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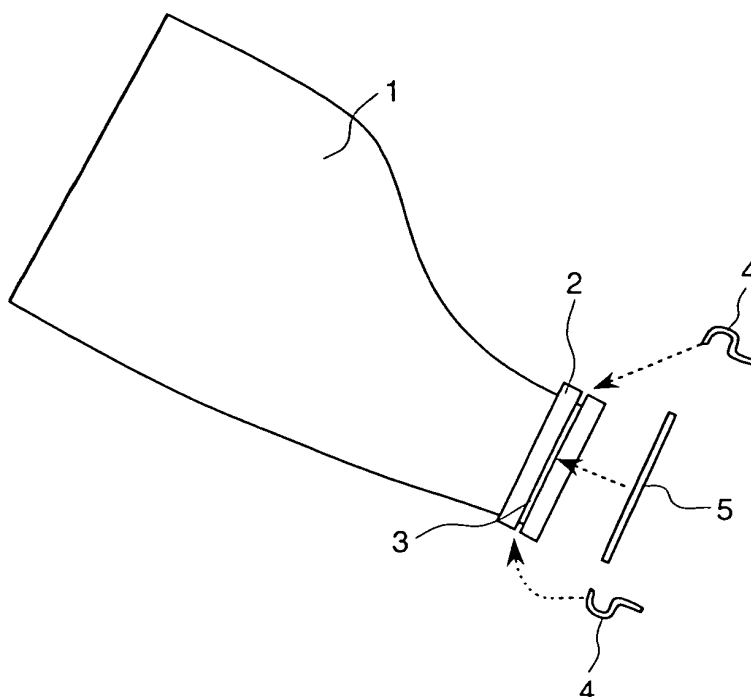
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(54) **High-temperature member for use in gas turbine**

(57) A high-temperature member for use in a gas turbine is formed from a cobalt-based alloy comprising 15-35 wt% of chromium; 0.02-1.5 wt% of silicon; 0.01-0.2 wt% of carbon; at least one kind of metal selected from the group consisting of niobium, tungsten, tantalum and rhenium, the total content of these four metals being controlled not to exceed 10 % by atomic ratio of the entirety of the alloy excluding carbon; and at least one metal selected from the group consisting of

nickel, manganese and iron, the total content of these metals being within a range of 1-9 wt%, the total content of nickel being controlled not to exceed 5 wt%, and the cobalt-based alloy having both of excellent resistance due to work hardening of the matrix and excellent ductility under room temperature. Then, in order to improve the high-temperature wear resistance, a pre-hardened layer is formed in the surface portion (8) of the member (3, 4) by shot peening.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

5 **[0001]** The present invention relates to a high-temperature member for use in a gas turbine. The member relating to the present invention is suitable for applying to a sealing plate for sealing a gap between a transition piece frame (picture frame) in a combustor and initial stage stationary blades of a turbine, or a sealing plate for sealing a gap between transition piece frames in the gas turbine having a plurality of combustors.

10 **[0002]** In the gas turbine under operation, vibration is caused resulting from high-speed rotation of its rotor, generation of combustion gas, flows of compressed cooling air, etc. This vibrational action may sometimes cause wear and damage at portions of high-temperature members constituting the gas turbine where the portions are in contact with other members by fitting or the like. Since it is necessary to use a wear resistant material for the member which would be worn and damaged, a material manufactured by dispersing hard particles such as carbide or boride particles in any one of a cobalt-based alloy, an iron-based alloy or a nickel-based alloy has been used. Therein, a technology using a cobalt-based alloy for gas turbine members is disclosed in Japanese Patent Application Laid-Open No. 6-240394 (JP6-240394A).

SUMMARY OF THE INVENTION

20 **[0003]** The conventional high-temperature wear resistant materials are poor in ductility because they contain a large number of hard particles. Consequently, there are problems in that they are hardly formed into a complex shape by machining or a sheet by rolling or pressing under room temperature, and accordingly, in that they have limitations in the shape of members into which they are made or the manufacturing process by which they are made into members. Although the member which has the complex shape can be made by reducing the amount of hard particles contained

25 in the wear resistant material, such an alloy is inevitably incomplete in the wear resistance.

