



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
24.08.2005 Bulletin 2005/34

(51) Int Cl.7: **C22C 38/00, C21D 9/46**

(21) Application number: **03751436.1**

(86) International application number:
PCT/JP2003/013001

(22) Date of filing: **10.10.2003**

(87) International publication number:
WO 2004/050931 (17.06.2004 Gazette 2004/25)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **29.11.2002 JP 2002347344**
24.02.2003 JP 2003045421

(71) Applicant: **Toyo Kohan Co., Ltd.**
Tokyo 102-8447 (JP)

(72) Inventors:
• **UEDA, Toshiyuki**
Kudamatsu-shi, Yamaguchi 744-8611 (JP)
• **ITOH, Hiroyasu**
Kudamatsu-shi, Yamaguchi 744-8611 (JP)
• **OHI, Satoshi**
Kudamatsu-shi, Yamaguchi 744-8611 (JP)
• **AOKI, Shinichi**
Kudamatsu-shi, Yamaguchi 744-8611 (JP)

(74) Representative: **Vossius & Partner**
Siebertstrasse 4
81675 München (DE)

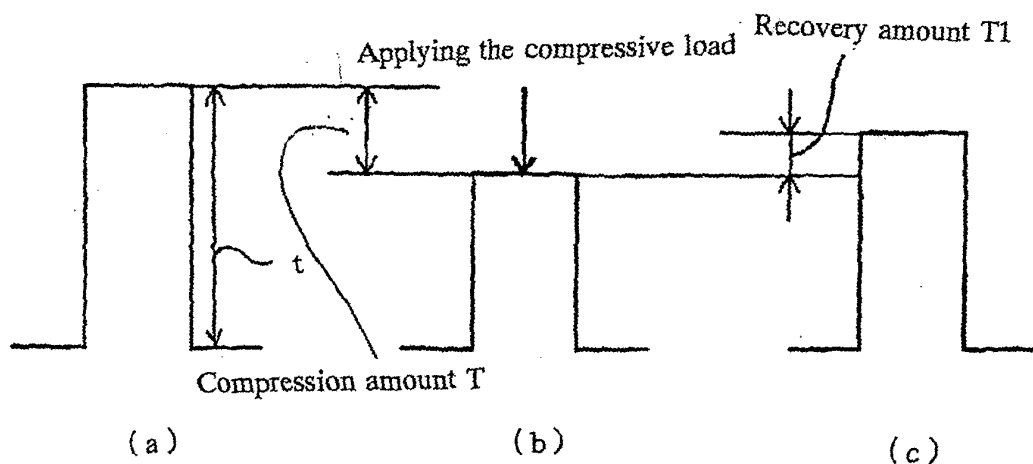
(54) **COLD ROLLED STEEL SHEET FOR GASKET MATERIAL, METHOD FOR PRODUCTION THEREOF AND GASKET MATERIAL PRODUCED BY THE METHOD**

(57) A cold rolled steel sheet for a gasket material, **characterized in that** it has a chemical composition, in wt %: C: 0.08 to 0.60 %, Si: 1.0 to 3.0 %, Mn: 0.5 to 3.0 %, P $\leq$ 0.06 %, S: $\leq$ 0.06 %, Al: $\leq$ 0.1 %, N: 0.0010 to 0.0150 %, and the balance: Fe and inevitable impurities: and a method for producing the steel sheet. The cold

collect steel sheet for a gasket material can provide a good balance between bead formability and spring characteristics, together with excellent gas sealing property, and can be produced at a low cost, and thus can be used for producing a gasket being suitably used at openings such as those for cooling water and a lubricating oil and a bolt hole.

Fig.2

Removing the compressive load



Description

Technical Field

[0001] The present invention concerns a cold rolled steel sheet for a gasket material used as a sealing material for each of opening portions including cylinders in internal combustion engines, a method for producing thereof and a gasket material produced by the method.

Background Art

[0002] Various gaskets including a cylinder head gasket have been used being concerned with an automobile engine. As the material for the gasket, asbestos have been used so far but non-asbestos materials have been sought in order to cope with environmental problems, improvement for the performance of engines, etc.

