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(54) **LOW ALLOY STEEL**

(57) A low alloy steel, containing, by mass percent, C: 0.01 to 0.15%, Si: 3% or less, Mn: 3% or less, B: 0.005 to 0.050%, and Al: 0.08% or less, and the balance being Fe and impurities, wherein in the impurities, N: 0.01% or less, P: 0.05% or less, S: 0.03% or less, and O: 0.03% or less. In the alloy steel, a HAZ has excellent resistance to embrittlement attributable to hydrogen such as stress corrosion cracking in wet hydrogen sulfide environments.

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Description

TECHNICAL FIELD

[0001] The present invention relates to a low alloy steel.

BACKGROUND ART

[0002] In the development of submarine oilfields, a steel pipe called a riser, flowline, or trunkline is used for transmission of crude oil or natural gas between an oil well or gas well located at the bottom of the sea and a platform on the sea or between the platform and a refinery station on the land. On the other hand, with the worldwide exhaustion of fossil fuels, oil fields containing much hydrogen sulfide having corrosiveness have been developed actively. A steel pipe for transmitting crude oil or natural gas exploited from oil fields containing such a corrosive gas is sometimes broken by embrittlement attributable to hydrogen formed from a corrosion reaction called hydrogen induced cracking (hereinafter, referred to as "HIC") and sulfide stress cracking (hereinafter, referred to as "SSC"). Many steels developed from the viewpoint of improving the HIC resistance and SSC resistance have traditionally been proposed.

[0003] For example, Patent Document 1 (JP5-255746A) proposes a steel provided with excellent HIC resistance by defining the heat history and heat treatment conditions at the production time without substantially containing Ni, Cu and Ca. Also, Patent Document 2 (JP6-336639A) proposes a steel provided with HIC resistance and SSC resistance by essentially adding Cr, Ni and Cu. Further, Patent Document 3 (JP2002-60894A) proposes a steel in which the HIC resistance and SSC resistance are enhanced by defining the specific ranges of amounts of C, Ti, N, V and O.

[0004] When a structure is assembled by using any of these steels, for example, when a steel pipe consisting of any of these steels is laid, welding work is generally performed. Unfortunately, for example, as described in Non-Patent Document 1, it is widely known that the SSC susceptibility is increased by the increase in hardness. When a steel undergoes heating due to welding, a hardened portion is produced in a so-called weld heat affected zone (hereinafter, referred to as a "HAZ: Heat Affected Zone"). As a result, however much the HIC resistance and SSC resistance of the steel itself are enhanced, practically sufficient performance of a welded structure cannot be achieved in many cases.

[0005] Therefore, in recent years, as described in Patent Document 4 (JP2010-24504A), there has also been proposed a high-strength steel in which, by reducing the amounts of C and Mn and by adding 0.5% or more of Mo, the hardening of weld heat affected zone is restrained, and both of HIC resistance and SSC resistance of base metal and HAZ are achieved.

LIST OF PRIOR ART DOCUMENT(S)

[0006]

Patent Document 1: JP5-255746A
Patent Document 2: JP6-336639A
Patent Document 3: JP2002-60894A
Patent Document 4: JP2010-24504A

[0007] Non-Patent Document 1:

Masanori Kowaka, Corrosion damage and anticorrosion engineering of metal, August 25, 1983, issued by Agne Corporation, p.198

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008] In the invention of Patent Document 4, Mo, which is an expensive element, is essential.

[0009] An objective of the present invention is to provide a low alloy steel in which a HAZ has excellent hydrogen embrittlement resistance in wet hydrogen sulfide environments or the like without requiring much cost.

MEANS FOR SOLVING THE PROBLEMS

[0010] The present inventors conducted examinations and studies to optimize the chemical composition capable of enhancing the hydrogen embrittlement resistance of a weld heat affected zone (HAZ: Heat Affected Zone, hereinafter,

referred to as a "HAZ").

