is less than 0.5 mass%. Therefore, a positive effect due to storage at room temperature can be suppressed so that a decrease in side impact energy absorption can be suppressed.

[0054] Moreover, the time management from extrusion to secondary processing is facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055]

- 5 FIG. 1 shows an aluminum alloy composition.
 FIG. 2 shows evaluation results for an aluminum alloy extruded product.
 FIG. 3 shows an example of a double hollow cross section of an aluminum alloy extruded product according to one aspect of the invention.
 10 FIGS. 4A and 4B show an example of a triple hollow cross section of an aluminum alloy extruded product according to one aspect of the invention.

15 BEST MODE FOR CARRYING OUT THE INVENTION

[0056] Molten metal having the composition shown in FIG. 1 (table) was prepared, and was cast into a cylindrical billet with a diameter of 204 mm. The billet was homogenized at 480 to 520°C for about 12 hours or more.

[0057] The value of each component shown in FIG. 1 indicates an analytical value or a significant value calculated from the analytical value.

- [0058]** Extruded products having a double hollow cross section shown in FIG. 3 and extruded products having a triple hollow cross section shown in FIGS. 4A and 4B were air-cooled using a fan immediately after extrusion, subjected to press quenching, and subjected to two-stage artificial aging (90°C×4 hours and 140°C×14 hours), or subjected to artificial aging (90°C×4 hours and 140°C×14 hours) after natural aging at 40 (i.e., 50°C or less) for one week (seven days) to obtain specimens. FIG. 2 (table) shows the 0.2% proof stress (significant value) and the Vickers hardness HV (significant value) (load: 5 kg) of each specimen.

[0059] A specimen for measuring the 0.2% proof stress was prepared based on a JIS Z 2201 metal material tensile test specimen, and the 0.2% proof stress was evaluated in accordance with JIS Z 2241 "Metal Material Tensile Test Method".

[0060] The Vickers hardness HV was evaluated in accordance with JIS Z 2244 "Vickers Hardness Test Method".

- [0061]** Examples 1 to 7 indicate aluminum alloy extruded products according to the examples of the invention. Comparative Examples 1 to 11 are provided to clarify the characteristics of the aluminum alloy extruded products according to Examples 1 to 7 of the invention.

[0062] In the table, an Mg content of 0.95 to 1.95 is indicated as "Good", and a Zn content of 5.10 to 7.90 is indicated as "Good".

[0063] A value $A = \text{Zn} - 5.36 \times \text{Mg}$ of $-2.64 \leq A \leq 0.50$ is indicated as "Good", an increase in 0.2% proof stress of 15 MPa or less is indicated as "Good", and an increase in hardness HV (load: 5 kg) of 7 or less is indicated as "Good".

[0064] The amount of MgZn_2 added was 6.38% in Example 1, 7.95% in Example 2, and 8.90% in Example 3.

The proof stress increased along with an increase in the amount of $MgZn_2$ added.

[0065] This tendency was also observed for the comparative examples. However, when comparing Example 1 with Comparative Examples 1, 2, 3, 4, and 8, an increase in proof stress due to natural aging was 9 MPa (i.e., 15 MPa or less) in Example 1 in which the excess Zn content (+exZn) was 0.02%. On the other hand, an increase in proof stress due to natural aging was more than 15 MPa in Comparative Examples 1, 2, 3, 4, and 8.

[0066] An increase in hardness HV due to natural aging was four (i.e., seven or less) in Example 1. On the other hand, an increase in hardness HV due to natural aging was 10 or more in Comparative Examples 1, 2, 3, 4, and 8.

[0067] Example 2 indicates a composition in which Zn and Mg were balanced. In Example 3 in which the excess Mg content (+exMg) was 0.41%, an increase in proof stress due to natural aging was 15 MPa or less, and an increase in hardness HV due to natural aging was seven or less.

[0068] In Comparative Examples 5, 6, and 7 in which the Zn content was increased to 5.40% (i.e., the Mg content was decreased), an increase in proof stress due to natural aging was more than 15 MPa.

[0069] In Examples 4 to 7, the Mg content was set at 0.95 to 1.95 and the Zn content was set at 5.10 to 7.90, and the relationship between the value $A=Zn-5.36 \times Mg$ and the positive effect due to natural aging was investigated while setting the excess Mg content or the excess Zn content with respect to the stoichiometric composition shown by $MgZn_2$ at less than 0.5 mass%.