[0003] As the substitute material for asbestos, those using aramid fibers or graphite and put to composite fabrication with soft steel sheets have been used. Further, as those quite different from the existent gasket structure, stainless steels coated with rubber coating materials have also been used.

[0004] Heretofore, as a casing of using a cold rolled steel sheet for the gasket material, JP-A No. Hei 9-194935, for example, discloses a method of heating to a recrystallization temperature or higher followed by quenching. In this case, because of quenching, warps occur in the cold rolled steel sheet after quenching to result in a problem in view of the flatness.

[0005] Further, JP-A No. 2000-109957 discloses an example of providing a stainless steel sheet. However, since the stainless steel sheet is expensive, this is not economical.

[0006] However, since those of using the aramid fibers or graphite or stainless steels coated with rubber coating materials require composite fabrication with other materials, they involve a problem of increasing the cost.

[0007] Fig. 3 is a schematic cross sectional view showing the manner of using a gasket material in an application use for springs requiring spring property and application use of fabrication requiring fabricability. As shown in Fig. 3, a gasket material 41 interposed between a cylinder 43 and a cylinder head 44 is formed with a bead portion 42 for improving the sealability. Accordingly, the characteristics as the gasket material 41 requiring the spring property include bead fabricability and the spring property. The bead fabricability and the spring property are properties contrary to each other in a metallurgical point of view.

[0008] Generally, for improving the fabricability, it is preferred to soften a steel material, whereas it is preferred to harden the steel material in order to improve the spring property.

[0009] Accordingly, it is an object of the present invention to provide a cold rolled steel sheet for a gasket material having excellent gas sealing property which is inexpensive and while has good balance between the bead fabricability and the spring property, as well as a method of producing the same.

[0010] Further, it is another object of the present invention to provide a gasket material having particularly excellent spring property required for the sealing performance for the opening of the cylinder, well conforming also with various kinds of openings such as an opening for cooling water, an opening for lubricant and a bolt hole, and also capable of obtaining good sealing performance with preferred spring property.

Disclosure of the Invention

[0011] For attaining the foregoing object, a cold rolled steel sheet for a gasket material according to claim 1 is characterized by comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities. According to this, the cold rolled steel sheet for a gasket material of the invention is inexpensive, and having excellent gas sealing property with good balance between the bead fabricability and the spring property. Further, the cold rolled steel sheet for a gasket material according to the invention is inexpensive and has a gas sealing property with excellent bendability capable of being bent by 180°C.

[0012] A method of producing a cold rolled steel plate for a gasket material according to claim 2 is characterized by hot rolling a continuously cast piece comprising on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%.

[0013] A method of producing a cold rolled steel plate for a gasket material according to claim 3 is characterized by hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to of 3.0% Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%, and further applying Zn or Ni plating on the surface.

[0014] A method of producing a cold rolled steel plate for a gasket material according to claim 4 is characterized by hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%,
 5 applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing and, subsequently, applying secondary rolling at a draft of 30% or more.

[0015] A method of producing a cold rolled steel plate for a gasket material according to claim 5 is characterized by hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%,
 10 applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing and, subsequently, applying secondary rolling at a draft of 7% or less.

[0016] A method of producing a cold rolled steel plate for a gasket material according to claim 6 is characterized by hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying a cold rolling at a draft of from 50 to 90%,
 15 applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing, subsequently, applying secondary rolling at a draft of 30% or more and, further, applying Zn or Ni plating on the surface.

[0017] A method of producing a cold rolled steel plate for a gasket material according to claim 7 is characterized by hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%,
 20 applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batch annealing, subsequently, applying secondary rolling at a draft of 7% or less and, further, applying Zn or Ni plating on the surface.

[0018] In the present invention, according to claims 2 to 4 and 6, a cold rolled steel sheet for a gasket material which is inexpensive and has excellent gas sealing property with good balance between the bead fabricability and the spring property can be produced.

[0019] According to the present invention in claims 2, 3, 5 and 7, a cold rolled steel sheet for a gasket material which is inexpensive and having gas sealing property of excellent bendability can be produced.

[0020] A gasket material according to claim 8 is produced by using the cold rolled steel sheet for a gasket material according to claim 1.

