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

(11) EP 2 762 577 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
27.04.2016 Bulletin 2016/17

(21) Application number: **11873399.7**

(22) Date of filing: **17.10.2011**

(51) Int Cl.:
C21D 1/09 *(2006.01)*
C22C 38/38 *(2006.01)*
C23C 2/04 *(2006.01)*

(86) International application number:
PCT/KR2011/007703

(87) International publication number:
WO 2013/047939 (04.04.2013 Gazette 2013/14)

(54) **PREPARATION METHOD OF STEEL PRODUCT HAVING DIFFERENT STRENGTHS USING LASER HEAT TREATMENT**

HERSTELLUNGSVERFAHREN FÜR EIN STAHLPRODUKT MIT UNTERSCHIEDLICHEN FESTIGKEITEN MITTELS LASERWÄRMEBEHANDLUNG

MÉTHODE DE FABRICATION D'UN PRODUIT EN ACIER AVEC RÉSISTANCES DIFFÉRENTES PAR TRAITEMENT THERMIQUE AVEC LASER

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **30.09.2011 KR 20110100174**

(43) Date of publication of application:
06.08.2014 Bulletin 2014/32

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Description

[Technical Field]

[0001] The present invention relates to a method for manufacturing a steel product such as seat frames and bumper back beams for automobiles, and more particularly a method for manufacturing a steel product with different strengths using laser heat treatment.

[Background Art]

[0002] Recently, components for automobiles are becoming lighter and stronger for improving fuel efficiency. The lighter and stronger components are realized through process such as alloying constituent of materials, heat treatment, etc.

[0003] Recently, hot stamping technology was developed in accordance with the growth of production technology for automobile components. Hot stamping technology is a technology that can produce high strength components with tensile strength of over 1000 MPa by heating a material with a tensile strength of about 500 MPa to about 900 °C and forming into a desired shape and at the same time cooled rapidly to form martensite in micro-structures.

[0004] Korean Patent Laid-open Publication No. 10-2009-0086970 (published on August 14, 2009), Korean Patent No. 10-0765723 (published on October 11, 2007) applies the hot stamping technology.

[0005] But, as described in the publications above, hot stamping technology is used only for strengthening an entire material, and is difficult to apply to partial strengthening.

[0006] Meanwhile, Korean Patent Laid-open Publication No. 10-2011-0062428 (published on June 10, 2011) mentions partial strengthening hot stamping. But, to partial strengthen using hot stamping method, issues such as going through a pre process such as applying insulation to parts where partial strengthening is not performed, etc. before hot stamping exist.

[0007] A laser induced hardening of martensite hardenable steel for local strengthening of car components is known from Axel Jahn et al., "Local Laser Strengthening of Steel Sheets for Load Adapted Component Design in Car Body Structures", PHYSICS PROCEDIA, vol. 12, pages 431 - 441, (2011), and a locally strengthening of seat structural components by different methods including the use of a laser beam is disclosed in WO 2011/056923 A1.

[Disclosure]

[Technical Problem]

[0008] An aspect of the present invention is to provide a method for manufacturing a steel product with different strengths using a single material without a separate pre-process.

[Technical Solution]

[0009] In accordance with an embodiment of the present invention to achieve the technical problem, a method for manufacturing a steel product comprising : (a) preparing a material comprising: by weight %, 0.1 ~ 0.5% of carbon (C) ; 0.1 ~ 0.5% of silicon (Si); 0.5 ~ 3.0% of manganese (Mn); 0.1% or less of phosphorus (P); 0.05% or less of sulfur (S); 0.01 ~ 1.0% of chromium (Cr); 0.1% or less of aluminum (Al); 0.2% or less of titanium (Ti); 0.0005 ~ 0.08% of boron (B); and the balance of Fe and unavoidable impurities; (b) producing a formed body by forming the material into a predetermined shape; and (c) performing laser heat treatment to a part requiring high strength (high strength part) in the formed body, and locally strengthening the high strength part by irradiating a laser on the high strength part and heating the high strength part to a temperature higher than Ac3, and then cooling to a temperature lower than Ms at a cooling rate of 5 ~ 300°C/sec.

[Advantageous Effects]

[0010] According to a method for manufacturing a steel product in accordance with the present invention, a local strengthening of a single material without a pre-process is possible by using laser heat treatment. Therefore, production method for steel products in accordance with the present invention may be applied for producing seat frames, bumper back beams, etc. for automobiles that require tensile strength.

