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(54) **SLIDING COMPONENT AND SLIDING STRUCTURE**

(57) Provided is a sliding component having excellent wear resistance. Also provided is a sliding structure including the sliding component. The sliding component has a composition including: in mass%, 0.7 to 1.6 % of C; 0.5 to 3.0 % of Si; 0.1 to 3.0 % of Mn; 0.05 % or less of P; 0.01 to 0.12 % of S; 0.3 to 1.5 % of Ni; 7.0 to 13.0 % of Cr; one or two of Mo and W satisfying a relational expression: (Mo+W/2) is 0.5 to 1.7 %; 0 to 0.70 % of V;

0.1 to 1.0 % of Cu; 0.10 to 0.70 % of Al; 0 to 0.30 % of Nb; and the remainder of Fe and impurities. The sliding component has hardness equal to or more than 52 HRC and less than 58 HRC. The sliding structure includes the sliding component configured to slide on a sliding surface of a counterpart component under an environment in which lubricant is provided on a sliding surface of the sliding component.

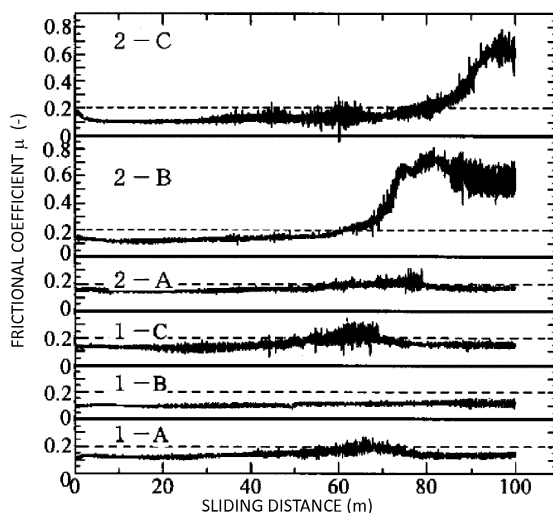


FIG.2

Description

Technical Field

5 **[0001]** The present invention relates to a sliding component used in, for example, various sliding environment such as an oil ring and a cam lobe which are built in an internal combustion engine. In addition, the present invention relates to a sliding structure such as an internal combustion engine, which includes the sliding component built therein.

Background Art

10 **[0002]** In the related art, SUJ2 or SKD11 which is JIS steel type has been used in a material of a sliding component such as an oil ring, a cam lobe, a tappet, a piston pin, a cylinder liner, a transmission gear, a thrust plate, or a vane, which is a constituent component of an internal combustion engine and constitutes a sliding structure. SKD11 is a kind of steel having excellent wear resistance because high hardness of 60 HRC or higher can be achieved by quenching and tempering and carbide in the structure thereof is also abundant. A press die in which sliding characteristics (self-lubricating property) are imparted to a material and wear resistance is improved by improving a composition of the material is suggested (PTL 1).

Citation List

20 Patent Literature

[0003] [PTL 1] JP-A-2007-002333

25 Summary of Invention

Technical Problem

30 **[0004]** The press die in PTL 1 has excellent wear resistance by exhibiting the self-lubricating property. However, applying the material of the press die in PTL 1 to a component of an internal combustion engine was not considered.

[0005] An object of the present invention is to provide a sliding component having excellent wear resistance. Another object of the present invention is to provide a sliding structure including the sliding component.

Solution to Problem

35 **[0006]** According to the present invention, a sliding component has a composition including: in mass%, 0.7 to 1.6% of C; 0.5 to 3.0% of Si; 0.1 to 3.0% of Mn; 0.05% or less of P; 0.01 to 0.12% of S; 0.3 to 1.5% of Ni; 7.0 to 13.0% of Cr; one or two of Mo and W satisfying a relational expression: $(Mo+W/2)$ is 0.5 to 1.7%; 0 to 0.70% of V; 0.1 to 1.0% of Cu; 0.10 to 0.70% of Al; 0 to 0.30% of Nb; and the remainder of Fe and impurities. Hardness of the sliding component is equal to or more than 52 HRC and less than 58 HRC.

40 **[0007]** According to the present invention, a sliding structure includes the above-described sliding component in the present invention and a counterpart component, the sliding component configured to slide on a sliding surface of the counterpart component under an environment in which lubricant is provided on a sliding surface of the sliding component.

