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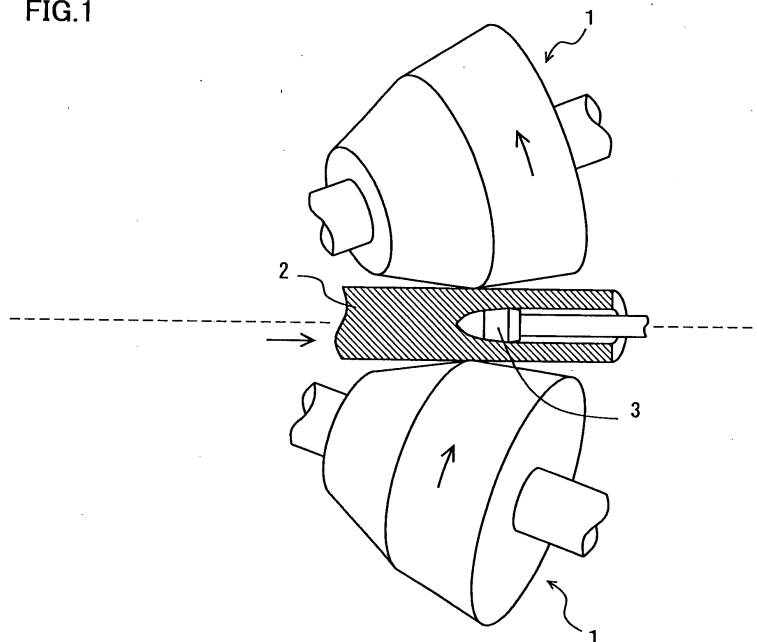
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DE FR(30) Priority: **27.05.2005 JP 2005155922**(71) Applicant: **SUMITOMO METAL INDUSTRIES, LTD.****Osaka-shi,****Osaka 541-0041 (JP)**(72) Inventor: **GOTO, Kunio,****c/o SUMITOMO METAL INDUSTRIES, LTD.****Osaka-shi,****Osaka 541-0041 (JP)**(74) Representative: **Jackson, Martin Peter****J.A. Kemp & Co.****14 South Square****Gray's Inn****London WC1R 5JJ (GB)**(54) **ROLL FOR ROLLING SEAMLESS PIPES**

(57) A roll for rolling a seamless pipe or tube according to the invention includes a roll neck portion and a roll barrel portion. The surface layer of the roll barrel portion includes, by mass, 1.5% to 2.5% C, 1.3% to 3.5% Si, 0.1% to 2.0% Mn, 0.5% to 8.0% Ni, 0.1% to 2.0% Cr, 0.2% to 5.0% Mo, 0.1% to 5.0% V, 0.1% to 5.0% W, 0.1%

to 5.0% Nb, and 0.05% to 2.0% Co, the balance consisting of Fe and impurities, and graphite having an area ratio of 0.5% to 5.0%. Therefore, the roll according to the invention has high wear resistance and a good biting characteristic.

FIG.1



EP 1 894 641 A1

Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a roll, and more specifically to a seamless pipe or tube rolling roll for use in piercing and rolling a seamless pipe.

BACKGROUND ART

10 **[0002]** A roll used in a rolling process in which a material is processed into a prescribed shape must have wear resistance so that the roll has an improved useful life. In order to improve the surface quality of a workpiece, the roll must have seize resistance. As a roll having improved wear resistance and seize resistance, a high speed tool steel roll as disclosed by JP 3219987 B has been developed. The high speed tool steel roll has a very high surface hardness and is mainly used for plate rolling.

15 **[0003]** On the other hand, a seamless pipe or tube (hereinafter referred as a seamless pipe) rolling roll used to produce a Mannesmann type seamless pipe must have a high biting characteristic. As shown in Fig. 1, when for example a material is pierced by a piercer, a pair of piercer rolls 1 contact with the material 2 and bite the material 2. The bitten material is pierced in the axial direction by a plug 3 while it is turned in the circumferential direction. When the piercer rolls 1 contact the material 2, the contact area of the piercer rolls 1 and the material 2 is very small. Therefore, the material 2 is not easily grasped and likely to slip. Therefore, a seamless pipe rolling roll such as a piercer roll and an elongator roll should have a good biting characteristic.