[0004] An object of the present invention is to provide a cobalt-based alloy that sufficient wear resistance can be obtained even though the content of hard particles is reduced.

30 **[0005]** The inventors of the present invention studied on the conventional wear resistant cobalt-based alloys, and found that the wear resistance depends on the characteristics of the cobalt-based alloy matrix as well as the hard particles. That is, when a cobalt-based alloy is worn by sliding on another member under high temperatures, it suffers serious work hardening in its deformed sliding surface. Once the hard work-deformed layer is formed in the matrix under the sliding surface by this sliding action, this hard layer prevent further deformation and further abrasion of the material from then on. The work-formed layer associated with the work hardening lies in crystal phase transformation from hexagonal structure (low-temperature phase at 421 °C) to face-centered cubic structure (high-temperature phase). Therefore, by forming the work-deformed layer in the matrix of the cobalt-based alloy when a member is worn by sliding on another member, wear resistance and ductility of the alloy can be improved even if the content of hard particles is reduced.

35 **[0006]** It was also found that by adding an element such as chromium, molybdenum, niobium, tungsten, tantalum, rhenium, silicon or germanium (hereinafter, referred to as "Group 1") to the cobalt-based alloy, the hard work-deformed layer is easily formed in the matrix when the work hardening is given. On the other hand, it was also found that incorporation with an element such as nickel, manganese, iron or carbon (hereinafter, referred to as "Group 2") weakens the work hardening characteristics to make it difficult to form the work-deformed layer.

40 **[0007]** Based on the above-described knowledge, the inventors of the present invention found out a cobalt-based alloy which comprises a composition of 15-35 wt% of chromium; 0.02-1.5 wt% of silicon; 0.01-0.2 wt% of carbon; at least one kind of metal selected from four refractory metals including 0.3-8 wt% of niobium, 1-20 wt% of tungsten, 1-10 wt% of tantalum and 0.3-10 wt% of rhenium, the total content of said four refractory metals being controlled not to exceed 10 % by atomic ratio of the entirety of said alloy excluding carbon; at least one metal selected from the group consisting of nickel, manganese and iron, the total content of said metals being within a range from 1 to 9 wt%, the total content of nickel being controlled not to exceed 5 wt%; and the balance being cobalt and inevitable impurities. In addition, in the cobalt-based alloy, it is necessary that the total content of the above-described four kinds of refractory metals is controlled so as not to exceed 10 % by atomic ratio of the entirety of the alloy excluding carbon, and that the content of nickel is controlled so as not to exceed 5%.

45 **[0008]** The cobalt-based alloy may further contain molybdenum within a range from 0.5 to 12 wt%. Here, the number of the kinds of refractory metals becomes five by adding molybdenum to the above-described four kinds of refractory metals. In this case of further containing molybdenum, it is preferable that the total content of the five refractory metals is controlled so as not to exceed 10 % by atomic ratio of the entirety of the alloy excluding carbon.

50 **[0009]** Further more, the cobalt-based alloy in accordance with the present invention may contain germanium within a range of 0.1 -4 wt%.

[0010] The cobalt-based alloys according to the present invention excel in ductility because they contain a very small amount of carbon to suppress forming of carbide particles. As the result, they can be easily formed into a sheet or a complex shaped member through rolling or pressing under room temperature.

[0011] In a case where a pre-hardened layer is formed through shot peening on a surface, particularly on a surface sliding on another member, of a gas turbine member made of the above-described cobalt-based alloy, it has been found that the wear resistant characteristics are improved by leaps and bounds.

[0012] Despite the fact that pure cobalt undergoes phase transformation from hexagonal structure (low-temperature phase) to face-centered cubic structure (high-temperature phase) at 421°C, as described above, the matrix of most cobalt-based alloys in practical use takes on the face-centered cubic structure under room temperature because alloying prevents phase transformation to hexagonal structure.

