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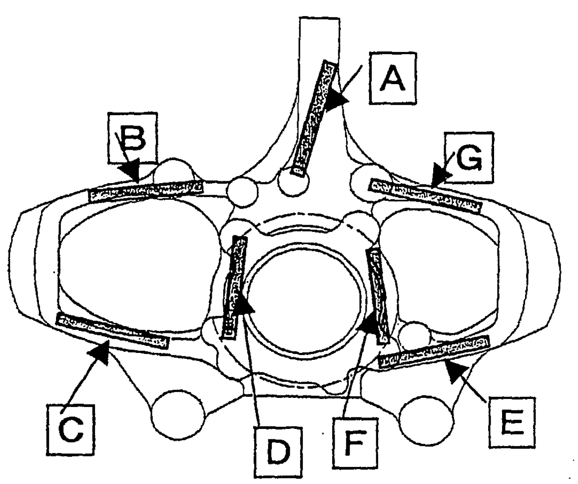
(54) Aluminum cast-forged product and method for manufacturing aluminum cast-forged product

(57) This invention is directed to a method for manufacturing an aluminum cast-forged product by forging a preform made of forged material obtained by casting a forged material of an aluminum alloy, and an aluminum cast-forged product produced thereby. Said method is a method wherein the forging is performed by heating the preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy. In this method, a recycled material may be used as a starting material, and some omission of the steps may be possible. There is provided a method for manufacturing an aluminum cast-forged product having excellent mechanical properties, such as, a higher tensile strength, higher proof stress, higher elongation, and the like with a lower production cost.

FIG.2



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Description

[0001] The present invention relates to a method for manufacturing an aluminum cast-forged product in which forging is performed at a forging temperature higher than a general forging temperature of an aluminum alloy in a forging process to improve mechanical properties.

[0002] To prevent global warming that is one of global environmental problems, reduction in fuel consumption of an automobile is required on a global scale. To reduce the fuel consumption, weight reduction techniques of an automobile are considered to be the most significant. It is because an automobile having reduced weight causes reduced load on a power source to allow reduction in fuel consumption of not only a gasoline engine but also of any power source. A most approachable weight reduction technique is to change a material to be used to a weight reduction material. Typically, using an aluminum alloy material, many automobile parts such as an engine cylinder head or an engine cylinder block have been manufactured and used.

[0003] However, many of the parts are what is called cast products. The cast products are easy to manufacture, but there is a limit of improvement in mechanical strength. Thus, it is difficult to use the cast products for automobile parts such as suspension parts that need to be less corrosive, have a sufficient strength and a good extending property, and have fewer defects, and that significantly relate to safety. Instead, forged products or squeeze cast products (low speed injection molded products) have been manufactured and used.

[0004] However, the forged products or the squeeze cast products have a problem to be solved of high cost, and applications thereof are extremely limited. The reasons why an aluminum forged product that uses a conventional A6061 alloy or the like and is preferably used for the suspension part for the automobile is high in cost include that the forged material per se is high in cost, and that the number of manufacturing steps is large. Further, for example, a squeeze cast product using an AC4CH alloy needs a large number of manufacturing steps and is low in injection speed, thus preventing an increase in productivity and cost reduction.

[0005] On the other hand, it is clearly difficult to apply general cast products to the suspension part used in hostile environments, even if cleaning molten metal causes reduction in occurrence of defects.

[0006] Thus, there have been increasing needs for reducing costs of the forged product having higher mechanical strength, and the needs have been met by a manufacturing method by casting and forging (hereinafter also referred to as a casting and forging method) in which a material for forging (hereinafter also referred to as a forged material) is melted, cast, and cast to obtain a preform made of forged material, then the preform made of forged material is forged.

[0007] The casting and forging method according to embodiments of the present invention offer the following advantages, compared to a general forging method in which a forged material such as of a wrought material in the form of a round bar is bought, cut into a length according to a metal product to be produced, and then, for example, forged with a die. First, unnecessary materials including burrs generated in a forging process can be repeatedly used as a starting material for a forged material to be melted. Generally, burrs that are not used for producing a product account for at least appropriately 30% of a starting material before the die forging. That is, at most approximately 70% of the forged material are used for producing a product, causing a big waste. This waste can be saved.

