(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2007 (11.01.2007)

PCT

(10) International Publication Number
WO 2007/004241 A1

(51) International Patent Classification:
B22D 47/00 (2006.01) *B22D 17/00* (2006.01)

(21) International Application Number:
PCT/IT2005/000381

(22) International Filing Date: 5 July 2005 (05.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **ALUMINIO TECNO INDUSTRIALES ORINOCO C.A.** [VE/VE]; Sector Chilemex, Urbanizacion las Antillas, Calle Las Antillas, Quinta G1-3, Puerto Ordaz - Estado Bolivar (VE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **MEDOLAGO, Albani, Lucio** [IT/IT]; Via Mose' Del Brolo 25, I-24100 Bergamo (IT).

(74) Agent: **GARAVELLI, Paolo**; A.Bre.Mar. S.r.l., Via Servais, 27, I-10146 Torino (IT).

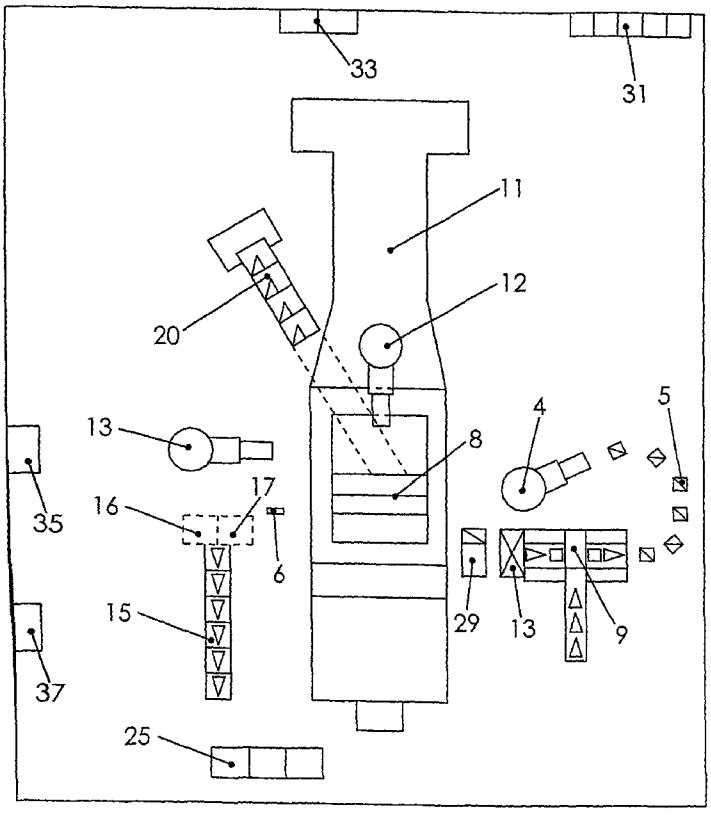
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

[Continued on next page]

(54) Title: PROCESS AND PLANT FOR PRODUCING COMPONENTS MADE OF THIXOTROPIC BILLETS OF AN ALUMINIUM ALLOY FOR VEHICULES , AND COMPONENTS OBTAINED THEREBY



(57) Abstract: A plant and a process are disclosed for producing components made of an aluminium alloy for vehicles and white goods, through the steps of: providing thixotropic billets made of an aluminium alloy; obtaining crop ends of material by sizing the billets; heating the crop ends in a range of temperatures during which both solid phase and liquid phase coexist with a prevalence in the solid phase (more than 50%) in heating furnaces (5); loading the heated crop ends in a die-casting machine (11) for products of the "Semi Solid Material" type; forming a molding with the die casting machine (11); extracting the molding; depositing the molding onto a conveyor belt (15); and controlling a quality of the obtained molding, sending then it to mechanical workings and/or an heat treatment; alternatively, previously cooling the molding in a tank (16); and depositing the cooled molding on a shearing die for shearing feedheads and/or risers.

