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(54) **HOT-STAMP FORMED ARTICLE**

(57) This hot stamped component has a predetermined chemical composition, in a position at 1/4 of a sheet thickness from a surface, in a texture of prior austenite, a maximum value of pole densities of an orientation group expressed by Euler angles of Φ = 60° to 90°, $\varphi1$ = 60° to 90°, and $\varphi2$ = 45° is 3.0 or more, an average value of block sizes of martensite, tempered martensite and bainite is 1.20 μm or less.

Description

Technical Field of Invention

[0001] The present invention relates to a hot stamped component.

[0002] Priority is claimed on Japanese Patent Application No. 2022-090847, filed June 3, 2022, the content of which is incorporated herein by reference.

Background Art

[0003] In recent years, there has been a demand for a reduction in a weight of a vehicle body for a vehicle from the perspective of environmental protection and resource saving, and a high-strength steel sheet has been applied to vehicle members. Vehicle members are manufactured by press forming, but not only a forming load is increased but also the formability deteriorates as the strength of a steel sheet is increased. For this reason, the formability of a high-strength steel sheet into a member having a complicated shape becomes an issue.

[0004] In order to solve this issue, the application of a hot stamping technique in which press forming is performed after a steel sheet is heated up to a high temperature of an austenite range where the steel sheet softens is in progress. Hot stamping is attracting attention as a technique that achieves both the formability of a steel sheet into a vehicle member and strength of a vehicle member by performing hardening of the steel sheet in a die at the same time as press working.

[0005] For example, Patent Document 1 discloses a hardenable steel having excellent cold formability that can obtain excellent impact strength and hardness by reheating and quenching the steel.

Prior Art Document

Patent Document

[0006] Patent Document 1
Japanese Unexamined Patent Application Publication No. 2020-508393

Non-Patent Document

[0007] Non-Patent Document 1
Acta Materialia, 58 (2010), 6393-6403

Disclosure of Invention

Problems to be Solved by Invention

[0008] When a hot stamped component with further improved tensile strength is used as a vehicle member, a greater effect of vehicle weight reduction can be achieved. However, since it is a vehicle member, it may be subjected to bending deformation due to a collision or the like, and therefore the hot stamped component needs to have high bendability. However, Patent Document 1 does not consider bendability.

[0009] The present invention has been made in view of the above-mentioned problem, and an object of the present invention is to provide a hot stamped component having high strength and excellent bendability.

Means for Solving the Problem

[0010] The gist of the present invention is as follows.

[1] A hot stamped component according to an aspect of the present invention comprising, as a chemical composition, by mass%:

C: 0.40% to 0.70%;
Si: 0.010% to 3.000%;
Mn: 0.10% or more and less than 0.60%;
P: 0.100% or less;
S: 0.0100% or less;
N: 0.0100% or less;

O: 0.0200% or less;
Al: 0.0010% to 0.5000%;
Nb: 0.0010% to 0.1000%;
Ti: 0.010% to 0.100%;
Cr: 0.010% to 1.000%;
Mo: 0.050% to 1.000%;
B: 0.0005% to 0.0100%;
Co: 0% to 3.00%;
Ni: 0% to 3.00%;
Cu: 0% to 3.00%;
V: 0% to 3.00%;
W: 0% to 3.00%;
Ca: 0% to 0.1000%;
Mg: 0% to 1.0000%;
REM: 0% to 1.0000%;
Sb: 0% to 1.000%;
Sn: 0% to 1.000%;
Zr: 0% to 1.000%;
As: 0% to 0.100%; and
a remainder: Fe and impurities,
in a position at 1/4 of a sheet thickness from a surface,
in a texture of prior austenite, a maximum value of pole densities of an orientation group expressed by Euler angles of Φ = 60° to 90°, $\varphi1$ = 60° to 90°, and $\varphi2$ = 45° is 3.0 or more,
an average value of block sizes of martensite, tempered martensite and bainite is 1.20 μm or less.

[2] The hot stamped component according to [1] may comprise, as the chemical composition, by mass%, one or more selected from the group consisting of:

Co: 0.01% to 3.00%;
Ni: 0.01% to 3.00%;
Cu: 0.01% to 3.00%;
V: 0.01% to 3.00%;
W: 0.01% to 3.00%;
Ca: 0.0001% to 0.1000%;
Mg: 0.0001% to 1.0000%;
REM: 0.0001% to 1.0000%;
Sb: 0.001% to 1.000%;
Sn: 0.001% to 1.000%;
Zr: 0.001% to 1.000%; and
As: 0.001% to 0.100%.

Effects of Invention

[0011] According to the above-described aspects of the present invention, it is possible to provide a hot stamped component having high strength and excellent bendability. Embodiments of Invention

[0012] The present inventors found that by controlling a texture of prior austenite and an average value of block sizes of martensite, tempered martensite and bainite in a position at 1/4 of a sheet thickness from a surface of a hot stamped component, the bendability of the hot stamped component can be improved. In particularly, the present inventors found that the bendability of a hot stamped component can be improved by controlling not a texture of martensite, tempered martensite, bainite, or the like, which are a microstructure of the hot stamped component but a texture of prior austenite before transformation to martensite, bainite, or the like (i.e., state of austenite at a high temperature of Ar3 point or higher) to be within a specific range.

[0013] In addition, the present inventors found that in order to obtain the hot stamped component having the above features, it is particularly effective to strictly control final rolling conditions during hot rolling.

[0014] Hereinafter, the hot stamped component according to the present embodiment will be described in detail. First, the reason the chemical composition of the hot stamped component according to the present embodiment is limited will be described.

[0015] A limited numerical range described using "to" described below includes a lower limit and an upper limit.

Numerical values represented using "less than" or "more than" are not included in a numerical range. All percentages (%) related to the chemical composition mean mass%.

[0016] The hot stamped component according to the present embodiment comprises, as a chemical composition, by mass%, C: 0.40% to 0.70%, Si: 0.010% to 3.000%, Mn: 0.10% or more and less than 0.60%, P: 0.100% or less, S: 0.0100% or less, N: 0.0100% or less, O: 0.0200% or less, Al: 0.0010% to 0.5000%, Nb: 0.0010% to 0.1000%, Ti: 0.010% to 0.100%, Cr: 0.010% to 1.000%, Mo: 0.050% to 1.000%, B: 0.0005% to 0.0100%, and a remainder: Fe and impurities.

[0017] Each element will be described below.

C: 0.40% to 0.70%

[0018] C is an element that improves the strength of the hot stamped component. When the C content is less than 0.40%, a desired strength of the hot stamped component cannot be obtained. For this reason, the C content is set to 0.40% or more. The C content is preferably more than 0.40%, 0.42% or more or 0.44% or more.

[0019] On the other hand, when the C content is more than 0.70%, the strength excessively increases and the bendability of the hot stamped component deteriorates. For this reason, the C content is set to 0.70% or less. The C content is preferably 0.65% or less or 0.60% or less.

Si: 0.010% to 3.000%

[0020] Si is an element that improves the strength of the hot stamped component by solid-solution strengthening. When the Si content is less than 0.010%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Si content is set to 0.010% or more. The Si content is preferably 0.100% or more, 0.300% or more or 0.500% or more.

[0021] On the other hand, when the Si content is more than 3.000%, the amount of ferrite increases and a desired strength of the hot stamped component cannot be obtained. For this reason, the Si content is set to 3.000% or less. The Si content is preferably 2.000% or less, 1.000% or less or 0.800% or less.

Mn: 0.10% or more and less than 0.60%

[0022] Mn is an element that increases hardenability of steel and increases the strength of the hot stamped component. When the Mn content is less than 0.10%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Mn content is set to 0.10% or more. The Mn content is preferably 0.20% or more or 0.35% or more.

[0023] On the other hand, when the Mn content is 0.60% or more, a desired texture of prior austenite cannot be obtained. For this reason, the Mn content is set to less than 0.60%. The Mn content is preferably 0.55% or less or 0.50% or less.

P: 0.100% or less

[0024] P decreases the strength of the grain boundaries by segregating in the grain boundaries. As a result, P deteriorates the bendability of the hot stamped component. When the P content is more than 0.100%, the bendability of the hot stamped component deteriorates significantly. For this reason, the P content is set to 0.100% or less. The P content is preferably 0.050% or less or 0.010% or less.

[0025] The lower limit of the P content may be 0%. However, when the P content is reduced to less than 0.0001%, the dephosphorization cost increases significantly, which is not preferable economically. For this reason, the P content may be set to 0.0001% or more.

S: 0.0100% or less

[0026] S forms inclusions in steel. When the S content is more than 0.0100%, the bendability of the hot stamped component deteriorates significantly. For this reason, the S content is set to 0.0100% or less. The S content is preferably 0.0080% or less, 0.0050% or less or 0.0030% or less.

[0027] The lower limit of the S content may be 0%. However, when the S content is reduced to less than 0.0001%, the desulfurization cost increases significantly, which is not preferable economically. For this reason, the S content may be set to 0.0001% or more.

N: 0.0100% or less

[0028] N forms nitrides in steel. When the N content is more than 0.0100%, the bendability of the hot stamped component deteriorates significantly. For this reason, the N content is set to 0.0100% or less. The N content is preferably 0.0080% or less, 0.0060% or less or 0.0040% or less.

[0029] The lower limit of the N content may be 0%. However, when the N content is reduced to less than 0.0001%, the denitrification cost increases significantly, which is not preferable economically. For this reason, the N content may be set to 0.0001% or more.

O: 0.0200% or less

[0030] O forms coarse oxides when a large amount of O is comprised in steel. When the O content is more than 0.0200%, the bendability of the hot stamped component deteriorates significantly. For this reason, the O content is set to 0.0200% or less. The O content is preferably 0.0100% or less, 0.0070% or less, 0.0040% or less or 0.0030% or less.
[0031] The O content may be 0%. However, in order to disperse many oxides during deoxidizing of molten steel, the O content may be set to 0.0005% or more.

Al: 0.0010% to 0.5000%

[0032] Al is an element having an effect of deoxidizing molten steel and achieving soundness of the steel (minimizing the occurrence of defects such as blowholes in steel). When the Al content is less than 0.0010%, deoxidation is not sufficiently performed, and coarse oxides are generated. As a result, the bendability of the hot stamped component deteriorates. For these reasons, the Al content is set to 0.0010% or more. The Al content is preferably 0.0050% or more, 0.0100% or more or 0.0300% or more.
[0033] On the other hand, when the Al content is more than 0.5000%, coarse oxides are generated in steel. As a result, the bendability of the hot stamped component deteriorates significantly. For this reason, the Al content is set to 0.5000% or less. The Al content is preferably 0.4000% or less, 0.3000% or less, or 0.2000% or less or 0.1000% or less.

Nb: 0.0010% to 0.1000%

[0034] Nb is an element that forms carbonitrides in steel and improves the strength of the hot stamped component by precipitation strengthening. When the Nb content is less than 0.0010%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Nb content is set to 0.0010% or more. The Nb content is preferably 0.0050% or more, 0.0100% or more or 0.0200% or more.
[0035] On the other hand, when the Nb content is more than 0.1000%, many carbonitrides are generated in steel, and the bendability of the hot stamped component deteriorates. For this reason, the Nb content is set to 0.1000% or less. The Nb content is preferably 0.0800% or less or 0.0600% or less.

Ti: 0.010% to 0.100%

[0036] Ti is an element that forms carbonitrides in steel and improves the strength of the hot stamped component by precipitation strengthening. When the Ti content is less than 0.010%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Ti content is set to 0.010% or more. The Ti content is preferably 0.020% or more or 0.025% or more.
[0037] On the other hand, when the Ti content is more than 0.100%, many carbonitrides are generated in steel, and the bendability of the hot stamped component deteriorates. For this reason, the Ti content is set to 0.100% or less. The Ti content is preferably 0.080% or less, 0.060% or less or 0.050% or less.

Cr: 0.010% to 1.000%

[0038] Cr is an element that increases the strength of the hot stamped component by dissolving in prior austenite grains during heating before hot stamping. When the Cr content is less than 0.010%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Cr content is set to 0.010% or more. The Cr content is preferably 0.100% or more, 0.150% or more or 0.200% or more.
[0039] On the other hand, when the Cr content is more than 1.000%, a desired texture of prior austenite cannot be obtained. For this reason, the Cr content is set to 1.000% or less. The Cr content is preferably 0.700% or less, 0.500% or less or 0.400% or less.