[0008] Next, the preform made of forged material obtained by casting can be formed into a shape to match a final product such that strength is increased by later forging but the forging process can be simplified. The conventional forging method requires a step of cutting the forged material in the form of the round bar into the length according to the final product, and depending on shapes of the final product, requires a step of bending the forged material or a step of coarse forging before rough forging, but these steps can be omitted.

[0009] The present invention preferably provides a manufacturing method capable of reducing costs by using the above described casting and forging method and of producing an aluminum cast and forged product having improved mechanical properties compared to a conventional forging method. For example, the present invention may preferably provide an aluminum cast and forged product that has high tensile strength, high proof stress, and high elongation, and good mechanical properties, and is low in cost, using the manufacturing method capable of using recycled materials as a starting material and omitting processes. The inventors have studied forging processes and found that a manufacturing method described below addresses the above described problem.

[0010] Specifically, according to the present invention, there is provided a method for manufacturing an aluminum cast-forged product, which includes a step of casting a forged material of an aluminum alloy to obtain a preformmade of forgedmaterial, and a step of forging the preform made of forged material to obtain an aluminum cast-forged product, wherein said step of forging includes a step of heating the preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy. According to the present invention, there is also provided a method for manufacturing an aluminum cast-forged product, which includes a step of casting a forged material of an aluminum alloy to obtain a preformmade of forgedmaterial, a step of forging that includes a plural steps of forging the preform made of forged material to obtain an aluminum cast-forged product, wherein a first step of forging in said plural steps of forging is a step of forging the preform made of forged material by heating the preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy.

[0011] In the above described two methods manufacturing an aluminum cast-forged product, the step of forging may include a step of rough forging and a step of finish forging. It is preferable to carry out a step of rough forging by heating the preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy. The step of rough forging is preferablyperformedbyheating the preform made of forged material at a temperature higher than a temperature in the step of finish forging. In the present invention, the aluminum alloy preferably contains 0.2 to 2. 5% by mass of silicon, and the forged material is preferably an aluminum alloy containing 0.4 to 0.8% by mass of silicon, 0.8 to 1.2% by mass of magnesium, 0.15 to 0.4% by mass of copper, and 0.04 to 0.35% by mass of chromium. It is preferred that the aluminum alloy is one consisting essentially of 0.2 to 2. 5% by mass of silicon, and the forged material is preferably an aluminum alloy containing 0.4 to 0.8% by mass of silicon, 0.8 to 1.2% by mass of magnesium, 0.15 to 0.4% by mass of copper, and 0.04 to 0.35% by mass of chromium. It is also preferable to use an aluminum alloy having a melting point of approximately 652°C. According to the present invention, there is also provided a vehicle suspension part manufactured by the above-described method for manufacturing an aluminum cast-forged product.

[0012] In another aspect, the present invention provides an aluminum cast-forged product obtained by or obtainable by carrying out the manufacturing method of the invention.

Fig. 1 shows a block flow chart of an embodiment of a method for manufacturing an aluminum cast-forged product according to the present invention.

Fig. 2 shows an embodiment of an aluminum cast and forged product according to the present invention, and is a side view of a vehicle suspension part.

[0013] Now, embodiments of a method for manufacturing an aluminum cast-forged product will be described in detail. The present invention is not limited to the embodiments, but various changes, modifications, and improvements may be made based on knowledge of those skilled in the art without departing the scope of the present invention.

[0014] The present invention relates to a method for manufacturing an aluminum cast-forged product obtained by forging a preform made of forged material obtained by casting a forged material of an aluminum alloy. For example, unnecessary burrs generated in forging can be included as a starting material, melted and cast. No limit is placed on a shape of the preform made of forged material, and the preform made of forged material may be in the form of a round bar. For example, the preform made of forged material may have a shape so as to provide preferable machinability such that a final product obtains a strength increase effect by forging and a manufacturing process can be simplified.

