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(54) **Corrosion-resistive martensitic stainless steel having no pin hole defect and manufacturing method thereof**

(57) The present invention relates to high corrosion-resistive martensitic stainless steel used in manufacturing a dinner knife, a knife, a pair of scissors, a spinning and weaving holder for textile industry, of which chemical composition in % by weight comprises C: 0.12% ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N: 0.06% ~ 0.10%, C+N: 0.210% ~ 0.265%, O: 0.01% or less, and the rebalance Fe and inevitable impurities, wherein the carbon content and the nitrogen content are optimized to prevent a lamination due to center segregation of carbide and the pin hole due to a nitrogen pore from being created.

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 2003-87345, filed December 05, 2004, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field of the Invention

[0002] The present invention relates to high corrosion-resistive martensitic stainless steel used in manufacturing a dinner knife, a knife, a pair of scissors, a spinning and weaving holder for textile industry and method for manufacturing it, and more particularly to martensitic stainless steel in which carbon and nitrogen are properly added in 13%Cr-stainless steel, thereby preventing a lamination defect due to the center segregation of a carbide and a pin hole defect due to a nitrogen pore without decreasing in its product and manufacturing method thereof.

2. Discussion of Related Art

[0003] Generally, as hard stainless steel, martensitic stainless steel is used as a raw material for manufacturing a tool having blade. Such a martensitic stainless steel is manufactured by the processes of producing a continuous casting slab containing predetermined elements; producing a hot rolled coil by hot-rolling the slab after reheating it; batch-annealing the hot rolled coil; pickling the hot coil; cold-rolling the pickled coil to cold rolled coil; annealing the cold rolled coil; and quenching the annealed coil.

[0004] In the hot-rolling process, the structure of the hot rolled coil was a dual phase of a martensite phase and a ferrite phase. Then, in the batch-annealing process, the dual phase of the hot rolled coil is transformed into a ferrite phase and carbide to be soft. And, in the quenching process, the ferrite phase and carbide are transformed into the martensite phase; thereby the stainless steel has high hardness.

[0005] Further, to enhance ductility, the martensitic stainless steel may be tempered as necessary after the quenching process.

[0006] As a representative matensite stainless steel, there are type 420J1 steel and type 420J2 steel, wherein the type 420J1 steel has a basic chemical composition of 13%Cr - 0.21%C and the type 420J2 steel has a basic chemical composition of 13%Cr - 0.32%C. Since these steels have relatively high carbon content, coarse carbide center segregation is formed while the continuous casting slab is manufactured. Referring to Fig. 1 showing the macrostructure of the continuous casting of the type 420J1 steel, it is noted that there is the center segregation in the slab. Further, as shown in Fig. 3, the center segregation formed in the slab is not easily removed in the reheating process or the annealing process and remains in the type of carbide band at the center of the hot rolled sintered plate. Therefore, as shown in Fig. 2, a lamination defect is formed due to the carbide center segregation during the process of cutting the hot rolled strip.

[0007] On the other hand, there has been disclosed technology of lowering a casting speed in the continuous casting process in order to minimize the center segregation, thereby the production capability of the continuous casting process is decreased.

[0008] Further, there has been disclosed other technology of controlling an annealing temperature and an annealing period in the annealing process, i.e., a batch annealing furnace (BAF) after the hot rolling process in order to completely melt the coarse carbide formed at the center of the slab in the casting process and the carbide formed when the hot rolled coil is cooled. However, this technology lowers the productivity in the hot rolling process.

[0009] Furthermore, there has been disclosed technology of substituting nitrogen for carbon in order to minimize the amount of the center segregation. However, this technology causes the continuous casting slab to have a pin hole defect, thereby producing the martensitic stainless steel with a surface defect due to the pin hole defect.

SUMMARY OF THE INVENTION

[0010] It is an object of this invention to provide high corrosion-resistive martensitic stainless steel in which the pin hole defect and the center segregation are minimized, and the corrosion resistivity and the quenching strength are improved without decreasing the product capability in order to resolve the above problems.

[0011] It is an other object of this invention to provide method for manufacturing high corrosion-resistive martensitic stainless steel in which the pin hole defect and the center segregation are minimized, and the corrosion resistivity and the quenching strength are improved without decreasing the product capability.

[0012] Accordingly, it is an aspect of the present invention to provide high corrosion-resistive martensitic stainless steel having no pin hole defect, of which chemical composition in % by weight is as follows: C: 0.12% ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N 0.06% ~ 0.10%, C+N: 0.210% ~ 0.265%, O: 0.01% or less, and the balance Fe and inevitable impurities.