[0013] Although metal under force is generally subject to slip deformation due to dislocation of lattice defects, metal of face-centered structure experiences wider dislocation and hence narrower cross slip, which leads to work hardening. When dislocation in face-centered metal expands, the resulting part has an atomic arrangement identical to that of hexagonal structure. Therefore, the property that a cobalt-based alloy changes into hexagonal structure at low temperatures facilitates expansion of dislocations and decreases cross slip, thereby promoting work hardening. In the high-temperature member in accordance with the present invention, outstanding high-temperature wear resistance is exhibited by optimizing the alloy composition so as to effectively exert the work hardening property which the cobalt-based alloy intrinsically has.

[0014] In a surface of a high-temperature member in accordance with the present invention, the surface sliding on another member, local deformation is caused in the surface of the member at the initial sliding period, and large compression stress due to work hardening is accumulated. Most part of residual stress due to the work hardening is accumulated in a region from the surface of the member to a depth of 200 μm . On the other hand, in the high-temperature member in accordance with the present invention, relief of work strain due to heat treatment is usually performed after machining and forming into an actual product shape, but at that time there exists no residual strain in the surface of the member in its unused state. Therefore, in order that the high-temperature member in accordance with the present invention exerts resistance against wear and damage, it is necessary to accumulate compression stress caused by a certain amount of deformation.

[0015] Magnitude of the compression stress accumulated in the work hardening layer in the surface of sliding portion is slightly different spot by spot depending on difference in micro-structure of the alloy, particularly depending on size of the crystal grain and orientation of the crystal grain. As the result, local dents and micro-cracks are produced in part of the slide portion, and wear and abrasion are sometimes accelerated starting from the dents and the cracks. As a method of preventing the local deterioration of the work-hardened layer, it is effective to form pre-hardened layer by performing shot peening treatment to the surface of the member before using. In a case where the surface is pre-hardened, large compression stress is accumulated to make the surface of sliding portion smoother even if deformation at the initial period of sliding is small. As the result, the local deterioration of the work-hardened layer is prevented, and accordingly the wear resistant characteristic of the high-temperature member is improved.

[0016] In order that better high-temperature wear resistance is exerted by the work hardening characteristic and forming of the pre-hardened layer, chemical composition of the alloy is important. Effect of each element in the cobalt-based alloy in accordance with the present invention will be described below. Incidentally, in the present specification, the amount of element added is expressed in terms of per cent by weight, unless otherwise specified.

[0017] Chromium improves wear resistance due to work hardening, and improves oxidation resistance by forming a stable chromium oxide protective film on the alloy surface under atmosphere at high temperatures. In order to produce these effects, it is necessary that the amount of chromium should be at least 15 %. However, an excess amount more than 35 % is not desirable because it precipitates a harmful phase to make the alloy brittle. A more appropriate amount of chromium is in the range from 18 to 30 %.

[0018] Addition of refractory metal elements of tungsten, niobium, tantalum and rhenium improves wear resistance by promoting work hardening, and increases high-temperature strength through solid solution strengthening. These four kinds of elements may be added alone or in combination with one another. However, in the case where one or more kinds of these elements are added, it is preferable that the total amount of the four elements should not exceed 10 % by atomic ratio to the entirety of the alloy elements excluding carbon because harmful compounds are formed to make the alloy brittle.

[0019] In a case of adding tungsten alone, it is preferable that the content of tungsten does not exceed 20 %, because harmful phase is produced if the content exceeds 20 %. Further, in the case of adding tungsten alone among five kinds of refractory metal elements including molybdenum, it is preferable that the content of tungsten exceeds 2 % in order to exert the effect of adding tungsten. A preferable content of tungsten is within a range from 3 to 18 %. In a case of adding tungsten together with at least one kind of refractory metal elements consisting of niobium, tantalum and rhenium, a lower-limit content of tungsten may be 1 %.

[0020] In a case of adding niobium alone, the desirable effect is small when added in an amount of 1 % or less, and

harmful phase is formed to make the alloy brittle when added in an amount exceeding 8 %. Therefore, a preferable amount of niobium is in a range from 0.5 to 8 %. A more preferable amount of niobium is in a range from 1 to 6 %. In a case of adding niobium together with at least one kind of refractory metal elements consisting of tungsten, tantalum and rhenium, a preferable content of niobium is 0.3 % or more.