20 **[0004]** A conventional seamless pipe rolling roll has a reduced hardness for its roll surface in order to achieve an improved biting characteristic. However, if the hardness of the roll surface is lowered, the wear resistance is lowered, and the useful life of the roll is shortened. When a high alloy steel or stainless steel is pierced and rolled in particular, the wear amount of the seamless pipe rolling roll increases. Therefore, the seamless pipe rolling roll must have both a good biting characteristic and high wear resistance at a time.

25 **[0005]** JP 10-81937 A discloses a forging roll for rolling a seamless pipe having a good biting characteristic and high wear resistance. The disclosed roll has large spherical carbides in the matrix. As the wear of the roll advances, the spherical carbides are exposed on the surface, and the roll surface attains a prescribed roughened state, which improves the biting characteristic.

30 **[0006]** However, it would not be possible to improve the biting characteristic only by the exposed spherical carbides.

DISCLOSURE OF THE INVENTION

35 **[0007]** It is an object of the invention to provide a seamless pipe rolling roll that has high wear resistance and a good biting characteristic.

[0008] The inventor considered that if a prescribed amount of graphite was generated in the matrix of a roll, the biting characteristic would be improved. If a roll having graphites generated in the matrix is used, the graphites are exposed on the surface as the surface wears off. The graphites exposed at the surface easily come off and are removed from the surface. Therefore, the roll surface has appropriate irregularities. The irregularities improve the biting characteristic of the roll.

40 **[0009]** Meanwhile, the inventor considered that in order to improve the wear resistance, generation of high hardness composite carbides would be crucial. If the matrix wears, the high hardness composite carbides exposed on the surface contact with a workpiece and can restrain the roll from being worn. The inventor considered that the addition of V, W, and Nb forming the high hardness carbides would be necessary.

45 **[0010]** Based on the above technological concept, the following invention was completed.

[0011] A roll for rolling a seamless pipe according to the invention includes a roll neck portion and a roll barrel portion, the surface layer of the roll barrel portion includes, by mass, 1.5% to 2.5% C, 1.3% to 3.5% Si, 0.1% to 2.0% Mn, 0.5% to 8.0% Ni, 0.1% to 2.0% Cr, 0.2% to 5.0% Mo, 0.1% to 5.0% V, 0.1% to 5.0% W, and 0.1% to 5.0% Nb, 0.05% to 2.0% Co, the balance consists of Fe and impurities, and the surface layer of the roll barrel portion includes graphite having an area ratio of 0.5% to 5.0%.

[0012] Herein, the seamless pipe rolling roll means a roll used for piercing and rolling a seamless pipe. Examples of such a roll include a cone type or barrel type piercer roll, an elongator roll, a mandrel roll, a reducer roll, and a sizer roll.

55 **[0013]** The seamless pipe rolling roll according to the invention includes graphite having an area ratio of 0.5% to 5.0% in the matrix. The graphites exposed on the surface come off easily from the roll, so that irregularities form on the surface, which improves the biting characteristic. The seamless pipe rolling roll according to the invention further includes MC type high hardness composite carbides such as V carbides, W carbides, and Nb carbides. Therefore, the high hardness composite carbides can improve the wear resistance.

[0014] The surface layer of the roll barrel portion preferably has a Shore hardness from 30 to 50.

[0015] In this way, the Shore hardness (Hs) of the surface layer is from 30 to 50, so that the wear resistance can further be improved. If the Shore hardness of the surface layer is from 30 to 50, graphite forms irregularities on the surface of the roll and therefore the biting characteristic can be secured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a view showing how a material is pierced by piercer rolls.

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] Now, an embodiment of the invention will be described in detail.

1. Structure of Roll

[0018] A seamless pipe rolling roll according to the embodiment includes a roll neck portion and a roll barrel portion. The seamless pipe rolling roll is used for piercing and rolling a seamless pipe. More specifically, examples of such a roll include a cone type or barrel type piercer roll, an elongator roll, a mandrel roll, a reducer roll, and a sizer roll.

[0019] In the seamless pipe roll, the roll neck portion and the roll barrel portion may be integrally formed as an integrated roll or as a composite roll in which the inside part (inner layer) and the surface layer part (outer layer) of the roll barrel portion are made of different kinds of steel. The surface layer preferably has a depth equal to at least 1% of the radius of the roll barrel portion from the roll surface, more preferably at least 5% of the radius of the roll barrel portion from the roll surface. In the composite roll, the surface layer preferably has a depth equal to at least 50% of the thickness of the outer layer from the surface of the outer layer.