[0013] It is other aspect of this invention to provide method for manufacturing high corrosion-resistive martensitic stainless steel comprising the process of making a slab by continuous casting hot melt having the chemical composition in % by weight is as follows: C: 0.12% ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N 0.06% ~ 0.10%, C+N: 0.210% ~ 0.265%, O: 0.01% or less, and the balance Fe and inevitable impurities; making hot rolled strip by hot rolling the slab; making cold rolled strip by annealing and cold rolling the hot rolled strip; and making stainless steel strip by quenching the cold rolled strip; in which the stainless steel strip having quenching hardness of 50 HRc or more.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

[0015] FIG. 1 is a photograph showing a macrostructure of center segregation formed in a continuous casing slab of type 420J1 steel;

[0016] FIG. 2 is a photograph showing a lamination defect and a crack in the microstructure due to the center segregation of a carbide during the working process of the type 420J1 steel;

[0017] FIG. 3 is a photograph showing a microstructure of the center of a hot-rolled annealed slab of the type 420J1 steel;

[0018] FIG. 4 is a photograph showing a sectional macrostructure of a continuous casting slab of type 420N7 steel in which a large pin hole defect is viewed on the surface of the slab side;

[0019] FIG. 5 is a photograph showing a pin hole defect existing on a plan section at a position 5mm below the surface of the type 420N7 cast steel;

[0020] FIG. 6 is a photograph showing a surface defect due to the pin hole defect in a hot rolled plate;

[0021] FIG. 7 is a graph showing a solubility of nitrogen with respect to temperature in 13.2Cr - 0.5Mn - 0.5Si - 0.1C - 0.12N steel as a comparative example;

[0022] FIG. 8 is a photograph showing a sectional structure of a continuous casting slab of type 420N3 steel;

[0023] FIG. 9 is a graph showing a solid-solution ratio of nitrogen with respect to temperature in 13.7Cr - 0.5Mn - 0.5 Si - 0.13C - 0.09N steel as an inventive example;

[0024] FIG. 10 is a graph showing nitrogen pore creation behavior in 13.2Cr - 0.5Mn - 0.5Si - 0.1C - 0.12N steel and 13.7Cr - 0.5Mn - 0.5Si - 0.13C - 0.09N steel;

[0025] FIG. 11 is a photograph showing a microstructure of the center of a hot-rolled annealed slab of the type 420N3 steel;

[0026] FIG. 12 is photographs showing a quenched structure of the type 420J1 steel and the type 420N3 steel, respectively;

[0027] FIG. 13 is photographs showing a microstructure of a knife made of the type 420J1 steel and a knife made of the type 420N4 steel, respectively; and

[0028] FIG. 14 is photograph showing corrosion surface state of the knife made of the type 420J1 steel and a knife made of the type 420N1 steel, respectively.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0029] Hereinafter, preferable embodiments according to the present invention will be described in detail with reference to the accompanying drawings.

[0030] Martensitic stainless steel according to an embodiment of the present invention has chemical composition in % by weight of C: 0.12 ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N: 0.06% ~ 0.10%, C+N: 0.210% ~ 0.265%, O: 0.01% or less, and the balance Fe and inevitable impurities, wherein the weight percentage is limited by the following reasons.

[0031] In the steel, an additional amount of chrome (Cr) content is limited to 12.5% ~ 14.5% to enhance corrosion resistance and a nitrogen solid-solution ratio. In the case where the amount of Cr content is less than 12.5%, the corrosion resistance and the nitrogen solid-solution ratio (solubility) are immaterially enhanced and increased, respectively. Oppositely, in the case where the amount of Cr content is more than 14.5%, the ferrite phase is likely to precipitate in the microstructure and it is expensive relative to the Cr addition effect. Thus, the weight percentage of the Cr content to be added is limited to 12.5% ~ 14.5%.

[0032] Carbon (C) is an effective element in enhancing the hardness of the stainless steel, but excess amount of carbons form center segregation of coarse chrome carbide in the center of a slab during a continuous casting process, which acts as a primary source resulting in lamination defect and low corrosion resistance. Meanwhile, in the case where less amount of carbon is added, it is difficult to manufacture the stainless steel with preferable hardness. Thus, the additional amount of the C content is limited to 0.12% ~ 0.17% in weight percentage.

[0033] Nitrogen (N) is preferable to enhance the hardness and the corrosion resistance of the stainless steel, so that the more, the better. However, too much nitrogen causes the slab to have a pin hole defect resulting from a pore formed by nitrogen. Contrarily, when a small quantity of nitrogen is ineffective in enhancing the corrosion resistance and the corrosion resistance to the desirable level. Thus, the weight percentage of the N content is limited to 0.06% ~ 0.10%.

[0034] As described above, the respective weight percentages of the N and C contents are important to enhance the mechanical properties of the stainless steel. Besides, the total weight percentage of the C+N contents is also important to prevent the slab from having the pin hole defect. The reason why the total weight percentage of the C+N contents is important is because both nitrogen and carbon are complementarily related to determine the hardness of the stainless steel. In the case where the total weight percentage of the C+N contents is less than 0.210%, it is difficult to have the desirable hardness of the stainless steel. In the case where the total weight percentage of the C+N contents is more than 0.265%, a pin hole may be created. Thus, the total weight percentage of the C+N contents is limited to 0.210% ~ 0.265%, thereby not only preventing the hardness of the stainless steel from being deteriorated but also preventing the pin hole from being created.