[0015] A feature of the present invention is that a forging process is performed with the preform made of forged material heated to a temperature between approximately 450°C to a melting point. The forging process includes a rough forging step and a finish forging step, and rough forging is preferably performed with the preform made of forged material heated to a temperature between approximately 450°C to a melting point. The finish forging after the rough forging is preferably performed at a temperature lower than the temperature in the rough forging, for example, a temperature between approximately 370 to 450°C that are forging temperatures applied to a general aluminum alloy.

[0016] Forging at the temperature higher than the conventional temperature allows the preform made of forged material that is a material to be forged to be in a thixotropic (semi-melted) condition, or allows Mg_2Si to be solid solution if the aluminum alloy contains silicon and magnesium, thus provides a product obtained by forging with mechanical strength equal to or higher than a product produced at the conventional forging temperature. Therefore, the method for manufacturing an aluminum cast-forged product according to the present invention can preferably producing a vehicle suspension part that is used in hostile environments and requires good mechanical properties, while reducing starting material costs and manufacturing costs.

[0017] Now, the method for manufacturing an aluminum cast-forged product according to the present invention will be described in detailed with reference to the drawings.

[0018] Fig. 1 shows a block flow of an embodiment of a manufacturing process including the method for manufacturing an aluminum cast-forged product according to the present invention. The manufacturing process of the aluminum cast and forged product includes, for example, a melting step 11 of melting a forged material 8 that is a starting material to obtain molten metal 3, a casting step 14 of casting the molten metal 3 to obtain a cast and cast preform made of forged material 6, a rough forging step 16 and a finish forging step 20 of forging the preform made of forged material 6 to obtain a forged material 4, and a trimming step 18 of trimming the forged material 4 to be a forged product.

[0019] In addition to these steps, there are preferably provided, for example, a cooling step 15 of lowering a temperature of the preform made of forged material 6 produced by the casting step 14 to a temperature appropriate for the rough forging step 16, and a heat treatment step 19 of improving mechanical properties of the forged and trimmed product to obtain a metal product 7.

[0020] Known as the forged material 8 is an aluminum alloy containing 0.2 to 2.5% by mass of silicon. Taking Al-Mg-Si system heat treatment type aluminum alloy wrought material A6061 (hereinafter also simply referred to as an A6061 alloy) by the Japanese Industrial Standard H4140 as an example, the block flow in Fig. 1 will be described from the start. The forged material 8 is not limited to the A6061 alloy.

[0021] The A6061 alloy contains, for example, 1.0% by mass of magnesium, 0.6% by mass of silicone, 0.25% by mass of copper, and 0.25% by mass of chromium in addition to pure aluminum as standard composition. The forged material 8 may include unnecessary materials such as burr materials,burr receivers, or defectives, but in such as case, component analysis of the molten metal 3 obtained later by melting is preferably performed by emission spectrochemical analysis.

[0022] In the melting step 11, the forged material 8 is heated to be liquid metal, that is, the molten metal 3. A fuel for heating may be any of liquid, solid, or gas. An electrical heating source such as electrical resistance, electrical induction, or an arc, or an electronic heating method such as laser or electronic beam may be used. Further, a preferable melting furnace may be selected from furnaces of a crucible type, a channel type, a rotary type, or the like depending on heating methods.

[0023] The aluminum alloy can be melted with its temperature kept at approximately 680 to 780°C to obtain the molten metal 3. When the starting material includes the unnecessary materials such as the burr materials, it is preferable to clean the obtained molten metal 3 for reducing impurities.

[0024] The casting step 14 is a step of pouring the molten metal 3 into a mold, and after solidification, obtaining a cast product, that is, the preform made of forged material 6 as solid metal. A preform made of forged material 6 having a shape similar to a shape of the final product can be obtained depending on molds, and it is preferable to determine the shape of the preform made of forged material 6 in view of a balance between an improvement effect of mechanical properties by later forging process and cost reduction by simplified forging process.

