(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 241 193 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **26.06.91 Bulletin 91/26**

(51) Int. Cl.[5]: **B21C 33/02**

(21) Application number: **87302718.9**

(22) Date of filing: **30.03.87**

(54) **Process for producing extruded aluminum alloys.**

(30) Priority: **04.04.86 JP 78931/86**
04.04.86 JP 78932/86

(43) Date of publication of application: **14.10.87 Bulletin 87/42**

(45) Publication of the grant of the patent: **26.06.91 Bulletin 91/26**

(84) Designated Contracting States: **CH DE FR GB LI**

(56) References cited:
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EP-A- 0 110 653
FR-A- 2 293 263
GB-A- 1 139 034

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Description

The present invention relates to a process for producing extruded aluminum alloys and more particularly to a process for producing extruded aluminum alloys regardless of the elements contained in relatively high percentage so as to improve mechanical properties, wherein the percentages are represented by weight.

To produce extruded aluminum or aluminum alloy the common practice is to make billets first and extrude them after heating. More specifically, ingots of aluminum or aluminum alloy are melted in a furnace, cast into billets and then homogenized in a homogenizing furnace. Finally the billets are heated to a temperature at which they can be extruded through an extruding machine.

Recently there is an increasing demand for extruded aluminum alloys having excellent mechanical properties, such as high wear- resistance, anti-friction, heat-proofness and lubricity. These properties are especially required in the production of automobiles, machine tools and engines. In building storage houses of nuclear wastes an excellent neutron absorptive ability is required.

In order to achieve these desired properties various second phase elements are added in the aluminum. For example, Zn, Mg and Cu are added in fairly high percentage so as to increase the strength of the alloy. Si is added when high wear-resistance is required and Ni, Fe, Cr and Mn are added in high proportions to enhance the heat-resistance. However when these elements are added in the aluminum alloy difficulties are involved in the production of billets, in the form of cracks and/or excessively increased hardness. Because of these difficulties the quantities and proportion of these elements to be added must be limited so that no problem is involved in the production of billets.

When low melting point metals, such as Pb and Sn, are added to improve the lubricity or when B is added to improve the neutron absorption ability the structural unequalness due to uneven crystallization of these elements is likely to arise. In addition, the billets will become difficult to cast.

GB-A-1139034 describes and claims a process for producing an extruded aluminum alloy by direct or indirect extrusion, comprising the steps of pouring a molten alloy into a container section of an extruding machine, applying pressure to the molten alloy in the container section by advancing a stem of the extruding machine in a state in which the container is closed, thereby allowing the molten alloy to form into a mass, stopping the application of pressure when the temperature of the mass reaches an optimum temperature suitable for extrusion and extruding the mass through the extruding machine without reheating it.

An object of the invention is to solve the problems pointed out with respect to the known methods of producing extruded aluminum alloys and to provide a process for producing extruded aluminum alloys having high percentages of second phase elements intended to improve the properties of the alloys whereby the alloys have a homogenized structure.

According to the present invention a process for producing an extruded aluminum alloy is characterized in that the pressure applied is in the range of 50 kgf/cm^2, to 1500 kgf/cm^2 (4,9 MPa to 147 MPa) heated to a temperature of 300°C to 350°C and the solidifying process is finished when the temperature of the aluminum alloy has fallen to 1/3 to 2/3 of the liquid phase temperature and the mass obtained is immediately extruded.

Solidification under pressure takes place in the container of the extruding machine.

Herein the solidification does not mean a complete solidification but includes a state in which a liquid phase is still present in the billet-like mass, that is, a semi-solid state.

As described the molten aluminum or aluminum alloy is introduced into the container section of the extruding machine, and solidified therein under pressure. This is advantageous firstly, in that the homogenizing process is dispensed with and secondly, in that the homogenous structure having fine grains avoids the possibility of producing mold cavities. A further advantage is that the alloy is effectively solidified and extruded regardless of the high percentage of high melting point metals. Under the known methods the extrusion would be difficult because of the presence of other elements. In addition, the homogenous structure having fine grains makes the extrusion smooth, thereby minimizing the extruding force. This leads to excellent mechanical properties. Furthermore, by eliminating the necessity for the homogenizing process the pre-heat treatment can be also dispensed with, thereby saving the energy costs.

As described above, the molten alloy can be fed directly to the container of an extruding machine. Under the known methods an intermediate solidifying step is required. The elimination of the intermediate step leads to the simplified and economical production of extruded aluminum alloys.