[0035] Manganese (Mn) is added to increase the solid solution ratio of nitrogen. However, much manganese deteriorates the quality of a strip surface and deteriorates the corrosion resistance of the stainless steel due to the formation of manganese sulfides MnS. Thus, the addition range of the Mn content is limited to 2.0% or less.

[0036] Sulfur (S) forms the sulfides in the structure of the slab and therefore deteriorates the corrosion resistance of the stainless steel. Thus, the addition range of the S content is strictly limited to 0.01% or less so as to prevent the formation of the sulfides.

[0037] Silicon (Si) does not exert large effect on the mechanical properties of the stainless steel, but when lots of silicon is added, the hot working characteristic of the stainless steel is deteriorated. Thus, the addition range of the Si content is limited to 1.0% or less in consideration of deoxidation process, through which the cleanliness of hot melt of stainless steel is improved.

[0038] Phosphor (P) may be added within the range of a well-known addition range of 0.045% or less in consideration of an economical refining process.

[0039] Oxygen (O) deteriorates the surface quality and the corrosion resistance of the stainless steel, therefore its weight percentage is limited to 0.01 % or less.

[Embodiment]

[0040] Test pieces are made of steel having the following composition, which is melted in a vacuum induction furnace, cast into an ingot, and hot-rolled under general conditions.

<Table 1>

	Test piece	C	N	Cr	Si	Mn	P	S	O	C+N
Inventive steel	420N1	0.131	0.0841	13.81	0.47	0.47	0.021	0.001	0.0089	0.2151
	420N2	0.137	0.0898	13.73	0.49	0.53	0.022	0.001	0.0043	0.2268
	420N3	0.141	0.0974	13.52	0.44	0.54	0.022	0.002	0.0077	0.2384
	420N4	0.154	0.0917	13.78	0.44	0.56	0.022	0.002	0.0062	0.2457
	420N5	0.165	0.0965	14.23	0.45	1.81	0.022	0.001	0.0048	0.2615
Comparative steel	420N6	0.125	0.0758	13.74	0.51	0.54	0.024	0.001	0.0061	0.2008
	420N7	0.108	0.1189	13.25	0.48	0.51	0.021	0.001	0.0048	0.2269
	420J1	0.213	0.0314	13.27	0.51	0.49	0.022	0.002	0.0054	0.2444

[0041] Referring to Table 1, in the type 420J1 steel as one of the comparative steels, the total weight percentage of carbon and nitrogen is beyond the addition range according to the present invention. Particularly, since the C content of the type 420J1 steel is too much, as shown in Fig. 1 the center segregation due to carbide is formed in the slab; and as shown in Fig. 2 the lamination defect may be caused by the center segregation of the carbide during the working process of the hot rolled strip. Also, band-shaped carbide as shown in Fig. 3 may remain in the center of a hot-rolled annealed slab.

[0042] On the other hand, the N content of the type 420J1 steel is relatively small to the addition range according to the present invention, so that there is no pin hole defect.

[0043] As for the type 420N7 steel as one of the comparative steels, the amount of C content is small relative to the addition range according to the present invention, so that there is no center segregation due to the carbide. However, since the quantity of N content of the type 420N7 steel is larger than the addition range according to the present invention, a large pin hole defect remains on the edge surfaces of the continuous casting slab as shown in Figs. 4 and 5. Fig. 5 is a photograph of a plan section when the surface of the type 420N7 cast steel is grinded to 5mm, in which lots of pin hole defects are shown.

[0044] As described above, the pin hole defect existing on the slab results in a large surface defect in a hot rolled plate as shown in Fig. 6. The large surface defect is hardly removed by surface grinding, thereby deteriorating the surface quality of the martensitic stainless steel.

[0045] On the basis of the foregoing description, it is noted that the pin hole defect is formed in proportion to the solid-solution ratio of the nitrogen in the steel resulting in the deterioration of the quality of the stainless steel product.

[0046] That is, referring to Fig. 7 showing a theoretical solid-solution ratio of nitrogen with respect to temperature in 13.2Cr - 0.5Mn - 0.5 Si - 0.1C - 0.12N steel on the basis of Thermo-Calc, the maximum solid-solution ratio of the nitrogen is about 1,600ppm in a liquid state, but it is decreased into about 558ppm with precipitating a _-phase while it is cooled. Here, the critical concentration of the nitrogen creating the pin hole is slightly higher than the minimum solid-solution ratio thereof because of atmospheric pressure, iron pressure, and surface tension of the pin hole. However, in the case where the nitrogen content in the steel is relatively high, the supersaturated nitrogen makes a pore, and then creates the pin hole.

[0047] According to the present invention, the nitrogen content in the steel is adjusted to minimize the formation amount of the pin hole, and the carbon content in the steel is adjusted to optimize the hardness of the steel in order to remove the prior problems.