2. Chemical Composition

[0020] At least the surface layer of the roll barrel portion of the seamless pipe rolling roll has the following chemical composition. Herein, the surface layer of the roll barrel portion refers to the surface layer portion of the barrel portion used for piercing or rolling a workpiece and has a prescribed depth from the surface of the roll barrel portion.

[0021] In the following description, "%" related to elements indicates "% by mass."

C: 1.5% to 2.5%

[0022] Carbon is crystallized as graphite and improves the biting characteristic of the roll. Carbon combines with V, W, and Nb as will be described to form MC type high hardness composite carbides, which improves the wear resistance of the roll. An excessive C content however causes the composite carbides to be excessively generated, which lowers the biting characteristic of the roll. Excessively generated graphite lowers the wear resistance and embrittles the matrix. An excessive C content also lowers the thermal crack resistance. Therefore, the C content is from 1.5% to 2.5%.

[0023] The crystallization of graphite in the matrix can be restrained by carbides-forming element (such as V, W, and Nb) that consumes C contained in the molten metal over the other elements. In consideration of the balance between the amount of graphite to be generated in the matrix and the amount of the high hardness carbides, a preferable C content is from 1.9% to 2.5%.

Si: 1.3% to 3.5%

Silicon deoxidizes the molten metal. Silicon also improves the fluidity characteristic of the molten metal. Silicon is an element necessary for causing graphite to be crystallized or precipitated. An excessive Si content however causes the graphite to be excessively generated, which lowers the wear resistance. In addition, an excess Si content lowers mechanical properties such as toughness. Therefore, the Si content is from 1.3% to 3.5%, preferably from 1.3% to 2.2%.

[0024] As will be described, 0.2% to 1.0% of the entire Si content is preferably added during casting. The remainder of the Si content is added to the molten metal before the casting.

Mn: 0.1% to 2.0%

Manganese deoxidizes the molten metal. Manganese combines with S in the steel to form MnS and restrains the matrix from being embrittled. An excessive Mn content however lowers the toughness. Therefore, the Mn content is from 0.1% to 2.0%.

Ni: 0.5% to 8.0%

Nickel enters the matrix in a solid-solution state and improves the strength. Nickel also accelerates the crystallization of graphite. An excessive Ni content however excessively generates graphite and lowers the wear resistance. Therefore, the Ni content is from 0.5% to 8.0%, preferably from 0.9% to 4.0%.

Cr: 0.1% to 2.0%

Chromium enters the matrix in a solid-solution state and improves the strength. Chromium combines with C to precipitate M_7C_3 type high hardness composite carbides, which improve the wear resistance and the toughness. An excessive Cr content however excessively generates the M_7C_3 type composite carbides, so that graphite and MC type composite carbides are prevented from being generated. Since the M_7C_3 type composite carbide has a lower hardness than that of the MC type composite carbide, and therefore an excessive Cr content may lower the wear resistance. Therefore, the Cr content is from 0.1% to 2.0%.

Mo: 0.2% to 5.0%

Molybdenum enters the matrix in a solid solution state and improves the high temperature softening resistance. Molybdenum combines with C to form M_6C type or M_2C type composite carbides, which improve the wear resistance. An excessive Mo content however prevents graphite from being produced. Therefore, the Mo content is from 0.2% to 5.0%, preferably from 0.5% to 4.5%.

V: 0.1% to 5.0%

Vanadium combines with C to produce MC type high hardness composite carbides, which improve the wear resistance. Vanadium serves to refine crystal grains, which improves the toughness. An excessive V content however prevents graphite from being produced. Therefore, the V content is from 0.1% to 5.0%, preferably from 0.2% to 4.0%.

W: 0.1% to 5.0%

Tungsten combines with C to form high hardness composite carbides, which improve the wear resistance. Tungsten also enters the matrix in a solid solution state to improve the high temperature softening resistance. An excessive W content however prevents graphite from being generated. Furthermore, the toughness and the thermal crack resistance are lowered, which increases the likelihood of segregation. Therefore, the W content is from 0.1% to 5.0%.