[0025] No limit is placed on a method of the casting step 14. For example, the mechanical properties of the final metal product 7 can be improved by low pressure casting. The low pressure casting is a method in which molten metal 3 is charged into a mold by low pressure by pressuring the molten metal 3 into a molten metal container by gas pressure, or vacuuming the molten metal 3 from the mold, and cast to obtain a cast product. It is preferable to inspect the preform made of forged material 6 obtained by casting for internal defects using, for example, a magnetic detector or an ultrasonic detector. It is because the forged material does not always have good castability, and confirming that there is no internal defect before die forging is preferable in terms of quality control.

[0026] It is important, after casting and molding, to perform rough forging when the temperature of the preform made of forged material 6 decreases to the temperature appropriate for the rough forging step 16, then perform finish forging when the temperature of the preform made of forged material 6 decreases to the temperature appropriate for the finish forging step 20 to obtain the forged material 4. This eliminates the need for a heating step of heating the forged material at room temperature to a certain temperature range required for die forging, and the need for heat, thus causing the heat for melting to be effectively used and reducing manufacturing costs.

[0027] For the aluminum alloy, the temperature of the material to be forged (preform made of forged material 6) required in the rough forging step 16 is preferably within a range between approximately 450°C to a melting point, which is higher than the general temperature. A melting point of the A6061 alloy is approximately 652°C. In the finish forging step 20, the temperature of the material to be forged is preferably lower than the temperature in the rough forging step 16, and for example, within a range between approximately 370 to 450°C generally required in forging the aluminum alloy. No limit is placed on means of the rough forging step 16 and the finish forging step 20, but when the A6061 alloy is used to produce a vehicle suspension part as the metal product 7, a pressing machine of 2000 to 4000 tons can be used. The forging process is not limited to the two steps of the rough forging and the finish forging, but single forging is also preferable to simplify the manufacturing process.

[0028] The forged material 4 is cooled by, for example, a cooling step 17, and then separated into the forged product and the burr materials by, for example, the trimming step 18. The forged product is then subjected to solution heat and aging treatment such as T3 to T6 by, for example, a heat treatment step 19 to improve the mechanical properties, thus becoming the final metal product 7. For the vehicle suspension part using the A6061 alloy requiring high tensile strength and hardness, T4 and T6 treatments are desirable as heat treatment.

[0029] In the method for manufacturing an aluminum cast-forged product according to the present invention, the preform made of forged material obtained by melting the starting material to obtain the molten metal and then casting can be formed into a shape similar to the shape of the final product rather than the round bar as the conventional forged material while obtaining the strength increasing effect by forging. Thus, there is no need for passing steps of extrusion, cutting, heating, coarse forging, rough forging, finish forging, or the like, as the conventional forging process, thereby simplifying the forging process and reducing manufacturing costs.

[0030] Now, the aluminum alloy preferably used in the method for manufacturing an aluminum cast-forged product according to the present invention will be described. Main trace metals contained in the aluminum alloy used in casting and forging are silicon, magnesium, copper, and manganese.

[0031] Silicon is an element that, when contained, increases fluidity, reduces occurrence of shrinkage cavities, is precipitated as Mg_2Si by being mixed with magnesium, and improves mechanical strength such as elongation, tensile strength, or proof stress. The aluminum alloy preferably contains 0.4 to 0.8% by mass of silicon. Less than 0.2% by mass of silicon reduces castability from the molten metal, and more than 0.8% by mass of silicon reduces forging machinability, thus both are not preferable.

[0032] Magnesium is an element that, when contained, is precipitated in a matrix as Mg_2Si by being mixed with silicon, and improves mechanical strength such as elongation, tensile strength, or proof stress. The aluminum alloy preferably contains 0.8 to 1.2% by mass of magnesium. Less than 0.8% by mass of magnesium causes insufficient strength, and more than 1.2% by mass of magnesium is likely to cause casting defects, thus both are not preferable.

[0033] Copper is an element that, when contained, improves strength. From the forged product containing copper, an Al-Cu or Al-Cu-Mg system precipitate can be obtained that is generated by aging treatment in which the forged product is cooled and then left at room temperature and crystals are precipitated over time. The precipitate promotes the strength increase effect by precipitated Mg_2Si as described above to increase strength. The aluminum alloy preferably contains 0.15 to 0. 4% by mass of copper. Less than 0.15% by mass of copper does not increase strength, and more than 0.4% by mass of copper reduces corrosion resistance to prevent the strength from being kept over time, thus both are not preferable.