[0011] It is considered that the reason why the HAZ is highly susceptible to hydrogen embrittlement is as follows. In the case where a steel is exposed to a corrosive environment containing hydrogen sulfide, hydrogen intrudes into the steel on account of corrosion reaction. This hydrogen can move freely in the crystal lattice of the steel. This hydrogen is so-called diffusible hydrogen. This hydrogen accumulates in a dislocation or a vacancy, which is one kind of defects in the crystal lattice to embrittle the steel. The HAZ is an as-quenched structure being heated to a high temperature by the heat history of welding, and cooled rapidly. Therefore, in the HAZ, the dislocations and vacancies in which hydrogen is trapped exist densely as compared with a thermally refined base metal. As a result, it is considered that the HAZ is highly susceptible to hydrogen embrittlement as compared with the base metal.

[0012] As a result of repeated earnest studies, it was found that, in order to enhance the hydrogen embrittlement susceptibility of HAZ, it was very effective to positively contain B, specifically, to contain 0.005 to 0.050% of B. The reason for this is considered to be as follows. Because having a small atom radius like hydrogen, B exists in a crystal lattice, and can move in the lattice. In addition, B has a tendency to segregate in a lattice defect and to exist stably. Therefore, for the steel containing much B, it is considered that hydrogen can be prevented from accumulating in the dislocation or vacancy introduced into the HAZ, and embrittlement can be suppressed.

[0013] The present invention has been made based on the above-described findings, and the gist thereof is low alloy steels described in the following items (1) to (5).

(1) A low alloy steel, containing, by mass percent, C: 0.01 to 0.15%, Si: 3% or less, Mn: 3% or less, B: 0.005 to 0.050%, and Al: 0.08% or less, and the balance being Fe and impurities, wherein in the impurities, N: 0.01% or less, P: 0.05% or less, S: 0.03% or less, and O: 0.03% or less.

(2) The low alloy steel described in item (1), wherein the low alloy steel contains, by mass percent, of one or more elements selected from Cr, Mo, Ni and Cu: 1.5% or less in total in lieu of a part of Fe.

(3) The low alloy steel described in item (1) or (2), wherein the low alloy steel contains, by mass percent, one or more elements selected from Ti, V and Nb: 0.2% or less in total, of in lieu of a part of Fe.

(4) The low alloy steel described in any one of items (1) to (3), wherein the low alloy steel contains, by mass percent, of Ca and/or Mg: 0.05% or less in total in lieu of a part of Fe.

(5) The low alloy steel described in any one of items (1) to (4), wherein the content of B satisfies Formula (1):

$$0.005 \times Hv/300 + 0.0023 \leq B \qquad \ldots (1)$$

where, "Hv" in the formula means the maximum value of Vickers hardness of HAZ, and "B" means the content of B (mass%).

MEANS FOR SOLVING THE PROBLEMS

[0014] According to the present invention, there can be provided a low alloy steel in which a HAZ has excellent resistance to embrittlement attributable to hydrogen such as stress corrosion cracking in wet hydrogen sulfide environments. This low alloy steel is best suitable as a starting material of a steel pipe for the transmission of crude oil or natural gas.

MODE FOR CARRYING OUT THE INVENTION

[0015] Hereunder, the range of chemical composition of the low alloy steel in accordance with the present invention and the reason for restricting the chemical composition are explained. In the following explanation, "%" representing the content of each element means "mass%".

C: 0.01 to 0.15%

[0016] C (carbon) is an element effective in enhancing the hardenability of steel and increasing the strength thereof. In order to achieve these effects, 0.01% or more of C must be contained. However, if the content of C exceeds 0.15%, the hardness in the quenched state increases too much, and the HAZ is hardened, so that the hydrogen embrittlement susceptibility of HAZ is enhanced. Therefore, the C content is set to 0.01 to 0.15%. The lower limit of the C content is preferably 0.02%, further preferably 0.03%. The C content is preferably 0.12% or less, further preferably less than 0.10%.

Si: 3% or less

[0017] Si (silicon) is an element effective for deoxidation, but brings about a decrease in toughness if being contained excessively. Therefore, the Si content is set to 3% or less. The Si content is preferably 2% or less. The lower limit of the Si content is not particularly defined; however, even if the Si content is decreased, the deoxidizing effect decreases, the cleanliness of steel is deteriorated, and an excessive decrease in the Si content leads to an increase in production cost. Therefore, the Si content is preferably 0.01% or more.