The aluminum alloy to be extruded, which contains a relatively large quantity of high melting point elements, is melted in the known manner and the molten alloy is poured into a container of the extruding machine in which the stem is withdrawn so as to close the container. Preferably the container is previously heated to 300°C to 350°C. The container has a lower temperature than 300°C, the molten alloy is likely to begin solidifying immediately near the wall of the container, which has a lower temperature than that of the molten alloy. Whereas, if the molten alloy has a higher temperature than 350°C, the cooling will take time, thereby prolonging the time for which the molten alloy solidifies. In addition, the resulting mass is likely to be coarse in the structural grain because of the excessive growth of the crystallization.

After the molten alloy is poured into the container pressure is applied thereto by moving the stem forward over a predetermined distance so as to solidify the molten alloy into billet-lime masses hard enough to be extruded smoothly. The pressurized solidification is conductive to the transfer of heat to the container of the extruding machine, thereby preventing the growth of primary and eutectic crystals. As a result the masses have a desired structure of fine grains. In addition, during the whole process of solidifying the molten alloy is pressurized, thereby preventing cavities and holes from being produced. The cavity-free masses are suitable for extrusion.

The pressure required in the process of solidifying is in the range of 50 kgf/cm^2 to 1500 kgf/cm^2 (4,9 MPa to 147 MPa), preferably 500 to 1,000 kgf/cm^2 (49MPa to 98 MPa). This range of pressure is effective to produce the structure of fine grains in the masses, which means that there is no need for providing an additional homogenizing process. The elimination of the extra process saves energy and time, thereby reducing the production cost. The degree of pressure had no major influence upon the quality of the masses, but the experiments have demonstrated that the range specified above is critical, if the pressure is smaller than 50 kgf/cm^2 (4,9 MPa), no desired strength or fine-grain structure of the products results and if it is greater than 1,500 kgf/cm^2 (147 MPa), it will not promise an increased effect proportional to the increased pressure but it may only result in the waste of energy. When the molten alloy becomes solid to a desired hardless, the application of pressure is suspended. Then the container is opened, the application of pressure is resumed by advancing the stem again. In this way the solid mass is obtained. It is possible to resume the forward movement of the stem after the temperature falls up to 1/3 to 2/3 of the liquid phase temperature, preferably 1/2 of it. In any case the immediate initiation of extrusion by the stem is advantageous in avoiding the fall of the temperature of the mass; otherwise the mass would be necessarily heated at an extra step.

The following advantages result :

(a) It is possible to obtain extruded aluminum alloys having excellent mechanical strength :

As aluminum alloys having excellent mechanical properties Al-Zn-Mg-Cu alloy is known under identification Nos. A7075, A7178 and A7050, but recently in line with the demand for the increased tensile strength greater quantities of Zn, Mg and Cu are added. However the increases in the quantities of these elements leads to the fragility or lack of tenacity. When the products having such deficiency are liable to breakage during forging or casting.

In contrast, the present invention has achieved a process of extruding Al-Zn-Mg-Cu alloy without trading off the desired properties arising from the addition of these elements, wherein the percentage of these elements are as follows :

Zn:	7.0 to 12%	Mg:	2.0 to 7.0%
Cu:	0.5 to 3.0%		

Preferably, one or more elements selected from 0.2 to 1.0% of Mn, 0.1 to 0.4% of Cr, and 0.05 to 0.3% of Zr are added.

The Zn, Mg and Cu are added to increase the mechanical strength and if the quantities of these elements are respectively less than 7.0%, 2.0% and 0.5%, the desired strength will not be achieved. Therefore if the quantities of these elements are less than the lower limits the billet-like masses can be cast by the known method.

If the quantities of these elements exceed each upper limit, that is, 12% of Zn, 7.0% of Mg and 3.0% of Cu, they are likely to crystallize in large sizes, which makes it difficult to achieve the desired strength of the alloy. The optimum range of quantities are 8.0 to 10% of Zn, 3.0 to 5.0% of Mg, and 1.0 to 2.0% of Cu.

Optional elements, such as Mn, Cr and Zr, can be added where necessary. These elements are equally conductive to the increased fine crystallization and mechanical and chemical strength, such as anti-stress and anti-corrosion, provided that the contents of them are in the ranges of 0.2 to 1.0% of Mn, 0.1 to 0.4% of Cr, and 0.05 to 0.3% of Zn. If the respective contents are less than the lower limits, no effects will result and if they exceed the upper limits, the elements are likely to crystallize in unfavourably large sizes.