[0034] Chromium is an element that, when contained, restrains recrystallization of the aluminum alloy and growth of crystal grains. This causes texture in the aluminum alloy to be maintained in a fine manner to keep the strength. When applied to the vehicle suspension part for an automobile or the like, the aluminum alloy preferably contains a trace amount of chromium, that is, 0 . 04 to 0.35% by mass of chromium, since the mechanical strength such as elongation, tensile strength, or proof stress needs to be held over time.

Examples

[0035] Now, an example of the present invention will be described, but the present invention is not limited to the example.

[0036] (Example) Fig. 2 shows an embodiment of the aluminum cast and forged product, and shows a knuckle steering of the vehicle suspension part. An A6061 alloy material was prepared as a starting material, and the knuckle steering was manufactured by the following steps.

[0037] The starting material was melted at a predetermined melting temperature to obtain molten metal, and a preform made of forged material formed into a shape so as to provide desired machinability with respect to a shape of a final knuckle steering was cast at a predetermined casting temperature. Then, the preform made of forged material was forged with a die under predetermined rough forging load by a forging press at a rough forging temperature of 500°C (surface temperature) to obtain a rough forged product. Next, the rough forged product was again forged with a die under predetermined finish forging load by a forging press at a finish forging temperature of 430°C (surface temperature). Finally, the forged product was trimmed, heated at 550°C for three hours as solution heat treatment using an atmosphere furnace, then cooled, and heated at 180°C for six hours as aging heat treatment to obtain the knuckle steering as a product.

[0038] From three pieces of knuckle steering as the obtained products (products No. 1 to 3), specimens are cut out at specimen taking positions A to G shown in Fig. 2, and tensile strength, proof stress, and elongation as mechanical properties for each specimen were measured. The results are shown in Table 1.

[0039] The mechanical properties such as tensile strength, proof stress, and elongation were obtained according to a test method defined by the Japanese Industrial Standard Z220, and the proof stress refers to 0.2% proof stress.

[Table 1]

		Mechanical properties		
Product No.	TP No.	Tensile strength [MPa]	Proof stress [MPa]	Elongation [%]
1	1-A	334	300	21.1
	1-B	343	302	19.6
	1-C	327	291	22.0
	1-D	320	287	21.1
	1-E	308	278	23.0
	1-F	333	294	20.1
	1-G	331	290	18.7

[Table 1] (continued)

		Mechanical properties		
Product No.	TP No.	Tensile strength [MPa]	Proof stress [MPa]	Elongation [%]
2	2-A	323	288	18.2
	2-B	342	301	15.8
	2-C	326	292	20.6
	2-D	322	288	22.0
	2-E	332	292	22.5
	2-F	313	280	24.9
	2-G	332	295	20.6
3	3-A	329	296	17.7
	3-B	335	294	22.0
	3-C	329	292	23.0
	3-D	320	285	20.6
	3-E	330	290	16.7
	3-F	312	277	23.9
	3-G	331	281	22.5
Average		327.24	290.14	20.79
MAX		343	302	24.9
MIN		308	277	15.8

[0040] (Comparative Example) A knuckle steering was manufactured similarly to the example except that the rough forging temperature was 430°C and the finish forging temperature was 430°C. From three pieces of knuckle steering as the obtained products (products No. 11 to 13), specimens are cut out similarly to the example, and tensile strength, proof stress, and elongation as mechanical properties for each specimen were measured. The results are shown in Table 2.