[0048] Fig. 8 is a photograph showing a sectional structure of a continuous casting slab of type 420N3 steel having compositions of the weight percentage within the addition range according to the present invention. As shown in Fig. 8, in this case, the slab's center segregation due to the carbide is substantially decreased and there is no pin hole defect due to the nitrogen pore, as compared with the steel of Figs. 2 and 4.

[0049] Further, referring to Fig. 9 theoretically showing on the basis of Thermo-Calc the solid-solution ratio of nitrogen with respect to temperature in 13.7Cr - 0.5Mn - 0.5Si - 0.13C - 0.09N steel having compositions of the weight percentage within the addition range according to the present invention, the maximum solid-solution ratio of the nitrogen is about 1,680ppm in a liquid state, but it is decreased into about 621ppm while being solidified. In this case, the solid-solution ratio of the nitrogen is increased as compared with the steel shown in Fig. 7. Here, the weight percentage of the alloy composition is optimized to decrease a _-phase precipitation section at a high temperature, thereby increasing the solid-solution ratio of the nitrogen as compared with the steel of Fig. 7.

[0050] Fig. 10 is a graph showing the nitrogen pore creation behavior in the 13.2Cr - 0.5Mn - 0.5Si - 0.1C - 0.12N steel departing from the addition range of this invention and the 13.7Cr - 0.5Mn - 0.5Si - 0.13C - 0.09N steel within the addition range of this invention. In the 13.2Cr - 0.5Mn - 0.5Si - 0.1C - 0.12N steel, the nitrogen pore is formed within the temperature range between about 1310°C and about 1480°C. In this case the temperature difference for creating the nitrogen pore is 170°C. However, in the 13.7Cr - 0.5Mn - 0.5Si - 0.13C - 0.09N steel, the nitrogen pore is created within a temperature range from about 1350°C to about 1450°C, in which the temperature difference for creating the nitrogen pore is 100°C. Thus, the difference of the temperature for creating the nitrogen pore is decreased from 170°C to 100°C; thereby the pore creation ratio of the nitrogen is also decreased by 50% or more.

[0051] With respect to the 13.2Cr - 0.5Mn - 0.5 Si - 0.1C - 0.12N steel as one of the comparative steels and the 13.7Cr - 0.5Mn - 0.5Si - 0.13C - 0.09N steel as one of the inventive steels, the solid-solution ratio and pore formation behavior of the nitrogen are herein below illustrated in Table 2.

<Table 2>

Items for Nitrogen	Comparative steel	Inventive steel
Maximum solid-solution ratio (ppm)	1600	1680
Minimum solid-solution ratio (ppm)	558	621
Pore formation starting temperature (°C)	1480	1460
Pore formation finishing temperature (°C)	1310	1360
Maximum amount of pore formation (moles)	0.00251	0.00115

[0052] Further, since the driving force for the pore formation is decreased and the cooling pattern of the continuous casting process is optimized in the pore formation range due to nitrogen according to the iron pressure and atmospheric pressure, the pin hole is not formed while the stainless steel having compositions within the addition range according to the present invention is commercially produced.

[0053] FIG. 11 is a photograph showing a microstructure of the center in the hot-rolled annealed slab of the type 420N3 steel as one of the inventive steels. As depicted therein, the band-shaped coarse carbide center segregation section is shown in the comparative type 420J1 steel (refer to Fig. 3), but the segregation section is substantially decreased and the size of the precipitation become also minute in the inventive steel, the type 420N3 steel. This is because the precipitation of the fine nitride is prior to that of the coarse carbide due to the increase of the nitrogen content.

[0054] Below tables 3 to 8 shows quenching stress of the inventive steels and the comparative steel, respectively according to the condition of quenching process.

[Table 3]

HRc for 420N1				
	5 min.	10 min.	15 min.	30 min.
950°C	42.9	45.8	47.2	49.0

[Table 3] (continued)

HRc for 420N1				
	5 min.	10 min.	15 min.	30 min.
1000°C	49.2	50.7	51.3	51.9
1050°C	51.2	52.0	51.9	51.3
1100°C	52.4	51.6	51.4	51.5
1150°C	52.3	52.4	51.6	51.5

[Table 4]

HRc for 420N2				
	5 min.	10 min.	15 min.	30 min.
950°C	44.1	47.0	47.4	48.8
1000°C	49.6	51.1	51.6	51.3
1050°C	52.1	52.1	52.0	52.1
1100°C	51.5	51.8	51.4	51.6
1150°C	51.4	51.2	51.3	52.1

[Table 5]

HRc for 420N3				
	5 min.	10 min.	15 min.	30 min.
950°C	43.2	44.4	45.8	48.4
1000°C	48.4	51.3	51.4	52.3
1050°C	51.8	52.0	52.1	51.5
1100°C	51.4	51.6	51.3	51.7
1150°C	51.1	50.4	51.7	51.0

[Table 6]

HRc for 420N4				
	5 min.	10 min.	15 min.	30 min. I
950°C	33.4	42.2	41.9	44.0
1000°C	41.5	45.7	48.0	50.9
1050°C	50.5	52.4	52.4	53.2
1100°C	51.5	53.1	54.0	53.1
1150°C	53.4	53.7	52.6	53.6