(b) It is possible to obtain extruded aluminum alloys having excellent wear-resistance :

The extrusion of Al-Si alloys is made easy, which would be difficult to achieve under the known methods. As well known in the art, Al-Si alloys have the improved wear and heat-resistance and have a low thermal coefficient of expansion ; they are widely used in various fields becuase of these excellent properties.

In order to improve the wear-resistance 4.0 to 40% of Si is is contained and preferably 4.0 to 20% Cu is added. In addition to Si and Cu the following elements can be added singly or in combination in the specific ranges of the following percentages :

Fe:	0.5 to 20%
Cr:	0.5 to 20%
Mn:	1.0 to 20%
Ni:	0.5 to 20%
Ti:	0.5 to 10%
Be:	1.0 to 20%
V :	1.0 to 20%
Y :	2.0 to 20%
Zr:	0.5 to 10%
Mg:	0.3 to 2.0%

4.0% or more of Si is contained, thereby increasing the wear-resistance in proportion to the increases in the quantity ; preferably, 12% or more of it is contained in the hypereutectic region of the alloy. However, if the quantity exceeds 40%, the extrusion becomes difficult. The experiments have revealed that the quantity is preferably in a range of 16 to 30% in the light of the desired wear-resistance and easiness of extrusion.

Fe, Cr, Mn, Ni, Ti, Cu, Be, V, Y and Zr are equally effective to improve the thermal characteristics, such as heat-proof ability and lower co-efficient of expansion, so that these elements are functionally equivalents to each other. The contents of these elements should be not less or more than the ranges specified above, that is, if they are less than the lower limits no desired effect will result in the thermal characteristics and if they are more than the upper limits the extrusion will become difficult because of the production of eutectic crystals of coarse grain. Mg is effective to increase the strenght of the alloy but if the content of it is less than 0.3% no effect will result. If it exceeds 2% the mechanical properties of the alloy will degenerate because of the production of eutectic crystals.

(c) It is possible to obtain extruded aluminum alloy having excellent neutron absorptive property :

According to this process Al-B alloy containing a relatively large quantity of boron can be extruded without any problem. The Al-B alloy containes 0.5 to 12% of B, and when necessary, 0.5 to 6.0% of Mg and 0.2 to 1.5% of Si and the balance consists of aluminum and impurities.

B is effective to impart the neutron absorptive ability to the alloy and also to increase the mechanical strength but if the content is less than 0.5%, no desired effect will result ; if it exceeds 12% the extrusion of the alloy will become difficult.

Optionnaly 0.5 to 6.0% of Mg or 0.2 to 1.5% of Si or both are added. Mg if added to increase the mechanical strength and maintain the rust-proofness but if the content of it is less than 0.5% no desired effect of increasing the strength will result. If it exceeds 6% the extrusion will become difficult and the extruded alloy is liable to crack under stress. Si is effective to increase the strength in co-operation with the Mg content but if the content of Si is less than 0.2% no desired effect will result. If it exceeds 1.5% the strength of the alloy will degenerate.

Optionnaly 0.1 to 0.6% of Mn, 0.05 to 0.3% of Cr and 0.05 to 0.3% of Zr can be added where necessary, so as to produce fine crystallisation and 0.01 to 0.2% of Ti can be added to obtain casing of fine grain.

(d) It is possible to obtain extruded aluminum alloys having excellent lubricity.

Lubricity is particularly important for bearings. The extruded aluminum alloy produced is suitable for producing bearings because of its excellent lubricity.

In order to improve the lubricity of the extruded alloys 1.5 to 7.0 of Cu is added and optionally, one or more of 1.0 to 15% of Pb, 1.0 to 15% of Sn, 1.0 to 15% of Bi and 1.0 to 15% of In are added. When necessary, 5.0 to 20% of Si or 0.1 to 3.0% of Mg or both are added. The balance consists of aluminum and unavoidable impurities.

Cu is essential for increasing the mechanical strength but if the content of it is less than 1.5% no desired effect will result. If it exceeds 7.0% the mechanical strength will be lost.

Low melting point elements, such as Pb, Bi, Sn and In, are equally effective to increase the lubricity of the alloy particularly required when it is used in frictional places. For this use they are exchangeable and when the alloy contains at least one of them the lubricity will be improved. If the content of each element is less than 1% no desired effect will result. However if it exceeds 15% the extrusion will become difficult.