WO 2007/004241 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PROCESS AND PLANT FOR PRODUCING COMPONENTS MADE OF THIXOTROPIC BILLETS OF AN ALUMINIUM ALLOY FOR VEHICULES, AND COMPONENTS OBTAINED THEREBY

The present invention refers to a process and a plant for producing components made of an aluminium alloy for vehicles and white goods, to the material to be used for producing such components, and to the components obtained through the above-stated process, plant and material.

In the field of parts made of an aluminium alloy for vehicles, no process of this type has ever been put in practical use. In fact, as regards the rest of the components in the motor vehicles field, but also in the railway and aeronautical fields, and in the field of white goods, the aluminium alloy in a thixotropic version has not yet been used, for the difficulties linked to its industrial production. Obviously, such type of material would be ideal in these applications, given its light weight and the chance of withstanding all working loads and operating stresses that such applications imply.

Object of the present invention is solving the above prior-art problems, by providing components made of an aluminium alloy for vehicles and white goods whose weight is very low and whose cost is much lower than the current one and that keep, and preferably highly improve, the quality characteristics of current products.

A further object of the present invention is providing a process and a plant that are adapted to realise components as mentioned above and that are such that the end product needs only reduced workings: this allows simplifying the production processes and highly reducing their costs, obviously at a benefit for the end product.

The above and other objects and advantages of the invention, as will appear from the following description, are obtained by a process, a plant, a material and an end product as those claimed, respectively, in Claims 1, 9, 23 and from 24 to 32. Preferred embodiments and non-trivial variations of the present invention are claimed in the dependent Claims.

The present invention will be better described by some preferred embodiments thereof, given as a non-limiting example, with reference to the enclosed drawings, in which the only Figure 1 is a schematic diagram of the plant adapted to realise the process of the present invention to produce the inventive components.

The process and the plant of the invention will be disclosed hereinbelow in their embodiment that is adapted to produce components for motor vehicles as listed below. It is obvious that the process and the plant could be used, practically without modifications apart from the dimensional ones, for producing components similar to those listed below.

The components that have been discovered as able to be produced through the plant, the process and the material of the present invention are as follows:

- vehicle body elements, such as internal bodywork, door panels, instrument-holding dashboard, framework for seats, framework for steering wheels and other

internal vehicle parts;

- internal door panels integrated with door drive moving functions;
- structural and aesthetic elements of car body and/or motorbyke chassis, engine blocks and motorbyke components;
- components for cars and motorbykes such as front and rear car suspensions, engine supporting frame and other component parts;
- vehicle engines;
- aeronautical elements, such as wheels, seats and panels for aeroplanes;
- railway elements, such as seats and panels for trains;
- components of machines in the white goods sector, such as washing machines, dish washing machines, small white goods and the like.

Fig. 1 is a schematic view of the plant for producing components for vehicles of the invention; first of all, such plant comprises means 5 for heating the crop ends formed of thixotropic billets made of an aluminium alloy (as can be better seen below), in which such billets are sized depending on the ratio between weight and size of the component to be realised. The means 5 are fed by a loader 4 and heat the crop ends in a range of temperatures during which both solid phase and liquid phase coexist with a prevalence in the solid phase (more than 50%), and in the preferred embodiment of the invention are composed of heating furnaces 5, that in particular are electromagnetic induction furnaces 5 comprising modular stations that are able to be composed. The induction heating furnace