[Table 7]

HRc for 420N5				
	5 min.	10 min.	15 min.	30 min.
950°C	45.1	48.5	49.1	50.6

[Table 7] (continued)

HRc for 420N5				
	5 min.	10 min.	15 min.	30 min.
1000°C	50.7	51.7	51.5	53.1
1050°C	52.8	52.8	52.8	54.4
1100°C	54.1	54.0	54.5	54.0
1150°C	53.5	53.0	52.8	53.5

[Table 8]

HRc for 420N6				
	5 min.	10 min.	15 min.	30 min.
950°C	43.2	45.4	45.9	45.7
1000°C	46.6	49.2	48.9	49.2
1050°C	49.9	49.8	49.7	50.0
1100°C	48.9	49.2	48.6	49.6
1150°C	49.0	48.7	47.6	48.3

[0055] We may note that the type 420N6 comparative steel in which the total amount of C and N is 2008 ppm (0.2008 wt%) in the steel does not have the desirable quenching hardness. However, the inventive steels have the desirable quenching hardness of 50 HRc or more under the several of quenching conditions relative to the comparative steel. This result from the increase of carbon contents in place of the decrease of nitrogen contents according to the invention.

[0056] FIG. 12 is a photograph showing microstructures of the type 420J1 steel as one of the comparative steels and the type 420N3 steel as one of the inventive steels which are quenched at a temperature of 1050°C for ten minutes, and FIG. 13 is a photograph showing microstructures of a knife made of the comparative type 420J1 steel and a knife made of the inventive type 420N4 steel. As shown therein, the precipitation exists in the comparative type 420J1 steel, but it is not viewed in the inventive 420N3 and 420N4 steels because it is fully solved as a solid solution. When the carbon component is increased a lot, the center segregation region is formed to cause the nonuniformity of the hardness like the case of the type 420J1 steel.

[0057] Further, after merging the knife made of the inventive type 420N1 steel and the knife made of the comparative type 420J1 steel into 3.5% NaCl solution for a predetermined period of time, their surface corrosion resistances were estimated. As shown in FIG. 14, the knife made of the steel according to the present invention has a clean surface, but the knife made of the comparative steel has a rusted surface. Thus, the precipitation has an adverse effect on the hardness and corrosion resistance of the stainless steel product.

[0058] On the basis of the foregoing description, the characteristic of the steel according to the present invention and the comparative steel which respectively have the compositions based on Table 1 are shown in Table. 9.

<Table 9>

	Test piece	Pin hole	Lamination	Hardness	Corrosion resistance
Inventive steel	420N1	Nonexistent	Nonexistent	Good	Good
	420N2	Nonexistent	Nonexistent	Good	Good
	420N3	Nonexistent	Nonexistent	Good	Good
	420N4	Nonexistent	Nonexistent	Good	Good
	420N5	Nonexistent	Nonexistent	Good	Good
Comparative steel	420N6	Existent	Nonexistent	Unsatisfactory	Good
	420N7	Existent	Nonexistent	Good	Good
	420J1	Nonexistent	Existent	Non-uniform	Unsatisfactory

[0059] Referring to Table 9, the pin hole appears in the comparative type 420N7 steel that has a relatively high weight percentage of the nitrogen content as compared with the weight percentage according to the present invention, wherein the pin hole is caused by the nitrogen pore. Oppositely, the comparative type 420N7 steel has a relatively low weight percentage of the carbon content as compared with the weight percentage according to the present invention, so that the center segregation due to the carbide is not formed and thus the lamination is not formed.

[0060] Further, the comparative type 420J1 steel has a relatively high weight percentage of the carbon content and a relatively low weight percentage of the nitrogen content as compared with the weight percentage according to the present invention, thereby the pin hole due to the nitrogen pore is not created but the lamination due to the center segregation of the carbide is formed.

[0061] Besides, as for the comparative type 420N6 steel, each weight percentage of the carbon content and the nitrogen content falls within the addition range according to the present invention, but the total weight percentage of carbon and nitrogen contents is off the addition range according to the present invention, so that the comparative type 420N6 steel has the unsatisfactory hardness.

[0062] On the other hand, the inventive steels of which the weight percentage falls within the addition range according to the present invention have no pin hole due to the nitrogen pore, no lamination due to the center segregation of the carbide, and good mechanical characteristic in both the hardness and the corrosion resistance.

[0063] As described above, the nitrogen content and the carbon content are strictly limited, so that both the lamination due to the center segregation of the carbide and the pin hole due to the nitrogen pore are prevented from being created, thereby improving the quality of the corrosion-resistive martensitic stainless steel without the deterioration of its productivity.

[0064] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. High corrosion-resistive martensitic stainless steel having no pin hole defect, of which
   chemical composition in % by weight comprises C: 0.12% ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N: 0.06% ~ 0.10%, O: 0.01% or less, and the balance Fe and inevitable impurities.