[0021] In a case of adding tantalum alone, the desirable effect is small when added in an amount of 1 % or less, and harmful phase is formed to make the alloy brittle when added in an amount exceeding 10 %. Therefore, a preferable amount of niobium is in a range from 1 to 10 %. A more preferable amount of tantalum is in a range from 2 to 8 %. In a case of adding tantalum together with at least one kind of refractory metal elements consisting of tungsten, niobium and rhenium, a preferable content of tantalum is 0.3 % or more.

[0022] In a case of adding rhenium alone, the desirable effect is small when added in an amount of 0.3 % or less, and material cost is increased when added in an amount exceeding 10 %. Therefore, a preferable amount of rhenium is in a range from 0.5 to 7 %. In a case of adding rhenium together with at least one kind of refractory metal elements consisting of tungsten, niobium and tantalum, a preferable content of rhenium is 0.3 % or more.

[0023] Addition of molybdenum improves wear resistance by promoting work hardening, and increases high-temperature strength through solid solution strengthening. The desirable effect is small when molybdenum is added in an amount of 0.5 % or less, and harmful phase is formed to make the alloy brittle when molybdenum is added in an amount exceeding 12 %. Therefore, a preferable amount of molybdenum is in a range from 0.5 to 12 %. Further, when the total amount of the five kinds of refractory metals including molybdenum exceeds 10 % by atomic ratio to the entirety of the alloy elements excluding carbon, harmful compounds are formed to make the alloy brittle. Therefore, it is preferable that the total amount of added refractory metal elements does not exceed 10 % by atomic ratio.

[0024] Addition of silicon contributes to improvement of work hardening by lowering stacking fault energy, and, at the same time, improvement of productivity by lowering the melting point of the resultant material. The desirable effect is small when silicon is added in an amount of 0.02 % or less, and ductility of the resultant material is lowered when silicon is added in an amount exceeding 1.5 %. Therefore, a preferable amount of silicon is in a range from 0.02 to 1.5 %.

[0025] Similarly to silicon, germanium contributes to improvement of work hardening and improvement of productivity by lowering the melting point of the resultant material. The desirable effect is small when germanium is added in an amount of 0.1 % or less, and strength of the resultant material is largely lowered when germanium is added in an amount exceeding 4 %. Therefore, a preferable amount of germanium is in a range from 0.1 to 4 %. A more preferable amount of germanium is in a range from 0.2 to 2.5 %.

[0026] Addition of nickel, manganese and iron suppresses work hardening of the matrix of cobalt-based alloy to lower the wear resistance of the alloy. When the total amount of these three elements exceeds 9 % by weight, the high-temperature wear resistance is largely decreased. Therefore, the content of these three elements exceeding this value should be avoided. On the other hand, when the total amount of these three elements is 1 % or less, ductility of the resultant alloy is largely decreased. Therefore, the total amount of these three elements should be in a range from 1 to 9 %. It is preferable that the total amount of these three elements should be in a range from 2 to 7 %.

[0027] Nickel improves ductility as well as high-temperature strength. However, content of nickel exceeding 5 % decreases the wear resistance of the alloy. The desirable amount of nickel is in a range from 0.2 to 5 %, and preferably, in a range from 0.5 to 4 %.

[0028] Manganese and iron improve the ductility of the alloy. However, the wear resistance is deteriorated when the content of each of metal elements exceeds 5 %. Therefore, each of the content is preferably in 5 % or less. On the other hand, they hardly produce the desired effect when content of each of the metal elements 0.2 % or less. The preferable contents of manganese and iron each range from 0.5 to 4 %.

[0029] Addition of a trace amount of carbon is necessary to strengthen the grain boundaries of alloy and to improve the ductility of alloy. An amount of carbon not more than 0.01 % is not enough to produce the effect of strengthening the grain boundaries. On the other hand, an amount exceeding 0.2 % lowers the ductility and deteriorates the work hardening characteristics due to increase of carbides. Therefore, an amount of carbon is preferably in a range from 0.05 to 0.15.