Mn: 3% or less

[0018] Like Si, Mn (manganese) is an element effective for deoxidation, and also is an element contributing to the enhancement of hardenability of steel and to the increase in strength thereof. However, if Mn is contained excessively, remarkable hardening of HAZ is caused, and the hydrogen embrittlement susceptibility is enhanced. Therefore, the Mn content is set to 3% or less. The lower limit of the Mn content is not particularly defined; however, in order to achieve the strength increasing effect of Mn, 0.2% or more of Mn is preferably contained. The lower limit thereof is further preferably 0.4%, and the preferable upper limit thereof is 2.8%.

B: 0.005 to 0.050%

[0019] B (boron) is an element that constitutes the findings, which are the basis of the present invention. As described before, B occupies the accumulation site of hydrogen, such as the dislocation or vacancy in the HAZ. Therefore, B is an element effective in enhancing the hydrogen embrittlement resistance. Furthermore, when a steel material is produced, B segregates at grain boundaries, thereby enhancing the hardenability indirectly, and contributes to the improvement in strength. In order to achieve these effects, 0.005% or more of B must be contained. On the other hand, if B is contained excessively, borides precipitate in large amounts in the HAZ, the interface between a matrix and borides acts as the accumulation site of hydrogen, and inversely embrittlement is produced. Therefore, the B content is set to 0.005 to 0.050%. The lower limit of the B content is preferably 0.006%, further preferably 0.008%. The upper limit thereof is preferably 0.045%, further preferably 0.040%.

[0020] In the case where the hardness of HAZ increases, the dislocation density increases, so that it is preferable that, in order to attain sufficient hydrogen embrittlement resistance, the lower limit of the B content be controlled according to the highest hardness of HAZ. That is to say, in order to attain sufficient hydrogen embrittlement resistance, the B content is preferably in the range satisfying Formula (1) in the relationship with the maximum value of Vickers hardness of HAZ:

$$0.005 \times Hv/300 + 0.0023 \leq B \quad \ldots (1)$$

where, "Hv" in the formula means the maximum value of Vickers hardness of HAZ, and "B" means the content of B (mass%). The maximum value of Vickers hardness of HAZ is a value that is determined by a Vickers test in which the test force is 98.07N in conformity to JIS Z2244.

Al: 0.08% or less

[0021] Al (aluminum) is an element effective for deoxidation, but if being contained excessively, the effect is saturated, and also the toughness is decreased. Therefore, the Al content is set to 0.08% or less. The Al content is preferably 0.06% or less. The lower limit of the Al content is not particularly defined; however, an excessive decrease in the Al content does not sufficiently achieve the deoxidizing effect, deteriorates the cleanliness of steel, and also increases the production cost. Therefore, 0.001% or more of Al is preferably contained. The Al content in the present invention means the content of acid soluble Al (so-called "sol.Al").

[0022] The low alloy steel in accordance with the present invention contains the above-described elements, and the balance consists of Fe and impurities. The "impurities" mean components that are mixed on account of various factors including raw materials such as ore or scrap when a steel material is produced on an industrial scale. Of the impurities, concerning the elements described below, the content thereof must be restricted stringently.

N: 0.01% or less

[0023] N (nitrogen) exists in the steel as an impurity. Nitrogen produces embrittlement when fine carbo-nitrides are

formed, and decreases the toughness even when being dissolved. Therefore, the N content must be restricted to 0.01% or less. The N content is preferably 0.008% or less. The lower limit of the N content is not particularly defined; however, an excessive decrease in the N content leads to a remarkable increase in production cost. Therefore, the lower limit of the N content is preferably 0.0001%.

P: 0.05% or less

[0024] P (phosphorus) exists in the steel as an impurity. Phosphorus segregates at grain boundaries in HAZ, and decreases the toughness. Therefore, the P content is restricted to 0.05% or less. The lower limit of the P content is not particularly defined; however, an excessive decrease in the P content leads to a remarkable increase in production cost. Therefore, the lower limit of the P content is preferably 0.001%.