[0021] A gasket material according to claim 9 is produced by using the cold rolled steel sheet for a gasket material according to any one of claim 2 to 7.

[0022] Thus, the gasket material of the present invention is particularly preferred in view of the spring property which is necessary as the sealing performance for the cylinder opening, well conforms also to various types of openings such as the opening for cooling water, the opening for lubricant and bolt holes, and can provide sealing performance with good spring property.

[0023] It is necessary that the gasket material has a strength of 1000 MPa or more, preferably, 1200 MPa or more in view of the tensile strength according to JIS No. 5 (tensile strength: hereinafter referred to as "T. S."). Further, it is necessary that the gasket material has an elongation of 3% or more (total elongation: hereinafter referred to as "T. EL."), more preferably, 5% or more for the fabrication of the bead portion as described above.

[0024] Further, in addition to the application use for springs requiring the spring property, the gasket material also includes a fabrication application use requiring bending fabrication as shown in Fig. 4. In this case, it is necessary that
 45 the strength is 500 MPa or more, preferably, 600 MPa or more as the T. S. according to JIS No. 5 piece and requires 15% or more and, preferably, 20% or more of T. EL.

Brief Description of the Drawings

[0025] Fig. 1 is a schematic view showing an evaluation method for the fabricability of a gasket. Fig. 2 is a schematic view showing a test method for evaluation of the spring property. Fig. 3 is a schematic cross sectional view showing the mode of using a gasket material for spring application. Fig. 4 is a schematic cross sectional view showing the mode of using the gasket material applied with a vending fabrication.

Best Mode for Practicing the Invention

[0026] Preferred embodiments of the present invention are to be described in details.

Steel ingredients of a cold rolled steel sheet for a gasket material as a starting plate

[0027] The steel ingredients in the cold rolled steel sheet for a gasket material according to the present invention comprises, on the weight % base, from 0.008 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities.

[0028] C is preferably 0.08% by weight or more in order to provide a high degree of fineness to a cold rolled steel sheet for a gasket material. On the other hand, in a case where the ingredient C exceeds 0.60% by weight, the precipitation amount of carbides increases to deteriorate the fabricability of the cold rolled steel sheet for the gasket material and, at the same time, causes lowering of the productivity such as increase of the load for cold rolling, deterioration of the shape, inhibition for sheet passing in a continuous annealing step, etc. Accordingly, the upper limit value for the ingredient C is defined as 0.60% by weight in the invention.

[0029] Since Mn is an essential ingredient for preventing embrittlement under red heating during hot rolling due to impurity S and, at the same time, providing high fineness to the cold rolled steel sheet for the gasket material like C described above, the Mn ingredient is defined as 0.5% by weight or more. However, also in the same manner as C, if it is excessive, it causes lowering of the productivity such as increase of the load for cold rolling, occurrence of crack during slab rolling, deterioration of the shape and inhibition for sheet passing in a continuous annealing step, etc., so that the upper limit value is defined as 3.0% by weight.

[0030] Since P is a crystal grain refining ingredient and also it improves the strength of the cold rolled steel sheet for the gasket, it is added at a predetermined ratio but, on the other hand, it hinders the corrosion resistance. In a case where P exceeds 0.06% by weight, the corrosion resistance, particularly, pit resistance is remarkably deteriorated for the application use of the invention, so that the upper limit value is defined as 0.06% by weight.

[0031] S is an impurity ingredient causing embrittleness under red heating during hot rolling and it is desirably as less as possible. However, since intrusion from iron ores, etc. can not be prevented completely and desulfurization during the step is difficult, it may inevitably remain to some extent. Since the embrittleness under red heating due to small amount of remained S can be moderated with Mn, the upper limit value for the S ingredient is defined as 0.06% by weight.

[0032] Al is added in a steel bath as a deoxidant upon steel making. However, if it is 0.10% by weight or more, excess Al reacts with an oxidation suppressor and oxygen in a casting mold powder used as an anti-scorching agent to a casting die in the continuous casting during continuous casting to hinder the intended powder effect. Accordingly, the amount of Al is controlled to 0.10% by weight or less.