Mo: 0.050% to 1.000%

[0040] Mo is an element that increases the strength of the hot stamped component by dissolving in prior austenite grains during heating before hot stamping. When the Mo content is less than 0.050%, a desired strength of the hot stamped component cannot be obtained. For this reason, the Mo content is set to 0.050% or more. The Mo content is preferably

0.100% or more or 0.150% or more.

[0041] On the other hand, when the Mo content is more than 1.000%, a desired texture of prior austenite cannot be obtained. For this reason, the Mo content is set to 1.000% or less. The Mo content is preferably 0.800% or less, 0.600% or less or 0.400% or less.

B: 0.0005% to 0.0100%

[0042] B is an element that improves the hardenability of steel. When the B content is less than 0.0005%, a desired strength of the hot stamped component cannot be obtained. For this reason, the B content is set to 0.0005% or more. The B content is preferably 0.0020% or more or 0.0030% or more.

[0043] On the other hand, when the B content is more than 0.0100%, coarse intermetallic compounds are formed in the hot stamped component. As a result, the bendability of the hot stamped component deteriorates. For this reason, the B content is set to 0.0100% or less. The B content is preferably 0.0080% or less, 0.0060% or less or 0.0040% or less.

[0044] The hot stamped component may comprise the following elements as optional elements in place of a part of Fe. The content of the following optional elements obtained when the following optional elements are not contained is 0%.

Co: 0.01% to 3.00%

[0045] Co is an element that improves strength of the hot stamped component by solid-solution strengthening. In order to reliably obtain the effect, the Co content is preferably set to 0.01% or more, and more preferably set to 0.05% or more.

[0046] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Co content is set to 3.00% or less. If necessary, the Co content may be limited to 2.00% or less, 1.50% or less, 1.00% or less or 0.50% or less.

Ni: 0.01% to 3.00%

[0047] Ni has an effect of increasing strength of the hot stamped component by dissolving in prior austenite grains during heating before hot stamping. In order to reliably obtain the effect, the Ni content is preferably set to 0.01% or more.

[0048] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Ni content is set to 3.00% or less. If necessary, the Ni content may be limited to 2.00% or less, 1.50% or less, 1.00% or less or 0.50% or less.

Cu: 0.01% to 3.00%

[0049] Cu has an effect that increases the strength of the hot stamped component by dissolving in prior austenite grains during heating before hot stamping. In order to reliably obtain the effect, the Cu content is preferably set to 0.01% or more, and more preferably set to 0.05% or more.

[0050] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Cu content is set to 3.00% or less. If necessary, the Cu content may be limited to 2.00% or less, 1.50% or less, 1.00% or less or 0.50% or less.

V: 0.01% to 3.00%

[0051] V has an effect that forms carbonitrides in steel and improves the strength of the hot stamped component by precipitation strengthening. In order to reliably obtain the effect, the V content is preferably set to 0.01% or more, and more preferably set to 0.05% or more.

[0052] On the other hand, when the V content is more than 3.00%, a lot of coarse carbonitrides is generated in steel. As a result, the bendability of the hot stamped component deteriorates. For this reason, the V content is set to 3.00% or less. If necessary, the V content may be limited to 2.00% or less, 1.50% or less, 1.00% or less or 0.50% or less.

W: 0.01% to 3.00%

[0053] W has an effect of improving the strength of the hot stamped component. In order to reliably obtain the effects, the W content is preferably set to 0.01% or more, and more preferably set to 0.05% or more.

[0054] On the other hand, since the above effect will be saturated even if a large amount is comprised, the W content is set to 3.00% or less. If necessary, the W content may be limited to 2.00% or less, 1.50% or less, 1.00% or less or 0.50% or less.

Ca: 0.0001% to 0.1000%

[0055] Ca is an element that suppresses generation of carbides that become starting points for fracture, and contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the Ca content is preferably set to 0.0001% or more, and more preferably set to 0.0010% or more.
[0056] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Ca content is set to 0.1000% or less. If necessary, the Ca content may be limited to 0.0500% or less, 0.0200% or less, 0.0100% or less or 0.0060% or less.

Mg: 0.0001% to 1.0000%

[0057] Mg refines the microstructure due to formation of oxides and sulfides in molten steel, suppressing formation of a coarse MnS, and dispersing a lot of fine oxides. As a result, Mg contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain these effects, the Mg content is preferably set to 0.0001% or more, and more preferably set to 0.0010% or more.
[0058] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Mg content is set to 1.0000% or less. If necessary, the Mg content may be limited to 0.0500% or less, 0.0200% or less, 0.0100% or less or 0.0060% or less.

REM: 0.0001% to 1.000%

[0059] REM suppresses generation of coarse oxides. As a result, REM contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the REM content is preferably set to 0.0001% or more, and more preferably set to 0.0010% or more.
[0060] On the other hand, since the above effect will be saturated even if a large amount is comprised, the REM content is set to 1.0000% or less. If necessary, the REM content may be limited to 0.0500% or less, 0.0200% or less, 0.0100% or less or 0.0060% or less.
[0061] In the present embodiment, REM refers to a total of 17 elements that are composed of Sc, Y and lanthanoid, and the REM content refers to the total content of these elements.

Sb: 0.001% to 1.000%

[0062] Sb suppresses generation of coarse oxides. As a result, Sb contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the Sb content is preferably set to 0.001% or more.
[0063] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Sb content is set to 1.000% or less. If necessary, the Sb content may be limited to 0.500% or less, 0.200% or less, 0.100% or less or 0.050% or less.

Sn: 0.001% to 1.000%

[0064] Sn suppresses generation of coarse oxides. As a result, Sn contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the Sn content is preferably set to 0.001% or more.
[0065] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Sn content is set to 1.000% or less. If necessary, the Sn content may be limited to 0.500% or less, 0.200% or less, 0.100% or less or 0.050% or less.

Zr: 0.001% to 1.000%

[0066] Zr suppresses generation of coarse oxides. As a result, Zr contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the Zr content is preferably set to 0.001% or more.
[0067] On the other hand, since the above effect will be saturated even if a large amount is comprised, the Zr content is set to 1.000% or less. If necessary, the Zr content may be limited to 0.500% or less, 0.200% or less, 0.100% or less or 0.050% or less.

As: 0.001% to 0.100%

[0068] As refines the prior austenite grains by lowering an austenite single-phase transformation temperature. As a result, As contributes for improvement of the bendability of the hot stamped component. In order to reliably obtain the effect, the As content is preferably set to 0.001% or more.

[0069] On the other hand, since the above effect will be saturated even if a large amount is comprised, the As content is set to 0.100% or less. If necessary, the As content may be limited to 0.500% or less, 0.200% or less, 0.100% or less or 0.050% or less.

[0070] The remainder of the chemical composition of the hot stamped component may be Fe and impurities. Elements which are unavoidably mixed from a steel raw material or scrap and/or during the manufacture of steel and are allowed in a range where the properties of the hot stamped component according to the present embodiment do not deteriorate are exemplary examples of the impurities.

[0071] The above-mentioned chemical composition of the hot stamped component may be measured by an ordinary analysis method. For example, the chemical composition may be measured using inductively coupled plasma-atomic emission spectrometry (ICP-AES). C and S may be measured using a combustion-infrared absorption method, N may be measured using an inert gas fusion-thermal conductivity method, and O may be measured using an inert gas fusion-nondispersive infrared absorption method.

[0072] When a plating layer or a coating film is provided on the surface of the hot stamped component, the chemical composition is analyzed after the plating layer or the coating film is removed by mechanical grinding.

[0073] Next, the microstructure of the hot stamped component according to the present embodiment will be described.

[0074] In the hot stamped component according to the present embodiment, in a position at 1/4 of a sheet thickness from a surface, in a texture of prior austenite, a maximum value of pole densities of an orientation group expressed by Euler angles of $\Phi = 60°$ to $90°$, $\varphi1 = 60°$ to $90°$, and $\varphi2 = 45°$ is 3.0 or more, an average value of block sizes of martensite, tempered martensite and bainite is 1.20 μm or less.

[0075] In the present embodiment, the microstructure is specified in the position at 1/4 of the sheet thickness from the surface of the hot stamped component (in a region from a depth of 1/8 of the sheet thickness from the surface to a depth of 3/8 of the sheet thickness from the surface). The reason therefor is that the microstructure at this position indicates a typical microstructure of the hot stamped component.

[0076] Note that when the hot stamped component has the plating layer or the coating film on the surface thereof, the "surface" refers to the interface of the plating layer or the coating film and the base steel sheet.

[0077] In texture of prior austenite, maximum value of pole densities of orientation group expressed by Euler angles of $\Phi = 60°$ to $90°$, $\varphi1 = 60°$ to $90°$, and $\varphi2 = 45°$: 3.0 or more

[0078] The present inventors obtained the following findings about a texture of prior austenite.

[0079] By developing the texture of prior austenite, it is possible to alleviate a strain concentration introduced by bending deformation. As a result, an increase of a load in an initial stage of the bending deformation is reduced and the bendability of the hot stamped component can be increased.

[0080] In the texture of prior austenite, when the maximum value of pole densities of the orientation group expressed by Euler angles of $\Phi = 60°$ to $90°$, $\varphi1 = 60°$ to $90°$, and $\varphi2 = 45°$ (hereinafter, it may be referred as the pole density in the texture of prior austenite) is less than 3.0, a desired bendability of the hot stamped component cannot be obtained. For this reason, the maximum value of the pole densities of the orientation group in the texture of prior austenite is set to 3.0 or more. It is preferably 5.0 or more.

[0081] The upper limit is not particularly limited, but the maximum value of the pole densities of the orientation group in the texture of prior austenite may be set to 50.0 or less, 20.0 or less, 15.0 or less or 10.0 or less.

[0082] The pole density in the texture of prior austenite is measured by the following method.

[0083] The pole density of the texture of prior austenite is measured using an EBSD analyzer including a thermal field emission type scanning electron microscope and an EBSD detector, and the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer. The pole density of the texture of prior austenite can be obtained by using the orientation data measured by the EBSD (Electron Back Scattering Diffraction) method and an orientation distribution function (ODF) that displays the three-dimensional texture calculated by computing, using spherical harmonics.

[0084] For a sample to be subjected to analysis by the EBSD method, a cross section parallel to a rolling direction and perpendicular to a sheet surface is mechanically polished, and strain is removed by chemical polishing or electrolytic polishing. Using this sample, EBSD measurement is performed at the position at 1/4 of the sheet thickness from the surface (in the region from the depth of 1/8 of the sheet thickness from the surface to the depth of 3/8 of the sheet thickness from the surface), with a measurement range of 150 μm in length and a region of 50 μm in the sheet thickness direction and measurement intervals of 0.2 μm. For the measurement, an EBSD analyzer including a thermal field emission type scanning electron microscope and an EBSD detector may be used, for example, an EBSD analyzer including JSM-7001F manufactured by JEOL Ltd. and DVC5-type detector manufactured by TSL Solutions may be used. In this case, the degree of vacuum in the EBSD analyzer may be set to 9.6×10^{-5} Pa or less, the acceleration voltage may be set to 15 kV and the irradiation current level may be set to 13.

[0085] The orientation of prior austenite is measured by the following method. The orientation of prior austenite is calculated by the method described in Non-Patent Document 1, and the orientation of the prior austenite in each coordinate of the EBSD-measured region is specified. Next, an orientation map of prior austenite is created using the

"Inverse Pole Figure" function installed in the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer. Based on the orientation map, the maximum value of pole densitis of an orientation group within the ranges of Φ = 60° to 90°, φ1 = 60° to 90° in section of φ2 = 45°is calculated. As a result, the maximum value of the pole densitis of the orientation group expressed by Euler angles of Φ = 60° to 90°, φ1 = 60° to 90°, and φ2 = 45° is obtained.

[0086] Analyses of a texture using the Euler angles (φ1, Φ, φ2) are widely performed. For example, the definition of the Euler angles (φ1, Φ, φ2) is described in Hiroshi Inoue: "Lecture (Easy Material Analysis Techniques) - Three-dimensional Orientation Analysis of Texture", Light Metals, Vol. 41, No. 6 (1992), 358. By performing analysis using the above-mentioned software, even a person who does not fully understand the definition of the Euler angles (φ1, Φ, φ2) can easily calculate the maximum value of the pole densitis of the orientation group within the ranges of Φ = 60° to 90°, φ1 = 60° to 90° in section of φ2 = 45°.