S: 0.03% or less

[0025] Like P, S (sulfur) exists in the steel as an impurity. Sulfur forms sulfides in a steel material, and since the interface with a matrix acts as an accumulation site of hydrogen, S enhances the hydrogen embrittlement susceptibility, and also decreases the HAZ toughness. Therefore, the S content is restricted to 0.03% or less, more severely than P. The lower limit of the S content is not particularly defined; however, an excessive decrease in the S content leads to a remarkable increase in production cost. Therefore, the lower limit of the S content is preferably 0.0001%.

O: 0.03% or less

[0026] O (oxygen) exists in the steel as an impurity. If much O is contained, large amounts of oxides are formed, and the workability and ductility are deteriorated. Therefore, the O content must be set to 0.03% or less. The O content is preferably 0.025% or less. The lower limit of the O content need not particularly be defined; however, an excessive decrease in the O content leads to a remarkable increase in production cost. Therefore, the O content is preferably 0.0005% or more.

[0027] The low alloy steel in accordance with the present invention may contain the elements described below in lieu of a part of Fe.

One or more elements selected from Cr, Mo, Ni and Cu: 1.5% or less in total

[0028] One or more elements selected from Cr (chromium), Mo (molybdenum), Ni (nickel) and Cu (copper) may be contained because these elements enhance the hardenability and contribute to the improvement in strength. However, if the contents thereof are excessively high, the HAZ is hardened remarkably, and therefore the hydrogen embrittlement susceptibility may be enhanced. Therefore, if one or more elements of these elements are contained, the contents thereof are set to 1.5% or less in total. The lower limit of the contents of these elements is preferably 0.02%, further preferably 0.05%. The upper limit thereof is preferably 1.2%.

One or more elements selected from Ti, V and Nb: 0.2% or less in total

[0029] One or more elements selected from Ti (titanium), V (vanadium) and Nb (niobium) may be contained because these elements are elements that form fine carbo-nitrides and contribute to the improvement in strength, and also stably supplement diffusible hydrogen, and bring about a considerable effect of reducing the hydrogen embrittlement susceptibility. However, if the contents thereof are excessively high, the formation of carbo-nitrides becomes excessive, and therefore the toughness may be decreased. Therefore, if one or more elements of these elements are contained, the contents thereof are set to 0.2% or less in total. The lower limit of the contents of these elements is preferably 0.001%, further preferably 0.003%. The upper limit thereof is preferably 0.15%.

Ca and/or Mg: 0.05% or less in total

[0030] At least one of Ca (calcium) and Mg (magnesium) may be contained because these elements improve the hot workability of steel. However, if the contents thereof are excessively high, these elements combine with oxygen to remarkably decrease the cleanliness, so that the hot workability may rather be deteriorated. Therefore, if at least one kind of these elements is contained, the contents thereof are set to 0.05% or less in total. The lower limit of the contents of Ca and/or Mg is preferably 0.0005%, further preferably 0.001%. The upper limit thereof is preferably 0.03%.

EXAMPLE(S)

[0031] To confirm the effects of the present invention, the experiments described below were conducted. A test material was prepared by machining a 12 mm-thick low alloy steel plate having the chemical composition given in Table 1 into a 12 mm square and a 100 mm length. This test material was subjected to HAZ-simulated thermal cycle in which the test material was heated to a temperature of 1350°C, at which the hardening of HAZ was remarkable, for 3 seconds by high-frequency induction heating, and thereafter was rapidly cooled. By using this test material, the tests described below were conducted.

<Tension test>

[0032] In conformity to JIS Z2241, a round-bar tensile test specimen having a parallel part diameter of 6 mm and a parallel part length of 10 mm was sampled from the obtained test material, and a tension test was conducted at normal temperature.

<Vickers test>

[0033] In conformity to JIS Z2244, the cross section of the obtained test material was caused to appear, and a Vickers test in which the test force was 98.07N was conducted to measure the Vickers hardness.