[0070] When the value A was -2.64 to 0.50, an increase in proof stress due to natural aging (40°C×7 days) was 15 MPa or less, and an increase in hardness HV due to natural aging was seven or less.

[0071] In Comparative Example 8 in which the Mg content and the Zn content were within the design ranges, but the excess Mg content was 0.72 mass% (i.e., 0.5 mass% or more) and the value A was -3.86 (i.e., -2.64 or less), an increase in proof stress was 16 MPa and an increase in hardness HV was 11 (i.e., the target values of the examples of the invention were exceeded).

[0072] In Comparative Examples 9, 10, and 11, when the excess Mg content or the excess Zn content was less than 0.5 mass%, but the Mg content was 5.10% or less or the Zn content was 0.95% or less, an increase in proof stress and an increase in hardness HV exceeded the target values of the examples of the invention. Therefore, it was found that it is preferable to set the Mg content and the Zn content within the above-mentioned ranges, and set the amount of $MgZn_2$ at 5.4% or more, and preferably 6.0% or more.

[0073] In the examples of the invention, the difference due to natural aging at 40°C for one week was evaluated by the proof stress value and the hardness. Since it was confirmed that the positive effect due to natural aging is suppressed, it is considered that the toughness is stabi-

lized due to artificial aging so that the impact resistance increases.

INDUSTRIAL APPLICABILITY

[0074] Since the aluminum alloy extruded products according to the examples of the invention can suppress the positive effect due to artificial aging after extrusion, the artificial aging effect after secondary processing is stabilized even if the extruded product is allowed to stand at room temperature for a long period of time. Therefore, the aluminum alloy extruded products can be widely used as 7000-series aluminum alloy extruded products utilized in the field in which the required quality is strictly limited to a narrow range, such as automotive bumper reinforcement members.

Claims

1. An aluminum alloy extruded product comprising a 7000-series aluminum alloy, the 7000-series aluminum alloy having an excess Mg content or an excess Zn content with respect to a stoichiometric composition shown by $MgZn_2$ of less than 0.5 mass%.
2. The aluminum alloy extruded product as defined in claim 1, the aluminum alloy extruded product having an Mg content of 0.95 to 1.95 mass% and a Zn content of 5.10 to 7.90 mass%.
3. The aluminum alloy extruded product as defined in claim 2, the aluminum alloy extruded product having a value A indicated by a relational expression $A=Zn-5.36 \times Mg$ (mass%) of -2.64 to 0.50.
4. The aluminum alloy extruded product as defined in any one of claims 1 to 3, an increase in proof stress due to natural aging being 15 MPa or less when comparing the proof stress of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to natural aging at 50°C or less for one week after extrusion and then subjecting the resulting product to artificial aging with the proof stress of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to artificial aging immediately after extrusion.
5. The aluminum alloy extruded product as defined in any one of claims 1 to 3, an increase in hardness HV due to natural aging being seven or less when comparing the hardness of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to natural aging at 50°C or less for one week after extrusion and then subjecting the resulting product to artificial aging with the hardness of the aluminum alloy extruded product obtained by subjecting the aluminum alloy to artificial aging immedi-

ately after extrusion.

6. A method of producing an aluminum alloy extruded product, the method comprising homogenizing a billet that is cast using the 7000-series aluminum alloy as defined in any one of claims 1 to 5 at 450 to 550°C, preheating the homogenized product at 480 to 540°C, extruding the preheated product, and subjecting the extruded product to press quenching at a cooling rate of 29°C/min or more.

