



(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification :
14.06.95 Bulletin 95/24

(51) Int. Cl.⁶ : **F01L 3/02**

(21) Application number : **92904041.8**

(22) Date of filing : **22.01.92**

(86) International application number :
PCT/DK92/00021

(87) International publication number :
WO 92/13179 06.08.92 Gazette 92/21

(54) **VALVE WITH HARD-FACING.**

(30) Priority : **23.01.91 DK 110/91**

(43) Date of publication of application :
10.11.93 Bulletin 93/45

(45) Publication of the grant of the patent :
14.06.95 Bulletin 95/24

(84) Designated Contracting States :
CH DE GB LI NL

(56) References cited :
EP-A- 0 325 760
EP-B- 0 073 685
DE-C- 970 509
NL-C- 150 611
SE-B- 422 338

(56) References cited :
US-A- 3 795 509
US-A- 4 727 740
PATENT ABSTRACTS OF JAPAN, Vol. 8, No.
93, C220, Abstract of JP 59009146, publ 1984-
01-18 (MITSUBISHI KINZOKU K.K.).

(73) Proprietor : **MAN B & W DIESEL A/S**
41 Teglsømsgade
DK-2450 Copenhagen SV (DK)

(72) Inventor : **HOEG, Harro**
Hesselrodevej 13
D-2980 Kokkedal (DK)

(74) Representative : **Indahl, Peter Jensen et al**
c/o Internationalt Patent-Bureau
Hoeje Taastrup Boulevard 23
DK-2630 Taastrup (DK)

EP 0 568 598 B1

Note : Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Description

Technical Field

5 The invention relates to a valve, in particular an exhaust valve for an internal combustion engine, comprising a movable valve member with a valve seat area of a nickel-base metallic alloy.

The chosen material composition of the valve seat area in exhaust valves for combustion engines has for many years been playing a great role as regards the reliability of operation of the engine concerned and as regards the lifetime of the exhaust valves and thus the extent of the necessary maintenance work.

10 In a combustion engine the combustion in the working cylinder generates coking residues consisting of hard particles to be carried off through the exhaust valve, in which the particles now and then get jammed between the closing valve seats which might lead to dent marks in the seat faces. Said marks may at first in a well known manner provoke a local leak and then a larger throughburning with a corrosional deterioration of the seat faces.

Prior Art

It is desirable that the valve seat material has a sufficient hardness to diminish or impede the formation of dent marks. In large heavy fuel oil combustion diesel engines attempts have been made during recent years 20 to produce the valve seat area from the nickel-base hard-facing material Alloy 50 which as the most important alloying components contain approximately 12% Cr, 3.9% Si, 2.9% Fe, 2.25% B and 0.5% C. Besides the desired hardness, Alloy 50 presents a high-temperature corrosion resistance to the strongly corroding environment which an exhaust valve in a heavy fuel oil diesel engine is exposed to. In engines with large cylinder bore, e.g. 600 to 900 mm, in which in addition to a good corrosion resistance ability heavy demands are made on 25 the mechanical strength of the applied materials, operation experience has shown that in certain cases radial cracks occur in the hard-facing material Alloy 50, thereby entailing throughburning of the seat or initiating the growth of dangerous circumferential cracks. With the view of eliminating the risk of damage the more ductile hard-facing material Stellite 6 is used for such engine sizes, i.e. a cobalt-base alloy which in the actual environment has turned out to have a smaller high-temperature corrosional resistance than Alloy 50, which leads 30 to shorter in-service intervals between each inspection of the valve condition.

It is well known that the hardness of the hard-facing material decreases at rising temperatures. Thus, Stellite 6 has a hardness of about 370 HB at room temperature and about 298 HB at a temperature of 500°C, and at corresponding temperatures the hardness of Alloy 50 decreases from about 530 HB to 420 HB.

It is likewise well known that particularly the hitherto known Ni-base hard-facing materials with high hardness 35 generally have a poor or no ductility and thus poor fatigue strength properties.

In hitherto known Ni-base alloys the desired hardness is preferably obtained by adding the constituents of B, Si and C. In particular the metal borides in the structure of said alloys have due to their size and configuration resulted in a very poor ductility of the hard-facing with the risk of crack formation already during welding or after shorter or longer working cycles.

40 In case the B-content has been reduced in or completely left out from the analysis it has been necessary to increase the C-content in order to enhance the hardness of the alloy by means of comprehensive carbide precipitations, resulting in that the precipitated carbide network likewise reduces the ductility to a considerable degree.

It is a common feature of the mentioned prior art nickel-base alloys that it is necessary to provide the alloy 45 with a very considerable hardness and thus brittleness at room temperature in order to obtain a high hardness at working temperatures about 500°C.