2. The high corrosion-resistive martensitic stainless steel according to claim 1, wherein the total weight percentage of C+N is limited to 0.210% ~ 0.265%.

3. Method for manufacturing high corrosion-resistive martensitic stainless steel comprising the process of;
   making a slab by continuous casting hot melt having the chemical composition in % by weight is as follows: C: 0.12% ~ 0.17%, Mn: 2.0% or less, P: 0.045% or less, S: 0.01% or less, Si: 1.0% or less, Cr: 12.5% ~ 14.5%, N 0.06% ~ 0.10%, O: 0.01% or less, and the balance Fe and inevitable impurities;
   making hot rolled strip by hot rolling the slab;
   making cold rolled strip by annealing and cold rolling the hot rolled strip; and
   making stainless steel strip by quenching the cold rolled strip;
   wherein stainless steel strip having quenching hardness of 50 HRc or more.

4. Method for manufacturing high corrosion-resistive martensitic stainless steel according to Claim 3, wherein the total weight percentage of C+N is limited to 0.210% ~ 0.265%.

FIG.1

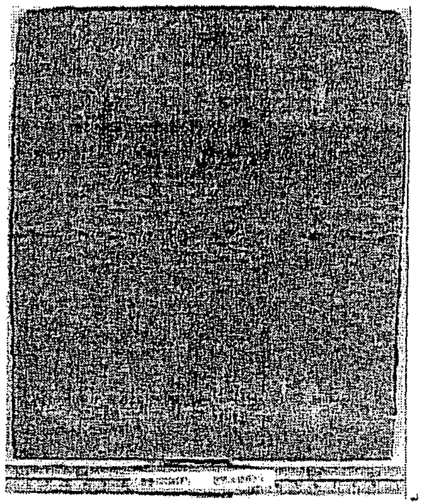
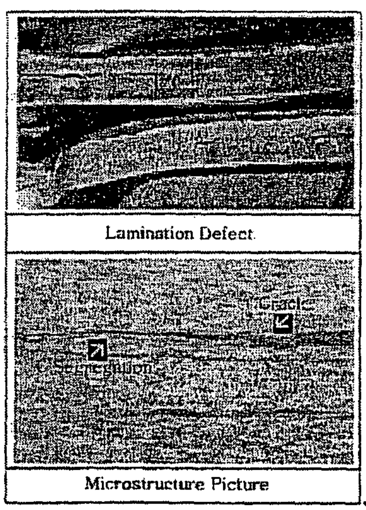