[0011] Also, the method for manufacturing a steel product in accordance with the present invention may pursue weight reduction because higher strength is possible through laser heat treatment and reinforcement may be omitted.

[Description of Drawings]

[0012]

Figure 1 is a flow chart showing an outline of a method for manufacturing a steel product according to an embodiment of the present invention.

Figure 2 is a view showing an example of a laser heat treatment applied to the present invention.

[Best Mode]

[0013] Advantages, features, and methods to achieve them will be apparent with reference to the exemplary embodiments and drawings that follow. It should be understood that the present invention is not limited to the following embodiments and may be embodied in different ways, and that the embodiments are given to provide complete disclosure of the invention and to provide thorough understanding of the invention to those skilled in the art. The scope of the invention is limited only by the accompanying claims and equivalents thereof.

[0014] Hereinafter, a method for manufacturing a steel product with different strengths using laser heat treatment and heat treated hardened steel used therein in accordance with the present invention will now be described in detail.

[0015] FIG. 1 is a flow chart showing an outline of a method for manufacturing a steel product according to an embodiment of the present invention.

[0016] Referring to FIG. 1, a method for manufacturing a steel product comprises preparing material (S110), producing a formed body (S120), and laser heat treatment (S130).

Preparing Material

[0017] A material comprising: by weight %, 0.1 ~ 0.5% of carbon (C) ; 0.1 ~ 0.5% of silicon (Si); 0.5 ~ 3.0% of manganese (Mn); 0.1% or less of phosphorus (P); 0.05% or less of sulfur (S); 0.01 ~ 1.0% of chromium (Cr); 0.1% or less of aluminum (Al); 0.2% or less of titanium (Ti); 0.0005 ~ 0.08% of boron (B); and the balance of Fe and unavoidable impurities are prepared in the preparing material step.

[0018] Also, the material may be in a blank shape, and hot rolled steel or cold rolled steel may be used.

[0019] Also, a layer selected from Al plating layer, Al-Si plating layer, Zn-Ni plating layer, Zn plating layer, Zn-Al plating layer and high-temperature oxidation-resistant resin coating layer may be formed on the surface of the material to prevent surface oxidization or decarbonization during laser heat treatment process.

[0020] Meanwhile, preparing heat treated hardened steel, which has a certain level of strength, has an excellent formability, and may have super high strength through heat treatment is preferable.

[0021] For a heat treated hardened steel with the proposed composition, a tensile strength of 400 ~ 990MPa and an elongation of 10 ~ 40% is obtainable through slab reheating, hot rolling higher than Ar3 and a normal hot rolling process applying a coiling temperature of about 500 ~ 600°C applied or a normal cold rolling process applying a annealing temperature of about 600 ~ 900°C.

[0022] Also, heat treated hardened steel with the composition has boron (B) added. Therefore, heat treated hardened steel with the composition may have a tensile strength of 1200 ~ 1900MPa and an elongation of 1 ~ 13% through heat treatment.

[0023] Hereinafter, contents of each component and reason for addition is described for the heat treated hardened steel in accordance with the present invention.

<u>Carbon</u> <u>(C)</u>

[0024] Carbon (C) is added to obtain the strength of the steel. Also, carbon plays a role of stabilizing austenite according to an amount of austenite concentration. Carbon is added with 0.1 ~ 0.5 wt% based on the total weight of the steel. When amount of carbon is less than 0.1 wt%, it is difficult to obtain sufficient strength. On the contrary, when amount of carbon is greater than 0.5 wt%, strength is increased but weldability may greatly decline.

<u>Silicon</u> <u>(Si)</u>

[0025] Silicon acts as a deoxidizer, and contributes to improving the strength of steel through solution strengthening. Silicon is added with 0.1 ~ 0.5 wt% based on the total weight of the steel. When amount of silicon is less than 0.1 wt%, the effect of addition is insufficient. On the contrary, when amount of silicon is greater than 0.5 wt%, weldability and plating characteristics may greatly decline.

Manganese (Mn)

[0026] Manganese (Mn) contributes to improving strength through austenite stabilization.

