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NICKEL-BASE ALLOYS

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2 Claims. (Cl. 75—171)

This invention relates to nickel-base casting alloys useful for the production of highly stressed components operating at elevated temperatures, for example, gas-turbine blades. For such applications the alloys used must have good creep rupture strength at the operating temperatures as well as satisfactory oxidation and corrosion resistance. Nickel-base alloys have become well established for such purposes, the desired resistance to oxidation and corrosion being obtained by having a substantial chromium content ranging from 10% to 30%, while elevated temperature strength is attained by the addition of strengthening agents such, for example, as aluminium, titanium, tungsten, molybdenum and the like.

We have found that by reducing the chromium content to below 10%, higher total percentages of hardening agents (for example, aluminium, titanium, tungsten and molybdenum) can be used with significant increase in creep rupture strength.

According to this invention alloys having good creep rupture strength and resistance to oxidation and corrosion consist essentially of the following, the proportions being by weight:

	Percent
Carbon	0.05–0.5
Chromium	3–10
Boron	0.001–0.3
Zirconium	0.001–0.3
Titanium	2–7
Aluminium	2–8
Tungsten	8–24
Silicon	<1
Manganese	<1
Cobalt	0–20
Iron	<5
Niobium	0–5
Tantalum	0–5

Nickel and impurities, balance.

In place of tungsten alone, molybdenum may also be present according to the formula $2\times Mo+W=8-24\%$.

In place of any or all of the ranges mentioned above

the following more restricted ranges may be used, the proportions being by weight:

	Percent
Carbon	0.1–0.2
Chromium	4–9
Boron	0.01–0.1
Zirconium	0.01–0.1
Titanium	2–7 } (1)
Aluminium	2–8 } (1)
Tungsten	11–20
Silicon	<0.2
Manganese	<0.2
Cobalt	5–15
Iron	<1
Niobium	0–3
Tantalum	0–3

Nickel and impurities, balance.

[1] Together 7–11%.

In place of tungsten alone in this more restricted range molybdenum may also be present according to the formula $2\times Mo+W=11-20\%$.

The following are examples of alloys according to the invention the proportions being by weight percent.

C	Cr	Co	B	Zr	Ti	Al	W	Mo	Nb	Ni and Impurities	Creep Rupture Hours 15 T.S.I. at 950° C.
0.1	5	10	.05	.05	5	4	11	------	------	Bal.	93
0.1	5	10	.05	.05	4	4	16	------	------	Bal.	140
0.1	5	10	.05	.05	5	4	16	------	------	Bal.	198
0.1	5	10	.05	.05	6	4	16	------	------	Bal.	149
0.1	5	10	.05	.05	4	5	16	------	------	Bal.	154
0.1	5	10	.05	.05	4	4	18	------	------	Bal.	194
0.1	5	10	.05	.05	4	4	20	------	------	Bal.	147
0.1	5	10	.05	.05	4	4	22	------	------	Bal.	175
0.1	5	10	.05	.05	4	4	14	5	------	Bal.	72
0.1	5	10	.05	.05	4	4	8	8	------	Bal.	63
0.1	9	10	.05	.05	4	4	8	6	1	Bal.	103
0.1	9	10	.05	.05	2	5.5	8	3	1	Bal.	138
0.08	9	10	0.025	.05	2	5.5	4	4	1	Bal.	128

The stress for rupture properties of a vacuum induction cast nickel-base alloy according to the invention consisting in percentage by weight of 0.1% carbon, 5% chromium, 10 cobalt, .05% boron, .05% zirconium, 4% titanium, 4% aluminium and 16% tungsten, are as follows:

Time, hours	Temperature, ° C.	Stress for Rupture, tons per sq. inch
30	950	20
	1,000	13.5
	1,030	10.7
	1,050	9.5
100	950	15.7
	1,000	10.6
	1,030	8.4
	1,050	7.1
300	950	12.7
	1,000	8.6
	1,030	6.5
	1,050	[1] 4.8
1,000	950	10.2
	1,000	6.5

[1] Extrapolated.

The impact result on an unnotched Ized specimen of this alloy at 900° C. was 26 to 34 ft. lbs.

It has been found that while the molybdenum-contain-

ing alloys may have lower creep rupture properties this may be compensated for in use for moving parts such as turbine blades by the lower density of such alloys. In addition the presence of molybdenum tends to increase the impact strength.

Articles made from alloys according to the invention may be aluminized or chromized with a view to improving resistance to oxidation and corrosion in the way that articles from the alloys with higher chromium contents are at present aluminized or chromized.

We claim:

1. A nickel base alloy having improved creep rupture strength and resistance to oxidation and corrosion at temperatures in the region of 1000° C. consisting essentially of the following, the proportions being by weight:

	Percent
Carbon	0.1
Chromium	5.0
Cobalt	10.0
Boron	0.05
Zirconium	0.05
Titanium	4.0
Aluminum	4.0
Tungsten	16.0

Nickel and impurities, balance.

2. Nickel base alloys having improved creep strength and resistance to oxidation and corrosion at temperatures

in the region of 1000° C. consisting essentially of the following, the proportions being by weight:

	Percent
Carbon	0.1
Chromium	5.0
Cobalt	10.0
Boron	0.05
Zirconium	0.05
Titanium	4.0–6.0
Aluminum	4.0–5.0
Tungsten	11.0–22.0

Nickel and impurities, balance.

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