[0033] N, like C and Mn, provides a high fineness to the cold rolled steel sheet for the gasket. While this is an essential ingredient for improving the proof stress, reduction to less than 0.01% by weight results in the difficulty in view of steel making. On the other hand, addition in excess of 0.0150% by weight remarkably lowers the yield of ferro nitrides added during steel making lacks in stability and also remarkably deteriorates the anisotropy during press molding. Further, since this results in cracks at the surface of a continuous cast piece to form casting defects, the range for the N ingredient is defined in the invention as from 0.001 to 0.0150% by weight. More preferably, it is defined as from 0.0021 to 0.0150%.

[0034] Si provides a main feature of the invention. Si has a significant solid solubilization strengthening performance in the steel and it is an effective element for obtaining a spring property. Accordingly, it is necessary by 1.0% by weight or more. Further, while more content is preferred in view of strengthening the material, since increase of load in the cold rolling and deterioration of the shape are caused when it exceeds 3.0% by weight, the upper limit value is defined as 3.0% by weight.

Hot rolling

[0035] The heating temperature for the steel piece in the hot rolling step is not specified in the present invention but it is preferably 1100°C or higher in view of positive decomposition and solid-solubilization of N and stable insurance of the hot finishing rolling temperature. Since the crystal tissue in a hot steel sheet gives a grain mixture and grain growth failing to obtain an aimed strength in a case where the hot rolling finishing temperature is below the Ar3 point, the hot rolling finishing temperature is preferably Ar3 point or higher. The take-up temperature is defined as 450°C to 650°C. 450°C is defined as the lower limit while considering the quality stability in the lateral direction and the longitudinal direction of the coil during hot rolling. Further, in a case where the take-up temperature exceeds 650°C, since the crystal grain size increases during hot rolling and continuous annealing thereby causing failure during fabrication of gasket beads, the take-up temperature is preferably 650°C or lower.

[0036] The steel sheet subjected to hot rolling with the ingredient system as described above is cold rolled, and the cold draft is an important strength factor together with the ingredients in the invention and it is conducted at 50 to 90% in order to obtain an aimed strength.

[0037] As described above, the material applied with cold rolling at 50 to 90% is degreased in a cleaning step and

then applied with continuous annealing at 630 to 870°C or higher and, preferably, at 680 to 870°C. Alternatively, batch-wise annealing is applied at 500 to 750°C or, preferably, 600 to 750°C. The annealing time may be within such a range as the material is recrystallized.

[0038] In the case of use for the spring application, secondary cold rolling is applied at a draft of 30% or more, preferably, 60% or more to introduce strains. Subsequently, surface roughness is optionally applied by temper rolling.

[0039] On the other hand, in a case of use for the fabrication application with excellent bending property, a secondary rolling at a draft of 7% or less or temper rolling is applied after annealing. Subsequently, the surface roughness is applied optionally by temper rolling.

[0040] Then, the cold rolled steel sheet for the gasket material according to the invention prepared as described above includes sheet-like and coil-like steel sheets, steel foils, or those formed by applying a surface treatment to the steel sheets described above. Particularly, electrolytic chromate treated steel sheets having a two-layered structure comprising a lower layer of a metallic chromium and an upper layer of chromium hydrate oxide, or extremely thin tin-plated steel sheets, nickel plated steel sheets, zinc plated steel sheets and those formed by applying a surface treatment with chromium hydrate oxide, or a surface treatment having a two-layered structure comprising an upper layer of chromium hydrate oxide and a lower layer of a metallic chromium layer to the plated steel sheets described above are excellent in view of the corrosion resistance.

Example

[0041] For examples of the invention and comparative examples, steel ingredients and manufacturing conditions such as a draft are shown in Table 1 and the results of evaluation for the characteristics thereof are shown in Table 2.

[0042] In view of Table 1 and Table 2, specimens Nos. 1 to 10 as the examples can be used for the spring application of high strength and showing high spring property, while specimens Nos. 11 to 13 can be used for fabrication of excellent bendability. In Table 2, specimens Nos. 1 to 10 used for spring application are indicated by symbols "O" in the columns for the spring evaluation and bead fabrication and favorable therefor, the bendability is indicated by "×" to which they can not be applied. Further, while the specimen Nos. 11 to 13 used for fabrication application are indicated by "×" in the column for the spring property and are not applicable to the spring application, they are indicated by "O" in the column for bending fabricability and show good bendability.