Average value of block sizes of martensite, tempered martensite and bainite: 1.20 μm or less

[0087] When the average value of block sizes of martensite, tempered martensite and bainite is more than 1.20 μm, a desired bendability of the hot stamped component cannot be obtained. For this reason, the average value of block sizes of martensite, tempered martensite and bainite is set to 1.20 μm or less. It is preferably 1.00 μm or less, and more preferably 0.90 μm or less.

[0088] The lower limit is not particularly limited, but it may be set to 0.30 μm or more, 0.40 μm or more or 0.50 μm or more.

[0089] The average value of block sizes of martensite, tempered martensite and bainite is measured by the following method.

[0090] A sample is cut out from an arbitrary position away from an end surface of the hot stamped component by a distance of 50 mm or more (a position that possibly avoids an end portion in a case where the sample cannot be collected at this position) so that a sheet thickness cross section parallel to the rolling direction can be observed. The size of the sample depends on a measurement device, but is set to a size that can be observed by at least about 10 mm in the rolling direction.

[0091] After polishing the cross section of the above sample using silicon carbide paper of #600 to #1500, the cross section is mirror-finished using liquid in which diamond powder having a grain size in the range of 1 to 6 μm is dispersed in a diluted solution of alcohol or the like or pure water. Next, the observation surface is finished by electrolytic polishing. Using this sample, in a position at 1/4 of the sheet thickness from the surface (a region from a depth of 1/8 of the sheet thickness from the surface to a depth of 3/8 of the sheet thickness from the surface), an orientation information is obtained by measurement using an electron backscatter diffraction method with a measurement range of 150 μm in length and a region of 50 μm in the sheet thickness direction and measurement intervals of 0.2 μm. For the measurement, an EBSD analyzer including a thermal field emission type scanning electron microscope and an EBSD detector may be used, for example, an EBSD analyzer including JSM-7001F manufactured by JEOL Ltd. and DVC5-type detector manufactured by TSL Solutions may be used. In this case, the degree of vacuum in the EBSD analyzer may be set to 9.6×10^{-5} Pa or less, the acceleration voltage may be set to 15 kV and the irradiation current level may be set to 13.

[0092] In the obtained orientation information, using "Phase Map" function installed in the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer, a region where a crystal structure is fcc is extracted. In these regions, using "Grain Average Misorientation" function installed in the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer, under the condition that boundary with a crystal misorientation of 5° or more is regarded as the grain boundary, regions where the grain average misorientation is more than 0.5° are extracted as martensite, tempered martensite and bainite. For the obtained region, under the condition that boundary with a crystal misorientation of 15° or more is regarded as the grain boundary, the average value of block sizes of martensite, tempered martensite and bainite is obtained by obtaining the value calculated by the Number method using the "Grain Size (diameter)" function.

[0093] Note that the rolling direction of the hot stamped component is determined by the following method.

[0094] First, a sample is collected so that a sheet thickness cross section of the hot stamped component can be observed. The sheet thickness cross section of the collected sample is finished by mirror polishing, and then observed with an optical microscope. The observation area is width of 500 μm and full of the sheet thickness, and the areas with low brightness are determined as inclusions. Next, using the sheet thickness cross section initially observed by the above method as a reference, in the range of 0° to 180° with the sheet thickness direction as the axis, the cross-sectional observations of the plane parallel to the plane rotated in 5° increments are performed in the same way as the above method. The average values of the lengths of the long axes of inclusions in each cross section are calculated respectively, and a direction parallel to the long axes of the inclusions in the cross section in which the average value of the length of the long axes of the inclusions is maximum is determined as the rolling direction.

[0095] Note that when the rolling direction of the hot stamped component is known in advance, the rolling direction of the hot stamped component may be determined without using the above-mentioned determination method.

[0096] The microstructure of the hot stamped component is not particularly limited as long as a desired strength and bendability can be obtained. For example, the microstructure may consist of, by area%, a total of 90% or more of martensite, bainite and tempered martensite, and 10% or less of ferrite and residual austenite.

The area ratios of each structure are measured by the following method.

[0097] A sample is cut out from an arbitrary position away from an end surface of the hot stamped component by a distance of 50 mm or more (a position that possibly avoids an end portion in a case where a sample cannot be collected at this position) so that a sheet thickness cross section parallel to the rolling direction can be observed. The size of the sample depends on a measurement device, but is set to a size that can be observed by at least about 10 mm in the rolling direction.
[0098] After polishing the cross section of the sample using silicon carbide paper of #600 to #1500, the cross section is mirror-finished using liquid in which diamond powder having a grain size in the range of 1 to 6 μm is dispersed in a diluted solution of alcohol or the like or pure water. Next, the observation surface is finished by electrolytic polishing. At an arbitrary position on the cross section of the sample in a longitudinal direction, for a region which has a length of 50 μm and is present in a region from the depth of 1/8 of the sheet thickness from the surface to the depth of 3/8 of the sheet thickness from the surface, an orientation information is obtained by measurement using the electron backscatter diffraction method with measurement intervals of 0.1 μm. For the measurement, an EBSD analyzer including a thermal field emission type scanning electron microscope and an EBSD detector may be used, for example, an EBSD analyzer including JSM-7001F manufactured by JEOL Ltd. and DVC5-type detector manufactured by TSL Solutions may be used. In this case, a degree of vacuum in the EBSD analyzer may be set to 9.6×10^{-5} Pa or less, the acceleration voltage may be set to 15 kV and the irradiation current level may be set to 13.
[0099] Using the obtained crystal structure information and the "Phase Map" function installed in the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer, a region where a crystal structure is fcc is determined as residual austenite. The ratio of the residual austenite is calculated, thereby obtaining the area ratio of the residual austenite. Next, in the regions where the crystal structure is bcc is determined as bainite, tempered martensite, martensite and ferrite. For these regions, using the "Grain Average Misorientation" function installed in the software "OIM Analysis (registered trademark)" attached to the EBSD analyzer, under the condition that boundary with a crystal misorientation of 5° or more is regarded as the grain boundary, regions where the grain average misorientation is 0.5° or less are extracted as ferrite. The area ratio of the extracted ferrite is calculated, thereby obtaining the area ratio of ferrite.
[0100] Subsequently, the area ratio of the remaining region (the region where "Grain Average Misorientation" is more than 0.5°) is regarded as the area ratio as martensite, tempered martensite and bainite.
[0101] The hot stamped component may have a plating layer or a coating film on the surface. By having the plating layer or the coating film on the surface, corrosion resistance can be improved after hot stamping. Examples of the plating layer include an aluminum plating layer, aluminum-galvanized layer, aluminum-silicon plating layer, hot-dip galvanized layer, electrogalvanized layer, galvannealed layer, zinc-nickel plating layer, aluminum-magnesium-zinc-based plating layer.
[0102] The sheet thickness of the hot stamped component according to the present embodiment is not particularly limited, but it is preferably set to 0.5 to 3.5 mm from the perspective of reducing the weight of a vehicle body or the like.
[0103] It is not specifically necessary to limit the shape of the hot stamped component. For example, the hot stamped component may have a flat sheet shape, a curved shape, or a three-dimensional shape such as a hat shape.
[0104] The hot stamped component according to the present embodiment preferably have a tensile strength of 2300 MPa or more. The tensile strength is more preferably 2400 MPa or more, and even more preferably 2500 MPa or more. It is not necessary to limit the upper limit of the tensile strength, if necessary, the tensile strength may be set to 3000 MPa or less or 2800 MPa or less.
[0105] The tensile strength is obtained according to the test method described in JIS Z 2241:2011 by producing a No. 5 test piece described in JIS Z 2241:2011 from a flat position of the hot stamped component. A crosshead speed is set to 1 mm/min.
[0106] When the hot stamped component according to the present embodiment has a flat sheet shape (has no curved portion, etc.), a load at a 1/2 stroke of a stroke at the maximum load is preferably 8050 N or more. It is more preferably 8100 N or more, and even more preferably 8150 N or more. However, these standards are based on the case where the sheet thickness of the hot stamped component is 1.6 mm.
[0107] The load at the 1/2 stroke is obtained by performing a bending test under the following conditions based on the VDA standard (VDA238-100: 2017-04) specified by the Verband der Automobilindustrie and obtaining the load at the 1/2 stroke of the stroke at the maximum load.
[0108] When the sheet thickness of the hot stamped component is more than 1.6 mm, the bending test is performed after reducing the sheet thickness to 1.6 mm.
[0109] When the sheet thickness of the hot stamped component is less than 1.6 mm, where t is the sheet thickness of the hot stamped component, the load at the 1/2 stroke of the stroke at the maximum load is preferably $8050 \times t/1.6$ (N) or more.
[0110] Note that the load at the 1/2 stroke of the stroke at the maximum load (however, when the sheet thickness of the hot stamped component is less than 1.6 mm, the value obtained by multiplying the load at the 1/2 stroke by 1.6/t (t is the sheet thickness in mm)) rarely exceeds 8500 N, 8300 N or 8200 N.
[0111]

Dimensions of test piece: 60 mm (rolling direction) × 30 mm (direction parallel to sheet width direction)
Bending ridge: direction parallel to sheet width direction
Test method: roll support and punch pressing
Roll diameter: φ 30 mm
Punch shape: tip end R=0.4 mm
Distance between rolls: 2.0 × sheet thickness (mm) + 0.5 mm
Pressing speed: 20 mm/min
Tester: for example, SHIMADZU AUTOGRAPH 20 kN

[0112] Next, a steel sheet for hot stamping for obtaining the hot stamped component according to the present embodiment will be described.

[0113] The steel sheet for hot stamping has the above-described chemical composition. The microstructure of the steel sheet for hot stamping is not particularly limited as long as a desired strength and bendability are obtained after hot stamping. For example, the microstructure may consist of, by area%, ferrite: 0% to 90%, bainite and martensite: 0% to 100%, pearlite: 0% to 80%, and residual austenite: 0% to 5%.

[0114] Further, the steel sheet for hot stamping may have a plating layer or a coating film on the surface. By having the plating layer or the coating film on the surface, corrosion resistance can be improved after hot stamping. Examples of the plating layer include an aluminum plating layer, aluminum-galvanized layer, aluminum-silicon plating layer, hot-dip galvanized layer, electrogalvanized layer, galvannealed layer, zinc-nickel plating layer, aluminum-magnesium-zinc-based plating layer.

Manufacturing method of steel sheet for hot stamping

[0115] A manufacturing method to obtain the steel sheet for hot stamping for obtaining the hot stamped component according to the present embodiment will be described. In order to obtain the above-described hot stamped component, it is particularly effective to control the finish rolling conditions during hot rolling in the manufacturing method of the steel sheet for hot stamping.

Finish rolling

[0116] In the finish rolling, it is preferable to perform a rolling at one stand before a final stand and a rolling at the final stand with a rolling reduction of *50%* or more respectively. By performing the rolling at one stand before the final stand and the rolling at the final stand with the rolling reduction of 50 % or more, it is possible to control prior austenite with a desired texture.

[0117] Note that the rolling reduction here can be expressed as (1-t1/t0)×100 (%), where t0 is an inlet sheet thickness and t1 is an outlet sheet thickness of each stand.

[0118] After the completion of the finish rolling (after the rolling of the final stand), it is preferable to start cooling after a lapse of 5.0 seconds or more. By elapsing 5.0 seconds or more before starting cooling, granular austenite grains can be generated. As a result, austenite grains with a flat shape are reduced, and granular austenite grains can be sufficiently secured.

[0119] Note that the cooling here does not include air cooling (cooling at an average cooling rate of slower than 10 °C/s), but includes, for example, such as water cooling at an average cooling rate of 10 °C/s or faster. The cooling stop temperature is preferably 550°C to 650°C.

[0120] By the cooling after the finish rolling, austenite transforms into ferrite and pearlite. At this time, pearlite transformation progresses from the grain boundaries of the prior austenite grains. Pearlite having a specific texture is generated by transformation from austenite grains having a specific texture.

[0121] In addition, in order to soften the hot-rolled steel sheet, a coil after coiling may be subjected to softening heat treatment. The method of the softening heat treatment is not particularly limited, and an ordinary conditions may be used.

[0122] The total reduction during cold rolling is preferably set to 50 % or less. The total reduction here can be expressed as (1-t3/t2)×100 (%), where t3 is the sheet thickness after the cold rolling and t2 is the sheet thickness before the cold rolling.