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FIG. 1

	CHEMICAL COMPONENT (MASS%)													EVALUATION		
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr	Al	AMOUNT OF MgZn ₂ (A)	(A) +exMg	(A) +exZn		A=Zn-5.30Mg -2.64 ≤ A ≤ 0.50	
															(B)	(C)
EXAMPLE 1	0.04	0.16	0.00	0.01	1.00	0.01	5.40	0.02	0.00	Bal.	6.38	0.00	0.02	0.04	GOOD	GOOD
EXAMPLE 2	0.05	0.17	0.25	0.02	1.25	0.01	6.70	0.02	0.20	Bal.	7.95	0.00	0.00	0.00	GOOD	GOOD
EXAMPLE 3	0.05	0.17	0.25	0.01	1.80	0.01	7.50	0.02	0.19	Bal.	8.90	0.41	0.00	-2.15	GOOD	GOOD
EXAMPLE 4	0.05	0.15	0.01	0.00	1.00	0.01	5.78	0.02	0.00	Bal.	6.38	0.00	0.40	0.42	GOOD	GOOD
EXAMPLE 5	0.05	0.15	0.01	0.01	1.40	0.01	5.40	0.02	0.00	Bal.	6.40	0.40	0.00	-2.10	GOOD	GOOD
EXAMPLE 6	0.05	0.15	0.01	0.01	1.25	0.00	7.12	0.02	0.00	Bal.	7.97	0.00	0.40	0.42	GOOD	GOOD
EXAMPLE 7	0.05	0.15	0.00	0.01	1.65	0.01	6.70	0.02	0.00	Bal.	7.95	0.40	0.00	-2.14	GOOD	GOOD
COMPARATIVE EXAMPLE 1	0.04	0.15	0.01	0.00	1.00	0.00	6.38	0.02	0.00	Bal.	6.38	0.00	1.00	1.02	BAD	BAD
COMPARATIVE EXAMPLE 2	0.04	0.15	0.00	0.01	1.00	0.02	5.88	0.02	0.00	Bal.	6.38	0.00	0.50	0.52	BAD	BAD
COMPARATIVE EXAMPLE 3	0.05	0.15	0.00	0.01	1.50	0.01	5.40	0.02	0.00	Bal.	6.40	0.50	0.00	-2.64	BAD	BAD
COMPARATIVE EXAMPLE 4	0.04	0.17	0.01	0.00	2.00	0.01	5.40	0.03	0.00	Bal.	6.40	1.00	0.00	-5.32	BAD	BAD
COMPARATIVE EXAMPLE 5	0.03	0.16	0.15	0.00	0.70	0.00	5.64	0.02	0.21	Bal.	4.47	0.00	1.87	1.89	BAD	BAD
COMPARATIVE EXAMPLE 6	0.07	0.16	0.16	0.00	0.62	0.00	5.39	0.02	0.18	Bal.	3.95	0.00	2.06	2.07	BAD	BAD
COMPARATIVE EXAMPLE 7	0.04	0.15	0.16	0.00	0.66	0.00	5.39	0.02	0.19	Bal.	4.21	0.00	1.84	1.85	BAD	BAD
COMPARATIVE EXAMPLE 8	0.06	0.16	0.25	0.02	1.81	0.01	5.84	0.02	0.19	Bal.	6.93	0.72	0.00	-3.86	BAD	BAD
COMPARATIVE EXAMPLE 9	0.05	0.15	0.01	0.00	0.85	0.00	4.97	0.02	0.00	Bal.	5.42	0.00	0.40	0.41	GOOD	GOOD
COMPARATIVE EXAMPLE 10	0.05	0.15	0.01	0.00	0.85	0.01	4.55	0.02	0.00	Bal.	5.40	0.00	0.00	-0.01	GOOD	BAD
COMPARATIVE EXAMPLE 11	0.05	0.15	0.00	0.01	1.25	0.01	4.55	0.02	0.00	Bal.	5.40	0.40	0.00	-2.15	GOOD	BAD

FIG. 2

	WITHOUT NATURAL AGING		NATURAL AGING (40°Cx1W)		DIFFERENCE DUE TO NATURAL AGING	
	0.2% PROOF STRESS (MPa)	HV5	0.2% PROOF STRESS (MPa)	HV5	0.2% PROOF STRESS (MPa)	HV5
EXAMPLE 1	341	114	350	118	9	4
EXAMPLE 2	420	149	422	151	2	2
EXAMPLE 3	542	172	552	177	10	5
EXAMPLE 4	316	107	322	110	6	3
EXAMPLE 5	374	133	385	138	11	5
EXAMPLE 6	452	156	458	158	6	2
EXAMPLE 7	494	166	499	168	5	2
COMPARATIVE EXAMPLE 1	344	119	378	135	34	16
COMPARATIVE EXAMPLE 2	317	110	345	123	28	13
COMPARATIVE EXAMPLE 3	375	130	409	142	34	12
COMPARATIVE EXAMPLE 4	418	139	471	169	53	30
COMPARATIVE EXAMPLE 5	223	74	267	89	44	15
COMPARATIVE EXAMPLE 6	212	71	247	82	35	11
COMPARATIVE EXAMPLE 7	225	75	273	101	48	26
COMPARATIVE EXAMPLE 8	445	157	461	168	16	11
COMPARATIVE EXAMPLE 9	227	72	270	102	43	30
COMPARATIVE EXAMPLE 10	210	66	242	86	32	20
COMPARATIVE EXAMPLE 11	315	105	354	117	39	12