[0027] Manganese is added with 0.5 ~ 3.0 wt% based on the total weight of the steel. When amount of manganes is less than 0.5 wt%, the effect of addition is insufficient. On the contrary, when amount of manganese is greater than 3.0 wt%, problems of weldability declining and toughness degradation occur.

Phosphorus (P), Sulfur (S)

[0028] Phosphorus (P) contributes to improving strength, but when added excessively, quality of material is degraded through segregation and weldability may decline. As such, content of phosphorus is limited to 0.1wt% or less based on the total weight of the steel.

[0029] Also, sulfur (S) contributes partially to improving machinability, but when added excessively, problem of excessive formation of MnS inclusion occurs. Therefore, content of sulfur is limited to 0.05 wt% or less based on the total weight of the steel.

Chromium (Cr)

[0030] Chromium (Cr) improves elongation by stabilizing ferrite grain, and contributes to improving strength through stabilizing austenite by improving the carbon in austenite concentration.

[0031] Chromium is added with 0.01 ~ 1.0 wt% based on the total weight of the steel. When amount of chromium is less than 0.01 wt%, the effect of addition is insufficient. On the contrary, when amount of chromium is greater than 1.0 wt%, problem of plating characteristics declining may occur.

Aluminum (Al)

[0032] Aluminum (Al) acts as preventing hydrogen embrittlement, and is effective for improving ductility and coatability. But, when aluminum is added greater than 0.1 wt%, excessive inclusion is formed and ductility and toughness of steel may be hindered.

[0033] Therefore, aluminum is added with 0.1 wt% or less based on the total weight of the steel.

Titanium (Ti)

[0034] Titanium (Ti) is a carbonitride forming element, and contributes to improving strength. But, when titanium is added greater than 0.2 wt%, toughness may be hindered.

[0035] Therefore, titanium is added with 0.2 wt% or less based on the total weight of the steel.

Boron (B)

[0036] Boron (B) is a strong hardening property element, and contributes to super hardening of steel after heat treatment by only adding 0.0005 wt%.

[0037] Boron is added with 0.0005 ~ 0.08 wt% based on the total weight of the steel. When amount of boron is less than 0.0005 wt%, the effect of addition is insufficient. On the contrary, when amount of boron is greater than 0.08 wt%, problem of toughness being greatly hindered due to excessive increase in hardening property occur.

Producing a Formed Body

[0038] Next, a formed body is produced by forming the material in a predetermined shape in the producing a formed body shape (S120).

[0039] Cold forming, etc. may be used for forming.

[0040] Meanwhile, all of the forming need not be done in this step (S120), and a protion of forming such as trimming, piercing, etc. may be done after laser heat treatment.

Laser Heat Treatment (Partial Strengthening)

[0041] Next, laser heat treatment is performed to a part requiring high strength (high strength part) in the formed body, and the high strength part is locally strengthened.

[0042] Here, high strength part may be a part where stress is concentrated such as a center part of a back beam of a bumper for automobiles, a part where stress is concentrated such as a rail, base, recliner, or arm applied to seat frames, etc.

[0043] Laser heat treatment is carried out by irradiating a laser such as a diode laser on a high strength part and locally heating the high strength part to a temperature higher than Ac3, about Ac3 + 200 °C, and then cooling to a temperature lower than Ms, about Ms ~ Ms - 200°C.

[0044] Cooling is performed at a cooling rate of 5 ~ 300°C/sec. When cooling rate is slower than 5 °C/sec, obtaining sufficient strength is difficult. On the contrary, when cooling rate is faster than 300 °C/sec, obtaining sufficient toughness and ductility is difficult.

[0045] In laser heat treatment, laser irradiating time and laser strength is adjusted for tensile strength of a high strength part is 1200 ~ 1900MPa. For example, laser irradiating time may be increased or laser strength may be increased for tensile strength of a high strength part to be about 1900 MPa. On the contrary, laser irradiating time may be relatively decreased or laser strength may be relatively decreased for tensile strength of a high strength part to be about 1200 MPa.

[0046] That is, laser irradiating time and laser strength in laser heat treatment may differ according to target strength of a high strength part. Also, laser irradiating time and laser strength may differ according to the laser irradiating device used for laser heat treatment.

[0047] FIG. 2 is a view showing an example of a laser heat treatment applied to the present invention.