The valve mentioned in the introduction of the description is inter alia known from the disclosure of JP-A-59-9146 (Kokai) dealing with a valve of a nickel alloy in which the Al-content is less than 4.5% in order to allow welding of the alloy. The alloy content of Ti, W and Mo in combination with a C-content of more than 0.55% 50 makes it possible to enhance the hardness of the alloy by the precipitation of carbides. The disclosed B-content of up to 2% may further considerably contribute to enhance the hardness. However, there will be a variation in the micro hardness of the alloy, because the very hard carbides and borides precipitate in a comparatively soft matrix phase and as mentioned above the carbide network may as well reduce the ductility.

The disclosure of US-A-3,795,510 relates to a nickel alloy containing 20% Cr, 5.5% Al, 2.5% Ti, 7.5% Fe 55 and 0.15% C. The valve proper is produced by friction welding a ready-made blank of nickel alloy on the remaining valve part consisting of carbon steel. The alloy is not weldable in a common manner and the hardness is inferior to the hardness aimed at by the present invention.

The Invention.

The object of the invention is to provide a valve with a hard-facing material that may be used for any size of engine and which combines a good high-temperature corrosion resistance to the combustion products with a high hardness at temperatures up to 500°C concurrently with preserving sufficient ductility to allow the application in mechanically highly loaded, cyclically operated valves.

With a view hereto, the initially mentioned valve is, according to the invention, characterized in that the nickel-base alloy, stated in % by weight and apart from generally occurring impurities, includes 20 to 24% Cr, 0 to 8% W, 4 to 7% Al, 0.2 to lower than 0.55% C, 0 to 1.8% Hf, 0 to 1.5% Nb, 0 to 8.0% Mo, 0 to 1.2% Si and 0 to 15% Fe, wherein the W-content and the Mo-content add up to no more than 10%.

It has now surprisingly turned out that an alloy of this type possesses the desired properties. It has previously been generally accepted that a welded nickel-alloy with said high content of Al presents an extreme heat cracking tendency in the weld metal together with crack formation in the heat affected area in multilayer welding. Thus, Ni-Cr alloys with more than 3 to 4% Al are described in literature as being non-weldable.

The weldability of the Ni-Cr-Al-C alloy according to the invention with the mentioned Al-content allows the utilization of the precipitation-hardening mechanism in this type of alloy, whereby the intermetallic phase Ni_3Al (γ') is precipitated as a coherent hardness increasing phase in the ductile nickel-matrix (γ). The γ' -phase may be precipitated in an structural amount of as much as 45% and preferably at least 20% in the basic γ -structure so as to obtain a material with the desired high strength and hardness, the strength and hardness being by and large constant in the temperature interval of 20 to 600°C covering the temperature interval that a normally working exhaust valve is exposed to.

The Cr-content of the alloy contributes to a considerable degree to fulfilling the requirement that the alloy must be highly corrosion-resistant in the actual environment in which sulphur compounds play a substantial role. The Al-content leads to the formation of a combined Al_2O_3 and Cr_2O_3 surface layer on the valve seat which offers an enhanced corrosion resistance which is particularly improved at temperatures of 750°C and more. Said improved corrosion resistance prevents in particular a rapid deterioration of the valve seat in case a leakage should occur over the seat as a consequence of the occurrence of dent marks, which leakage may locally result in surface temperatures that are substantially higher than the general working temperature of the valve.

The Cr-content further has a solution-strengthening effect contributing to increase the strength of the alloy. The solution-strengthening effect may further be promoted by adding Mo and W which are interchangeable. The total content of W and Mo must not exceed 10%, since the carbide configuration of the alloy would otherwise be negatively affected.

The final determination of the hardness of the alloy is effected by regulating the C-content, thereby influencing the amount and configuration of the carbide precipitations. If the C-content is less than 0.2% the desired hardness cannot be obtained and in case the C-content exceeds 0.55% the desired ductility is difficult to obtain. It has turned out that an alloy with a C-content in the range between 0.3 and less than 0.55% offers a combination of hardness and ductility that is advantageous for use as valve material.

Contrary to the Ni, Cr, B and Si hard-facing alloys commercially available it has further been possible to make use of the alloy according to the invention in the manufacture of Hot Isostatic Pressure (HIP) compound exhaust valves, because the solidus temperature of the alloy is close to the solidus temperature of the valve base material, this being a prerequisite of utilizing the HIP-process.

The ductility of the alloy is to a high degree affected by the carbide configuration and in particular needle-shaped and flakelike carbide precipitations influence the ductility in the negative direction. As regards the actual alloy it has been ascertained that the tendency to form disadvantageous carbide configurations of the type called "chinese script" is rising in step with increasing C-content and for that reason the C-content should not exceed 0.6%.

It has been found that the carbide configuration may be positively affected by the addition of Hf in amounts from 1 to 2%. By the addition of Hf the carbide configuration changes from flakelike and needle-shaped carbides into more rounded forms which do not to the same degree attenuate the ductility of the alloy. Unexpectedly, it has turned out, however, that in case the carbon content exceeds 0.5%, the carbide precipitation is affected only to a limited extent by the addition of Hf, and in this case the C-content may therefore conveniently be adjusted to 0.35 to 0.50%.