FIG. 3

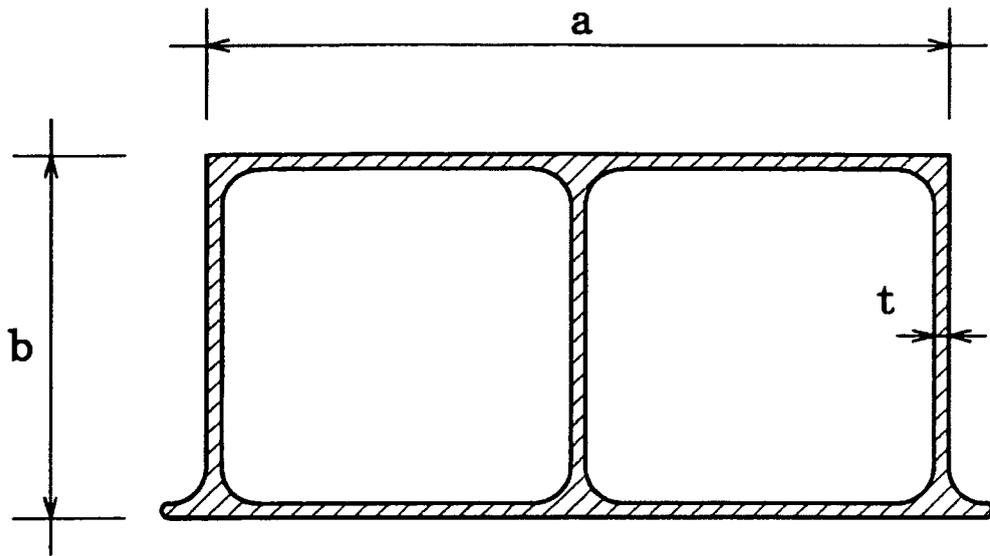


FIG. 4B

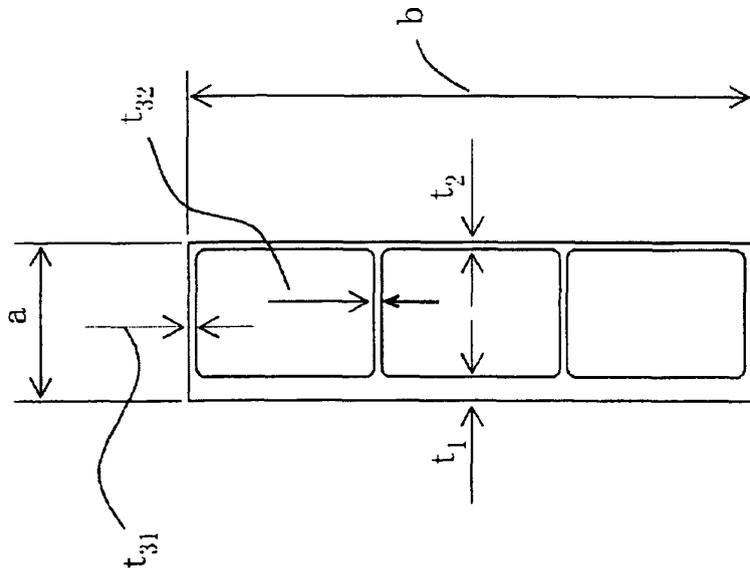
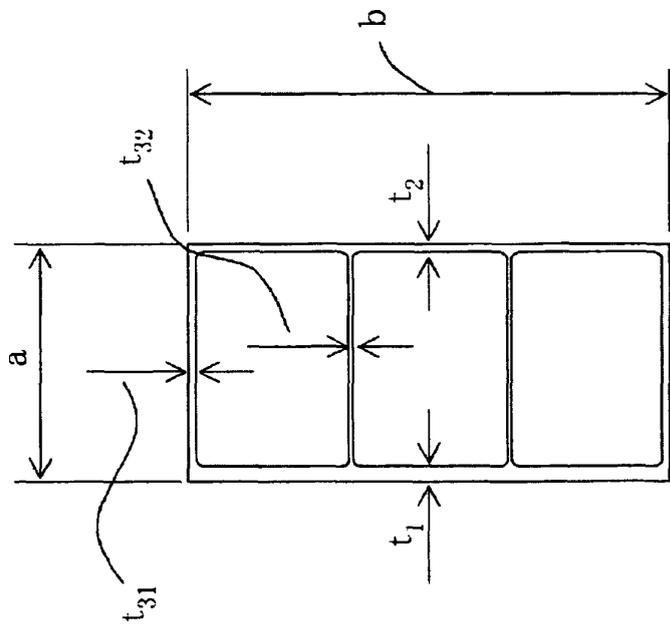