FIG.2



Lamination Defect

Microstructure Picture

FIG.3

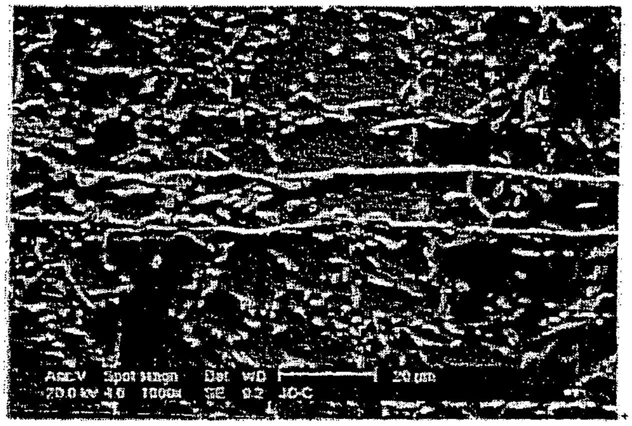


FIG.4

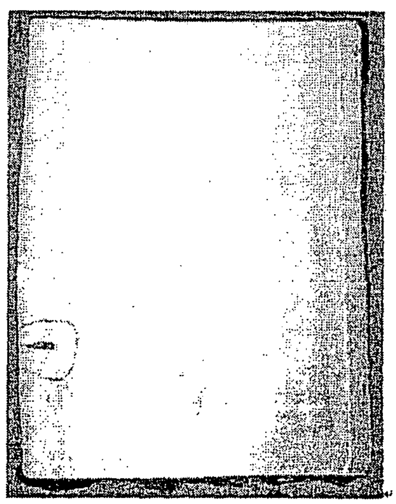


FIG.5

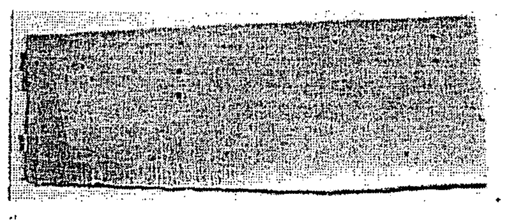


FIG.6

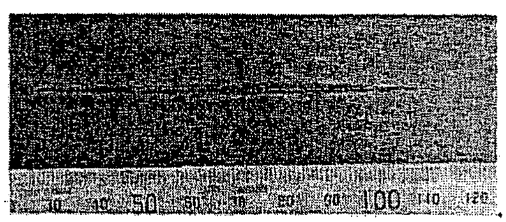


FIG.7

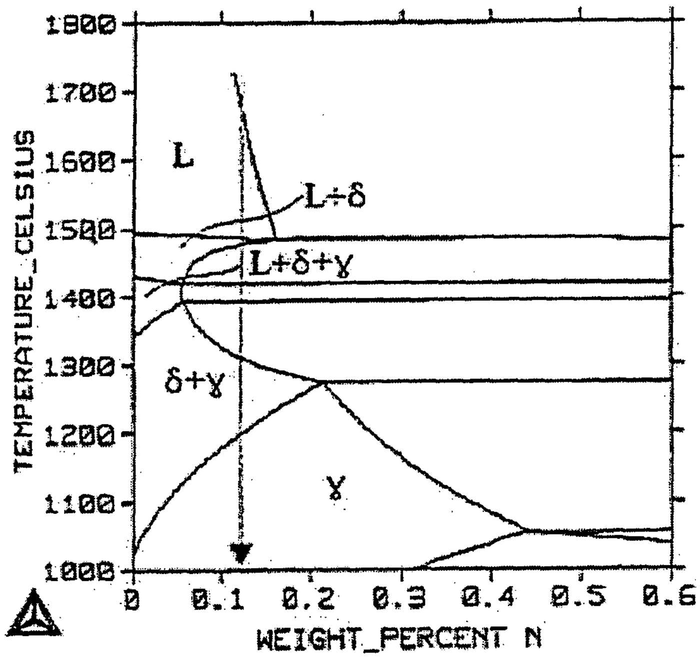

1800
1700
1600
1500
1400
1300
1200
1100
1000
TEMPERATURE_CELSIUS
L
L+δ
L+δ+γ
δ+γ
γ
0
0.1
0.2
0.3
0.4
0.5
0.6
WEIGHT_PERCENT N

FIG.8

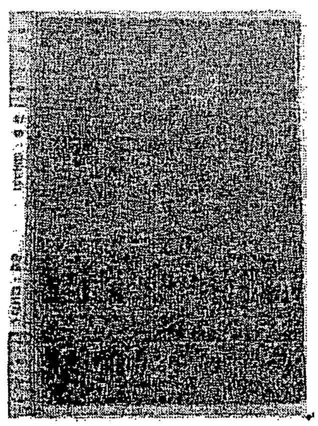


FIG.9

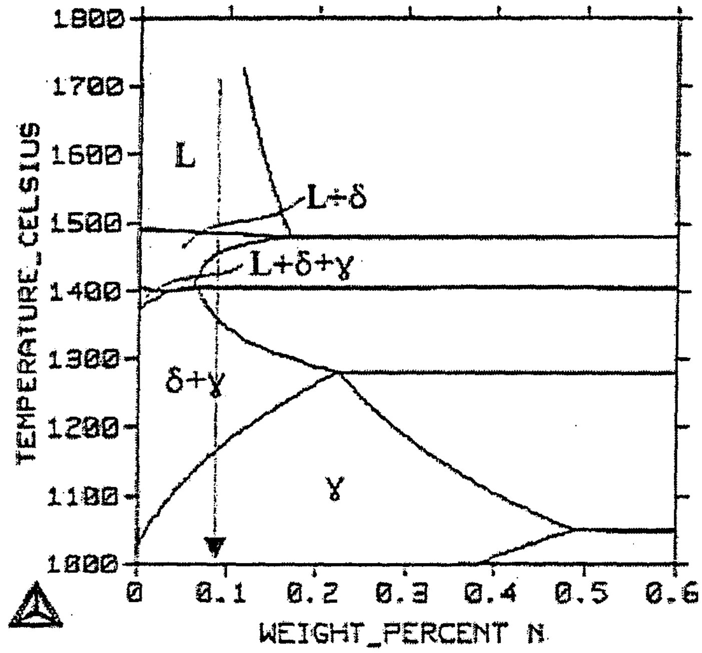

L
L+δ
L+δ+γ
δ+γ
γ
TEMPERATURE_CELSIUS
WEIGHT_PERCENT N
1800
1700
1600
1500
1400
1300
1200
1100
1000
0
0.1
0.2
0.3
0.4
0.5
0.6