<SCC resistance test>

[0034] A test specimen having a thickness of 2 mm, a width of 10 mm, and a length of 75 mm was sampled from the obtained test material, and the SCC resistance was evaluated by a four-point bending test in conformity to EFC16 specified by the European Federation of Corrosion. In the test, after a stress corresponding to 50% of 0.2% yield stress, which was derived from the tension test, had been applied to the sampled test specimen by four-point bending, the test specimen was immersed in a 5% common salt + 0.5% acetic acid aqueous solution of normal temperature (24°C), in which 1 atm hydrogen sulfide gas is saturated, for 336 hours, whereby the presence of occurrence of SSC was examined. In addition, the same test was also conducted in a 5% common salt + 0.5% acetic acid aqueous solution of 4°C, which temperature is more stringent as an SSC environment. Test No. in which SSC did not occur was made acceptable, and test No. in which SSC occurred was made unacceptable.

[0035] These test results are given in Table 2.

Table 1

No.	Chemical composition(mass% Balance being Fe and impurities)															
	C	Si	Mn	P	S	B	Al	N	O	Cr	Ni	Mo	Ti	Nb	V	Others
A1	0.10	0.25	1.99	0.013	0.001	0.0087	0.024	0.0063	0.001	-	-	-	-	-	-	-
A2	0.10	0.25	1.98	0.013	0.001	0.0140	0.024	0.0062	0.002	-	-	0.03	0.003	-	-	-
A3	0.09	0.24	1.98	0.013	0.001	0.0170	0.024	0.0061	0.002	-	-	-	-	-	-	-
A4	0.05	0.24	2.04	0.013	0.001	0.0095	0.020	0.0047	0.002	-	-	-	-	-	-	-
A5	0.03	0.23	2.00	0.014	0.001	0.0140	0.016	0.0045	0.002	0.02	0.02	0.03	-	0.01	0.01	Cu:0.02
A6	0.05	0.24	1.62	0.014	0.001	0.0130	0.019	0.0050	0.001	-	0.03	-	0.05	-	-	Ca:0.003
A7	0.10	0.25	1.81	0.015	0.001	0.0079	0.021	0.0050	0.001	0.20	-	-	-	-	0.01	-
A8	0.01	0.25	1.81	0.015	0.001	0.0065	0.020	0.0046	0.003	-	0.60	-	-	-	-	Mg:0.002
B1	0.10	0.24	2.02	0.014	0.001	0.0001*	0.021	0.0044	0.001	-	-	-	-	-	-	-
B2	0.05	0.23	2.93	0.014	0.001	0.0001*	0.021	0.0052	0.001	-	-	-	-	-	-	-
B3	0.05	0.24	2.53	0.014	0.001	0.0035*	0.017	0.0056	0.001	-	0.05	0.01	0.01	-	-	-
B4	0.10	0.26	1.80	0.014	0.001	0.0048*	0.022	0.0048	0.003	0.03	-	-	-	0.02	0.01	-
B5	0.05	0.24	1.61	0.014	0.001	0.0531*	0.020	0.0051	0.002	-	0.03	0.03	-	-	-	-
* indicates it does not satisfy the claimed range.																

Table 2

No.	B content (mass%)	Hardness (Hv)	The left side value of formula (1)	Evaluation of SSC test	
				24°C	4°C
A1	0.0087	328	0.0078	No SSC	No SSC
A2	0.0140	330	0.0078	No SSC	No SSC
A3	0.0170	331	0.0078	No SSC	No SSC
A4	0.0095	299	0.0073	No SSC	No SSC
A5	0.0140	262	0.0067	No SSC	No SSC
A6	0.0130	273	0.0069	No SSC	No SSC
A7	0.0079	279	0.0070	No SSC	No SSC
A8	0.0065	249	0.0065	No SSC	No SSC
B1	0.0001	330	0.0078	SSC	SSC
B2	0.0001	317	0.0076	SSC	SSC
B3	0.0035	318	0.0076	SSC	SSC
B4	0.0048	267	0.0068	No SSC	SSC
B5	0.0531	251	0.0065	SSC	SSC