[0030] A high-temperature member for use in a gas turbine in accordance with the present invention can be produced through a manufacturing method to be described below. The process starts with preparation of an ingot by melting a cobalt-based alloy having a specified composition under a vacuum. Next, the ingot undergoes pressing or rolling or the both in a temperature range of 1100-1230 °C. Then, the ingot undergoes solution heat treatment for homogenization of composition and relief of residual stress. Further, the solution heat treatment may be followed by somewhat work under room temperature or high temperature in order to adjust the product shape.

[0031] After forming into the final product shape, shot peening is performed to a portion to be in contact with another member, the portion expects to be worn and damaged. In the cobalt-based alloy in accordance with the present invention, a hardened layer produced through the shot peening is preferably formed in a range from the surface to a depth of about 200 μm. There is a tendency that hardness of the hardened layer increases as approaching to the surface.

Vickers hardness (HV) of the alloy after solution heat treatment in accordance with the present invention is about HV 300. Therefore, it is preferable that a treatment condition of the shot peening is set so that the maximum hardness may become HV 400 or higher within a range from the surface to a depth of 100 μm .

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

Fig. 1 is a side view showing the shape of a transition piece and a state of attaching a sealing plate to a frame portion.

Fig. 2 is a front view showing the transition piece and the state of attaching a sealing plate to the frame portion seeing from the exit side.

Fig. 3 is a cross-sectional view showing the transition piece and the state of attaching a sealing plate to the frame portion.

DESCRIPTION OF REFERENCE CHARACTERS

[0033] 1...transition piece main body, 2...frame, 3...frame sealing groove, 4 and 5...sealing plate, 6...first stage stationary blade, 7...stationary blade sealing groove, 8...sliding portion of sealing plate

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiment 1

[0034] Table 1 shows the chemical composition of the cobalt-based wear-resistant alloys which are prepared.

Table 1

(unit: wt%)

Sample	Co	Cr	Mo	Nb	W	Ta
No.1	Bal.	19.88	5.33	4.20	-	-
No.2	Bal.	20.13	3.94	-	9.68	-
No.3	Bal.	19.61	5.18	-	-	5.22
No.4	Bal.	19.85	3.81	-	4.37	-
No.5	Bal.	19.47	-	-	15.22	-
No.6	Bal.	20.05	-	-	9.92	-
No.7	Bal.	20.71	-	3.56	10.16	-
No.8	Bal.	19.45	-	-	9.43	5.73
Comparative	Bal.	20.38	-	-	14.84	-

Re	Ge	Ni	Mn	Fe	Si	C
-	-	2.66	0.49	1.02	0.56	0.10
-	-	2.38	0.43	0.95	0.47	0.09
-	-	2.40	0.60	0.89	0.52	0.11
6.20	-	2.59	0.52	0.98	0.40	0.09
-	-	2.52	0.57	1.15	0.58	0.09
-	2.15	2.55	0.48	1.08	0.51	0.10
-	-	2.68	0.63	0.88	0.38	0.08
-	-	2.73	0.42	1.12	0.44	0.09
-	-	10.32	0.92	0.92	0.43	0.10

[0035] For the alloys in accordance with the present invention and a comparative material, each ingot was prepared by melting a raw material adjusted to the specified chemical composition, and the ingot was forged several times, and then the forged ingot underwent solution heat treatment at 1200 °C for 2 hours to obtain each test sample. Observations on fine structure revealed that all the alloys have the additive elements almost uniformly dissolved in the cobalt matrix, and that chromium micro-carbides were precipitated inside the matrix. It was also revealed that carbides bonding to niobium or tantalum were found in the test samples Nos. 1, 3, 7 and 8 which niobium or tantalum was added to.