Nb: 0.1% to 5.0%

Niobium combines with C to form MC type high hardness composite carbides, which improve the wear resistance. Niobium serves to refine the crystal grains to improve the toughness and the thermal crack resistance. An excessive Nb content however prevents graphite from being generated. An excessive Nb content lowers the toughness and the thermal crack resistance. Therefore, the Nb content is from 0.1% to 5.0%, preferably from 0.1% to 4.5%.

Co: 0.05% to 2.0%

Cobalt enters the matrix in a solid solution state to improve the hardness and the high temperature softening resistance of the matrix, which improves the wear resistance. An excessive Co content however causes carbides to be more easily segregated, which lowers the toughness of the matrix. Therefore, the Co content is from 0.05% to 2.0%.

[0025] Note that the balance includes Fe but it could sometimes contain impurities such as P and S.

[0026] Phosphorous and sulfur degrade the mechanical properties and therefore the contents of these elements are preferably as little as possible. Therefore, the P content is preferably not more than 0.2% and the S content is preferably not more than 0.2%.

[0027] Note that for various causes in the process of manufacture, impurities other than P and S may be contained.

3. Structure

Amount of Graphite

[0028] The surface layer of the roll barrel portion of the seamless pipe rolling roll according to the embodiment includes graphite. The area ratio of the graphite included in the surface layer is from 0.5% to 5.0%.

[0029] The area ratio of the graphite can be measured by the following method. An arbitrary region of the surface of the barrel portion of the seamless pipe rolling roll is selected. Using an optical microscope or a scanning electron microscope (SEM), the area ratio of the graphite in the selected region is measured. The area ratio of the graphite may be measured for example by image analysis using a metal structure image in a non-etched state or a photograph.

[0030] The graphites exposed at the roll surface easily come off and are removed from the roll surface. Therefore, irregularities are formed on the roll surface. If the roll surface is worn, the graphites exposed at the surface layer by wear sequentially come off and therefore there are always irregularities on the roll surface. The irregularities improve the biting characteristic. The graphite has a lubricating function and therefore can prevent seizure from being generated on the roll surface.

[0031] If the area ratio of the graphite is less than 0.5%, the amount of the graphite is insufficient, and irregularities are unlikely to be formed on the surface. This lowers the biting characteristic. On the other hand, if the area ratio of the graphite exceeds 5.0%, the roll matrix is embrittled and the wear resistance is lowered.

[0032] The shape of the graphite is not restricted. It may be either spherical or flaky.

Hardness

[0033] The Shore hardness of the surface layer of the seamless pipe rolling roll is preferably in the range from 30 to 50 (Hs). If the Shore hardness is too low, the wear resistance is lowered, while if the Shore resistance is too high, the biting characteristic is lowered. If the Shore hardness is from 30 to 50, high wear resistance as well as the biting characteristic by the graphite may be secured. Note that if the Shore hardness of the seamless pipe rolling roll is outside the above-described range, the biting characteristic and the wear resistance are improved over the conventional case as long as the above-described chemical composition requirement is satisfied and graphite with the above-described area ratio is contained.

[0034] The Shore hardness of the surface layer can be measured by the following method. A Shore hardness test (JISZ2240) is carried out in a plurality of regions at the surface of the barrel portion of the seamless pipe rolling roll. The average of the measurement values obtained in the plurality of regions is determined as the Shore hardness.

[0035] It is only necessary that the requirements for the chemical composition and structure described above are satisfied at least at the surface layer of the roll barrel portion, while the entire roll barrel portion may have the chemical composition and structure described above or the entire roll may have the chemical composition and structure described above.

4. Manufacturing Method

[0036] The seamless pipe rolling roll according to the embodiment may be produced as an integrated roll or a composite roll.

Method of Manufacturing Integrated Roll

[0037] When a seamless pipe rolling roll according to the embodiment is formed as an integrated roll, the seamless pipe rolling roll is produced by static casting or forging.

[0038] In order to adjust the area ratio of the graphite to be from 0.5% to 5.0%, the following conditions (A) and (B) are preferably satisfied at the time of casting.

(A) During casting, the cooling rate up to immediately above the solid phase line in the phase diagram is set lower than a normal cooling rate. The graphite is produced in the vicinity of the solid phase line, and therefore if the cooling rate is low, the amount of the graphite to be produced can be increased.