[0036] As shown in Table 2, because the content of B contained in the steel was less than 0.005% in test Nos. B1 to B3, and because the content of B contained in the steel exceeded 0.050% in test No. B5, large amounts of borides were precipitated in the HAZ, and since the precipitated borides became the starting point of embrittlement, SSC occurred in the four-point bending test at normal temperature. Also, in test No. B4, although the B content was as low as 0.0048%, and SSC did not occur at normal temperature, under the more stringent condition of 4°C, SSC occurred. Contrarily, in test Nos. A1 to A8 in which the requirements of the present invention were met, the occurrence of SSC was not recognized in the four-point bending test under both of the test conditions of normal temperature and 4°C.

INDUSTRIAL APPLICABILITY

[0037] According to the present invention, there can be provided a low alloy steel in which a HAZ has excellent resistance to embrittlement attributable to hydrogen such as stress corrosion cracking in wet hydrogen sulfide environments. This low alloy steel is best suitable as a starting material of a steel pipe for the transmission of crude oil or natural gas.

Claims

1. A low alloy steel containing, by mass percent,

C: 0.01 to 0.15%,
Si: 3% or less,
Mn: 3% or less,
B: 0.005 to 0.050%,
Al: 0.08% or less, and
the balance being Fe and impurities,
wherein in the impurities,
N: 0.01% or less,
P: 0.05% or less,
S: 0.03% or less, and
O: 0.03% or less.

2. A low alloy steel containing, by mass percent,

C: 0.01 to 0.15%,
Si: 3% or less,
Mn: 3% or less,
B: 0.005 to 0.050%,
Al: 0.08% or less,
one or more elements selected from the elements described in (A) to (C) below:

(A) one or more elements selected from Cr, Mo, Ni and Cu: 1.5% or less in total,
(B) one or more elements selected from Ti, V and Nb: 0.2% or less in total,
(C) Ca and/or Mg: 0.05% or less in total, and

the balance being Fe and impurities,
wherein in the impurities,
N: 0.01% or less,
P: 0.05% or less,
S: 0.03% or less, and
O: 0.03% or less.

3. The low alloy steel according to claim 1 or 2, wherein the content of B satisfies Formula (1):

$$0.005 \times \mathrm{Hv}/300 + 0.0023 \leq \mathrm{B} \qquad \ldots (1)$$

where, "Hv" in the formula means the maximum value of Vickers hardness of HAZ, and "B" means the content of B (mass%).

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/082606

A. CLASSIFICATION OF SUBJECT MATTER
C22C38/00(2006.01)i, *C22C38/06*(2006.01)i, *C22C38/58*(2006.01)i

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, C22C38/06, C22C38/58

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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.
X A	JP 2011-67871 A (JFE Steel Corp.), 07 April 2011 (07.04.2011), table 3, wire type b (Family: none)	2 1,3
X A	JP 2010-94686 A (Nippon Steel Corp.), 30 April 2010 (30.04.2010), table 2, wire types W1, W4, W15, W17, W18, W21, W23, W25 (Family: none)	2 1,3
X A	JP 2009-50867 A (Nippon Steel Corp.), 12 March 2009 (12.03.2009), table 1, wire types WA1, WA2, WB4 (Family: none)	2 1,3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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Date of the actual completion of the international search 28 February, 2013 (28.02.13)	Date of mailing of the international search report 12 March, 2013 (12.03.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/082606

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2004-137554 A (Nippon Steel Corp.), 13 May 2004 (13.05.2004), claims (Family: none)	1,2 3
X A	JP 9-53123 A (Nippon Steel Corp.), 25 February 1997 (25.02.1997), paragraph [0046]; table 1, steel no.12 (Family: none)	1,2 3
X A	JP 5-320759 A (Nippon Steel Corp.), 03 December 1993 (03.12.1993), paragraph [0015]; table 1, no.A, C, E (Family: none)	2 1,3
X A	JP 55-122820 A (Kawasaki Steel Corp.), 20 September 1980 (20.09.1980), division I on the table 1 (Family: none)	1,2 3

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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