[0048] Referring to FIG. 2, laser irradiation for laser heat treatment is performed by irradiating a laser beam 210 to a high strength part of a formed body 201 fastened to a fixed jig 220. Heat is conducted from a part where a laser beam directly irradiates to an adjacent part and a certain part is heated to a high temperature.

Examples

[0049] Hereinafter, the composition and effects of the invention will be explained in more detail by means of a description of a possible embodiment according to the invention. It should be understood that the embodiments are presented as a preferred example and the present invention is not limited to the following embodiments.

[0050] Descriptions of details apparent to those skilled in the art will be omitted for clarity.

1. Producing Specimens

[0051] Cold rolled specimens, which have compositions shown in Table 1 and was annealing treated in a temperature shown in Table2, are prepared. Then, laser heat treatment is performed for specimens 1 ~ 10. For laser heat treatment, diode laser device (Produced by Eurovision) is used so that the temperature of the center of each specimen becomes 950°C, and then is cooled to 100°C at a cooling rate of 50°C/sec.

[Table 1] (Unit: wt %)

No.	C	Si	Mn	P	S	Cr	Al	Ti	B
1	0.22	0.23	1.23	0.0015	0.0001	0.17	0.04	0.018	0.003
2	0.21	0.26	1.33	0.0020	0.0008	0.20	0.05	0.022	0.003
3	0.20	0.19	1.13	0.0115	0.0021	0.22	0.07	0.024	0.003
4	0.23	0.26	1.51	0.0098	0.0001	0.09	0.04	0.011	0.003
5	0.19	0.22	1.61	0.0110	0.0021	0.03	0.08	0.084	0.003
6	0.23	0.26	1.51	0.0098	0.0001	0.09	0.04	0.011	0.003
7	0.17	0.13	1.12	0.0021	0.0001	0.32	0.08	0.008	0.021
8	0.35	0.11	1.81	0.0032	0.003	0.18	0.003	0.121	0.007
9	0.38	0.41	2.21	0.08	0.020	0.82	0.012	0.17	0.062
10	0.43	0.44	0.71	0.001	0.0002	0.92	0.09	0.18	0.001

[0052] For specimens 1 ~ 10, mechanical properties (B) of the center of specimens after laser heat treatment, mechanical properties (A) of the center of specimens before laser heat treatment, and mechanical properties (C) of the edge of specimens where laser heat treatment is not performed are measured.

[0053] A Tensile strength (TS) and an elongation (El) are measured, and the results are shown in Table 2.

[Table 2]

No.	ANNEALING TEMPERATURE (°C)	A		B		C	
		TS(MPa)	El(%)	TS(MPa)	Et(%)	TS(MPa)	El(%)
1	730	559	29	1600	7	559	29
2	820	782	19	1532	7	782	19
3	860	830	12	1512	7	831	12
4	710	519	30	1612	8	519	30
5	710	519	30	1612	8	520	30
6	820	778	22	1482	9	778	22
7	640	452	35	1289	11	453	35
8	710	855	13	1816	4	856	13
9	800	982	11	1805	2	982	11
10	710	820	12	1724	4	822	12

[0054] Referring to Table2, for specimens 1 ~ 10 after laser heat treatment, tensile strength became super high strength at 1200 ~ 1900MPa for parts laser heat treatment is performed, and tensile strength was 400 ~ 990MPa and elongation was 10 ~ 40%, same properties as before heat treatment, for parts where laser heat treatment was not performed.

[0055] Therefore, production method for steel components according to the present invention may be applied to steel components requiring different strengths such as bumper back beams for automobiles. Accordingly, using a separate reinforcement may be omitted, and may contribute to weight reduction. Also, since partial strengthening is possible by using only laser heat treatment, a separate pre-process for providing different strengths to a single material is not required.

[0056] Although some exemplary embodiments have been described herein, it should be understood by those skilled in the art that these embodiments are given by way of illustration only, and that various modifications, variations and alterations can be made without departing from the spirit and scope of the invention. The scope of the present invention should be defined by the appended claims.