45 Advantageous Effects of Invention

[0008] According to the present invention, it is possible to improve wear resistance of the sliding component.

Brief Description of Drawings

50 **[0009]**

Fig. 1 is a diagram illustrating an example of a relationship between hardness and fatigue strength of sliding components of an Example in the present invention and a Comparative Example.

55 Fig. 2 is a diagram illustrating an example of results of a frictional coefficient, which are measured by a ball-on-disk test, in the sliding components of an Example in the present invention and the Comparative Example.

Fig. 3 is a diagram illustrating an example of a relationship between fatigue strength and a sliding distance when the frictional coefficient measured by the ball-on-disk test reaches 0.20, in the sliding components of an Example

in the present invention and the Comparative Example.

Description of Embodiments

[0010] Many sliding components constituting various sliding structure are used in a manner of sliding on a sliding surface of the counterpart component under an environment in which a lubricant is provided on a sliding surface of the sliding component, as represented by components (such as an oil ring and a cam lobe) of an internal combustion engine. It was found that the sliding component in the present invention efficiently exhibited self-lubricating property and wear resistance of the sliding component was improved under the environment. Hereinafter, configuration requirements of the present invention will be described.

[0011]

(1) The sliding component according to the present invention has a composition including: in mass%, 0.7 to 1.6% of C; 0.5 to 3.0% of Si; 0.1 to 3.0% of Mn; 0.05% or less of P; 0.01 to 0.12% of S; 0.3 to 1.5% of Ni; 7.0 to 13.0% of Cr; one or two of Mo and W satisfying a relational expression: $(Mo+W/2)$ is 0.5 to 1.7%; 0 to 0.70% of V; 0.1 to 1.0% of Cu; 0.10 to 0.70% of Al; 0 to 0.30% of Nb; and the remainder of Fe and impurities.

[0012] Regarding the composition, in particular, the feature of the sliding component in the present invention is "addition-together of S and Cu" which largely contributes to exhibition of the self-lubricating property. In the related art, S and Cu are elements which have been hardly actively added to a steel material because of being considered as elements that hinder hot workability of the steel material. An effect of the composition of the sliding component in the present invention will be described below.

- C: 0.7 to 1.6 mass% (briefly described as "%" below)

[0013] C is an element that is subjected to solid solution in a base and imparts strength to the sliding component. C is an element that forms carbide and thus improves wear resistance or galling resistance of the sliding component. However, if C is provided too much, the C content subjected to solid solution in the base is increased, and thus machinability is deteriorated when finishing to be the shape of the sliding component is performed. In addition, coarse carbide is formed and dimensions are largely changed by a heat treatment during quenching. Thus, C is set to be 0.7% to 1.6%. Preferably, C is equal to or more than 0.9%. In addition, preferably, C is set to be equal to or less than 1.3%. More preferably, C is set to be equal to or less than 1.1%.

- Si: 0.5% to 3.0%

[0014] Si is an element that improves resistance to high temperature softening of the sliding component. However, if Si is provided too much, delta ferrite is significantly formed in the structure, and this hinders maintaining of hardness of the sliding component. Thus, Si is set to be 0.5% to 3.0%. Preferably, Si is equal to or more than 0.9%. In addition, preferably, Si is set to be equal to or less than 2.0%. More preferably, Si is set to be equal to or less than 1.5%. Further preferably, Si is set to be equal to or less than 1.1%.

- Mn: 0.1 to 3.0%

[0015] Mn is an element that improves hardenability. However, if Mn is provided too much, machinability is deteriorated. Thus, Mn is set to be 0.1% to 3.0%. Preferably, Mn is equal to or more than 0.3%. More preferably, Mn is set to be equal to or more than 0.4%. In addition, preferably, Mn is set to be equal to or less than 1.0%. More preferably, Mn is set to be equal to or less than 0.6%.

- P: 0.05% or less

[0016] P is an element which is generally inevitably contained although P is not added. P is an element that hinders toughness of the sliding component. Thus, P is set to be equal to or less than 0.05%. Preferably, P is set to be equal to or less than 0.03%. More preferably, P is set to be equal to or less than 0.02%.