Optionally 5.0 to 20% of Si or 0.1 to 3.0% of Mg or both and additionally one or more of 0.1 to 0.8% of Mn, 0.05 to 0.35% of Cr 0.05 to 0.3% of Zr, 0.01 to 0.2% of Ti and 0.002 to 0.04% of B can be added regardless of whether Si and/or Mg is contained. Si is effective to increase the wear-resistance of the alloy but if the content of it is less than 5% no desired effect will result. It it exceeds 20% the extrusion will become difficult. Mg is effective to increase the mechanical strength of the alloy but if the content of it is less than 0.1% no desired effect will result. If it exceeds 3.0% the mechanical strength will be lost, Mn, Cr and Zr are equally effective to obtain the structure of fine grain of the alloy and Ti and B are equally effective to secure a casting of fine grain. However if the content of each element is less than the lower limit no desired effect will result and if it exceeds the upper limit, Mn, Cr or Zr is likely to produce unfavourably large crystals, thereby reducing the mechanical strength.

The invention will be better understood from the following examples :

EXAMPLE 1

An Al-Zn-Mg-Cu base alloy was used in Example 1, whose chemical composition is shown in Table 1. This aluminum alloy is known for its mechanical strength. It will be appreciated from the table that Zn is contained in a greater quantity than that in the known No. A7000 alloys, which would be difficult to extrude by known methods :

TABLE 1

Specimen No.		Chemical Composition (wt%)						
		Zn	Mg	Cu	Mn	Cr	Zr	Aℓ
Process of Invention	1	8.7	3.6	1.1	-	-	-	Balance
	2	8.3	3.0	1.0	-	-	0.14	Balance
	3	9.9	4.1	0.9	0.8	-	-	Balance
	4	11.5	6.2	1.3	-	0.25	-	Balance
	5	8.5	2.3	2.1	0.4	-	0.18	Balance
Comp. Process	6	6.4	2.5	1.8	0.3	0.2	-	Balance
	7	6.8	2.9	2.0		0.2	-	Balance
	8	6.1	2.3	2.3	-	-	0.14	Balance

The alloys from Nos. 1 to 5 were dissolved at a temperature 100°C higher than its liquid phase temperature (hereinafter expressed as "at the liquid phase temperature + 100°C"), and the molten alloy was poured into the container previously heated to about 320°C. Immediately it was allowed to solidify at a pressure of 1,000 kgf/cm^2 (98 MPa) by advancing the stem. When the temperature of the molten mass fell to 1/2 of the liquid phase temperature the application of pressure was stopped. In this way a mass (75 mm in diameter, and 100 mm in length) was obtained, which was placed in the container of the extruding machine and extruded therethrough into a rod having a diameter of 12 mm. The mass was free from any crack and the extrusion was smoothly carried out.

The extruded alloy was subjected to solid solution heat treatment at 460°C and aging at 120°C for 24 Hours. The resulting mechanical properties are shown in Table 2. In tables 1 and 2 each of the comparative alloys contained Zn, Mg and Cu to the extent that it was considered as the upper limit for production under the known method and was formed in a billet thereunder. Then it was subjected to homogenizing heat treatment and extruded by an extruding machine.

TABLE 2

Specimen No.		Mechanical Properties		
		Tensile Strength (Kgf/mm^2)	Load Strength (Kgf/mm^2)	Elongation (%)
Process of Invention	1	64.9	56.9	6.9
	2	68.0	65.0	8.1
	3	81.5	78.3	5.9
	4	83.4	79.1	4.7
	5	65.9	60.1	9.8
Comp. Process	6	63.1	58.9	10.2
	7	62.8	59.0	10.4
	8	59.1	55.2	12.1

It will be understood from Table 2 that the alloys produced under the process of the present invention is excellent in tensile strength and load strength though it is slightly inferior in elongation to the comparative alloys because of the Zn content in a relatively high percentage.

EXAMPLE 2

This experiment was conducted to obtain aluminum alloy having excellent wear-resistance and the chemical composition of the specimens are shown in Table 3. As evident from Table 3 the percentages of twelve elements, particularly Si, are high to such an extent that the extrusion would become difficult under the known methods.