guarantees, in addition to keeping the temperature within very restricted tolerances, an energy induction into the billets, which guarantees that a perfect metallographic structure re-forms at an intermediate physical state between the solid state and the liquid state. Therefore, the temperature of the piece is detected by measuring the active power of the induced energy in the material in a predetermined period of time. The inventive plant further comprises means 9 for loading the heated crop ends in a vessel for further workings, that must have specific characteristics for products of the "Semi Solid Material" (S.S.M.) type; the loading means 9 are composed of a first handling robot, that is an anthropomorphic robot equipped with a mechanical gripping hand adapted to handle the vessel in which the billets are placed in order to be heated and transported. The plant then comprises means 11 for forming a molding, which operate with injection steps that are specific of the S.S.M. process; in particular, such means 11 for forming are composed of a die-casting machine, that is equipped with a die 8 adapted to produce components in S.S.M. The die 8 is lubricated by lubricating means 12 before every injection of metal through a detaching agent. Preferably, the die-casting machine 11 is equipped with an injection unit controlled by a closed-loop system, that allows a real-time control of a first and a second injection steps and of a third gearing step. With the above-mentioned arrangements, the press with which the die-casting machine 11 is equipped has a very powerful injection system that is able to manage the injection step with a high dynamicity, and a maximum increasing speed of the injection force according to the construction specifications. This is made possible by controlling the injection process through a closed-loop system that allows

a real-time control. A high dynamicity is then realised not only as regards the speed, but also for acceleration, braking and repeatability and programmability of the process. The closed loop allows a programmability on at least ten injection variables with 0.1 m/s resolutions. The suitably-adjusted press injects the billet inside the recesses of the die 8.

Further preferably, the lubricating means 12 are composed of a lubricating robot equipped with a lubricating head adapted to spray water, air and a detaching agent onto the die 8; such operation can also be performed through a manual nozzle.

Returning to Fig. 1, the plant of the invention further comprises means 13 for extracting the molding, and means for depositing the molding from the extracting means 13 onto a conveyor belt 15, that are preferably composed of a second handling robot or of extracting means 13 of a manual type.

In a variation of the inventive plant, the means for depositing the molding are replaced by means 16 for previously cooling the molding, and means for depositing the cooled molding onto a shearing die installed on a shearing press 17 for shearing feedheads and/or risers, that are unloaded through unloading means 20.

In particular, the means 16 for previously cooling can be composed of a tank 16 containing heated and heat-adjusted water. In Fig. 1 a station 26 is further provided for cleaning the vessel prepared when going out of the furnace 5.

Finally, the inventive plant comprises means for controlling the quality of the obtained molding, before sending the molding to downstream mechanical workings and/or an heat treatment. Such means for controlling the

quality of the obtained molding are composed of a device 27 for detecting the presence of the molding, a control pulpit 29, control panels 31 for the billet heater, process control panels 33, a control panel 35 of the extractor 13 and a control panel 37 of the conveyor 15 for the finished pieces.

In the above-described plant, the die 8 installed on the press for producing components can be equipped with one or more carriages for defining possible channels of the components and is equipped with air vents. The die 8 can be further equipped with shearing or tearing plates in order to remove the feehead from the molding, and with internal heat-adjusting channels.

In order to use such a die 8, the plant can be further equipped with units 25 for heat-adjusting the die 8 itself, that are composed of a modular system equipped with resistances or gas boilers for heating water or diathermic oil, and with pipings for flowing such water or oil from a pump of the unit inside the heat-adjusting channels of the die 8.

The above-described plant is adapted to realise the process for producing components for vehicles and white goods of the invention, which process comprises the steps of:

- providing thixotropic billets made of an aluminium alloy;
- sizing said billets depending on the ratio between weight and size of the component to be produced, thereby obtaining crop ends of material;
- heating the crop ends in a range of temperatures during which both solid phase and liquid phase coexist with a prevalence in the solid phase (more than 50%) in heating means 5 (of the modular induction furnaces type);

- loading, through loading means 9, the heated crop ends in a vessel for further workings with machines with specific characteristics for products of the "Semi Solid Material" (S.S.M.) type;
- forming a molding with a die-casting machine 11 with injection steps that are specific of the S.S.M. process;
- extracting the molding through extracting means 13;
- depositing the molding from the extracting means 13 onto a conveyor belt 15; and
- controlling the quality of the obtained molding, and then sending the molding itself to downstream mechanical workings and/or an heat treatment.