Moreover, it has surprisingly been ascertained that the structure of the alloy, in particular as regards slowly solidifying melts, presents an enhanced hardness, provided Nb be added in an amount not exceeding 1.5%, which is probably due to the fact that Nb increases the amount of carbide precipitations and/or alters the carbide composition. It has concurrently been ascertained that by the addition of Nb to the alloy an altered carbide configuration occurs in the form of finely dispersed metal carbides that are supposed to exert a positive influence on the ductility of the alloy.

When the valve seat area is applied by welding, Si may be added to the alloy to improve the welding properties due to the deoxidating effect of silicium. The Si-content may appropriately be fixed to 0.8 to 1.2%. However, it has surprisingly turned out that said Si-content causes the formation of an Al, Si, Cr and probably C rich eutecticum, when the Al-content exceeds 5 to 5.5%. Since it has unexpectedly turned out that said eutecticum is substantially less corrosion-resistant than the remaining structural elements of the alloy, it is desirable to confine the phase-amount of said eutecticum to no more than about 5%.

The valve member proper carrying the valve seat area is generally made from an austenitic stainless steel alloy. When the valve seat area is applied by welding, there will occur a slight mixing of the steel alloy into the nickel-base filler material, thereby adding by mixture, particularly in the first applied weld layer, an amount not exceeding 15% of Fe.

Fe in amounts of no more than 20% may have a strengthening effect in the γ -phase, but at the same time the corrosion resistance is reduced. Already at a Fe-content of 5% there is a risk of deteriorated corrosion properties, and it should therefore be aimed at obtaining that the Fe-content in the finally welded layer or in the vicinity of the surface of the valve seat area does not exceed 10%, and preferably is less than 5%.

In the area close to the surface of the valve the alloy should advantageously comprise at least 55% Ni, because lower Ni-content may lead to attenuating the precipitation-hardening and thus to reducing the hardness of the alloy.

As mentioned above, the hardness of the alloy is obtained by a combination of the precipitation-hardening in which the high Al-content of the alloy entails an increase of hardness of the Ni-base material itself (Ni-matrix), which hardness is kept at high-temperatures, and a precipitation of carbides in the base material proper. In order to preserve a favourable carbide configuration the alloy should, in addition to the stated Cr-content, comprise a certain minimal content of carbide formers. It is therefore advantageous that the content of Hf, Nb, W and Mo amounts to at least 5%.

Brief Description of the Drawings.

Various examples of the invention will now be described in detail partly with reference to the drawings, in which Figs 1 to 4 illustrate photographs, enlarged 320 times, of ground and polished samples of four different alloys according to the invention.

Preferred Embodiments.

EXAMPLE 1

With the view of obtaining a basis of comparison between the alloy according to the invention and previously known valve seat alloys, there were produced four pieces of geometrically identical valve spindle blanks in the form of a valve head of austenitic stainless steel with a diameter of D=250 mm. After preheating of the spindle members the four different alloys were welded each to a respective blank by means of plasma welding with transferred arc and the following weld parameters:

Grain size of welding powder:	50-150 μ m
Deposit yield :	1,7 kg/hour
Welding current :	120 A
Welding velocity :	approx. 60 mm/hour

The weld seam was built by three layers and had a depth of 8 mm and a width of 25 mm with seam side angles of 60°.

The approximate analysis of the produced alloys appears from Table 1 in which Stellite 6 and Alloy 50 are mentioned above and the alloy labelled BW1-50 is likewise a commercially available nickel alloy whereas the alloy labelled I-1 is an alloy according to the invention.

TABLE 1
Composition in % by weight

	C	Si	B	Cr	Fe	Ni	W	Mo	Al	Other
Stellite 6	1.14	1.06	-	28.5	0.43	-	4.65	-	-	balance Co
Alloy 50	0.46	3.9	2.25	10.78	2.88	balance	-	-	-	-
BW 1-50	0.49	6.99	0.92	19.30	3.5	balance	1.75	-	-	-
I-1	0.51	1.02	-	23.05	0.23	balance	7.1	-	5.63	0.43Y

After welding the weld seam surfaces were turned and checked of defects by capillar testing.

The blanks were subsequently placed in an oven and heated to 250°C, following which they were quenched in a water bath at a temperature of about 40°C. The blanks were visually checked and by capillar testing and no cracks were found in the seat materials.

All blanks were again placed in the oven and heated to 350°C, following which they were firstly quenched in a water bath at a temperature of about 70°C and then controlled visually and by capillar testing, thereby discovering in Alloy 50 three radial cracks and a few crackles, whereas the three remaining pieces were free from defects.

The temperature chock test was repeated of the three perfect pieces which were heated to 450°C. After quenching in water at about 70°C, a crack pattern in the form of a coarsely meshed crackle was found in the BW 1-50 alloy, whereas the two remaining pieces were undamaged in the valve seat area proper.