Hot stamping

[0123] A hot stamped component according to the present embodiment is obtained by hot stamping the steel sheet for hot stamping manufactured by the above-described method. As the hot stamping conditions, for example, it is preferable to heat the steel sheet for hot stamping to a temperature range of 800°C to 1000°C and hold in this temperature range for 60 to 1200 seconds.

[0124] By heating during hot stamping, a reverse transformation from pearlite to austenite is caused. Because pearlite has a specific texture, the texture of the austenite generated by the reverse transformation develops. By cooling after hot stamping, a transformation from austenite to martensite is caused. When the final structure becomes martensite, the texture of austenite is preserved. Therefore, the texture of the prior austenite remains developed in the structure after hot stamping.

[0125] When the heating temperature is lower than 800°C or the holding time is shorter than 60 seconds, austenitization becomes insufficient, and the bendability may deteriorate or a desired strength may not be obtained in the hot stamped component. On the other hand, when the heating temperature is higher than 1000°C or the holding time is longer than 1200 seconds, the grains of prior austenite grow excessively, and the bendability may deteriorate or a desired strength may not be obtained in the hot stamped component.

[0126] A heating atmosphere is, for example, such as the atmosphere, a gas combustion atmosphere with a controlled ratio of air and fuel, or a nitrogen atmosphere, and the dew point of these gases may be controlled.

[0127] After holding in the temperature range, hot stamping is performed. After hot stamping, cooling may be performed to a temperature range of 250°C or lower at an average cooling rate of 20°C/s or faster.

[0128] Examples of heating methods before hot stamping include heating using an electric furnace and a gas furnace, a flame heating, an electrical heating, a highfrequency heating, and an induction heating.

[0129] By the above methods, the hot stamped component according to the present embodiment is obtained. A tempering treatment at 130°C to 600°C may be performed after hot stamping for softening, or a baking hardening treatment after painting may be performed. In addition, a portion of the hot stamped component may be tempered by laser irradiation or the like to provide a partially softened region.

Examples

[0130] Next, examples of the present invention will be described. Conditions in the examples are one example of conditions employed to confirm the feasibility and effects of the present invention, but the present invention is not limited to these examples. The present invention may employ various conditions to achieve the object of the present invention without departing from the scope of the present invention.

[0131] Slabs manufactured by casting molten steel having a chemical composition shown in Tables 1A to 1F were held in a temperature range of 1200°C or higher for 20 minutes or longer, and then subjected to hot rolling, coiling, and cold rolling. The final rolling was performed under conditions shown in Tables 2A to 2E.

[0132] Note that after the completion of the finish rolling, the average cooling rate of cooling after a lapse of 5.0 seconds or more was 10 °C/s or faster, and the cooling stop temperature was 550°C to 650°C. In addition, the total reduction of cold rolling was 50% or less.

[0133] The obtained steel sheets for hot stamping were subjected to hot stamping under the conditions shown in Tables 2A to 2E, and then cooled to the temperature range of 250°C or lower at an average cooling rate of 20°C/s or faster. As a result, the hot-stamping formed bodies shown in Tables 3A to 3G were obtained.

[0134] However, for some examples, as described in the tables, plating or heating treatment for softening were performed.

[0135] The underlines in the tables indicate that it is outside the scope of the present invention, falls outside the preferable manufacturing conditions, or the characteristic value is not preferable.

[0136] The microstructure of the hot stamped component according to the present invention consisted of, by area%, a total of 90% or more of martensite, bainite and tempered martensite, and 10% or less of ferrite and residual austenite. In addition, the sheet thickness of the hot stamped component according to the present invention was 0.5 to 3.5 mm.

[0137] Measurements of the microstructure of the hot stamped component and the measurement of the mechanical properties of the hot stamped component were performed by the above-described methods.

[0138] The bending test according to the VDA standard (VDA238-100: 2017-04) is widely performed on components for vehicle, but the bending test targets only flat sheet. Therefore, this VDA standard cannot evaluate the bendability of the hot stamped component with shapes other than flat sheet shape. On the other hand, when the hot stamped component has a bent portion, the bend portion is affected by such as the curvature of the bent portion. For this reason, the inventors considered that it is appropriate to evaluate the bendability according to this VDA standard using a hot stamped component with a flat sheet shape as a test material. Therefore, the bending test was performed on a hot stamped component with a flat sheet shape obtained by hot stamping without bending (using a die that can obtain a hot stamped component without a bent portion). In addition, since the rolling direction of the hot stamped component was known in advance, the rolling direction of the hot stamped component was determined without determining of the rolling direction by evaluation using the above-mentioned determination method. For the bending test machine, a SHIMADZU AUTOGRAPH 20kN was used.

[0139] When the tensile strength TS was 2300 MPa or more, it was determined as having high strength and acceptable, and when the tensile strength TS was less than 2300 MPa, it was determined as not having high strength and unacceptable.

[0140] When the load at the 1/2 stroke of the stroke at the maximum load was 8050 N or more, it was determined as having excellent bendability and acceptable. On the other hand, when the load at the 1/2 stroke of the stroke at the maximum load was less than 8050 N, it was determined as not having excellent bendability and unacceptable. However, in a case where the sheet thickness of the hot stamped component was less than 1.6 mm, where t was the sheet thickness of the hot stamped component, when the load at the 1/2 stroke of the stroke at the maximum load was $8050 \times t/1.6$ (N) or more, it was determined as having excellent bendability and acceptable. On the other hand, when the load at the 1/2 stroke of the stroke at the maximum load was less than $8050 \times t/1.6$ (N), it was determined as not having excellent bendability and unacceptable. Note that in a case where the sheet thickness of the hot stamped component was less than 1.6 mm, the value obtained by multiplying the load at the 1/2 stroke by 1.6/t (t is the sheet thickness in mm) was mentioned in the "Load at 1/2 stroke" in Tables 3 A to 3G.

[Table 1A]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
1	0.38	0.550	0.57	0.005	0.0005	0.0016	0.0016	0.0460	0.0360	0.020	0.350	0.230	0.0021		Comparative steel
2	0.41	0.330	0.30	0.004	0.0021	0.0046	0.0027	0.0520	0.0260	0.037	0.140	0.150	0.0034		Steel of present invention
3	0.43	0.580	0.49	0.005	0.0006	0.0040	0.0012	0.0590	0.0410	0.047	0.430	0.210	0.0033		Steel of present invention
4	0.47	0.440	0.45	0.009	0.0013	0.0018	0.0012	0.0450	0.0230	0.043	0.190	0.200	0.0018		Steel of present invention
5	0.55	0.380	0.57	0.011	0.0020	0.0028	0.0017	0.0420	0.0330	0.030	0.430	0.190	0.0026		Steel of present invention
6	0.66	0.270	0.56	0.005	0.0020	0.0024	0.0015	0.0440	0.0330	0.022	0.230	0.230	0.0026		Steel of present invention
7	0.72	0.500	0.29	0.009	0.0004	0.0022	0.0033	0.0520	0.0360	0.020	0.170	0.240	0.0030		Comparative steel
8	0.46	0.008	0.57	0.006	0.0004	0.0046	0.0017	0.0400	0.0150	0.030	0.320	0.170	0.0031		Comparative steel
9	0.46	0.020	0.35	0.009	0.0017	0.0042	0.0029	0.0610	0.0290	0.039	0.230	0.180	0.0021		Steel of present invention
10	0.44	0.070	0.35	0.008	0.0013	0.0029	0.0025	0.0470	0.0270	0.034	0.110	0.180	0.0023		Steel of present invention
11	0.44	0.140	0.24	0.008	0.0018	0.0021	0.0014	0.0560	0.0410	0.025	0.170	0.180	0.0025		Steel of present invention
12	0.46	0.260	0.47	0.009	0.0015	0.0038	0.0010	0.0580	0.0310	0.036	0.160	0.190	0.0022		Steel of present invention
13	0.45	0.440	0.39	0.004	0.0018	0.0023	0.0010	0.0610	0.0380	0.039	0.380	0.180	0.0019		Steel of present invention
14	0.47	0.870	0.32	0.006	0.0020	0.0046	0.0016	0.0550	0.0190	0.019	0.200	0.220	0.0025		Steel of present invention
15	0.47	1.600	0.49	0.004	0.0007	0.0037	0.0025	0.0410	0.0340	0.035	0.310	0.210	0.0024		Steel of present invention
16	0.45	2.700	0.36	0.007	0.0018	0.0022	0.0030	0.0450	0.0200	0.027	0.230	0.140	0.0032		Steel of present invention
17	0.47	3.200	0.33	0.005	0.0018	0.0040	0.0020	0.0450	0.0180	0.040	0.300	0.210	0.0030		Comparative steel
18	0.45	0.250	0.05	0.007	0.0012	0.0033	0.0025	0.0550	0.0360	0.047	0.330	0.230	0.0032		Comparative steel
19	0.44	0.660	0.16	0.004	0.0008	0.0037	0.0015	0.0440	0.0150	0.038	0.320	0.180	0.0034		Steel of present invention
20	0.46	0.480	0.24	0.006	0.0020	0.0029	0.0033	0.0570	0.0390	0.033	0.220	0.130	0.0029		Steel of present invention
21	0.45	0.630	0.39	0.007	0.0015	0.0021	0.0019	0.0500	0.0360	0.048	0.350	0.150	0.0022		Steel of present invention
22	0.45	0.510	0.46	0.011	0.0009	0.0016	0.0023	0.0490	0.0220	0.025	0.410	0.200	0.0028		Steel of present invention
23	0.44	0.480	0.55	0.007	0.0020	0.0039	0.0012	0.0500	0.0280	0.031	0.340	0.190	0.0027		Steel of present invention
24	0.45	0.450	0.84	0.004	0.0007	0.0019	0.0024	0.0390	0.0210	0.033	0.240	0.160	0.0034		Comparative steel
25	0.47	0.220	0.35	0.006	0.0013	0.0017	0.0033	0.0490	0.0210	0.037	0.380	0.180	0.0016		Steel of present invention

(continued)

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
26	0.47	0.570	0.29	0.012	0.0013	0.0037	0.0011	0.0400	0.0290	0.029	0.340	0.230	0.0032		Steel of present invention

[0141] The underline indicates that it is outside the scope of the present invention.

[Table 1B]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
27	0.46	0.450	0.24	0.025	0.0021	0.0032	0.0019	0.0580	0.0240	0.037	0.110	0.240	0.0022		Steel of present invention
28	0.45	0.270	0.35	0.046	0.0008	0.0020	0.0017	0.0390	0.0310	0.041	0.140	0.120	0.0029		Steel of present invention
29	0.44	0.590	0.39	0.083	0.0019	0.0023	0.0031	0.0470	0.0130	0.026	0.150	0.200	0.0027		Steel of present invention
30	0.45	0.210	0.55	0.120	0.0021	0.0030	0.0010	0.0430	0.0230	0.029	0.330	0.220	0.0030		Comparative steel
31	0.44	0.580	0.28	0.010	0.0012	0.0024	0.0026	0.0610	0.0280	0.020	0.110	0.240	0.0023		Steel of present invention
32	0.44	0.250	0.49	0.011	0.0028	0.0028	0.0023	0.0490	0.0210	0.047	0.190	0.140	0.0030		Steel of present invention
33	0.47	0.400	0.26	0.008	0.0043	0.0041	0.0011	0.0590	0.0240	0.048	0.260	0.230	0.0028		Steel of present invention
34	0.47	0.640	0.47	0.005	0.0075	0.0039	0.0022	0.0530	0.0200	0.028	0.260	0.130	0.0029		Steel of present invention
35	0.46	0.350	0.55	0.004	0.0092	0.0041	0.0011	0.0580	0.0160	0.035	0.140	0.190	0.0029		Steel of present invention
36	0.44	0.280	0.39	0.012	0.0134	0.0042	0.0016	0.0550	0.0140	0.035	0.430	0.170	0.0032		Comparative steel
37	0.47	0.410	0.38	0.010	0.0003	0.0012	0.0014	0.0420	0.0230	0.035	0.140	0.140	0.0030		Steel of present invention
38	0.47	0.590	0.55	0.010	0.0012	0.0022	0.0013	0.0530	0.0200	0.022	0.180	0.200	0.0023		Steel of present invention
39	0.44	0.530	0.55	0.006	0.0011	0.0047	0.0013	0.0490	0.0190	0.043	0.410	0.160	0.0033		Steel of present invention
40	0.46	0.520	0.48	0.008	0.0015	0.0065	0.0022	0.0490	0.0360	0.025	0.280	0.220	0.0034		Steel of present invention
41	0.47	0.660	0.25	0.006	0.0020	0.0089	0.0019	0.0460	0.0280	0.021	0.280	0.150	0.0034		Steel of present invention
42	0.44	0.310	0.57	0.009	0.0012	0.0121	0.0016	0.0400	0.0150	0.026	0.200	0.230	0.0026		Comparative steel
43	0.46	0.480	0.57	0.006	0.0015	0.0034	0.0017	0.0440	0.0170	0.037	0.190	0.150	0.0017		Steel of present invention
44	0.45	0.530	0.49	0.010	0.0013	0.0016	0.0038	0.0580	0.0130	0.032	0.250	0.130	0.0025		Steel of present invention
45	0.45	0.280	0.49	0.006	0.0012	0.0019	0.0058	0.0410	0.0290	0.038	0.250	0.200	0.0034		Steel of present invention
46	0.46	0.420	0.53	0.011	0.0004	0.0019	0.0084	0.0510	0.0240	0.046	0.270	0.220	0.0028		Steel of present invention
47	0.44	0.240	0.25	0.008	0.0011	0.0043	0.0176	0.0590	0.0220	0.028	0.410	0.180	0.0022		Steel of present invention
48	0.46	0.290	0.55	0.008	0.0012	0.0026	0.0240	0.0570	0.0340	0.025	0.260	0.220	0.0031		Comparative steel
49	0.45	0.470	0.28	0.009	0.0009	0.0040	0.0024	0.0006	0.0150	0.037	0.430	0.230	0.0022		Comparative steel
50	0.46	0.210	0.37	0.012	0.0011	0.0038	0.0009	0.0019	0.0200	0.035	0.290	0.190	0.0022		Steel of present invention
51	0.47	0.560	0.53	0.006	0.0018	0.0026	0.0020	0.0052	0.0340	0.041	0.130	0.160	0.0017		Steel of present invention