Alternatively, the process of the invention can be realised so that the step of depositing the molding is replaced by the steps of:

- previously cooling the molding in a tank 16 containing heated and heat-adjusted water; and
- depositing the cooled molding onto a shearing die installed on a shearing press 17 for shearing feedheads and/or risers.

In order to allow an optimum use of the above-stated process and plant, it is also necessary to provide a suitable material, that has an innovative composition and concept when is applied to such process and plant. This material allows producing components in an aluminium alloy for vehicles and white goods of the invention and is composed of an aluminium alloy having the following characteristics:

- centesimal chemical composition; and
- finely-divided, metallographic structure of the globular type, that is a thixotropic structure. The globular microstructure provides the billet with a high

fluidodynamic property even with high fractions of matter at a solid state. This allows performing the die-casting process at temperatures that are near the solidification one.

The main characteristic of the aluminium alloys that are die-cast with the thixotropic system consists (when they are in a partial solidification phase) in the dreastic reduction of the so-called "casting errors", that are the macro- and micro-cavities from shrinking or gas. The production cycle of a part produced with a thixotropic alloy can have different results according to the system being used for the mixing action and the degassing system used in the billet-production step.

With the above-described process and system, and using the above material, it is possible to realise components made of an aluminium alloy whose characteristics are equal to or better than those of similar currently-marketed components.

In particular, the advantages of the die-casting with the S.S.M. process when producing components for vehicles are as follows:

- product with high metallurgic and mechanical performance characteristics;
- innovative solutions that are able to improve the reliability under operating conditions;
- high health of the part;
- reduction of scraps;
- reduction of mechanical workings;
- exceptional mechanical characteristics with a possible heat treatment:

• minimum traction strength: 300 mpa
• minimum ultimate tensile strength: 225 mpa

- minimum elongation: 12%

(all the above results being obtained with reference to an A 356.0 alloy).

It is further necessary to point out the positive results due to the S.S.M. process that cannot be directly measured on the product, but are connected thereto, such as for example lower working temperatures that have as a direct consequence energy savings, lower emissions of smokes and powders and consequently better environmental conditions.

CLAIMS

1. Process for producing components made of an aluminium alloy for vehicles and white goods, comprising the steps of:

- providing thixotropic billets made of an aluminium alloy;
- sizing said billets depending on a ratio between weight and size of the component to be produced, thereby obtaining crop ends of material;
- heating said crop ends in a range of temperatures during which both a solid phase and a liquid phase coexist with a prevalence in the solid phase (more than 50%) in heating means (5);
- loading, through loading means (9), said heated crop ends in a vessel for further workings with machines with specific characteristics for products of the "Semi Solid Material" (S.S.M.) type;
- forming a molding with a die-casting machine (11) with injection steps that are specific of the S.S.M. process;
- extracting the molding through extracting means (13);
- depositing the molding from said extracting means (13) onto a conveyor belt (15); and
- controlling a quality of the obtained molding, said molding being then sent to downstream mechanical workings and/or an heat treatment.

2. Process according to Claim 1, characterised in that said step of depositing the molding is replaced by the steps of:

- previously cooling the molding in a tank (16) containing heated and heat-adjusted water; and
- depositing the cooled molding onto a shearing die installed on a shearing press (17) for shearing feedheads

and/or risers.

3. Process according to Claim 1, characterised in that said heating means (5) are modular induction furnaces (5) comprising a plurality of sections.

4. Process according to Claim 1, characterised in that said loading means (9) are composed of a first handling robot, said first handling robot being an anthropomorphic robot equipped with a mechanical gripping hand adapted to handle the vessel in which the billets are placed in order to be heated and transported.

5. Process according to Claim 1, characterised in that said die-casting machine (11) is equipped with a die (8) adapted to produce components in S.S.M., said die (8) being lubricated by lubricating means (12) before every injection of metal through a detaching agent.