These two pieces were then heated to 520°C and quenched in water at about 70°C, following which a visual control and by capillar testing showed a large number of radial small cracks in the Stellite 6 alloy and one radial crack in the valve seat area proper in the I-1 alloy. Contrary to the cracks in the three remaining alloys, the crack in the I-1 alloy showed clear signs of plastic deformation in the form of rounded crack edges.

The nickel-base alloy according to the invention thus presents a surprisingly good weldability and a ductility and crack resistance completely on a level with Stellite 6 and substantially better than the nickel alloys Alloy 50 and BW 1-50.

From the seat area of each of the valve spindle pieces there was made a radial cutout on which hardness tests (HV 20) at room temperature in varying distances from the seat surface were effected approximately in the middle of the welding. The results are presented in Table 2.

TABLE 2

	Alloy	Stellite 6	Alloy 50	BW 1-50	I-1	
5	Thickness of					
	weld seam in mm	8.8	9.5	8.0	8.5	
		Measured hardness (HV20)				
10	Position of					
	measuring					
	point in mm					
	below seat					
15	surface	0.5	426	473	490	457
		1.5	441	473	509	412
		2.5	441	473	509	426
20		3.5	426	490	509	426
		4.5	386	473	374	441
		5.5	412	374	412	362
25		6.5	412	374	374	374
		7.5	399	386	278	286
		8.5	412	271	232	303
		9.5	257	271	-	226
30		10.5	-	232	-	-

It appears that the hardness of the nickel-base alloys is sensitive to mixing of the material of the valve spindle in the seat material, and that the hardness of the outer half of the seat material varies within the limits to be expected due to fact that the melt bath solidifies rapidly, thereby impeding a complete equalization of the composition of the alloy.

EXAMPLE 2

In order to test the hardness of the alloy at increased temperature there were produced rod blanks from a powdered starting material by a so-called HIP-process (Hot Isostatic Pressure), said rod blanks having a diameter of 30 mm and a length of 160 mm from which about 8 mm thick slices were cut for use in measuring the hardness. The blanks were produced in the alloy Stellite 6 and in a nickel-base alloy with an analysis corresponding to I-1 in Table 1. The measured hardnesses (HB 10/3000/15) are referenced in Table 3, from which it appears that the high-temperature hardness at 500°C shows a marked fall (28%) as regards Stellite 6, while the hardness of the alloy according to the invention only falls very slightly (3%).

TABLE 3

	Stellite 6	I-1
Temperature	Hardness HB	
20°C	415	406
500°C	298	393

With the view of comparing the hardnesses to those of Table 2 there was effected a hardness measuring (HV20) of three slices of Stellite 6 and I-1 at room temperature with the following result:

TABLE 4

	Stellite 6			I-1		
	a	b	c	a	b	c
HV (20)	441	441	438	426	426	426

The hardness of 473 HV of Alloy 50 seat material measured in Table 2 at approximately 20°C diminishes at the working temperature of the seat material by approximately 20% to a hardness of 378 HV, whereas the hardness of the I-1 alloy only diminishes about 3% to a hardness at a working temperature of about 413 HV.

EXAMPLE 3

By manual TIG welding there were welded different alloys (I-3, I-4, I-5) according to the invention (in I-2 the C-content exceeds the upper limit claimed in claim 1) onto blanks of austenitic stainless valve steel with a diameter of 80 mm and a thickness of 20 mm. The approximate analysis of the alloys is referenced in Table 5.

Hardness measurings (HB 10/3000/15) were made of each alloy at both 20°C and at about 500°C.

TABLE 5

	C	Si	Cr	W	Nb	Mo	Al	Ni	20°C	500°C
I-2	0.55	1.14	23.3	6.53	-	-	6.04	balance	438	429
I-3	0.5	1.05	23	5.88	0.35	0.9	5.44	balance	435	415
I-4	0.44	0.95	23	5.22	0.7	1.8	4.83	balance	420	388
I-5	0.4	0.86	23	4.57	1.05	2.7	4.22	balance	415	385

It appears that the drop in hardness at heating from room temperature to about 500°C increases from about 2% for the alloy I-2 to about 7% for the alloy I-5.

There was further made a ground and polished sample of each alloy, and Figs 1 to 4 of the drawings show a photograph of the samples of the alloys I-2 to I-5.

In Fig. 1 nodular dark precipitations will be seen in the alloy I-2, probably consisting of the Al-, Si-, Cr- and C-containing eutectic Perovskite, together with elongated light precipitations of aluminium-free metal carbides. An alloy with a higher ductility may be provided by reducing the carbide precipitations.

The alloy I-3 in Fig. 2 shows a clear dendrite structure having cells in which the material has a uniform crystal lattice orientation. There are a few precipitations of Perovskite and precipitations of metal carbides between the dendrite arms. This alloy has probably a good ductility together with high high-temperature hardness.

Alloy I-4 in Fig. 3 has a dendrite structure that is somewhat less uniform and presents only quite few precipitations of Perovskite, and in alloy I-5 in Fig. 4 the Perovskite precipitations have by and large disappeared.