[0043] On the other hand, specimens Nos. 14 to 31 as comparative examples do not satisfy the characteristics for the spring property for the bead fabricability and can not be applied to the spring application (symbol "×" is indicated the column for the spring property or the bead fabricability in Table 2). Further, the bendability is poor in each of the cases being indicated by "×".

Table 1: Steel ingredient, rolled down ratio and annealing condition

Specimen No.	Example or Comparative Example	Chemical ingredient (wt %)						Primary rolling (draft %)	Continuous annealing temperature	Batchwise annealing temperature (8 hrs.)	Secondary rolling (draft %)
		C	Si	Mn	P	Al	N				
1	Example 1	0.09	1.5	2.5	0.030	0.031	0.0050	70%	820°C	-	52%
2	Example 2	0.15	2.8	1.7	0.010	0.062	0.0032	70%	820°C	-	40%
3	Example 3	0.13	2.0	2.1	0.021	0.044	0.0028	70%	820°C	-	65%
4	Example 4	0.58	1.1	0.6	0.008	0.005	0.0061	70%	820°C	-	70%
5	Example 5	0.35	1.1	0.8	0.052	0.052	0.0041	70%	820°C	-	65%
6	Example 6	0.09	1.5	2.5	0.030	0.031	0.0050	70%	800°C	-	65%
7	Example 7	0.15	2.8	1.7	0.010	0.062	0.0032	70%	800°C	-	65%
8	Example 8	0.13	1.0	2.1	0.021	0.044	0.0028	70%	830°C	-	65%
9	Example 9	0.58	1.1	0.6	0.008	0.005	0.0061	70%	830°C	-	65%
10	Example 10	0.35	1.1	0.8	0.052	0.052	0.0041	70%	830°C	-	65%
11	Example 11	0.09	1.5	2.5	0.030	0.031	0.0050	70%	720°C	-	none
12	Example 12	0.15	2.8	1.7	0.010	0.062	0.0032	70%	670 °C	-	none
13	Example 13	0.13	2.0	2.1	0.021	0.044	0.0028	70%	-	630°C	none
14	Comparative Example 1	0.04	1.5	1.7	0.011	0.061	0.0029	70%	830°C	-	65%
15	Comparative Example 2	0.15	0.8	1.8	0.021	0.049	0.0054	70%	830°C	-	65%
16	Comparative Example 3	0.72	1.8	1.7	0.008	0.022	0.0033	70%	830°C	-	65%
17	Comparative Example 4	0.16	3.2	1.2	0.014	0.012	0.0011	70%	830°C	-	65%
18	Comparative Example 5	0.28	1.1	3.3	0.015	0.007	0.0024	70%	830°C	-	65%
19	Comparative Example 6	0.22	2.1	0.3	0.020	0.082	0.0110	70%	830°C	-	65%
20	Comparative Example 7	0.09	1.5	2.5	0.030	0.032	0.0050	70%	600°C	-	65%
21	Comparative Example 8	0.13	2.0	2.1	0.021	0.044	0.0028	70%	-	490°C	none
22	Comparative Example 9	0.15	0.8	1.8	0.021	0.049	0.0054	70%	800°C	-	15%
23	Comparative Example 10	0.72	1.8	1.7	0.008	0.022	0.0033	70%	800°C	-	20%

Table 2:

Result for the Evaluation of Characteristic						
Specimen No.	Example or Comparative Example	T. S. (MPa)	T.EL. (%)	Spring property	Bead fabricability	Bendability
1	Example 1	1,080	5.2%	○	○	×
2	Example 2	1,180	5.0%	○	○	×
3	Example 3	1,145	5.1%	○	○	×
4	Example 4	1,250	3.9%	○	○	×
5	Example 5	1,210	4.2%	○	○	×
6	Example 6	1,080	8.2%	○	○	×
7	Example 7	1,280	8.0%	○	○	×
8	Example 8	1,220	7.2%	○	○	×
9	Example 9	1,320	4.2%	○	○	×
10	Example 10	1,290	4.9%	○	○	×
11	Example 11	560	25.0%	×	○	○
12	Example 12	595	17.0%	×	○	○
13	Example 13	600	20.0%	×	○	○
14	Comp. Example 1	980	8.0%	×	○	×
15	Comp. Example 2	990	8.2%	×	○	×
16	Comp. Example 3	1,320	0.8%	○	×	×
17	Comp. Example 4	1,290	0.9%	○	×	×
18	Comp. Example 5	1290	0.9%	○	×	×
19	Comp. Example 6	940	7.8%	×	○	×
20	Comp. Example 7	1,080	0.8%	×	×	×
21	Comp. Example 8	1,290	0.7%	○	×	×
22	Comp. Example 9	880	12.0%	×	○	×
23	Comp. Example 10	990	7.8%	×	○	×

Evaluation for spring property and bead fabricability

[0044] For bead fabricability and the spring property for the gasket of the present invention were evaluated as described below. At first, a steel sheet was pressed into a cross sectional shape as shown in Fig. 1 (fabrication of flanged bead groove), to form a bead portion of width w and height t . During bead fabrication, those where no cracks were generated in the bead portion were indicated by "O" and evaluated as satisfactory, whereas those where cracks were generated were judged as failed for the bead fabricability and evaluated as "×".

[0045] Fig. 2 shows a step of a compression test as a test method for the evaluation of the spring property. In Fig. 2, (a) shows a state of the fabricated bead portion before compression, (b) shows a state of applying a compressive load and (c) shows the state of removing the compressive load.

[0046] As shown in Fig. 2, a compressive load was applied from above to the bead portion by a compression tester. After removing the load, those in which the recovery amount (T1) exceeded 40% relative to the compression amount (T) were regarded as satisfactory for the spring property and indicated by "O". On the other hand, those of 40% or less were judged as failed with the spring property being indicated by "×".

[0047] Evaluation for the bendability.

[0048] The bendability was evaluated by subjecting specimens to 180°C bending fabrication at 0T (sheet not interposed in the bent portion) and was evaluated depending on whether cracks occurred or not in the specimen. Those with generation of cracks were indicated as "×" and evaluated as failed. On the contrary, those with no generation of cracks were indicated as "O" and evaluated as satisfactory. Specimens showing elongation of 15% or more were favorable in view of the bendability.

Industrial Applicability

[0049] Since the cold rolled steel sheet for the gasket material and the production method thereof according to the present invention are constituted and function as described above, a cold rolled steel sheet for the gasket material having excellent gas sealing property while being inexpensive and with good balance between the bead fabricability and the spring property can be obtained.

[0050] The gasket material according to the present invention has excellent gas sealing property both for the spring application with good balance between the fabricability and the spring property, and for the fabrication application being excellent in the OT bendability, by changing the production method slightly.

[0051] Further, the gasket material applied with the surface treatment shows excellent corrosion resistance and shows gas sealing property for a long period of time even when it is exposed to the state of high temperature. Further, the gasket material according to the present invention has particularly preferred spring property required for the sealing performance for openings of the cylinder in the spring application and can be used suitably also to various kinds of openings such as the opening for cooling water, opening for lubricant and bolt holes. For the fabrication application. Although it can not be applied to the use for spring application, it can be used suitably also for various kinds of openings such as the opening for cooling water, the opening for lubricant and bolt holes.

Claims

1. A cold rolled steel sheet for a gasket material **characterized by** comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities.
2. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%.
3. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%, and further applying Zn or Ni plating on the surface.
4. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%, applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing and, subsequently, applying secondary rolling at a draft of 30% or more.
5. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of

Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%, applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing and, subsequently, applying secondary rolling at a draft of 7% or less.