[Table 2]

		Mechanical properties		
Product No.	TP No.	Tensile strength [MPa]	Proof stress [MPa]	Elongation [%]
11	11-A	334	294	14.8
	11-B	338	297	20.1
	11-C	333	295	18.2
	11-D	312	288	15.8
	11-E	336	293	15.8
	11-F	319	283	20.1
	11-G	338	292	21.1

[Table 2] (continued)

		Mechanical properties		
Product No.	TP No.	Tensile strength [MPa]	Proof stress [MPa]	Elongation [%]
12	12-A	338	299	9.6
	12-B	336	294	19.1
	12-C	330	294	19.1
	12-D	319	289	18.7
	12-E	336	292	17.2
	12-F	319	281	18.2
	12-G	339	303	21.1
13	13-A	336	298	12.4
	13-B	335	287	20.1
	13-C	326	289	18.7
	13-D	309	272	18.2
	13-E	333	289	16.3
	13-F	316	280	20.6
	13-G	340	296	12.9
Average		329.62	290.71	17.53
MAX		340	303	21.1
MIN		309	272	9.6

[0041] The results of the example revealed that the aluminum cast and forged product produced by the method for manufacturing an aluminum cast-forged product according to the present invention has the mechanical properties superior in all of the tensile strength, the proof stress, and the elongation. Further, the results of the example in combination with the results of the comparative example revealed that the aluminum cast and forged product produced by the method for manufacturing an aluminum cast-forged product according to the present invention has the mechanical properties such that, in particular, elongation is remarkably improved with less variation, compared to the aluminum cast and forged product manufactured at the forging temperature lower than the temperature in the present invention.

[0042] As described above, the present invention can provide the aluminum cast and forged product that has high tensile strength, high proof stress, and high elongation, and good mechanical properties, using the manufacturing method capable of using recycled materials as the starting material, omitting processes, and reducing manufacturing costs. Thus, if, for example, the vehicle suspension part is widely supplied as the aluminum cast and forged product, the weight of the vehicle is reduced to achieve reduction in fuel cost, thus reducing discharged carbon dioxide and contributing to prevention of global warming.

Claims

1. A method for manufacturing an aluminum cast-forged product, which includes

a step of obtaining a preform made of forged material by casting a forged material of an aluminum alloy, and

a step of forging said preform made of forged material to obtain an aluminum cast-forged product,

wherein said step of forging includes a step of heating said preform made of forged material to a temperature of from approximately 450°C to a melting point of said alloy.

2. A method for manufacturing an aluminum cast-forged product, which includes

a step of obtaining a preform made of forged material by casting a forged material of an aluminum alloy, and

a step of forging that includes a plural steps of forging the preform made of forged material to obtain an aluminum cast-forged product,

wherein a first step of forging in said plural steps of forging is a step of forging the preform made of forged material by heating the preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy

3. The method for manufacturing an aluminum cast-forged product according to claim 1,
wherein said step of forging includes a step of rough forging and a step of finish forging, and
said step of rough forging is performed by heating said preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy.

4. The method for manufacturing an aluminum cast-forged product according to claim 2,
wherein said step of forging includes a step of rough forging and a step of finish forging, and
said step of rough forging is performed by heating said preform made of forged material at a temperature of from approximately 450°C to a melting point of the alloy.

5. The method for manufacturing an aluminum cast-forged product according to claim 3,
wherein said step of rough forging is performed by heating said preform made of forged material at a temperature higher than a temperature in said step of finish forging.

6. The method for manufacturing an aluminum cast-forged product according to claim 4,
wherein said step of rough forging is performed by heating said preform made of forged material at a temperature higher than a temperature in said step of finish forging.

7. The method for manufacturing an aluminum cast-forged product according to claim 2, wherein said aluminum alloy contains 0.2 to 2.5% by mass of silicon.

8. The method for manufacturing an aluminum cast-forged product according to claim 1, wherein said forged material is an aluminum alloy containing 0.4 to 0.8% by mass of silicon, 0.8 to 1.2% by mass of magnesium, 0.15 to 0.4% by mass of copper, and 0.04 to 0.35% by mass of chromium.

9. The method for manufacturing an aluminum cast-forged product according to claim 1, wherein said melting point is approximately 652°C.

10. The method for manufacturing an aluminum cast-forged product according to claim 3, wherein said melting point is approximately 652°C.

11. A use of an aluminum cast-forged product manufactured by a method according to any one of claims 1 to 10 as a vehicle suspension part.