Claims

1. A method for manufacturing a steel product, comprising:

(a) preparing a material comprising: by weight %, 0.1 ~ 0.5% of carbon (C) ; 0.1 ~ 0.5% of silicon (Si); 0.5 ~ 3.0% of manganese (Mn); 0.1% or less of phosphorus (P); 0.05% or less of sulfur (S); 0.01 ~ 1.0% of chromium (Cr); 0.1% or less of aluminum (Al); 0.2% or less of titanium (Ti); 0.0005 ~ 0.08% of boron (B); and the balance of Fe and unavoidable impurities;
(b) producing a formed body by forming the material into a predetermined shape; and
(c) performing laser heat treatment to a part requiring high strength (high strength part) in the formed body, and locally strengthening the high strength part by irradiating a laser on the high strength part and heating the high strength part to a temperature higher than Ac3, and then cooling to a temperature lower than Ms at a cooling rate of 5 ~ 300°C/sec.

2. The method according to claim 1, wherein, in step (a), a layer selected from Al plating layer, Al-Si plating layer, Zn-Ni plating layer, Zn plating layer, Zn-Al plating layer and high-temperature oxidation-resistant resin coating layer is formed on the surface of the material.

3. The method according to claim 1, wherein, in step (a), the material has a tensile strength of 400 ~ 990MPa and an elongation of 10 ~ 40%.

4. The method according to claim 3, wherein, in step (c), laser irradiating time and laser strength is adjusted for the tensile strength of the high strength part is 1200 ~ 1900MPa in the laser heat treatment.

Patentansprüche

1. Verfahren zur Herstellung eines Stahlprodukts, umfassend:

   (a) Herstellen eines Materials umfassend: in Gew.-%, 0,1 - 0,5 % an Kohlenstoff (C); 0,1 - 0,5 % an Silicium (Si); 0,5 - 3,0 % an Mangan (Mn); 0,1 % oder weniger an Phosphor (P); 0,05 % oder weniger an Schwefel (S); 0,01 - 1,0 % an Chrom (Cr); 0,1 % oder weniger an Aluminium (Al); 0,2 % oder weniger an Titan (Ti); 0,0005 - 0,08 % an Bor (B); und der Rest Fe und unvermeidbare Verunreinigungen;
   (b) Erzeugen eines Formkörpers indem das Material zu einer vorbestimmten Gestalt geformt wird; und
   (c) Durchführen einer Laser-Wärmebehandlung an einem Teil in dem Formkörper, für das eine hohe Festigkeit gefordert ist (hochfester Teil), und lokales Festigen des hochfesten Teils durch Strahlen eines Lasers auf das hochfeste Teil und Erwärmen des hochfesten Teils auf eine Temperatur, die höher als Ac3 ist, und dann Kühlen auf eine Temperatur, die geringer als Ms ist, mit einer Abkühlrate von 5 - 300 °C/s.

2. Verfahren nach Anspruch 1, wobei in Schritt (a) auf der Oberfläche des Materials eine Schicht ausgebildet ist ausgewählt aus einer Al-Beschichtung, Al-Si-Beschichtung, Zn-Ni-Beschichtung, Zn-Beschichtung, Zn-Al-Beschichtung und einer gegen Oxidation bei hohen Temperaturen beständigen Harzbeschichtungsschicht.

3. Verfahren nach Anspruch 1, wobei in Schritt (a) das Material eine Zugfestigkeit von 400 - 990 MPa und eine Dehnung von 10 - 40 % aufweist.

4. Verfahren nach Anspruch 3, wobei bei der Laserbestrahlung in Schritt (c) eine Laserbestrahlungszeit und eine Laserstärke so eingestellt werden, dass die Zugfestigkeit des hochfesten Teils 1200 - 1900 MPa beträgt.

Revendications

1. Procédé de fabrication d'un produit en acier, comprenant :

   (a) la préparation d'un matériau comprenant : en % en poids, 0,1 à 0,5 % de carbone (C) ; 0,1 à 0,5 % de silicium (Si) ; 0,5 à 3,0 % de manganèse (Mn) ; 0,1 % ou moins de phosphore (P) ; 0,05 % ou moins de soufre (S) ; 0,01 à 1,0 % de chrome (Cr) ; 0,1 % ou moins d'aluminium (Al) ; 0,2 % ou moins de titane (Ti) ; 0,0005 à 0,08 % de bore (B) ; le reste étant Fe et des impuretés inévitables ;
   (b) la production d'un corps façonné par façonnage du matériau en une forme prédéterminée ; et
   (c) la réalisation d'un traitement thermique laser sur une partie nécessitant une résistance élevée (partie de résistance élevée) dans le corps façonné, et le renforcement local de la partie de résistance élevée par exposition de la partie de résistance élevée à un laser et chauffage de la partie de résistance élevée à une température supérieure à Ac3, puis refroidissement à une température inférieure à Ms à un taux de refroidissement de 5 à 300 °C/s.