6. Process according to Claim 5, characterised in that said die-casting machine (11) is equipped with an injection unit controlled by a closed-loop system, said closed-loop control system allowing a real-time control of a first and a second injection steps and of a third gearing step.

7. Process according to Claim 5, characterised in that said lubricating means (12) are composed of a lubricating robot equipped with a lubricating head adapted to spray water, air and detaching agent onto the die (8), or through a manual nozzle.

8. Process according to Claim 1, characterised in that said extracting means (13) are composed of a second handling robot, said second handling robot being an anthropomorphic robot equipped with a mechanical gripping hand adapted to handle the moldings composed of raw components, said extracting means (13) being also able to perform a manual extraction.

9. Plant for producing components made of an aluminium

alloy for vehicles and white goods, characterised in that it comprises:

- means (5) for heating crop ends formed of thixotropic billets made of an aluminium alloy, said billets being sized depending on a ratio between weight and size of the component, said means (5) heating said crop ends in a range of temperatures during which both a solid phase and a liquid phase coexist with a prevalence in the solid phase (more than 50%);
- means (9) for loading said heated crop ends in a vessel for further workings with machines with specific characteristics for products of the "Semi Solid Material" (S.S.M.) type;
- means (11) for forming a molding, said means (11) operating with injection steps that are specific of the S.S.M. process;
- means (13) for extracting the molding;
- means for depositing the molding from said extracting means (13) onto a conveyor belt (15); and
- means (27, 29, 31, 33, 35, 37) for controlling a quality of the obtained molding, said molding being then sent to downstream mechanical workings and/or an heat treatment.

10. Plant according to Claim 9, characterised in that said means for depositing the molding are replaced by:

- means (16) for previously cooling the molding; and
- means for depositing the cooled molding onto a shearing die installed on a shearing press (17) for shearing feedheads and/or risers.

11. Plant according to Claim 9, characterised in that said heating means (5) are composed of electromagnetic induction furnaces (5) comprising modular stations that are able to

be composed.

12. Plant according to Claim 9, characterised in that said loading means (9) are composed of a first handling robot, said first handling robot being an anthropomorphic robot equipped with a mechanical gripping hand adapted to handle the vessel in which the billets are placed in order to be heated and transported.

13. Plant according to Claim 9, characterised in that said means (11) for forming are composed of a die-casting machine, said die-casting machine (11) being equipped with a die (8) adapted to produce components in S.S.M., said die (8) being lubricated by lubricating means (12) before every injection of metal through a detaching agent.

14. Plant according to Claim 13, characterised in that said die-casting machine (11) is equipped with an injection unit controlled by a closed-loop system, said closed-loop control system allowing a real-time control of a first and a second injection steps and of a third gearing step.

15. Plant according to Claim 13, characterised in that said lubricating means (12) are composed of a lubricating robot equipped with a lubricating head adapted to spray water, air and detaching agent onto the die (8), or through a manual nozzle.

16. Plant according to Claim 9, characterised in that said extracting means (13) are composed of a second handling robot, or of manual extracting means.

17. Plant according to Claim 9, characterised in that said means (16) for previously cooling are composed of a tank (16) containing heated and heat-adjusted water.

18. Plant according to Claim 9, characterised in that the die (8) installed on the press for producing components (1) is equipped with one or more carriages for defining a channel of the component and is equipped with air vents.

19. Plant according to Claim 18, characterised in that said die (8) is further equipped with shearing or tearing plates in order to remove the feehead from the molding.

20. Plant according to Claim 18, characterised in that said die (8) is further equipped with internal heat-adjusting channels.

21. Plant according to Claim 9, characterised in that said plant is further equipped with units (25) for heat-adjusting the die (8).

22. Plant according to Claim 21, characterised in that said heat-adjusting units are a modular system equipped with resistances or gas boilers for heating water or diathermic oil, and with pipings for flowing such water or oil from a pump of the unit inside the heat-adjusting channels of the die (8).