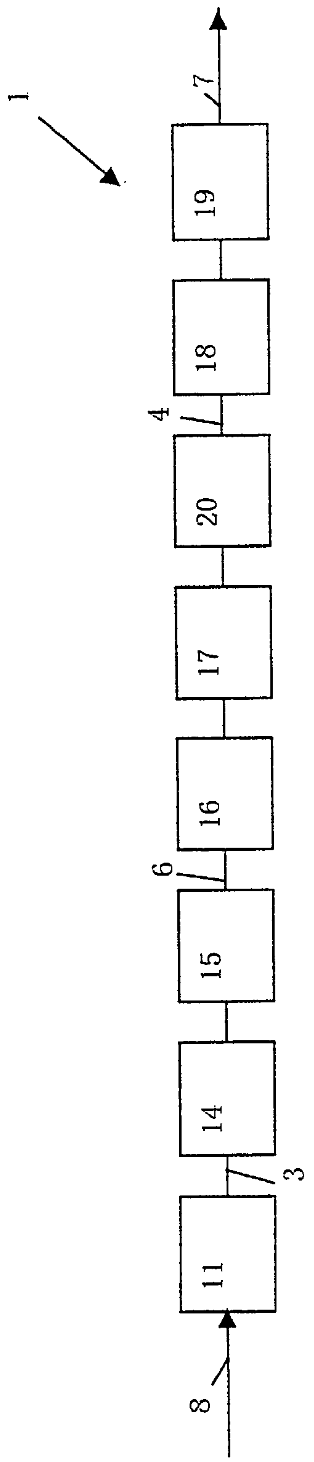
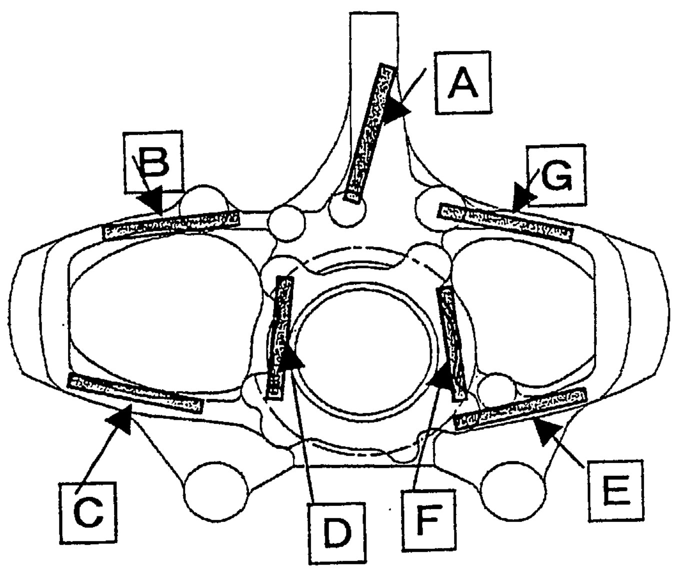


FIG.1

FIG.2



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EUROPEAN SEARCH REPORT

Application Number
EP 02 25 6532

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 04, 30 April 1999 (1999-04-30) -& JP 11 012675 A (KOBE STEEL LTD), 19 January 1999 (1999-01-19) * abstract * ---	1-11	B21J5/00
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 21, 3 August 2001 (2001-08-03) -& JP 2001 105090 A (YOROZU CORP;MURAYAMA TEKKOSHO:KK), 17 April 2001 (2001-04-17) * abstract * ---	1,2,11	
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 21, 3 August 2001 (2001-08-03) & JP 2001 107168 A (KOBE STEEL LTD), 17 April 2001 (2001-04-17) * abstract * ---	1-11	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 328 (C-1215), 22 June 1994 (1994-06-22) -& JP 06 073482 A (HONDA MOTOR CO LTD), 15 March 1994 (1994-03-15) * abstract * ---	1-11	B21J
A	EP 0 955 113 A (SERIO EMILE DI) 10 November 1999 (1999-11-10) * claim 1 * ---	1	
A	FR 2 803 232 A (SERIO EMILE DI) 6 July 2001 (2001-07-06) * claim 1 * ---	1	
	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 February 2003	Barrow, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons
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EPO FORM 1503 03 82 (P04C01)

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EUROPEAN SEARCH REPORT

Application Number
EP 02 25 6532

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

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