(B) During casting, inoculation is carried out. More specifically, during casting, an inoculant (such as ferrosilicon) including Si is added. The Si included in the inoculant forms nucleuses for generating graphite. Therefore, a desired amount of graphite can be produced during the casting.

[0039] The addition of Si during the casting increases the amount of graphite, while if Si is excessively added during the casting, coarse graphite is produced, which lowers the mechanical properties of the seamless pipe rolling roll. Therefore, the amount of Si added during the casting is preferably from 0.2% to 1.0%, more preferably from 0.2% to 0.6%.

[0040] Silicon is added during casting, the amount of the Si to be added to the molten metal before the casting is smaller than target components. In short, the amount of Si to be added during melting and casting is regulated so that the Si content at the end of casting equals the Si content described in 2.

[0041] According to the above-described method, in order to remove the distortion of the roll and adjust the hardness of the roll, the roll is subjected to thermal treatment after the casting or the forging. More specifically, the quenching/tempering process is carried out. Preferably, the quenching is carried out at a quenching temperature from 1000°C to 1200°C, and then the tempering is carried out a number of times at a tempering temperature from 450°C to 650°C. The thermal treatment allows the Shore hardness of the surface layer of the seamless pipe rolling roll to be 30 to 50.

Method of Manufacturing Composite Roll

[0042] When the seamless pipe rolling roll is produced as a composite roll, the outer layer is formed to have a chemical composition and a structure described in 2. and 3. The inner layer may be any generally available tough material such as ductile cast iron, plain cast iron, graphite cast iron, spherical graphite cast iron, forged steel, cast steel, and the like.

[0043] The composite roll is produced for example by a centrifugal casting method, a continuous overlaying method (disclosed by JP 44-4903 B) using radio-frequency heating, a manufacturing method (disclosed by JP 47-2851 A) according to which an outer layer is formed by hot isostatic press by a powder metallurgy method, and an overlaying method (disclosed by JP 57-2862 A) using electroslag melting or the like.

[0044] When the outer layer is cast, the above described conditions (A) and (B) are preferably satisfied. The thermal

treatment after the casting is carried out in the same manner as that in the method of manufacturing the integrated roll.

Example 1

[0045] Piercer rolls having various chemical compositions and various amounts of graphite were prepared and examined for their biting characteristics and wearing resistance.

[0046] A cone type piercer roll having the chemical composition shown in Table 1 was produced.

Table 1

roll No.	chemical composition (% by mass, the balance consists of Fe and impurities)										graphite area ratio (%)	hardness (Hs)
	C	Si	Mn	Ni	Cr	Mo	V	W	Nb	Co		
inventive example	1	1.5	1.3	0.6	2.9	0.5	0.8	0.2	0.1	1.1	0.05	28
	2	1.5	1.3	0.6	2.5	0.5	0.8	0.4	0.1	1.1	0.07	31
	3	2.1	2.5	0.5	0.9	1.8	1.0	0.2	0.1	0.1	0.05	33
	4	1.8	1.5	0.6	1.2	0.1	3.4	0.2	0.1	1.8	0.06	40
	5	2.0	2.0	0.5	2.0	0.5	0.2	3.8	0.2	0.2	0.10	42
	6	2.1	1.9	0.4	1.8	1.0	1.0	0.1	0.1	4.2	0.09	35
	7	2.3	2.5	0.5	2.8	1.1	0.8	0.2	4.8	0.1	0.55	46
	8	1.9	1.8	0.4	1.1	1.6	1.2	1.5	0.1	2.2	1.70	44
	9	2.5	2.8	0.6	2.5	1.7	2.1	0.5	1.9	2.4	0.13	42
	10	2.3	3.0	0.5	2.5	1.5	4.2	1.1	0.1	2.8	0.08	52
comparative example	11	2.0	0.8*	0.6	2.1	0.5	0.3	3.5	0.2	0.2	0.10	45
	12	1.2*	0.7*	0.7	3.5	0.6	1.0	1.5	6.4	2.3	0.09	51
	13	2.7*	2.5	0.6	2.5	0.5	0.5	0.2	0.2	0.2	0.05	33
	14	2.1	3.8*	0.5	2.5	1.2	1.0	0.2	0.3	2.3	0.09	37
	15	1.5	1.9	0.6	0.1*	2.0	2.1	2.5	0.2	3.2	0.10	55
	16	1.9	1.6	0.7	1.2	5.0*	1.5	5.6*	5.5*	5.7*	0.10	65
	17	1.5	1.4	0.6	0.5	2.0	2.0	2.8	0.2	3.0	0.10	57
	18	2.5	2.8	0.7	2.5	1.8	1.9	0.6	1.7	2.5	0.10	35

Numerals with * are outside the range defined by the invention.