FIG. 4A



EP 2 141 253 A1

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2008/055408
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<p>A. CLASSIFICATION OF SUBJECT MATTER C22C21/10(2006.01) i, B21C23/00(2006.01) i, C22F1/053(2006.01) i, C22F1/00(2006.01) n</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																																
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) C22C21/00-21/18, B21C23/00, C22F1/04-1/057, C22F1/00</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008 Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>																																
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>JP 09-310141 A (Nippon Light Metal Co., Ltd.), 02 December, 1997 (02.12.97), Claim 2; samples No.3 and No.4 according to the embodiments of this invention on the table 1 (Family: none)</td> <td>1-6</td> </tr> <tr> <td>X</td> <td>JP 08-144031 A (The Furukawa Electric Co., Ltd.), 04 June, 1996 (04.06.96), Claim 1; alloys No.1 and No.2 according to this invention on the table 1 (Family: none)</td> <td>1-6</td> </tr> <tr> <td>X</td> <td>JP 09-268342 A (Aisin Keikinzo Co., Ltd.), 14 October, 1997 (14.10.97), Claim 2; alloys A and B on the table 1 (Family: none)</td> <td>1-3</td> </tr> </tbody> </table> <p><input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p> <table border="1"> <tr> <td>* Special categories of cited documents:</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table> <table border="1"> <tr> <td>Date of the actual completion of the international search 05 June, 2008 (05.06.08)</td> <td>Date of mailing of the international search report 17 June, 2008 (17.06.08)</td> </tr> <tr> <td>Name and mailing address of the ISA/ Japanese Patent Office</td> <td>Authorized officer</td> </tr> <tr> <td>Facsimile No.</td> <td>Telephone No.</td> </tr> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	JP 09-310141 A (Nippon Light Metal Co., Ltd.), 02 December, 1997 (02.12.97), Claim 2; samples No.3 and No.4 according to the embodiments of this invention on the table 1 (Family: none)	1-6	X	JP 08-144031 A (The Furukawa Electric Co., Ltd.), 04 June, 1996 (04.06.96), Claim 1; alloys No.1 and No.2 according to this invention on the table 1 (Family: none)	1-6	X	JP 09-268342 A (Aisin Keikinzo Co., Ltd.), 14 October, 1997 (14.10.97), Claim 2; alloys A and B on the table 1 (Family: none)	1-3	* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means		"P" document published prior to the international filing date but later than the priority date claimed		Date of the actual completion of the international search 05 June, 2008 (05.06.08)	Date of mailing of the international search report 17 June, 2008 (17.06.08)	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	Facsimile No.	Telephone No.
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Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/055408

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 59-140346 A (Mitsui Aruminiumu Kogyo Kabushiki Kaisha), 11 August, 1984 (11.08.84), Page 2, left column, line 16 to right column, line 1; alloy I according to the invention on the table 1 (Family: none)	1-3
X	JP 2006-233336 A (Kobe Steel, Ltd.), 07 September, 2006 (07.09.06), Table 1 in Par. Nos. [0017], [0018] (Family: none)	1,2

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/055408

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The invention of claims 1-3 and 6 is directed to a 7000 aluminum alloy extrudate wherein in the composition of contained Mg and Zn components, the mutual quantitative relationship between Mg and Zn contents is specified, or a process for producing the same.

The invention of claims 4 and 6 is directed to an aluminum alloy extrudate wherein in addition to claims 1-3, the upper limit of the effect of proof strength increase by natural aging is specified, or a process for producing the same.

The invention of claims 5 and 6 is directed to an aluminum alloy extrudate (continued to extra sheet)

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

the

- The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/055408

Continuation of Box No. III of continuation of first sheet (2)

wherein in addition to claims 1-3, the upper limit of the effect of hardness increase by natural aging is specified, or a process for producing the same.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3772962 B [0008]