23. Material for producing components made of an aluminium alloy for vehicles and white goods, characterised in that it is composed of an aluminium alloy having the following characteristics:

- centesimal chemical composition; and
- finely-divided, metallographic structure of the globular type, that is a thixotropic structure.

24. Components made of an aluminium alloy for vehicles and white goods, characterised in that they are produced through the process according to any one of Claims 1 to 8, through the plant according to any one of Claims 9 to 22 and using the material according to Claim 23.

25. Components according to Claim 24, characterised in that they comprise vehicle body elements, such as internal bodywork, door panels, instrument-holding dashboard, framework for seats, framework for steering wheels and other internal vehicle parts.

26. Components according to Claim 24, characterised in

that they comprise internal door panels integrated with door drive moving functions.

27. Components according to Claim 24, characterised in that they comprise structural and aesthetic elements of car body and/or motorbyke chassis, engine blocks and motorbyke components.

28. Components according to Claim 24, characterised in that they comprise components for cars and motorbykes such as front and rear car suspensions, engine supporting frame and other component parts of cars and motorbykes.

29. Components according to Claim 24, characterised in that they comprise vehicle engines.

30. Components according to Claim 24, characterised in that they comprise aeronautical elements, such as wheels, seats and panels for aeroplanes.

31. Components according to Claim 24, characterised in that they comprise railway elements, such as seats and panels for trains.

32. Components according to Claim 24, characterised in that they comprise components of machines in the white goods sector, such as washing machines, dish washing machines, small white goods and the like.

33. Process according to Claim 1, characterised in that said step of heating is performed through a normal heating with traditional furnaces.

34. Process according to Claim 1, characterised in that said step of heating is performed through a normal heating with traditional furnaces followed by an inductive heating.

