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NICKEL ALUMINUM BASE ALLOYS

Harold V. Kinsey, Manor Park Village, Ontario, Canada, assignor to His Majesty the King in the right of Canada, as represented by the Minister of Mines and Technical Surveys

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6 Claims. (Cl. 75—170)

1

This invention relates to non-ferrous alloys and particularly to nickel-aluminium base alloys which have high strength and superior resistance to creep and oxidation at high temperatures, and which are particularly adapted to withstand the effect of long exposure to hot combustion gases as for example when used in the form of blades for the hot end of gas turbine engines.

In accordance with the invention the base of such alloys is nickel and aluminium but cobalt could be substituted for part of the nickel provided the ratio of nickel to cobalt is no less than 4. That is to say not more than 20% of the nickel may be replaced with cobalt. The ratio of nickel to aluminium (or nickel plus cobalt to aluminium) may vary between 25 and 6. It should be stated that properties of cobalt are similar to those of nickel in many respects but in an alloy containing aluminium it does not behave the same as nickel in all respects. Thus the substitution of cobalt for nickel must be confined within the limits stated for the purpose of the present alloys.

Applicant has found that the addition to this metal base of the transition metals now to be defined provides an alloy which has high tensile strength and at the same time high resistance to creep, both of which properties are critically important in stressed metal structures or parts which are required to remain dimensionally stable under high temperatures and in the presence of corrosive gases.

Thus, in accordance with the invention, there is added to the above-described metal base a transition metal having the alloying characteristics of molybdenum. It is essential that the oxide of this added metal should not be so volatile at the service temperature as to substantially reduce the ability of the surface of the alloy to resist corrosion. The service temperature may be in excess of 800° C. Tungsten, tantalum and columbium meet these requirements to a somewhat greater degree than molybdenum. However, molybdenum is more readily available and economical.

An alloy of the invention contains at least 10% and not more than 30% molybdenum. If two or more of these conditioning metals are used the minimum amount is 10% but the upper limit may be 35%.

It will be recognized that the metals incorporated in these alloys may contain traces or minor portions of so-called "tramp" elements, such as iron, manganese, silicon, carbon, nitrogen and the like, which may thus appear in the

2

alloys. Iron should not be present in excess of 1%, manganese in excess of 0.5% or carbon in excess of 0.15% and the total of such tramp constituents should not substantially exceed 2% of the weight of the alloy.

According to the invention the alloy contains the following elements in the following percentages of the weight of the whole alloy:

	Per cent
Nickel (or nickel and cobalt)	54.00–81.74
Aluminium	2.42–12.14
Conditioning metal	10.00–35.00
Tramp elements	Not more than 2.00

The following are specific examples of the alloy:

(1) Nickel 75.2, aluminium 8.4, molybdenum 15.8, iron 0.4, silicon 0.24, carbon 0.03. At a temperature of 815° C. this alloy will support a tensile stress of 36,000, 26,000 and 20,000 p. s. i. for 100, 1000 and 5000 hours respectively before fracture occurs. At this stress the respective creep rates are 0.0025, 0.0016 and 0.0008 per cent per hour. A tensile stress of 22,000 p. s. i. which produces a minimum creep rate of 0.001 per cent per hour at 815° C. will not cause fracture in less than 3000 hours.

(2) Nickel 66.5, aluminium 7.0, molybdenum 25.5, iron 0.8, silicon 0.16 and carbon 0.03. At a temperature of 815° C. this alloy will support a tensile stress of 40,000, 27,000 and 21,000 p. s. i. for 100, 1000 and 5000 hours respectively before fracture occurs. At this stress the respective creep rates are 0.0033, 0.0022 and 0.0011 per cent per hour. A tensile stress of 26,000 p. s. i. which produces a minimum creep rate of 0.002 per cent per hour at 815° C. will not cause fracture in less than 1200 hours. At room temperature bars of this alloy have a tensile strength of 130,000 p. s. i. and a Vickers hardness value (30-kg. load) of 391.

Analysis and examination of such alloys from various points of view show that the presence of molybdenum, or other of the modifying metals defined, in the proportions specified produce a pronounced effect in increasing the strength and resistance to creep and oxidation at high temperatures of alloys containing nickel and aluminium within the limits defined.

What is claimed is:

1. A nickel aluminium base alloy consisting of 54.00 to 81.74% nickel, 2.42 to 12.14% aluminium, the weight ratio of nickel to aluminium being not more than 25 nor less than 6, 10 to 35% of two addition metals from the group consisting

of molybdenum, tungsten, tantalum and columbium and, not more than substantially 2% of all other elements including not substantially more than 1% iron, 0.5% manganese, 0.15% carbon.

2. A nickel aluminium base alloy consisting of 54.00 to 81.74% nickel plus cobalt, the weight ratio of nickel to cobalt being not less than 4, 2.42 to 12.14% aluminium, the weight ratio of nickel plus cobalt to aluminium being not more than 25 nor less than 6, 10 to 35% two addition metals from the group consisting of molybdenum, tungsten, tantalum and columbium, and not substantially more than 2% of all other elements including not substantially more than 1% iron, 0.5% manganese, 0.15% carbon.

3. An alloy consisting of 54.00 to 81.74% nickel, 2.42 to 12.14% aluminium, 10 to 30% of molybdenum, and not substantially more than 2% of all other elements, including not substantially more than 1% iron, 0.5% manganese, 0.15% carbon and the ratio of nickel to aluminium by weight being between 25 and 6.

4. An alloy consisting of 54.00 to 81.74% nickel plus cobalt, the weight ratio of nickel to cobalt being not less than 4, 2.42 to 12.14% aluminium, the weight ratio of nickel plus cobalt to aluminium being not more than 25 nor less than 6, 10 to 30% molybdenum and not substantially more than 2% of all other elements including not substantially more than 1% iron, 0.5% manganese, 0.15% carbon.

5. An alloy consisting of nickel 75.2, aluminium 8.4, molybdenum 15.8% by weight and not substantially more than 0.4% iron, 0.24% silicon and 0.03% carbon.

6. An alloy consisting of nickel 66.5, aluminium 7.0, molybdenum 25.5% by weight and not substantially more than 0.8% iron, 0.16% silicon and 0.03% carbon.

HAROLD V. KINSEY.

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