(continued)

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
52	0.44	0.420	0.26	0.009	0.0015	0.0026	0.0026	0.0130	0.0270	0.040	0.290	0.150	0.0018		Steel of present invention

[0142] The underline indicates that it is outside the scope of the present invention.

[Table 1C]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
53	0.45	0.500	0.27	0.007	0.0021	0.0019	0.0016	0.0390	0.0130	0.041	0.260	0.170	0.0017		Steel of present invention
54	0.45	0.320	0.32	0.010	0.0005	0.0041	0.0018	0.0820	0.0270	0.020	0.120	0.180	0.0032		Steel of present invention
55	0.47	0.670	0.53	0.010	0.0020	0.0023	0.0023	0.1800	0.0400	0.019	0.380	0.210	0.0021		Steel of present invention
56	0.47	0.600	0.30	0.009	0.0021	0.0035	0.0033	0.2500	0.0320	0.021	0.110	0.150	0.0029		Steel of present invention
57	0.45	0.550	0.53	0.011	0.0014	0.0032	0.0028	0.3200	0.0400	0.029	0.240	0.200	0.0029		Steel of present invention
58	0.46	0.470	0.55	0.010	0.0019	0.0038	0.0009	0.4800	0.0410	0.041	0.110	0.170	0.0023		Steel of present invention
59	0.45	0.560	0.31	0.006	0.0012	0.0025	0.0031	<u>0.6200</u>	0.0150	0.042	0.360	0.170	0.0023		Comparative steel
60	0.46	0.560	0.33	0.009	0.0020	0.0042	0.0015	0.0520	<u>0.0008</u>	0.031	0.230	0.190	0.0018		Comparative steel
61	0.44	0.620	0.44	0.010	0.0007	0.0032	0.0021	0.0500	0.0012	0.034	0.370	0.220	0.0026		Steel of present invention
62	0.45	0.570	0.38	0.009	0.0006	0.0016	0.0032	0.0600	0.0039	0.048	0.170	0.170	0.0026		Steel of present invention
63	0.45	0.400	0.35	0.012	0.0003	0.0023	0.0011	0.0490	0.0076	0.020	0.160	0.240	0.0034		Steel of present invention
64	0.46	0.300	0.55	0.009	0.0014	0.0040	0.0028	0.0510	0.0120	0.038	0.430	0.140	0.0022		Steel of present invention
65	0.45	0.280	0.49	0.007	0.0004	0.0040	0.0013	0.0450	0.0180	0.034	0.190	0.170	0.0033		Steel of present invention
66	0.45	0.400	0.27	0.011	0.0011	0.0042	0.0013	0.0420	0.0340	0.025	0.200	0.240	0.0020		Steel of present invention
67	0.45	0.220	0.44	0.012	0.0003	0.0027	0.0014	0.0510	0.0560	0.039	0.190	0.120	0.0023		Steel of present invention
68	0.45	0.620	0.44	0.007	0.0009	0.0036	0.0030	0.0570	0.0880	0.044	0.160	0.190	0.0030		Steel of present invention
69	0.47	0.470	0.55	0.007	0.0002	0.0018	0.0009	0.0580	<u>0.1330</u>	0.029	0.170	0.140	0.0026		Comparative steel
70	0.46	0.620	0.35	0.011	0.0018	0.0028	0.0030	0.0390	0.0220	<u>0.007</u>	0.260	0.120	0.0024		Comparative steel
71	0.46	0.560	0.32	0.005	0.0003	0.0015	0.0029	0.0610	0.0140	0.013	0.350	0.240	0.0019		Steel of present invention
72	0.44	0.440	0.42	0.004	0.0020	0.0016	0.0009	0.0440	0.0280	0.022	0.220	0.120	0.0019		Steel of present invention
73	0.46	0.330	0.27	0.005	0.0013	0.0039	0.0029	0.0530	0.0380	0.038	0.140	0.120	0.0023		Steel of present invention
74	0.45	0.540	0.34	0.007	0.0018	0.0042	0.0025	0.0540	0.0160	0.047	0.420	0.220	0.0018		Steel of present invention
75	0.45	0.590	0.33	0.005	0.0008	0.0024	0.0017	0.0500	0.0260	0.062	0.280	0.150	0.0031		Steel of present invention
76	0.45	0.330	0.28	0.012	0.0014	0.0022	0.0019	0.0590	0.0310	0.075	0.290	0.230	0.0032		Steel of present invention
77	0.47	0.570	0.28	0.012	0.0002	0.0016	0.0015	0.0500	0.0210	0.087	0.180	0.150	0.0026		Steel of present invention

(continued)

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
78	0.46	0.310	0.39	0.008	0.0012	0.0038	0.0020	0.0410	0.0230	0.121	0.230	0.230	0.0018		Comparative steel
79	0.45	0.290	0.52	0.007	0.0019	0.0033	0.0027	0.0520	0.0320	0.040	0.007	0.150	0.0018		Comparative steel

[0143] The underline indicates that it is outside the scope of the present invention.

[Table 1D]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
80	0.45	0.250	0.52	0.010	0.0009	0.0034	0.0013	0.0610	0.0140	0.032	0.018	0.230	0.0022		Steel of present invention
81	0.45	0.670	0.35	<u>0.007</u>	0.0007	0.0024	0.0014	0.0550	0.0130	0.034	0.110	0.180	0.0024		Steel of present invention
82	0.44	0.550	0.50	0.010	0.0009	0.0025	0.0016	0.0480	0.0210	0.027	0.280	0.170	0.0025		Steel of present invention
83	0.44	0.250	0.33	0.009	0.0021	0.0041	0.0021	0.0530	0.0370	0.020	0.350	0.180	0.0033		Steel of present invention
84	0.44	0.450	0.33	0.006	0.0019	0.0037	0.0021	0.0520	0.0190	0.037	0.480	0.240	0.0028		Steel of present invention
85	0.46	0.280	0.43	0.008	0.0010	0.0027	0.0022	0.0460	0.0210	0.031	0.650	0.170	0.0017		Steel of present invention
86	0.44	0.330	0.25	0.007	0.0005	0.0017	0.0016	0.0460	0.0170	0.048	0.880	0.160	0.0018		Steel of present invention
87	0.46	0.410	0.32	0.012	0.0008	0.0027	0.0018	0.0550	0.0200	0.019	<u>1.220</u>	0.180	0.0018		Comparative steel
88	0.46	0.530	0.41	0.011	0.0005	0.0046	0.0020	0.0460	0.0170	0.019	0.140	<u>0.020</u>	0.0018		Comparative steel
89	0.44	0.600	0.29	0.008	0.0006	0.0021	0.0015	0.0430	0.0160	0.043	0.190	0.070	0.0019		Steel of present invention
90	0.44	0.630	0.33	0.008	0.0021	0.0019	0.0024	0.0580	0.0360	0.030	0.410	0.110	0.0023		Steel of present invention
91	0.46	0.560	0.50	0.005	0.0013	0.0028	0.0026	0.0420	0.0320	0.047	0.310	0.190	0.0027		Steel of present invention
92	0.44	0.660	0.49	0.008	0.0014	0.0036	0.0026	0.0470	0.0310	0.034	0.320	0.330	0.0021		Steel of present invention
93	0.46	0.580	0.24	0.005	0.0016	0.0019	0.0016	0.0610	0.0310	0.046	0.330	0.560	0.0022		Steel of present invention
94	0.46	0.480	0.53	0.007	0.0002	0.0035	0.0026	0.0500	0.0350	0.042	0.220	0.780	0.0029		Steel of present invention
95	0.46	0.250	0.39	0.006	0.0003	0.0044	0.0012	0.0430	0.0240	0.028	0.390	0.930	0.0024		Steel of present invention
96	0.44	0.420	0.27	0.004	0.0005	0.0024	0.0015	0.0540	0.0250	0.022	0.230	<u>1.230</u>	0.0024		Comparative steel
97	0.44	0.460	0.38	<u>0.007</u>	0.0003	0.0045	0.0012	0.0540	0.0300	0.029	0.260	0.230	<u>0.0004</u>		Comparative steel
98	0.45	0.300	0.34	0.011	0.0017	0.0029	0.0031	0.0510	0.0270	0.021	0.110	0.140	0.0007		Steel of present invention
99	0.44	0.250	0.37	0.009	0.0019	0.0033	0.0032	0.0460	0.0190	0.033	0.170	0.220	0.0012		Steel of present invention
100	0.45	0.610	0.57	0.010	0.0011	0.0040	0.0012	0.0410	0.0400	0.032	0.130	0.170	0.0019		Steel of present invention
101	0.45	0.580	0.40	<u>0.007</u>	0.0008	0.0024	0.0016	0.0610	0.0130	0.033	0.290	0.190	0.0032		Steel of present invention
102	0.46	0.220	0.42	0.005	0.0005	0.0031	0.0023	0.0450	0.0300	0.039	0.410	0.210	0.0055		Steel of present invention
103	0.44	0.620	0.46	0.005	0.0004	0.0036	0.0029	0.0600	0.0260	0.035	0.380	0.210	0.0072		Steel of present invention
104	0.46	0.350	0.54	0.012	0.0006	0.0020	0.0033	0.0430	0.0260	0.032	0.120	0.210	0.0086		Steel of present invention

(continued)

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
105	0.46	0.230	0.37	0.005	0.0015	0.0031	0.0033	0.0530	0.0250	0.026	0.180	0.210	<u>0.0115</u>		<u>Comparative steel</u>

[0144] The underline indicates that it is outside the scope of the present invention.