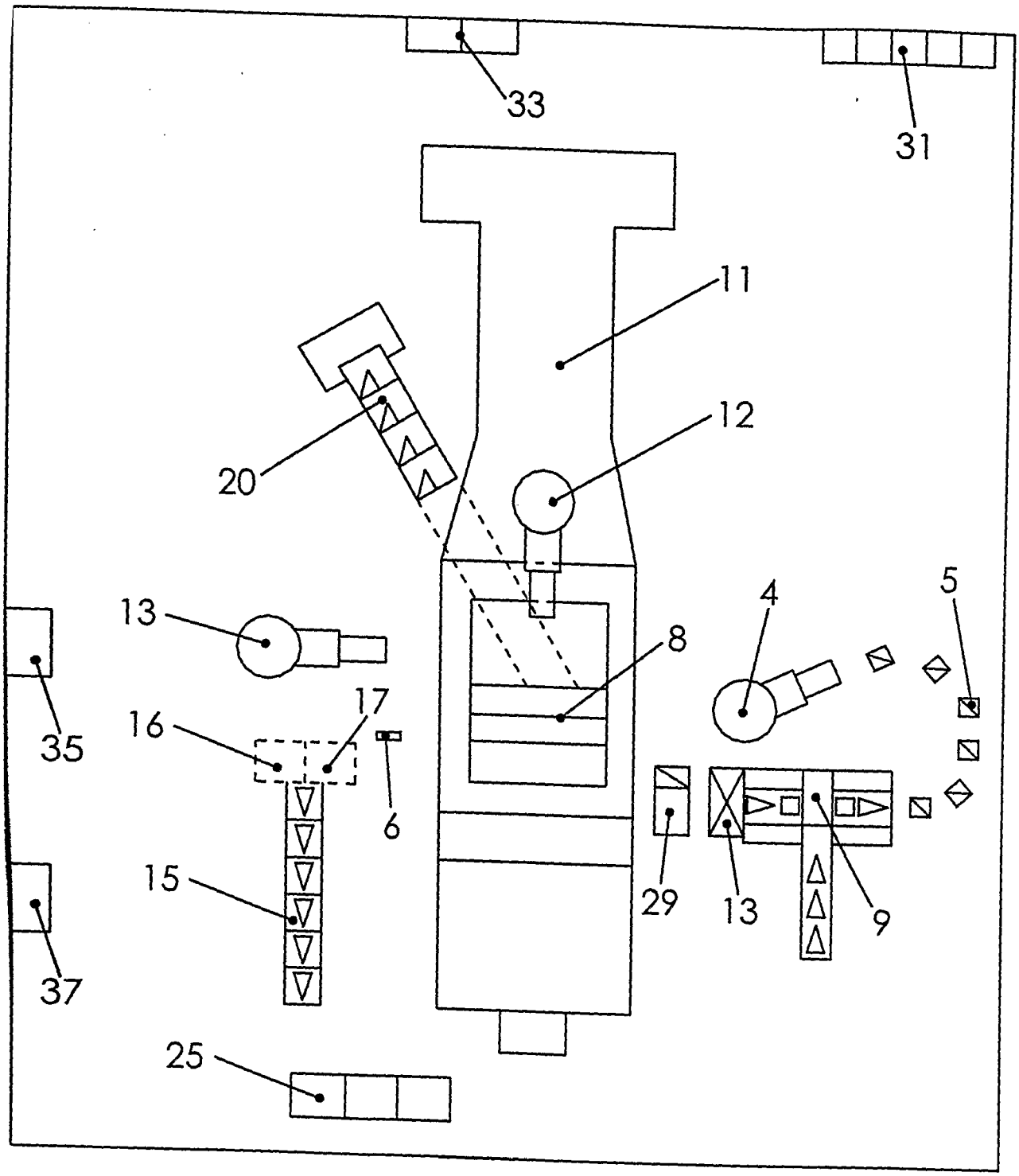


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2005/000381

A. CLASSIFICATION OF SUBJECT MATTER
B22D47/00 B22D17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/081125 A (ALKADIA S.R.L; MARITANO, FELICE) 17 October 2002 (2002-10-17) the whole document	1-34
X	WO 03/045609 A (BUEHLER DRUCKGUSS AG; NIEDERMANN, BENNO; BOLOGNA, ROBERTO; FUCHS, MARC) 5 June 2003 (2003-06-05) page 3 - page 4; figure 1 & US 2005/022384 A1 (NIEDERMANN BENNO ET AL) 3 February 2005 (2005-02-03)	1-34
X	MOSCHINI R: "MANUFACTURE OF AUTOMOTIVE COMPONENTS BY SEMI-LIQUID FORMING PROCESS" METALLURGICAL SCIENCE AND TECHNOLOGY, TORINO, IT, vol. 9, no. 3, January 1991 (1991-01), pages 142-150, XP000472977 the whole document	1-34

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"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

"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

"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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2006	31/03/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lombois, T

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MOSCHINI R: "MANUFACTURE OF AUTOMOTIVE COMPONENTS BY PRESSURE DIECASTING IN SEMI LIQUID STATE" FOUNDRY TRADE JOURNAL, INSTITUTE OF CAST METALS ENGINEERS, WEST BROMWICH, GB, 1 October 1992 (1992-10-01), pages 72,74-76, XP000311336 ISSN: 0015-9042 the whole document	1-34
X	EP 0 513 523 A (WEBER S.R.L; MAGNETI MARELLI S.P.A) 19 November 1992 (1992-11-19) the whole document	1-34
X	EP 0 645 206 A (WEBER S.R.L; MAGNETI MARELLI S.P.A) 29 March 1995 (1995-03-29) the whole document	1-34
X	EP 0 909 600 A (MAGNETI MARELLI S.P.A; MAGNETI MARELLI POWERTRAIN S.P.A) 21 April 1999 (1999-04-21) the whole document	1-34
X	EP 0 710 515 A (REYNOLDS WHEELS INTERNATIONAL LTD) 8 May 1996 (1996-05-08) the whole document	1-34
Y	EP 0 411 329 A (WEBER S.R.L) 6 February 1991 (1991-02-06) the whole document	1-34
Y	GABATHULER J-P ET AL: "THIXOFORMING-BAUTEILE FUR DEN AUTOMOBILBAU" MTZ MOTORTECHNISCHE ZEITSCHRIFT, VIEWEG VERLAG, WIESBADEN, DE, vol. 57, no. 7/8, 1 July 1996 (1996-07-01), pages 19-21, XP000595563 ISSN: 0024-8525 the whole document	1-34
Y	WO 95/19237 A (ALUMINIUM PECHINEY; GARAT, MICHEL; LOUE, WILLEM) 20 July 1995 (1995-07-20) the whole document	1-34
A	CH 690 753 A5 (BUEHLER AG PATENTABTEILUNG) 15 January 2001 (2001-01-15) the whole document	1-34