TABLE 3

Specimen No.		Chemical Composition (Wt%)												
		Si	Cu	Mg	Fe	Cr	Mn	Ni	Ti	Be	V	Zr	Y	Aℓ
Process of Invention	1	12.1	4.3	0.6	4.5									Balance
	2	14.2	7.1		15.1									Balance
	3	17.8	4.5			7.2								Balance
	4	21.3	4.3			14.1								Balance
	5	20.5	4.1	1.1			5.1							Balance
	6	19.6	3.9				16.3							Balance
	7	30.5						4.1						Balance
	8	21.0						11.3						Balance
	9	8.6							5.9					Balance
	10	22.0							5.6					Balance
	11	17.9								5.1				Balance
	12	20.3								10.7				Balance
	13	16.7									4.7			Balance
	14	19.8									9.9			Balance
	15	24.3										5.9		Balance
	16	25.4										12.1		Balance
	17	22.1											3.9	Balance
	18	16.3											7.8	Balance

The alloys having the chemical compositions shown in Table 3 were dissolved at its liquid phase temperature + 100°C and each molten alloy was poured into the container previously heated to about 320°C. Immediately it was allowed to solidify at a pressure of 1,000 kgf/cm^2 (98 MPa) by advancing the stem. When the molten mass was cooled to 1/2 of the liquid phase temperature, the solidifying process was finished. Then the billet-like mass of 75 mm in diameter and 100 mm in length was obtained, which was immediately extruded into a rod having a diameter of 12 mm. No difficulty arose in extruding it.

Each of the extruded alloys was subjected to solid solution heat treatment at 490°C and aging at 180°C for 7 hours. Each alloy was tested on its tensile strength at 300°C, co-efficiency of expansion and wear-resistance. The results are shown in Table 4.

The wear-resistance test was conducted at a rubbing speed of 2 m/sec., with the use of an "Ohkoshi" abrasion tester (dry) and a rubbing material FC30 (JIS).

TABLE 4

Specimen No.		Properties: Tensile Strength Kgf/mm^2 (300°C)	Properties: Coef. of Expansion 10^{-6}/°C	Properties: Wear-Resistance mm^2×kg×10^{-7}
Process of Invention	1	17.3	16.9	10
	2	18.2	15.5	12
	3	17.1	15.7	11
	4	17.5	13.5	9
	5	17.3	17.4	10
	6	19.2	14.2	9
	7	17.4	14.8	6
	8	18.5	15.1	9
	9	17.1	17.4	12
	10	18.1	16.9	9
	11	17.2	18.5	10
	12	18.4	17.5	8
	13	17.3	17.5	12
	14	19.1	14.4	10
	15	17.3	16.5	10
	16	19.2	14.6	9
	17	16.8	17.0	9
	18	17.4	16.6	8

As evident from Table 4 the extruded aluminum alloy produced under the present invention is excellent in wear-resistance, heat-proof ability and has a low co-efficient of expansion.

EXAMPLE 3

The experiment was conducted to produce extruded aluminum alloys having excellent neutron absorptive property.

TABLE 5

Specimen No.		Alloy Composition (Wt%)			
		B	Mg	Si	Aℓ
Process of Invention	1	3			Balance
	2	5	1.0	0.8	Balance
	3	8	-	-	Balance
	4	2	4.5	-	Balance

The alloys having the chemical compositions shown in Table 5 were extruded into a rod of 12 mm in diameter by the same method as that used in Example 2.

The specimens Nos. 1, 3 and 4 were tested on their mechanical properties without subjecting them to any treatment. The specimen No. 2 was subjected to solid solution heat treatment at 520°C, followed by quenching in water and aging at 180°C for 7 hours.

The resulting alloy was tested on its mechanical properties, the results of which are shown in Table 6 :

TABLE 6

Specimen No.		Alloy Composition (Wt%)		
		Tensile Strength (Kgf/mm^2)	0.2% Load Strength (Kgf/mm^2)	Elongation (%)
Process of Invention	1	15	10	16
	2	26	22	12
	3	17	12	9
	4	27	20	19

For comparison a "Boral" alloy of a dispersed type having 30 to 35% of B, C was tested on its tensile strength. The test revealed that it was about 10 kgf/mm^2 (1 N/mm^2).

As evident from Table 6 the extruded aluminum alloy produced under the process of the present invention has excellent mechanical strength as compared with the "Boral" alloy. As seen from the No. 3 specimen the alloy was extruded without any difficulty regardless of the relatively large quantity of B.

EXAMPLE 4

This experiment was conducted to obtain extruded aluminum alloy having excellent lubricity.