[Table 1E]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
106	0.45	0.530	0.30	0.007	0.0003	0.0024	0.0011	0.0520	0.0410	0.047	0.210	0.210	0.0024	Co=0.06	Steel of present invention
107	0.47	0.270	0.42	0.006	0.0021	0.0032	0.0030	0.0420	0.0240	0.024	0.190	0.200	0.0016	Co=1.30	Steel of present invention
108	0.47	0.390	0.40	0.012	0.0004	0.0020	0.0009	0.0410	0.0330	0.032	0.280	0.130	0.0021	Co=2.50	Steel of present invention
109	0.45	0.660	0.33	0.006	0.0005	0.0040	0.0029	0.0530	0.0260	0.033	0.390	0.150	0.0029	Ni=0.03	Steel of present invention
110	0.47	0.390	0.44	0.009	0.0019	0.0025	0.0015	0.0520	0.0270	0.032	0.260	0.120	0.0032	Ni=1.10	Steel of present invention
111	0.46	0.220	0.48	0.011	0.0018	0.0021	0.0010	0.0390	0.0370	0.036	0.380	0.120	0.0020	Ni=2.60	Steel of present invention
112	0.47	0.330	0.52	0.007	0.0008	0.0022	0.0012	0.0470	0.0250	0.031	0.220	0.140	0.0034	Cu=0.07	Steel of present invention
113	0.46	0.440	0.57	0.009	0.0018	0.0046	0.0017	0.0400	0.0160	0.031	0.370	0.190	0.0019	Cu=1.20	Steel of present invention
114	0.46	0.660	0.43	0.005	0.0002	0.0020	0.0032	0.0390	0.0290	0.038	0.290	0.230	0.0017	Cu=2.70	Steel of present invention
115	0.46	0.260	0.56	0.004	0.0006	0.0037	0.0015	0.0570	0.0270	0.028	0.390	0.190	0.0017	V=0.06	Steel of present invention
116	0.44	0.230	0.26	0.012	0.0006	0.0031	0.0014	0.0580	0.0150	0.033	0.120	0.160	0.0019	V=0.90	Steel of present invention
117	0.44	0.610	0.39	0.007	0.0021	0.0028	0.0030	0.0610	0.0230	0.029	0.420	0.150	0.0031	V=2.20	Steel of present invention
118	0.46	0.220	0.28	0.006	0.0003	0.0030	0.0029	0.0460	0.0400	0.021	0.140	0.130	0.0025	W=0.09	Steel of present invention
119	0.45	0.620	0.44	0.005	0.0010	0.0035	0.0010	0.0500	0.0140	0.019	0.410	0.210	0.0033	W=1.50	Steel of present invention
120	0.47	0.620	0.38	0.011	0.0010	0.0024	0.0030	0.0570	0.0310	0.020	0.320	0.150	0.0029	W=2.60	Steel of present invention
121	0.44	0.620	0.45	0.012	0.0019	0.0028	0.0026	0.0410	0.0230	0.034	0.120	0.220	0.0032	Ca=0.0016	Steel of present invention
122	0.46	0.250	0.47	0.007	0.0013	0.0026	0.0014	0.0410	0.0350	0.023	0.160	0.160	0.0017	Ca=0.0120	Steel of present invention
123	0.44	0.620	0.32	0.012	0.0002	0.0036	0.0032	0.0460	0.0210	0.029	0.400	0.170	0.0020	Ca=0.0860	Steel of present invention
124	0.45	0.470	0.41	0.007	0.0018	0.0027	0.0025	0.0410	0.0400	0.037	0.340	0.150	0.0034	Mg=0.0018	Steel of present invention
125	0.46	0.640	0.53	0.008	0.0018	0.0023	0.0021	0.0520	0.0230	0.025	0.430	0.230	0.0034	Mg=0.2100	Steel of present invention
126	0.45	0.640	0.39	0.006	0.0005	0.0027	0.0017	0.0390	0.0260	0.041	0.190	0.240	0.0026	Mg=0.9200	Steel of present invention
127	0.46	0.660	0.37	0.012	0.0021	0.0017	0.0016	0.0590	0.0180	0.033	0.390	0.150	0.0023	REM=0.0016	Steel of present invention
128	0.44	0.370	0.36	0.011	0.0004	0.0038	0.0022	0.0500	0.0300	0.034	0.110	0.120	0.0022	REM=0.1300	Steel of present invention
129	0.45	0.650	0.51	0.012	0.0013	0.0027	0.0033	0.0440	0.0160	0.024	0.330	0.220	0.0019	REM=0.6700	Steel of present invention

[Table 1F]

Steel No.	Chemical composition (mass%) remainder being Fe and impurities														Notes
	C	Si	Mn	P	S	N	O	Al	Nb	Ti	Cr	Mo	B	Others	
130	0.45	0.620	0.38	0.007	0.0006	0.0026	0.0019	0.0420	0.0220	0.037	0.160	0.160	0.0020	Sb=0.006	Steel of present invention
131	0.45	0.630	0.39	0.005	0.0017	0.0037	0.0010	0.0440	0.0340	0.027	0.140	0.140	0.0020	Sb=0.140	Steel of present invention
132	0.45	0.470	0.47	0.009	0.0009	0.0031	0.0011	0.0400	0.0150	0.042	0.190	0.170	0.0030	Sb=0.850	Steel of present invention
133	0.46	0.220	0.47	0.005	0.0013	0.0026	0.0013	0.0540	0.0400	0.031	0.200	0.230	0.0034	Sn=0.003	Steel of present invention
134	0.47	0.660	0.31	0.005	0.0010	0.0030	0.0015	0.0550	0.0210	0.036	0.160	0.140	0.0033	Sn=0.120	Steel of present invention
135	0.44	0.670	0.33	0.006	0.0019	0.0040	0.0017	0.0500	0.0280	0.036	0.350	0.240	0.0033	Sn=0.790	Steel of present invention
136	0.44	0.410	0.50	0.009	0.0004	0.0038	0.0017	0.0400	0.0210	0.020	0.120	0.240	0.0031	Zr=0.005	Steel of present invention
137	0.45	0.550	0.32	0.007	0.0012	0.0028	0.0013	0.0480	0.0400	0.040	0.210	0.150	0.0017	Zr=0.090	Steel of present invention
138	0.46	0.360	0.26	0.005	0.0021	0.0020	0.0015	0.0520	0.0270	0.035	0.140	0.120	0.0018	Zr=0.720	Steel of present invention
139	0.47	0.510	0.39	0.010	0.0014	0.0015	0.0025	0.0580	0.0320	0.022	0.170	0.170	0.0032	As=0.003	Steel of present invention
140	0.46	0.260	0.53	0.008	0.0016	0.0025	0.0012	0.0520	0.0220	0.028	0.340	0.180	0.0025	As=0.042	Steel of present invention
141	0.46	0.580	0.50	0.007	0.0020	0.0037	0.0033	0.0550	0.0140	0.045	0.340	0.160	0.0019	As=0.093	Steel of present invention
142	0.45	0.420	0.48	0.012	0.0003	0.0033	0.0022	0.0470	0.0370	0.036	0.410	0.150	0.0020	Co=1.40, Ni=1.20	Steel of present invention
143	0.44	0.430	0.27	0.010	0.0010	0.0036	0.0027	0.0590	0.0370	0.022	0.410	0.220	0.0022	Co=1.30, Cu=1.40	Steel of present invention
144	0.45	0.550	0.27	0.010	0.0010	0.0046	0.0030	0.0410	0.0200	0.033	0.200	0.170	0.0025	Co=1.40, W=1.60	Steel of present invention
145	0.45	0.270	0.43	0.007	0.0013	0.0025	0.0024	0.0580	0.0400	0.034	0.230	0.200	0.0018	Co=1.50, Mg=0.1900	Steel of present invention
146	0.44	0.490	0.42	0.010	0.0019	0.0023	0.0033	0.0390	0.0160	0.044	0.180	0.200	0.0033	Ni=1.30, Cu=1.20	Steel of present invention
147	0.46	0.540	0.34	0.006	0.0004	0.0029	0.0017	0.0580	0.0250	0.048	0.200	0.150	0.0034	Ni=1.20, W=1.40	Steel of present invention
148	0.46	0.300	0.48	0.005	0.0007	0.0016	0.0027	0.0610	0.0250	0.034	0.310	0.220	0.0027	Ni=1.10, Mg=0.1800	Steel of present invention
149	0.47	0.280	0.31	0.008	0.0013	0.0028	0.0016	0.0450	0.0210	0.046	0.260	0.180	0.0017	Cu=1.10, W=1.30	Steel of present invention
150	0.44	0.210	0.56	0.011	0.0017	0.0040	0.0033	0.0540	0.0400	0.041	0.290	0.190	0.0018	Cu=1.20, Mg=0.2200	Steel of present invention
151	0.44	0.260	0.54	0.005	0.0004	0.0025	0.0026	0.0580	0.0170	0.042	0.260	0.190	0.0026	W=1.40, Mg=0.2100	Steel of present invention

[Table 2A]

Manufacturing No.	Steel No.	Final rolling: Rolling reduction at one stand before final stand %	Final rolling: Rolling reduction at final stand %	Cooling: Time until starting cooling s	Hot stamping: Heating temperature °C	Hot stamping: Holding time s	Notes
1	1	54	51	6.9	920	478	Comparative example
2	2	53	51	6.4	882	481	Present invention example
3	3	51	51	6.6	919	495	Present invention example
4	4	53	55	6.2	892	465	Present invention example
5	5	55	56	6.3	881	466	Present invention example
6	6	52	54	5.2	914	495	Present invention example
7	7	53	51	6.3	906	479	Comparative example
8	8	50	54	7.1	911	481	Comparative example
9	9	54	55	5.9	885	477	Present invention example
10	10	50	52	5.4	882	481	Present invention example
11	11	53	52	5.7	896	478	Present invention example
12	12	52	55	7.4	894	478	Present invention example
13	13	53	53	5.3	892	495	Present invention example
14	14	54	56	5.9	904	465	Present invention example
15	15	52	55	6.5	896	478	Present invention example
16	16	54	54	7.2	916	477	Present invention example
17	17	52	50	5.4	905	492	Comparative example
18	18	52	51	6.7	903	489	Comparative example
19	19	54	52	6.7	912	493	Present invention example
20	20	55	50	7.4	882	474	Present invention example
21	21	51	51	6.6	896	474	Present invention example
22	22	50	56	6.5	882	480	Present invention example
23	23	52	51	7.0	889	485	Present invention example
24	24	51	53	5.0	911	487	Comparative example
25	25	51	54	6.3	894	479	Present invention example
26	26	54	50	6.6	915	472	Present invention example
27	27	55	50	6.0	898	479	Present invention example
28	28	50	53	6.2	881	473	Present invention example
29	29	53	55	7.4	899	470	Present invention example
30	30	51	52	5.4	885	468	Comparative example
31	31	50	55	6.8	918	484	Present invention example
32	32	52	55	6.5	897	475	Present invention example
33	33	52	50	6.0	894	473	Present invention example
34	34	52	56	5.1	903	491	Present invention example
35	35	53	50	5.6	918	465	Present invention example
36	36	55	52	5.6	888	482	Comparative example
37	37	54	50	6.7	909	466	Present invention example

The underline indicates that the manufacturing condition is not preferable.

[Table 2B]

Manufacturing No.	Steel No.	Final rolling: Rolling reduction at one stand before final stand %	Final rolling: Rolling reduction at final stand %	Cooling: Time until starting cooling s	Hot stamping: Heating temperature °C	Hot stamping: Holding time s	Notes
38	38	55	52	6.6	904	472	Present invention example
39	39	54	51	7.1	916	477	Present invention example
40	40	52	52	7.3	918	486	Present invention example
41	41	51	54	6.8	887	471	Present invention example
42	42	51	50	7.2	906	484	Comparative example
43	43	54	52	5.3	893	476	Present invention example
44	44	51	55	5.7	903	491	Present invention example
45	45	51	52	5.6	914	489	Present invention example
46	46	52	53	6.5	900	469	Present invention example
47	47	53	52	6.0	917	470	Present invention example
48	48	55	50	6.6	906	482	Comparative example
49	49	52	52	5.3	919	490	Comparative example
50	50	55	56	6.9	887	495	Present invention example
51	51	52	54	7.1	897	467	Present invention example
52	52	54	53	6.1	882	471	Present invention example
53	53	55	54	6.2	910	467	Present invention example
54	54	53	50	6.8	900	488	Present invention example
55	55	55	51	6.2	881	468	Present invention example
56	56	53	51	7.2	902	495	Present invention example
57	57	52	54	5.7	911	483	Present invention example
58	58	52	55	6.4	918	494	Present invention example
59	59	50	52	5.7	882	473	Comparative example
60	60	52	52	5.1	882	482	Comparative example
61	61	53	55	5.3	900	491	Present invention example
62	62	53	52	5.1	908	478	Present invention example
63	63	53	53	6.2	895	492	Present invention example
64	64	53	50	6.1	912	480	Present invention example
65	65	54	54	5.2	912	479	Present invention example
66	66	52	51	5.4	891	484	Present invention example
67	67	51	56	5.5	909	478	Present invention example
68	68	52	52	7.3	909	484	Present invention example
69	69	55	52	6.6	889	483	Comparative example
70	70	50	56	5.3	897	493	Comparative example
71	71	55	52	5.9	897	477	Present invention example
72	72	50	55	5.3	910	478	Present invention example
73	73	51	54	6.8	891	493	Present invention example
74	74	53	54	6.4	898	485	Present invention example
75	75	52	50	5.9	915	485	Present invention example

The underline indicates that the manufacturing condition is not preferable.