EXAMPLE 4

A hardness test corresponding to the one described in Example 2 was made on a nickel-base alloy with an analysis corresponding to I-1 in Tables 1 and 3, but prior to measuring the hardness the blanks were subjected to a heat treatment consisting of a solution treatment for two hours at a temperature of 1150°C followed by a precipitation hardening for at least two hours at a temperature of 750°C. The measured hardness (HB 10/3000/15) are referenced in Table 6 and (HV20) in Table 7.

TABLE 6

	I-1	
	Temperature	Hardness HB
5	20°C	496
	500°C	462

TABLE 7

	I-1		
	a	b	c
10			
	HV (20)	502	509
			506

15 Although the high-temperature hardness shows a slight fall (7%) the resulting hardness of approximately 460 HB at 500°C is very considerably higher than the hardnesses obtainable by the prior art hard-facing alloys.

If the Cr-content of the alloy gets less than 20% the corrosion resistance becomes too insignificant at a high temperature and if the Cr-content exceeds 24%, the strength properties of the alloy appear to be affected in a disadvantageous direction and additionally the weldability is deteriorated.

20 With an Al-content of less than 4% the high temperature hardness appears to be too low, and with an Al-content of more than 7% the Perovskite precipitations are inconvenient to the corrosion resistance and the ductility of the alloy.

The alloy may either be used for welding a valve seat area onto a valve member and in this case the alloy should include Si and the content of the easily oxidizing Y should be kept as low as possible, or may be used in the manufacture of valve members by means of the HIP-method.

It has been ascertained that nickel alloys comprising 20 to 23% Cr, 4 to 5.5% Al, 0 to 5% Fe, 0.3 to 0.5% C and from 5 to 7.5% W and/or Mo have a high hardness as well as a good ductility, and if the valve seat area is applied by welding, this may appropriately be effected by adding a nickel-base filler material comprising 20 to 23% Cr, 4 to 5.5% Al, 0.3 to 0.5% C, 0.8 to 1.2% Si and 5 to 7.5% W and/or Mo.

Alloys comprising 22.5 to 23.5% Cr, 4.0 to 5.0% Al, 0.40 to 0.45% C, 1.0 to 1.5% Hf and 5.5 to 6% W and/or Mo seem to be applicable in case very heavy demands are made on the crack resistance ability.

If the alloys are produced by the HIP method it is possible to include Y in the analysis, thereby effecting a positive influence on the high temperature resistance.

35 As a matter of form it should be observed that the individual constituents of the alloy are all stated in % by weight.

Claims

1. A valve, in particular an exhaust valve for an internal combustion engine, comprising a movable valve member with a valve seat area of a nickel-base metallic alloy, characterized in that the nickel-base alloy, stated in % by weight and apart from generally occurring impurities, comprises 20 to 24% Cr, 0 to 8% W, 4 to 7% Al, 0.2 to lower than 0.55% C, 0 to 2% Hf, 0 to 1.5% Nb, 0 to 8.0% Mo, 0 to 1.2% Si and 0 to 15% Fe, wherein the W-content and the Mo-content add up to no more than 10%.
2. A valve as claimed in claim 1, characterized in that the alloy comprises 20 to 23% Cr, 4 to 5.5% Al, 0 to 5% Fe, 0.3 to 0.5% C and from 5 to 7.5% W and/or Mo.
3. A valve as claimed in claim 1, characterized in that the alloy comprises 22.5 to 23.5% Cr, 4 to 5% Al, 0.40 to 0.45% C and 1 to 1.5% Hf and 5.5 to 6% W and/or Mo.
4. A valve as claimed in any of claims 1 to 3, characterized in that the alloy comprises 1 to 2% Hf and preferably 0.35 to 0.5% C.
5. A valve as claimed in any of claims 1 to 4, characterized in that the alloy comprises 0.3 to 1.5% Nb, preferably 0.5 to 1.4% Nb.

6. A valve as claimed in any of claims 1 to 5, characterized in that the alloy comprises 0.6 to 4.0% of Mo and W.
- 5 7. A valve as claimed in any of claims 1 to 6, characterized in that the alloy content of at least one of the constituents Hf, Nb and Mo amounts substantially to 0%.
8. A valve as claimed in any of claims 1 to 6, characterized in that the alloy comprises 0.6 to 1.2%, preferably 0.8 to 1,2% Si.
- 10 9. A valve as claimed in any of claims 1 to 6, characterized in that the alloy in the vicinity of the surface of the valve seat area includes no more than 5% Fe.
- 10 10. A valve as claimed in any of claims 1 to 9, characterized in that the alloy content of Hf, Nb, W and Mo in total amount to at least 5%.
- 15 11. A valve as claimed in any of claims 1 to 10, characterized in that the alloy in the vicinity of the valve surface includes at least 55% Ni.
- 20 12. A method of manufacturing a valve as claimed in any of claim 1 to 11, in which a valve seat area is applied to the valve member by welding, characterized in that during the welding there is added a filler material in the form of a nickel alloy which apart from generally occurring impurities comprises 20 to 23% Cr, 4 to 5.5% Al, 0.3 to 0.5% C, 0.8 to 1.2% Si, 0 to 2% Hf, 5 to 7.5% W and/or Mo and the balance Ni.