TABLE 7

Specimen No.		Alloy Composition (wt%)												
		Cu	Pb	Sn	Bi	In	Si	Mg	Mn	Cr	Zr	Ti	B	Aℓ
Poecess of Invention	1	6	5	-	-	-	-	-	-	-	-	0.02	0.004	Balance
	2	3	-	6	-	-	8	0.5	-	-	-	-	-	Balance
	3	4	-	-	4	-	-	-	0.4	-	0.1	0.1	0.02	Balance
	4	4	-	-	-	7	-	-	-	0.2	-	-	-	Balance
	5	5	9	-	-	-	-	-	-	-	0.2	-	-	Balance
	6	3	-	10	-	-	-	1	-	0.1	-	-	-	Balance
Comp. Process	7	4	5	-	-	-	-	-	-	-	-	-	-	Balance
	8	5	-	6	-	-	9	1	-	-	-	-	-	Balance

Nos. 1 to 6 specimens were extruded into rods having a diameter of 12 mm by the same method as that used in Example 2.

Each extruded alloy was subjected to solid solution heat treatment at 490°C and aging at 180°C for 7 hours. Then each of them was tested on its mechanical properties and wear-resistance. The wear-resistance test was conducted in the same manner as that in Example 2.

Nos. 7 and 8 alloys were cast in the known manner and then they were subjected to the same heat treatment as in Example 2. The resulting alloys were tested on their mechanical properties and wear-resistance in the same manner, the results of which are shown in Table 8 :

TABLE 8

Specimen No.		Mechanical Properties			Wear Resistance
		Tensile Strength (Kgf/mm²)	0.2% Load Strength (Kgf/mm²)	Elongation (%)	Specific Wear Amount (×10⁻⁷mm²/kg)
Process of Invention	1	35	27	12	12
	2	39	33	11	11
	3	34	26	12	13
	4	33	25	11	12
	5	35	26	12	10
	6	40	34	11	10
Comp. Process	7	27	22	10	15
	8	29	23	9	14

As evident from Table 8 the extruded aluminum ally produced under the present invention has excellent mechanical properties and wear-resistance as compared with the comparative alloys Nos. 7 and 8. Presumably the improved wear-resistance is derived from the lubricity enhanced by the low melting point elements solved by frictional heat.

Claims

1. A process for producing an extruded aluminum alloy by direct or indirect extrusion, comprising the steps of pouring a molten alloy into a container section of an extruding machine, applying pressure to the molten alloy in the container section by advancing a stem of the extruding machine in a state in which the container is closed, thereby allowing the molten alloy to form into a mass, stopping the application of pressure when the temperature of the mass reaches an optimum temperature suitable for extrusion and extruding the mass through the extruding machine without reheating it, characterized in that the pressure applied is in the range of 50 kgf/cm² to 1500 kgf/cm² (4,9 MPa to 147 MPa), the container section is previously heated to a temperature of 300°C to 350°C and the solidifying process is finished when the temperature of the aluminum alloy has fallen to 1/3 to 2/3 of the liquid phase temperature and the mass obtained is immediately extruded.

2. A process according to claim 1, characterized in that the aluminum alloy contains 7.0 to 12% of Zn, 2.0 to 7.0% of Mg and 0.5 to 3.0% of Cu, the balance being substantially aluminum.

3. A process according to claim 2, characterized in that the aluminum alloy contains one or more elements selected from 0.2 to 1.0% of Mn, 0.1 to 0.4% of Cr and 0.05 to 0.3% of Zr.

4. A process according to claim 1, characterized in that the aluminum alloy contains 4.0 to 40% of Si, the balance being substantially aluminum, thereby increasing the wear-resistance of the extruded alloy.

5. A process according to claim 4, characterized in that the aluminum alloy further contains 4.0 to 20% of Cu.

6. A process according to claim 4 or 5, characterized in that the aluminum alloy further contains at least one element, selected from 0.5 to 20% of Fe, 0.5 to 20% of Cr, 1.0 to 20% of Mn, 0.5 to 20% of Ni, 0.5 to 10% of Ti, 1.0 to 20% of Be, 1.0 to 20% of V, 2.0 to 20% of Y, 0.5 to 10% of Zr and 0. 3 to 2.0% of Mg.

7. A process according to claim 1, characterized in that the aluminum alloy contins 0.5 to 12% of B, the

balance being substantially aluminum, thereby increasing the neutron absorptive ability.

8. A process according to claim 7, characterized in that the aluminum alloy further contains at least one element selected from 0.5 to 6.0% of Mg and 0.2 to 1.5% of Si.

9. A process according to claim 7 or 8, characterized in that the aluminum alloy further contains at least one element selected from 0.1 to 0.6% of Mn, 0.05 to 0.3% of Cr, 0.05 to 0.3% of Zr and 0.01 to 0.2% of Ti.