[0036] Wear resistance tests under high temperatures were carried out by sampling test pieces from the produced

alloy materials. The test pieces in a form of sheet and the test pieces in a form of pin with a knife-edge tip in combination with each other were used. The wear test method performed was that the flat part of the sheet-form test piece was arranged so as to be in vertically contact with the edge of the fixed pin-form test piece, and a load was applied to the back sides of the sheet-form test piece, and then the sheet-form test piece was vibrated back and forth in a direction vertical to the direction of the load. Hereinafter, the vibrated sheet-form test piece is referred to as "mobile piece", and the fixed pin-form test piece is referred to as "stationary piece". The stationary piece used for the test was sharpened so that the edge tip had a radius of curvature of 0.2 mm. The load applied to the movable piece was 5 kg, and the conditions of the back and forth vibration were a frequency of 100 Hz and an amplitude of 1.0 mm. The tests were carried out under atmosphere at a test temperature of 700 °C for a test period of 5 hours.

[0037] The stationary piece and the movable piece in combination with each other used in the test were made of the same kind of alloy. As to the sheet formed test piece, a movable piece, which had the work hardened layer in its slide surface formed through shot peening after solution heat treatment, was made in order to compare a wear amount with a wear amount of a movable piece without shot peening. An apparatus of air blast type was used as the shot-peening apparatus, and the shots used were made of steel. Evaluation of the amount of wear after the test was performed by measuring a profile of the slide surface shape of the movable piece using a surface roughness measuring apparatus, and then by comparing characteristics among the alloys taking the maximum abraded depth in the worn portion as the abraded amount due to wear.

[0038] Table 2 shows the results of measured abraded amount after carrying out the wear tests at 700 °C using the alloys in accordance with the present invention and the comparative alloy.

Table 2

(unit: μm)			
Sample	As Received (A)	After Shot Peening (B)	B/A
No. 1	66	40	0.61
No. 2	57	29	0.51
No. 3	53	37	0.70
No. 4	49	20	0.41
No. 5	37	24	0.65
No. 6	63	35	0.56
No. 7	65	47	0.72
No. 8	54	34	0.63
Comparative piece	135	124	0.92

Test conditions:

Amplitude: 1.0 mm
Frequency: 100 Hz
Load: 5 kgf

[0039] Each numeric number in the column of As Received (A) of Table 2 shows an amount of wear of the wear test result using each movable test piece in a state after the solution treatment. The values of wear amount of the present-invention alloys Nos. 1-8 are within a range of 30-70 μm , but the value of wear amount of the comparative test piece is 135 μm which is 2 or 3 times as large as the values of wear amount of the test pieces made of the developed alloys. On the other hand, each numeric value in the column of After Shot Peening (B) shows an amount of wear of the wear test result using each movable test piece in a state after the shot peening treatment. The values of the amounts of wear for all the alloys of After Shot Peening (B) are reduced comparing to the values of As Received (A). Therefore, the effect of improving the wear resistance due to shot peening can be verified.

[0040] Each numeric value in the right-hand end column of Table 2 shows a value of dividing the wear amount of After Shot Peening (B) by the wear amount of As Received (before peening) (A) for each alloy. It shows that the smaller this value, the more the wear resistance due to shot peening is improved. All the values of B/A for the alloys in accordance with the present invention are about 0.7 or less. However, the value of B/A for the comparative material is 0.92 which is larger than the values for the alloys in accordance with the present invention. That is, improving effect of shot peening for the comparative material is smaller. As described above, it can be understood that the alloys in accordance

with the present invention even in the state after solution treatment (in the as-received state) show excellent wear resistance at 700 °C compared to the comparative material, and that the effect of improving the wear resistance by performing shot peening is also large compared to the effect for the comparative material.

[0041] Each of all the alloys in accordance with the present invention No. 1 to No. 8 can be easily formed into a thin plate of 2 mm thickness without any damage such as producing cracks by pressing under a high temperature or room temperature, or repeating rolling and heat treatment several times. Thereby, it is verified that the alloys in accordance with the present invention have good workability and good formability.