Patentansprüche

- 25 1. Ventil, insbesondere Abgasventil für eine Verbrennungskraftmaschine, umfassend ein bewegbares Ventilelement mit einem Ventilsitzbereich aus einer Metall-Legierung auf Nickel-Basis,
dadurch gekennzeichnet,
daß die Legierung auf Nickel-Basis, angegeben in Gew.-% und neben allgemein auftretenden Verunreinigungen, 20 bis 24% Cr, 0 bis 8% W, 4 bis 7% Al, 0,2 bis weniger als 0,55% C, 0 bis 2% Hf, 0 bis 1,5% Nb, 0 bis 8,0% Mo, 0 bis 1,2% Si und 0 bis 15% Fe enthält, wobei der W-Gehalt und der Mo-Gehalt zusammen nicht mehr als 10% ausmachen.
- 30 2. Ventil nach Anspruch 1, **dadurch gekennzeichnet,**
daß die Legierung 20 bis 23% Cr, 4 bis 5,5% Al, 0 bis 5% Fe, 0,3 bis 0,5% C und 5 bis 7,5% W und/oder Mo enthält.
- 35 3. Ventil nach Anspruch 1, **dadurch gekennzeichnet,**
daß die Legierung 22,5 bis 23,5% Cr, 4 bis 5% Al, 0,40 bis 0,45% C und 1 bis 1,5% Hf und 5,5 bis 6% W und/oder Mo enthält.
- 40 4. Ventil nach einem der Ansprüche 1 bis 3,
dadurch gekennzeichnet,
daß die Legierung 1 bis 2% Hf und vorzugsweise 0,35 bis 0,5% C enthält.
- 45 5. Ventil nach einem der Ansprüche 1 bis 4,
dadurch gekennzeichnet,
daß die Legierung 0,3 bis 1,5% Nb, vorzugsweise 0,5 bis 1,4% Nb enthält.
- 50 6. Ventil nach einem der Ansprüche 1 bis 5,
dadurch gekennzeichnet,
daß die Legierung 0,6 bis 4,0% Mo und W enthält.
- 55 7. Ventil nach einem der Ansprüche 1 bis 6,
dadurch gekennzeichnet,
daß der Gehalt von mindestens einem der Bestandteile Hf, Nb und Mo in der Legierung im wesentlichen 0% beträgt.
8. Ventil nach einem der Ansprüche 1 bis 6,

dadurch gekennzeichnet,

daß die Legierung 0,6 bis 1,2%, vorzugsweise 0,8 bis 1,2% Si enthält.

- 5 9. Ventil nach einem der Ansprüche 1 bis 6,
dadurch gekennzeichnet,
daß die Legierung in der Nachbarschaft der Oberfläche des Ventilsitzbereichs nicht mehr als 5% Fe aufweist.
- 10 10. Ventil nach einem der Ansprüche 1 bis 9,
dadurch gekennzeichnet,
daß der Gesamtgehalt von Hf, Nb, W und Mo in der Legierung mindestens 5% beträgt.
- 15 11. Ventil nach einem der Ansprüche 1 bis 10,
dadurch gekennzeichnet,
daß die Legierung in der Nachbarschaft der Ventilloberfläche mindestens 55% Ni enthält.
- 20 12. Verfahren zum Herstellen eines Ventils wie in einem der Ansprüche 1 bis 11 beansprucht, in welchem ein Ventilsitzbereich durch Schweißen auf das Ventil-Element aufgebracht wird, **dadurch gekennzeichnet,** daß während des Schweißens ein Füllmaterial in Form einer Nickel-Legierung hinzugefügt wird, welches neben allgemein auftretenden Verunreinigungen 20 bis 23% Cr, 4 bis 5,5% Al, 0,3 bis 0,5% C, 0,8 bis 1,2% Si, 0 bis 2% Hf, 5 bis 7,5% W und/oder Mo enthält, wobei der Rest aus Ni besteht.