10. A process according to claim 1, characterized in that the aluminum alloy contains 1.5 to 7.0% of Cu and at least one element selected from 1.0 to 15% of Pb, 1.0 to 15% of Sn, 1.0 to 15% of Bi and 1.0 to 15% of In, the balance being substantially aluminum, thereby increasing the lubricity of the alloy.

11. A process according to claim 10, characterized in that the aluminum alloy further contains at least one element selected from 5.0 to 20% of Si and 0.1 to 3.0% of Mg.

12. A process according to claim 10 or 11, characterized in that the aluminum alloy further contains 0.1 to 0.8% of Mn, 0.05 to 0.35% of Cr, 0.05 to 0.3% of Zr, 0.01 to 0.2% of Ti and 0.002 to 0.04% of B.

Revendications

1. Un procédé de fabrication d'un produit extrudé en alliage d'aluminium par extrusion directe ou indirecte, comprenant les étapes de versement d'un alliage liquide dans une section de récipient d'une extrudeuse, d'application d'une pression sur l'alliage liquide dans la section de récipient en avançant une tige de l'extrudeuse dans un état où le récipient est fermé, permettant ainsi que l'alliage liquide forme une masse, d'arrêt de l'application de la pression lorsque la température de la masse atteint une température optimale convenant pour l'extrusion et d'extrusion de la masse dans l'extrudeuse sans la réchauffer, caractérisé en ce que la pression appliquée est de l'ordre de 50 kg/cm2 à 1500 kg/cm2 (4,9 MPa à 147 MPa), que la section de récipient est préalablement chauffée à une température de 300° à 350° et que le processus de solidification se termine lorsque la température de l'alliage d'aluminium est tombée à 1/3 à 2/3 de la température de la phase liquide et que la masse obtenue est immédiatement extrudée.

2. Un procédé suivant la revendication 1, caractérisé en ce que l'alliage d'aluminium contient de 7,0 à 12% de Zn, de 2,0 à 7,0% de Mg et de 0,5 à 3,0% de Cu, le reste étant essentiellement de l'aluminium.

3. Un procédé suivant la revendication 2, caractérisé en ce que l'alliage d'aluminium contient un ou plusieurs éléments sélectionnés parmi 0,2 à 1,0% de Mn, 0,1 à 0,4% de Cr et 0,05 à 0,3% de Zr.

4. Un procédé suivant la revendication 1, caractérisé en ce que l'alliage d'aluminium contient de 4,0 à 40% de Si, le reste étant essentiellement de l'aluminium, augmentant ainsi la résistance à l'usure du produit extrudé en alliage.

5. Un procédé suivant la revendication 4, caractérisé en ce que l'alliage d'aluminium contient, en outre, de 4,0 à 20% de Cu.

6. Un procédé suivant la revendication 4 ou 5, caractérisé en ce que l'alliage d'aluminium contient, en outre, au moins un élément sélectionné parmi 0,5 à 20% de Fe, 0,5 à 20% de Cr, 1,0 à 20% de Mn, 0,5 à 20% de Ni, 0,5 à 10% de Ti, 1,0 à 20% de Be, 1,0 à 20% de V, 2,0 à 20% de Y, 0,5 à 10% de Zr et 0,3 à 2,0% de Mg.

7. Un procédé suivant la revendication 1, caractérisé en ce que l'alliage d'aluminium contient de 0,5 à 12% de B, le reste étant essentiellement de l'aluminium, augmentant ainsi le pouvoir d'absorption de neutrons.

8. Un procédé suivant la revendication 7, caractérisé en ce que l'alliage d'aluminium contient, en outre, au moins un élément sélectionné parmi 0,5 à 6,0% de Mg et 0,2 à 1,5% de Si.

9. Un procédé suivant la revendication 7 ou 8, caractérisé en ce que l'alliage d'aluminium contient, en outre, au moins un élément sélectionné parmi 0,1 à 0,6% de Mn, 0,05 à 0,3% de Cr, 0,05 à 0,3% de Zr et 0,01 à 0,2% de Ti.

10. Un procédé suivant la revendication 1, caractérisé en ce que l'alliage d'aluminium contient de 1,5 à 7,0% de Cu et au moins un élément sélectionné parmi 1,0 à 15% de Pb, 1,0 à 15% de Sn, 1,0 à 15% de Bi et 1,0 à 15% de In, le reste étant essentiellement de l'aluminium.

11. Un procédé suivant la revendication 10, caractérisé en ce que l'alliage d'aluminium contient, en outre, au moins un élément sélectionné parmi 5,0 à 20% de Si et 0,1 à 3,0% de Mg.