- S: 0.01% to 0.12%

[0017] S is an element that contributes to improvement of the self-lubricating property of the sliding component in the present invention, along with Cu which will be described later. The inventors examined a phenomenon occurring on a

sliding surface when a sliding component having a composition in PTL 1 was used under an environment in which a lubricant was provided on the sliding surface. As a result, the inventors found that, when this sliding component was used, if sliding surfaces of the sliding component and the counterpart component came into contact with each other at surface pressure which was as high as galling occurs, an organic component in the lubricant adhering to the sliding surface of the sliding component was dehydrogenated, and thus was changed to a substance such as diamond or graphite. It was found that, among the diamond, the graphite, and the like, "a graphite intercalation compound" having a configuration in which sulfate ions or sulfuric acid molecules were regularly interposed could improve the self-lubricating property of the sliding component and maintain a low frictional coefficient between the sliding surfaces.

[0018] S in the sliding component is oxidized on the sliding surface which is being used, and thus generates sulfate ions. The generated sulfate ions are interposed between graphite layers, and thus accelerate forming of the graphite intercalation compound. Alternatively, the generated sulfate ions are combined with hydrogen ions generated by dehydrogenating the lubricant, and thus form sulfuric acid molecules. The formed sulfuric acid molecules are interposed between the graphite layers, and thus accelerate forming of the graphite intercalation compound. Accordingly, spacing of the graphite in a C-axial direction is increased and thus allotropic modification of graphite to diamond in a nano-level state is suppressed, the degree of freedom of sliding is improved, and lubricity is improved. However, if S in the sliding component is excessive, sulfate ions which are excessive as much as being not interposed between the graphite layers are generated on the sliding surface. The excessive sulfate ions aggravate damage of the sliding surface and hinder exhibition of the self-lubricating property. Thus, S is set to be 0.01% to 0.12%. Preferably, S is equal to or more than 0.03%. More preferably, S is equal to or more than 0.04%. Further preferably, S is equal to or more than 0.05%. In addition, preferably, S is equal to or less than 0.09%. More preferably, S is equal to or less than 0.08%.

- Ni: 0.3 to 1.5%

[0019] Ni is an element that is combined to Al (which will be described later) so as to precipitate a Ni-Al intermetallic compound, and contributes to maintaining of hardness of the sliding component in a quenching and tempering process. However, if Ni is provided too much, machinability when working to be the shape of the sliding component is performed is deteriorated in an annealed state before quenching and tempering. Thus, Ni is set to be 0.3% to 1.5%. Preferably, Ni is equal to or more than 0.4%. In addition, preferably, Ni is equal to or less than 1.0%. More preferably, Ni is equal to or less than 0.8%. Further preferably, Ni is equal to or less than 0.6%.

- Cr: 7.0% to 13.0%

[0020] Cr is an element that improves hardenability of the base. Cr is an element that forms carbide along with the above-described C and improves the wear resistance or the galling resistance of the sliding component. However, an increase of carbide causes deterioration of machinability. Thus, Cr is set to be 7.0% to 13.0%. Preferably, Cr is equal to or more than 7.5%. More preferably, Cr is equal to or more than 8.0%. In addition, preferably, Cr is equal to or less than 11.0%. More preferably, Cr is equal to or less than 10.0%. Further preferably, Cr is equal to or less than 9.0%.

- One or two of Mo and W: satisfies a relational expression: $(Mo + W/2)$ is 0.5% to 1.7%

[0021] Mo and W are elements that form fine carbide in the structure after quenching and tempering, and impart fatigue strength to the sliding component. However, if Mo and W are provided too much, Mo and W cause degradation of the machinability or the toughness. Mo and W can be added singly or in complex thereof. The added amount of Mo and W at this time can be defined together in a relational expression of $(Mo + W/2)$ because W has an atomic weight of about twice that of Mo. In the present invention, the value of $(Mo + W/2)$ is set to be 0.5% to 1.7%. Preferably, the value is equal to or more than 0.7%. More preferably, the value is equal to or more than 0.9%. Further preferably, the value is equal to or more than 1.0%. In addition, preferably, the value is equal to or less than 1.5%. More preferably, the value is equal to or less than 1.3%. Further preferably, the value is equal to or less than 1.2%.

- V: 0% to 0.70%

[0022] V can be contained in order to improve hardenability. Since V forms hard VC carbide, if V is excessively contained, machinability is hindered. Thus, in the present invention, although V is contained, V is set to be equal to or less than 0.70%. Preferably, V is equal to or less than 0.50%. More preferably, V is equal to or less than 0.30%. Further preferably, V is equal to or less than 0.20%.