Embodiment 2

[0042] Fig. 1 and Fig. 2 show a cylindrical member called as a transition piece for introducing high temperature gas ignited in a gas turbine combustor liner to a turbine portion. The transition piece main body 1 has a round gas entrance opening in the front side so as to engage with the combustor liner and a square gas exit opening in the back side. Sealing plates 4 and 5 for sealing the high temperature gas are attached on the side surfaces of a portion called as a rectangular frame 2. The sealing plate 4 is for connecting a gas turbine first stage stationary blade 6 shown in Fig. 3 and the frame 2 together. The sealing plate 5 is for connecting transition piece frames together. The sealing plate 5 is flat-plate shaped, but an end portion of the sealing plate 4 for connecting the gas turbine first stage stationary blade and the frame is bent by pressing work. One end of the sealing plate 4 is engaged with a stationary blade sealing groove 7, and the other end is engaged the frame by hooking the bent portion of the sealing plate into a frame sealing groove 3. Fig. 3 shows the cross-sectional structure of the state that the sealing plate 4 is attached to the frame 2 and the first stage stationary blade 6. Wear and damage will mainly occur on the surface of the sealing plate 5 and on the inside surface of bent portion of the sealing plate 4 shown in Fig. 2.

[0043] The sealing plates 4 and 5 were produced using the cobalt-based alloy No. 5 shown in Table 1. These sealing plates were produced through the process of forming the product shapes by cold pressing after forging and solution treatment; performing heat treatment at 1100 °C in order to release stress; and then performing shot peening to a slide portion 8 of the sealing plate. The result of combustion tests with an actual gas turbine showed that the sealing plates produced from the existing cobalt-based alloy suffered abrasion due to wear on the surface of the plate 5 and on the inside surface of the bent portion of the plate 4. Whereas, regarding all the sealing plates produced from the individual cobalt-based alloys according to the present invention, the abrasion depths due to wear were decreased to 1/3 to 1/4 of the abrasion depths of the plates produced from the existing cobalt-based alloy. Thus it was verified that application of the cobalt-based alloys having the pre-hardened layer in accordance with the present invention is very effective at reducing wear and damage in gas turbine combustors.

[0044] According to the present invention, the excellent wear resistance under a high-temperature environment can be achieved. By applying the high-temperature members in accordance with the present invention, wear and damage of the high-temperature members during gas turbine operation can be reduced.

Claims

1. A high-temperature member for use in a gas turbine, said member (4, 5) being formed from a cobalt-based alloy which comprises 15-35 wt% of chromium; 0.02-1.5 wt% of silicon; 0.01-0.2 wt% of carbon; at least one kind of metal selected from four refractory metals including 0.3-8 wt% of niobium, 1-20 wt% of tungsten, 1-10 wt% of tantalum and 0.3-10 wt% of rhenium, the total content of said four refractory metals being controlled not to exceed 10 % by atomic ratio of the entirety of said alloy excluding carbon; at least one metal selected from the group consisting of nickel, manganese and iron, the total content of said metals being within a range of 1-9 wt%, the total content of nickel being controlled not to exceed 5 wt%; and the balance being cobalt.
2. High-temperature member according to claim 1, **characterized in that** said member (3, 4) having a hardened layer formed by shot peening at least in a surface portion (8) in contact with another member.
3. High-temperature member according to claim 1 or 2, **characterized in that** said alloy further comprises 0.5-12 wt% of molybdenum, and the total content of the five kinds of molybdenum, niobium, tungsten, tantalum and rhenium is controlled so as not to exceed 10 % by atomic ratio of the entirety of said alloy excluding carbon.
4. High-temperature member according to at least one of claims 1 - 3, **characterized in that** said alloy further comprises 0.1-4 wt% of germanium.