12. Un procédé suivant la revendication 10 ou 11, caractérisé en ce que l'alliage d'aluminium contient, en outre, 0,1 à 0,8% de Mn, 0,05 à 0,35% de Cr, 0,05 à 0,3% de Zr, 0,01 à 0,02% de Ti et 0,002 à 0,04% de B.

Ansprüche

1. Verfahren zur Herstellung einer durch direktes oder indirektes Pressen stranggepreßten Aluminiumlegierung, umfassend das Gießen einer geschmolzenen Legierung in die Aufnahmebuchse einer Strangpresse,

die Aufbringung von Druck auf die geschmolzene Legierung in der Aufnahmebuchse über einen vorangetriebenen Druckstempel der Presse bei geschlossener Buchse, wodurch die geschmolzene Legierung eine Paste bildet, Unterbrechung der Druckbeaufschlagung, wenn die Temperatur die für das Strangpressen geeignete optimale Temperatur erreicht hat, und das Strangpressen der Paste durch die Strangpresse ohne Wiedererwärmung, dadurch gekennzeichnet, daß der Druck zwischen 50 kgf/cm2 bis 1500 kgf/cm2 (4,9 MPa bis 147 MPa) beträgt, daß die Aufnahmebuchse vorgeheizt ist auf eine Temperatur von 300°C bis 350°C und daß der Erstarrungsvorgang dann beendet ist, wenn die Temperatur der Aluminiumlegierung auf 1/3 bis 2/3 der Temperatur der Flüssigkeitsphase gefallen und die erhaltene Masse sofort stranggepreßt ist.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Aluminiumlegierung 7,0 bis 12% Zn, 2,0 bis 7,0% Mg und 0,5 bis 3,0% Cu enthält, Ausgleichsrest im wesentlichen Aluminium.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Aluminiumlegierung eine oder mehrere der ausgewählten Elemente aus 0,2 bis 1% Mn, 0,1 bis 0,4% Cr und 0,05 bis 0,3% Zr enthält.

4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Aluminiumlegierung 4,0 bis 40% Si enthält, Ausgleichsrest im wesentlichen Aluminium, zur Erhöhung der Verschleißfestigkeit.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß die Aluminiumlegierung zusätzlich 4,0 bis 20% Cu enthält.

6. Verfahren nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die Aluminiumlegierung weiterhin mindestens eines der ausgewählten Elemente aus 0,5 bis 20% Fe, 0,5 bis 20% Cr, 1,0 bis 20% Mn, 0,5 bis 20% Ni, 0,5 bis 10% Ti, 1,0 bis 20% Be, 1,0 bis 20% V, 2,0 bis 20% Y, 0,5 bis 10% Zr und 0,3 bis 2,0% Mg enthält.

7. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Aluminiumlegierung 0,5 bis 12% B enthält, Ausgleichsrest im wesentlichen Aluminium, zur Erhöhung der Neutronenabsorptionsfähigkeit.

8. Verfahren nach Anspruch 7, dadurch gekennzeichnet, daß die Aluminiumlegierung außerdem mindestens eines der ausgewählten Elemente aus 0,5 bis 6,0% Mg und 0,2 bis 1,5% Si enthält.

9. Verfahren nach Anspruch 7 oder 8, dadurch gekennzeichnet, daß die Aluminiumlegierung außerdem mindestens eines der ausgewählten Elemente aus 0,1 bis 0,6% Mn, 0,05 bis 0,3% Cr, 0,05 bis 0,3% Zr und 0,01 bis 0,2% Ti enthält.

10. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Aluminiumlegierung 1,5 bis 7,0% Cu und mindestens eines der ausgewählten Elemente aus 1,0 bis 15% Pb, 1,0 bis 15% Sn, 1,0 bis 15% Bi und 1,0 bis 15% In enthält, Ausgleichsrest im wesentlichen Aluminium, zur Erhöhung der Schmierfähigkeit der Legierung.

11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Aluminiumlegierung weiterhin mindestens eines der ausgewählten Elemente aus 5,0 bis 20% Si und 0,1 bis 3,0% Mg enthält.

12. Verfahren nach Anspruch 10 oder 11, dadurch gekennzeichnet, daß die Aluminiumlegierung außerdem 0,1 bis 0,8% Mn, 0,05 bis 0,35% Cr, 0,05 bis 0,3% Zr, 0,01 bis 0,2% Ti und 0,002 bis 0,04% B enthält.