- Cu: 0.1 to 1.0%

[0023] Cu is an element that contributes to improvement of the self-lubricating property of the sliding component in the present invention, along with the above-described S. That is, Cu is an element that shows a catalyst action for generating "the graphite intercalation compound". A very small amount of Cu can be precipitated on the sliding surface of the sliding component after quenching and tempering. Cu precipitated on the sliding surface has a function as a catalyst of promoting forming of the above-described "graphite intercalation compound". However, if Cu is excessively contained, Cu causes hot embrittlement of the material and thus hot workability is deteriorated. Thus, Cu is set to be 0.1% to 1.0%. Preferably, Cu is equal to or more than 0.2%. More preferably, Cu is equal to or more than 0.3%. In addition, preferably, Cu is equal to or less than 0.8%. More preferably, Cu is equal to or less than 0.6%. Further preferably, V is equal to or less than 0.5%.

- Al: 0.10% to 0.70%

[0024] Al is an element that is combined to Ni so as to form a Ni-Al intermetallic compound, and contributes to maintaining of hardness of the sliding component. However, if Al is provided too much, delta ferrite is significantly formed in the structure, and this hinders maintaining of hardness of the sliding component. Thus, Al is set to be 0.10% to 0.70%. Preferably, Al is set to be equal to or more than 0.15%. More preferably, Al is set to be equal to or more than 0.25%. In addition, preferably, Al is set to be equal to or less than 0.50%. More preferably, Al is equal to or less than 0.45%.

- Nb: 0% to 0.30%

[0025] Similar to V, Nb can be contained in order to improve the hardenability. However, if Nb is excessively contained, machinability is hindered. Thus, in the present invention, although Nb is contained, Nb is set to be equal to or less than 0.30%. Preferably, Nb is set to be equal to or less than 0.20%. More preferably, Nb is set to be equal to or less than 0.15%. The content of Nb, which is preferable for obtaining the above effect is equal to or more than 0.03%. More preferably, the content of Nb is equal to or more than 0.05%. Further preferably, the content of Nb is equal to or more than 0.07%.

[0026] With the above-described composition, the self-lubricating property of the sliding component in the present invention is exhibited by using "an alteration action by friction" of the lubricant provided on the sliding surface. Thus, in order to exhibit the self-lubricating property according to the present invention, the lubricant which is, for example, hydrocarbon type may be interposed between the component and the counterpart component during the use. The material of the counterpart component may be widely selected.

[0027]

(2) The sliding component of the present invention has hardness which is equal to or more than 52 HRC and less than 58 HRC. Generally, it is considered that lowering the hardness of the sliding component causes the decrease of the wear resistance of the sliding component. Thus, the sliding component in the related art had hardness which was adjusted to be equal to or more than 60 HRC. However, the sliding component in the present invention has fatigue strength which is higher than SKD11 in the related art, by the above-described composition. The value of the fatigue strength is more significantly improved by moderately lowering the hardness of the sliding component. That is, as illustrated in Fig. 1, SKD11 (a mark of x in Fig. 1) in the related art has fatigue strength of about 560 MPa when being adjusted to be 60 HRC which is hardness of a general sliding component. The value of the fatigue strength thereof is increased up to only about 600 MPa even if the hardness is reduced. In a case of the material (a mark of O in Fig. 1) of the composition according to the present invention, the value of the fatigue strength thereof indicates high fatigue strength of about 630 MPa when the hardness is lowered to 58 HRC. Then, the high fatigue strength is maintained in a low hardness range.

[0028] In the sliding component in the present invention, which has the above-described composition, the frictional coefficient shown by the sliding component during the use is effectively reduced with an increase of the value of the fatigue strength of the sliding component. Thus, the self-lubricating property in the present invention is synergistically improved (see Fig. 3). As the fatigue strength which causes the self-lubricating property which is synergistically improved to be stably obtained, the object of the present invention is a sliding component having fatigue strength which is more than 600 MPa. It is difficult to reach the fatigue strength which is more than 600 MPa by using SKD11 in the related art. Preferably, the fatigue strength is more than 630 MPa. The hardness of the sliding component in the present invention is set to be less than 58 HRC as a range in which fatigue strength of more than 600 MPa can be easily achieved. Preferably, the hardness is equal to or less than 57 HRC.