Revendications

- 25 1. Soupape, en particulier soupape d'échappement pour moteur à combustion interne, comportant une pièce de soupape mobile avec une zone de siège de soupape en alliage métallique à base de nickel, **caractérisé** en ce que l'alliage à base de nickel comprend, exprimé en pourcentage en poids et hormis des impuretés généralement présentes, 20 à 24% de Cr, 0 à 8% de W, 4 à 7% d'Al, 0,2 à moins de 0,55% de C, 0 à 2% de Hf, 0 à 1,5% de Nb, 0 à 8% de Mo, 0 à 1,2% de Si et 0 à 15% de Fe, le total du contenu en W et du contenu en Mo n'excédant pas 10%.
- 30 2. Soupape selon la revendication 1, **caractérisé** en ce que l'alliage comprend 20 à 23% de Cr, 4 à 5,5% d'Al, 0 à 5% de Fe, 0,3 à 0,5% de C et 5 à 7,5% de W et/ou Mo.
- 35 3. Soupape selon la revendication 1, **caractérisé** en ce que l'alliage comprend 22,5 à 23,5% de Cr, 4 à 5% d'Al, 0,40 à 0,45% de C et 1 à 1,5% de Hf et 5,5 à 6% de W et/ou Mo.
- 40 4. Soupape selon l'une quelconque des revendications 1 à 3, **caractérisé** en ce que l'alliage comprend 1 à 2% de Hf et de préférence 0,35 à 0,5% de C.
- 45 5. Soupape selon l'une quelconque des revendications 1 à 4, **caractérisé** en ce que l'alliage comprend 0,3 à 1,5% de Nb, de préférence 0,5 à 1,4% de Nb.
- 50 6. Soupape selon l'une quelconque des revendications 1 à 5, **caractérisé** en ce que l'alliage comprend 0,6 à 4% de Mo et W.
7. Soupape selon l'une quelconque des revendications 1 à 6, **caractérisé** en ce que le contenu d'au moins un des constituants Hf, Nb et Mo dans l'alliage se monte essentiellement à 0%.
8. Soupape selon l'une quelconque des revendications 1 à 6, **caractérisé** en ce que l'alliage comprend 0,8 à 1,2% de Si.
9. Soupape selon l'une quelconque des revendications 1 à 6, **caractérisé** en ce que l'alliage, à proximité de la surface de la zone de siège de soupape, ne comprend pas plus de 5% de Fe.
- 55 10. Soupape selon l'une quelconque des revendications 1 à 9, **caractérisé** en ce que le contenu de Hf, Nb, W et Mo dans l'alliage se monte au total à au moins 5%.
11. Soupape selon l'une quelconque des revendications 1 à 10, **caractérisé** en ce que l'alliage, à proximité

de la surface de la soupape, comprend au moins 55% de Ni.

- 5 **12.** Procédé de fabrication d'une soupape selon l'une quelconque des revendications 1 à 11 et dans lequel une zone de siège de soupape est appliquée à la pièce de soupape par soudage, **caractérisé** en ce que au cours du soudage on apporte un matériau d'appoint sous la forme d'un alliage de nickel qui, hormis des impuretés généralement présentes, comprend 20 à 23% de Cr, 4 à 5,5% d'Al, 0,3 à 0,5% de C, 0,8 à 1,2% de Si, 0 à 2% de Hf, 5 à 7% de W et/ou Mo, le reste étant du nickel.