FIG.10

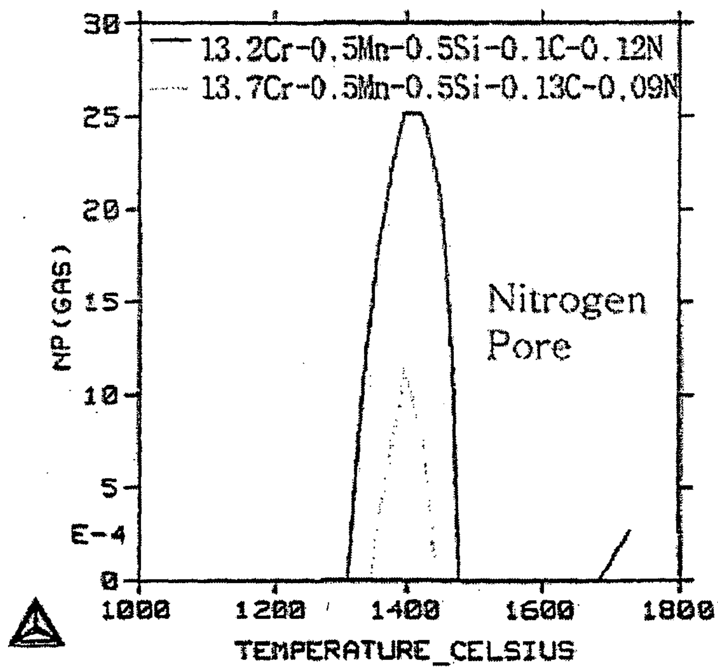

13.2Cr-0.5Mn-0.5Si-0.1C-0.12N
13.7Cr-0.5Mn-0.5Si-0.13C-0.09N
Nitrogen
Pore
NP(GAS)
TEMPERATURE_CELSIUS
E-4
30
25
20
15
10
5
0
1000
1200
1400
1600
1800

FIG.11

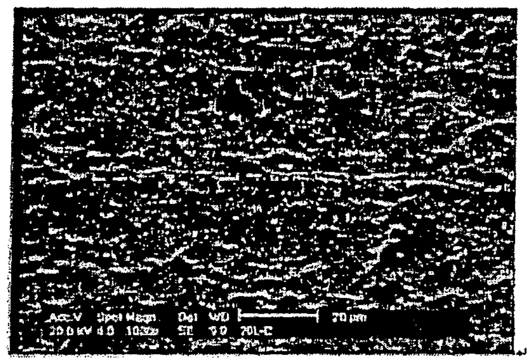


FIG.12

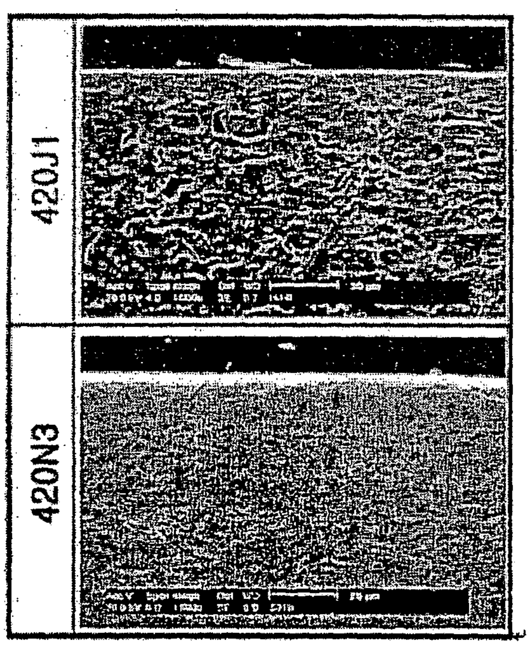


FIG.13

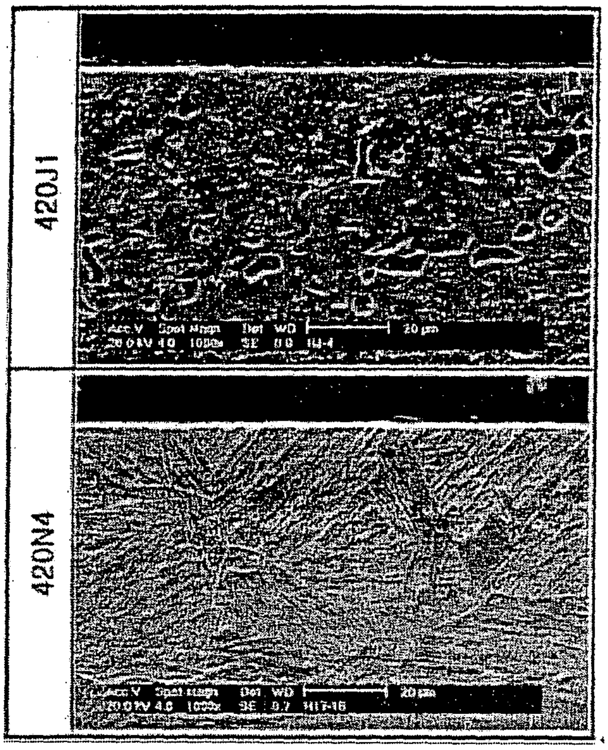
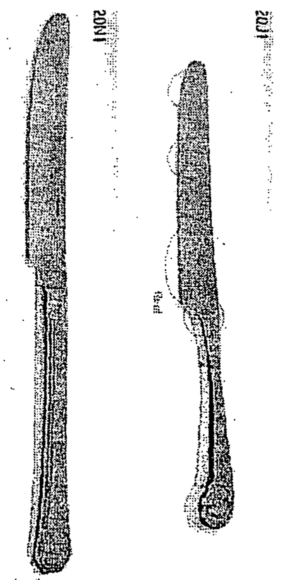


FIG.14



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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 February 2005	Gavriliu, A

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