[0029] When the sliding component in the present invention is used, if it is assumed that hardness of the counterpart

component is high, reduction in hardness of the sliding component in the present invention is not favorable measures therefor. For example, in a case where SUJ2 which is bearing steel of the JIS steel type is used in the counterpart component, the hardness of the counterpart component is generally adjusted to be 60 to 62 HRC. That is, the hardness is higher than that of the sliding component in the present invention. SUJ2 is "high carbon chromium bearing steel" standardized in JIS-G-4805. The composition of SUJ2 is as follows, in mass%.

C: 0.95% to 1.10%; Si: 0.15% to 0.35%; Mn: 0.50% or less; P: 0.025% or less; S: 0.025% or less; Cr: 1.30% to 1.60%; and the remainder of Fe and impurities

[0030] If the sliding component in the present invention corresponds to an oil ring or a cam lobe, the sliding surface of the sliding component slides on the sliding surface of the counterpart component in an "intermittent" contact form which is referred to as a rotational motion or a reciprocating motion. In such a contact form, if the hardness of the sliding component in the present invention is much less than the hardness of the counterpart component, Hertz stress to be applied is increased. If the Hertz stress exceeds the fatigue strength of the sliding component, fine plastic deformation occurs on the sliding surface. Peeling and wear from the sliding component are induced, and thus the frictional coefficient between the sliding surfaces is increased, and self-lubricating property in the present invention is hindered. Accordingly, the lower limit of the hardness of the sliding component in the present invention is set to 52 HRC. The lower limit thereof is preferably 53 HRC. The lower limit thereof is more preferably 54 HRC. The lower limit thereof is further preferably 55 HRC.

[0031] With the conditions, for example, it is possible to use a metal material such as SUJ2, as the material of the counterpart component. Accordingly, it is possible to obtain a mechanism of a sliding structure which achieves both suppression of an occurrence of galling (adhesion) damage and improvement of a fatigue life and has a long life.

Examples

[0032] Sliding components 1 and 2 which had compositions of Sample No. 1 and 2 in Table 1 were prepared respectively. Sample No. 2 is SKD11.

[Table 1]

Sample No.	Composition (mass%)													
	C	Si	Mn	P	S	Ni	Cr	Mo	W	V	Cu	Al	Nb	Fe*
1	1.0	1.0	0.5	0.02	0.06	0.5	8.0	0.9	0.4	-	0.4	0.35	0.10	Bal.
2	1.5	0.3	0.3	0.02	-	-	12.0	1.0	-	0.25	-	-	-	Bal.
*Including impurities														

[0033] Then, regarding each of the sliding components 1 and 2, sliding components in which hardness was adjusted to have three types of A (50 HRC), B (55 HRC), and C (60 HRC) were prepared. At this time, regarding the practical hardness of each of the sliding components, a sliding component 1-A was 50.4 HRC, a sliding component 1-B was 56.2 HRC, a sliding component 1-C was 62.0 HRC, a sliding component 2-A was 50.0 HRC, a sliding component 2-B was 55.8 HRC, and a sliding component 2-C was 61.0 HRC. The sliding component 2-C which has the aimed hardness of 60 HRC which is hardness of SKD11 corresponds to the sliding component in the related art. The fatigue strength of each of the sliding components was measured. As a method of measuring the fatigue strength, each of the sliding components was worked to make a rotary bending fatigue test piece and an Ogoshi-type rotary bending fatigue test was performed on the test piece. Surface stress of the test piece was adjusted by a sectional secondary moment determined by the shape of the test piece and adjustment of the weight of a weight hung at the center of parts of the test piece, which are parallel to each other. Stress amplitude had a condition (referred to as an Amplitude ratio: 1) in which stress of tension was equal to stress of compression, in one rotation of the test piece. A rotation speed of the test piece was set to 50Hz (3,000 rpm). Stress when the rotary bending fatigue test piece was broken was set to be the fatigue strength. Fig. 1 shows results.

[0034] A ball-on-disk test was performed on each of the sliding component and the self-lubricating property of each of the sliding components was evaluated. Test conditions are as follows. A change of the frictional coefficient was continuously measured until the sliding distance reached 100 m. Fig. 2 shows results.