[0047] More specifically, molten metals having the chemical compositions in Table 1 were produced by melting using an electric furnace. Then, the molten metals were each made into a steel ingot by an ingot casting method.

[0048] For roll Nos. 1 to 16, 0.2% to 1.0% of Si by mass was added as an inoculant during casting. Meanwhile, roll No. 17 was not provided with an inoculant during the casting. For roll No. 18, 1.5% of Si from the Si content of 2.8% was added during the casting.

[0049] The produced ingot was forged to form cone type piercer rolls. The formed rolls were quenched and tempered, so that the surface layers of the rolls had Shore hardness values (Hs) shown in Table 1. The Shore hardness was measured according to the method described in 3. The area ratio (%) of graphite on the formed roll surface was measured by the method described in 3. The measured area ratio (%) of the graphite is given in Table 1.

[0050] Note that each of the piercer rolls produced according to the embodiment was an integrated roll and had a gorge size of 410 mm.

[0051] The rolls in Table 1 were each incorporated into the piercer. The cross angle of each of the rolls in Table 1 was from 0° to 30°.

[0052] After the rolls were incorporated, ten billets of a high alloy (25% Cr-35% Ni) having an outer diameter of 70 mm and a length of 400 mm were prepared for each roll, and the rolls were examined for the biting characteristic, the wear resistance, and the seize resistance. The results of examination are given in Table 2.

Table 2

	roll No.	biting characteristic	wear amount (μm)	seize resistance
inventive example	1	⊙	68	○
	2	⊙	31	○
	3	⊙	44	○
	4	⊙	22	○
	5	⊙	9	○
	6	⊙	25	○
	7	⊙	15	○
	8	⊙	11	○
	9	⊙	18	○
	10	○	13	○
comparative example	11	×	-	-
	12	×	-	-
	13	⊙	150	○
	14	⊙	117	○
	15	×	-	-
	16	×	-	-
	17	×	-	-
	18	⊙	128	○

Biting Characteristic

[0053] When the ten billets were pierced, the biting characteristics were determined with eyes. The results of determination are indicated in the "biting characteristic" column in Table 2. When all the ten billets were bitten into a roll without slipping with the roll and pierced, it was determined that the biting characteristic of the roll was very high ("⊙" in Table 2). It was determined that the biting characteristic of the roll was high when all the billets are bitten and pierced though at least one of the ten billets slipped with the roll ("○" in Table 2). It was determined that the biting characteristic was low when at least one of the ten billets was not bitten by the roll and could not be pierced ("×" in Table 2).

Wear Resistance

[0054] Among the numbered rolls, the rolls that successfully pierced all the ten billets were inspected for the wear amount (μm). The result of inspection is given in the "wear amount" column in Table 2. The wear amount was measured by the following method. The surface of the roll barrel portion was measured before and after piercing the ten billets using two-dimensional shape measuring instrument. Based on the measurement data before and after the piercing, the maximum wear depth was obtained, and the obtained maximum wear depth (μm) was determined as the wear amount of the roll. Note that "-" in Table 2 indicates that the wear resistance could not be evaluated because the biting characteristic was low.

Seize Resistance

[0055] Among the numbered rolls, the rolls that successfully pierced all the ten billets were inspected by eyes for the presence/absence of seizure at the roll after the piercing. The result of determination is given in the "seize resistance" column in Table 2. It was determined that the seize resistance was high when any part of the pierced billets was not deposited on the surface of the roll after the piercing ("○" in Table 2). On the other hand, it was determined that the seize resistance was low when a part of the billets was deposited on the surface of the roll after the piercing. Note that the "-" in Table 2 indicates that the seize resistance could not be evaluated because the biting characteristic was low.

Test Results

[0056] Referring to Tables 1 and 2, the rolls designated as roll Nos. 1 to 10 each had a chemical composition and a graphite area ratio within the ranges of the invention, and therefore they all had a high biting characteristic. The wear amount was as small as less than 70 μm and the wear resistance was high.