[Table 2C]

Manufacturing No.	Steel No.	Final rolling: Rolling reduction at one stand before final stand %	Final rolling: Rolling reduction at final stand %	Cooling: Time until starting cooling s	Hot stamping: Heating temperature °C	Hot stamping: Holding time s	Notes
76	76	54	52	7.4	897	493	Present invention example
77	77	51	50	5.5	905	465	Present invention example
78	78	53	56	6.3	886	494	Comparative example
79	79	55	50	6.2	881	482	Comparative example
80	80	54	55	6.4	894	491	Present invention example
81	81	50	52	5.8	894	488	Present invention example
82	82	55	54	5.1	897	467	Present invention example
83	83	52	53	6.4	903	483	Present invention example
84	84	54	50	7.0	911	483	Present invention example
85	85	54	55	7.4	907	487	Present invention example
86	86	55	51	5.2	888	476	Present invention example
87	87	54	54	6.4	898	488	Comparative example
88	88	54	50	5.8	910	478	Comparative example
89	89	50	50	7.0	884	478	Present invention example
90	90	54	53	6.7	902	474	Present invention example
91	91	55	52	5.0	900	476	Present invention example
92	92	54	51	5.2	907	495	Present invention example
93	93	53	54	6.0	881	480	Present invention example
94	94	55	50	6.6	901	471	Present invention example
95	95	54	55	5.1	911	478	Present invention example
96	96	52	52	5.0	905	494	Comparative example
97	97	54	52	7.0	894	484	Comparative example
98	98	54	52	5.5	905	495	Present invention example
99	99	51	56	5.6	917	487	Present invention example
100	100	55	55	5.9	914	485	Present invention example
101	101	52	50	5.0	899	470	Present invention example
102	102	51	51	6.8	915	483	Present invention example
103	103	55	56	7.1	887	477	Present invention example
104	104	50	51	5.3	919	466	Present invention example
105	105	54	50	5.0	882	466	Comparative example
106	106	52	53	5.5	905	484	Present invention example
107	107	51	50	6.2	902	477	Present invention example
108	108	50	54	5.2	894	472	Present invention example
109	109	53	51	7.2	916	482	Present invention example
110	110	53	50	7.1	915	492	Present invention example
111	111	51	52	6.1	903	479	Present invention example

The underline indicates that the manufacturing condition is not preferable.

[Table 2D]

Manufacturing No.	Steel No.	Final rolling: Rolling reduction at one stand before final stand %	Final rolling: Rolling reduction at final stand %	Cooling: Time until starting cooling s	Hot stamping: Heating temperature °C	Hot stamping: Holding time s	Notes
112	112	50	55	6.9	880	489	Present invention example
113	113	53	56	5.3	886	472	Present invention example
114	114	52	55	5.9	915	492	Present invention example
115	115	52	56	6.6	899	466	Present invention example
116	116	54	55	7.4	898	495	Present invention example
117	117	55	51	7.3	904	466	Present invention example
118	118	55	52	5.3	884	484	Present invention example
119	119	51	50	7.0	918	493	Present invention example
120	120	53	50	6.6	903	492	Present invention example
121	121	53	52	5.1	887	488	Present invention example
122	122	53	52	7.2	881	470	Present invention example
123	123	52	53	5.0	882	494	Present invention example
124	124	53	55	5.8	886	478	Present invention example
125	125	50	55	6.2	914	488	Present invention example
126	126	53	51	7.0	896	473	Present invention example
127	127	54	53	6.9	892	477	Present invention example
128	128	50	50	6.2	880	481	Present invention example
129	129	50	54	6.0	900	480	Present invention example
130	130	51	52	6.4	898	481	Present invention example
131	131	55	53	7.2	901	465	Present invention example
132	132	53	50	7.3	903	491	Present invention example
133	133	51	55	6.2	910	494	Present invention example
134	134	53	52	6.8	889	472	Present invention example
135	135	53	53	7.0	900	472	Present invention example
136	136	54	51	7.3	900	480	Present invention example
137	137	55	55	6.2	920	485	Present invention example
138	138	50	54	5.4	918	480	Present invention example
139	139	55	56	6.5	890	494	Present invention example
140	140	52	56	5.3	907	476	Present invention example
141	141	54	52	7.2	915	494	Present invention example
142	142	55	56	5.5	887	489	Present invention example
143	143	55	52	6.3	885	465	Present invention example
144	144	53	52	6.3	882	488	Present invention example
145	145	53	53	5.5	916	470	Present invention example
146	146	54	55	5.8	885	486	Present invention example
147	147	55	50	6.5	918	480	Present invention example
148	148	55	50	6.1	910	485	Present invention example
149	149	54	52	5.2	904	486	Present invention example
150	150	53	50	5.4	895	482	Present invention example

[Table 2E]

Manufacturing No.	Steel No.	Final rolling: Rolling reduction at one stand before final stand %	Final rolling: Rolling reduction at final stand %	Cooling: Time until starting cooling s	Hot stamping: Heating temperature °C	Hot stamping: Holding time s	Notes
151	151	52	52	7.0	889	482	Present invention example
152	11	20	10	6.4	880	494	Comparative example
153	11	20	20	7.4	920	481	Comparative example
154	14	30	30	5.2	910	465	Comparative example
155	22	40	30	6.1	881	466	Comparative example
156	14	30	40	6.3	899	478	Comparative example
157	20	40	40	5.1	919	470	Comparative example
158	20	20	50	5.8	890	477	Comparative example
159	14	50	20	5.8	909	471	Comparative example
160	12	55	50	0.4	913	478	Comparative example
161	22	52	54	2.2	919	475	Comparative example
162	14	51	51	4.1	904	485	Comparative example
163	21	54	54	6.1	895	470	Present invention example
164	12	51	56	6.7	911	471	Present invention example
165	13	51	54	5.5	892	487	Present invention example
166	11	50	53	5.3	886	466	Present invention example
167	22	50	56	7.0	909	475	Present invention example
168	21	55	53	5.1	903	468	Present invention example
169	11	55	50	7.1	897	470	Present invention example
170	14	51	52	5.5	881	489	Present invention example
171	22	52	54	6.3	745	478	Comparative example
172	22	50	52	6.3	843	490	Present invention example
173	14	53	54	5.2	895	482	Present invention example
174	20	53	52	5.6	952	483	Present invention example
175	22	53	53	5.0	1023	489	Comparative example
176	14	51	51	6.0	890	38	Comparative example
177	22	51	51	7.0	899	62	Present invention example
178	14	51	51	6.7	885	481	Present invention example
179	14	51	52	6.7	908	955	Present invention example
180	13	52	53	5.2	891	1258	Comparative example
181	11	53	50	6.6	907	466	Present invention example
182	12	50	52	6.8	881	476	Present invention example
183	21	54	53	6.5	880	478	Present invention example
184	14	51	56	7.4	895	486	Present invention example
185	12	50	53	6.4	883	489	Present invention example
186	20	54	52	5.2	911	482	Present invention example
187	13	50	50	6.2	883	492	Present invention example
188	13	53	50	5.3	899	488	Present invention example

The underline indicates that the manufacturing condition is not preferable.

[Table 3A]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densitis of texture of prior austenite -	Average value of block sizes µm	Tensile strength MPa	Load at 1/2 stroke N	
1	1				6.6	0.69	2083	8149	Comparative example
2	2				4.4	0.81	2306	8131	Present invention example
3	3				9.0	0.74	2445	8090	Present invention example
4	4				4.7	0.70	2521	8073	Present invention example
5	5				4.0	0.76	2762	8129	Present invention example
6	6				4.4	0.68	2855	8151	Present invention example
7	7				9.0	0.74	2937	7826	Comparative example
8	8				8.8	0.70	2214	8146	Comparative example
9	9				8.6	0.80	2325	8127	Present invention example
10	10				4.0	0.85	2436	8152	Present invention example
11	11				9.7	0.75	2463	8120	Present invention example
12	12				5.6	0.85	2387	8137	Present invention example
13	13				10.1	0.77	2361	8153	Present invention example
14	14				3.4	0.71	2385	8089	Present invention example
15	15				4.9	0.84	2468	8091	Present invention example
16	16				8.3	0.70	2317	8119	Present invention example
17	17				9.8	0.78	2216	8076	Comparative example
18	18				6.0	0.82	2187	8072	Comparative example
19	19				3.9	0.74	2341	8128	Present invention example
20	20				4.4	0.81	2460	8148	Present invention example
21	21				9.4	0.79	2418	8080	Present invention example
22	22				8.2	0.78	2372	8081	Present invention example
23	23				4.6	0.73	2520	8093	Present invention example
24	24				2.1	0.85	2377	8004	Comparative example
25	25				4.0	0.79	2400	8093	Present invention example
26	26				9.6	0.85	2392	8148	Present invention example
27	27				9.3	0.72	2451	8093	Present invention example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[Table 3B]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes µm	Tensile strength MPa	Load at 1/2 stroke N	
28	28				7.4	0.81	2469	8130	Present invention example
29	29				4.6	0.71	2478	8053	Present invention example
30	30				2.7	0.69	2420	7832	Comparative example
31	31				4.1	0.85	2496	8141	Present invention example
32	32				9.8	0.73	2367	8102	Present invention example
33	33				7.1	0.84	2493	8139	Present invention example
34	34				10.3	0.79	2527	8077	Present invention example
35	35				6.1	0.75	2377	8067	Present invention example
36	36				2.8	0.83	2416	7838	Comparative example
37	37				6.7	0.81	2385	8099	Present invention example
38	38				6.9	0.70	2374	8116	Present invention example
39	39				3.5	0.83	2384	8134	Present invention example
40	40				3.8	0.72	2353	8150	Present invention example
41	41				4.2	0.68	2525	8077	Present invention example
42	42				1.7	0.72	2418	7972	Comparative example
43	43				5.2	0.73	2549	8125	Present invention example
44	44				9.0	0.69	2500	8076	Present invention example
45	45				9.1	0.73	2546	8146	Present invention example
46	46				9.2	0.82	2389	8096	Present invention example
47	47				4.1	0.72	2460	8056	Present invention example
48	48				2.2	0.77	2369	7885	Comparative example
49	49				2.4	0.85	2526	7913	Comparative example
50	50				6.9	0.79	2430	8065	Present invention example
51	51				8.8	0.84	2547	8125	Present invention example
52	52				8.0	0.79	2379	8096	Present invention example
53	53				9.1	0.78	2394	8143	Present invention example
54	54				9.7	0.69	2476	8075	Present invention example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[Table 3C]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes µm	Tensile strength MPa	Load at 1/2 stroke N	
55	55				6.0	0.77	2473	8134	Present invention example
56	56				6.1	0.81	2417	8086	Present invention example
57	57				6.8	0.76	2437	8144	Present invention example
58	58				6.8	0.85	2447	8058	Present invention example
59	59				2.6	0.76	2547	7838	Comparative example
60	60				8.0	0.68	2175	8124	Comparative example
61	61				9.2	0.72	2311	8085	Present invention example
62	62				9.8	0.79	2363	8128	Present invention example
63	63				5.5	0.79	2355	8103	Present invention example
64	64				6.2	0.68	2375	8081	Present invention example
65	65				4.7	0.80	2484	8120	Present invention example
66	66				5.8	0.81	2352	8148	Present invention example
67	67				6.1	0.75	2454	8091	Present invention example
68	68				3.9	0.83	2547	8066	Present invention example
69	69				1.9	0.76	2375	7962	Comparative example
70	70				3.7	0.77	2226	8120	Comparative example
71	71				7.4	0.79	2374	8117	Present invention example
72	72				4.1	0.83	2534	8097	Present invention example
73	73				3.5	0.68	2366	8092	Present invention example
74	74				7.3	0.76	2440	8121	Present invention example
75	75				6.0	0.74	2355	8089	Present invention example
76	76				6.6	0.72	2533	8146	Present invention example
77	77				7.2	0.75	2486	8070	Present invention example
78	78				2.3	0.71	2465	7953	Comparative example
79	79				8.3	0.80	2298	8149	Comparative example
80	80				7.9	0.78	2336	8130	Present invention example
81	81				7.0	0.82	2375	8129	Present invention example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[Table 3D]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes µm	Tensile strength MPa	Load at 1/2 stroke N	
82	82				5.9	0.80	2388	8095	Present invention example
83	83				8.0	0.73	2481	8126	Present invention example
84	84				4.5	0.81	2509	8077	Present invention example
85	85				10.3	0.77	2444	8116	Present invention example
86	86				3.8	0.73	2441	8128	Present invention example
87	87				2.6	0.80	2457	7963	Comparative example
88	88				6.4	0.79	2244	8117	Comparative example
89	89				6.7	0.81	2328	8119	Present invention example
90	90				3.5	0.81	2451	8154	Present invention example
91	91				8.4	0.82	2390	8104	Present invention example
92	92				3.5	0.77	2442	8117	Present invention example
93	93				4.0	0.84	2489	8112	Present invention example
94	94				7.1	0.80	2414	8136	Present invention example
95	95				4.2	0.82	2426	8091	Present invention example
96	96				2.2	0.68	2403	7889	Comparative example
97	97				3.9	0.81	2209	8108	Comparative example
98	98				3.3	0.71	2348	8089	Present invention example
99	99				7.8	0.80	2528	8148	Present invention example
100	100				3.7	0.71	2542	8102	Present invention example
101	101				7.0	0.80	2400	8143	Present invention example
102	102				6.9	0.77	2438	8120	Present invention example
103	103				6.7	0.78	2394	8114	Present invention example
104	104				5.5	0.80	2414	8055	Present invention example
105	105				2.1	0.77	2426	7859	Comparative example
106	106				10.3	0.82	2451	8074	Present invention example
107	107				7.4	0.78	2479	8138	Present invention example
108	108				7.8	0.85	2470	8106	Present invention example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[Table 3E]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes μm	Tensile strength MPa	Load at 1/2 stroke N	
109	109				8.3	0.70	2492	8115	Present invention example
110	110				6.8	0.72	2424	8140	Present invention example
111	111				8.2	0.69	2354	8078	Present invention example
112	112				6.9	0.78	2530	8074	Present invention example
113	113				8.1	0.78	2400	8152	Present invention example
114	114				10.2	0.83	2419	8131	Present invention example
115	115				3.3	0.80	2529	8093	Present invention example
116	116				7.8	0.77	2414	8103	Present invention example
117	117				9.2	0.72	2484	8121	Present invention example
118	118				9.3	0.82	2541	8084	Present invention example
119	119				6.7	0.84	2390	8090	Present invention example
120	120				7.7	0.69	2415	8138	Present invention example
121	121				3.2	0.70	2502	8154	Present invention example
122	122				10.1	0.69	2512	8147	Present invention example
123	123				6.7	0.73	2465	8112	Present invention example
124	124				7.7	0.71	2362	8112	Present invention example
125	125				9.2	0.72	2434	8126	Present invention example
126	126				6.5	0.83	2524	8119	Present invention example
127	127				7.5	0.68	2508	8136	Present invention example
128	128				5.8	0.81	2409	8137	Present invention example
129	129				5.3	0.79	2478	8093	Present invention example
130	130				3.4	0.80	2464	8128	Present invention example
131	131				9.7	0.75	2383	8118	Present invention example
132	132				9.5	0.85	2545	8117	Present invention example
133	133				5.5	0.83	2464	8081	Present invention example
134	134				3.4	0.77	2396	8107	Present invention example
135	135				3.6	0.85	2429	8141	Present invention example