10

15

20

25

30

35

40

45

50

55

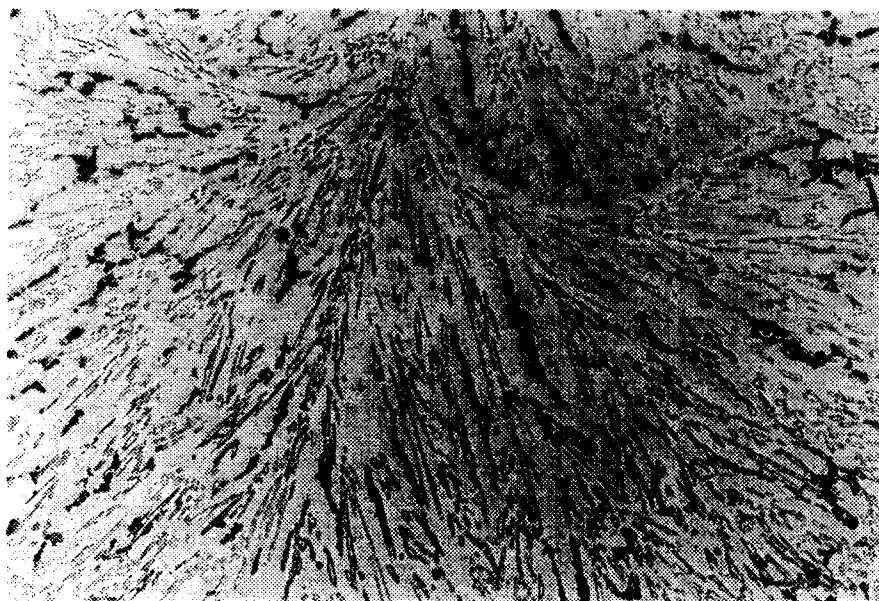


Fig. 1

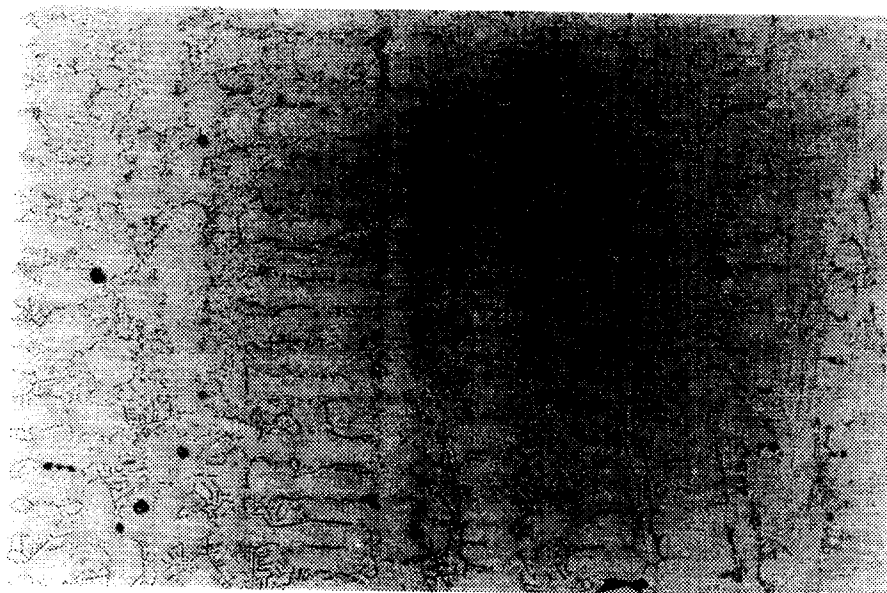


Fig. 2

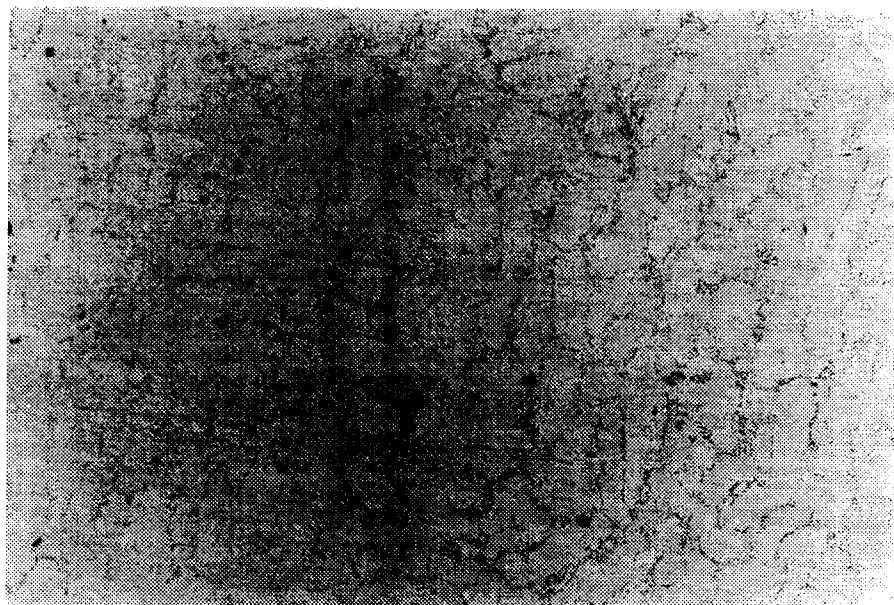


Fig. 3

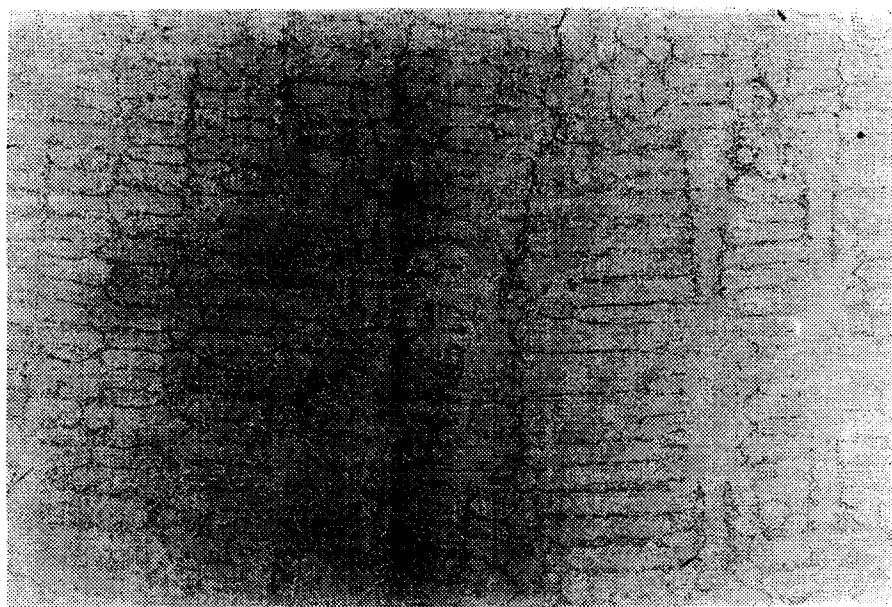


Fig. 4