[0057] Rolls designated as roll Nos. 2 to 9 each had a Shore hardness (Hs) within the range from 30 to 50, therefore the biting characteristic was very high and the wear amount was less than 50 μm .

[0058] Rolls designated as roll Nos. 1 to 10 each had high seize resistance.

[0059] On the other hand, rolls designated as roll Nos. 11 to 18 each had a chemical composition or a graphite area ratio outside the ranges of the invention, and therefore the biting characteristic and/or wear resistance was low. More specifically, roll No. 11 had a low Si content and a graphite area ratio less than the lower limit according to the invention, and therefore the biting characteristic was low. Roll No. 12 had low C and Si contents, and a graphite area ratio less than the lower limit according to the invention, and therefore the biting characteristic was low. Roll No. 13 had a high C content and a graphite area ratio exceeding the upper limit according to the invention. Therefore, the wear amount was more than 70 μm and the wear resistance was low. Roll No. 14 had a high Si content and a graphite area ratio exceeding the upper limit according to the invention. Therefore, the wear amount was more than 70 μm and the wear resistance was low. Roll No. 15 had a low Ni content and a graphite area ratio less than the lower limit according to the invention. Therefore, the biting characteristic was low. Roll No. 16 had high Cr, V, W, and Nb contents that forms a high hardness composite carbide and the graphite area ratio was less than the lower limit according to the invention. Therefore, the biting characteristic was low.

[0060] Roll No. 17 had a chemical composition within the range of the invention, but an inoculant was not added during the casting, and therefore the graphite area ratio was less than the lower limit according to the invention. Therefore, the biting characteristic was low.

[0061] Roll No. 18 had a chemical composition within the range of the invention, and the chemical composition was similar to the chemical composition of roll No. 9. However, the Si amount added during the casting was as high as 1.5%, so that the graphite area ratio exceeded the upper limit according to the invention. Therefore, the wear resistance exceeded 70 μm and the wear resistance was low.

[0062] Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation. The invention may be embodied in various modified forms without departing from the spirit and scope of the invention.