[Table 3F]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes μm	Tensile strength MPa	Load at 1/2 stroke N	
136	136				8.1	0.80	2458	8081	Present invention example
137	137				10.3	0.78	2460	8146	Present invention example
138	138				7.8	0.79	2527	8126	Present invention example
139	139				7.6	0.73	2494	8134	Present invention example
140	140				8.7	0.85	2501	8074	Present invention example
141	141				4.6	0.77	2531	8092	Present invention example
142	142				7.7	0.73	2372	8106	Present invention example
143	143				4.4	0.83	2396	8078	Present invention example
144	144				9.1	0.85	2464	8128	Present invention example
145	145				9.9	0.68	2510	8122	Present invention example
146	146				9.4	0.79	2376	8073	Present invention example
147	147				3.7	0.68	2527	8107	Present invention example
148	148				6.5	0.85	2457	8111	Present invention example
149	149				4.3	0.79	2396	8137	Present invention example
150	150				9.2	0.79	2398	8132	Present invention example
151	151				9.9	0.73	2509	8134	Present invention example
152	11				1.9	0.75	2425	7964	Comparative example
153	11				1.8	0.72	2549	7965	Comparative example
154	14				2.2	0.79	2441	7982	Comparative example
155	22				2.4	0.84	2502	8002	Comparative example
156	14				2.7	0.80	2491	8011	Comparative example
157	20				2.8	0.72	2466	8039	Comparative example
158	20				2.2	0.84	2424	7995	Comparative example
159	14				2.5	0.81	2501	8011	Comparative example
160	12				2.3	0.78	2372	7896	Comparative example
161	22				2.1	0.71	2359	7923	Comparative example
162	14				2.4	0.71	2451	7984	Comparative example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[Table 3G]

Manufacturing No.	Steel No.	Hot stamped component							Notes
		Plating	Tempering	Partially softened region	Maximum value of pole densities of texture of prior austenite -	Average value of block sizes μm	Tensile strength MPa	Load at 1/2 stroke N	
163	21	aluminum plating			9.4	0.78	2547	8104	Present invention example
164	12	aluminum-galvanized			9.5	0.73	2512	8117	Present invention example
165	13	aluminum-silicon plating			5.1	0.71	2540	8132	Present invention example
166	11	hot-dip galvanized			6.1	0.74	2399	8116	Present invention example
167	22	electrogalvanized			6.7	0.73	2487	8147	Present invention example
168	21	galvannealed			6.6	0.80	2490	8098	Present invention example
169	11	zinc-nickel plating			7.5	0.75	2387	8073	Present invention example
170	14	aluminum-magnesium-zinc-based plating			5.8	0.72	2540	8090	Present invention example
<u>171</u>	22				<u>2.5</u>	0.91	<u>2265</u>	<u>7898</u>	Comparative example
172	22				7.9	0.88	2334	8056	Present invention example
173	14				9.2	0.78	2418	8075	Present invention example
174	20				8.3	0.93	2386	8062	Present invention example
<u>175</u>	22				<u>1.9</u>	<u>1.31</u>	<u>2156</u>	<u>7762</u>	Comparative example
<u>176</u>	14				<u>2.4</u>	0.87	<u>2259</u>	<u>7930</u>	Comparative example
177	22				8.2	0.75	2346	8067	Present invention example
178	14				9.6	0.79	2481	8111	Present invention example
179	14				7.6	0.85	2335	8056	Present invention example
<u>180</u>	13				<u>2.2</u>	<u>1.27</u>	<u>2203</u>	<u>7991</u>	Comparative example
181	11		Tempering temperature 153°C		8.9	0.76	2456	8097	Present invention example
182	12		Tempering temperature 172°C		9.3	0.84	2363	8140	Present invention example
183	21		Tempering temperature 205°C		9.5	0.71	2531	8104	Present invention example
184	14		Tempering temperature 339°C		6.5	0.79	2434	8092	Present invention example
185	12		Tempering temperature 432°C		7.2	0.73	2354	8121	Present invention example
186	20		Tempering temperature 515°C		10.2	0.71	2369	8151	Present invention example
187	13		Tempering temperature 588°C		5.8	0.81	2459	8137	Present invention example
188	13			Partially softened treatment	4.1	0.78	2448	8126	Present invention example

The underline indicates that it is outside the scope of the present invention, or the characteristic value is not preferable.

[0145] From Tables 3A to 3G, it can be seen that the hot-stamping formed bodies according to the present invention examples had high strength and excellent bendability.

[0146] On the other hand, it can be seen that in the hot-stamping formed bodies according to comparative examples, one or more of the properties deteriorated.

Industrial Applicability

[0147] According to the above-described aspects of the present invention, it is possible to provide a hot stamped component having high strength and excellent bendability.

Claims

1. A hot stamped component comprising, as a chemical composition, by mass%:

C: 0.40% to 0.70%;
Si: 0.010% to 3.000%;
Mn: 0.10% or more and less than 0.60%;
P: 0.100% or less;
S: 0.0100% or less;
N: 0.0100% or less;
O: 0.0200% or less;
Al: 0.0010% to 0.5000%;
Nb: 0.0010% to 0.1000%;
Ti: 0.010% to 0.100%;
Cr: 0.010% to 1.000%;
Mo: 0.050% to 1.000%;
B: 0.0005% to 0.0100%;
Co: 0% to 3.00%;
Ni: 0% to 3.00%;
Cu: 0% to 3.00%;
V: 0% to 3.00%;

W: 0% to 3.00%;
Ca: 0% to 0.1000%;
Mg: 0% to 1.0000%;
REM: 0% to 1.0000%;
Sb: 0% to 1.000%;
Sn: 0% to 1.000%;
Zr: 0% to 1.000%;
As: 0% to 0.100%; and
a remainder: Fe and impurities,
in a position at 1/4 of a sheet thickness from a surface,
in a texture of prior austenite, a maximum value of pole densities of an orientation group expressed by Euler angles of Φ = 60° to 90°, $\varphi1$ = 60° to 90°, and $\varphi2$ = 45° is 3.0 or more,
an average value of block sizes of martensite, tempered martensite and bainite is 1.20 μm or less.

2. The hot stamped component according to claim 1 comprising, as the chemical composition, by mass%, one or more selected from the group consisting of:

Co: 0.01% to 3.00%;
Ni: 0.01% to 3.00%;
Cu: 0.01% to 3.00%;
V: 0.01% to 3.00%;
W: 0.01% to 3.00%;
Ca: 0.0001% to 0.1000%;
Mg: 0.0001% to 1.0000%;
REM: 0.0001% to 1.0000%;
Sb: 0.001% to 1.000%;
Sn: 0.001% to 1.000%;
Zr: 0.001% to 1.000%; and
As: 0.001% to 0.100%.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/020238

A. CLASSIFICATION OF SUBJECT MATTER

C22C 38/00(2006.01)i; ***C21D 1/18***(2006.01)i; ***C21D 9/00***(2006.01)i; ***C22C 38/60***(2006.01)i; *C21D 8/02*(2006.01)n; *C21D 9/46*(2006.01)n
FI: C22C38/00 301Z; C22C38/60; C21D1/18 C; C21D9/00 A; C22C38/00 301S; C21D9/46 G; C21D8/02 A

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)

C22C38/00-38/60; C21D1/18; C21D9/00; C21D8/02; C21D9/46

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2019/186930 A1 (NIPPON STEEL CORP) 03 October 2019 (2019-10-03) claims, paragraphs [0016]-[0023], tables 2-1 to 3-3	1-2
A	WO 2021/230149 A1 (NIPPON STEEL CORP) 18 November 2021 (2021-11-18) claims, paragraphs [0074]-[0077], [0095]	1-2
A	WO 2021/230150 A1 (NIPPON STEEL CORP) 18 November 2021 (2021-11-18) claims, paragraphs [0075]-[0078], [0096]	1-2
A	WO 2019/003539 A1 (JFE STEEL CORPORATION) 03 January 2019 (2019-01-03) claims, paragraph [0011], tables 2-1 to 3-3	1-2
P, A	WO 2022/239731 A1 (NIPPON STEEL CORP) 17 November 2022 (2022-11-17) claims, paragraphs [0073]-[0077], [0084]-[0085]	1-2

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2023	**22 August 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/020238

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2019/186930 A1	03 October 2019	EP 3778951 A1 claims, paragraphs [0012]-[0019], tables 2-1 to 3-3 US 2021/0010118 A1 CN 111655885 A	
WO 2021/230149 A1	18 November 2021	EP 4151757 A1 claims, paragraphs [0090]-[0093], [0114] US 2023/0091784 A1 CN 115151669 A	
WO 2021/230150 A1	18 November 2021	EP 4151758 A1 claims, paragraphs [0089]-[0092], [0114] US 2023/0081832 A1 CN 115135790 A	
WO 2019/003539 A1	03 January 2019	EP 3647448 A1 claims, paragraph [0011], tables 2-1 to 3-3 US 2020/0353527 A1 CN 110809631 A	
WO 2022/239731 A1	17 November 2022	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2022090847 A **[0002]**
- JP 2020508393 A **[0006]**

Non-patent literature cited in the description

- *Acta Materialia*, 2010, vol. 58, 6393-6403 **[0007]**
- **HIROSHI INOUE**. Lecture (Easy Material Analysis Techniques) - Three-dimensional Orientation Analysis of Texture. *Light Metals*, 1992, vol. 41 (6), 358 **[0086]**