Device: friction wear tester manufactured by CSM

Test piece:

- Disk (sliding component): diameter of 20 mm× thickness of 5 mm
- Ball (counterpart component): SUJ2 (diameter of 6 mm, hardness of 62 HRC)

Ball load: 10 N

Number of rotations of disk: 500 rpm

Sliding radius: 3.3 mm

Sliding distance: 100 m

Amount of coating oil: 0.1 μ l

Oil type (lubricant):

- Base oil: commercial paraffin oil
- Formic acid: added amount of 2.9×10^{-4} ppm

[0035] With Fig. 2, in the sliding components 2-A, 2-B, and 2-C being compositions which did not exhibit the self-lubricating property, the frictional coefficient was increased and the value of the frictional coefficient which was more than 0.30 was measured. In the sliding components 2-B and 2-C, before the sliding distance reached 100 m, galling occurred and the frictional coefficient was rapidly increased.

[0036] On the contrary, in the sliding components 1-A, 1-B, and 1-C being compositions which exhibited the self-lubricating property, galling did not occur until the sliding distance reached 100 m. In the sliding components 1-A and 1-B, the value of the frictional coefficient during that period was maintained so as to be equal to or less than 0.30. In the sliding component 1-B in the present invention, in which the composition exhibited the self-lubricating property and hardness had been adjusted to be "equal to or more than 52 HRC and less than 58 HRC", the self-lubricating property was synergistically improved, the frictional coefficient was more decreased, and the value thereof was equal to or less than 0.20.

[0037] Fig. 3 illustrates a relationship between the fatigue strength of each of the sliding components and the sliding distance when the frictional coefficient measured in the above descriptions reaches 0.20. Here, the value of the frictional coefficient which is "0.20" is an indicator of the frictional coefficient when the sliding component exhibits the synergistical self-lubricating property, in the test conditions of the example, as described above. With Fig. 3, in the sliding component 1-B in the present invention, the fatigue strength is larger than 600 MPa. Thus, even when the sliding distance reached 100 m, the low frictional coefficient of 0.20 or less was maintained (in Fig. 3, for convenience, the value was indicated at a position of "100 m"). In the sliding component 1-B in the present invention, the self-lubricating property was improved (the frictional coefficient was small) and the improved self-lubricating property was stably maintained at a long sliding distance, in comparison to the sliding components 1-A and 1-C.

Claims

1. A sliding component having a composition including: in mass%, 0.7 to 1.6 % of C; 0.5 to 3.0 % of Si; 0.1 to 3.0 % of Mn; 0.05 % or less of P; 0.01 to 0.12 % of S; 0.3 to 1.5 % of Ni; 7.0 to 13.0 % of Cr; one or two of Mo and W satisfying a relational expression: $(Mo+W/2)$ is 0.5 to 1.7 %; 0 to 0.70 % of V; 0.1 to 1.0 % of Cu; 0.10 to 0.70 % of Al; 0 to 0.30 % of Nb; and the remainder of Fe and impurities, the sliding component having hardness equal to or more than 52 HRC and less than 58 HRC.
2. A sliding structure including the sliding component of claim 1 and a counterpart component, the sliding component configured to slide on a sliding surface of the counterpart component under an environment in which lubricant is provided on a sliding surface of the sliding component.