FIG. 1

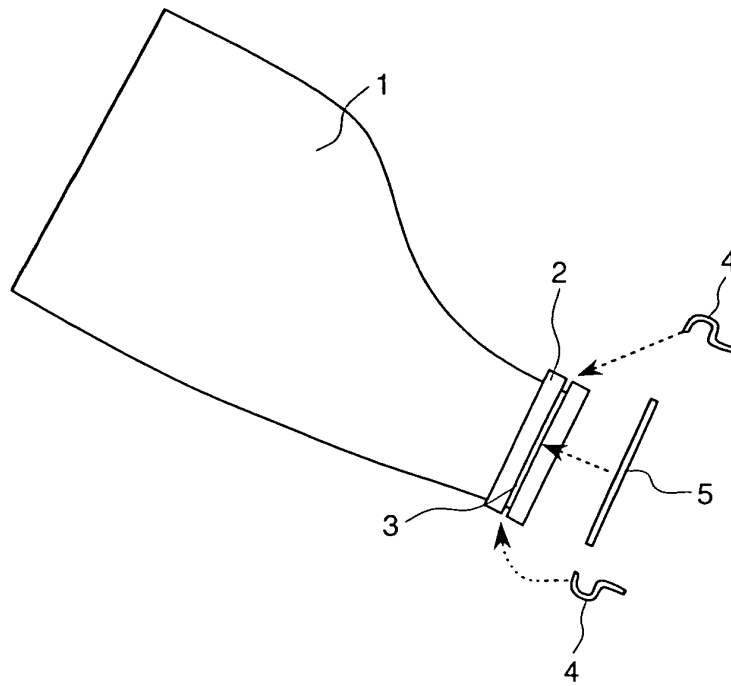


FIG. 2

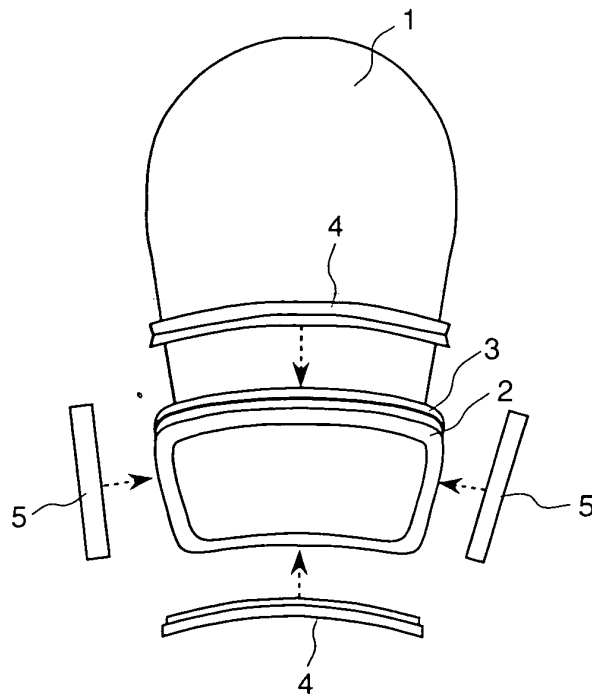
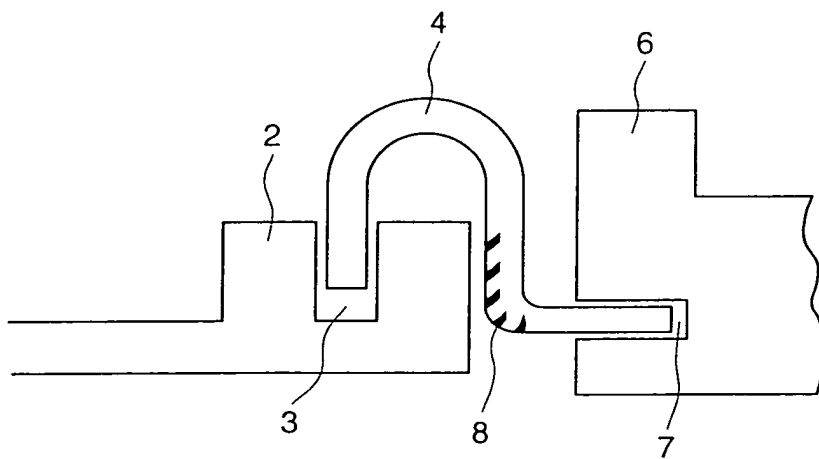


FIG. 3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 8928

DOCUMENTS CONSIDERED TO BE RELEVANT			
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