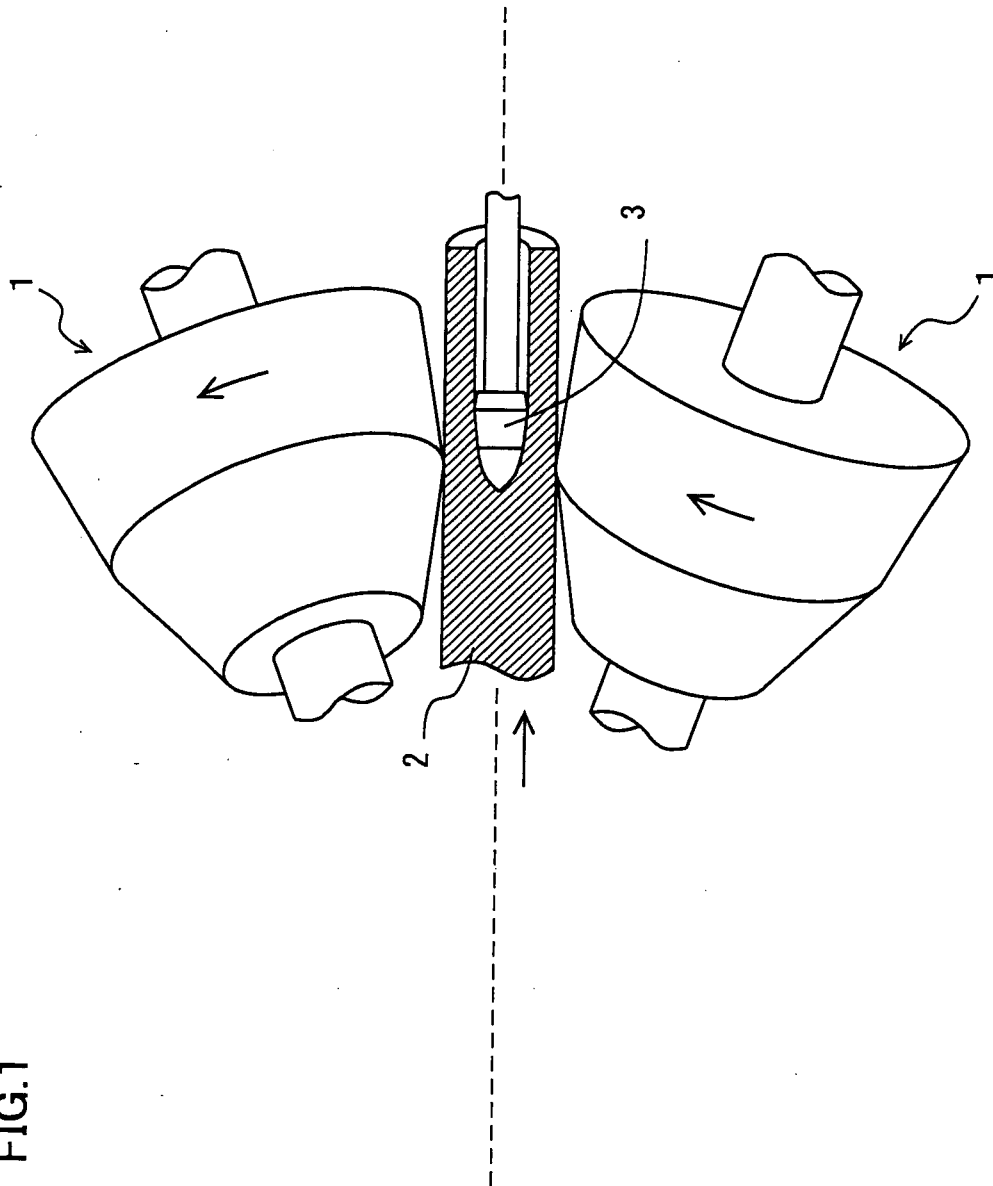
INDUSTRIAL APPLICABILITY

[0063] A seamless pipe rolling roll according to the invention is widely applicable as a roll used for piercing and rolling a seamless pipe. The invention is particularly applicable to a barrel type or a cone type piercer roll that pierces and rolls in the axial direction while the material is turned in the circumferential direction.

Claims

1. A roll for rolling a seamless pipe or tube comprising a roll neck portion and a roll barrel portion, the surface layer of said roll barrel portion comprising, by mass, 1.5% to 2.5% C, 1.3% to 3.5% Si, 0.1% to 2.0% Mn, 0.5% to 8.0% Ni, 0.1% to 2.0% Cr, 0.2% to 5.0% Mo, 0.1% to 5.0% V, 0.1% to 5.0% W, and 0.1% to 5.0% Nb, 0.05% to 2.0% Co, the balance consisting of Fe and impurities, said surface layer comprising graphite having an area ratio of 0.5% to 5.0 %.
2. The roll according to claim 1, wherein the surface layer of said roll barrel portion has a Shore hardness from 30 to 50.

FIG.1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/310563

A. CLASSIFICATION OF SUBJECT MATTER

B21B27/02(2006.01)i, B21B19/04(2006.01)i, C22C37/00(2006.01)i, C22C38/00(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)

B21B27/02, B21B19/04, C22C37/00, C22C38/00, 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 1996-2006
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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.
Y	JP 2001-179311 A (Nijieda Kabushiki Kaisha), 03 July, 2001 (03.07.01), Par. No. [0031]; tables 1 to 2 (Family: none)	1-2
Y	JP 2002-16334 A (Nippon Steel Corp.), 04 June, 2002 (04.06.02), Par. Nos. [0015] to [0018] (Family: none)	1-2
Y	JP 2004-250729 A (JFE Steel Corp.), 09 September, 2004 (09.09.04), Par. Nos. [0008], [0027] to [0030] (Family: none)	2

☒ 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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
23 August, 2006 (23.08.06)

Date of mailing of the international search report
05 September, 2006 (05.09.06)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/310563

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-081937 A (Pacific Steel Mfg. Co., Ltd.), 31 March, 1998 (31.03.98), Par. Nos. [0007] to [0008], [0023] to [0026] & US 5813962 A & US 5950310 A & EP 0816521 A2 & DE 69706608 D & AU 2836797 A & AU 733467 B	2

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3219987 B [0002]
- JP 10081937 A [0005]
- JP 444903 B [0043]
- JP 47002851 A [0043]
- JP 57002862 A [0043]