- 5
10
15
20
25
30
35
40
45
50
55
6. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying a cold rolling at a draft of from 50 to 90%, applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batchwise annealing, subsequently, applying secondary rolling at a draft of 30% or more and, further, applying Zn or Ni plating on the surface.
7. A method of producing a cold rolled steel plate for a gasket material, **characterized by** hot rolling a continuously cast piece comprising, on the weight % base, from 0.08 to 0.60% of C, from 1.0 to 3.0% of Si, from 0.5 to 3.0% of Mn, 0.06% or more of P, 0.06% or less of S, 0.1% or less of Al, from 0.0010 to 0.0150% of N and the balance of Fe and inevitable impurities, conducting pickling, applying cold rolling at a draft of from 50 to 90%, applying annealing at 630 to 870°C or higher by continuous annealing or at 500 to 750°C or higher by batch annealing, subsequently, applying secondary rolling at a draft of 7% or less and, further, applying Zn or Ni plating on the surface.
8. A gasket material produced by using the cold rolled steel sheet for a gasket material according to claim 1.
9. A gasket material produced by using the cold rolled steel sheet for a gasket material according to any one of claim 2 to 7.

Fig.1

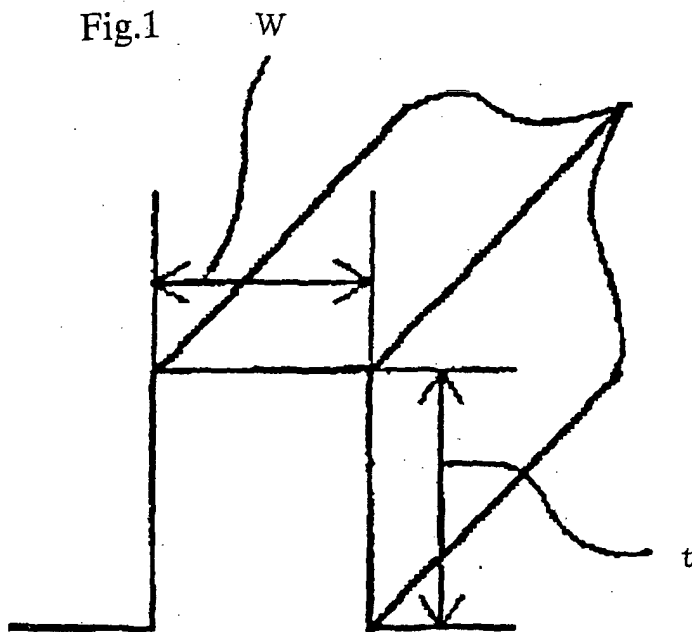


Fig.2

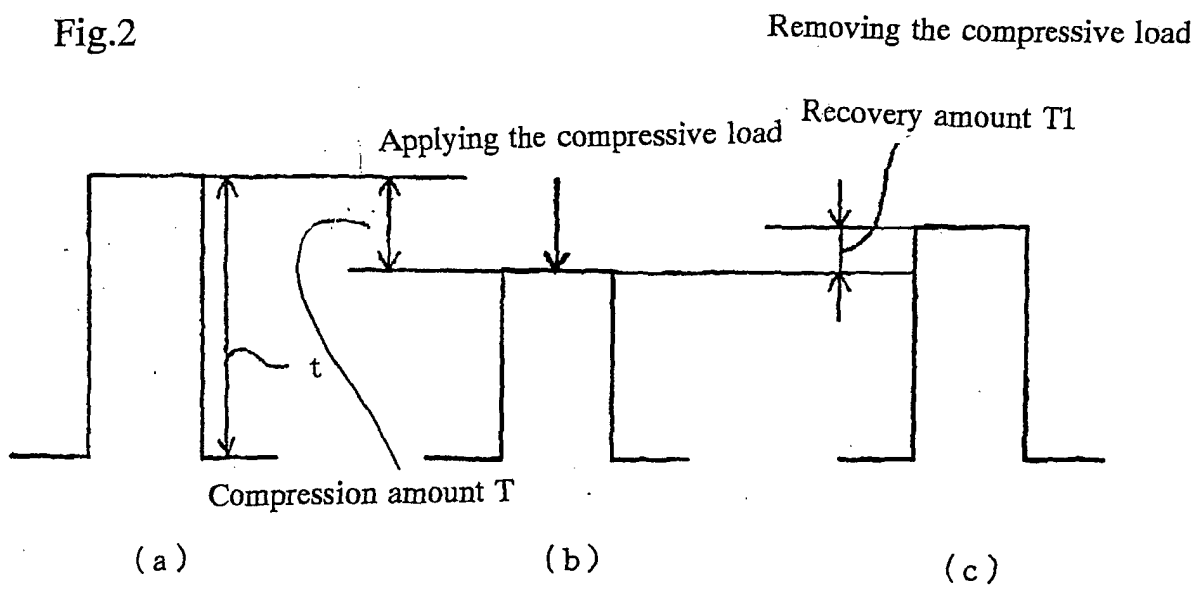


Fig.3

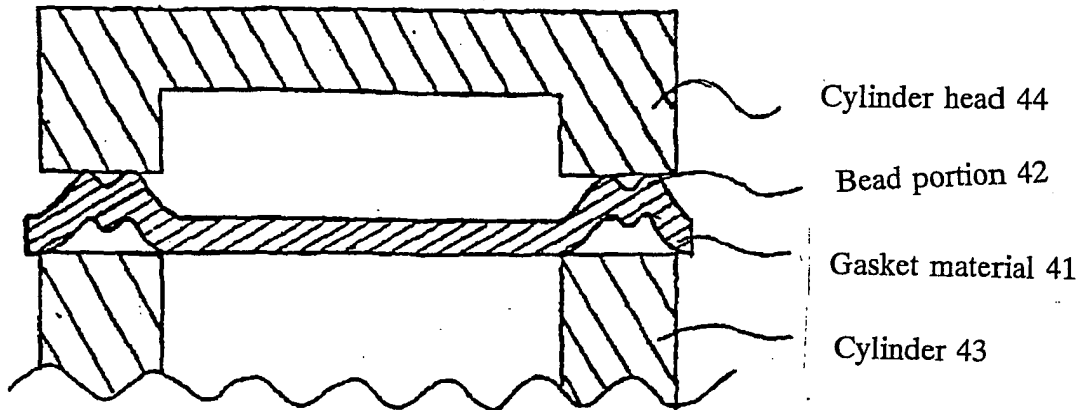
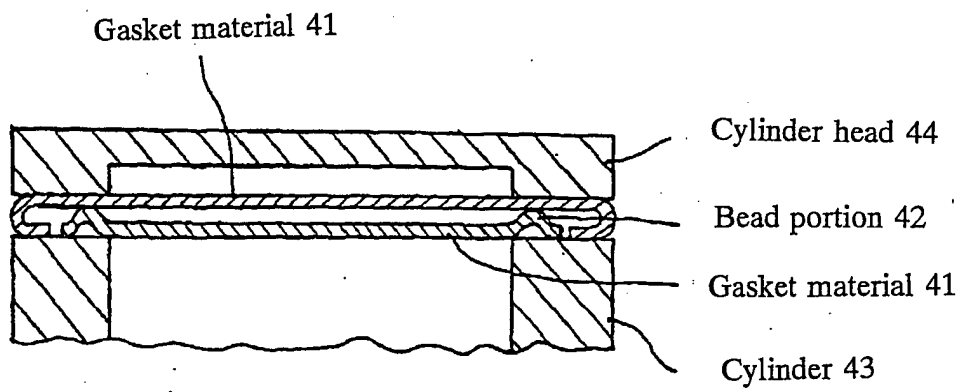


Fig.4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/13001

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ C22C38/00, C21D9/46		
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) Int.Cl ⁷ C22C38/00-38/60, C21D8/02-8/04, 9/46-9/48, F16J15/08		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2003 Kokai Jitsuyo Shinan Koho 1971-2003 Jitsuyo Shinan Toroku Koho 1996-2003		
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	JP 9-194935 A (Toyo Kohan Co., Ltd.), 29 July, 1997 (29.07.97), Claims (Family: none)	1-9
A	JP 3-87320 A (Kobe Steel, Ltd.), 12 April, 1991 (12.04.91), Claims; page 3, upper left column, lines 1, 2 (Family: none)	1-9
☐ 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 document 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 "I" 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 04 December, 2003 (04.12.03)		Date of mailing of the international search report 16 December, 2003 (16.12.03)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)