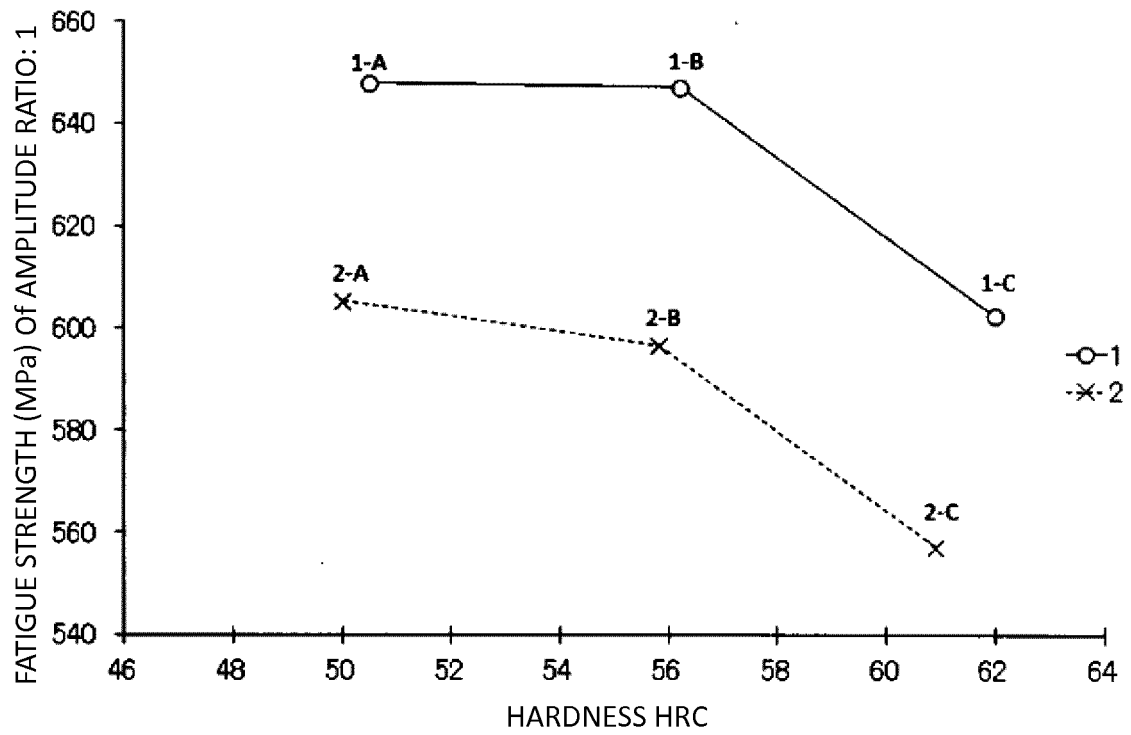


FIG.1

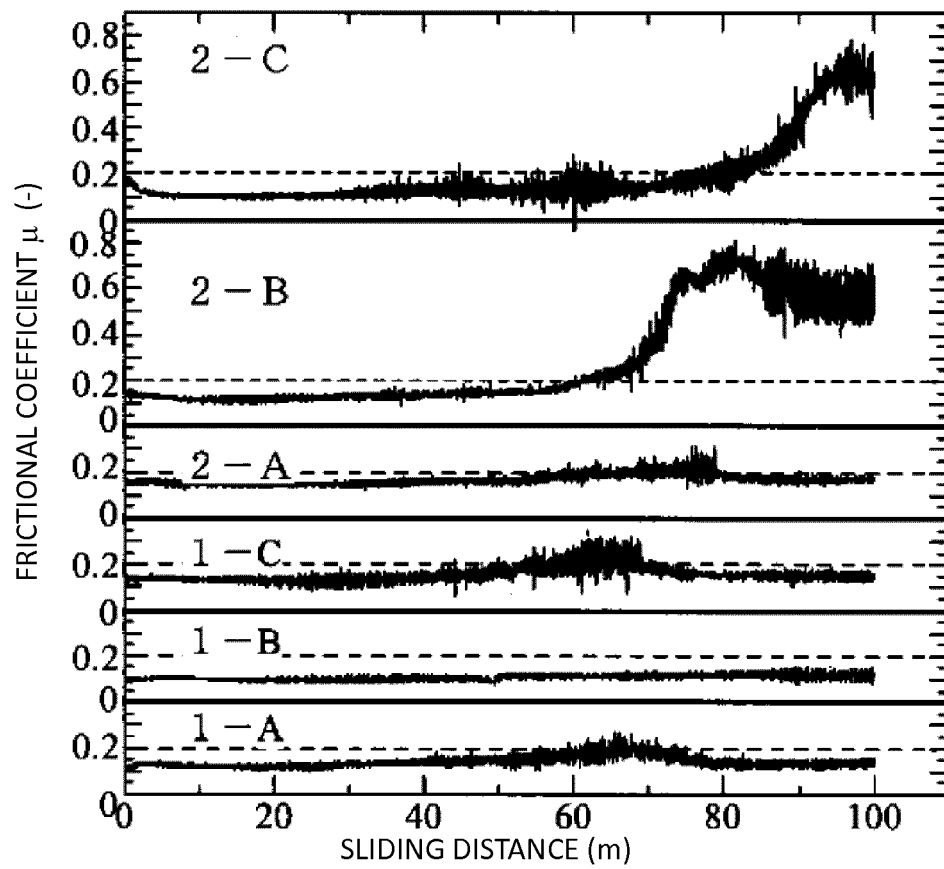


FIG.2

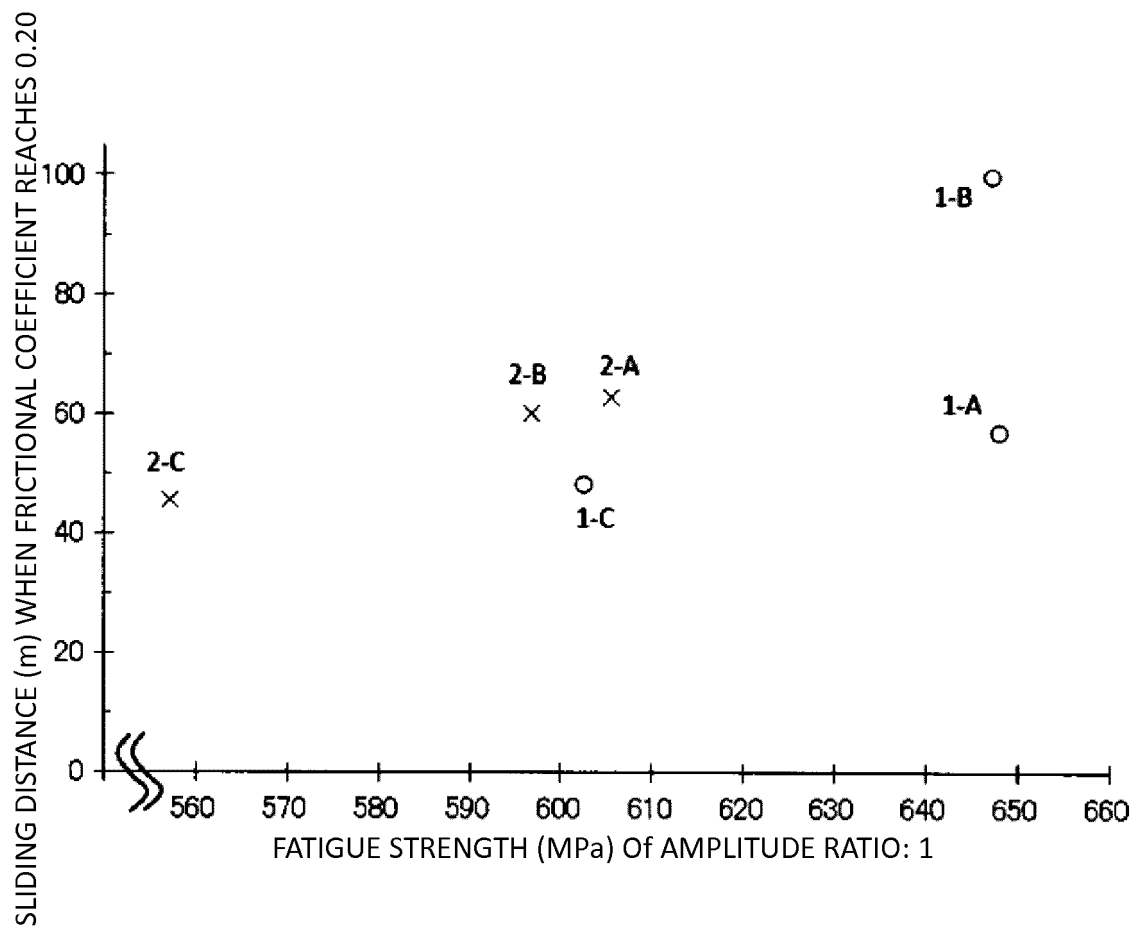


FIG.3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/059355

A. CLASSIFICATION OF SUBJECT MATTER

C22C38/00(2006.01) i, C22C38/60(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C22C38/00-C22C38/60Documentation 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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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 2007-2333 A (Hitachi Metals, Ltd.), 11 January 2007 (11.01.2007), paragraphs [0001] to [0002]; table 1, sample no. 1; fig. 3 (Family: none)	1-2
Y	JP 5-345958 A (Nikko Yozai Kogyo Kabushiki Kaisha), 27 December 1993 (27.12.1993), paragraph [0001]; table 1, no. 2 to 6 (Family: none)	1-2
Y A	JP 2003-113443 A (NKK Corp.), 18 April 2003 (18.04.2003), paragraph [0002] (Family: none)	2 1

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

* Special categories of cited documents:

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Date of the actual completion of the international search
08 June 2016 (08.06.16)Date of mailing of the international search report
21 June 2016 (21.06.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
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Patent documents cited in the description

- JP 2007002333 A [0003]