-/--

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KAUFMANN H: "ENDABMESSUNGSNAHES GIESSEN: EIN VERGLEICH VON SQUEEZE-CASTING UND THIXOCASTING" GIESSEREI, GIESSEREI VERLAG, DUSSELDORF, DE, vol. 81, no. 11, 6 June 1994 (1994-06-06), pages 342-350, XP000450309 ISSN: 0016-9765 the whole document	1-34

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2005/000381

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 02081125	A	17-10-2002	NONE		
WO 03045609	A	05-06-2003	AT	305835 T	15-10-2005
			AU	2002339288 A1	10-06-2003
			CN	1596168 A	16-03-2005
			EP	1448331 A2	25-08-2004
			US	2005022384 A1	03-02-2005
US 2005022384	A1	03-02-2005	AT	305835 T	15-10-2005
			AU	2002339288 A1	10-06-2003
			WO	03045609 A2	05-06-2003
			CN	1596168 A	16-03-2005
			EP	1448331 A2	25-08-2004
EP 0513523	A	19-11-1992	BR	9201567 A	01-12-1992
			DE	69226397 D1	03-09-1998
			DE	69226397 T2	03-12-1998
			ES	2119786 T3	16-10-1998
			IT	1245080 B	13-09-1994
			JP	2793430 B2	03-09-1998
			JP	6142870 A	24-05-1994
			RU	2081725 C1	20-06-1997
EP 0645206	A	29-03-1995	BR	9403623 A	30-05-1995
			DE	69410202 D1	18-06-1998
			DE	69410202 T2	24-09-1998
			ES	2116497 T3	16-07-1998
			IT	1260684 B	22-04-1996
			US	5533562 A	09-07-1996
EP 0909600	A	21-04-1999	BR	9804460 A	23-11-1999
			DE	69803733 D1	21-03-2002
			DE	69803733 T2	22-08-2002
			ES	2172073 T3	16-09-2002
			IT	1295226 B1	04-05-1999
			US	2001040305 A1	15-11-2001
EP 0710515	A	08-05-1996	AT	173419 T	15-12-1998
			DE	69506075 D1	24-12-1998
			DE	69506075 T2	15-04-1999
			IT	BO940484 A1	07-05-1996
EP 0411329	A	06-02-1991	BR	9003601 A	27-08-1991
			DE	69009333 D1	07-07-1994
			DE	69009333 T2	27-10-1994
			ES	2057286 T3	16-10-1994
			IT	1233232 B	20-03-1992
			SU	1838029 A3	30-08-1993
			US	5119977 A	09-06-1992
WO 9519237	A	20-07-1995	CA	2153258 A1	20-07-1995
			CN	1122115 A	08-05-1996
			DE	689485 T1	24-10-1996
			EP	0689485 A1	03-01-1996
			FR	2715088 A1	21-07-1995
			JP	8507968 T	27-08-1996
			US	5630466 A	20-05-1997

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2005/000381

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CH 690753 A5	15-01-2001	NONE	