2. Procédé selon la revendication 1, dans lequel, à l'étape (a), une couche choisie parmi une couche de placage en Al, une couche de placage en Al-Si, une coche de placage en Zn-Ni, une couche de placage en Zn, une couche de placage en Zn-Al et une couche de revêtement de résine résistante à l'oxydation à température élevée est formée sur la surface du matériau.

3. Procédé selon la revendication 1, dans lequel, à l'étape (a), le matériau a une résistance à la traction de 400 à 990 MPa et un allongement de 10 à 40 %.

4. Procédé selon la revendication 3, dans lequel, à l'étape (c), la durée d'exposition au laser et la puissance du laser sont ajustées pour que la résistance à la traction de la partie de résistance élevée soit de 1 200 à 1 900 MPa lors du traitement thermique laser.

FIG. 1

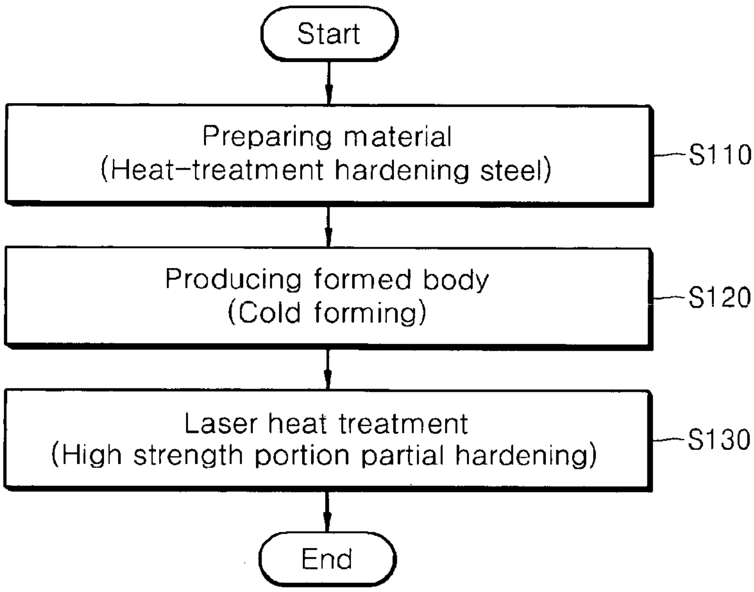
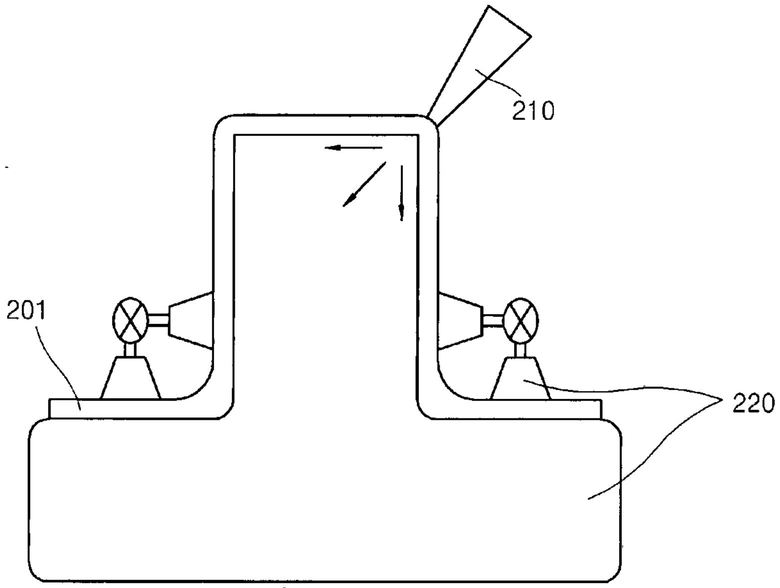

Start
Preparing material
(Heat-treatment hardening steel)
S110
Producing formed body
(Cold forming)
S120
Laser heat treatment
(High strength portion partial hardening)
S130
End

FIG. 2



REFERENCES CITED IN THE DESCRIPTION

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